Price Disclosure, Marginal Abatement Cost Information and Market Power in a Bilateral GHG Emissions Trading Experiment#

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and

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ABSTRACT

We conducted an experiment to examine the performance of the bilateral trading institution in GHG emissions trading. First, we found that the efficiency of bilateral trading is quite high, regardless of open or closed information of contracted prices and/or marginal abatement cost curves. Second, marginal abatement costs are equalized over time. Third, on the other hand, contracted prices did not converge to the competitive price over time. Fourth, subjects who had market power did not use it.

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1. Introduction

To prevent the global warming, the discussion on how to control the total amount of greenhouse gases (GHG's) has started among countries in the late of 1980's. At the third session of the Conference of the Parties (COP3) to the United Nations Framework Convention on Climate Change (UNFCCC) at Kyoto in December, 1997, the Kyoto Protocol was adopted, which was the first agreement on the quantified GHG emission limitation. It assigns each Annex B country (an advanced country or a country that are undergoing the process of transition to market economy) the quantity she should comply with, and calls for these countries to reduce their overall emissions by at least five percent below the 1990 level in the commitment period 2008 to 2012. To assist the countries in achieving compliance, the Protocol authorizes three major mechanisms, that is, emissions trading, joint implementation and the Clean Development Mechanism. The details of mechanisms, however, remained to be elaborated. Designing these mechanisms is an urgent task since they should start working by 2008 at the latest. Among them, this paper focuses on designing desirable institutions for GHG emissions trading through the use of experimental economics. [1]

Although we know "roughly" that introducing a market for GHG emissions achieves the lowest cost to reduce them, we do not know how the emissions should be traded in the market. As a first step toward designing the GHG emissions trading institution, this paper deals with bilateral trading. There are two main backgrounds to start with bilateral trading. First, the participants in the GHG emissions trading in the Kyoto Protocol are countries. Thus, bilateral negotiations between the government officials of two countries can be the major style of trading. Second, we already have an

[1] For recent experimental results in emissions trading, see Cason and Plott (1996), Godby, Mestelman and Muller (1998), and Muller and Mestelman (1998).

example of bilateral trading used as an emissions trading institution. In the U.S.A., the acid-rain control program in the Clean Air Act Amendments of 1990 introduced tradable emission allowances for sulfur dioxide, and most of the trades have been carried out through bilateral trading. This program attained the greater reduction of sulfur dioxide emissions than the assigned amount. However, we cannot conclude from this observation that bilateral trading works best as an emissions trading institution because there were other factors which might lead to this great reduction, for example, the permission for banking, the existence of technologies reducing marginal abatement costs, and the combined use of annual auctions.[2] We cannot compare the result of this program with the case of competitive equilibrium or the case of other institutions, without the firms' abatement cost information or the data from other institutions. Thus, the experiment on bilateral trading provides a means for study in a controlled environment isolated from these complicating factors. The experiment will also help to provide insight on emissions trading policy under alternative policies for which no field data exists. Such data may be useful for evaluating existing schemes, such as those used in the U.S.A., and provide suggestions for further improvement.[3]

The bilateral trading examined in this paper has a special feature, which we call the *dual role property* of a trader. That is, each participant in the institution can be a buyer and a seller depending on the allowance price. This is a natural property of real emissions trading, but each subject is assigned to be either a buyer or a seller in most previous experiments in emissions trading. Recently, Bohm (1997) employed this property, and reported a bilateral trading experiment among four teams consisting of experienced public officials or experts appointed by the Energy Ministries. Each team represented one of the

[2] 2.8% of annual total allowances is auctioned once a year.

four Nordic countries, and had some information on the marginal abatement cost curves of all teams.[4] The asks and bids were exchanged by fax without revealing this information to other teams. It took four days to complete this experiment. The resulting prices were very close to the competitive equilibrium price and its efficiency was 97%, which was very high.

Following Bohm's experiment, we designed a bilateral trading experiment with two controls: (i) open or closed information of contracted prices, and (ii) open or closed information of marginal abatement cost curves. Thus, there are four different treatments. In this way, we can understand which information treatment would be effective for bilateral trading to work as a GHG emissions trading institution.

We conducted two sessions for each treatment. The first finding is that the efficiency of the eight sessions is very high, regardless of open or closed information. That is, open information of contracted prices and/or marginal abatement costs does not improve efficiency. It was more than 99% in 6 sessions, and 98% and 92% in the remaining sessions. This finding contrasts with the widely accepted view on bilateral trading, that is, (i) it would be inefficient in the sense that some dissatisfied traders could not be eliminated due to mismatching, and (ii) the revelation of contracted prices would improve its efficiency.[5] Second, marginal abatement costs are equalized in most of the sessions except for the 92% efficiency session. Third, the contracted prices did not converge to the competitive equilibrium price. This observation is different from Bohm's.

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[3] Some evaluation of sulfur dioxide emissions trading has just started. See, for example, Schmalensee et. al. (1998) and Stavins (1998).

[4] Bohm distinguished two concepts of marginal abatement cost curves. *Technical* marginal cost curves are based upon scientific knowledge. He assumed that each team knew the others' technical cost curves very well, but did not know *social* marginal abatement cost curves. Social abatement costs include considerations of real-world political constraints concerning employment and distribution effects. Cost curves used in his experiment were social ones. In our experiment, these two concepts coincide.

[5] These views are not based upon either economic theory or empirical evidence. Feldman (1973) shows that allocations through bilateral trading can attain Pareto efficiency in a finite number of steps.

Fourth, subjects who could exercise market power did not use that power. In each session, we had six subjects who were supposed to represent Russia, Ukraine, U.S.A., Poland, EU, and Japan.[6] In our setting, only the U.S.A. had market power, and the subjects who were assigned this role did not reduce their quantity demanded in order to lower the price.

The paper is organized as follows. In the next section, we describe the experimental design in detail, and section 3 presents the results. In section 4, we discuss why efficiency is so high. Section 5 discusses the future agenda.

2. Experimental Design

The experiment has two controls: (i) open or closed information of contracted prices, and (ii) open or closed information of marginal abatement cost curves. Therefore, there are four treatments. Repeating the same treatment twice yields eight sessions. In what follows, "O" represents " open" information and "C" represents "closed" information. For example, "OC2" indicates session 2 in the open information treatment of contracted prices and marginal cost curves. That is, the first digit indicates price information, the second digit marginal cost curve information, and the last the session number.

We recruited at least six students for each session by campus-wide advertisement at Osaka University, Japan, during October, 1998. These students were told that there would be an opportunity to earn money in a research experiment. None of them had prior experience in a bilateral trading experiment. It took approximately 160 minutes for each session. The mean payoff per subject was $31.25 ($1=115 yen). The maximum payoff was $66.09, and the minimum payoff was $17.39.

[6] Although we designed our experiment supposing that subjects represent these countries, we used abstract terms during the experiment to avoid any effect of country names or the term "emissions trading" on subjects'

Figure 1 is around here

Let us describe an "OO" session. Eight subjects were seated at desks in a relatively large room and listened to a tape-recorded voice giving instructions. This instruction part took about 45 minutes. In this part, each subject received a sample graph (see Figure 1). The upper half is a sample marginal abatement cost curve. Each subject was told that the initial position is at 0.[7] If the subject moves to the right, she buys the allowance and earns benefits, and if she moves to the left, she sells the allowance and obtains a profit. All possible situations were depicted in the lower half of Figure 1. After receiving instructions on how to transact with other subjects, all subjects took an examination to check their understanding of the instructions. The best six subjects continued the experiment, and the rest were asked to leave the room with $13.[8] Then each subject was assigned an identification number from 1 to 6 and, at the same time, each subject received her own marginal abatement cost curve. In the "OO" session, each subject received Figure 2 with all six abatement cost curves, and had fifteen minutes to examine it (i.e., open information of marginal abatement cost curves).[9] Then bilateral trading started. Since every subject had a tag with an identification number, subjects could identify other subjects' marginal abatement cost curves. Every subject could move around the room freely to find a subject with whom to transact. During negotiations, subjects were not allowed to talk. Only numbers (price and quantity), and "yes" and "no" symbols on their negotiation sheets, were exchanged in order to avoid information leakage. Once a pair reached an agreement, they reported the price and quantity to an experimenter, who

behavior.

[7] We implicitly presume that position 0 is the position where each country attains the goal required by the Kyoto Protocol. In other words, our experimental setting asks what kind of trading should be done in order to achieve that goal. That is, we did not address the non-compliance issue.

[8] The number of subjects who actually participated in bilateral trading was 6. Sessions where 8 subjects participated at the outset were "OO1", "OO2", and "CO2", sessions with 7 subjects were "OC2", "CC1", and "CC2", and sessions with 6 subjects were "OC1" and "CO1".

[9] Since information on the marginal abatement cost curves around 2010 is hard to obtain, we draw these curves based upon some information provided by Dr. Kawashima.

announced these numbers on the blackboard (i.e., open information of contracted prices). The maximum time for negotiations was 60 minutes, and subjects could end their negotiations early if all subjects agreed to it. The full 60 minutes was used in all sessions except "CO2." In this session, subjects quit at 58:30.

Figure 2 is around here

During the experiment, we did not use any country names or the term "emissions trading." That is, subjects faced a situation where trading of an abstract commodity was conducted with an abstract price.

3. Experimental Results

3.1 Efficiency of Bilateral Trading

Let us define the efficiency of bilateral trading as follows:

$$\frac{\text{Surplus extracted in the experiment}}{\text{Surplus extracted at competitive equilibrium}}$$

This is a standard measure of efficiency. Efficiency in experiments is usually measured as the percentage of the maximum possible surplus extracted from the institution. Since our institution includes no externality, the maximum is attained at the competitive equilibrium.[10] In our design, the competitive equilibrium price ranges from 118 to 120. We regard 119, which is the midpoint between 118 and 120, as the competitive equilibrium price. At this price, the surplus is 6990. In Table 1, the top row indicates the name of the sessions, the left column shows the I.D. numbers of subjects, and the numbers in parentheses are their individual surplus at the competitive equilibrium price. In each cell, the upper figure is the actual individual surplus the subject earned, and the lower

[10] For the efficiency concept, see Davis and Holt (1993).

figure is the efficiency of this subject. For example, the figure of 0.732 for subject 1 in the "OO2" session is the ratio between 1870 and 2555, which we call individual efficiency.

Table 1 is around here

As Table 1 shows, the efficiency of each session is quite high except "CO1." The reason for the low efficiency level in this session is that subject 5 traded with other subjects even though she suffered a loss. Individual efficiencies are quite different even for the same subject number. Statistical tests show that Russia consistently earned a much lower surplus than that of the competitive equilibrium and Poland earned a greater surplus than that of the competitive equilibrium. The efficiency of the other countries is close to one. As we discuss later, the only country that had some market power was the U.S.A. We still do not understand why Russia and Poland deviated from the competitive equilibrium efficiency and why the U.S.A. did not use its market power.

Figure 3 is around here

Figure 3 shows efficiency changes over time. After sixteen minutes, the efficiency in all sessions except session "CC2" was greater than 80%, and it was more than 90% in 6 sessions of 8 after 25 minutes. Efficiency usually is monotonically increasing, but in session "OC2" efficiency moved up and down. This was due to the fact that one subject bought allowances at a loss, but sold them at a relatively high price. Summarizing these findings, we have:

Observation 1. (i) *The efficiency of bilateral trading is almost one, regardless of open or closed information of contracted prices and marginal abatement cost curves.*

(ii) *Russia's efficiency is low, Poland's efficiency is high, and the efficiency of the other countries is close to one.*

(iii) *The efficiency in 6 sessions of 8 was more than 90% after 25 minutes.*

Support. To verify whether each country's efficiency is higher than, lower than or close to one, we conducted a *t* test for the mean. Ignoring the treatment, we have eight observations for each country's efficiency. Since the treatments are different among these observations, and the data size is small, we also conducted a sign test. The null hypothesis is that the efficiency of the country is one. The *t*-statistics of Russia, Poland and Japan were significantly far from 0; they were -10.35, 3.89 and 2.68 respectively. The *p*-values of the sign test on these three countries were 0.01, 0.01 and 0.29 respectively. The high *p*-value of the sign test on Japan means that her relatively high efficiency in the experiment can happen by accident with probability 0.29 even if her efficiency was in fact close to one. Thus, we conclude that the efficiency of Japan cannot be said to be higher than one. For the efficiency of each session, we did not use statistics because it cannot rise beyond one and so the distribution is not symmetric with regard to one. However, as Table 1 shows, the efficiency is almost one in all sessions except "CO1", whose efficiency is 0.919 and still high. Observation 1-(iii) comes from Figure 3.

From this observation, high efficiency seems to be an intrinsic property of bilateral trading under the dual role property.

3.2 Contracted Prices in Bilateral Trading

Figures 4-1 and 4-2 show contracted prices and quantities over time. The gray horizontal line in each small graph shows the competitive equilibrium price range of 118-

120. The left-hand side number of a square is the seller's subject number, the right-hand side number is the buyer's subject number, and the number under the square is the contracted quantity. If the variance of the last three contracted prices is significantly smaller than the variance of the first three contracted prices, then we say that the contracted price sequence converges. We find the convergence of contracted prices in five of eight sessions, but no information disclosure effect is observed. Similarly, Figures 5-1 and 5-2 show bids and asks over time. A square denotes an ask, and a triangle a bid.

Figures 4-1, 4-2, 5-1, and 5-2 are around here

Observation 2. (i) *Contracted average prices in the "CC" sessions (under closed information of contracted prices and marginal abatement cost curves) roughly equal the competitive equilibrium price, but the variances of prices in the "CC" sessions are larger than those of the rest except "OC1".*

(ii) *Average prices cannot be said to equal the competitive equilibrium price in sessions other than the "CC" sessions.*

(iii) *The average price of the last three contracts is not equal to the competitive equilibrium price in any session.*

(iv) *The convergence of contracted prices is found in five of eight sessions, but no information disclosure effect on convergence is observed.*

Support. To verify whether the average price of each session is equal to the competitive price, we conducted a *t* test for the mean. However, since more than one unit of allowances were traded at the same price between two subjects at once, observations are not independent. Thus, we also conducted a sign test. The null hypothesis is that the average price of the session is equal to the competitive price. The t-statistics of only "CC1" and "CC2" were not significantly far from 0; they were -1.40 and -1.64 respectively. The sign test obtained high p-values in "CO1", "CC1" and "CC2"; they were 0.08, 0.27 and 0.65 respectively. Since t-statistic of "CO1" was significantly far from 0 (-4.65), and the p-value of the sign test on this session was relatively small, we conclude that the average price of "CO1" is not equal to the competitive price while those of "CC1" and "CC2" are. Similarly, we conducted the same t test on the average price of the last three contracts for each session, and in every session, it was significantly far from the competitive price (we did not use a sign test here because the number of price levels was only three and so a sign test cannot provide any strong evidence). To compare the variances of contracted prices between sessions, we conducted an F test for equal variance. The null hypothesis is that there is no difference of variances between two sessions. The F-statistics are summarized in Table 2. In each cell, the upper figure is the F-statistic between sessions in the row and column. The lower figure in parentheses is its one-side p-value. The variances of prices in "CC1" and "CC2" were 459.79 and 613.18 respectively, which were greater than those of other sessions except "OC1", in which it was 530.51. Table 2 shows that the variance difference is significantly large between the "CC" session and others except "OC1". We also conducted the same test on the variance between the first three and the last three contracted prices within each session. The F-statistics (one-side p-values) of "OO2", "OC2" and "CO2" were 1.33 (0.19), 1.02 (0.47) and 1.10 (0.39) respectively, while those of other sessions were so large that the p-values were almost 0.

Table 2 is around here

By the nature of bilateral trading, the price contracted by a pair of subjects is determined by negotiation. Even though several other contracted prices have already been announced, a pair of subjects cannot reach an agreement if either of them rejects these prices. For this reason, the competitive equilibrium price cannot play the role of the standard of trade. The step-function nature of marginal abatement cost curves can be a supplementary reason why contracted prices did not converge to the competitive price. For example, in session "CO2", Russia sold 8 allowances at price 90 at 35 minutes and her marginal abatement cost reached the kink which includes the competitive price (see Figures 4-2 and 2). Since her marginal cost from -32 to -55 is constant and it is 90, she did not suffer any loss in this trade. However, this made the average price of the last three contracts significantly lower than the competitive price in this session. If her marginal abatement cost curve were smooth, she should have suffered loss and so would not have accepted such a low price.

3.3 The Effect of Disclosure of Contracted Price and Marginal Abatement Cost Curve Information

The effect of disclosure of contracted prices can be calculated by comparing the "OO" and "CO" sessions, and the "OC" and "CC" sessions. However, since the variances of contracted prices in sessions "OC1" and "OC2" cannot be said to be the same, we omitted these sessions from the comparison. Under this constraint, we compare the "OO" sessions with the "CO" sessions. No differences are observed among the variances of these sessions.

For the same reason mentioned in the above paragraph, we compare the "CO" sessions with the "CC" sessions to measure the effect of disclosure of marginal abatement cost curve information. We find that the variance of contracted prices in the "CO" sessions is smaller than in the "CC" sessions. Summarizing these facts, we have:

Observation 3. (i) *Assuming that each subject knows other subjects' marginal abatement cost curves well, the disclosure of contracted prices does not have any impact on the variance of contracted prices.*

(ii) *Under closed information of contracted prices, the disclosure of marginal abatement cost curves reduces the variance of contracted prices.*

Support. Comparing two sessions within the same treatment, we find the *F*-statistic for equal variance between "OC1" and "OC2" being significantly large, which is 5.35 (see Table 2). This implies that the variances are different between these sessions. The *F*-statistics between "OO" sessions and "CO" sessions are small except between "OO2" and "CO2", for which it is 1.41. If we employ a two-side test between these two sessions, however, the null hypothesis cannot be rejected with the 5% significance level. Therefore, we conclude that the variances of the "OO" and "CO" sessions are not different. On the other hand, the *F*-statistics between the "CO" and "CC" sessions are significantly large, and so their variances are different.

3.4 Equalization of Marginal Abatement Costs over Time

Behind efficiency, we can see how marginal abatement costs changed over time. Figures 6-1 and 6-2 show their change in each session. If a subject sells allowances and reaches the kink on the marginal cost curve, we choose the right-hand side cost figure, and if a subject buys allowances and reaches the kink on the marginal cost curve, we choose the left-hand side cost figure. Due to the step-function nature of our marginal abatement cost curve, we must be careful when evaluating marginal costs. For example, the marginal abatement cost of Russia in session "OO1" was 90 after 25 minutes. Checking the raw data, we find that Russia sold exactly 55 units of emissions allowance in 25 minutes. Therefore, if the subject wanted to sell one more unit, its marginal abatement cost would have been 120 (see Figure 2). Taking account of this fact, we have:

Observation 4. *Except for the EU subject in session "CO1," the marginal abatement costs of all subjects approach the competitive equilibrium price.*

Support. The step-function nature of our marginal abatement cost curves allows the data to take only some particular values. For example, the EU's marginal cost can be only 0, 90, 130, 170, 210 or 250. Thus, instead of using statistics, we drew Figures 6-1 and 6-2, examined them taking the step-function nature into account, and reached Observation 4.

Figures 6-1 and 6-2 are around here

3.5 Market Power Issue

We define market power as follows. Given that all other countries behave as price takers, if a country can increase her surplus by changing her behavior, that is, how many allowances she sells or buys at each price, then we say that she has market power. This is called unilateral market power.[11] Each country's marginal abatement cost curve can be regarded as her excess demand curve. To understand how much market power a particular country has, we first aggregate these excess demand curves of all countries other than this country. Given the aggregate excess demand curve of other countries, by changing how many allowances this country sells or buys at each price, the market-clearing price also changes. Using the new price, we calculate this country's surplus and compare it with her surplus at the competitive equilibrium. This procedure shows that the only country that has market power in our design is the U.S.A. Note that the U.S.A. subject can find her market power before the actual trade only in marginal abatement cost disclosure sessions. In sessions with closed information of marginal cost curves, she can only guess it negotiating with other subjects. Although the surplus of the U.S.A. was more than three times her surplus at the competitive equilibrium in two sessions of eight, the statistical tests used in Observation 1 showed that they were not different as a whole. That is, the U.S.A did not exercise market power to increase her surplus. Most probably, the subjects could not exploit the marginal abatement cost curve information to use such market power.

4. Discussion

Let us think about how high efficiency can be promoted by the dual role property, that is, each country can buy *and* sell the allowance depending on the price. Consider the following simple demand and supply curves with two sellers and two buyers drawn in Figure 7. Each seller has just one unit of a good. On the other hand, each buyer wants to buy just one unit of the good. Apparently the competitive equilibrium price must be between 4 and 7, and the social surplus becomes 8. If buyers can only buy and sellers can only sell, a mismatch can easily occur. Consider a pair in which the buyer's value is 10 and the seller's cost is 7. If they trade with each other, the surplus is 3. Consider another pair in which the buyer's value is 4 and the seller's cost is 2. The surplus of this pair is 2 and hence the sum of the surplus is 5, which is less than 8. After these trades, no mutually beneficial trade will occur. Now consider the case in which everyone can buy and sell. After these trades, the buyer whose value is 4 has one unit of the good and hence she can sell it. Since the seller whose cost is 7 does not have any good, he can buy it. If this pair

[11] For the definitions of market power, see Holt (1995).

trades with each other, they can enjoy 3 units of surplus, so that the total surplus becomes 8. Actually, starting from any trading pair, we can find a path that leads to a Pareto efficient allocation.[12]

Figure 7 is around here

Thus, the dual role property seems to be an important factor in achieving high efficiency. In order to confirm this statement, we need to conduct a bilateral experiment with the *uni*-role property where the role of a buyer or a seller is fixed. In an experiment that studies electronic bulletin board trading for emission permits, Cason and Gangadharan (1998) investigated bilateral negotiation with the uni-role property. The efficiencies of three sessions with bilateral negotiation are 57 percent, 77 percent, and 68 percent, which are less than those of the continuous double auction. Since the experiment of Cason and Gangadharan is quite different from our experiment, further study is needed to obtain new insights between the dual role and uni-role properties.

5. Concluding Remarks

In this experiment, it was found that, first, the efficiency of bilateral trading is quite high, regardless of open or closed information of contracted prices and/or marginal abatement cost curves. That is, high efficiency seems to be an intrinsic property of bilateral trading under the dual role property. Second, marginal abatement costs are equalized over time. Third, on the other hand, contracted prices did not converge to the competitive price over time. Fourth, subjects who had market power did not use it.

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[12] See Feldman (1973).

We used just six subjects in each session. If the number of participants increases, the number of possible matchings increases with the square order of the number of participants. That is, if there are many participants in bilateral trading, they cannot communicate well through matching. Therefore, the number of subjects is an open question to be explored.

Our experiment is a prelude to several more experiments that aim at designing the entire emissions trading institutions. In order to provide a solid basis for such a design, we plan to conduct the following: (1) Oral double auction experiment, (2) Banking experiment, (3) Non-compliance experiment, (4) Liability experiment and (5) Market power experiment.

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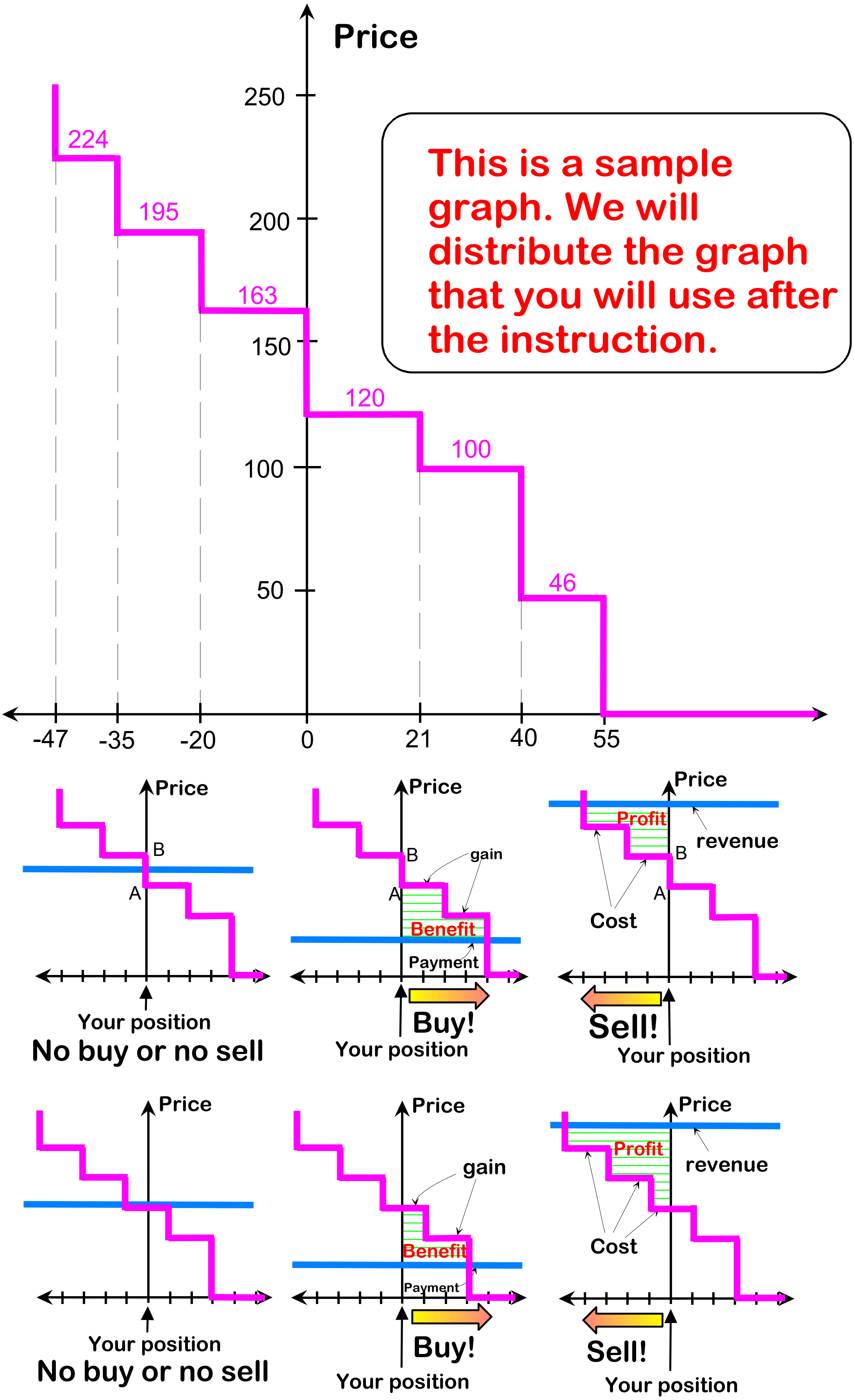
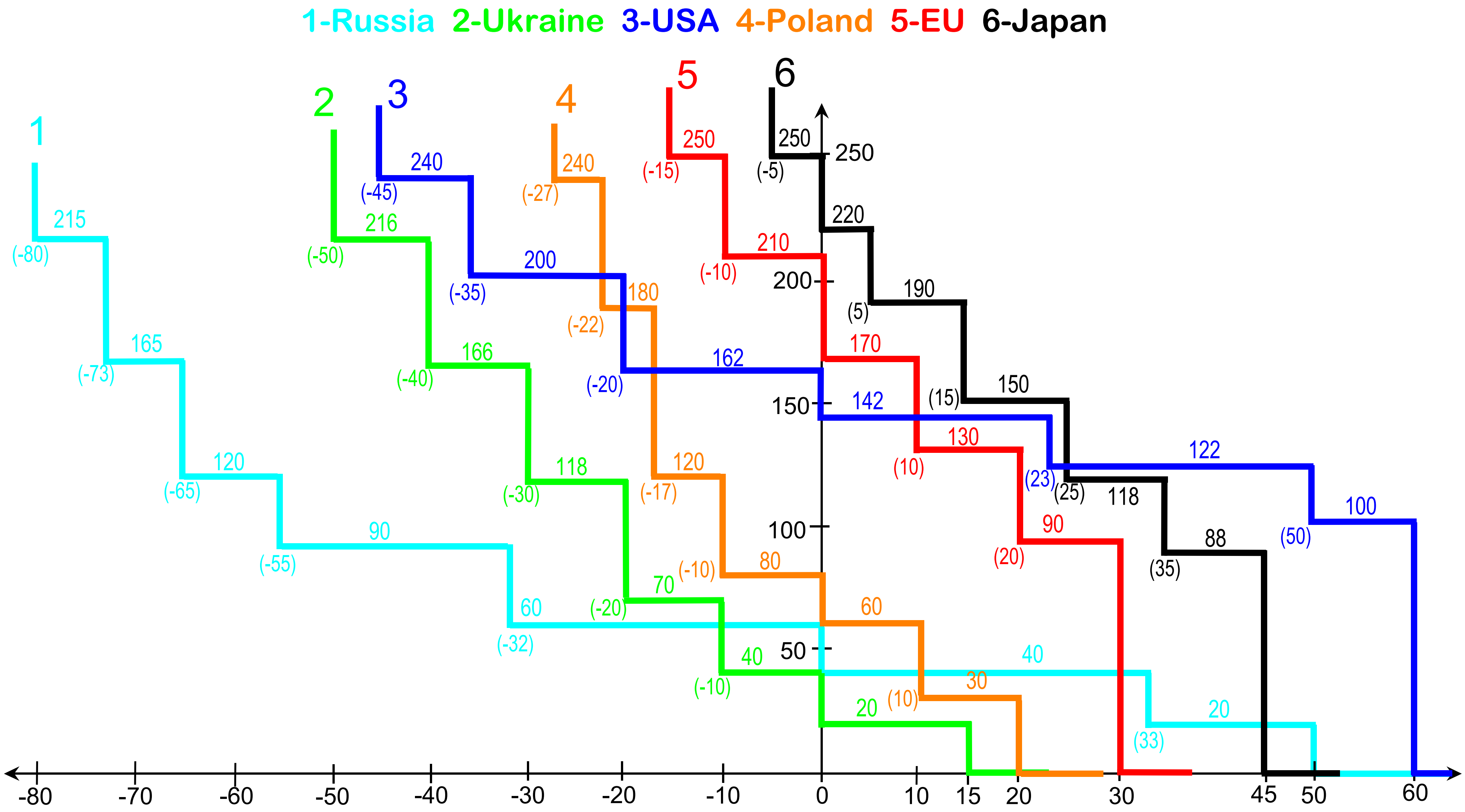


Figure 1. A Sample Graph



No country names were given to subjects in the experiment.

Figure 2. All Marginal Abatement Cost Curves

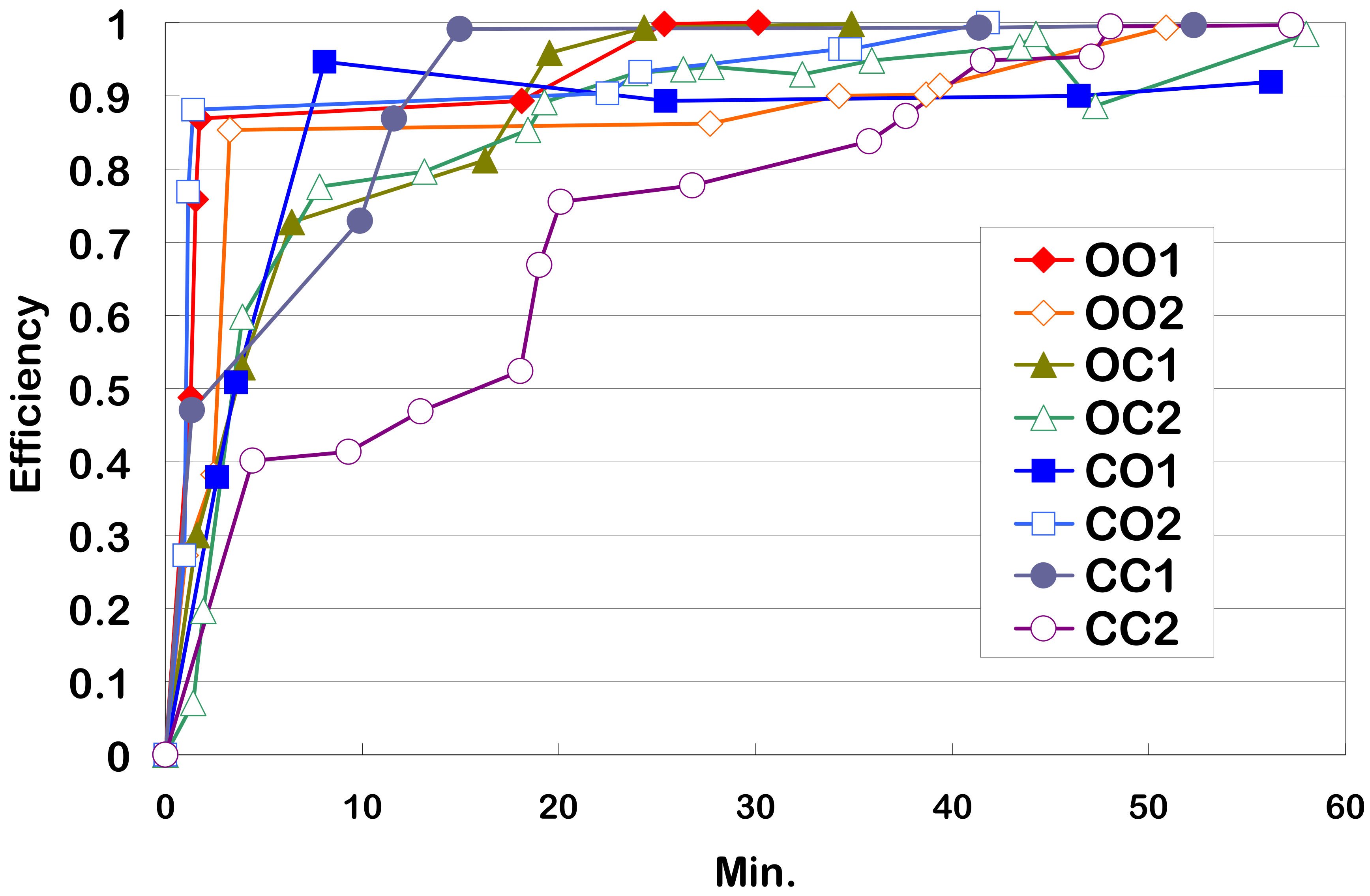


Figure 3. Efficiency Over Time.

Figure 4-1. Contracted Prices and Quantities over Time.

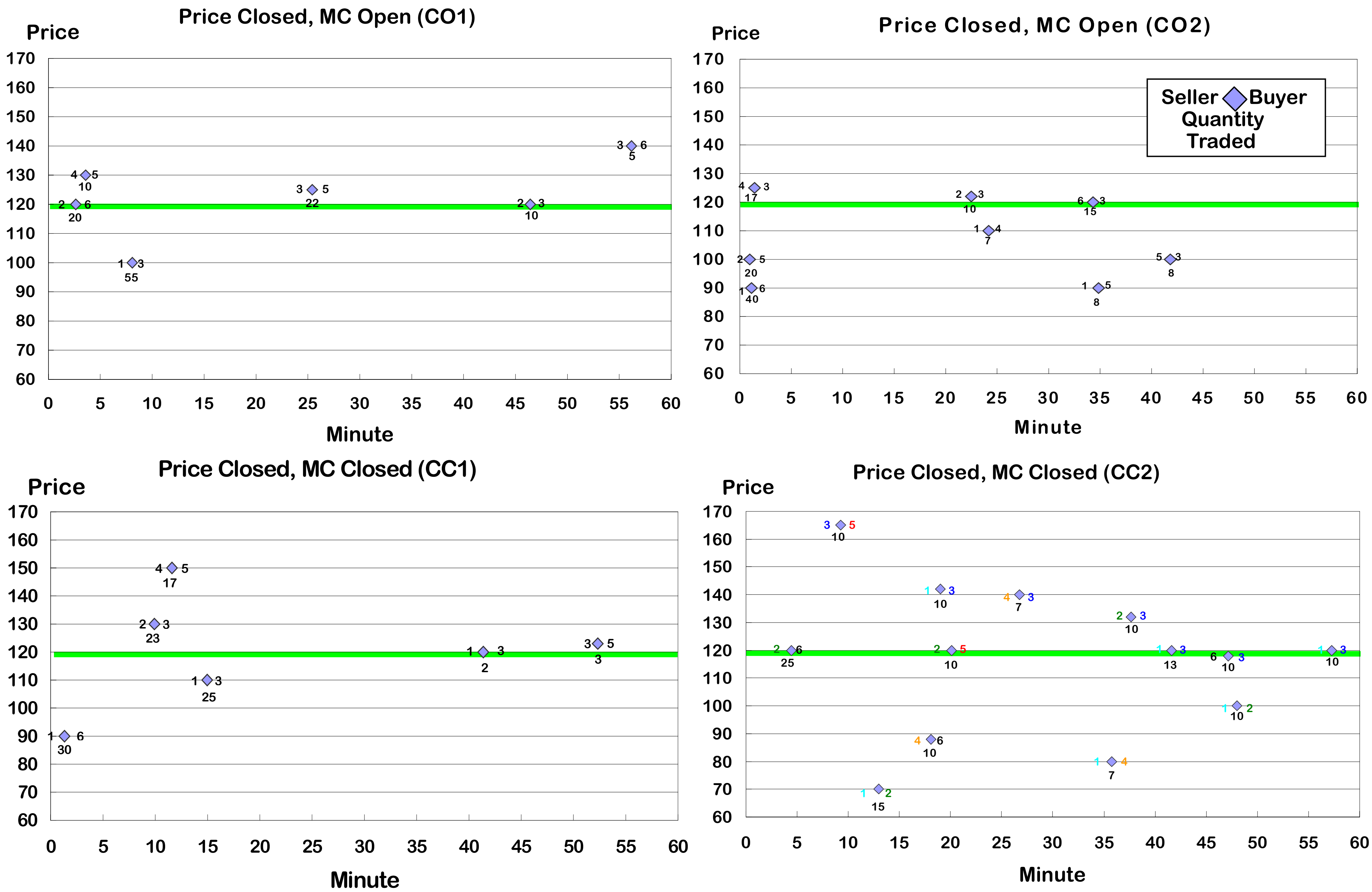


Figure 4-2. Contracted Prices and Quantities over Time.

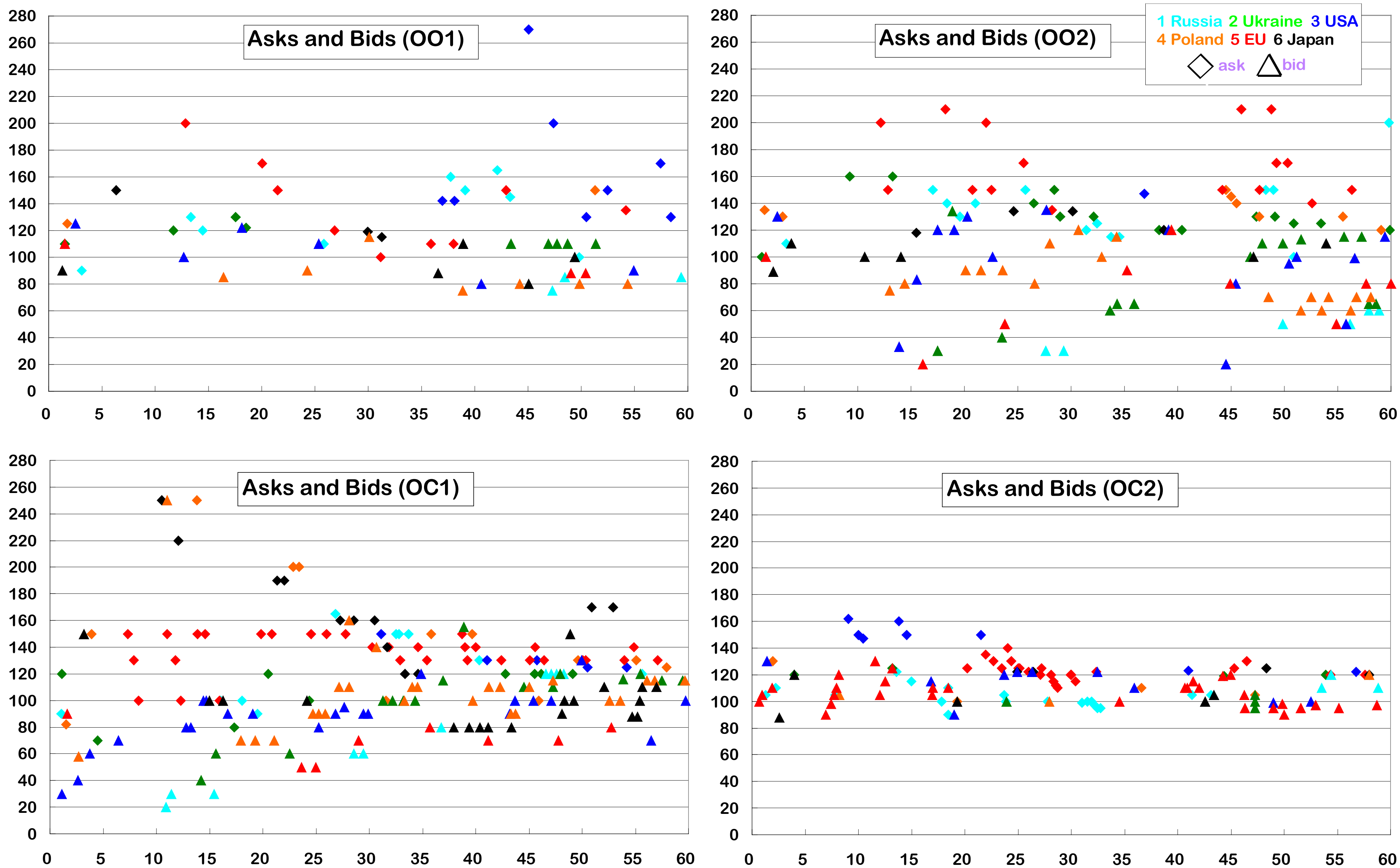


Figure 5-1. Bids and Asks over Time.

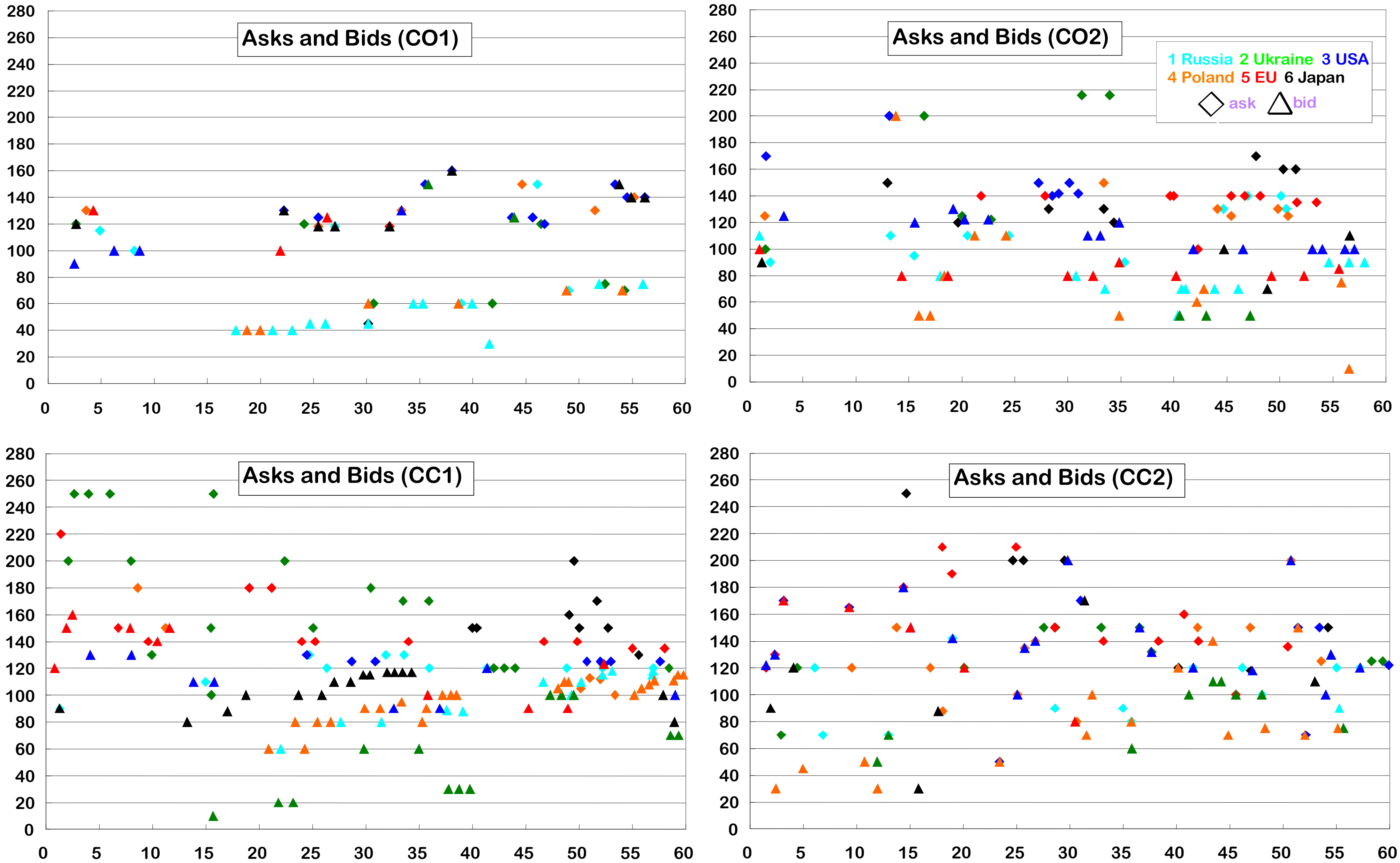


Figure 5-2. Bids and Asks over Time.

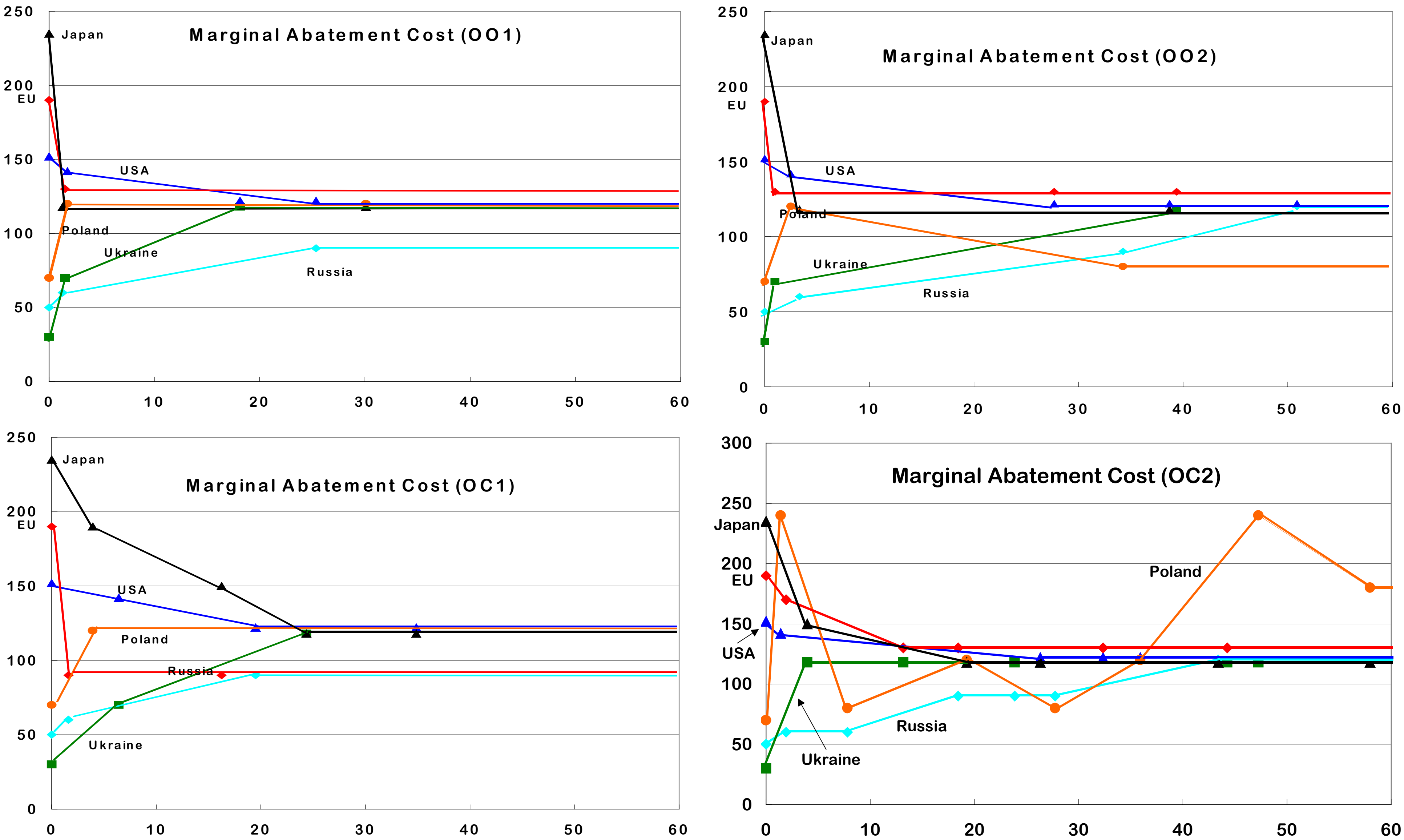


Figure 6-1. Marginal Abatement Cost over Time.

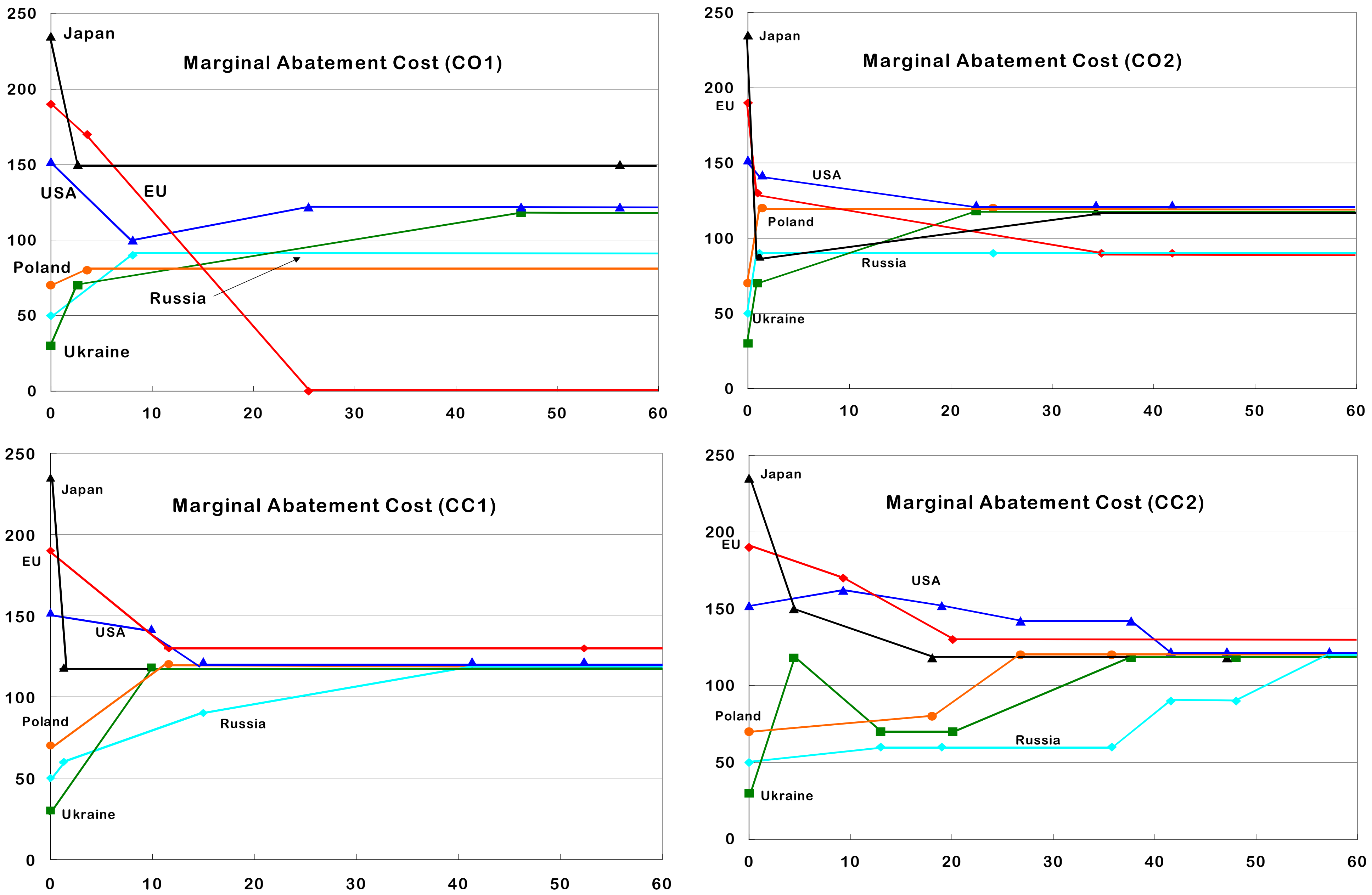


Figure 6-2. Marginal Abatement Cost over Time.

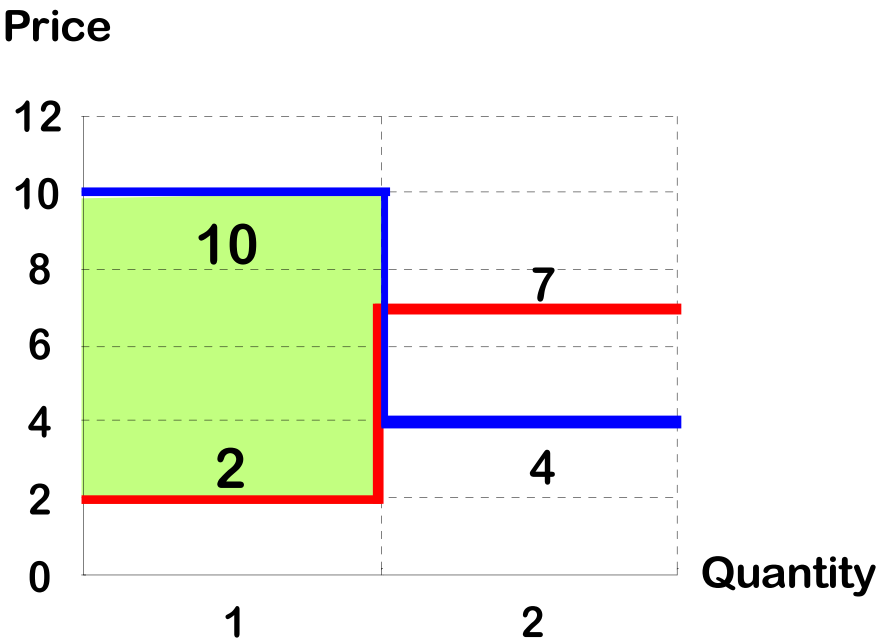


Figure 7. Efficiency of Bilateral Trading

Subject No.	OO1	OO2	OC1	OC2	CO1	CO2	CC1	CC2
1(2555) (Russia)	1420 0.556	1870 0.732	960 0.376	1710 0.669	1510 0.591	1100 0.431	1460 0.571	1600 0.626
2(1290) (Ukraine)	1140 0.884	914 0.709	360 0.279	1665 1.291	1320 1.023	940 0.729	1536 1.191	2370 1.837
3(610) (U.S.A.)	685 1.123	683 1.120	2060 3.377	372 0.610	1846 3.026	615 1.008	583 0.956	550 0.902
4(390) (Poland)	520 1.333	570 1.462	850 2.179	530 1.359	500 1.282	555 1.423	910 2.333	500 1.282
5(620) (EU)	800 1.290	1105 1.782	1300 2.097	755 1.218	-150 -0.242	1080 1.742	81 0.131	150 0.242
6(1525) (Japan)	2425 1.590	1800 1.180	1450 0.951	1844 1.209	1400 0.918	2700 1.770	2390 1.567	1800 1.180
Sum(6990)	6990 1	6942 0.993	6980 0.999	6876 0.984	6426 0.919	6990 1	6960 0.996	6970 0.997

Table 1. Efficiency of Bilateral Trading

	OO2	OC1	OC2	CO1	CO2	CC1	CC2
OO1	1.17 (0.21)	3.23 (0.00)	1.66 (0.00)	1.03 (0.44)	1.21 (0.15)	2.80 (0.00)	3.73 (0.00)
OO2		3.77 (0.00)	1.42 (0.02)	1.20 (0.16)	1.41 (0.03)	3.27 (0.00)	4.35 (0.00)
OC1			5.35 (0.00)	3.14 (0.00)	2.67 (0.00)	1.15 (0.23)	1.16 (0.21)
OC2				1.70 (0.00)	2.01 (0.00)	4.64 (0.00)	6.18 (0.00)
CO1					1.18 (0.18)	2.72 (0.00)	3.63 (0.00)
CO2						2.31 (0.00)	3.08 (0.00)
CC1							1.33 (0.06)

Table 2. *F*-statistics (*P*-values) for Equal Variance of Contracted Prices