AN EXPLORATION OF THE BEHAVIOUR OF RESALE MARKETS THROUGH COMPUTER SIMULATION

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Abstract

It has been estimated that at least 25% of marketing transaction activities in North America (and a considerably higher percentage in the other continents) take place in secondary or resale markets. In spite of this, very little academic attention has been paid to the behaviour of these markets.

The research project described in this paper consists of 35 separate experiments; it is a heuristic study utilizing computer simulation. The objective of the research is to investigate to what extent (if any) the average transaction prices and volumes are affected by various degrees of price-information and/or bargaining strength on the one hand, and the form of supply and demand schedules on the other.

INTRODUCTION

Economists originally recognized only two kinds of organized economic markets: "perfect competition", where prices were determined only by the interaction of aggregate supply and demand, and "monopoly", where prices were determined by the restrictive practices of the monopolist. Later the repertoire got enlarged by recognizing two additional forms in between these two extreme cases: "oligopoly", where prices were determined by the interaction of oligopolists, and "monopolistic competition", where prices were determined partially by the restrictive practices of the sellers and partially by the preferences for the differentiated products of the buyers. In all of these cases, however, there was only one recognized market price.

While these models are important in analyzing typical "primary-market" behaviour, they are not at all inclusive with regard to real economic phenomena. *In real life, there are markets where for essentially the same goods or services, several prices exist* and these prices may fluctuate as a result of varying degrees of price-information and varying degrees of bargaining power available to either or both parties of the transaction. Such markets are typically called "secondary" or resale markets.

Examples of such markets are plentiful. Real estate resale markets, used car resale markets, the various capital markets, and the employment market for executives and professionals are only a few of the many examples one could readily list.

THE RESEARCH QUESTIONS

This research project is designed to find the answer to four specific research questions:

1. To what extent (if any) does bargaining strength influence average prices and average volumes in resale markets?
2. To what extent (if any) does price-information influence average prices and average volumes in resale markets?
3. To what extent (if any) does the slope and form of the supply and demand curves influence average transaction prices and volumes in resale markets?
4. To what extent (if any) are secondary or resale markets more effective marketing devices (as measured by average transaction prices and volumes) than their perfect or primary market equivalents?

THE EXPERIMENTAL DESIGN

In the experimental design, five distinct Test Cases (designated as Cases 1, 2, 3, 4 and 5) were specified, representing combinations of various typical linear supply and demand schedules. The difference between the cases are essentially in the respective slopes of the specified supply and demand curves.

As this is a heuristic analysis, specific hypothetical values had to be assigned to the various supply and demand schedules. To associate the schedules with a realistic example, the reader could visualize a resale market for identical townhouses (i.e., same age, same size, same type, same

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builder) in a large suburban community. In our simulated example, there were 51 potential buyers and the same number of potential sellers for these townhouses[1] and their reserve prices (i.e., price limits) varied between $10,000 and $110,000 in the extreme cases and between $47,500 and $72,500 in the more moderate ones. But in each case the "equilibrium price", that is, the sale price determined by the intersection of the supply and demand curves, had these been "perfect" and organized primary markets, would have been $60,000.[2]

Details of the various supply and demand schedules we have used in the experiments are given in Appendix A.

However, as resale markets are neither "perfect"[3] nor organized primary markets but in fact imperfect secondary markets where potential buyers and sellers are bargaining with each other on an individual and random basis, the actual transaction prices are not directly predictable. We know that if a potential buyer and seller meet and the bottom price (i.e., reserve price) of the seller is equal to or smaller than the top price (i.e., reserve price) of the buyer - a deal is possible, and the actual price eventually agreed upon by both parties will be within the range of the overlapping reserve prices of the two negotiating parties. If these reserve prices do not overlap, no deal could be made and both the potential buyer and the seller must continue to seek out new partners for a transaction.

We also know from experience that if a deal is possible, the realized transaction price may be influenced, on the one hand, by the degree of bargaining strength of the buyer and/or seller, and on the other hand, by the amount of price information that is available to the buyer and/or seller. Admittedly, there may also be other subjective factors influencing the outcome of a deal in a resale market, but given rational behaviour, it is not unreasonable to assume that the two parameters mostly affecting the outcome of the transaction in resale markets are: *market-dominance* (i.e., the phenomenon of seller's market or buyer's market) and *price-information* (i.e., knowledge of previous transaction prices). Thus, in order to observe the specific influence of each of these parameters, we constructed seven different markets (designated as Markets 1, 2, 3, 4, 5, 6, and 7) depicting various distinct combinations of these two parameters. The seven different markets are the following:

1. Seller Dominated Market (seller's market)
2. Buyer Dominated Market (buyer's market)
3. Undominated Market (balanced market)
4. Seller Informed Market (only seller has last-price information)
5. Buyer Informed Market (only buyer has last-price information)
6. Informed Market (both buyer and seller have last-price information)
7. Past-price Informed Market (both buyer and seller have not only last-price, but all previous price information as well).

These markets and their respective pricing models are shown in detail in Appendix B.

Thus, the experimental design is two-dimensional. In the one dimension we have seven Markets representing various market conditions with regard to degree of "bargaining strength" and "price-information" available to market participants, and in the other dimension we have five specific Cases representing various typical benchmark positions of supply and demand conditions. Within each Case, each Market is simulated separately which provides us with 35 distinct experiments. Each experiment is repeated 100 times and the outcomes are averaged in order to obtain statistically reliable results. (A total of 3,500 cycles were simulated and analyzed.)

The results of the experiments are summarized in two five by seven matrixes, one containing information regarding "Transaction Volumes" (as differential percentages relative to the equilibrium value of the equivalent perfect market), and the other containing information regarding "Transaction Prices" organized the same way. These summary tables allow us to readily observe differences and to draw conclusions directly about the effects of the various parameters. Unfortunately the space limitation of this paper does not allow the publication of the detailed documentation one should include with a research article of this kind. The simulation generated a great deal of data which was analyzed statistically and summarized in various computer printout reports.

THE COMPUTER SIMULATION

The computer program for this simulation was written in FORTRAN. The program is in an interactive real-time/on-line mode to allow for direct experimentation with the effects of changes in the data base (sensitivity analysis) and to allow for selective processing of any one of the 35 experiments (7 Test Markets and 5 Test Cases) for any subset of data. While the program is a relatively large one (634 lines of compact coding) it is essentially a simple one conceptually, for it attempts to simulate real life conditions in a secondary market. It consists of the following logical steps:

1. A demand schedule is generated for the specific Test Case.
2. A supply schedule is generated for the specific Test Case.
3. Through random sampling from the demand schedule the experimental market demand schedule (a subset of the demand schedule) is selected (e.g., 30 potential buyers are identified).
4. Through random sampling from the supply schedule the experimental market supply schedule (a subset of the supply schedule) is selected (e.g., 30 potential sellers are identified).
5. Using the values of 3 and 4, the buyers and sellers are arranged in a descending and ascending order respectively and the perfect

market equivalent values (i.e., equilibrium price and equilibrium quantity) are determined.

6. Using the values of 3 and 4 a specific buyer (with his or her reserve price) is selected randomly.
7. Using the values of 3 and 4 a specific seller (with his or her reserve price) is selected randomly.
8. The randomly selected buyer's reserve price is compared with the randomly selected seller's reserve price. If the reserve price of the buyer is less than that of the seller, a deal cannot be made, thus both parties are returned to the market.
9. If the reserve price of the buyer is greater than or equal to the reserve price of the seller, then a deal is consumated in accordance with the relevant formula that applies to the particular test market. (See Appendix B).
10. If a deal was made, the participating buyer and seller (and their respective reserve prices) are removed from the remaining experimental market supply and demand schedules and the particulars of the transaction (transaction price, buyer's and seller's reserve prices, etc.) are recorded.
11. Steps 6-10 are repeated until it is found that no further deals may be made. (The process actually stops after 500 consecutive unsuccessful matching attempts.)
12. The remaining buyers and sellers are surveyed to determine if any further deals could have been made if the market were kept open (i.e., the simulation carried on) longer. If there are any such potential matches remaining, the appropriate transactions are completed and the deals are recorded as "forced deals".[4]
13. The results are tabulated and various statistics and indexes are calculated and printed out. This printout is identified as a Cycle Summary.
14. The same process (steps 3-13) is repeated 100 times (each iteration is called a "cycle") and the results are averaged to obtain statistically significant experimental results. This average result and a full statistical analysis of the 100 samples, as well as the summary of the experiment is printed out as an "Event Summary". (There are 35 "events" in the simulation: the set of events consist of the combinations of the 5 Test Cases and the 7 Test Markets.)
15. Having obtained the results of the 100 cycles and their summary for the specific event under study, we repeat the whole experiment (steps 3-14) for each of the remaining six pre-specified Test Markets. (See Appendix A). Note that the formula used to establish the transaction prices in step #9 will vary with each Test Market.
16. Having obtained the complete set of results for this Test Case we repeat the complete simulation (steps 1-14) for the remaining four Test Cases.
17. Analyse and compare the results conceptually and statistically for the 35 experiments (each with a sample size of 100) and generate transaction price and transaction volume summaries for the 35 distinct experiments in a matrix format relating the 5 Test Cases to the 7 Test Markets.

The reader will note that while the logic of the simulation experiment is rather straight forward the execution is rather complex. This is partly due to the double random sampling process and the volume of the data generated and partly due to the magnitude and variety of statistical analyses performed. Because of the interactive nature of the computer program, the sensitivity of the findings to any of the assumed parameters could be easily tested. This simulation program may easily be adopted for any further research in atomistic[5] markets operating under different constraints, assumptions and supply and demand conditions.

EXPERIMENTAL RESULTS

The research project with its 35 separate experiments generated a great deal of very interesting information. The results are summarized in Table I (Transaction Volume Percentage Differentials) and Table II (Transaction Price Percentage Differentials) below. Some of the results reinforce common or intuitive expectations of market behaviour but some are quite unexpected.

TABLE I

TRANSACTION VOLUME PERCENTAGE DIFFERENTIALS

((ACTUAL - EXPECTED)/EXPECTED)*100

	MARKET						
CASE	1	2	3	4	5	6	7
1	39.17	38.05	38.42	26.61	25.96	23.00	22.27
2	40.05	39.04	38.54	25.77	25.15	22.11	22.34
3	37.81	37.93	39.04	25.46	26.54	22.73	22.85
4	17.64	23.62	18.11	18.31	12.50	13.11	12.42
5	23.78	17.29	18.61	12.50	18.50	12.96	13.11

TABLE II

TRANSACTION PRICE PERCENTAGE DIFFERENTIALS

((ACTUAL - EXPECTED)/EXPECTED)*100

	MARKET						
CASE	1	2	3	4	5	6	7
1	8.17	-9.03	.04	6.24	-6.30	.09	.09
2	4.03	-4.24	.04	3.12	-3.13	.04	.04
3	15.82	-18.86	.00	12.33	-12.31	-.15	.03
4	.12	-31.82	-15.14	-8.16	-22.19	-15.47	-15.52
5	29.35	-.03	15.16	22.20	8.13	15.47	15.55

In the following we shall list on a point by point basis the major findings.

In Symmetrical Markets (Cases 1, 2 and 3)

1. *When bargaining strength and/or price information is equally distributed* between buyers and sellers (Markets 3, 6 and 7), average transaction *volumes are about 22 to 39 per cent higher* than in equivalent perfect markets. The higher figure represents the situation where price-information is not available to either party (Market 3) and the lower figure shows the situation when price-information is available to both parties (Markets 6 and 7).

   Average *transaction prices* in these markets, on the other hand, are equal to the anticipated prices, i.e., they *equal* the so-called *equilibrium prices* of equivalent perfect markets (the difference is statistically insignificant).

2. *When bargaining strength is equally distributed but price information is unequally shared* by buyers and sellers (Markets 4 and 5), average transaction *volumes are still about 25 per cent higher* than in equivalent perfect markets.

   Average *transaction prices shift*, however, in favour of the information privileged party, but this shift is relatively small; on the average it is *about 7.5 per cent.* The magnitude of this shift appears to be directly related to the slopes of the given supply and demand curves; in our experiments the figure varied from 3% for the least price sensitive (Case 2) to 12% for the most price sensitive (Case 3) situation.[6]

3. *When price information is equally shared, but bargaining strength is unequally distributed* between buyers and sellers (Markets 1 and 2), average *transaction volumes are about 38 to 40 per cent higher* than in equivalent perfect markets. The small range appears to be related to the slopes of the schedules, the higher figure representing the least price sensitive case (Case 2) and the lower the most price sensitive one (Case 3).

   Average *transaction prices shift* again in favour of the market-dominating party, but again this shift is relatively small, on the average *about 10 per cent.* Again as with price information, the magnitude of this shift appears to be directly related to the slopes of the given supply and demand curves; in our experiments the figure varied from approximately 4% for the least price sensitive (Case 2) to approximately 19% for the most price sensitive situation.

In Assymetrical Markets (Cases 4 and 5)

4. *When bargaining strength and/or price information is equally distributed between buyers and sellers* (Markets 3, 6 and 7), average transaction *volumes are about 12 to 19 per cent higher,* than in equivalent perfect markets. The higher figure represents the situation where price-information is not available to either party (Market 3) and the lower figure shows the situation when price information is available to both parties (Markets 6 and 7).

   Average *transaction prices* in these markets are *about 15% off* the expected equilibrium prices, *favouring the party with the lower relative price sensitivity* by that amount. Thus in Case 4, where the demand curve is a great deal less price sensitive than the supply curve, the average price is about 5% less than equilibrium, and in Case 5, where the roles are reversed, the same price is about 15% more than the corresponding price of the equivalent perfect market.

5. *When bargaining strength is equally distributed but price information is unequally shared* by buyers and sellers (Markets 4 and 5), average transaction *volumes are still about 12%-18% higher* than in equivalent perfect markets.

   Average transaction prices also shift very significantly here. If the party has access to price information and is also a member of a relatively price insensitive supply or demand schedule the price shift may be as high as 22% in his or her favour. If he or she has access to price information but is a member of a relatively price sensitive supply or demand schedule, the price shift may actually be to his disadvantage as much as 8% off the equilibrium price. Thus, having access to price-information does not even compensate for relative price sensitivity in resale markets. In other words, in resale markets, the "price sensitivity effect" is greater than the "information effect".

6. *When price information is equally shared, but bargaining strength is unequally distributed* between buyers and sellers (Markets 1 and 2), average *transaction volumes are nearly 20% higher* than in equivalent perfect markets. Average transaction prices again shift in favour of the market-dominating party, but again this shift is relatively small, on the average about 10 per cent. Again as with bargaining strength, the magnitude of this shift appears to be indirectly related to the price sensitivity of the given supply and demand curves; in our experiments the figure varied from 33% for the least price sensitive to 8% for the most price sensitive situation.

The above points, different as they are, have one thing in common. In each instance, transaction volumes are significantly higher than expected while average transaction prices are not. This would indicate a consistent trend of higher market effectiveness than expected, using average price behaviour instead of individual price behaviour as a measurement of collective welfare

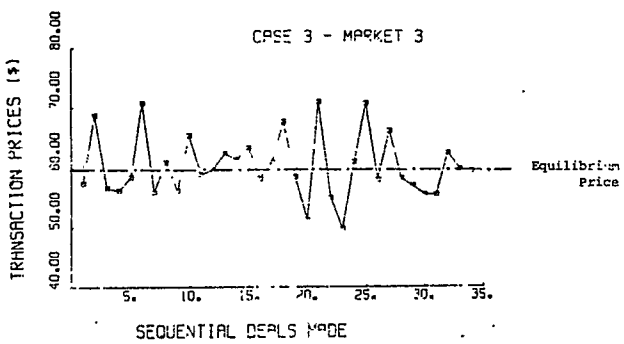
of buyers and sellers. Individual transaction prices in resale markets fluctuate around the average transaction price, of course, and it appears that the major role of price-information made available to buyers and sellers is not in influencing the average transaction prices but in dampening the fluctuation of individual prices around the average price. We have traced the sequential behaviour of prices in a randomly selected sample of cycles and reviewed these price formation tendencies from event to event in the three relevant markets (Markets 3, 6 and 7).

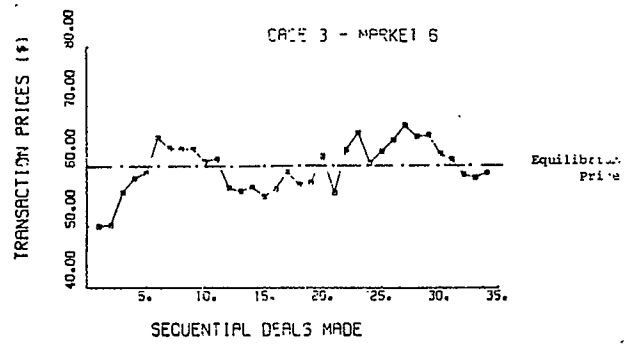
The trend of lessened price fluctuation as we move from a price ignorant market (Market 3) to price informed markets (Markets 6 and 7) is obvious although not as pronounced as one would have expected. Figures 1, 2 and 3 below show this behaviour for a randomly selected cycle for each of the above markets. These results then allow us to list two more points of specific findings:

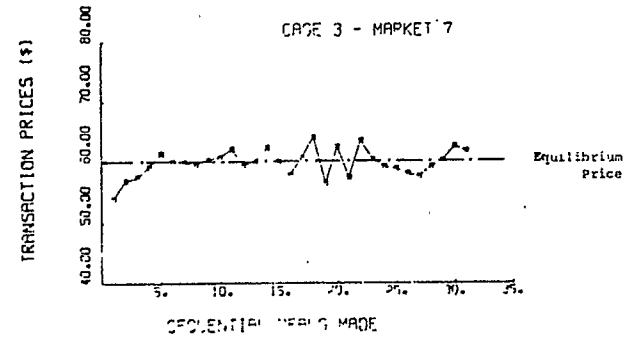
7. Price-information has a curious effect on resale markets. The relationship appears to be a negative one; *access to price-information reduces transaction volumes without affecting average transaction prices.* The major negative impact is obtained when last-price information is made available to a price-information ignorant market reducing transaction volumes from approximately 39 per cent above equilibrium values to 23 per cent in symmetrical markets, and from approximately 18 per cent to 13 per cent in assymetrical markets. This reduction takes place without any effect on overall transaction prices - they do not change as the amount of price-information is varied. Adding additional historical price information (last prices), quite surprisingly appears to have very little additional effect on either transaction volumes or average transaction prices.

8. The extent of historical price information available to buyers and sellers, however, does have a positive stabilizing influence on the market; *the more historical price information is provided, the less price fluctuation there is* around the average transaction price. (See Figures 1, 2 and 3).

FIGURES 1, 2 AND 3







STATISTICAL ANALYSIS

The results of each simulation were analyzed statistically by the computer program. The standard statistical measures (mean, median, standard deviations, skewness and coefficient of variation) were calculated for each price and volume statistic and standard tests of significance (t tests) were conducted to assess the validity of the findings. As a result of this analysis we can confirm that all findings reported in the previous section, entitled: Experimental Results, have been verified as statistically significant.

SUMMARY AND CONCLUSIONS

Quite unexpectedly, we found that in secondary or resale markets where buyers and sellers match up randomly, many of the market parameters that one would expect to have a great deal of influence, do not, in fact, do so.

With regard to the type of supply and demand curves we found that their relative positions (i.e., their relative slopes or their relative price sensitivities) had a great deal of influence on both volumes and prices but their absolute positions (i.e., their absolute slopes or their absolute price sensitivities) had only a negligible effect on either prices or volumes. Thus the critical parameter appears to be not the total price sensitivity of the market, but the differential price sensitivities of buyers and sellers.

With regard to *price-information,* to our great surprise we found that supplying information to a price-ignorant market had not a positive but a negative effect on volumes and had no significant effect on average prices. Furthermore we learned that providing additional price information (historical prices) did not have a significant

additional effect either on volumes or average prices. This was just as surprising as the previous result. We further learned that if only one party had access to price information, the negative effect on volume was somewhat smaller, but the effect was still very notable. In this situation, average prices, as expected, were favourable to the information privileged parties, but much less so than generally assumed.

With regard to *bargaining strength*, we found that bargaining had no significant effect on transaction volumes although it had an important but much less than expected influence on average transaction prices. This was another somewhat surprising result.

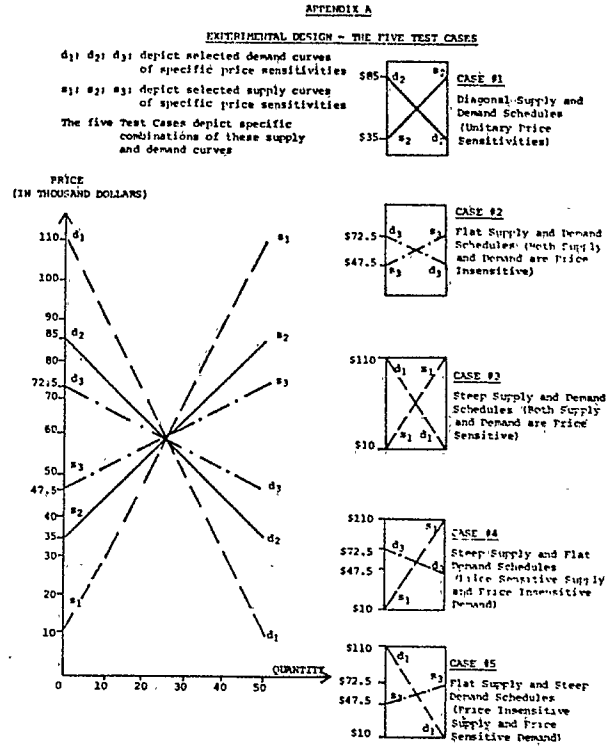
In short, we found that the possession of bargaining strength, in general, had a much less than expected effect, and access to price-information had an unexpected negative effect on resale markets. In terms of economic market characteristics, we found that only very different relative price sensitivities mattered.

We also found that resale markets in their current imperfect form appear economically superior in performance to the "perfect markets" prescribed by economic theory. We found that, on the average, resale markets generate much higher transaction volumes than equivalent perfect markets without a compensating adjustment in average transaction prices. This, of course, does not make our imperfect markets more efficient than their perfect market equivalents, only more effective. Market efficiency is usually defined in the Pareto equilibrium sense and in that sense our imperfect markets are less efficient than their perfect market equivalents. But if we accept the Hicks-Kaldor criterion of welfare improvement, i.e., as long as the total gains to the collectivity of participants are larger than the total losses, the net benefit to the participants is deemed to be positive, then our imperfect markets are more effective than their perfect market equivalents. While some of our individual transaction prices may be higher and others may be lower than equilibrium prices, the average of these values is the same as the equilibrium value and the total number of transactions are higher than equilibrium quantity, this results in a total transaction flow which is greater than in the equivalent perfect market. This makes the net benefits of our atomistic markets in the Hicks-Kaldor sense greater than those in their perfect market equivalents making our atomistic market more effective than the corresponding perfect markets.

We must conclude then by stating that while we are somewhat surprised by the consistency and the magnitude of our findings, perhaps we ought not be that surprised, because in practice, actual resale markets do not voluntarily propagate price information nor do they assign a special significance to the role of bargaining between buyers and sellers. The intuitive position of real estate agents and used car dealers whom we interviewed in the exploratory stage of the research, was that any systematic disclosure of transaction prices would retard and not improve the current real estate and used car markets. They were also convinced that their markets were very little affected by the degree of bargaining power of either potential buyers or sellers. Based on our findings it would appear that there may be some merit in the emotional objections of some marketing practitioners to the various new centralized and computerized real-time transaction information systems proposed for secondary markets which could be interrogated by all interested parties with regard to "asked" prices, "bid" prices and "actual" transaction prices of previous sales. It would appear that the introduction of such a system may not improve the effectiveness of resale markets at all but in fact, due to the lower number of resulting transactions, it may actually decrease the collective welfare of buyers and sellers.

APPENDIX A

EXPERIMENTAL DESIGN - THE FIVE TEST CASES



APPENDIX B

EXPERIMENTAL DESIGN - THE SEVEN TEST MARKETS

The seven markets are represented by seven different models for seven different market conditions - both market dominance (bargaining skill, bargaining power) and the degree of price information is varied from market to market. In all of these experiments, deals will be made only if the buyer's reserve price (B_{MAX}) is equal to, or larger than, the seller's reserve price (S_{MIN}). Namely, the overall constraint on all of these cases is that

$B_{MAX} \geq S_{MIN}$.

The notation used in the models is the following:

B_{MAX}: Buyer's reserve price

B^*_{MAX}: Buyer's reserve price adjusted because of access to "last price" information

B^{**}_{MAX}: Buyer's reserve price adjusted because of access to "past price" information

S_{MIN}: Seller's reserve price

S^*_{MIN}: Seller's reserve price adjusted because of access to "last price" information

S^{**}_{MIN}: Seller's reserve price adjusted because of access to "past price" information

P_{ACT}: Actual transaction price realized in current deal

P_{t-1}: Transaction price of the deal immediately preceding the current deal under consideration, i.e., "last price"

P_{t-i}: Transaction price of the deal, i deals preceding the current deal under consideration

$\bar{P}_t$: Weighted average of transaction prices of several preceding deals, i.e., "past price"

The first three markets represent situations where price information of previous transactions is not available to buyers or sellers, and transaction prices are determined solely through the bargaining positions of the parties. Market 1 represents the situation when the market is dominated completely by the seller (seller's market), and consequently the individual bargaining sessions will result in transaction prices that equal the reserve prices of the individual buyers. In simple terms, the buyer's offer price is forced up to the maximum limit determined by his reserve price. Expressed in mathematical terms: $P_{ACT}=B_{MAX}$. Market 2 represents the opposite situation, where the market is dominated completely by the buyer (buyer's market), and consequently, the individual bargaining sessions will result in transaction prices that equal the reserve prices of the individual sellers. In simple terms, the seller's asking price is forced down to the minimum limit determined by his reserve price. Expressed in mathematical terms: $P_{ACT}=S_{MIN}$.

Market 3 represents the situation where the market is not dominated by either buyers or sellers (balanced market), and neither party has excessive bargaining skills or influence. Consequently, we postulate that the individual bargaining sessions will result in transaction prices that are in the middle of the potential price range, a range determined by the individual reserve prices of the bargaining parties. Expressed in mathematical terms: $P_{ACT}=(B_{MAX}+S_{MIN})/2$.

The next four markets represent situations where price information of previous transactions is available to the various parties in varying degrees. Both buyers and sellers are assumed to have equal bargaining positions (no excessive bargaining skill or influence), and consequently, individual transaction prices are determined solely by the availability of price information.

Market 4 represents the situation when only the immediately preceding transaction price (hereinafter called: last price, and denoted: P_{t-1}) is available, and available to the seller only.

The model will determine the transaction price in the following way:

If the last transaction price (P_{t-1}) was higher than the seller's (minimum) reserve price, then the seller will raise his reserve price to halfway between his original reserve price and the last price. As only he is aware of the last transaction price, the reserve price of the buyer will not be affected. If, however, the last transaction price was lower, or equal to the seller's (minimum) reserve price, the seller will not change his reserve price. As only he is privy to this information, there will be no undue market pressure from the buyer to make such an adjustment. Expressed in mathematical terms:

$$P_{ACT} = \frac{B_{MAX} + S^*_{MIN}}{2}$$

where:

$$S^*_{MIN} = \begin{cases} \frac{S_{MIN} + P_{t-1}}{2}, & \text{if } P_{t-1} > S_{MIN} \\ S_{MIN}, & \text{if } P_{t-1} \leq S_{MIN} \end{cases}$$

Market 5 represents the inverse situation to Market 4, when only the last transaction price is available, and it is available to the buyer only. Following the logic and arguments expressed above, the model will determine the transaction price the following way:

If the last transaction price was lower than the buyer's (maximum) reserve price, then the buyer will lower his reserve price to halfway between his original reserve price and the last price. As only he is aware of the last transaction price, the reserve price of the seller will not be affected. If, however, the last transaction price was higher or equal to the buyer's (maximum) reserve price, the buyer will not change his reserve price. As only he is privy to this information, there will be no undue market pressure from the seller to make such an adjustment. Expressed in mathematical terms:

$$P_{ACT} = \frac{B^*_{MAX} + S_{MIN}}{2}$$

where:

$$B^*_{MAX} = \begin{cases} \frac{B_{MAX} + P_{t-1}}{2}, & \text{if } P_{t-1} < B_{MAX} \\ B_{MAX}, & \text{if } P_{t-1} \geq B_{MAX} \end{cases}$$

Behaviour of Resale Markets (continued)

Market 6 models the situation when both parties have equal access to this information (i.e., the last transaction price) and, accordingly, both will make the appropriate adjustments in their reserve prices in line with the attitude assumed in Markets 4 and 5. Again, the adjustments will be made by sellers and buyers only if, the last price is above the reserve price of the seller, or below the reserve price of the buyer, respectively. The reserve prices will be then adjusted to respectively higher or lower levels, and the transaction price agreed upon will be in the middle of the so redefined range of potential transaction prices. Expressed in mathematical terms:

$$P_{ACT} = \frac{B^*_{MAX} + S^*_{MIN}}{2}$$

where: B^*_{MAX} and S^*_{MIN} are as defined earlier.

Market 7 represents the situation where a vector of past prices is available to both bargaining parties. As in real situations, the most recent price carries the greatest weight, and the oldest price the smallest one. This kind of "discounting" of past information may be accomplished through an arithmetic or a geometric distribution, whereby past price information is discounted for obsolescence, in accordance with the age of the information.

This method of discounting the past, or weighting the most recent past events most heavily, is exactly the way most of us intuitively operate. The things that happened yesterday, have a greater influence on the decisions we make today, than the things that happened the day before yesterday, or last week. For these experiments, we have chosen a simple, arithmetically declining discounting scheme by giving the weight of five, four, three, two and one to the last, second last, the third, the fourth, and the fifth last price respectively. We will assume that prices before that, have either no effect, or only a negligible effect on new prices. The formula for this weighting scheme is:

$$P_{\bar{t}} = \frac{5P_{t-1} + 4P_{t-2} + 3P_{t-3} + 2P_{t-4} + 1P_{t-5}}{15}$$

The resulting transaction prices will be especially interesting in comparison to the results of Market 6, where price information was also available to both parties, but consisted only of the last price.

The individual transaction prices will be determined the same way as before, once the buyer and seller have adjusted their limits in light of the price information available to them. In the absence of significant differences in bargaining skills, the transaction price acceptable to both parties will be in the middle of the redefined range of overlapping reserve prices. The model of Market 7, expressed in mathematical terms is the following:

$$P_{ACT} = \frac{B^{**}_{MAX} + S^{**}_{MIN}}{2}$$

where:

$$B^{**}_{MAX} = \begin{cases} \dfrac{B_{MAX} + P_{\bar{t}}}{2} & , \text{ if } P_{\bar{t}} < B_{MAX} \\ B_{MAX} & , \text{ if } P_{\bar{t}} \geq B_{MAX} \end{cases}$$

$$\text{and: } S^{**}_{MIN} = \begin{cases} \dfrac{S_{MIN} + P_{\bar{t}}}{2} & , \text{ if } P_{\bar{t}} > S_{MIN} \\ S_{MIN} & , \text{ if } P_{\bar{t}} \leq S_{MIN} \end{cases}$$

FOOTNOTES

1 Except in the special situations of "buyer's market"-s and "seller's market"-s where representing a typical lack of balance between supply and demand, 41 buyers faced 51 sellers, and 51 buyers faced 41 sellers, respectively.

2 In the special situations of "buyer's market" and "seller's market" due to the imbalance between buyers and sellers, the specific equilibrium prices could not be predetermined - they were calculated individually by the program during the simulation.

3 In a "perfect market" there is perfect knowledge on the part of all buyers and sellers about conditions in the market. Also it is assumed that there are a sufficiently large number of buyers and sellers in the market so that any action by any individual party will have no noticeable effect on either prices or volumes.

4 These deals are recorded as "forced deals" to see whether their number is significant enough to affect the accuracy of the statistics. In all of the experiments, these "forced deals" were found to be rather small (0, 1 or 2) and thus it was concluded that their inclusion would not affect the transaction statistics significantly in any way.

5 An atomistic market is an imperfect market where buyers and sellers individually and randomly seek and find trading partners and complete transactions based on their respective individual reserve prices.

6 As noted in Appendix A, "price sensitivity" in this paper is defined as the magnitude of change in price associated with a marginal change in quantity. Thus steep supply and demand curves represent "price sensitive" situations and flat supply and demand curves represent "price insensitive" situations.