

Two Patterns of Price Dynamics were Observed in Greenhouse Gases Emissions Trading Experiments: An Application of Point Equilibrium

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1. Introduction

COP3 (Kyoto in December 1997)

Its protocol calls for Annex B countries to reduce their average greenhouse gas emissions over 2008-2012 to at least **five percent** below 1990 levels.

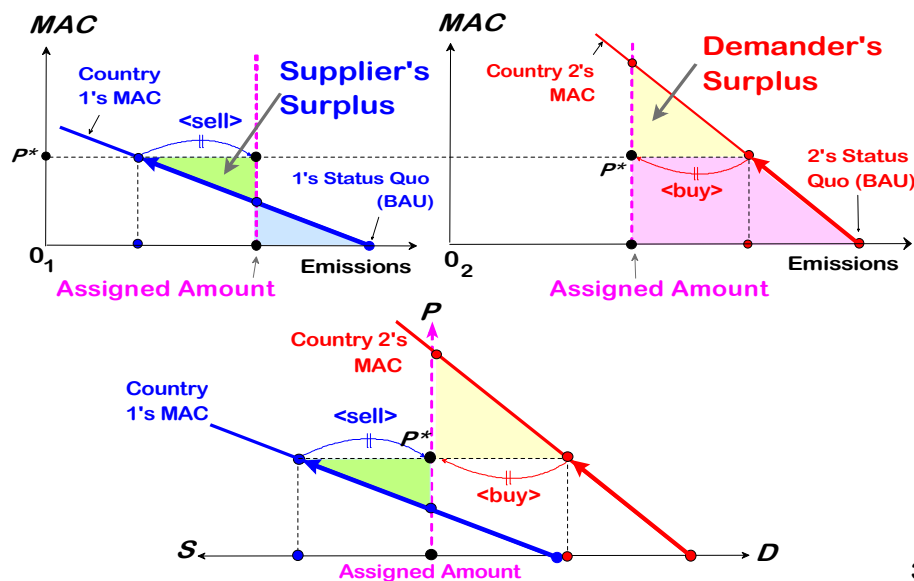
The Kyoto Mechanisms:

- **Emissions Trading**
- Joint Implementation
- The Clean Development Mechanism

Since no details were given at COPs, we have to *design* the mechanisms.

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2. Emissions Trading



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3. Experimental Design

12 sessions using human subjects in 1999

(1) Common features

- 6 subjects in each session
(Russia, Ukraine, USA, Poland, EU, and Japan)
- No country names were announced to subjects
- Used realistic marginal abatement cost curves
- Every subject could be a **buyer and a seller** depending on the prices. Bohm (1997)
- We paid subjects money that was proportional to the earnings in experiment.

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(2) Experimental Controls: Trading Methods and Information

Trading Methods

Information of contracts
(subject #, p & q)

	Bilateral Trading	Double Auction
open	Bo1~Bo4	D1~D4
closed	Bc1~Bc4	-----

• **Bilateral Trading:** A pair negotiates the price and quantity vs.

• **Double Auction:**

	Buyers' Bids	Sellers' Asks
(3)	\$56, 20 units	(6) \$104, 15 units
(1)	\$86, 13 units	(4) \$92, 20 units
(2)	grabs (4)'s ask	
	⋮	⋮

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(3) Investment Irreversibility

- A country must start emission trading from the status quo.
- Can move from right to left on MAC, but not the reverse.
- Domestic reduction: 30 minutes
- Emissions trading: throughout 60 minutes.



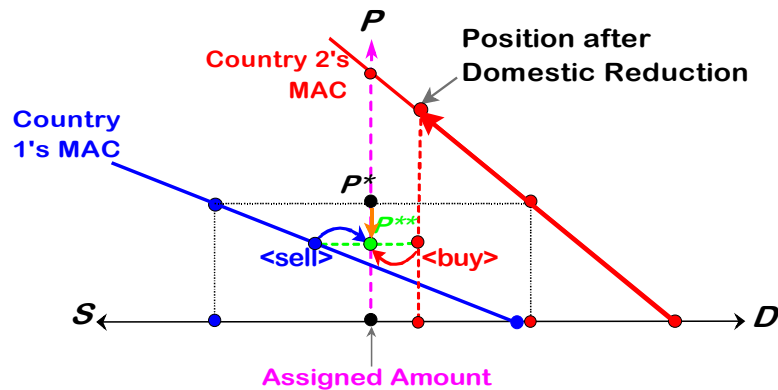
(4) Non-Compliance Penalty

- If a country can't attain her assigned amount, she must pay \$300 penalty per unit (competitive equilibrium price = \$118-120).

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4. Point Equilibrium

Excessive Domestic Reduction → Price Decrease



Point Equilibrium Price: "Should be" Price Level after domestic reductions at each point of time

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5. Experimental Results

(1) Efficiency

$$\frac{\text{The sum of benefit and profit of each subject}}{\text{The sum of benefit and profit at market equilibrium}} \leq 1$$

	Average efficiency	Modified average efficiency
Bilateral trading (closure)	0.605	0.811
Bilateral trading (disclosure)	0.502	0.807
Double auction	0.634	0.873

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(2) Price dynamics: Two Cases

(Case 1)

The Early (Point Equilibrium) Price Decrease Case (5/12)

- ⇒ **High contracted price** (fear for penalty)
- ⇒ Excessive reduction ⇒ Excess supply of permits
- ⇒ Point eq. P drops but contracted P doesn't drop. (Inertia)
- ⇒ Excessive reduction ⇒ Crash in contracted prices

Low Efficiency

(Case 2)

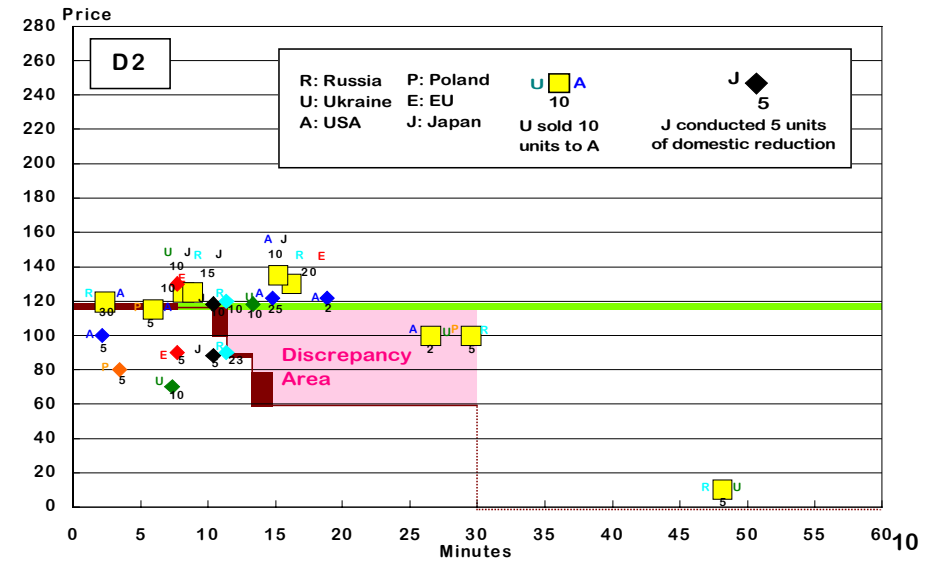
The Constant (Point Equilibrium) Price Case (7/12)

- ⇒ **Low contracted price**
- ⇒ Insufficient reduction ⇒ Excess demand of permits
- ⇒ Contracted P gradually rises but not sufficiently. (Inertia)
- ⇒ Demander's excessive reduction to avoid penalty.

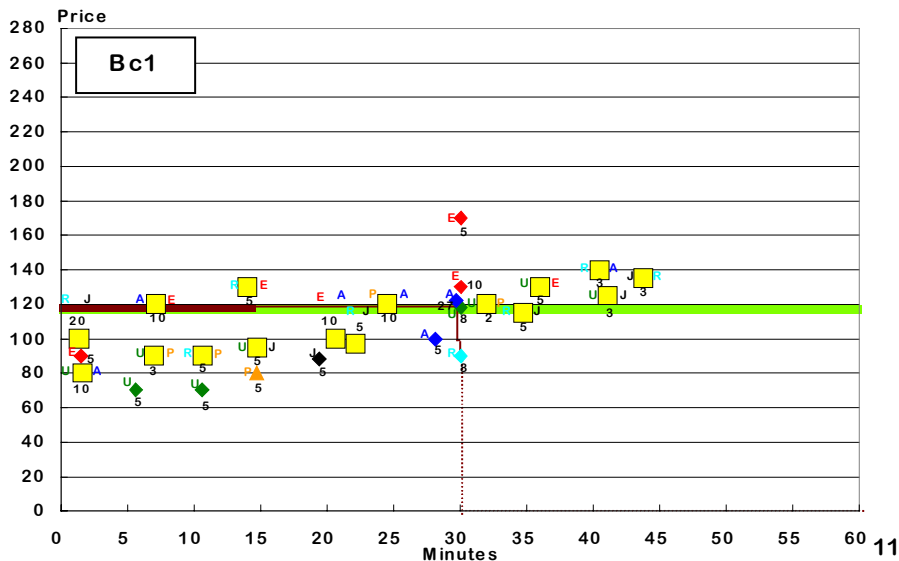
High Efficiency

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The Early Point Equilibrium Price Decrease Case 83.8% (35.0%)
Permit Surplus: 47

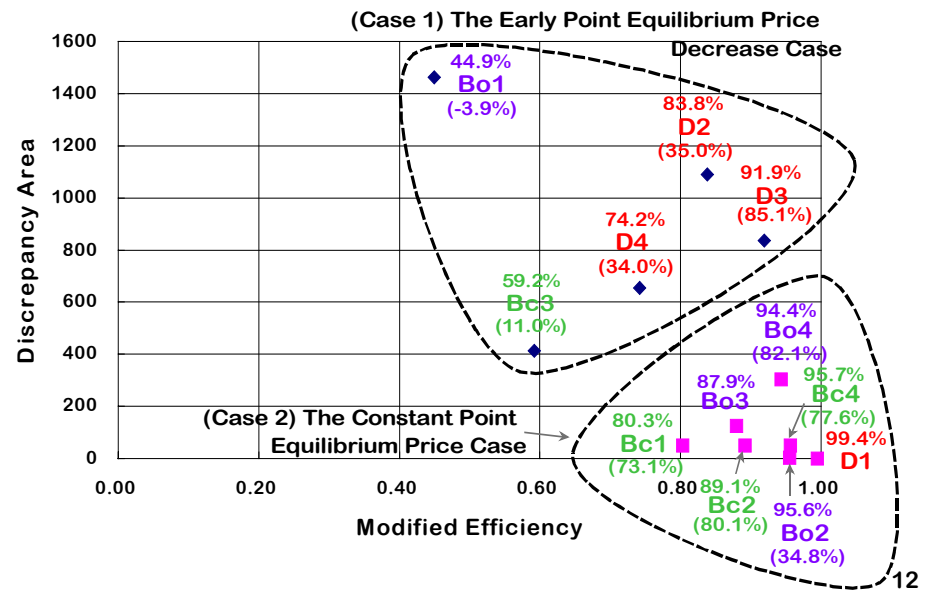


The Constant Point Equilibrium Price Case 80.3% (73.1%)
Permit Surplus: 5



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(3) Discrepancy Area and Modified Efficiency



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Result 1: Two cases are observed.

Result 2: In case (1), high price inertia and excessive domestic reduction ⇒ Sudden price drop

Result 3: In case (2), low price and insufficient domestic reduction ⇒ Demander's excessive domestic reduction

Result 4: Bilateral Trading is less likely to result in case (1) and more likely to result in case (2) than double auction.

Result 5: In both cases, modified efficiencies of double auction are higher than those of bilateral trading.

Result 6: Emissions trading lowered emission reduction costs.

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6. Concluding Remarks and Policy Implications

- Two patterns of price dynamics were observed
The Bad Case: High transaction prices and inertia => Excessive abatement investment => sudden fall of the price

Market Mechanism does not always work well when investment comes into real decision variables

- Which is better between **double auction** and **bilateral trading**? => In each case, double auction is better than bilateral trading, but bilateral trading is dominant in the good case! => need further experiments!

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