**Durability, Re-trading and Market Performance**

J. Dickhaut, S. Lin, D. Porter and V. Smith

"*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 might be so noting that the distinctions we examine are at the core of understanding how differential market performance relates to the current Great Recession.

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 current values based on common public information on expected future 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.

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

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, affects the observed variation in market performance.

## Background Literature

### Early 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]

[2] Smith (1962), Fouraker and Siegel (1963), Plott and Smith (1978), 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 Domenech and Vriend (2008).

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

**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 perceptions, 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], unlike the SD experiments, that state emerged reliably only after multiple sessions of experience.[6]

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. An implication of this model is that price bubbles are greater the larger is the asset economy's endowment of cash (see Caginalp et al. (1998)). Figure 1 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 observed 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.

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[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 these exceptions illustrate the severe limitations on such re-trading.

[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, et al. (2008), Haruvy, et al. (2007), and Dufwenburg (2005).

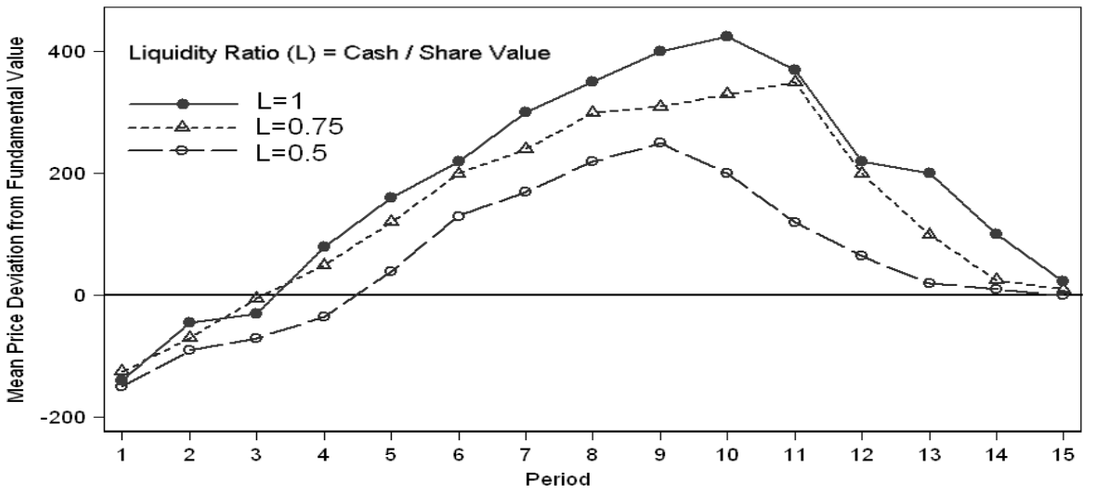


**Figure 1. Cash abundance and mean price deviation in asset market experiments.** This figure demonstrates how the liquidity ratio, $L$, defined as the total market cash endowments divided by total fundamental share value, affects the amplitude of price bubbles. For each level of liquidity ratio, the mean price deviations from the fundamental value are charted for each period of the market from 4 independent experiments in each liquidity treatment. As can be seen, larger endowments of cash lead to larger price bubbles relative to the same fundamental value.

This result is in contrast to SD experiments and suggests that the existence of a second commodity—cash—is not neutral.

## New Experiments and Results

Exploring differences in the behavior of durable goods and non durable goods/services markets is fundamental to understanding the great recession of 2007-2009, as well as previous downturns extending back to the Great Depression (Gjerstad and Smith, 2008). Houses are the most durable of consumer goods, and bubbles in housing-mortgage markets have been prominent sources of recent and historical economic distress.[7] Recessions never find their origin in the 60% of GDP that is perishable, and indeed this is the component of national final demand that is most stubbornly resistant to change in good economic times and bad.

[7] Gjerstad and Smith (2010) report that in eleven of the last fourteen recessions, including the Depression, percentage declines in housing expenditures both preceded and exceeded percentage declines in every other major component of GDP. Moreover, housing expenditures have recovered faster than any other major sector of the economy after every recession.

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. Each subject is assigned a utility consumption value ("dividend") for a fixed number of assets units held at the end of the period. The value schedules and endowments of cash and asset units for each subject are shown in Figure 2. For example, the first subject is endowed with 410 cash and no asset units. She has a consumption 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.

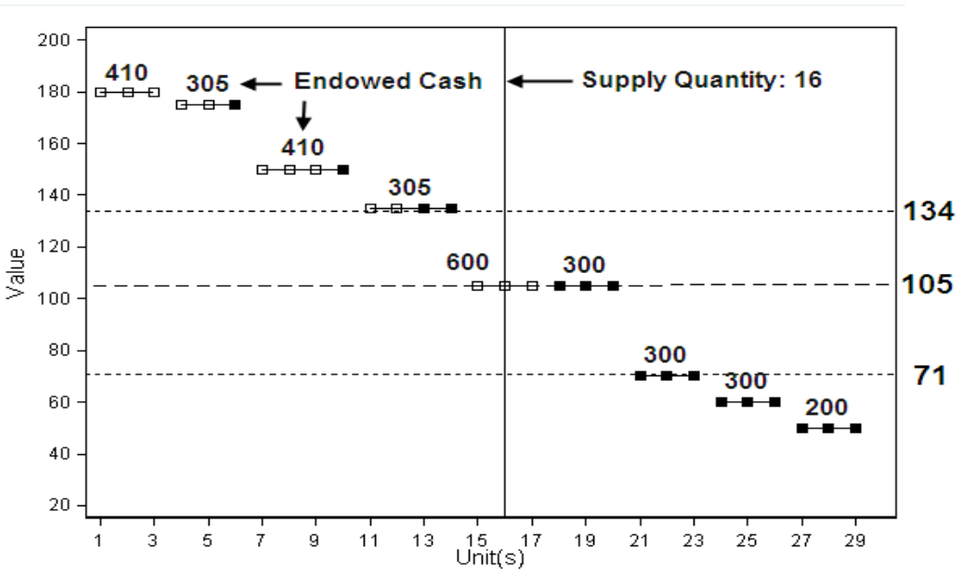


**Figure 2. Environment for new experiments.** Nine subjects are numbered in decreasing order of their dividend demand value. At each value a square represents a subject's (Ss) demand unit; a filled square is also a unit in the subject's endowed supply. Hence, 29 units are in demand, 16 total units in supply. Each Ss cluster of demand units are connected by a horizontal line with his cash endowment shown above the cluster. For maximum efficiency, 10 units from the endowment of Ss 6-9, must be transferred to Ss 1-4. No single market clearing price exists at which every transfer is strictly profitable, with the number of units in demand at that price equal to the number offered. Nor is there an equilibrium bid/ask spread: e.g., 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 individual transaction prices.

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:

- 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.
- 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 and 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.
- 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 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 conditions 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 *only* during the period, and all value realizations do not occur until the end of the trading period[8].

The second treatment, Specialization (SP) is similar to SD experiments.[9] 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.

In both the RT and SP experiments, all endowments and dividend values are refreshed at the beginning of each of a series of ten trading periods, with no carryover cash or asset units across periods, and in this sense replicate the environment and settlement features of SD experiments.

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 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 in the absence 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. The asset is durable only for the length of one trading period.

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[8] This is similar to the experimental set-up found in Cason and Gangadharan (2006) where firms trade pollution permits to avoid abatement costs. Firms can re-trade permits and trade in cash. However, there are several differences from our environment. First, the marginal values of permits for a firm are derived as the cost of abating pollution. That is, values are generated indirectly from avoiding abatement, with some firms having higher abatement efficiency. Second, subjects went through a training session of five periods before actual session starts. Third, a complete experiment has four stages, with the first stage for trading permits and the rest for selecting abatement levels and reporting. Trading has limited attention split. Fourth, each subject had a downward-sloping demand for permits. Fifth, there was a clearly defined competitive equilibrium.

[9] 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 across periods. Price bubbles were significantly mitigated when re-trading was not allowed, but levels of mispricing relative to predictions remained.

**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 as a medium of exchange nor a 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 period. 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.

**(a) Design Differences across Experiments**

| | | New Experiments | | |
|---|---|---|---|---|
| Environment Characteristics | SD | SP | RT | AM |
| Asset Durability | Perishable | Perishable | Durable | Durable |
| Buyers/Sellers Specialized | Yes | Yes | No | No |
| 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 |
| Re-trade Across periods | No | No | No | Yes |

## Performance Results and Analysis

Figures 3 and 4 plot the transaction time series from our two treatments: SP and RT. As shown, RT experiences higher volumes and lower efficiencies.

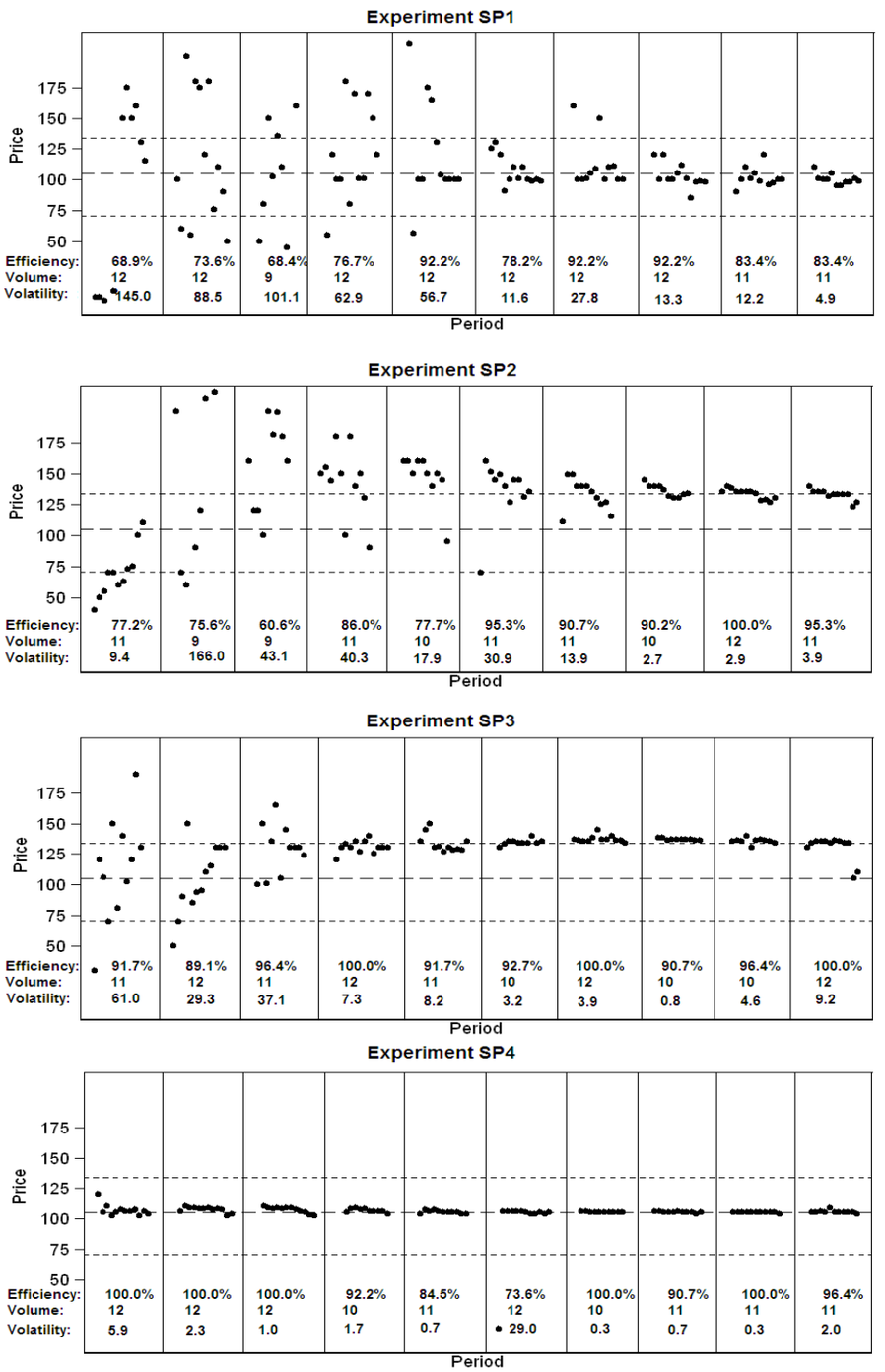


**Figure 3**. Time series of contracts for the 4 specialization (SP) treatment experiments is charted. For each of the 10 period replications for each experiment the efficiency, trade volume and return volatility.

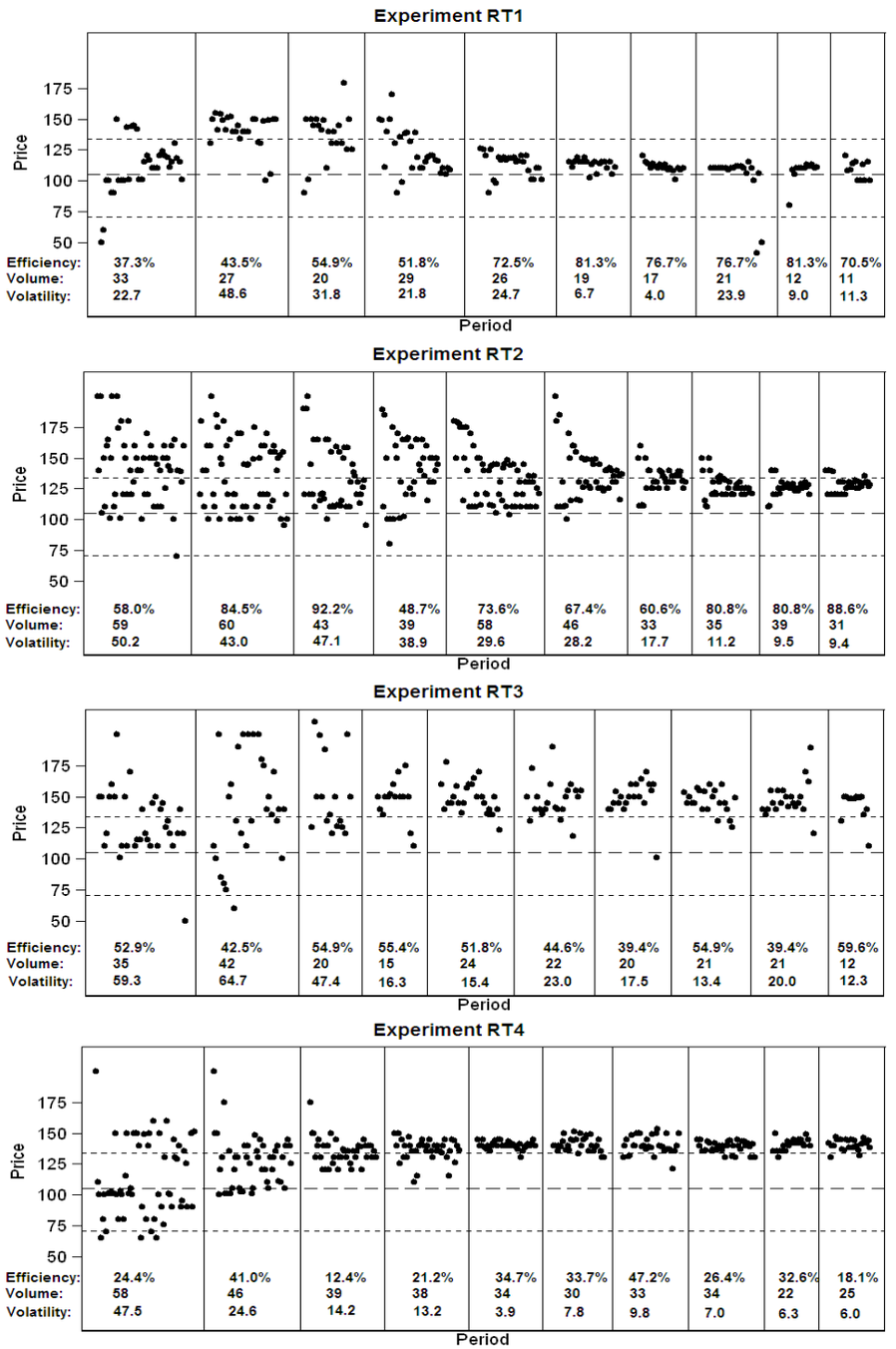


**Figure 4**. Time series of contracts for the 4 re-trade (RT) treatment experiments is charted. For each experiment and each of the 10 period replications the efficiency, trade volume and return volatility are listed.

The aggregate performance results in terms of efficiency, volume and return volatility[10] for all experiments are reported in Table 2. We decompose the results by periods with the first half of the experiments consisting of results from periods 1-5 and the second half results are from periods 6-10.

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

The market performances in terms of efficiency, volume and return volatility are reported below for the New Experiments. Four Re-trade Treatment (RT) experiment sessions and 4 Specialization Treatment (SP) sessions are summarized. The numbers in parenthesis are the standard deviation for each measurement. Each session lasts 10 periods. We split the results for each session into two halves. The 1st half consists of periods 1-5 and the 2nd half is from periods 6-10.

| | Efficiency | Volume | Volatility |
|---|---|---|---|
| SP | 0.886<br>(0.105)<br>n=40 | 11.08<br>(0.94)<br>n=40 | 26.59<br>(38.88)<br>n=40 |
| SP-1st Half | 0.851<br>(0.121)<br>n=20 | 11.05<br>(1.10)<br>n=20 | 44.27<br>(48.46)<br>n=20 |
| SP-2nd Half | 0.921<br>(0.075)<br>n=20 | 11.10<br>(0.79)<br>n=20 | 8.91<br>(9.80)<br>n=20 |
| RT | 0.542<br>(0.209)<br>n=40 | 30.98<br>(13.12)<br>n=40 | 22.97<br>(16.5)<br>n=40 |
| RT-1st Half | 0.504<br>(0.201)<br>n=20 | 37.25<br>(13.75)<br>n=20 | 33.25<br>(17.10)<br>n=20 |
| RT-2nd Half | 0.580<br>(0.216)<br>n=20 | 24.70<br>(9.03)<br>n=20 | 12.70<br>(6.80)<br>n=20 |

Efficiency is approximately 35 percentage points higher in the SP treatment than RT in both halves. Efficiency does increase in the second half for both treatments. Volume is much higher in the RT treatment but falls significantly in the second half of the experiments. Volatility decreases over time in both treatments.

To formally test the significance of the difference across the two treatments and also the change across periods, the following random effects model with robust standard errors is estimated:

$$y_{it} = \alpha + \beta \bullet treatment + \theta \bullet phase + u_i + \varepsilon_{it}$$

[10] Return volatility is defined as the standard deviation of price change between two adjacent transactions in a period.

where $y_{it}$ is the efficiency, volume or return volatility in experiment $i$ period $t$, independent variable *treatment* is dummy variable for either SP or RT treatment, *phase* is a dummy variable for either 1st half or 2nd half of an experiment, and $u_i$ is random effect component for each experiment. The random effect regression clusters the standard errors on experiments.[11]

The estimates of the model can be found in Table 3. In terms of statistical significance, we find that efficiency is adversely affected by re-trading and although volume is significantly reduced in the RT treatment over time, it is still significantly above SP. Surprisingly, price volatility is not different across the treatments.

**Table 3. Regression Estimates on Efficiency, Volume and Volatility.** The regression estimates for the mixed effects model are provided for efficiency, trade volume and return volatility. Using dummy variables for the RT treatment and for the first half (H1: periods 1-5) and second half (H2: periods 6-10) the z-statistics are provided for the tests of equality among the treatments and halves of the experiments. There are consistent differences among the treatments in both efficiency and trade volume.

| | Random Effect Estimator<br>Robust Standard Errors<br>z-Statistic<br>p-Value | | |
|---|---|---|---|
| | Efficiency | Volume | Volatility |
| SP vs RT<br>($\beta$) | -0.344<br>(0.096)<br>z=-3.59<br>**p=0.000** | 19.90<br>(4.86)<br>z=4.09<br>**p=0.000** | -3.62<br>(10.27)<br>z=-0.35<br>p=0.724 |
| SP-H1 vs RT-H1<br>($\beta,\ if\ phase = 1$) | -0.347<br>(0.100)<br>z=-3.47<br>**p=0.001** | 26.20<br>(5.76)<br>z=4.55<br>**p=0.000** | -11.02<br>(18.35)<br>z=-0.60<br>p=0.548 |
| SP-H2 vs RT-H2<br>($\beta,\ if\ phase = 2$) | -0.341<br>(0.107)<br>z=-3.20<br>**p=0.001** | 13.60<br>(4.06)<br>z=3.35<br>p=0.001 | 3.78<br>(2.90)<br>z=1.30<br>p=0.192 |
| SP-H1 v.s. SP-H2<br>($\theta,\ if\ treatment = SP$) | 0.070<br>(0.049)<br>z=1.431<br>p=0.154 | 0.05<br>(0.36)<br>z=0.14<br>p=0.891 | -35.35<br>(17.27)<br>z=-2.05<br>**p=0.041** |
| RT-H1 v.s. RT-H2<br>($\theta,\ if\ treatment = RT$) | 0.076<br>(0.063)<br>z=1.21<br>p=0.227 | -12.55<br>(1.98)<br>z=-6.35<br>**p=0.000** | -20.55<br>(2.92)<br>z=-7.04<br>**p=0.000** |

RT results are puzzling in that efficiencies remain low given such high transaction volume. To investigate why efficiencies remain low throughout the RT experiments, we summarize each

[11] To address the potential correlation across the three regressions, we ran additional Seemingly Unrelated Regressions (SUR) as a robustness check. The results remain unchanged.

trader type's trading activities. In Figure 5, 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 answer this, we measure the average quantity that a subject type buys at prices above her dividend value or sells at prices 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 predicted 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, an average 0.2 shares were bought above what it was worth to her. Subject 1 also sold an average 1.9 shares, all of which are sold below her value. Thus, on net, the average number of units held at the end of the period by subject 1 is 1.9 units (1.1 units less than the efficient outcome).

All subject types end up both buying and selling and specialization is rare. Re-trading is prevalent for all subjects. The prevalence of buying above, or selling below, one's own dividend value suggests that subjects are trading for purposes other than final consumption.

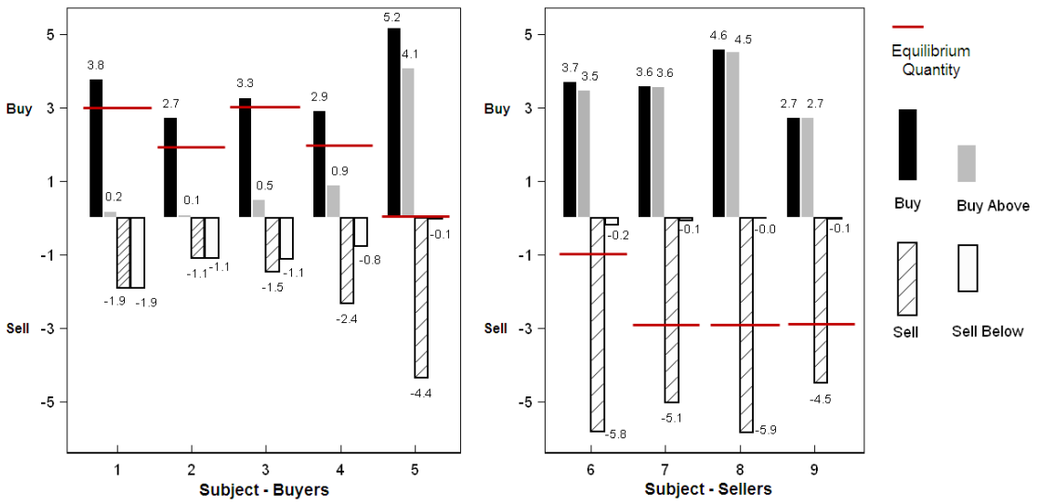


**Figure 3. Re-trading in RT Experiments.** In equilibrium, only Ss 1-4 would buy Shares, only Ss 6-9 would sell Shares. Subject 5 would not transact. Across all 40 periods of results, the average quantities that a subject buys, sells, buys above value or sells below value are reported. The efficient quantity that a Ss types should buy or sell is marked by the horizontal lines. The left panel summarizes the trading for Ss 1-5 for whom it is optimal only to buy (or not). Ss 1-5 all buy more than predicted, but sell units as well. Subjects 1-5 are also found to deviate from their own valuations, with substantial selling below their own values. The right panel summarizes trading for Ss 6-9 who are supposed only to sell, but all sell more units than predicted, including units at prices below value and they also buy units.

## Concluding Remarks

Our RT 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 when there is no clearly defined competitive equilibrium. Volume is much higher than the minimum needed to exhaust positive sum gains from exchange—and surplus fails to converge to a maximum. 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 prevalent, as in our experiments where it not functional in promoting efficiency. 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 4). In the light of our experiments, this high volume does not seem clearly justified as part of the process of equilibrium price discovery.[13]

**Table 4. 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 |

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 for the world's 9 major derivative exchanges between year 2001 and 2008.

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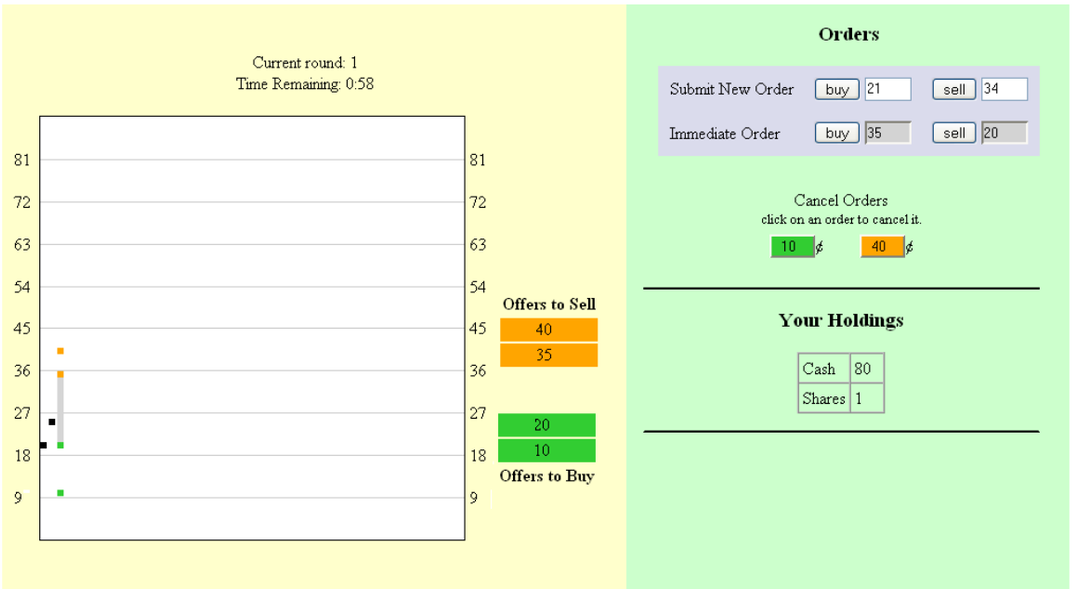
**Appendix A: Experiment Instructions and Quizzes**

**A1: Re-trade (RT) Experiment Instructions**

http://esi2.chapman.edu/sandler/holdinglimit/page1.html

**Figure A1: 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

**A2: Specialization (SP) Experiment Instruction and Quiz**

http://esi2.chapman.edu/sandler/holdinglimit/buyonly/page1.html

http://esi2.chapman.edu/sandler/holdinglimit/sellonly/page1.html

**A2.1 Specialization (SP) Experiment Instruction and Quiz for Buyers (Abbreviated)**

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)

**A2.2 Specialization (SP) Experiment Instruction and Quiz for Sellers (Abbreviated)**

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)