



Tradable Emission Permits as Efficient Strategy for Achieving Environmental Goals

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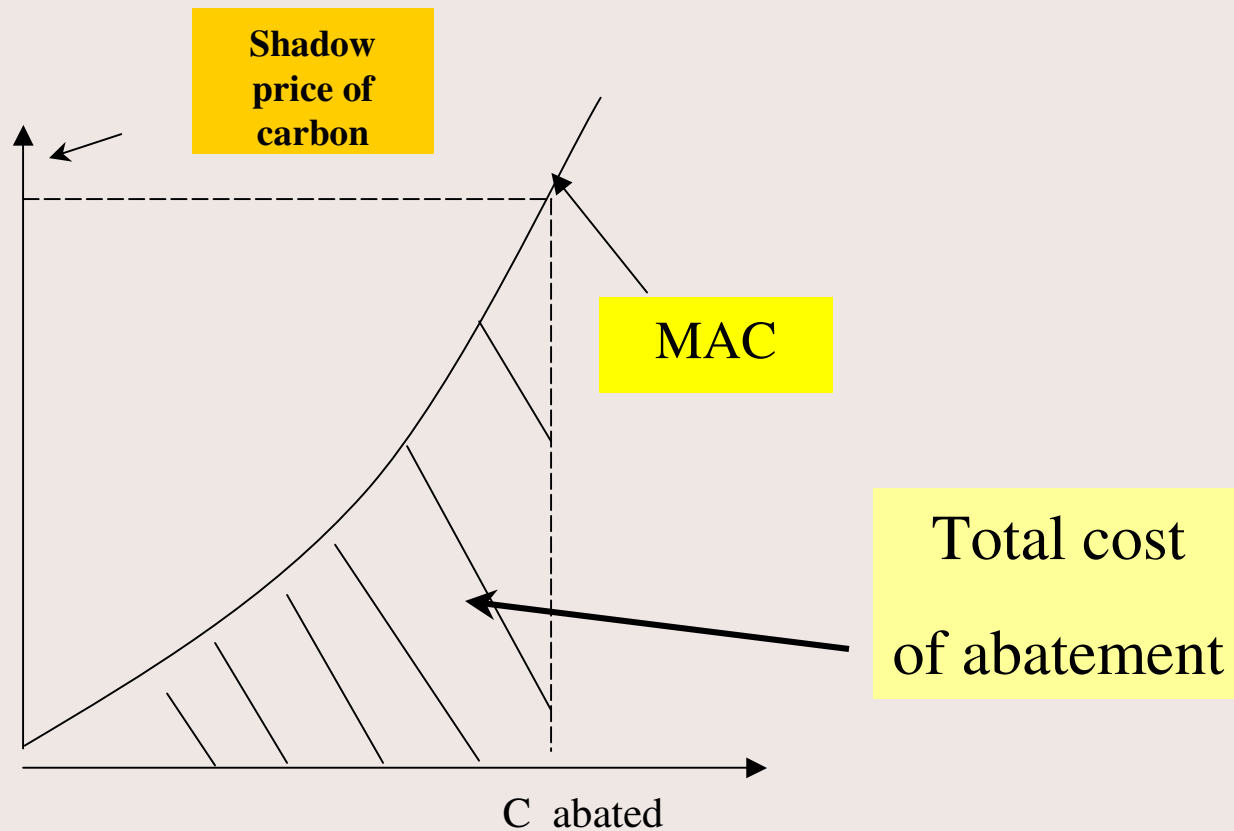
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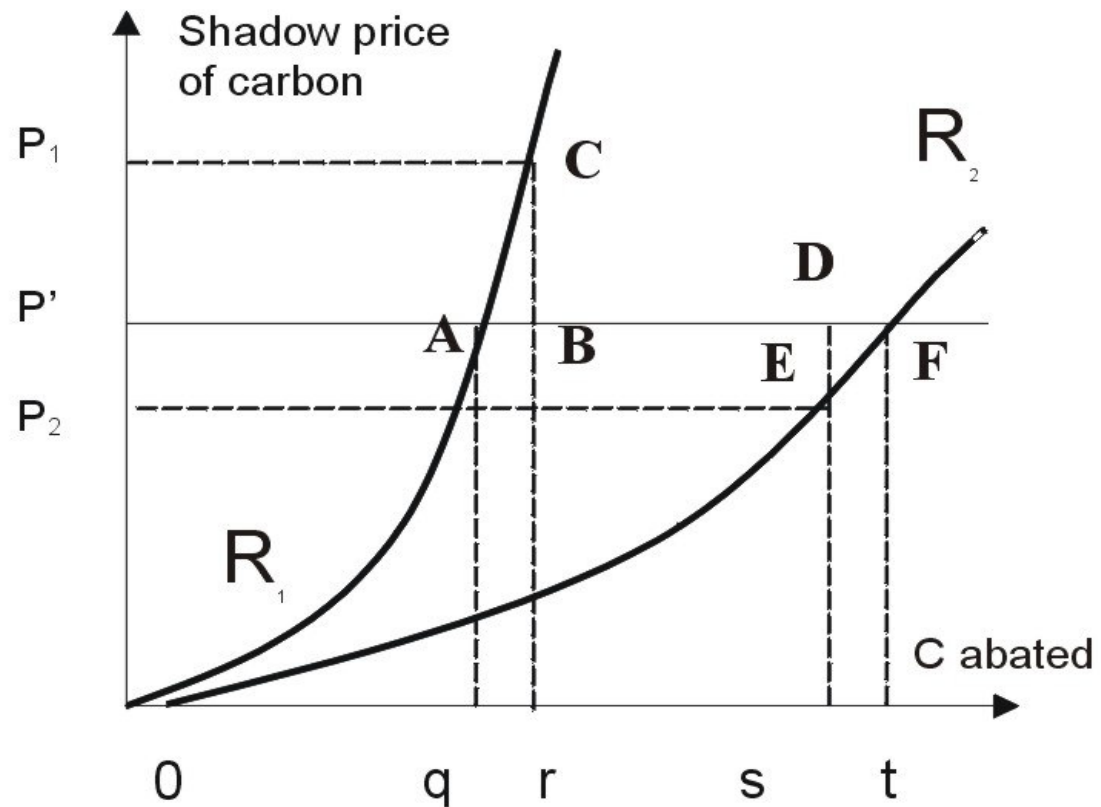
Outline

- The idea of marginal abatement curve
- Trading and uncertainty
- Optimisation problem
- Scenarios
- Results
- Conclusion

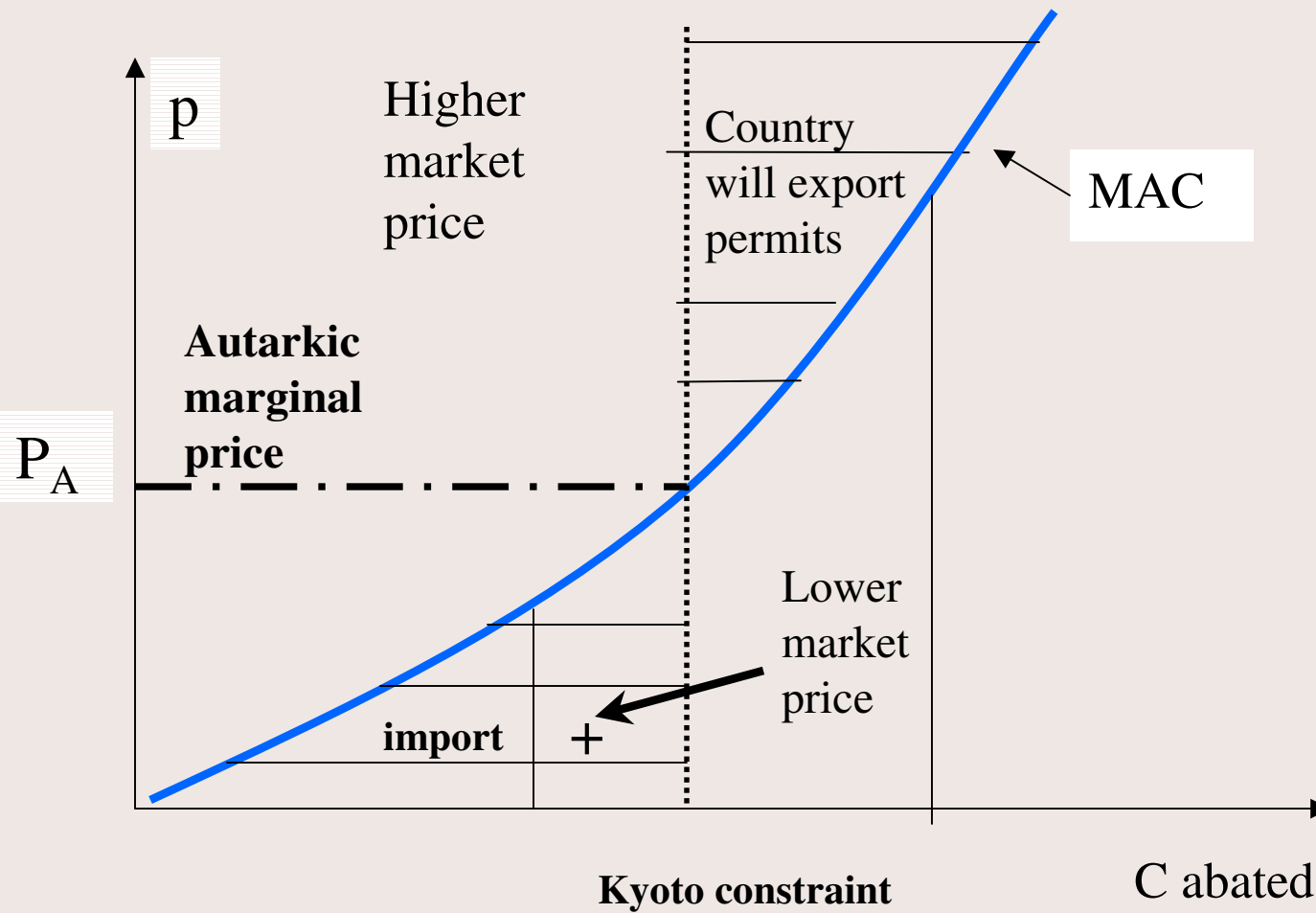
Marginal abatement cost curve



MAC for 2 regions (example)



Import/Exports of permits



Analysed countries

- USA
- Japan (JPN)
- European Community 12 (as 1992) (EEC)
- Other OECD (OOE)
- Eastern Europe (EET)
- Former Soviet Union (FSU)

How to calculate the marginal and total costs

- Equation of shadow price of carbon
- $P = aQ^2 + bQ$,
- Equation of total costs
- $C = 0.33aQ^3 + 0.5bQ^2$.
- Coeficients a, b were taken from Ellerman(1996)

Optimisation problem

$$f_i(y) = \min_{x_i} \sum_{i=1}^6 [c_i(x_i)]$$

$$st. \quad x_i + (1 + 2\alpha) d_i n_i \leq K_i + y_i$$

for each i region

- d_i - relative uncertainty of the source i
- n_i - anticipated emissions
- x_i - emissions after trading and reduction
- Alfa-risk not satisfying Kyoto target

Relative uncertainty of the region i

- USA 0,15
- JPN 0,1
- EEC 0,2
- OOE 0,17
- EET 0,3
- FSU 0,3

Necessary abatement

	Emissions in 1990y. Mton	Kyota qouta -2-	Emission target Mton	Anticipated emissions in 2010 Mton	Necessary abatement Mton
			= '2' x '1'		= '4' - '3'
USA	1362	7%	1266,66	1838	571,34
JAPAN	298	6%	280,12	424	143,88
EEC	822	8%	756,24	1064	307,76
OOE	318	6%	300,51	472	171,49
EET	266	-4%	276,64	395	118,36
FSU	891	2%	873,18	763	

Results, $\alpha=0.5$ no uncertainty

alfa 0.5	USA	JPN	EEC	OOE	EET	FSU	SUM
Marginal costs (\$/ton)*	186	582	274	233	116	\	\
Reduction agreed	571	<u>144</u>	308	171	124	\	1318
Reduction after trade	468	<u>49</u>	202	129	125	235	1207
Permits exp(-)/imp(+)	103	94	106	43	-1	-345	0
Commitment	18%	<u>65%</u>	34%	25%			

permits price 128 \$/ton

Reduction, permits exp/imp- (Mton)

Results, $\alpha=0.5$, no uncertainty

alfa 0,5	USA	JPN	EEC	OOE	EET	FSU	SUM
Cost of abatement no trading (\$bill.)*	37	34	30	13	5	0	119
Cost of abatement after trade (\$bill.)*	<u>21</u>	3	10	5	5	10	54
Permits exp(-)/imp(+) (\$bill.)	13	12	14	5	0	-44	0
Abatement+permits (\$ bill.)	<u>34</u>	<u>15</u>	<u>23</u>	10	5	-34	54
Gain from trade (\$bill.)	3	19	7	3	0	34	66
Gain/cost no trade (%)	9%	56%	23%	22%	0%		55%

Results, $a=0$, uncertainty fully accounted for

alfa 0	USA	JPN	EEC	OOE	EET	FSU	SUM
Marginal costs (\$/ton)*	315	1044	729	514	455	33	\
Reduction agreed	755	207	521	252	237	119	2090
Reduction after trading	810	105	358	212	211	395	2090
Permits exp(-)/imp(+)	-55	103	163	40	26	-277	0
%Commitment (import)		50%	31%	16%	11%		

permits price 360 \$/ton

Reduction, permits exp/imp- (Mton)

Results, $a=0$, uncertainty fully accounted for

alfa 0	USA	JPN	EEC	OOE	EET	FSU	SUM
Cost of abatement no trading (\$bill.)*	<u>82</u>	<u>85</u>	<u>132</u>	42	36	1	378
Cost of abatement after trade (\$bill.)*	101	<u>16</u>	46	25	25	47	260
Permits exp(-)/imp(+) (\$bill.)	-19	<u>37</u>	<u>59</u>	14	1	-100	-8
Abatement+permits (\$ bill.)	82	53	105	39	26	-53	252
Gain from trade (\$bill.)	0	32	27	3	10	54	126
Gain/Cost no trade (%)		38%	20%	7%	28%		33%

Results, $\alpha=0.33$, uncertainty partly accounted for

alfa 0.33	USA	JPN	EEC	OOE	EET	FSU	SUM
Marginal costs (\$/ton)*	225	<u>721</u>	400	314	204	\	\
Reduction agreed	632	165	378	198	157	\	1530
Reduction after trading	580	67	253	156	152	288	1495
Permits exp(-)/imp(+)	52	<u>98</u>	<u>125</u>	42	5	-322	0
% Commitment	8%	<u>60%</u>	<u>33%</u>	<u>21%</u>	3%		

permit price 190 \$/ton

Reduction, permits exp/imp-
(Mton)

Results, $\alpha=0.33$, uncertainty partly accounted for

alfa 0,33	USA	JPN	EEC	OOE	EET	FSU	SUM
Cost of abatement no trading (\$bill.)*	<u>50</u>	<u>48</u>	<u>54</u>	20	11		183
Cost of abatement after trade (\$bill.)*	39	<u>6</u>	18	9	9	18	99
Permits exp(-)/imp(+) (\$bill.)	10	<u>18</u>	<u>24</u>	8	1	-61	
Abatement+permits (\$ bill.)	49	24	42	17	10	-43	99
Gain from trade (\$bill.)	1	24	12	3	1	43	84
Gain/Cost reduction (%)	2%	50%	22%	15%	9%		46%

Gain from trading

Gain from Trade	USA	JPN	EEC	OOE	EET	FSU	SUM
a= 0	0	32	27	3	10	54	126
a=0.33	1	24	12	3	1	43	84
a=0.5	3	19	7	3	0	34	66

How far autarkic marginal costs from market price?

	USA	JPN	EEC	OOE	EET	FSU
a= 0	-45	684	369	154	95	-327
a=0.33	35	531	210	124	14	/
a=0.5	58	454	146	105	-12	/

Conclusion

- The effect of trading: cost reductions
- In regions whose autarkic marginal cost is further from the trading equilibrium will benefit more than those whose cost is closer to the trading equilibrium.
- The greatest benefits obtains FSU, that is the biggest exporter of permits, and Japan that imports more than 60% of its Kyoto commitment. When $a=0$, most regions gain from trading