# Durability, Re-trading and Market Performance

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"*The spectacle of modern investment markets has sometimes moved me towards the conclusion that to make the purchase of an investment permanent and indissoluble, like marriage, except by reason of death or other grave cause, might be a useful remedy for our contemporary evils. For this would force the investor to direct his mind to the long-term prospects and to those only*." - John Maynard Keynes[1], 1936

## Introduction

Key differential structural characteristics of environments studied in previous market experiments have documented large divergences in their observed performance, particularly discrepancies in their convergence to expected equilibrium outcomes. We investigate why this should be so.

The type of competitive equilibrium where a market clears at a particular price as initiated by Arrow and Debreu (1954) has long been studied in the laboratory. We refer to these experiments as Supply and Demand (SD) experiments. SD experiments are highly reduced in form: items are not re-tradable, buyers and sellers are specialized in these roles, and no second commodity, cash, is used as a medium of exchange, although cash enters as a numeraire qua reward incentive for subjects. Markets with these features that are repeated over time converge rapidly to the predicted equilibrium under a regime of strict private dispersed information on individual values that define the equilibrium predictions.

In contrast, consider asset markets, in which shares can be freely re-traded against cash within and across periods, shares have well-defined common values based on common public information on expected cash "dividend" yields, and individuals are not specialized as buyers or sellers. These markets produce price bubbles that converge only with experience across repeat sessions. The prospect of re-trade, and perhaps the lack of buyer/seller specialization, results in market behavior that contrasts sharply with the perishable goods that characterize the SD experiments.

Building on this background analysis we report new experiments that combine features of both environments and initiate an investigation of how commodity durability that constrains re-trading characteristics affect the observed variation in market performance.

[1] The General Theory of Employment, Interest and Money, Chapter 12.

## Background Literature

### Early Supply and Demand (SD) Experiments

Experimental market studies initiated in the mid-twentieth century demonstrated unexpectedly high performance, and subsequently these findings were found to be very robust with respect to variations in the supply and demand environment, subject pools, numbers of buyers and/or sellers, multiple interdependent commodities, and, with some qualifications, the exchange institution.[2] These experiments reflected several abstract features of the Walrasian general equilibrium models that motivated them. In particular the traded goods were for immediate settlement (consumption or use) in the sense that, following every exchange in a given trading period, the items could not be re-traded; i.e., all individual buyer values (seller costs) were realized on each transaction in the trading period in which it was executed. This process was then repeated beginning with the assignment of replenished values (costs) for designated buyers (sellers), then trading for a fixed time period, followed by settlement, and so on until the close of the experiment. In keeping with the general equilibrium models of the day, cash was a numeraire whose utility incentivized demand and supply based on induced buyer values and seller opportunity costs. For purposes of this paper the salient features of this environment are that the traded goods are *perishable* with the transaction—think of retail services like haircuts, prepared foods like hamburgers, or exercising the right to an airplane passenger seat—and the traders are specialized either in their role as buyers who receive the goods, or sellers who deliver them.

These characteristics of the traded experimental goods are typical of most consumer expenditures. The US Gross Domestic Product (GDP) consists of 40% consumer services, and 20% nondurable consumer goods. Therefore, 60 percent of the GDP is composed of perishable consumption items that severely limit the feasibility and likelihood of being re-traded.[3] [4]

Figure 1 charts the typical results from such markets in the laboratory. As can be seen prices and volumes converge to the competitive equilibrium in a single session consisting of eight repetitions of the same economic environment.

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[2] Smith (1962), Fouraker and Siegel (1963), Smith, et al (1982), Ketcham, et al (1984). The first Cournot oligopoly experiments, were reported by Hoggatt (1959) and Sauermann and Selten (1959, 1960); for a summary see Bosch-Domenech and Vriend in Plott and Smith (2008).

[3] See Bauer and Shenk (2008) for a review of the components of GDP.

[4] Although services are not re-tradable, claim rights to services can be re-traded through intermediaries, as with hotel and airline reservations conveying rights to pre-scheduled airline seats or rooms that are allocated by bulk purchases to internet discount agencies. But this exception also illustrates the severe limitations on such re-trading.

## Asset Market Bubbles

Experiments in the 1980s began to examine the performance of asset markets; one of these asset economic environments contrasted sharply with the earlier SD markets in that items, generally called "shares", were durable across the life of the experiment, could be re-traded within or across periods in the experiment, and a second good, cash (also a durable asset within and across periods) could be exchanged for shares and vice versa. Subjects were not specified as buyers or sellers, and freely chose to buy or sell based on their cash and share positions. Moreover, this economic environment was particularly transparent: shares earned a common probabilistic yield, or "dividend," each period, and this structure was common public information. Although this transparency was thought to argue strongly for observing rational expectation equilibrium[5], that state emerged reliably only after multiple sessions of experience.[6]

Convergence across three sessions with the same subjects returning twice after their first experimental session is shown in Figure 2. These asset market bubbles have been modeled using differential equations to capture the interaction of two additive forms of hypothesized trading behavior: a component in which net purchases are in proportion to the difference between fundamental value and the current price—long run rational expectations; and a component of net purchases that are in proportion to the rate of change of the current price—myopic rational expectations.[7] An implication of this model is that price bubbles are greater the larger is the asset economy's endowment of cash. Figure 3 provides an example of experiments in which the treatment variable is the liquidity ratio, $L$, the ratio of cash to total fundamental share value across three groups of four independent replications. By changing the liquidity ratio, $L$ , the path and amplitude of the price bubble changes. In particular, the spread between the mean prices across the treatments emerges only after the bubble begins to develop, and tends to narrow as the horizon end approaches.

Some other asset markets have explored the role of asymmetric information in price formation[8]. While the focus here is not asymmetric information, a subclass of the literature[9] suggests that such markets generate both high volume and price deviations from rational expectation equilibrium.

[5] In such equilibrium price equals the expected payoff of the asset, as defined in Lucas (1972) whether the payoff is immediate or accrues in the form of a future stream of benefits.
[6] Smith, et al (1988); Porter and Smith (1994); Hussam, Porter and Smith (2008), and Haruvy, et al. (2007),
[7] Caginalp et al. (1998)
[8] See Forsythe, Palfrey and Plott (1982), Plott and Sunder (1982) and Plott and Sunder (1988).

## New Experiments and Results

Exploring differences in the behavior of durable goods and non durable goods/services markets is essential to understanding the great recession of 2007-2009, as well as previous downturns extending back to the Great Depression. Houses are the most durable of consumer goods, and bubbles in housing-mortgage markets have been prominent sources of recent and historical economic distress. Such distress never finds its origin in the 60% of GDP that is perishable, and indeed this is the component of national final demand that tends to be stubbornly resistant to change in good times and bad.[10]

We report two types of new experiments in which we vary commodity durability by allowing or restricting units (shares) to be re-traded within each trading period. The medium of exchange is a cash asset that is also reinitialized each trading period. Subjects receive endowments of cash and shares at the beginning of each trading period, with some traders receiving cash only. Each subject is assigned a value ("dividend") for a fixed number of assets held *at the end of the period*. The demand and holdings schedule for each subject are shown in Figure 4. For example, the first subject is endowed with 410 cash and no units. She has a value of 180 for up to 3 units, that is, each of the first 3 units earns her 180 each at the end of the period while extra units are worth nothing. Each participant is paid earnings equal to the sum of her final cash holdings and dividends collected from her allowed share holdings.

In each experiment there are 9 subjects, each with private information on his or her values and endowments; each must decide, based on observed market bids, asks and prices, whether to buy or sell units. The set of endowments and unit values define potential equilibrium outcomes as follows (See Figure 4):

- An asset endowment total of 16 units is the total supply quantity available within the market.
- Consider a Walrasian auctioneer who facilitates exchange at a quoted price $P$. $P$ is to be adjusted until units demanded equals units supplied. Consider two sets of price ranges: $P_a \in \{P : 71 < P < 105\}$ and $P_b \in \{P : 105 < P < 134\}$. When price falls within $P_a$, subjects 7-9 can profitably sell 9 units and subjects 1-5 will want to buy 13 units, yielding an excess demand of 4. When price falls within $P_b$, subjects 6-9 can profitably sell 12 units and subjects 1-4 will want to buy 10 units, yielding an excess supply of 2.

[9] See Hason, Porter and Oprea (2006), Lin (2009)
[10] Gjerstad and Smith (2008, 2010)

- At a price of 105, subjects 1-4 can profitably buy 10 additional units, and subjects 7-9 can profitably sell their 9 units. Subjects 5-6 have no strict incentive to buy or sell since their values are both 105. An excess demand of 1 exists. Only a pseudo equilibrium exists: at the price 105, it is weakly dominant for subject 6 to sell one unit and supply equates demand. The stability of this pseudo equilibrium is solely dependent upon subject 5's choice. Once subject 5 chooses not to participate or offers more than 1 unit, the market price will adjust accordingly.
- Notice this pseudo equilibrium is a weakly dominant equilibrium whereby its stability is solely dependent upon subject 5's choice. Once subject 5 chooses not to participate or offers more than 1 unit, the market price will adjust accordingly. Therefore, this design argues for price volatility in the double auction trading of one unit at a time.
- Given this indeterminateness of competitive equilibrium, it should be noted that each subject receives more cash than what is required to clear the market. At the pseudo equilibrium of 105, the 9 subjects have ending cash balances of near 95, 95, 95, 95, 600, 405, 615, 615 and 515 respectively. This cash-rich design opens the possibility for other activities than merely earning the final dividend payout. If items can be re-traded, then speculative purchases in anticipation of resale are likely to be fostered by this design.

We call the above the Re-trade (RT) treatment. In RT, subjects are not informed as to their potential specialized roles and they must discover this during the market process. They can buy or sell units as long as their unit and cash holdings permit. Units are durable in the sense that they can be re-traded during the period and all value realizations do not occur until the end of the trading period.

The second treatment, Specialization (SP) is similar to SD experiments[11]. The units are treated as perishable items and once transacted must be removed from the market immediately. Subjects can potentially profit if they buy when price is below their values and sell when price is above their values. Therefore, buyers and sellers can be identified given the competitive equilibrium. In SP, subjects 1-5 act as buyers only and cannot sell at any time, and subjects 6-9 act as sellers only and cannot buy at any time. See Figure 5a and 5b.

Table 1 provides a check-list summary of market experiments and their implied environment characteristics (commodity durability, role of cash, agent specialization) that potentially explain

[11] Lei, Noussair and Plott (2001) designed a version of the asset market that corresponds to our perishable-specialization interpretation of commodity markets. Their motivation was to control for capital gains expectations. Price bubbles were significantly mitigated, though levels of mispricing relative to predictions remained.

differences in observed outcomes. New Experiments seek to bridge the environmental difference between SD and Asset Market experiments.

Our SP experiments are a replication of SD with the addition of cash as an exchange medium. RT experiments are a replication of SP experiments with the removal of revealed and enforced specialization. In RT, units can be re-traded and specialization knowledge needs to be discovered by the market process. RT experiments are similar to asset market experiments in that re-trading is allowed, but only within the period that the unit is acquired.

**Performance Results and Analysis**

Figure 5a and 5b plot the transaction time series from two experiments: SP3 and RT3. As shown, the RT experiment experiences higher volumes and lower efficiencies.

The complete performance results in terms of efficiency, volume and price convergence for all experiments are reported in Table 2.

As shown in Table 2, the RT experiments have an average of 54.2% efficiency, 31.0 volume and 30.2 absolute price deviation of, while the SP experiments have an average of 88.6% efficiency, 11.1 volume and 25.1 absolute price deviation.

To test the significance of the differences across the two treatments, the following random effects model is estimated:

$$y_{it} = \alpha + \beta \bullet treatment + u_i + \sum_{k=1}^{10} \theta_k \bullet period_k + \varepsilon_{it} ,$$

where $y_{it}$ is the efficiency, volume or average absolute price deviation in experiment $i$ period $t$, independent variable $treatment$ is dummy variable for either SP or RT treatment, $u_i$ is random effect component for each experiment, and $period_k$ is a dummy variable for each period.

The random effect coefficient $\beta$ suggests that RE experiments achieves 34% less efficiency, 19.9 more trading volume and 9.73 more absolute price deviation relative to the SP experiments. Efficiency and

volume are significantly different across the two treatments. The absolute average price deviation is not statistically different.

To address the potential correlation across the three regressions, we run additional Seemingly Unrelated Regressions (SUR) as a robustness check. The SUR results are similar.

An average volume of 31.1 is about 3 times the predicted volume and 2 times the market's overall share inventory. In addition, it is puzzling that efficiencies remain low given such high transaction volume. To investigate why efficiencies remain low throughout the RT experiments, we summarize each trader type's trading activities. In Figure 6, each subject's buying and selling activities are sampled over 4 RT experiments covering a total of 40 trading periods. The first question is whether subject types specialize. If a subject is found to be both buying and selling, a second question is whether she makes such decisions based upon her own dividend value. To create a measure on the adoption of such rule, we measure the average quantity that a subject type buys at prices above her dividend value or sells at prices below her dividend value.

Figure 6 summarizes each subject type's trading activities, including how much a trader type buys, sells, buys above her dividend value or sell below her dividend value. In equilibrium, subjects 1- 4 should specialize as buyers, while subjects 6- 9 should specialize as sellers. For example, subject 1 is supposed to buy 3 units in equilibrium. However, over 4 experiments and 10 periods per experiment, subject 1 on average bought 3.8 shares. Moreover, out of 3.8 shares bought, 0.2 shares were bought above what it was worth to her. Subject 1 also sold 1.9 shares, all of which are sold below her value.

All subject types end up both buying and selling and specialization is not common. Re-trading is prevalent for all subjects. The presence of buying above one's own dividend value or selling below that suggests that subjects are not trading for the sole purpose of final consumption. Part of re-trading must be motivated by other purposes.

## Concluding Remarks

Our new experiments suggest that even when re-trading is restricted to intra-period exchange, and each period is replicated with the same endowment, market performance is poor relative to the SD markets. Volume is much higher than the minimum needed to exhaust positive sum gains from exchange—and

surplus fails to converge to a maximum. Agents behave myopically, responding to current price movements that cause them to leave money on the table even after 10 periods of experience. The ubiquity of ignoring one's own valuation indicates that disequilibrium expectations play a critical role in durable goods markets. In real-world markets, re-trading is also extremely high, and not clearly functional. Based on the data published by World Federation of Exchanges, the NYSE Euronext (US) market had a turnover velocity[12] of 192.7% and NASDAQ QMX had a turnover velocity of 1143.5% in 2008. (See Table 3). In the light of our experiments, this high volume does not seem justified as part of the process of equilibrium discovery. [13]

When subjects are constrained to specialize as buyers or sellers, based on their values and costs, market performance is much improved. These results help to explain the much greater stability of expenditure patterns in perishable final goods markets relative to durable goods, credit and financial markets.

[12] The ratio between total transaction revenue and the total market capitalization.

[13] In the commodity future markets, the ratios between the annual total of contracts traded and the yearly number of open interests on an exchange, are between 50 and 1000 times yearly for the world's 9 major derivative exchanges from year 2001 to 2008.

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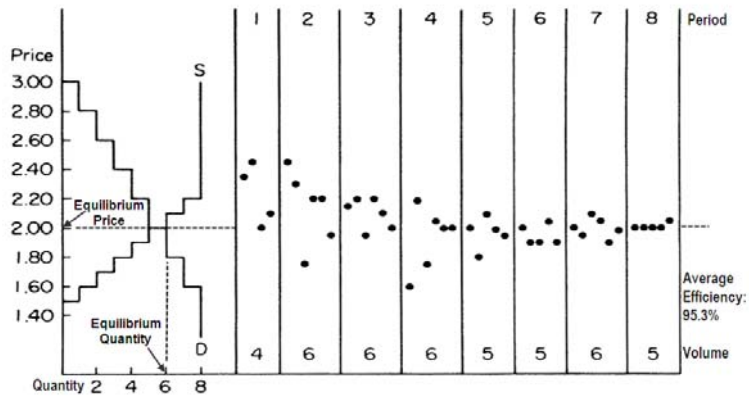



**Figure 1. Supply and Demand Experiment.** In the chart, 4 subjects specialize as buyers while 4 specialize as sellers. The buyers have values for acquiring the units while the sellers have costs for producing the units. A total demand of 8 units is derived from buyer values at 3.0, 2.8, 2.6, 2.4, 2.2, 2.0, 1.8 and 1.6, and a total supply of 8 units is derived from seller costs at 1.5, 1.6, 1.7, 1.8, 1.9, 2.0, 2.1 and 2.2. When a transaction takes place at a certain price, the buyer earns a profit equal to his value minus the price paid and the seller earns a profit equal to the price received minus his cost. No cash is involved until after the experiment, when accumulated profit credits are paid privately in cash to each participant. Once a transaction is completed, the unit is removed from the market permanently in that trading period. The competitive equilibrium, where excess demand is zero, has a predicted price of 2.00 and a volume of 5 or 6. The experiment is repeated for 8 identical periods. The dots are the transactions and the volume for each period is indicated in the lower portion of each period. An average of 95.3% of maximum surplus, defined as efficiency, is realized during the 8 periods.

**(a) Fundamental asset value in asset markets** **(b) Mean contract prices across levels of experience**

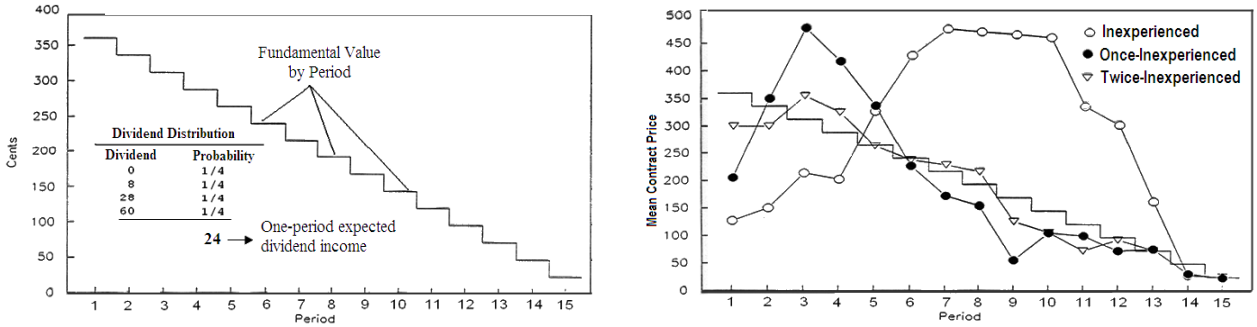



**Figure 2. Asset Market Experiment.** The asset market experiment features an asset called Share that lives for 15 periods. At the end of each period, each Share pays a dividend to its current holder. The dividend can take on the value of 0, 8, 28 or 60 cents with equal probabilities. The expected dividend for each period is 24 cents. The fundamental value of Shares declines over periods as dividends are gradually paid out, with a starting value of 360 cents and an ending value of 24 cents. This detail is shown in panel (a). In panel (b), a set of experiments is reported. With inexperienced subjects, mean prices rose, peaked out in period 7, eroded in periods 8-10, then dropped sharply in the final periods while the fundamental value declined steadily at 24 cents per period. A qualitatively similar bubble and crash pattern is found among a large number of replications under various trading institutions from a large variety of different subject pools. When subjects became once-experienced, the bubble mitigates. With twice-experienced subjects, mean prices deviate much less from fundamental value. Source:

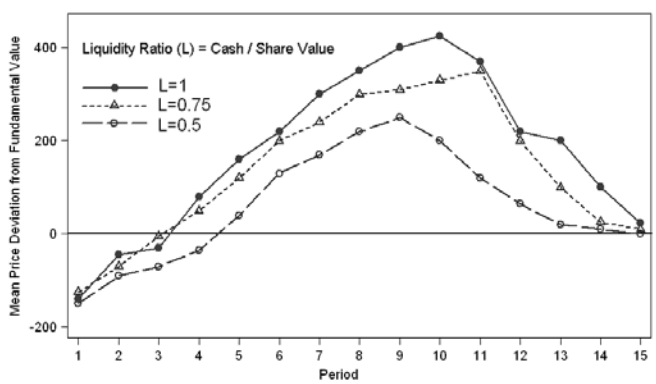



**Figure 3. Cash abundance and mean price deviation in Asset Market Experiments.** This figure demonstrate how the liquidity ratio, $L$, defined as the total market cash endowments divided by total fundamental share value, affects the amplitude of price bubbles. For each level of liquidity ratio, the mean price deviations from the fundamental value, as defined in Figure 2(a), are derived from 4 experiments in each liquidity treatment. As can be seen, larger endowments of cash lead to larger price bubbles relative to the same fundamental value.

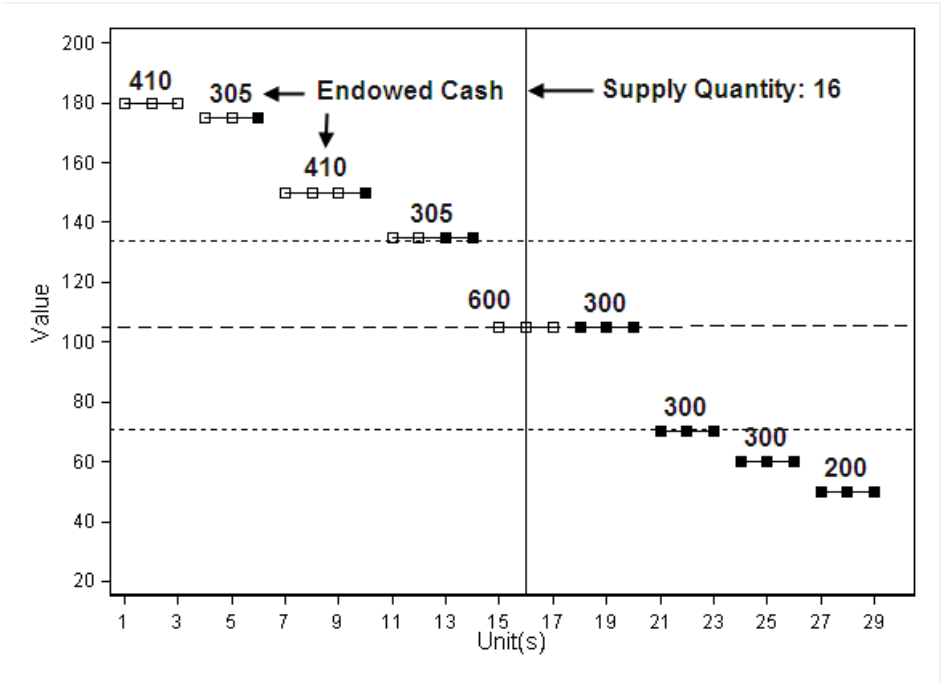
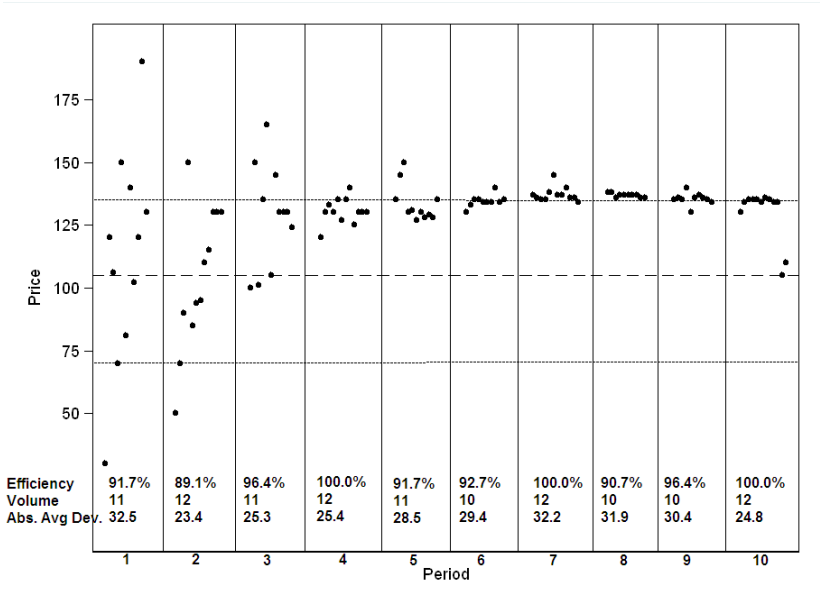



**Figure 4. Environment for New Experiments.** Subjects are numbered in decreasing order of their dividend valuation. At each value a square represents a demand unit by the subject; if the diamond is filled it is a unit in the subject's endowed supply. Hence, there are 29 units in demand and 16 total units in supply. Each subject's demand is connected by a horizontal line. Thus, each cluster represents a subject's demand. Each subject's cash endowment is shown above the cluster. For an efficient allocation, 10 units from the endowments of subjects 6-9, must be transferred to subjects 1-4. There exists no single market clearing price at which every trade is strictly profitable, and the number of units in demand at that price are equal to the number offered. Similarly there is no equilibrium bid/ask spread; for example, with {bid 104, ask 106}, 13 units can be profitably bid at 104 but only 9 profitably accepted; 12 units are offered at 106, but only 10 are acceptable. With continuous double auction trading, 10 units might be efficiently transferred, and 100% efficiency achieved because of variability in transaction prices in the interval [71, 134].

**(a) Specialization (SP) Results – SP3**




**(b) Re-trade (RT) Results – RT3**

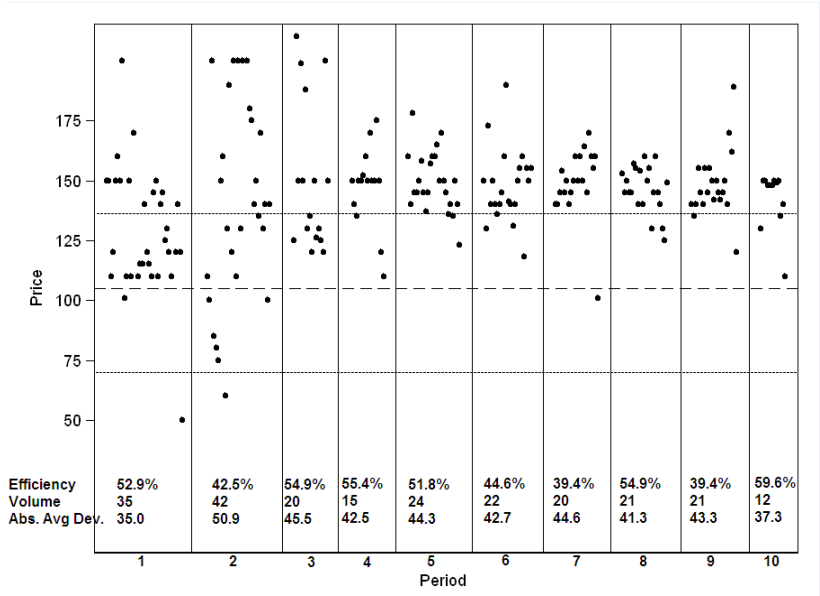



**Figure 2. Results. (a) Specialization (SP) Experiment.** In the SP treatment, each subject is told her specialization role and the roles are enforced. Subjects 1-5 act as buyers only and subjects 6-9 act as sellers only. This means that if a unit is purchased it cannot be resold. **(b) Re-trade (RT) Experiment.** In the RT treatment, subjects are not assigned specific buyer/seller roles and are free to both buy and sell depending on the prices they see. If specialization occurs it is discovered because of the price pattern that emerges. Four experiments of SP and four of RT were conducted. Each experiment lasts for 10 repeated periods. The transaction time series is indicated by the dots, efficiency, volume and average price deviation from equilibrium are indicated at the bottom of each period column of transaction price plots.

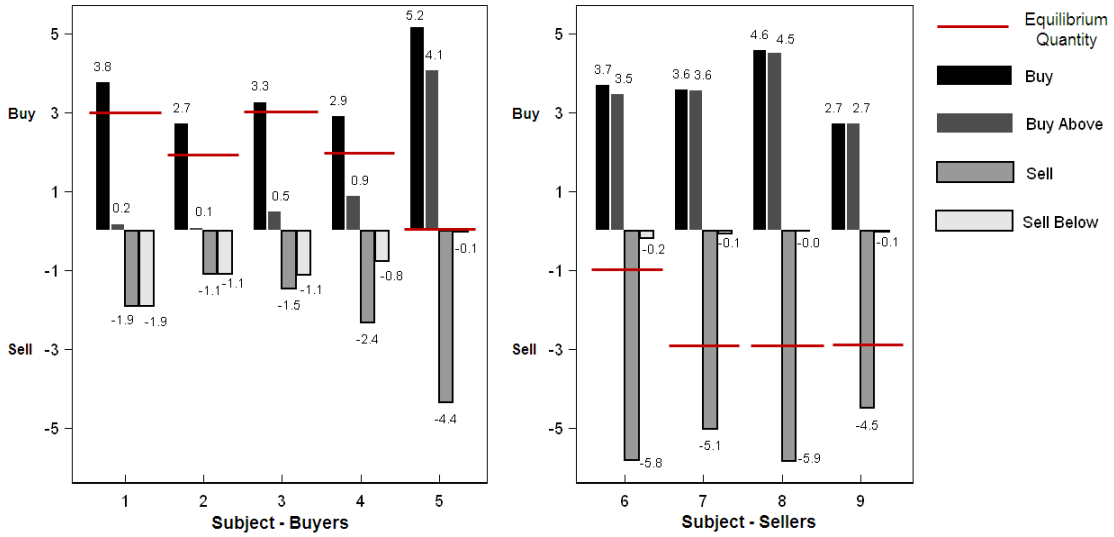



**Figure 6. Re-trading in RT Experiments.** In equilibrium, subjects 1-4 would only buy Shares and subjects 6-9 would only sell Shares. Subject 5 would not transact. Sampled from all 40 periods of results, the average quantities that a subject buys, sells, buys above her dividend or sells below her dividend are reported. To compare, the quantity that a subject type should buy or sell in equilibrium is marked by the horizontal lines. The left portion summaries the trading activities for subjects 1-5 who are supposed to only buy or have no transaction in equilibrium. As can be seen, subjects 1-5 are all buying more than the predicted volume and are all selling units as well. Subjects 1-5 are also shown to deviate from their own valuations, with substantial selling below their own values. The right portion summaries the trading activities for subjects 6-9 who are supposed to only sell in the competitive equilibrium. As can be seen, subjects 6-9 are all selling more units than their predicted volume and buying units as well. Subjects 6-9 are found to be buying above their dividend values.

**Table 1: Comparison between Experiments.**

Supply and Demand (SD) experiment characterizes a perishable commodity that is exchanged during one period between buyers who have consumption values and sellers who have production costs. Neither cash medium of exchange nor budget limit is present for completing trades. Specialization of buyer/seller roles is strictly enforced and re-trading is not allowed. Experiments conducted in this report are named New Experiments. The first treatment of New Experiments is called Specialization (SP). SP differs from SD design in that cash is used as an exchange medium and buyers' transactions are bounded by their own cash budget. The second treatment of New Experiments is called Re-trade (RT). RT differs from SP design in that assets are durable and can be re-traded in the market. In asset market (AM) experiments, the values are common and thus no gains from exchange exist. Yet, the value is uncertain because the dividend payouts are randomly drawn from a defined distribution. The market performances for each type of experiments, including price and convergence to prediction and efficiency are reported on the lower half the table. Among them asset market experiments have no prediction for volume since there exists no direct gains from exchange.

**(a) Design Differences across Experiments**

| | Supply & Demand Experiment | New Experiments | | Asset Markets |
|---|---|---|---|---|
| Environment Characteristics | (SD) | Specialization (SP) | Re-trade (RT) | (AM) |
| Asset Durability | Perishable | Perishable | Durable | Durable |
| Buyers/Sellers Specialized | Yes | Yes | No | No |
| Positive Sum Gains from Exchange (Heterogeneous Values/Costs) | Yes | Yes | Yes | No |
| Cash Asset as Medium of Exchange | No | Yes | Yes | Yes |
| Re-trade Within Periods | No | No | Yes | Yes |
| Market Length | 1 Period | 1 Period | 1 Period | 15 Periods |

**(b) Performance**

| | | | | |
|---|---|---|---|---|
| Price Convergence to Prediction | Single session: less than 10 periods | Slowly | NO | NO |
| Volume Convergence to Prediction | Yes | Yes | NO and High Turnover | NO and High Turnover |
| Efficiency | High | High | Low | NA |

## Table 2. Market Performance in the New Experiments: Re-trade V.S. Specialization

The market performances in terms of efficiency, volume and average absolute price deviations from equilibrium are reported below for the New Experiments. 4 experiments of Re-trade Treatment (RT) and 4 experiments of Specialization Treatment (SP) are summarized. The numbers in parenthesis are the standard deviation for each measurement. Each experiment lasts 10 periods. Using random effect model, the difference between the two treatments are tested for significance. As the three regressions could potentially be correlated, seemingly unrelated regressions (SUR) are run to correct for any correlation.

| | RT Treatment | SP Treatment | Treatment Effect | |
|---|---|---|---|---|
| | Mean<br>(Standard Deviation) | Mean<br>(Standard Deviation) | Random Effect Estimator<br>(Standard Deviation)<br>z-Statistic<br>p-Value | SUR Estimator<br>(Standard Deviation)<br>z-Statistic<br>p-Value |
| Efficiency | 0.542<br>(0.209) | 0.886<br>(0.105) | -0.34<br>(0.10)<br>z=-3.35<br>p=0.001 | -0.34<br>(0.04)<br>z=-9.41<br>p=0.000 |
| Volume | 31.0<br>(13.1) | 11.1<br>(0.9) | 19.9<br>(5.22)<br>z=3.81<br>p=0.000 | 19.9<br>(2.05)<br>z=9.69<br>p=0.000 |
| Absolute Price Deviation from Equilibrium | 30.2<br>(12.0) | 25.1<br>(21.3) | 5.18<br>(9.97)<br>z=0.52<br>p=0.604 | 5.18<br>(3.82)<br>z=1.36<br>p=0.175 |

**Table 3. Turnover Velocity for the world 9 largest Equity Exchanges**

The turnover velocity is computed in two steps: first, derive the annualized ratio for each month as (Monthly Domestic Share Turnover/Month-end Domestic Market Capitalization×12). Once the turnover velocity ratio for each month is derived, the ratios are added together by using a moving average weighting method. Only domestic shares are used in order to be consistent.

| | 2008 | 2007 | 2006 | 2005 | 2004 | 2003 | 2002 | 2001 |
|---|---|---|---|---|---|---|---|---|
| NYSE Euronext (US) | 240.2% | 166.9% | 134.3% | 99.1% | 89.8% | 89.5% | 94.8% | 86.9% |
| Tokyo SE Group | 151.2% | 138.4% | 125.8% | 115.3% | 97.1% | 82.6% | 67.9% | 60.0% |
| Nasdaq | 1026.5% | 625.2% | 269.9% | 250.4% | 249.5% | 280.7% | 319.5% | 359.2% |
| London SE | 152.7% | 154.2% | 124.8% | 110.1% | 116.6% | 106.6% | 97.3% | 83.8% |
| Shanghai SE | 118.2% | 211.0% | 153.8% | 82.1% | 87.0% | 118.0% | NA | NA |
| Hong Kong Exchanges | 86.0% | 94.1% | 62.1% | 50.3% | 57.7% | 51.7% | 39.7% | 43.9% |
| TSX Group | 103.8% | 83.7% | 76.4% | 69.2% | 66.2% | 65.8% | 67.9% | 70.8% |
| Deutsche Börse | 264.0% | 208.4% | 173.7% | 149.4% | 133.7% | 148.1% | 125.1% | 118.3% |
| BME Spanish Exchanges | 171.4% | 191.9% | 167.0% | 161.2% | 187.1% | 167.4% | 137.8% | NA |

**Appendix A: Transaction Time Series from other Markets**

Figure A1: RT1

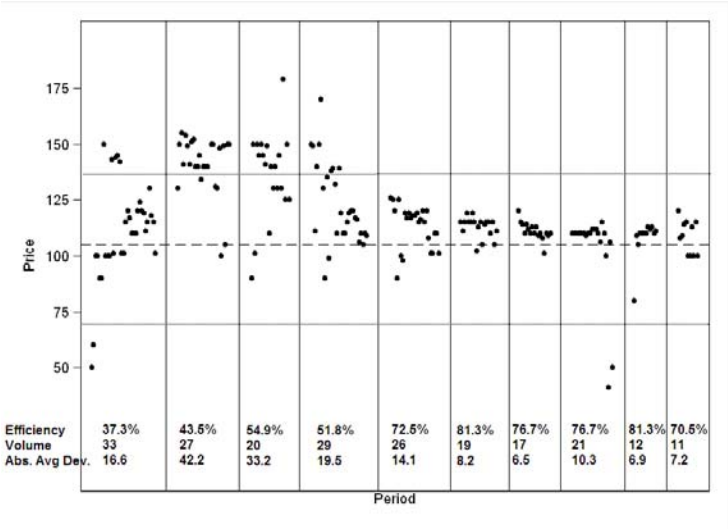



Figure A2: RT2

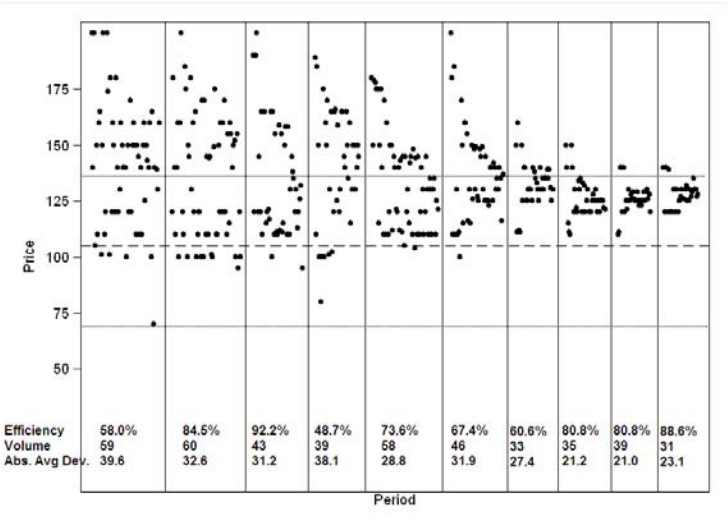



Figure A3: RT4

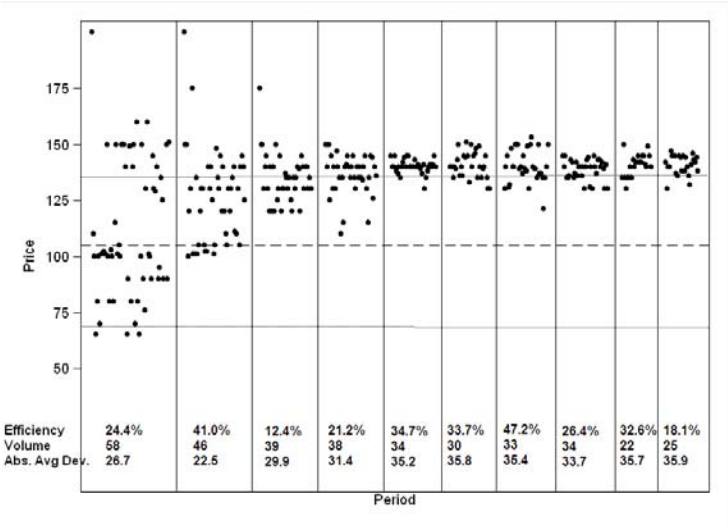



Figure A4: SP1

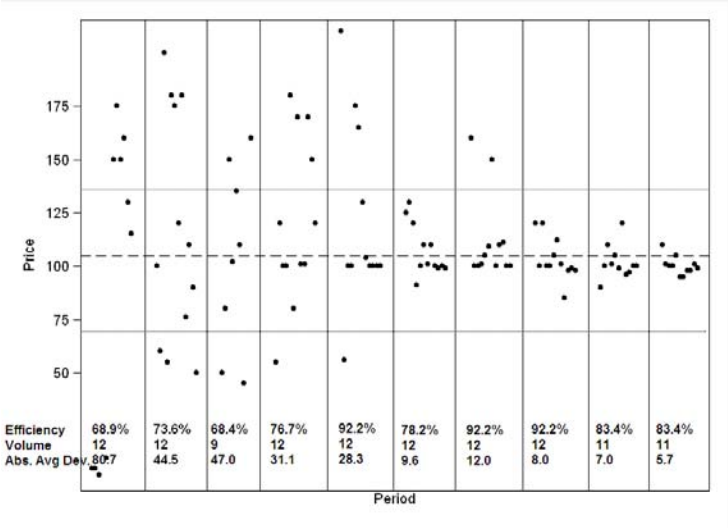



Figure A5: SP2

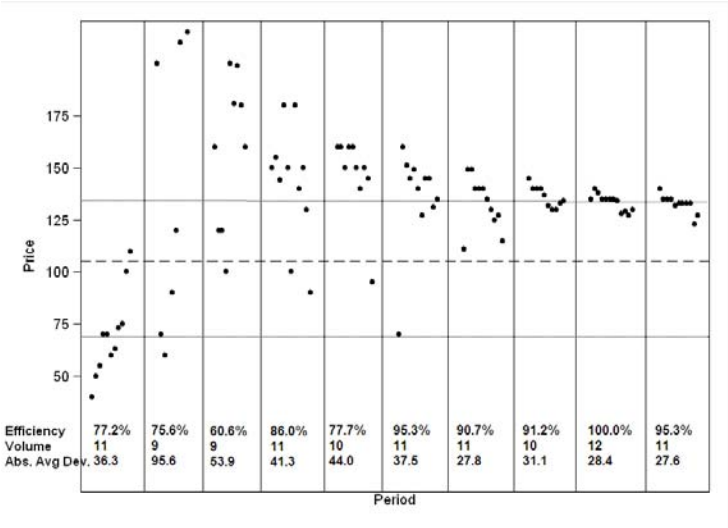
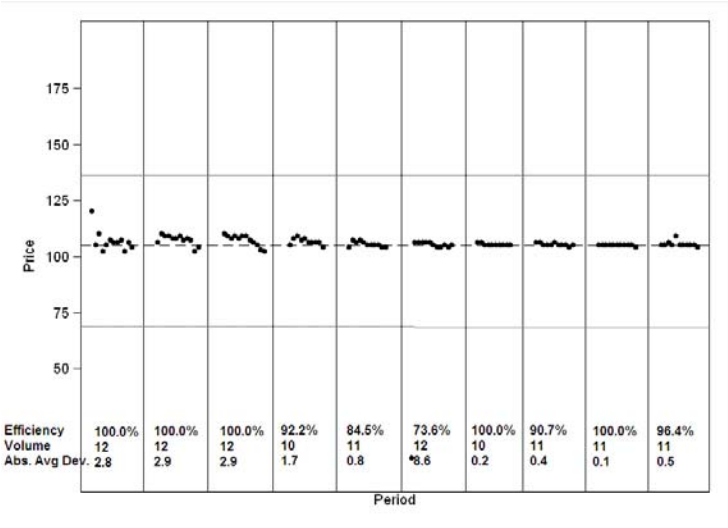


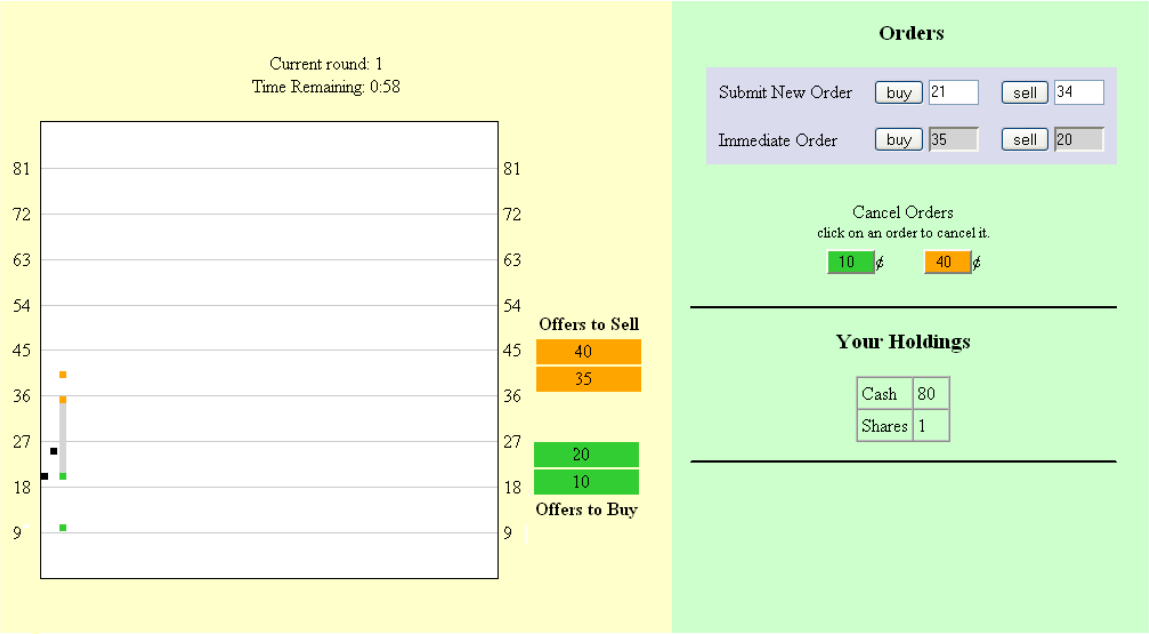

Figure A6: SP4




## Appendix B: Experiment Instructions and Quizzes

### B1: Re-trade (RT) Experiment Instruction

**Figure B1: Experiment Program Interface.** The picture is next to the text during most part of the instruction.




This is an experiment in market decision making. You will be paid in cash for your participation at the end of the experiment. Different participants may earn different amounts. What you earn depends on your decisions and the decisions of others. Every 200 experimental cents you make today will be worth $1.

The experiment will take place through computer terminals at which you are seated. If you have any questions during the instruction round, raise your hand and a monitor will come by to answer your question. If any difficulties arise after the experiment has begun, raise your hand, and someone will assist you.

In this experiment you will be able to buy and sell a commodity, called Shares, from one another. At the start of the experiment, every participant will be given some Cash and Shares. A share will pay the owner a fixed dividend at the end of a trading round. Each participant is able to receive his/her dividends from their own share holding. The dividend is NOT the same for everyone. A participant is able to receive dividends from up to a certain number of Shares and beyond that number, the additional shares will pay no dividends.

Here is an example:

Suppose your dividend is 110 cents per share and you will receive dividends for up to 2 shares. At the end of a trading round, if you own 5 shares, you will be able to receive:

110 cents × 2 shares + 0 cents × 3 shares = 220 cents, not 110 cents × 5 shares.

Your earnings for a trading round are the sum of your end-of-period Cash and the dividends you collect from your share holdings. Continue with the previous example, if you began with 500 cents in your cash account and through trading (buying and selling shares) you finished with 420 cents, then your earnings would be: $6.60 = $2.20 (dividend earnings) + $4.20 (remaining cash).

Your computer screen will provide you information on trading prices in the market and your current cash and share position. On the left part of this screen you will find a graph which will supply you with a history of trading in the round. On the bottom right-hand part of this screen you will find your current holdings. For these instructions, you have 150 cents in cash and 3 shares. You are also provided with information about YOUR dividend value for each share you own at the end of the round. In these instructions, let's assume YOUR dividend is 110 cents and you will receive dividends for up to 3 shares.

During every round, Traders can buy or sell shares from one another by making offers to buy or to sell.

Every time someone makes an offer to buy a share, a GREEN dot will appear on the graph to the left. Every time someone makes an offer to sell, an ORANGE dot will appear on the graph to the left. The offers to buy will be listed in ascending order in GREEN, while the offers to sell will be listed in descending order in ORANGE.

Once a trade is actually made, the trade will be shown as a BLACK dot in the graph. Offers are also listed on the Market Book to the right of the graph.

To enter a New Offer to buy or to sell, type in the price you would like to buy, or sell at in the appropriate Submit New Order box. Click the Buy or Sell button to submit your order.

To accept an existing offer from another participant, click the Buy or Sell button in the Immediate Offer section above. The Immediate Order section shows you the best prices to buy, or sell, that are currently available on the market. By clicking on the Buy button, you buy at the listed price; by clicking on the Sell button, you sell at the listed price. Whenever you enter new offers to buy, or sell, you will have those offers appear as buttons under "Cancel Orders". By clicking on these buttons, you can take them out of the market.

At the end of the round, each share within your holding limit will pay you the amount list at the bottom of your screen. For these instructions that amount is 110. The earned dividends (for shares) will be added to the cash account of the holder. The number of your shares and cash will change, only when you buy, or sell, shares.

An example:

Suppose you have 3 shares and 150 in Cash at the start of the round, and you make one transaction during the round purchasing a share for 20 cents within the round. Your Cash holdings will decrease by 20 to 130 cents. Your share holdings would go from 3 to 4 units. If the round ended, then your earnings would be the sum of your final cash and the dividends collected. In this example, since you can receive dividends from up to 3 shares, you are going to collect dividends from 3 shares, not 4 shares.

In this case, your earnings are: $1.30 Cash + $3.30 Dividends (3 shares × 110 cents) = $4.60

Summary

1. You will be given an initial amount of Cash and Shares.

2. A share pays the owner a dividend at the end of a trading round. The dividends are not the same for each participant. Each participant will receive dividends for up to a particular number of shares.

3. You can submit offers to BUY shares and offers to SELL shares.

4. You make trades by buying at the current lowest offer to sell or selling at the current highest offer to buy.

5. The trading round lasts for 6 minutes.

6. Your earnings for a round are the sum of your remaining cash and YOUR dividend times the number of shares you own at the end of the round.

7. Your cash and shares from one round DO NOT carry over to the next round. You will be given a new initial amount and shares at the start of a new round.

**Quiz for RT Experiments**

1. At the end of each round, each share value is:

A. 0

B. 80 cents

C. 110 cents

D. not the same for everyone

2. You can put a new offer to buy in the market by:

A. Submitting a new order to buy above the highest current buy order

B. Submitting a new order to sell below the lowest current sell order

C. Clicking the Buy immediate order

D. Clicking the Sell immediate order

3. You can accept an existing lowest offer to sell in the market by:

A. Submitting a new order to buy above the highest current buy order

B. Submitting a new order to sell below the lowest current sell order

C. Clicking the Buy immediate order

D. Clicking the Sell immediate order

4. If you can receive dividends for up to 3 and you have 6 shares at the end of a round, how many shares will you receive dividends from?

A. 0

B. 1

C. 3

D. 6

**B2: Specialization (SP) Experiment Instruction and Quiz**

**B2.1 Specialization (SP) Experiment Instruction and Quiz for Buyers (Abbreviated Version)**

In this experiment you are allowed to buy a commodity, called Shares, from others.

At the start of the experiment, you will receive some Cash and Shares. If you decide to buy a share at a certain price, the amount will be paid out of your cash.

Each share will pay a dividend at the end of the trading round. The dividend is NOT the same for everyone. A participant is able to receive dividends from up to a certain number of Shares and beyond that number, the additional shares will pay no dividends.

Here is an example: Suppose your dividend is 110 cents per share and you will receive dividends for up to 2 shares. At the end of a trading round, if you own 5 shares, you will be able to receive: 110 cents × 2 shares + 0 cents × 3 shares = 220 cents, not 110 cents × 5 shares. Your earnings for a trading round are the sum of your end-of-period Cash and the dividends you collect from your share holdings. Say, if you began with 500 cents in your cash account and through buying you finished with 420 cents, then your earnings would be: $6.60 = $2.20 (dividend earnings) + $4.20 (remaining cash)

**B2.2 Specialization (SP) Experiment Instruction and Quiz for Sellers (Abbreviated Version)**

In this experiment you are allowed to sell a commodity, called Shares, to others.

At the start of the experiment, you will receive some Cash and Shares. If you sell a share to another participant at a certain price, the amount will be added to your cash holding.

Each share will pay a dividend at the end of the trading round. The dividend is NOT the same for everyone. A participant is able to receive dividends from up to a certain number of Shares and beyond that number, the additional shares will pay no dividends.

Here is an example:

Suppose your dividend is 110 cents per share and you will receive dividends for up to 2 shares. At the end of a trading round, if you own 3 shares, you will be able to receive: 110 cents × 2 shares + 0 cents × 1 shares = 220 cents, not 110 cents × 3 shares. Your earnings for a trading round are the sum of your end-of-period Cash and the dividends you collect from your share holdings. Say, if you began with 200 cents in your cash account and through selling you finished with 420 cents, then your earnings would be:

$6.40 = $2.20 (dividend earnings) + $4.20 (remaining cash)