

GHG Emission Trading Experiments: Trading Methods, Non-Compliance Penalty and Abatement Irreversibility

Side Event at COP6

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1. Introduction

- 12 Emission Trading Experiments using human subjects in 1999
- Impose monetary penalty to non-compliance
- Irreversibility of abatement investment

<Price Dynamics>

(1) The Early (Point Equilibrium) Price Decrease Case (5)

High price (fear for non-compliance) \Rightarrow **Excessive domestic reduction** \Rightarrow **Excess supply** of emission permits \Rightarrow **Low price**
(The IEA experiment in 2000 falls into this case)

(2) The Constant (Point Equilibrium) Price Case (7)

Relatively low price \Rightarrow **insufficient domestic reduction** of supply countries \Rightarrow **excessive domestic reduction** of demand countries at a final stage

Result 1: Two cases are observed.

Result 2: Excessive domestic reduction in both cases.

Result 3: In both cases, efficiencies of (double) auction experiments are higher than those of bilateral trading.

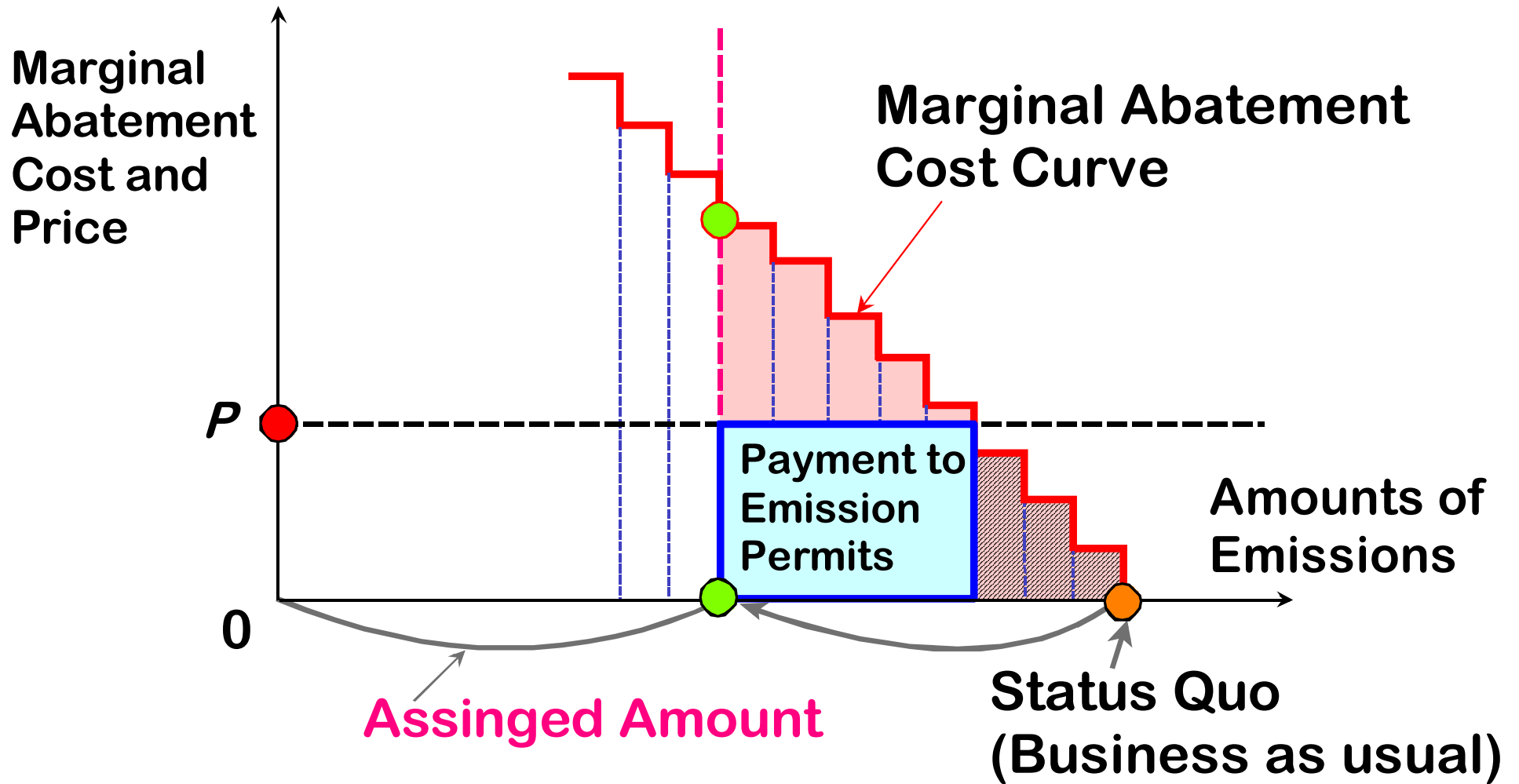
Result 4: In case (1), high price inertia, but (sudden) price drop.

Result 5: In case (2), insufficient reduction of supply countries and excessive domestic reduction of demand countries.

Result 6: Emission trading considerably saved emission reduction costs.

2. Emission Trading & Point Equilibrium

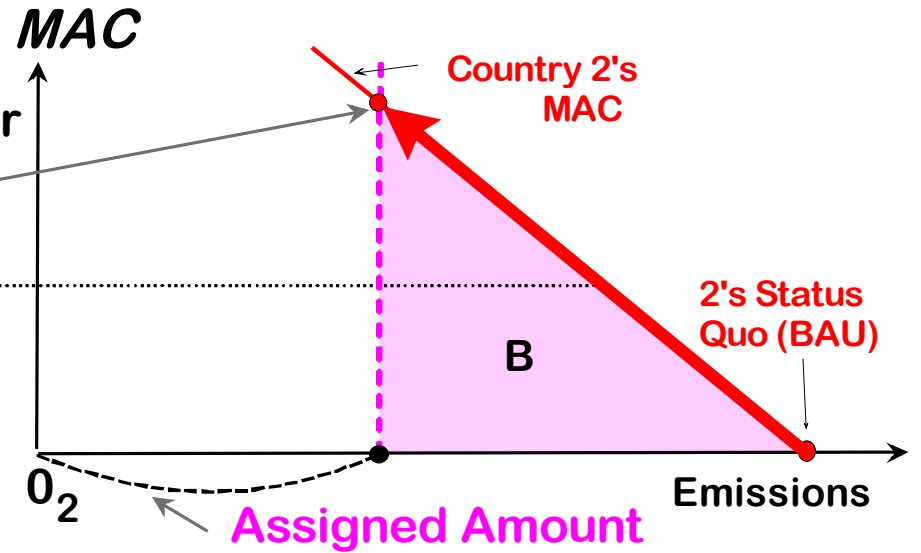
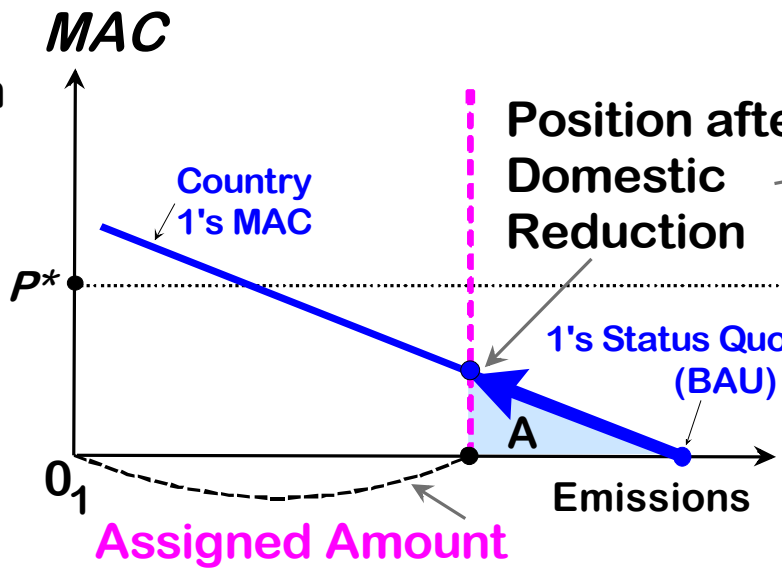
Marginal Abatement Cost Curve



Domestic Reduction Only vs. Emission Trading

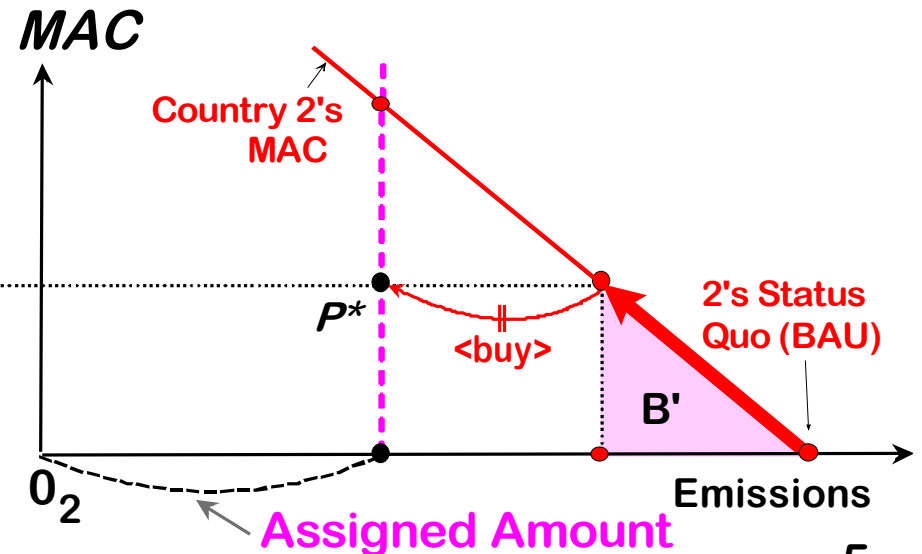
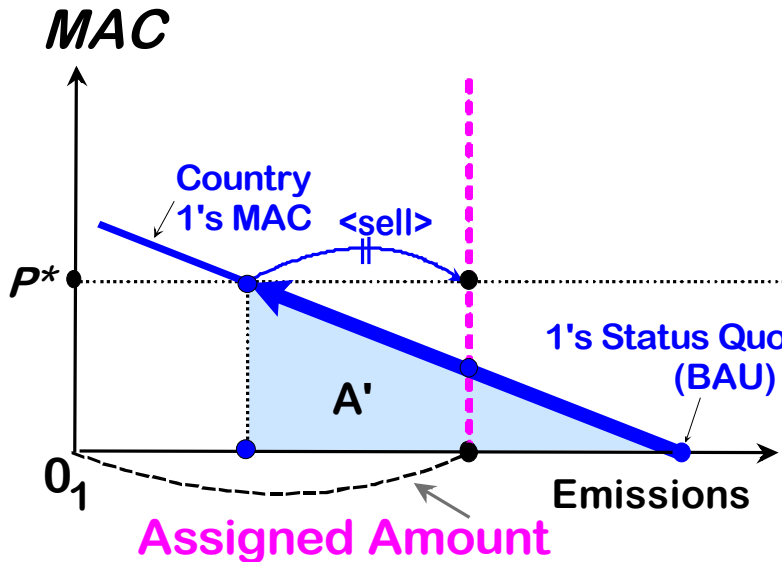
Domestic Reduction Only

Cost = A+B

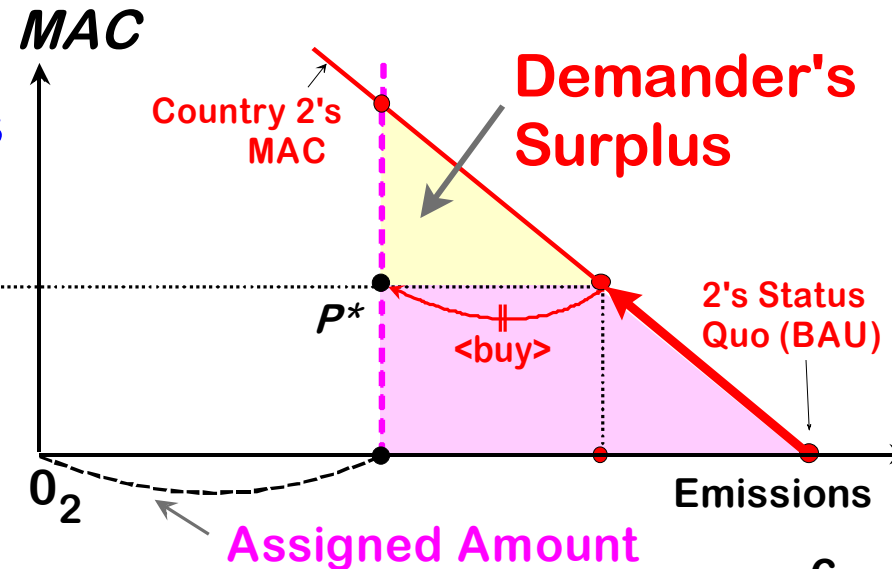
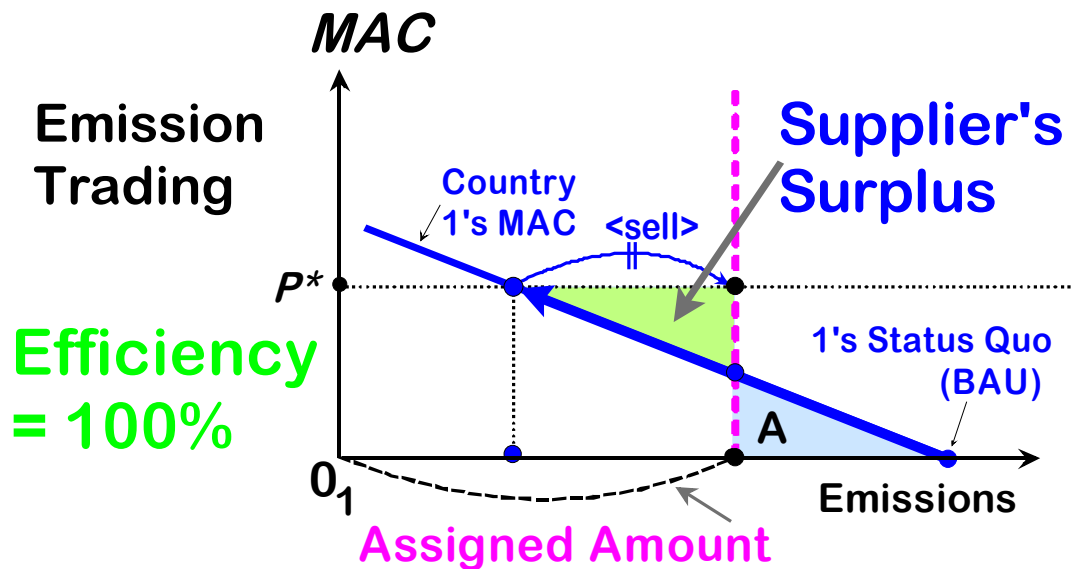
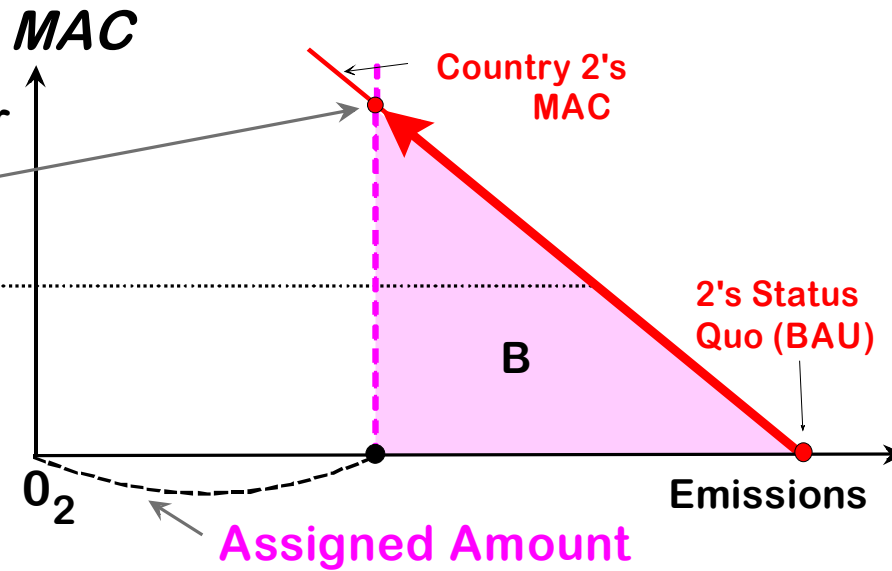
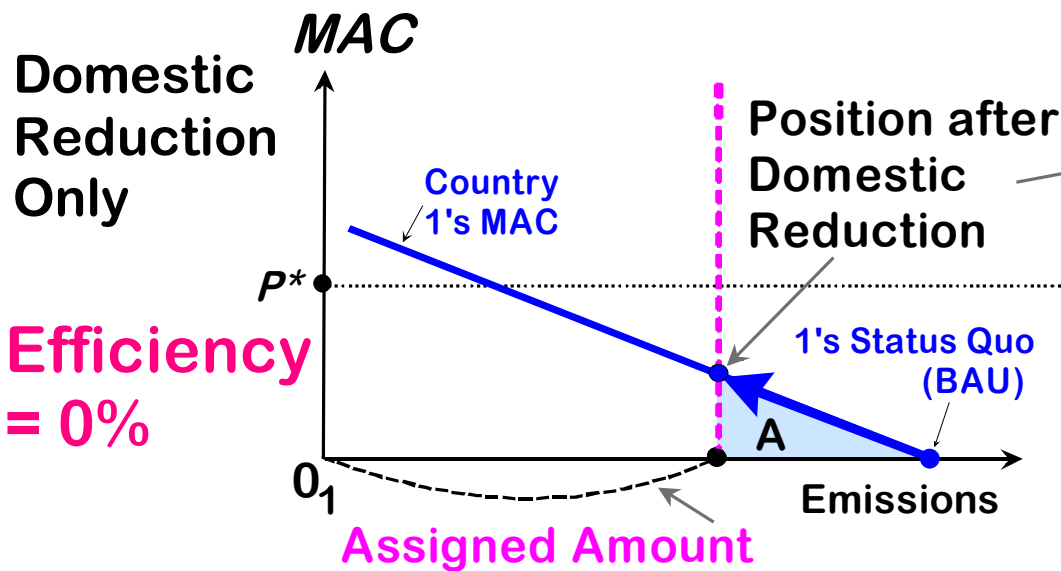


Emission Trading

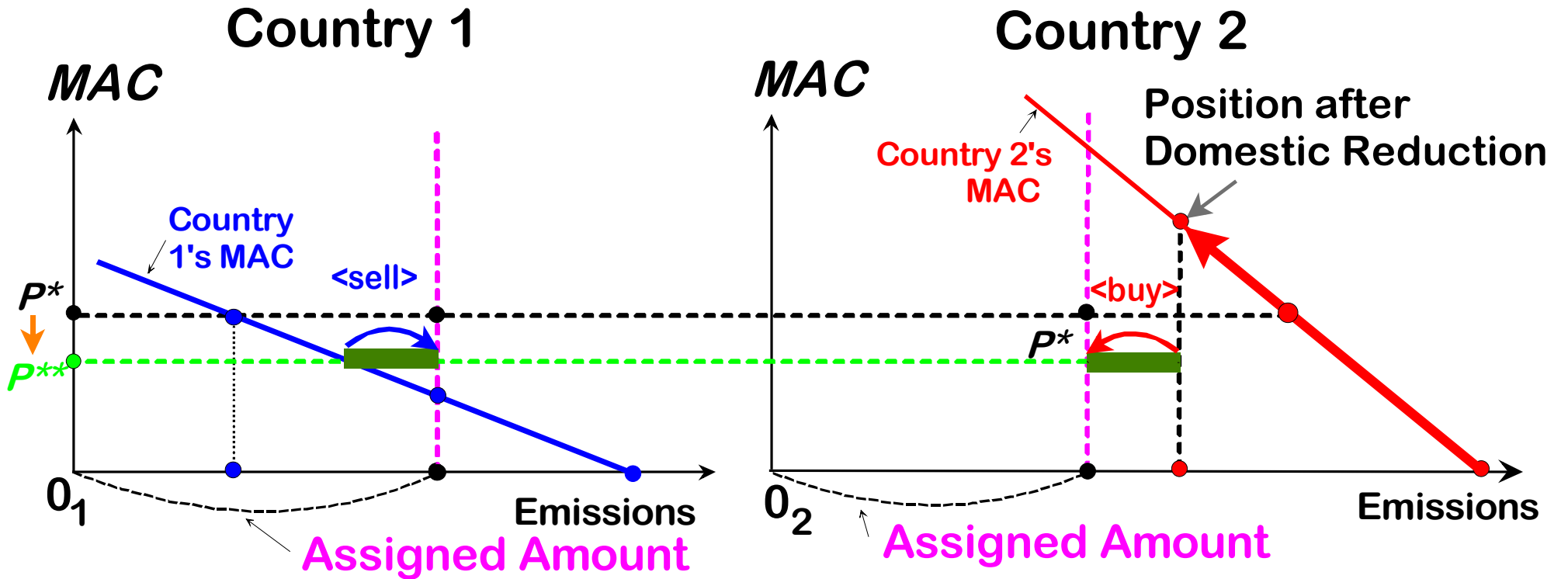
Cost = A'+B'



Efficiency: Domestic Reduction Only vs. Emission Trading



Excessive Domestic Reduction → Price Decrease



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

3. Experimental Design

(1) Trading Methods: Bilateral Trading vs. Double Auction

- Bilateral Trading:

A pair negotiates the price and quantity each other
(Is it inefficient due to mismatching? Does the revelation of contracted prices improve its efficiency?)

- Double Auction:

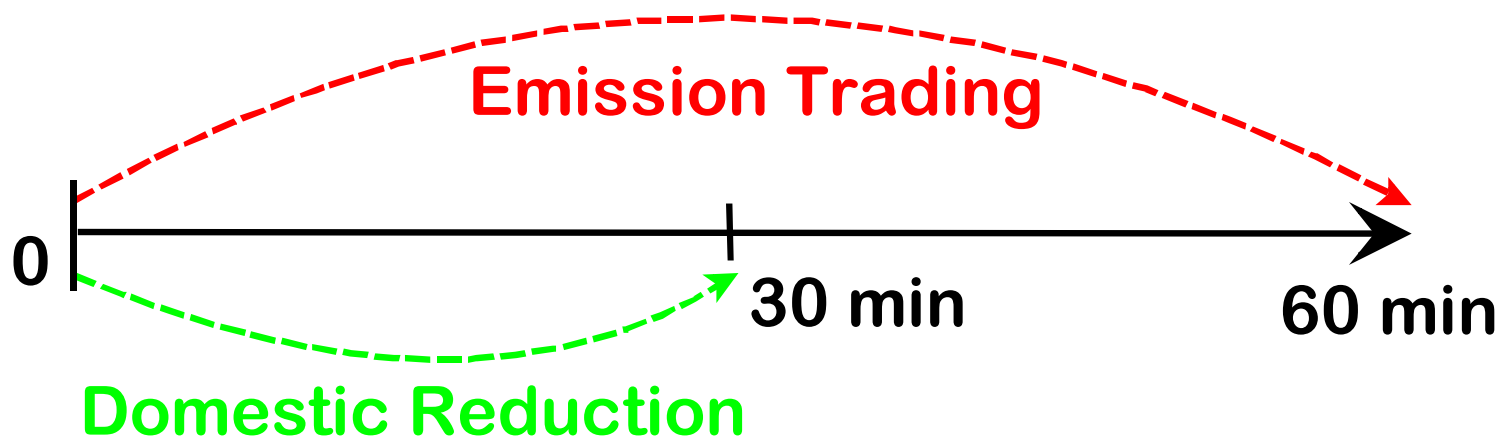
| Buyers' Bids | Sellers' Asks |
|---------------------|---------------------|
| (3) \$56, 20 units | (6) \$104, 15 units |
| (1) \$86, 13 units | (4) \$92, 20 units |
| (2) grabs (4)'s ask | |
| ⋮ | ⋮ |

(2) Non-Compliance Penalty

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

(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.
- A country must decide her domestic reduction or emission up to half an hour. On the other hand, each country can use emissions trading throughout 60 min.



(4) 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.

(5) Experimental Controls

Trading Methods

Information
of contracts
(subject #,
p & q)

| | Bilateral Trading | Double Auction |
|------------|----------------------|-------------------|
| disclosure | Bd1~Bd4 | D1~D4 |
| closure | Bc1~Bc4 | ----- |

In each cell, we conducted four sessions.

4. 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 |

Efficiency Table

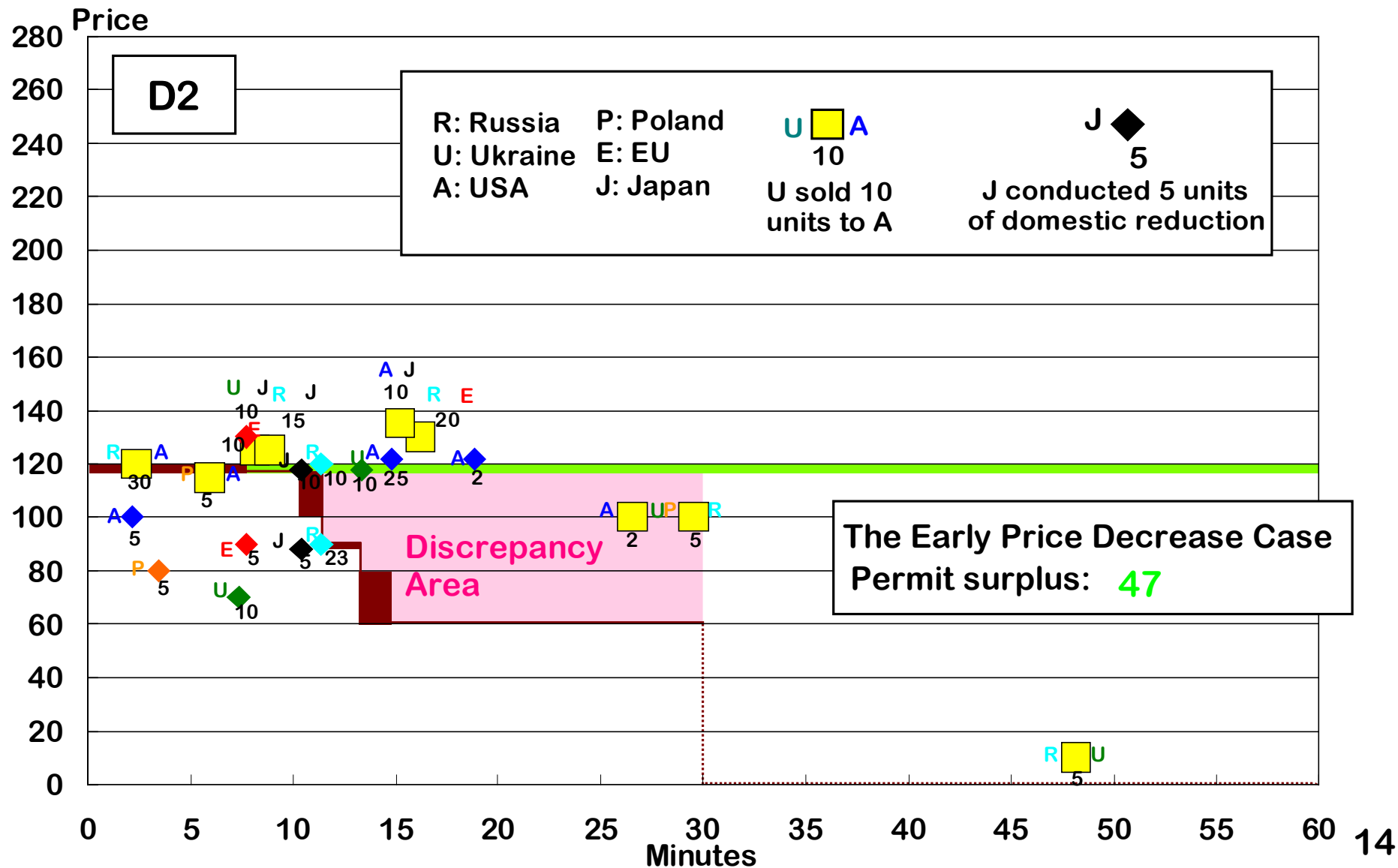
Non-Compliance

Over Compliance

| Subject No. | Bilateral Trading | | | | | | | | Double Auction | | | |
|--------------|-------------------|--------|----------|--------|----------|--------|--------|--------|----------------|----------|--------|----------|
| | Bc1 | Bc2 | Bc3 | Bc4 | Bd1 | Bd2 | Bd3 | Bd4 | D1 | D2 | D3 | D4 |
| 1 (2555) | 1535 | 1600 | 620 | 656 | 1415 | 384 | 1825 | 1465 | 1425 | 2435 | 1360 | 2060 |
| (Russia) | 0.601 | 0.626 | 0.243 | 0.257 | 0.554 | 0.150 | 0.714 | 0.573 | 0.558 | 0.953 | 0.532 | 0.806 |
| (-32)(-55,0) | -40, 0 | -32, 0 | -65, -22 | -42, 0 | -55, -3 | -52, 0 | -33, 0 | -52, 0 | -55, 0 | -65, 0 | -44, 0 | -60, 0 |
| 2 (1290) | 766 | 1175 | 1820 | 700 | -565 | 2625 | 1285 | 2200 | 1195 | -30 | 850 | -1925 |
| (Ukraine) | 0.594 | 0.911 | 1.411 | 0.543 | -0.438 | 2.035 | 0.996 | 1.705 | 0.926 | -0.023 | 0.659 | -1.492 |
| (-10)(-30,0) | -28, 0 | -20, 0 | -30, 0 | -20, 0 | -20, -15 | -20, 0 | -25, 0 | -20, 0 | -30, 0 | -30, -27 | -20, 0 | -30, -37 |
| 3 (610) | 1046 | 220 | 556 | 1416 | -4130 | -4094 | 481 | 316 | 890 | 641 | 769 | -404 |
| (U.S.A.) | 1.715 | 0.361 | 0.911 | 2.321 | -6.770 | -6.711 | 0.789 | 0.518 | 1.459 | 1.051 | 1.261 | -0.662 |
| (55)(50,0) | 23, 0 | 30, 3 | 23, 0 | 23, 0 | -20, -30 | 50, 23 | 23, 0 | 23, -2 | 40, 0 | 23, 0 | 23, 0 | 23, 0 |
| 4 (390) | 240 | 100 | 20 | 94 | 77 | 500 | 300 | 450 | 165 | 275 | 375 | 763 |
| (Poland) | 0.615 | 0.256 | 0.051 | 0.241 | 0.197 | 1.282 | 0.769 | 1.154 | 0.423 | 0.705 | 0.962 | 1.956 |
| (-5)(-10,0) | -5, 0 | -10, 0 | -17, 0 | -10, 0 | -10, 0 | -10, 0 | -13, 0 | -10, 0 | -10, 0 | -10, 0 | -11, 0 | -17, 0 |
| 5 (620) | -650 | 375 | 850 | 850 | 1002 | 975 | 630 | 965 | 760 | -900 | 770 | 682 |
| (EU) | -1.048 | 0.605 | 1.371 | 1.371 | 1.616 | 1.573 | 1.016 | 1.556 | 1.226 | -1.452 | 1.242 | 1.100 |
| (25)(20,0) | 5, -5 | 10, 0 | 25, 0 | 20, 0 | 20, 0 | 20, 0 | 20, 0 | 20, -2 | 20, 0 | 10, -10 | 20, 0 | 20, 0 |
| 6 (1525) | 2175 | 2130 | -3100 | 1710 | 1931 | 2040 | 1625 | 340 | 2515 | 25 | 1822 | 1200 |
| (Japan) | 1.426 | 1.397 | -2.033 | 0.245 | 1.266 | 1.338 | 1.066 | 0.223 | 1.649 | 0.016 | 1.195 | 0.787 |
| (40)(25,0) | 35, 0 | 25, 0 | 15, -25 | 35, 6 | 35, 0 | 25, 0 | 25, 0 | 30, -5 | 35, 0 | 25, -10 | 25, -5 | 25, 0 |
| Sum (6990) | 5112 | 5600 | 766 | 5426 | -270 | 2430 | 6146 | 5736 | 6950 | 2446 | 5946 | 2376 |
| | 0.731 | 0.801 | 0.110 | 0.776 | -0.039 | 0.348 | 0.879 | 0.821 | 0.994 | 0.350 | 0.851 | 0.340 |
| | 5612 | 6230 | 4136 | 6686 | 3140 | 6680 | | 6596 | | 5856 | 6426 | 5186 |
| | 0.803 | 0.891 | 0.592 | 0.957 | 0.449 | 0.956 | | 0.944 | | 0.838 | 0.919 | 0.742 |

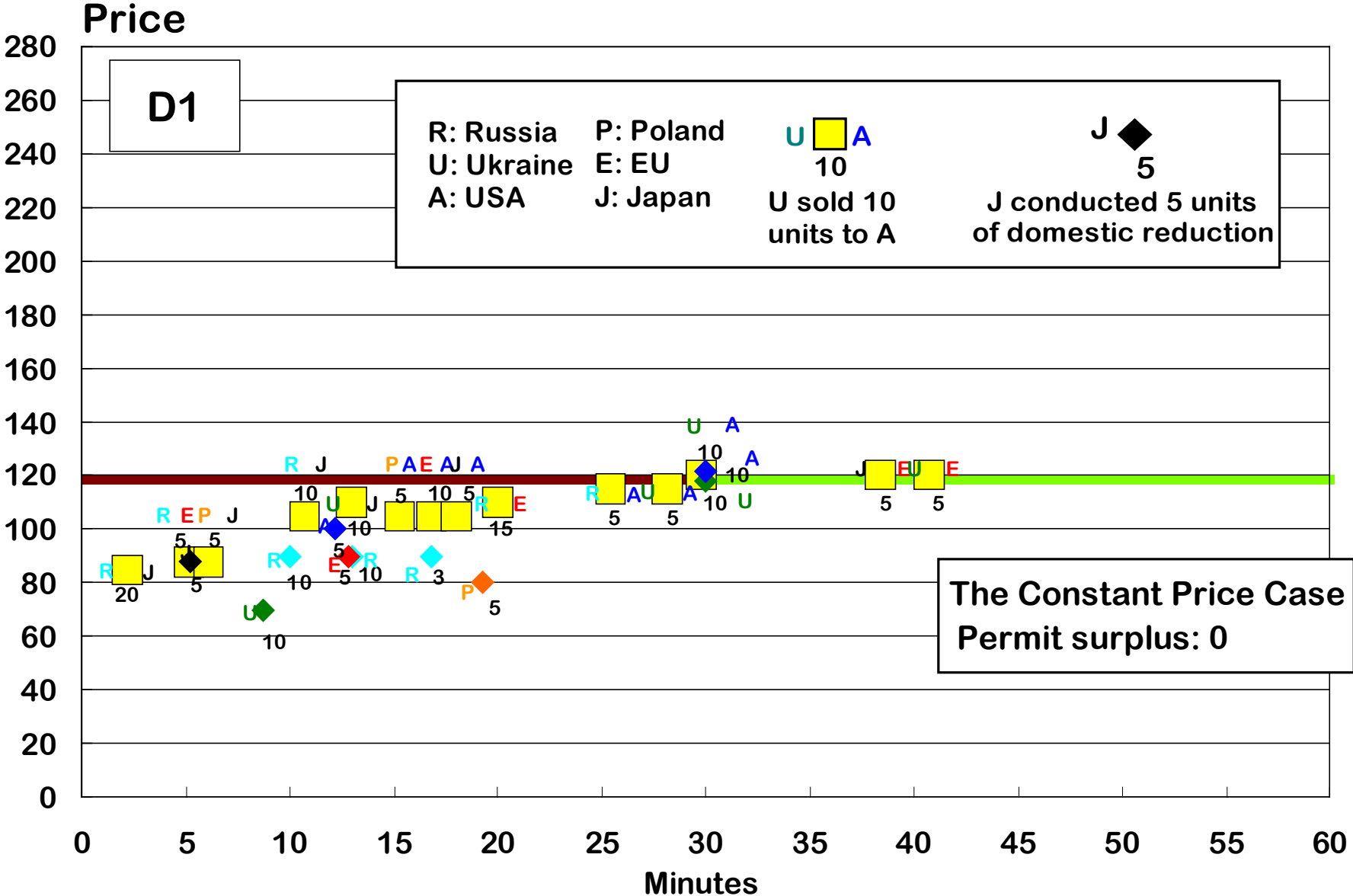
(2) Price dynamics: Two Cases

The Early Point Equilibrium Price Decrease Case 97.7% (35.0%)

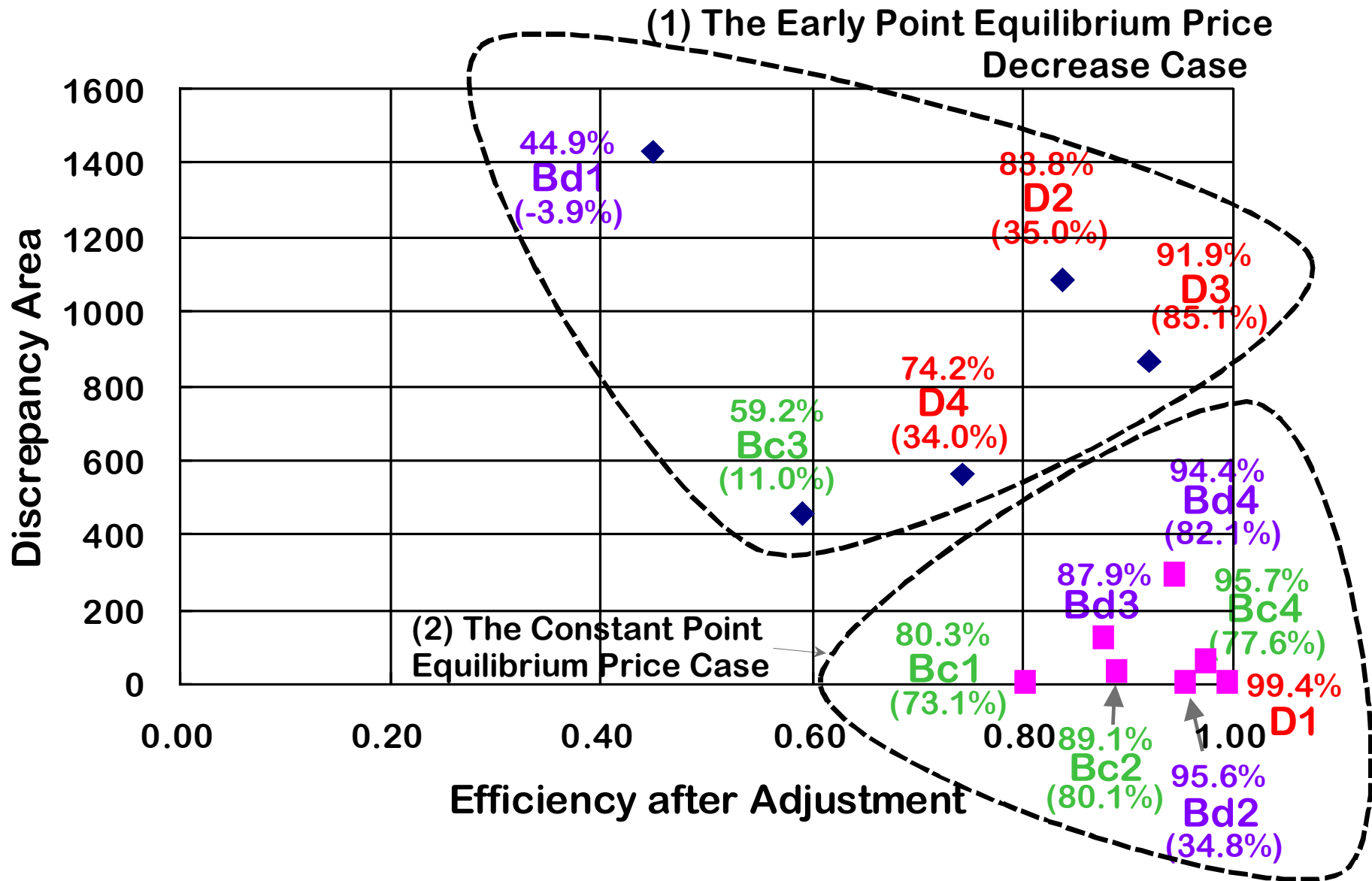


The Constant Point Equilibrium Price Case

99.4%



(3) Discrepancy Area and Efficiency



5. Concluding Remarks and Policy Implications

- Price drop in case (1) would be overcome by **banking** in the protocol (see Muller-Mestelman (1998)).
- In either trading rule, early domestic reduction resulted in case (1) and caused efficiency lower than that of case (2). ⇒ **Haste makes waste!!**

The full paper will be available at

<http://www.iser.osaka-u.ac.jp/~saijo/index-e.html>

soon. Saijo's e-mail address: saijo@iser.osaka-u.ac.jp

6. Coming Soon! (Next SB)

Liability (Seller vs. Buyer) Experiments are now in progress at GISPRI