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CC [Climate Change]: Monopoly Issues

Stack:	Row:	Section:	Shelf:	Position:
S	20	6	1	3

Russian Market Power and Compliance

Russia will be the largest seller on the international permit market. In a trading regime among Annex I nations, the Former Soviet Union (FSU) will supply 78% of the total traded permits (507 of 646 mmtc total), the majority from Russia. Because of its dominant position, Russia may seek to increase its profits by restricting sales and driving up international permit prices.

On the other hand, there are worries about Russian compliance with their emissions cap. Ignoring market power considerations, without an adequate compliance mechanism, Russia will make more profit by simply selling all of their permits, leaving them out of compliance by the amount of their emissions.

In what follows, we compare the level of permit sales by Russia and permit prices under a variety of conditions to see whether market power or compliance issues are more likely to be the dominant concern.

Market Power and Compliance Issues- Illustrations:

We look at three scenarios: 1) Russia does not exercise its market power and abates emissions to generate more permits than its "hot-air" (has positive marginal abatement costs); 2) Russia complies with Kyoto, but acts as a monopolist; 3) Russia does not undertake abatement policies (has zero abatement costs), behaving like a "cheating monopolist."

These scenarios are based on estimated marginal abatement cost curves including non-CO2 greenhouse gases and full Annex I trading. Russia would have significantly less market power in a full global trading regime.

Summary of CEA Illustration:

	Competitive Result	Monopoly, Kyoto Met	Cheating Monopoly
Permit Price ($/Ton)	$49	$69	$59
Quantity Traded (Mmtc)	491	356	420
# "Hot Air" Permits	318	318	421
# Real Permits	173	39	0
Permit Price Increase (Relative to compet.)	-	$19	$9.9
US Compliance Cost Increase (Billion)	-	$5.6	$3
FSU Profit (Billion)	$20	$24	$25

FSU complies & acts competitively -- FSU sells permits for 491 MMTC (318 MMTC "hot air" and 173 MMTC real reductions) at the international permit price of $50/ton, making a profit of approximately $20.3 billion (1992$).

FSU complies, acts as a monopolist -- FSU restricts its sale of permits to 357 MMTC (only 39 MMTC of real reductions) as permit prices rise to about $69/ton, and profits increase to 24.4 billion. This increases US compliance costs relative to the baseline by $5.6 billion because of higher permit prices and the need to switch to more expensive domestic abatement measures.

FSU violates Kyoto, acts as a monopolist -- FSU sells 421 mmtc of permits (103 more than its hot-air). FSU profits increase to 25.1 billion, and US compliance costs increase 3.0 billion relative to the comply/competitive scenario.

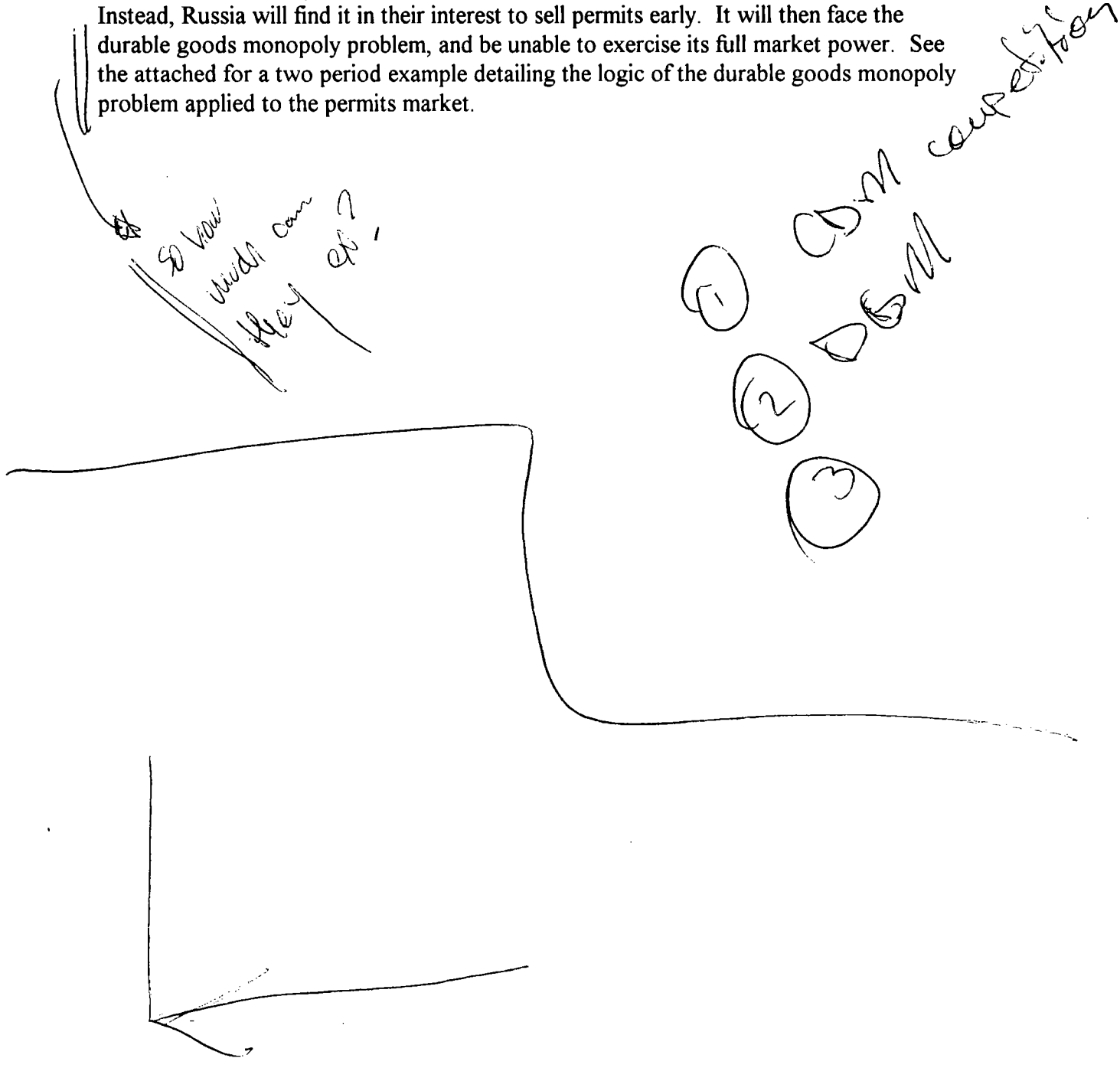
Other Modeler's Results

Two outside models also found a significant reduction in the quantity of permits sold by the FSU acting as a monopolist versus acting competitively. However, these other models did not find that the FSU acting as a cheating monopolist would restrict permit sales to below their competitive compliance levels. Instead, they show a cheating monopolist would increase permit sales well above competitive compliance levels. (See attached for comparison) These results depend critically on the shape of the underlying Annex I demand curve and should be checked.

Will Russia be able to Exercise Market Power?

Because there are many possible transaction dates during the budget period, the permit market may be similar to a durable goods monopoly problem. In a durable goods market, the monopolist sells a product that lasts multiple periods, thereby creating its own competition in future periods, and leading to higher sales and lower prices than in a static monopoly problem.

Russia could avoid the durable goods problem by refusing to sell any permits until the last instant when it could act as a static monopolist. However, if Russia has a higher discount rate than buyers, Russia will not want to wait until the last instant to sell. Instead, Russia will find it in their interest to sell permits early. It will then face the durable goods monopoly problem, and be unable to exercise its full market power. See the attached for a two period example detailing the logic of the durable goods monopoly problem applied to the permits market.

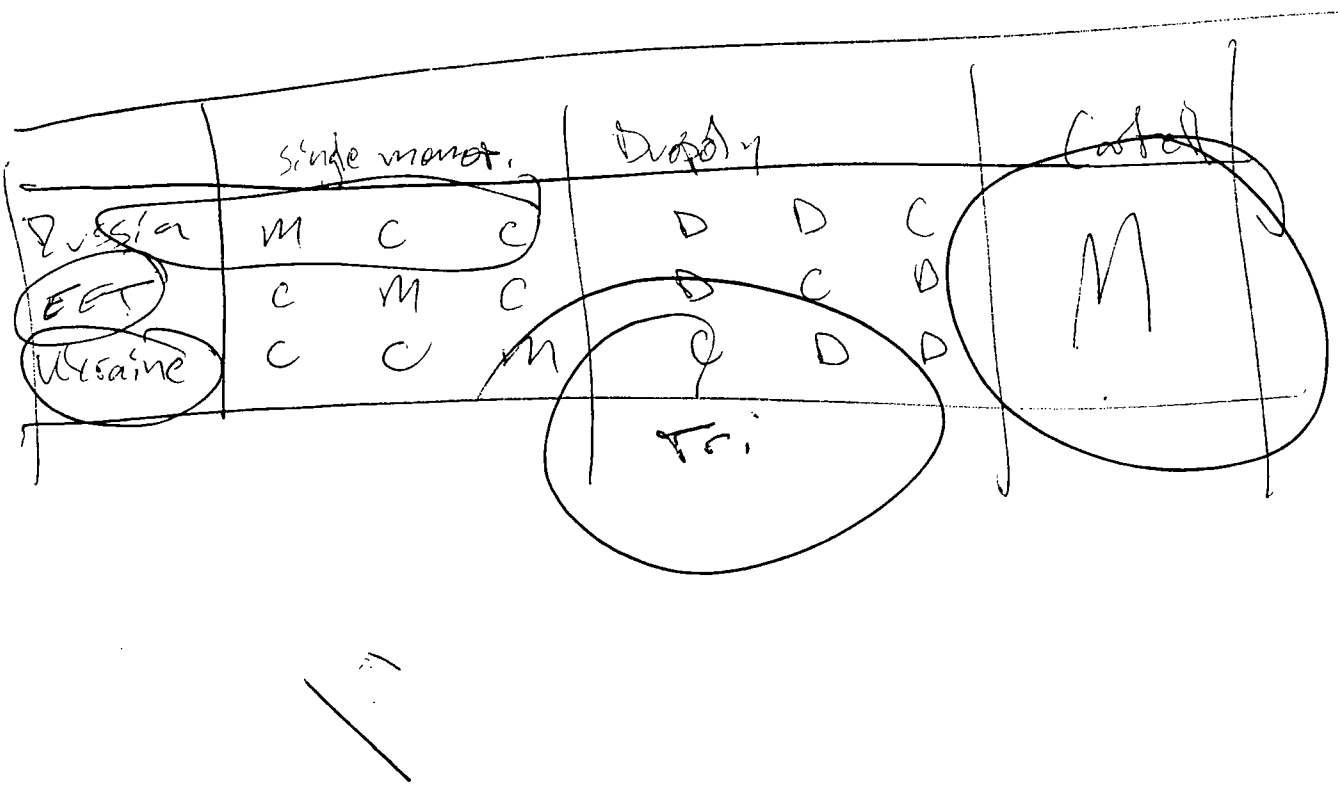


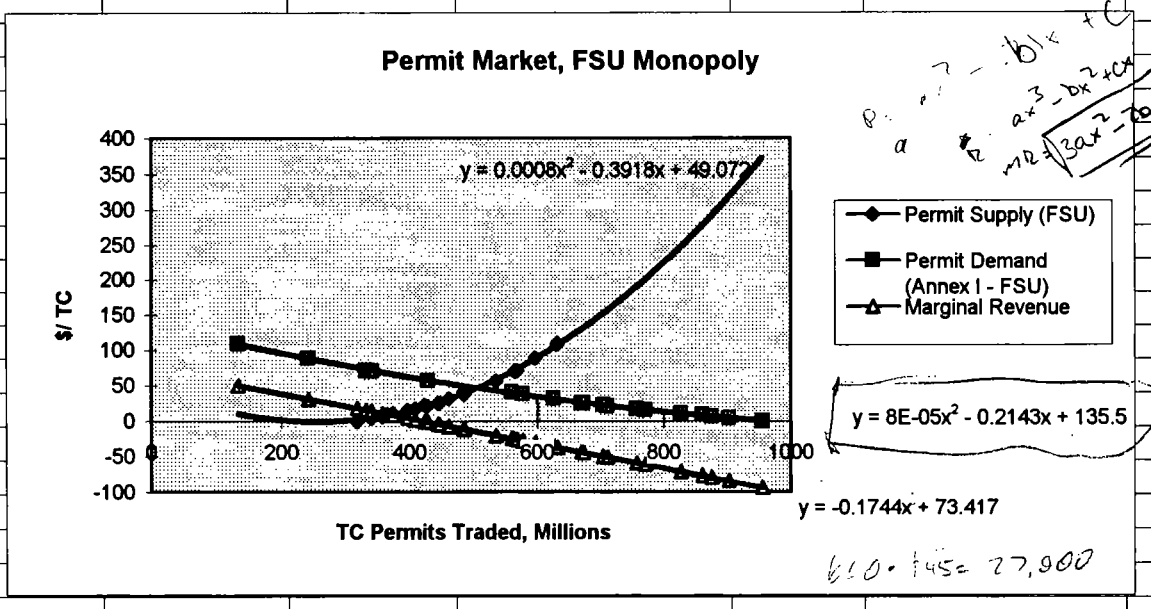
Persistent Organic Pollutants

12 →

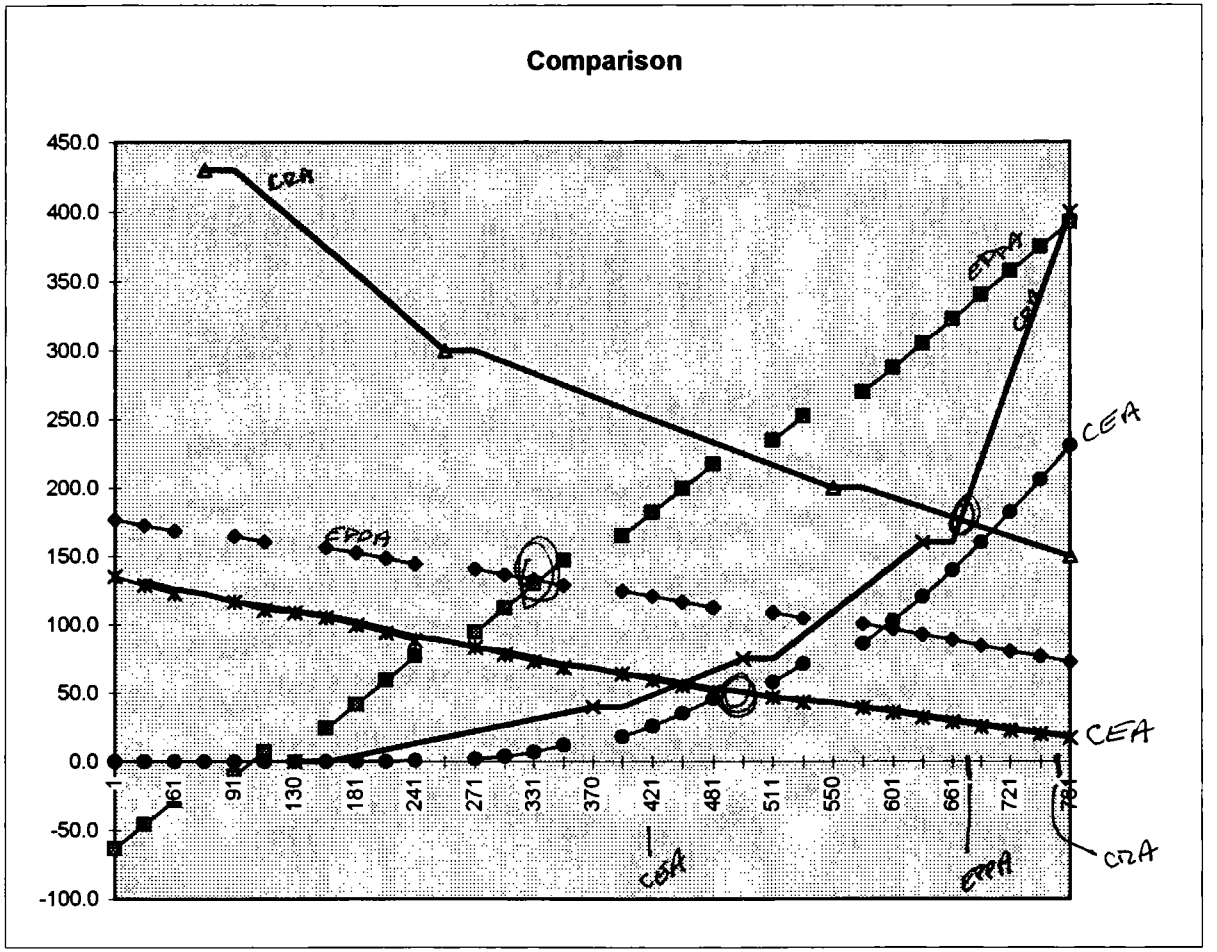
(1) Russia Monopoly —

(FE) Russia ~~AA~~ ; EET Duopoly.





BASELINE						
Competitive Pricing			FSU Profit			
$/Ton	49.6166826		$	20,299,691,381		
Quantity	491.1362817					
(Millions)						
# Hot Air	318					
# Real	173					
CASE I						
Monopolistic Pricing, Kyoto Met						
$/Ton	69.26188625					
Quantity	356.9932164					
(Millions)						
# Hot Air	318					
# Real	39					
Price Increase/Ton				19.64520365		
FSU Profits			$	24,411,529,137		
Increase in US Compliance Cost			$	35,585,994,737		
CASE II						
Monopolistic Pricing, Kyoto Violated						
$/Ton	59.53352982					
Quantity	420.9690367					
(Millions)						
# Hot Air	421					
# Real	0					
Price Increase/Ton				9.916847221		
FSU Profits			$	25,061,772,701		
Increase in US Compliance Cost			$	17,410,051,939		


Comparison
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
-50.0
-100.0
1
61
91
130
181
241
271
331
370
421
481
511
550
601
661
721
784
CEA
EPPA
CEA
EPPA
CEA
CEA
CEA
EPPA
CEA

Joseph E. Aldy
08/08/98 12:04:52 AM

Record Type: Record

To: Michael A. Egner/CEA/EOP

cc: Alan S. Polasky/CEA/EOP, Quindi C. Franco/CEA/EOP
Subject: emissions and marginal abatement cost curves

Mike,

The attached excel file has 2 sheets -- 1 is the marginal abatement cost curves for each country/region in SGM and the cost curves for various trading blocs; the other had the required emissions cuts for each SGM country/region to achieve the Kyoto target. Could you play around with these some next week, see how the permit price changes with the emissions cuts implied by the EPA spreadsheet, and also work on developing equations to describe these curves.

First, on evaluating permit prices, let's run through an example. If you are considering Annex I trading, you go to the Annex I trading columns (1 for emissions reductions, and 1 for prices). You see the required emissions cut for all of Annex I (1073 MMTCE), so you go down the emissions column until you reach the 2 emissions levels that are above and below 1073. Then you need to interpolate the permit price for 1073 based on the permit prices associated with the emissions levels just above and below 1073. This should be $48/ton (note, this is in 92$ -- in 97$ this would be $54/ton). Also note that all trading blocs are a function of adding up emissions reductions for all bloc participants, so Annex I trading would have all the emissions reductions for all Annex I countries/regions in SGM for a given price. So, for a series of prices, we can then trace out the marginal abatement cost curve. If you have questions, feel free to call me in Myrtle Beach (843-497-9918) or talk to Steve and/or Quindi.

Second, we would like to take these data points and develop functions to describe them. This would involve regressing price on emissions, although it will not be a linear function. Since Steve and Quindi were in the meeting this afternoon where we discussed this, I suggest contacting them.

If you find other things of interest to work on, feel free to do those and we can handle this when I get back. Have a good week.

Joe

MACSRF1.XLS

① Online & Memo
② Look @ other People's Stuff

Market Power: Will FSU Comply?

I. Potential Monopoly Problem
- FSU would be a dominant player on international permit market, supplying 78% of total permits (507 of 646 mmtc total sold)
- If Russia acted as a monopolist, would restrict permit sales to drive up prices, potentially alleviating concern of FSU selling all of its permits and fleeing the regime
- But would increase cost to US

Illustrations:

A. Case I: FSU Intends to comply and acts as a monopolist
   - permits sold (compared to base case) fraction "paper", fraction real
   - int. permit price
   - Gains to FSU for acting as monopolist

B. Case II: FSU Intends not to comply, acts as monopolist with zero production cost
   - same stats as above

mike

II. Costs to the US of Monopoly Power
- Cost of FSU acting in this way could be severe: [model results] mike

II. FSU as a Durable Goods Monopolist
- On the other hand, for FSU to be able to sell its permits at the higher monopolist price, the market would have to believe FSU would not sell additional permits at a later date
- 2-Period Example:
  FSU restricts sales in period one to drive up price.
  Permits are durable goods during the 5year compliance period.
  There is an incentive for FSU to sell additional permits in period 2
  knowing the above, market will not be willing to pay monopolist price for permits in t1.

Market Power in EMF-16

SGM-Battelle: Permit prices go up from 25$/ton (Annex I trading) to approx. 75$/ton; .2% GNP cost to .29% GNP loss in 2010

CRA (Bernstein & Montgomery): Permit price rises from ~120 $/ton to 150 $/ton, while sales restrict from 550 mmtc to 450 mmtc in 2010. Additional GDP loss of ~ 0.17%; extrapolating to a non-compliance scenario -

Abide

Qty Sold	P	MC	C	R	MR	Profit
1	176.7	-63.5	0.0	176.7		$177
26	173.3	-48.8	0.0	4506.7	173.2	$4,507
51	170.0	-34.2	0.0	8670.0	166.5	$8,670
76	166.7	-19.6	0.0	12666.7	159.9	$12,667
101	163.3	-5.0	0.0	16496.7	153.2	$16,497
126	160.0	9.6	241.2	20160.0	146.5	$19,919
151	156.7	24.3	848.0	23656.7	139.9	$22,809
176	153.3	38.9	1820.2	26986.7	133.2	$25,166
201	150.0	53.5	3157.9	30150.0	126.5	$26,992
226	146.7	68.1	4861.1	33146.7	119.9	$28,286
251	143.3	82.7	6929.8	35976.7	113.2	$29,047
276	140.0	97.4	9364.0	38640.0	106.5	$29,276
301	136.7	112.0	12163.7	41136.7	99.9	$28,973
326	133.3	126.6	15328.9	43466.7	93.2	$28,138
351	130.0	141.2	18859.6	45630.0	86.5	$26,770
376	126.7	155.8	22755.8	47626.7	79.9	$24,871
401	123.3	170.5	27017.5	49456.7	73.2	$22,439
426	120.0	185.1	31644.7	51120.0	66.5	$19,475
451	116.7	199.7	36637.4	52616.7	59.9	$15,979
476	113.3	214.3	41995.6	53946.7	53.2	$11,951

	Competitive	Monopoly
Qty (MtC)	326.0	276.0
Profit	$28,138	$29,276

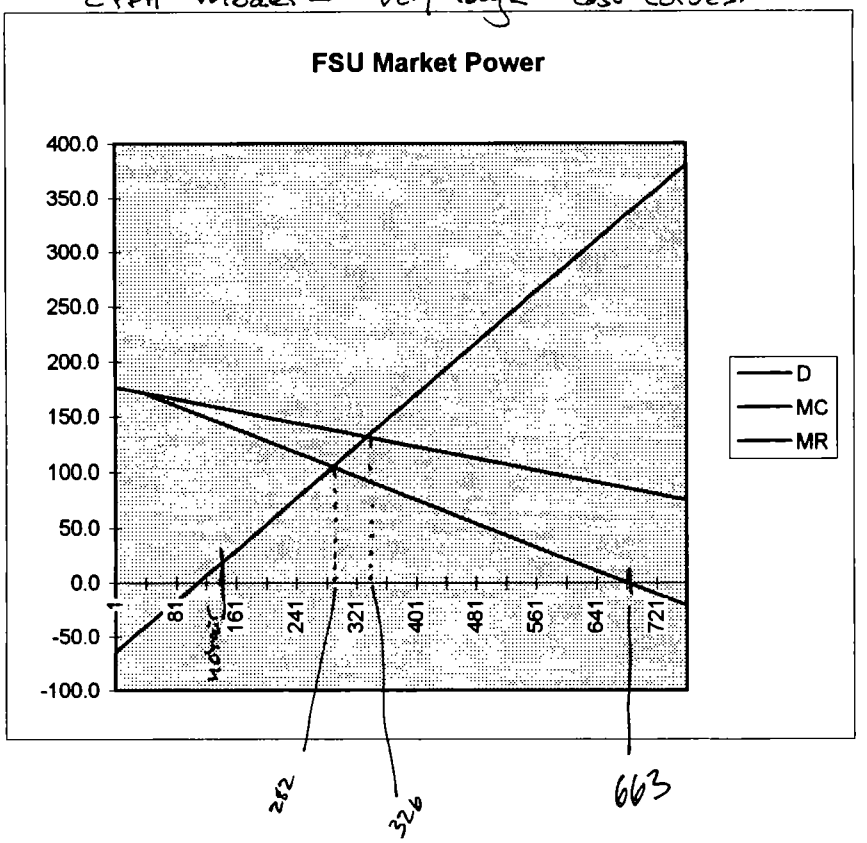
Creat/monopoly (MC=0)
663

110 of which is "not air"

Sloan } models
CRA }

Creat

EPPA Model — very rough cost curves.

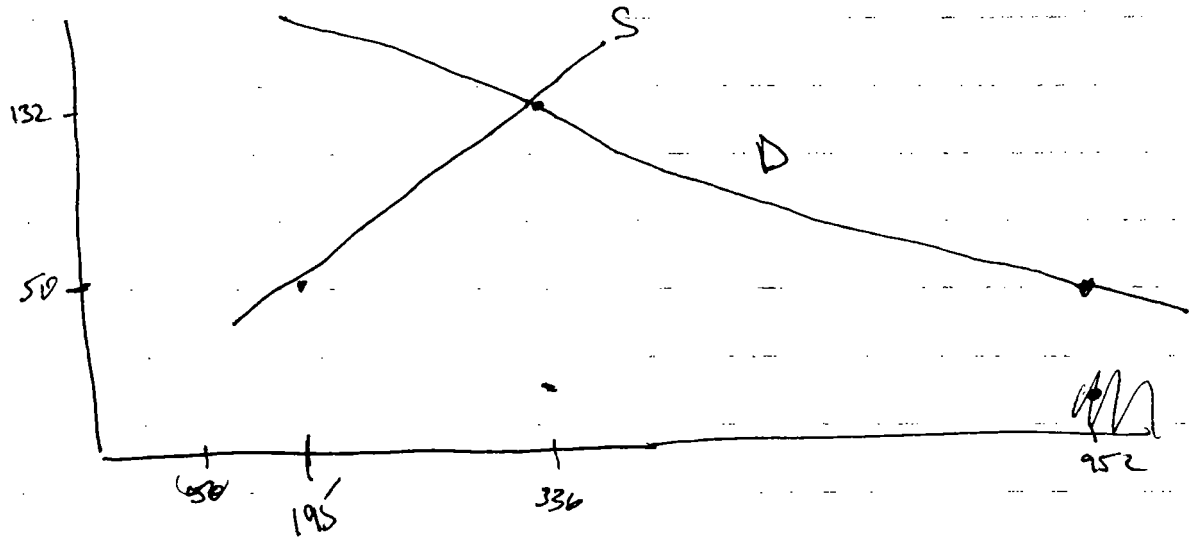


BAU Emissions: 763 MTc

Kyoto Commitment: 873

"Hot Air" : 110 MTc

EPPA Model



Demand:

$Q_D = P \cdot A + B$

$336 = 132(A) + B$

$B = 336 - 132A$

$952 = 50(A) + 336 - 132A$

$952 = 50A + 336 - 132A$

$616 = -82A$

$A = \frac{616}{82} = -7.5$

$195 = 50 \cdot 7.5 + B$

$195 - 375 = B$

$B = 180$

$Q_D = 7.5P + 180$

$336 = 132(7.5) + B$

$336 + 990 = B$

$1326 = B$

$Q_D = 1326 - 7.5(P)$

$Q_S = P \cdot 1.71 + 109.5$

$Q_S = P \cdot A + B$

$195 = 50A + B$

$B = 195 - 50A$

$336 = 132A + 195 - 50A$

$141 = 82A$

$A = 1.71$

$195 = 50(1.71) + B$

$109.5 = B$

$336 = 132(1.71) + 109.5$

$Q_D = 1326 - 7.5(P)$

$-7.5P = Q - 1326$

$$P_D = -\frac{Q - 1326}{7.5} = \frac{1326 - Q}{7.5}$$

P_{cost} : $Q = P \cdot 1.71 + 109.5$

$$P = \frac{Q - 109.5}{1.71}$$

$Q_D = 1326 - 7.5P$

$Q_S = 1.71P + 109.5$

$R = P \cdot Q$ $\quad P_D = \frac{1326 - Q}{7.5}$

$C_S = \frac{Q - 109.5}{1.71}$

$R = Q \cdot \frac{1326 - Q}{7.5}$

$\frac{1326Q - Q^2}{7.5} = R$

$\frac{1326}{7.5} Q - \frac{1}{7.5} Q^2 = R$

$MR = \frac{\partial R}{\partial Q} = \boxed{\frac{1326}{7.5} - \frac{2}{7.5} Q}$

Monopoly Solution

$MR \qquad MC$

$\frac{1326}{7.5} - \frac{2}{7.5} Q = \frac{Q - 109.5}{1.71} = \frac{Q}{1.71} - \frac{109.5}{1.71}$

$176.8 + 64.03 = \frac{Q}{1.71} + \frac{2}{7.5} Q$

M+Carson

$240.8 = Q\left(\frac{1}{1.71} + \frac{2}{7.5}\right) = Q(.585 + .266)$

$= Q(.851)$

$\frac{240.8}{.851} = \boxed{282.9 = Q}$

Checking Solution

$MR = 0 = \frac{1326}{7.5} - \frac{2}{7.5} Q$

$\frac{1326}{7.5} = \frac{2}{7.5} Q$

$1326 = 2Q$

$\boxed{1 \; Q = 663}$

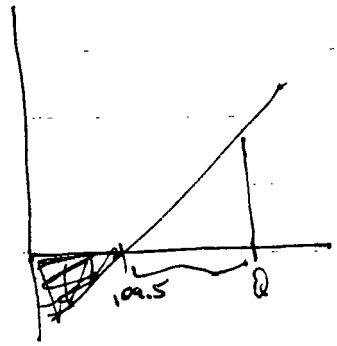
Abide - π's:

$\frac{2 \cdot 2}{2}$

π:

$P \cdot Q - \int_0^Q MC$

Competitive Solution:



$336.132 - \int_0^{236} \frac{Q - 109.5}{1.71}$

$= 44352 - \int_0^{\cdot} \frac{Q}{1.71} - \frac{109.5}{1.71}$

$MC = \frac{Q - 109.5}{1.71} = 0 \qquad Q/_{1.71} = 109.5/1.71$

$Q = 109.5$

$Cost = \frac{(Q - 109.5) \cdot \frac{Q - 109.5}{1.71}}{2}$

$= \frac{Q}{2} - \frac{109.5}{2} \cdot \frac{Q}{1.71} -$

$Cost = \frac{(Q - 109.5)^2}{3.42}$

Summary

				Competitive			Monopoly			Cheat			
Model	BAU Emissions	Commitment	Hot Air	Qty	Price	Profit	Qty	Price	Profit	Qty	Price	Profit	Notes
EPPA	763	873	110	336	132	$29,351	283	139	$30,554	663	88.4	$58,609	all in Megatons of carbon
CRA	1075	1290	215	630	185	$81,525	500	215	$92,625	770	160	$123,200	
				491	$50	$20,300	356	$69	$24,411	420	$60	$25,000	

Possible Reasons

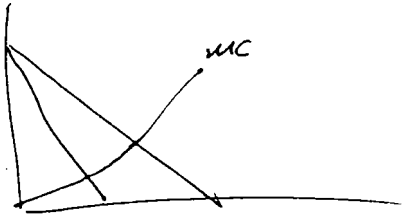
1. World trading? ~~[illegible]~~ NO
2. Demand Curve
3. Supply Curve
4. Time Frame

$MR = 3(.00006)x^2 - 2(.2143)x + 135$

$0 = .00024x^2 - .42x + 135$

$135 = .42x - .00024x^2$

$135 =$



Fax [redacted] to Kacey

– Elec. Grid costs

cost curve

Buffalo Billiards

8:00

$500.430 + 1/2(500 \cdot (1000 - 430))$

$= 215000 + 42500$

$= \$257500$

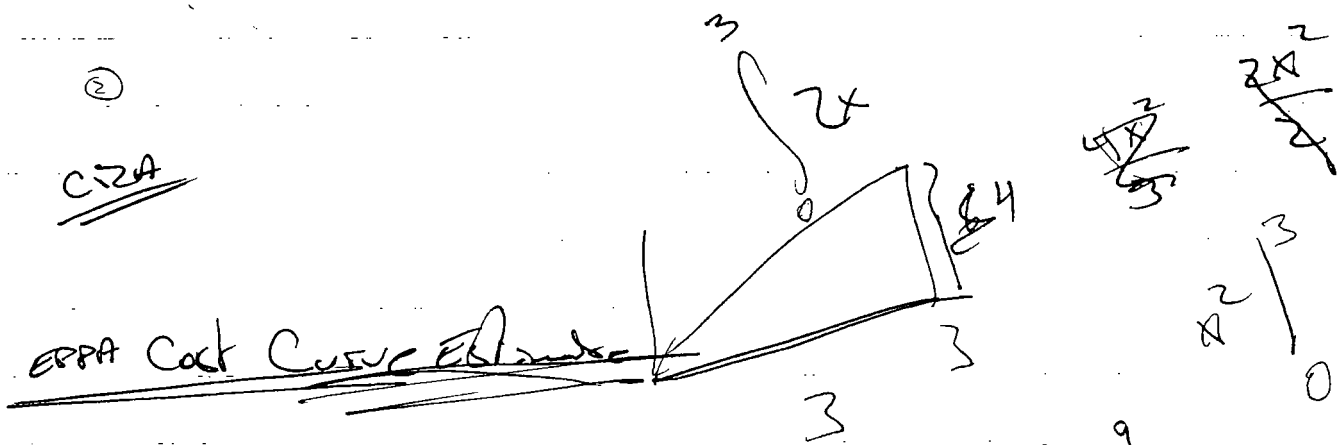
① ②

$\frac{0.15}{2} = 10.5$

$\int_0^3 2x = x^2 \Big|_0^3 = 9-0 = 8$

②

CIZA



$\frac{4x^2}{4}$

x^2

$6 \cdot 3 = \frac{18}{2} = 9$

$8 + 0$

$P = aR^2 + bR$

$.0023 \quad .0042$

491.47

$\int_1^7 x \quad \frac{x^2}{2} \Big|_0^8$

$\frac{1}{2} \cdot 6 \cdot 4 = 12$

(4)

3

9

(2)

2

2

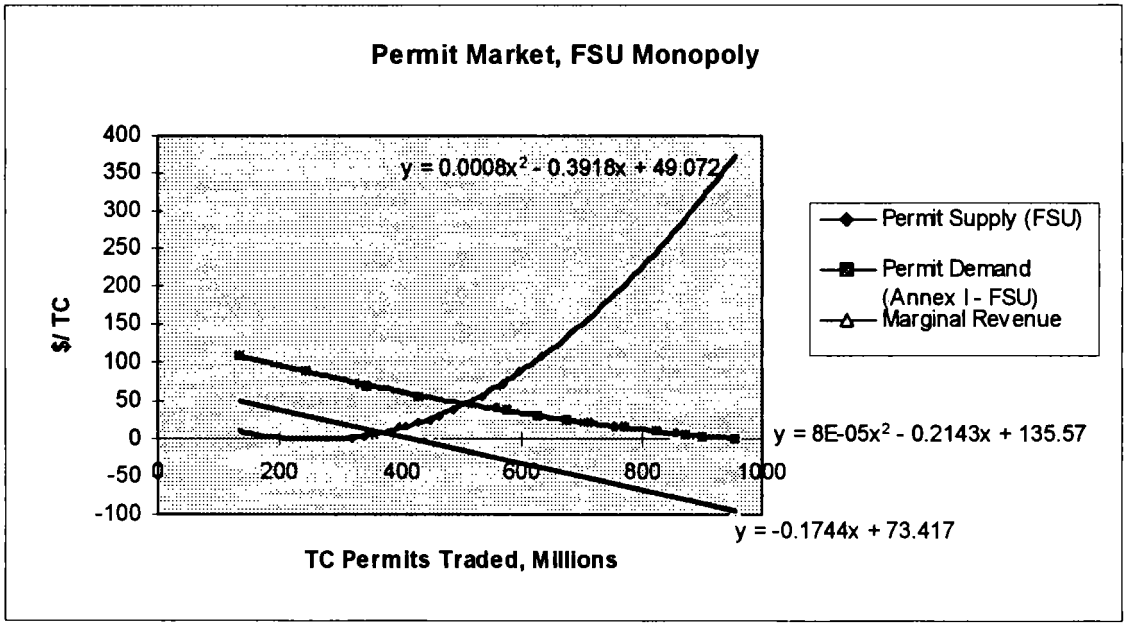
Constructing demand and supply curves from the marginal emissions abatement costs[1] of Annex I and the FSU, and pricing permits competitively results in a baseline equilibrium permit price of approximately $50/ton, with 491 million permits traded. The FSU sells all of its 318 MMTC "hot air" because all such reductions have a zero abatement cost. This leaves 173 MMTC real reductions for the FSU. Under such a scenario, the FSU makes a profit of approximately 20.3 billion.

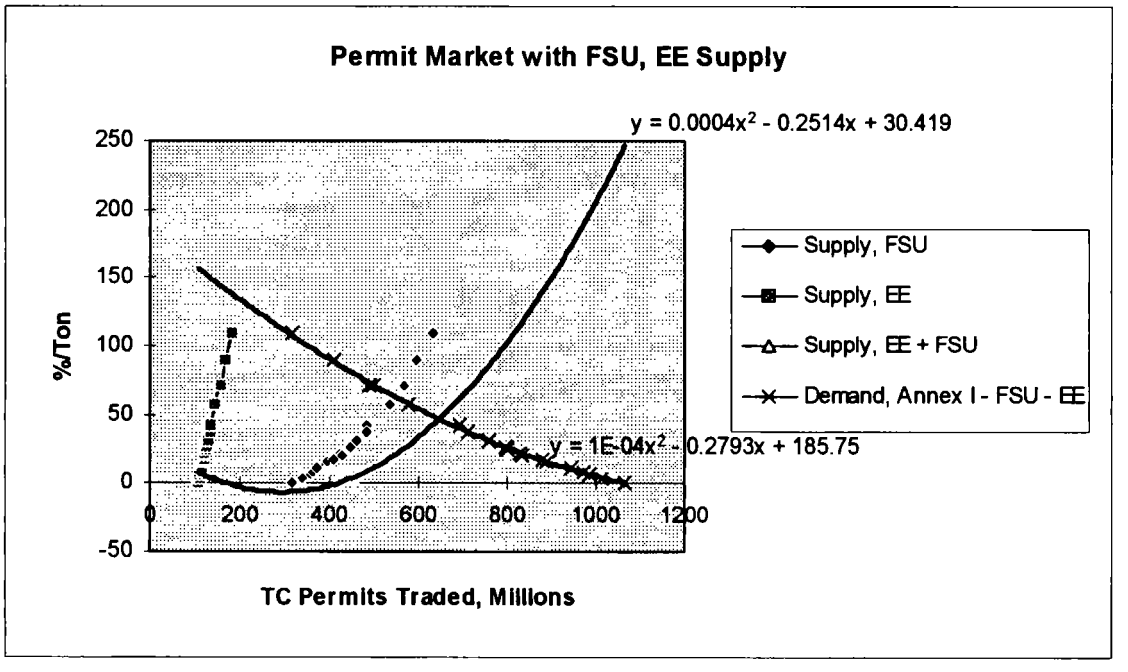
If the FSU prices permits as a monopoly, and chooses to reduce its allowable emissions when selling permits (in accordance with Kyoto), permit prices rise to about $69/ton, with 357 million permits traded. Again, all 318 MMTC of hot air are used, resulting in a real reduction of 39 MMTC. FSU profits rise to 24.4 billion with monopoly pricing. This change in policy increases US compliance costs relative to the baseline by 5.6 billion, in part because of higher permit prices, but mostly because the US economy is forced to switch to more expensive abatement measures.

If the FSU prices permits monopolistically, but violates Kyoto by not reducing emissions with permit sales, the permit price will drop to $60/ton (disregarding the lowered reliability of permit value). The price decreases because quantity traded has increased to 421 million permits; quantity has decreased because, no longer constrained by any marginal abatement costs, the FSU finds it more profitable to increase supply to 421 (the point where marginal revenue = 0). All 421 MMTC are hot air, so no real reductions are undertaken. FSU profits rise still higher to 25.1 billion, while the increase in US compliance costs from the baseline drops to 3.0 billion. Compliance costs are lower because the expenditure from greater permit demand is more than offset from permit price drops and smaller abatement requirements.

	Baseline, No Monopoly Pricing	Monopoly, Kyoto Met	Monopoly, Kyoto Violated
Permit Price ($/Ton)	49.6166826	69.26188625	59.53352982
Quantity Traded (Millions)	491.1362817	356.9932164	420.9690367
# "Hot Air" Reductions	318	318	421
# Real Reductions	173	39	0
Permit Price Increase ($/Ton)	-	19.64520365	9.916847221
US Compliance Cost Increase	-	$5,667,397,573	$3,016,956,161
FSU Profit	$20,299,691,381	$24,411,529,137	$25,061,772,201

[1] Annex I demand was calculated as the total required emissions reduction under Kyoto, minus the amount of reductions with marginal abatement cost lower than a given permit price. FSU supply was calculated as total permit allocation, minus the amount of reductions with marginal abatement cost higher than a given permit price.


Permit Market, FSU Monopoly
y = 0.0008x² - 0.3918x + 49.072
y = 8E-05x² - 0.2143x + 135.57
y = -0.1744x + 73.417
Permit Supply (FSU)
Permit Demand (Annex I - FSU)
Marginal Revenue
$/ TC
TC Permits Traded, Millions
400
350
300
250
200
150
100
50
0
-50
-100
0
200
400
600
800
1000


Permit Market with FSU, EE Supply
y = 0.0004x² - 0.2514x + 30.419
y = 1E-04x² - 0.2793x + 185.75
Supply, FSU
Supply, EE
Supply, EE + FSU
Demand, Annex I - FSU - EE
%/Ton
TC Permits Traded, Millions
250
200
150
100
50
0
-50
0
200
400
600
800
1000
1200

Summary

				Competitive			Monopoly			Cheat			
Model	BAU Emissions	Commitment	Hot Air	Qty	Price	Profit (million)	Qty	Price	Profit	Qty	Price	Profit	Notes
EPPA	763	873	110	336	132	$29,351	283	139	$30,554	663	88.4	$58,609	Only CO2, 1995 year dollars.
CRA	1075	1290	215	630	185	$81,525	500	215	$92,625	770	160	$123,200	2030?, gases?
CEA			318	491	50	$20,300	356	69	$24,411	420	60	$25,000	All gases, 1992 year dollars

Monopoly with multiple transactions dates within a single budget period: Illustrative example

A) Basic assumptions:

1) The discount factor, $\delta < 1$, is the difference in discounting between the seller's discount factor and the buyers' discount factor.

2) There are two transaction dates: $t = 1, 2$

3) The price of permits at each date, P1 and P2, are expressed in present value terms for buyers.

4) Monopolist can abate at zero cost (hot air or because they don't intend to comply)

B. Demand Side

1) Buyers care about the number of permits held at the end of budget period not when they are purchased. With positive sales of permits at each date, in equilibrium, permits prices across dates 1 and 2 must be equal: $P1 = P2 = P$.

2) Let the demand for permits by buyers be given by $Q = D(P) = a - P$, with $a > 0$, and where Q is total permits demanded ($Q = Q1 + Q2$, where Q1 is quantity demanded at date 1 and Q2 is quantity demanded at date 2).

C. Monopolist

1) At the second date, the monopolist faces the following maximization problem:

$$\text{Max } (a - Q1 - Q2)Q2$$

The solution yields, $Q2 = (a-Q1)/2$.

2) At the first date, the monopolist faces the maximization problem over the budget period:

$$\text{Max } (a - Q1 - Q2)Q1 + \delta(a-Q1-Q2)Q2$$

Substitute for Q2:

$$\text{Max } [(a-Q1)/2]Q1 + \delta\ [(a-Q1)/2]^2$$

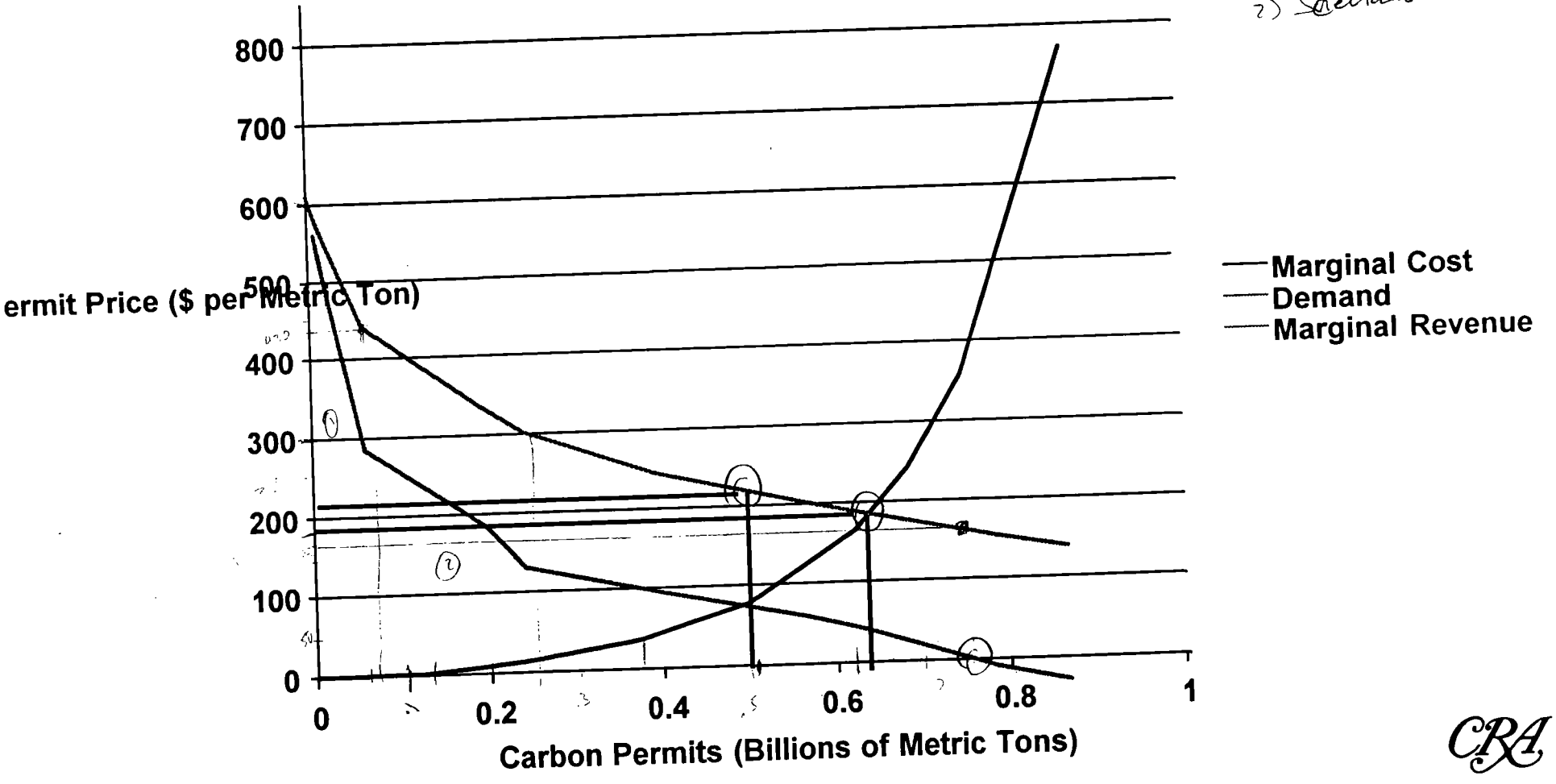
The solution is then: $Q1 = (1-\delta)a/(2-\delta)$, and $Q2 = a/2(2-\delta)$

Note that $Q = Q1 + Q2 = (3-2\ \delta)a/2(2-\delta) > a/2$, for $\delta < 1$. In words, an impatient monopolist facing multiple transactions dates will sell more than a static monopolist.

This example is a simple application of the durable goods monopoly problem. Given more transactions dates, the problem for the monopolist intensifies and total quantity sold will continue to increase towards the level of competitive sales.

Russia's Monopoly Power Could Raise Permit Prices

1) - 2030 time frame?
2) Scenario - Annotate?



Source: CRA calculations based on Multi-Region Trade Model

CRA

Total (-FSU) Demand = $ap^2 + bp + c$

$$P = aq^2 + bq + c$$

$$P - C = aq^2 + bq$$

$$P - C = q(aq + b)$$

$$q = \frac{-2ab + b \pm \sqrt{(2ab+b)^2 - 4a^2c}}{2ac}$$

$$P = .0335q^2 - 10.964q + 941.66$$

$$Q_S = -.0191P^2 + 4.8066P + 326.63$$

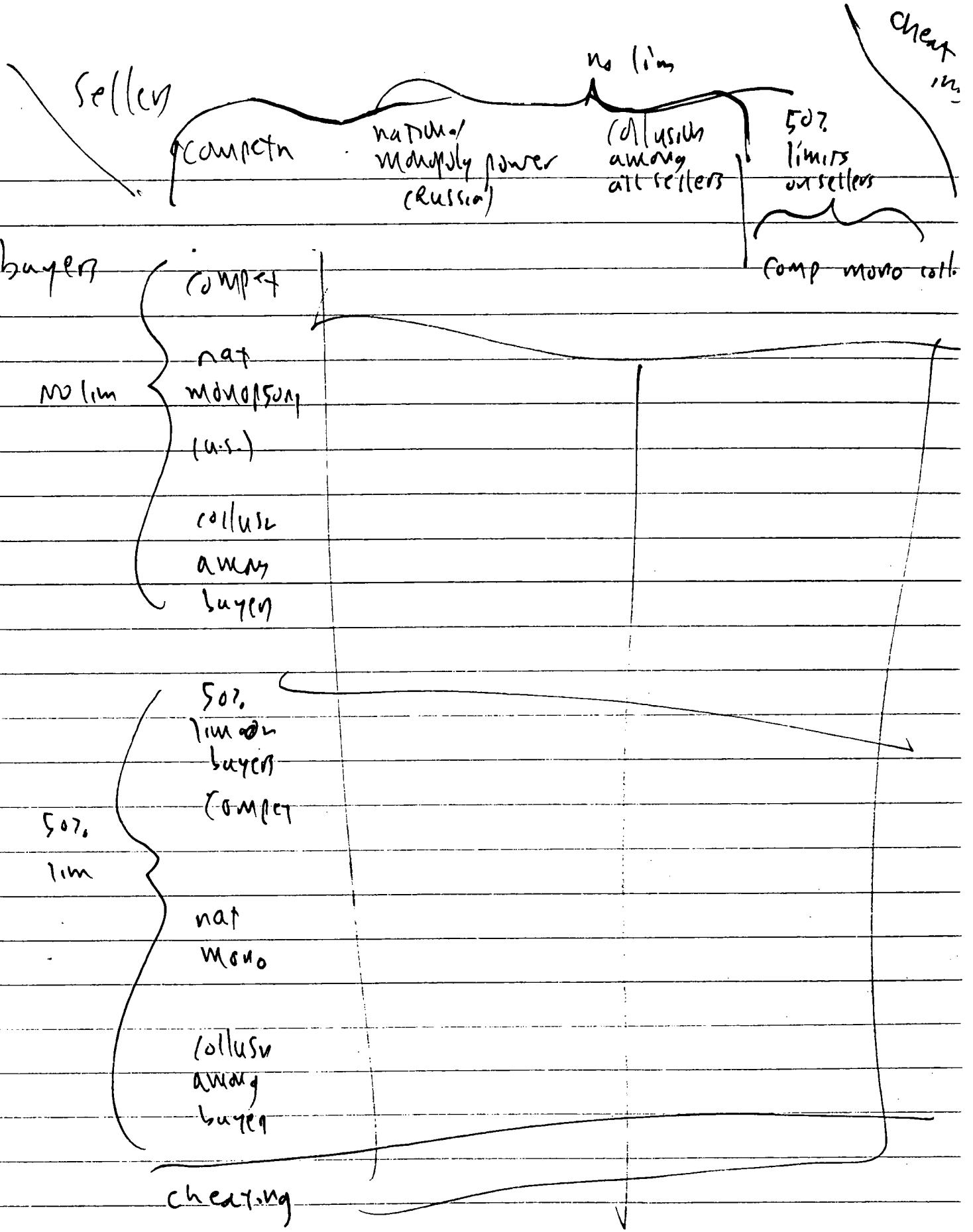


Table 1: effect on us

Table 2: all buyers

Dimensions on Megatable