Payout Policy, Investor Rationality, and Market Efficiency: Evidence From Laboratory Experiments*

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Abstract

We use laboratory experiments to examine the longstanding question of whether investors have a preference for particular patterns of firm payouts and whether these preferences are reflected in market prices. We construct a market that closely mimics the conditions underlying the perfect markets conditions outlined in the Miller and Modigliani (1961) famous irrelevance proposition. Despite the absence of meaningful market frictions our evidence suggests that investors do not view "homemade" dividends as perfect substitutes for cash payouts. We find that investors with known consumption needs prefer to fund these needs with certain cash payouts rather than through security sales at potentially unknown prices. Moreover, we find evidence that the preferences for dividend paying securities are also reflected in market prices. The price of the dividend paying security is consistently higher than that of the non-dividend paying one.

I. Introduction

An investor who holds a firm's stock can receive returns in two forms: cash dividend payments and capital appreciation (increases in the stock price). Prior to the 1960's conventional wisdom (e.g., Graham and Dodd (1951) and Gordon (1959)) was that firms that paid dividends would command higher market values compared to non-dividend paying firms because the receipt of a cash dividend ("a bird in the hand") was safer than uncertain capital appreciation. In a seminal paper, which has become a cornerstone in the field of finance, Miller and Modigliani (1961) establish conditions under which dividend (or payout) policy is irrelevant to the value of the firm. Miller and Modigliani (M&M) show that payout policy is irrelevant in competitive markets with no transactions costs, and when investors are fully rational and symmetrically informed. The basic intuition underlying the M&M proposition is that firms are not rewarded for following a particular payout policy because investors with a desire for dividend income can create "homemade" dividends by selling shares at their *fair* value in the market.

Using the irrelevance proposition as a guide, academic researchers have developed a number of theories that relax various assumptions underlying the M&M arguments (by introducing taxes, asymmetric information, agency problems, etc.) in an attempt to explain the costs and benefits associated with particular dividend policies.[1] Nevertheless, despite more than three decades of both theoretical and empirical research, there is still substantial disagreement about the factors that affect firm's payout decisions and whether dividend policy affects firm value.

In this paper we examine the Modigliani and Miller irrelevance proposition in the laboratory by creating markets that are as close as possible to the theory's assumptions. Rather than focusing on the role of market frictions, we instead focus our attention on the implicit assumption in M&M's arguments that relies on the notion of rational expectations and thus requires that agents' forecasts about future prices be correct. Our

[1]For a comprehensive survey of the research on payout policy see Allen and Michaely (2002).

goal is to provide evidence on the extent to which investors view homemade dividends as substitutes for cash dividend payments and whether this affects market prices in a setting that closely mimics the conditions outlined by M&M.

In our market setting investors trade two securities that differ only in the timing of their payouts. We refer to the first security as the dividend paying security, and to the second, as the non-dividend paying security. Trading takes place in two consecutive periods. The first security pays a cash dividend of 100 US cents at the end of the first period, and an uncertain liquidating dividend (with a known distribution) in the end of the second period. The second security pays no dividends in the first period and pays a liquidating dividend that is always exactly 100 cents higher than the corresponding dividend of the first security. Thus, the two securities deliver identical cumulative payoffs across the two periods.

The market is populated with two types of traders: arbitrageurs and hedgers.[2] Arbitrageurs have no intermediate consumption needs and trade only to maximize final wealth. Traders of this type act as (rational) liquidity providers. The hedgers have a certian intermediate consumption need that must be financed out of some combination of dividend income and sales of securities. All investors are fully informed about the payoff structure, the consumption needs, and all other attributes of the market.

Given this setting, the arguments of M&M would suggest that competition between arbitrageurs should equalize the prices of the two securities before dividends are distributed and should equate the difference between those prices to the dividend of the first security after this dividend is distributed. As a consequence both types of traders should be indifferent between the two securities. Moreover, even if hedgers prefer the dividend-paying security, competition among arbitrageurs should still make the above pricing relationship hold. Alternatively, we conjecture that if both hedgers and arbitrageurs are uncertain about the prices in each state of the world in the second period

[2]In the experimental instructions we do not refer to the traders as arbitrageurs and hedgers, they are called type N and type C traders respectively.

(contrary to the rational expectations assumption), then the dividend paying security might demand a premium in the first period if viewed as providing a hedge against the price uncertainty.

Our evidence suggests that the hedgers are indeed not indifferent toward payout policy. We find that in the first trading period there is significant net buying pressure by the hedgers in the dividend paying security. This evidence is consistent with the idea that the hedgers accumulate dividends in order to finance their consumption needs in the second period. More importantly, our results suggest that this buying pressure coupled with the imperfect foresight (of all traders) and the imperfect competition among arbitrageurs serve to drive the price of the dividend paying security above that of the non-dividend paying stock. Thus, hedgers suffer welfare losses compared to the case in which the two securities are priced as perfect substitutes.

Our pricing results are similar to those documented by Long (1978) for the case of Citizen's Utilities. Citizen's utilities was a firm that issued two classes of stock that differed only in the form of their dividend payout. One class of shares paid cash dividends while the other paid stock dividends. In spite of potentially unfavorable tax treatment of cash dividends, Long finds that the prices of the cash dividend paying shares exceed those of the non-dividend paying shares. Examining a later time period, however, Poterba (1986) finds no evidence of differential pricing between the two classes of shares. We argue that our use of laboratory experiments offers a number of advantages relative to the use of field data in understanding the effects of payout policy. In particular, in our experiments the asset structure, the individuals' payoff functions, and the market design are known and can be controlled by the experimenter. Also, each individual's actions (order submissions and cancellations) are recorded and this information is readily available in addition to the information about individual transactions and holdings.

Arbitrageurs in our market do not eliminate price discrepancies between the two classes of shares. This can happen if all traders exhibit an inherent preference for

dividends (e.g., Shefrin and Statman (1984)). In this case, market clearing prices will reflect these preferences. We conjecture that it is the inability of both types of traders to perfectly predict future prices–possibly due to the inability of both types to predict the level of competition among arbitrageurs– that drives this preference for the dividend paying security.

In general, our analysis contributes to several strands of the literature. First, our results suggest that payout policy may affect firm value even in the absence of meaningful market frictions like taxes and asymmetric information. Our analysis suggests that payout policy might be relevant if investors are uncertain whether they will be able to sell securities at fair prices when they need to. This type of uncertainty could potentially arise from limited arbitrage combined with noise trader sentiment or simply from investors' inability to rationally forecast future prices. In this regard our results provide some commentary on notions of dynamic equilibrium (e.g., Radner (1972)) in which agents are hypothesized to choose investment plans given current prices and forecasts of future prices. Finally our analysis is relevant to the catering theory of dividends proposed by Baker and Wurgler (2003). Baker and Wurgler provide evidence that managers tend to initiate dividend payments when investor demand for cash dividends is high and omit them when investor demand is low.

The remainder of the paper is structured as follows. Section II is dedicated to a simple theoretical model, Section III describes our experimental setup, while Section IV presents some conjectures based on the theoretical model to be tested using the experimental data. Section V summarizes the experimental sessions, and Section VI analyzes the data. Section VII concludes with a brief summary.

II. Theory

In what follows, we present a simple two-period model that serves as a theoretical benchmark for our experimental results.

Consider a two-period economy populated by two types of agents, which we call arbitrageurs and hedgers. The hedgers have a known consumption need to fulfill before period 2 is over. Arbitrageurs only care about final wealth. The two assets in the economy, with payoffs expressed in the notional currency, are called A and B. Asset A (B) pays a dividend of 100 (0) at the end of period 1 at time t_1, and a final stochastic payoff at the end of period 2, at time t_2. The final payoffs of both assets depend on the realization of a state variable with four equally likely states, determined by two tosses of a fair coin and denoted by HH, TH, HT and TT. Asset A pays a liquidating dividend of 300 in state HH, 100 in TH, and 0 in HT and TT. Asset B pays exactly 100 above the payoff of asset A.

At time t_0 all agents receive initial endowments consisting of some units of A, units of B, and cash. In the first period, agents trade at prices $p_1 = (p_{A,1},\ p_{B,1})$. To prevent hedgers from funding their consumption need with period-1 cash, we assume that their cash perishes in the end of the first trading period but before dividends are paid. With this assumption, the only decision that hedgers have to make is to form a portfolio consisting of assets A and B.

At time t_1 dividends are distributed and the outcome of the first of the two coin tosses becomes publicly known. The payoff from dividends can be used as cash for trading in the second period, i.e., it becomes the only source of cash in the hedgers' trading accounts.

Prices in the second period are denoted $p_2 = (p_{A,2},\ p_{B,2})$. After trading concludes, and before assets pay their dividends, hedgers have a requirement to secure K in cash. This can be interpreted as hedgers having a known consumption need worth K and being

required to secure it. If there is shortfall of S in meeting the requirement, a penalty of S is assessed on the hedgers. Finally, at time t_2, the second coin toss is realized, securities pay their liquidating dividends and expire worthless.

A time-line for the economy is presented in Figure 1.

Definition: An Economy E is a collection of endowments, utilities, beliefs and a matrix of security payoffs.

Definition: Equilibrium in this economy consists of prices p_1 for period 1, net trades for period 1, $z_1^i = (z_{A,1}^i, z_{B,1}^i)$, period-1 predictions for prices that will prevail in period 2, in each state of the world $s = H, T$, $\hat{p}_2^s$, along with net trade plans for period 2 and state s, $\hat{z}_2^{is} = (\hat{z}_{A,2}^{is}, \hat{z}_{B,2}^{is})$, prices for period 2, p_2^s and net trades for that period, $z_2^{is} = (z_{A,2}^{is}, z_{B,2}^{is})$ s.t.

(1) $\hat{p}_2^s = p_2^s$, $\hat{z}_2^{is} = z_2^{is}$ (Perfect Foresight)

(2) z_1^i and z_2^i are such that given prices p_1 and p_2 agent i maximizes expected utility subject to the appropriate constraints.

(3) $\sum_{i=1}^{I} z_1^i = 0$ (Market Clearance in Period 1)

(4) $\sum_{i=1}^{I} z_2^{is} = 0$ (Market Clearance in Period 2 in each state s)

When arbitrageurs face no short sale and borrowing constraints it can be shown (following a straightforward arbitrage argument) that in the second period the two prices should be related by $p_{A,2}^s + 100 = p_{B,2}^s$. Consequently, it must be that in the first period $p_{A,1} = p_{B,1}$. Therefore prices of the two assets in the first period should be equal independent of the demand from the hedgers.

III. Experimental Design

The experiment and the theory were designed closely together. Each experimental session consisted of six rounds. A round represented a single replication of the two-period model. All accounting in the experiment was done is US dollars. The payoffs of the traded assets were expressed in US cents. Details on the workings of our experimental markets follow, while the instructions given to the subjects are shown in the Appendix.

At the start of a round each trader was endowed with units of security A, security B, and some cash. In the experimental instructions the arbitrageurs and hedgers were called N-traders and C-traders respectively. The arbitrageurs started each round with 20 units of security A, 20 units of security B and with 200 of cash. The hedgers started each round with 2 units of A, 2 units of B and 2400 in cash. Each participant traded in four of the rounds as a hedger and in the other two rounds as an arbitrageur. In each round the proportion of hedgers was set to two thirds.

Trading in each round was conducted in a sequence of two trading periods. Security A (B) paid a dividend of 100 (0) before the start of the second trading period. Both securities paid liquidating dividends at the end of the second period.

The liquidating payoffs were determined by the outcomes of two (fair) coin tosses. All participants were informed that the two outcomes, H and T, were equally likely. Security A paid a liquidating dividend of 300 in state HH, 100 in TH, and 0 in HT and TT. Asset B paid exactly 100 plus the payoff of asset A. The payoff is represented in Figure 2. The figure is taken from the instruction script presented to the participants.

The outcome of the first coin toss was made public between the two trading periods. Hedgers, or C-traders, had to secure 2000 in cash before the announcement of the outcome of the second coin toss, and thus before the securities paid their liquidating dividend. Hedgers were penalized 1 cent for each cent of shortfall from the target of 2000 cents.

A hedger thus ended each round with a payoff equal to the sum of the liquidating dividends of the securities held in the end of the second trading period plus her cash minus the penalty if one was incurred. An arbitrageur ended each round with a payoff equal to the sum of the liquidating dividends of the securities held in the end of the second period plus her cash minus 4000. The 4000 cents were subtracted from the earnings of each arbitrageur because their initial portfolio paid on average 8200 cents but 4200 cents was the minimal payment (each of the 40 securities in the endowment portfolio of the arbitrageurs delivered sure dividend of 100). Thus, arbitrageurs had incentive to sell their securities to the hedgers if they wished to reduce their risk exposure.

After the conclusion of a round there was a short break and a new round was initiated.

Each participant in the experiment earned a payoff equal to the average of their round earnings plus a fixed amount. The fixed amount was announced as \$5 in the instructions, however, it varied from session to session depending on how long a session took. It varied from \$5 to \$20.

IV. Conjectures

The rational expectations model is subjected to empirical validation through analysis of transaction prices and individual demands data. We use the theory to formulate a number of conjectures that address the relationship between the prices of the traded securities, both cross-sectionally and in time-series.

(A) The two securities' transaction prices are equal in the first trading period, i.e. $p_{A,1} = p_{B,1}$.

(B) The two securities' transaction prices differ by 100 cents in the second trading period, i.e. $p_{A,2} + 100 = p_{B,2}$.

(C) Given equal prices of the two securities, traders are indifferent between the relative proportions of A and B in their end-of-first-period portfolios.

We explore the validity of these conjectures on an extensive dataset of order and transaction activity from the experimental sessions described in next section.

V. Summary of the Sessions

The experiment consisted of six sessions conducted at the University of Utah Laboratory for Experimental Economics and Finance (ULEEF), with six identical trading rounds within each session.

The first session was a control session where there were only arbitrageurs. In each round a third of them started with endowments identical to the endowments of the arbitrageurs in the treatment sessions, namely 20 units of each security and 200 on cash. The other two thirds of the participants started with endowments equal to the endowments of the hedgers in the treatment sessions, namely 2 units of each security and 2400 in cash. Incentives to trade in this session were purely for diversification reasons. This session had 20 participants, the session took about 1.5 hours and participants earned $53 on average.

We conducted five treatment sessions with 21 to 24 participants each. Those session took 2.5 to 3.5 hours to complete. As a result for sessions that lasted longer the fixed pay was increased from $5 to $10, $15, or $20 depending on how long the session continued. The earnings from the treatment sessions were equal to $71 on average.

A summary of the sessions is presented in Table I.

At the start of a session subjects were randomly assigned a computer and a trader ID number. Next, instructions (provided in the Appendix) were read out loud with subjects following along with their own copies. During the instruction period partici-

pants were asked to answer a number of questions to ensure their understanding of the market structure, the structure of their own payoffs, and the trading rules. All subjects participated in three practice rounds before proceeding to the six trading rounds. In the first practice round all participants were N-traders. In the second and third practice rounds each participant got to be an N-trader once and a C-trader once. The market mechanism used for trading was a continuous time electronic double auction. It was implemented by a software called Flex-e-markets. A snapshot of the screen is provided Figure 3.[3] The software implements an open book continuous double auction system. Each of the two trading periods lasted at least 5 minutes each. If in the last 20 seconds of trading time allotment there was trading activity the trading was extended by an additional minute. The same protocol was applied to this extra minute, etc. We conducted two pilot sessions preceding the actual sessions. The first of those sessions had a 5-minute trading rule. In this session, we collected surveys and talked to the participants afterwards about their strategies. Several of the arbitrageurs expressed to us that their strategy was to hold up their trading until the very end of trading period in attempt to inflate (in Period 1) prices or to deflate them (in Period 2). Close inspection of the data revealed that indeed there was clustering of sell offers in Period 1 and buy offers in Period 2, by arbitrageurs, towards the end of the trading periods. To minimize this end-of-period focal point for collusive behavior of arbitrageurs, we implemented the above timing rule. The second pilot was run under this rule and the data no longer showed clustering, nor did any of the participants suggest the timing strategy.

VI. Empirical Results

Figure 4 presents the average transaction prices of the two securities, A and B, for the first and second periods of each experimental round, respectively. For every experimental session and each round the figure shows a candle stick colored either red or blue. The

[3]Or, alternatively, one can visit www.flexemarkets.com and http://uleef.business.utah/flexemarkets

stick is red when the average trading price of A in the respective period is higher than the price of B, and blue when average price of B is higher. The red diamonds and the blue diamonds correspond to the average prices of A and B respectively. To ease comparison, in the second-trading-period graph instead of price of A, we plotted the price of A plus 100. The green lines in the graphs represent the expected prices. In the firs-trading-period graph the expected prices for both A and B are 200 cents. In the second-trading-period graph the expected prices depend on the first coin toss realization - if the coin landed heads the expected price of B and A(+100 cents) is 250 cents, while if the coin landed tails this expectation is 150 cents.

As the first graph shows, in the control treatment , with the exception of round 2, prices of A and B were not different. In contrast, throughout the five treatment sessions in 27 out of 30 rounds the price of A was above the price of B. Results are similar for the second trading periods. The the price of security A is higher than the price of B more often than not. Notice, that this is not the case in the control session. In the control session when asked why they valued security B more than security A, subjects indicated that the risk they perceived in A was higher than that of B.

To provide additional evidence on the relation between the prices of the two securities, Figure 5 presents the box plots for the logarithms of the ratios of the transaction prices of the two securities, p_A/p_B for each trading round. [4] As you can see, in most rounds of our 5 treatment sessions the box plots are above the zero line.

Finally, Table III summarizes the visual evidence presented in the figures. It reports the average difference in prices along with the p-values for the Wilcoxon matched-pairs signed-ranks test. The pairs are exactly the ones used in plotting of Figure 5. The

[4]one security trades at any one time, the data is split into periods in which both securities traded at least once, with one of them trading exactly once. The logarithm is taken using the last two transaction prices within each period. For example, if the subscript denotes the transaction time, and the sequence of transaction prices is $p_A^1 = 155$, $p_B^2 = 153$, $p_B^3 = 155$, $p_B^4 = 140$, $p_A^5 = 158$, $p_A^6 = 150$ etc., then the first points on the plot would account for $logp_A^1/p_B^2$, $logp_A^5/p_B^4$, etc. The results remain unchanged if one uses transaction time, in which the clock advances whenever one of the assets trades, and the price of the asset that does not trade is set to its most recent transaction price.

hypothesis that the prices of A and B are equal in the first trading periods is rejected in 26 out of 30 rounds of our treatment sessions. The averages of differences between price A and B are almost always positive (accounting only for the statistically significant differences) except in session 6 round 6. In the control session in four of the six rounds the differences are statistically significant. The differences are mostly positive, however the magnitudes of these differences are considerably lower than in our treatment sessions. Examining the second trading periods, the null that the prices of the two securities (after adding 100 to the price of A) is rejected in 31 out 36 rounds, including the control session. In the control session the differences are negative in 5 out of 6 rounds, which means that price of B was above price of A. In the treatment sessions (accounting only for the statistically significant differences) in 5 rounds out of 25 the differences were negative, meaning that the price of B was above price of A.

Because the Wilcoxon test assumes independence of the paired observations, we also present the results of a co-integration test that accounts for the autocorrelation in the price series. When the data is analyzed period by period, in all periods the transaction price series of both securities contain a unit root. Tables IV and V present the results of the Dickey-Fuller cointegration tests for the first and the second trading periods correspondingly. Out of the 30 first trading periods (excluding the control session), the cointegration coefficient is greater than one in 27 of the cases, and equal to 1 in one of them. Using a binomial test the probability of observing at least 27 greater than one coefficients is less than 0.001. When the second trading periods are considered, the number of greater (less/equal) than one cointegration coefficients is 24(5/2). Using binomial tests, the probability that at least 24 coefficients are greater than 1 is less than 0.003. Based on the above analysis one can conclude that the price of A is higher than the price of B in both trading periods.

Overall, the evidence refutes conjecture (A) and instead suggests that investors exhibit a preference for the dividend paying security in the first trading period. Moreover,

the results are very similar to those documented by Long (1978) using field data for the case of Citizen's Utilities. Our evidence suggests that the price of security A continues to be higher than that of B also in the second trading sessions.

To provide further evidence on the apparent preference for dividends documented above we examine the net trades of the hedgers across the trading periods. As expected in the first periods of each six rounds of the five (treatment) sessions, the hedgers are net buyers of the two securities. In 16 of the 30 periods they buy more A than B. In the second period, in contrast, in 19 of the 30 rounds the number of units B sold by hedgers exceeded that of A. Thus, the behavior of traders is as follows–hedgers appear to use security A to partially fund their consumption need, however,when making home-made dividends, they use more security B for that, thus creating selling pressure in the second trading periods.

We are left with two puzzles. The first is that while theory does not predict systematic preference for either of the assets, the hedgers buy more of security A in the first period. One possible explanation is that they are uncertain whether they will be able to sell securities at fair prices when they need to. This type of uncertainty could potentially arise from limited arbitrage combined with noise trader sentiment (e.g., Delong, Shleifer, Summers and Waldman (1990) and Shleifer and Vishny (1997)) or simply from investors' inability to rationally forecast future prices. However, and this is the second puzzle, even if for whatever reason the hedgers have a preference for the dividend-paying stock A, this preference should not be reflected in the first-period prices–unless the arbitrageurs have an inherent preference for the dividend-paying stock as well. It could be that the competition among the arbitrageurs is inadequate to eliminate the pricing discrepancies.

VII. Concluding Remarks

We use laboratory experiments to examine the longstanding question of whether investors have a preference for particular patterns of firm payouts and whether these preferences are reflected in market prices. We construct a market that closely mimics the conditions underlying the perfect markets conditions outlined in M&M's famous irrelevance proposition. Despite the absence of meaningful market frictions our evidence suggests that investors do not view "homemade" dividends as perfect substitutes for cash payouts. We find that investors with known consumption needs prefer to fund these needs with certain cash payouts rather than through security sales at potentially unknown prices. More puzzling is the evidence that these preferences for dividend paying securities are also reflected in market prices. The price of dividend paying security is consistently higher than that of the non-dividend paying security. These pricing discrepancies hold despite the fact that there is little evidence of meaningful market frictions that would limit arbitrage. Our results have implications for how firms should set payout policy and suggest a number of avenues for additional research, including the role of market frictions and market design in determining the relative pricing of substitute securities.

References

Allen, Franklin, and Roni Michaely, 2002, Payout Policy, in George Constantinides, Milton Harris, and Rene Stulz, (eds.), *Handbook of the Economics of Finance* (New York: North Holland).

Baker, Malcolm, and Jeffrey Wurgler, 2004, A catering theory of dividends, *Journal of Finance* 59, 1125-65.

DeLong, J. Bradford, Andrei Shleifer, Lawrence H. Summers, and Robert Waldmann, 1990, Noise trader risk in financial markets, *Journal of Political Economy* 98, 703-738.

Graham, Benjamin, and David L. Dodd, 1951, *Security Analysis: Principles and Techniques*, McGraw-Hill, New York, NY.

Gordon, Myron J., 1959, Dividends, earnings, and stock prices, *Review of Economics and Statistics* 41, 99-105.

Long, John B., 1978, The market valuation of cash dividends: A case to consider, *Journal of Financial Economics* 6, 235-264.

Miller, Merton H., and Franco Modigliani, 1961, Dividend policy, growth and the valuation of shares, *Journal of Business*, 34, 411-433.

Poterba, James M., 1986, The market valuation of cash dividends: The Citizens Utilities case reconsidered, *Journal of Financial Economics*, 15, 395-405.

Radner, Roy, 1972, Existence of Equilibrium of Plans, Prices, and Price Expectations in a Sequence of Markets, *Econometrica*, 40(2), 289-303.

Rietz, Thomas A., 2005, Behavioral Mis-pricing and Arbitrage in Experimental Asset Markets, Working Paper.

Shefrin, Hersh M., and Meir Statman, 1984, Explaining investor preference for cash dividends, *Journal of Financial Economics*, 13, 253-282.

Shleifer, Andrei, and Robert W. Vishny, 1997, The limits of arbitrage, *Journal of Finance*, 52, 35-55.

Appendix: Instruction Set

Instructions

This is an experiment in decision making and trading. You will be paid for your participation. The exact amount you receive will depend on your decisions and the decisions of others. You will be paid in cash at the end of today's session. If you have a question during the session, please, raise your hand and one of us, the experimenters, will assist you. You will be given $5 for coming here on time and listening to the instructions.

1. The Market and the Stocks

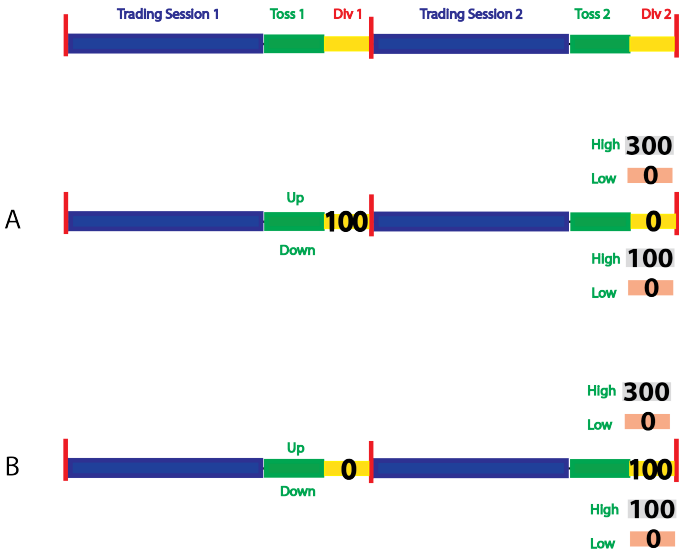
Flex-e-markets is an electronic market for two stocks, A and B. Trading is conducted in a series of rounds. Your earnings are evaluated separately for each round and your final earnings equal the average from the rounds. All accounting is done in US cents. You start a round with some units of A, B, and cash. Markets open and you can trade.

Each round has two trading sessions, Trading Session 1 and Trading Session 2. Each session is followed by two breaks: one reserved for a fair coin toss and one for dividend distributions. The breaks are called Toss1 and Toss2, and Div1 and Div2 respectively. Below is the time line of a Round and the dividends for A and B.

The two stocks, A and B, pay the same total amount in dividends, but they differ in the timing of the payments. A pays 100 in Div1 while B pays 100 in Div 2.

Beyond the sure 100 in dividends, both A and B may pay additional dividends in Div2. The amounts depend on two tosses of a fair coin, at Toss 1 and Toss 2. If the coin in Toss 1 lands on Heads, the payoffs relevant for this round are listed on top of the timeline. If it lands on Tails, the payoffs are below the timeline.

If the coin lands on Heads in Toss 2, then both stocks pay "High" and if it lands on Tails, both stocks pay "Low."



You are entitled to dividends from stock A in Div1, only if you hold the stock at the end of Trading Session 1. If you acquire the stock A in Trading Session 2, you are only entitled to the Div2 distributions.

After paying dividends in Div2, both stocks expire worthless.

Questionnaire about the Dividend Structures of the Two Stocks

Q1 You end Trading Session 1 with 10 units of A and 2 units of B:
2.1 What dividends will you collect from your holdings of A in Div1?
2.2 What dividends will you collect from your holdings of B in Div1?

Q2 In Trading Session 2 you purchase one unit of A and one unit of B and you do not plan on selling them. Toss 1 is Up.
3.1 How much will you collect in dividends from your unit of A on average in Div 2?
3.2 How much will you collect in dividends from your unit of B on average in Div 2?

Q3 In Trading Session 2 you purchase one unit of A and one unit of B and you do not plan on selling them. Toss 1 is Down.
3.1 How much will you collect in dividends from your unit of A on average in Div 2?
3.2 How much will you collect in dividends from your unit of B on average in Div 2?

Q4 In the beginning of Trading Session 1, you have one unit of A and one unit of B.
1.1 How much do you expect to collect in dividends from your unit of A on average?
1.2 How much do you expect to collect in dividends from your unit of B on average?

2. Trading

At the beginning of each round you will be given, as "working capital," a number of units of A, units of B and some cash (US cents). In each round you will be assigned the role of one of two possible types of traders—N or C (called N-traders and C-traders).

2.1 N-Traders

N-traders trade in Trading Session 1. They receive dividends in Div1, and those are automatically added to their cash holdings.

N-traders start Trading Session 2 with the same units of A and B with which they finished Trading Session 1, and the cash amount they had at the end of Trading Session 1 plus the dividends received in Div1. After the end of Trading Session 2, N-traders receive dividends from their holdings in Div2. Thus, at the end of the round the N-traders have only cash. This cash minus 4000 is an N-trader's earnings for the round. The reduction of 4000 reflects the fact that all N traders start with a rich initial portfolio.

N-traders can make money by buying low and selling high either of the two stocks. In addition, the N traders can shield the high risks of their initial portfolio by trading away from some of their stock pile and into cash.

Example 1

If an N-trader does not trade, the earnings s/he would receive in the end of a period have a high risk.

Take an N-trader with 20 units of A, 20 units of B, and 200 in cash.

The possible final payoffs with no trading are presented below.

Below is also an example of the final payoffs with some trading.

Practice round 1 Round P1 will be for practice only. Everyone will be an N-trader in this round.

2.2 C-Traders

C-traders cannot carry over cash from Trading Session 1 to Trading Session 2! After Trading Session 1 all their cash (if any) is automatically ***forfeited*** and is thus no longer available to them. *Hence, as a C-trader you will want to spend all of your initial cash allocation to buy stocks during Trading Session 1!*

Dividends from stock A are distributed during Div1 (same as for the N-traders). So the cash you receive from A during Div1 is carried over to Trading Session 2.

C-traders start Trading Session 2 with the same number of A and B as they finished Trading Session 1, and with cash equal to the dividends collected in Div1.

C-traders have a requirement of having in their account 2000 cents after Trading Session 2 is concluded and before Toss2 and Div2.

If a C-trader has less than 2000, Flex-E-Markets will automatically charge an overdraft fee. The fee is equal to the amount of shortfall. Say, if a C-trader ends up with 800, the fee will equal 1200 (=2000-800). A C-trader should attempt to procure sufficient cash to avoid the fee.

A C-trader's earnings equal to the final cash minus the shortfall on the cash requirement.

Practice rounds P2 and P3 You will be a C-trader in one round, and an N-trader in the other.

Figures

Figure 1. Time-line for the Economy

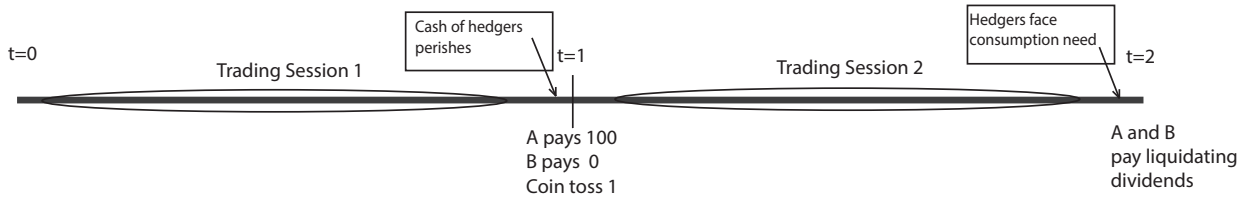


Figure 2. Payoffs of A and B. Up is realized when the outcome of the first coin toss is H. Down is after a coin toss of T. Then high second period liquidating dividend is after a toss of H of the second coin. It the toss is T, payoffs are low.

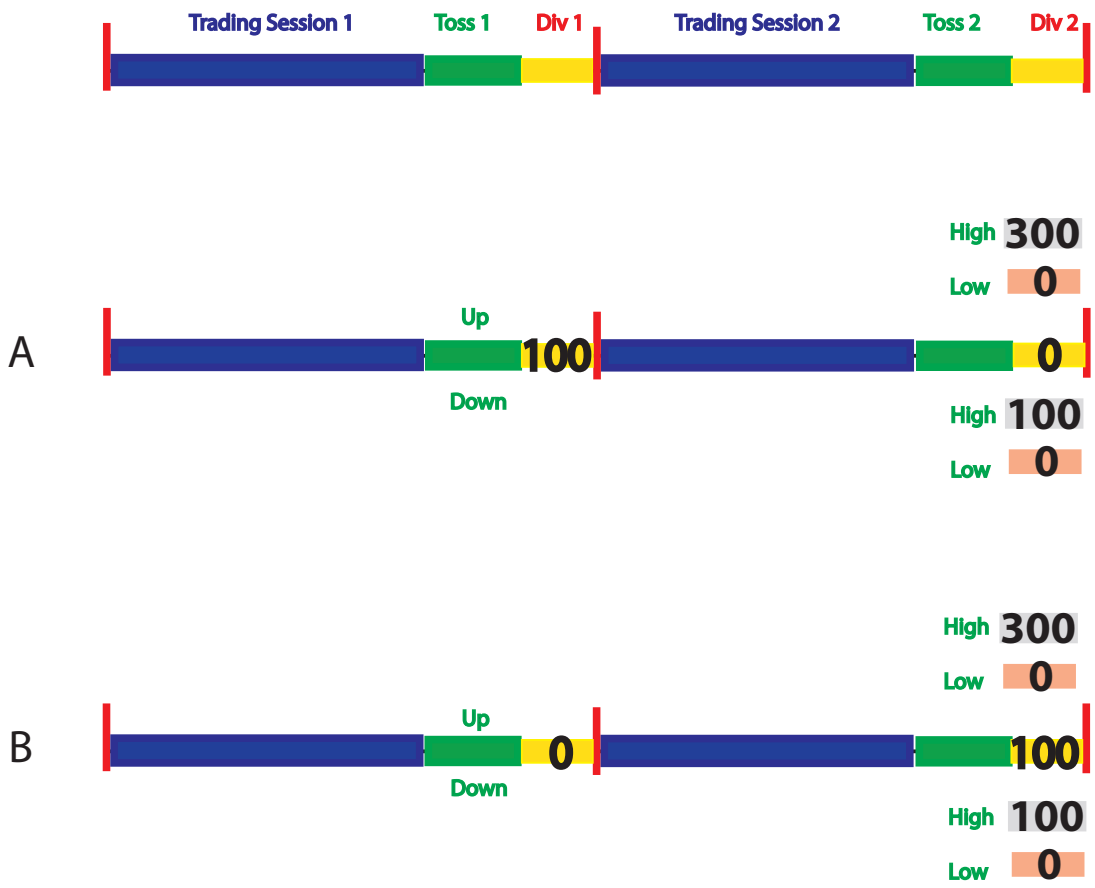


Figure 3. Screenshot of the Trading Software Flex-e-markets

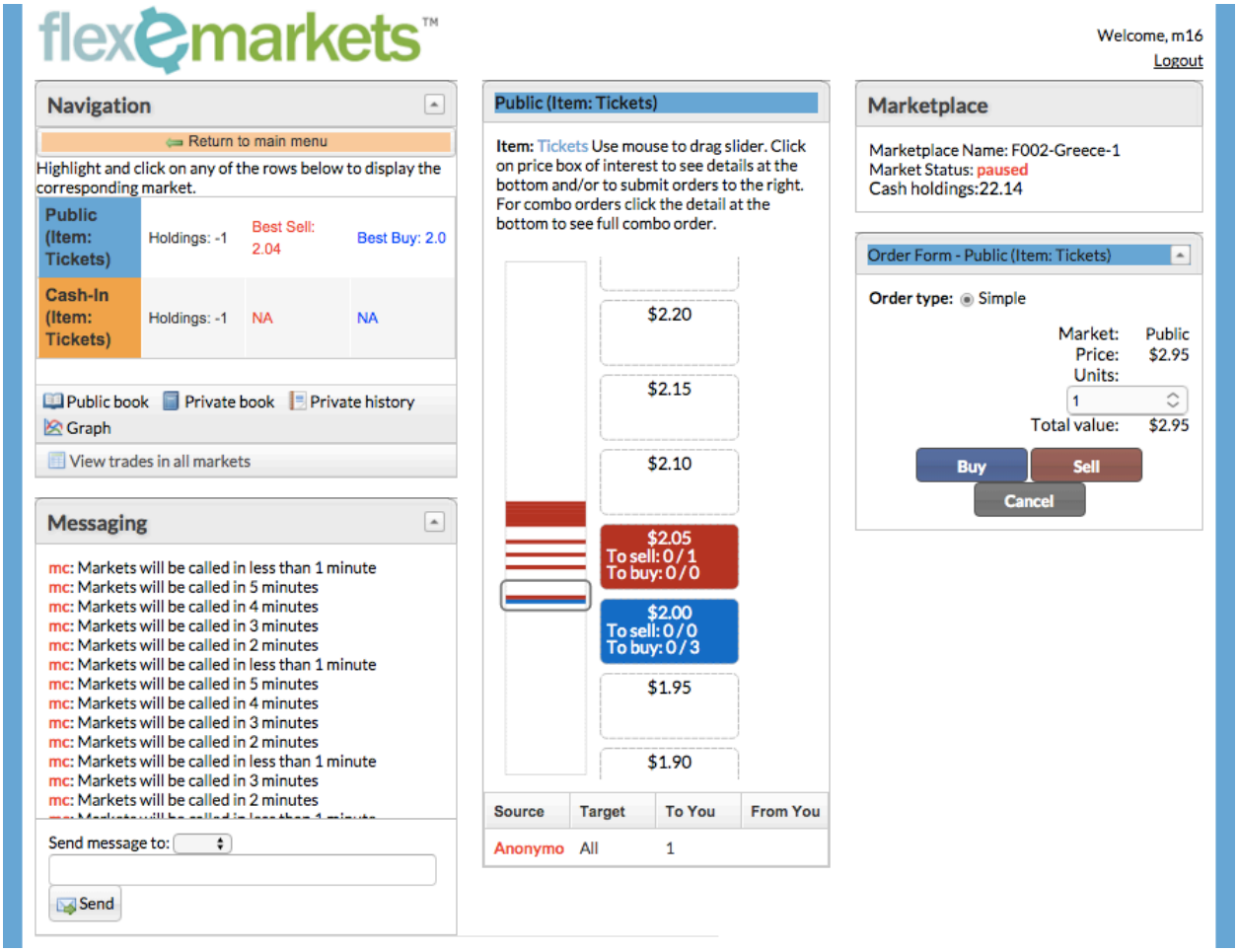
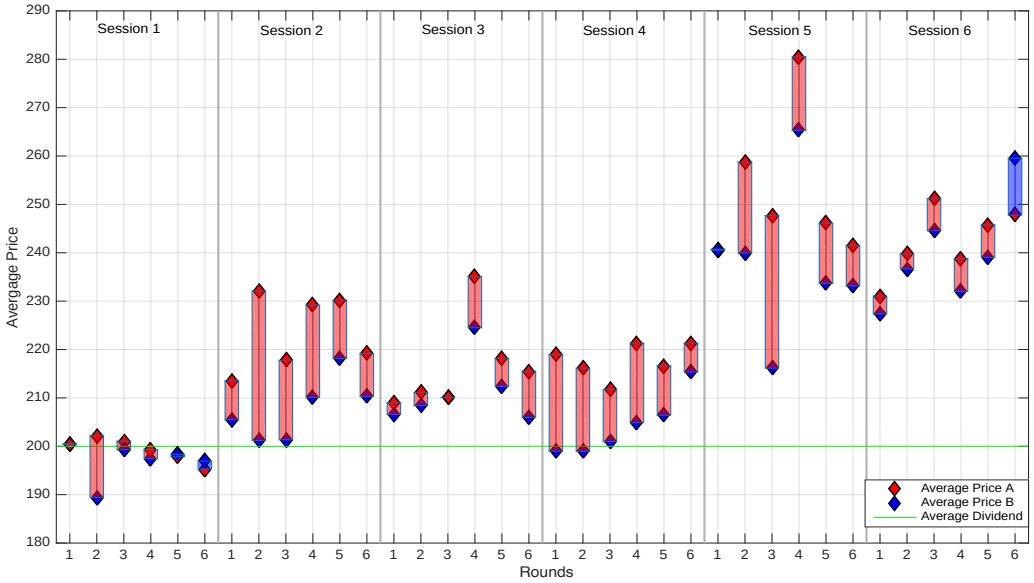


Figure 4. Average Transaction Prices. On the left is the average of the first period prices. Across the six rounds, with two trading periods each, trading periods are enumerated from 1 to 12. Odd numbers correspond to first periods within a round. Even numbers are second periods.

(a) First Periods of Trading



(b) Second Periods of Trading

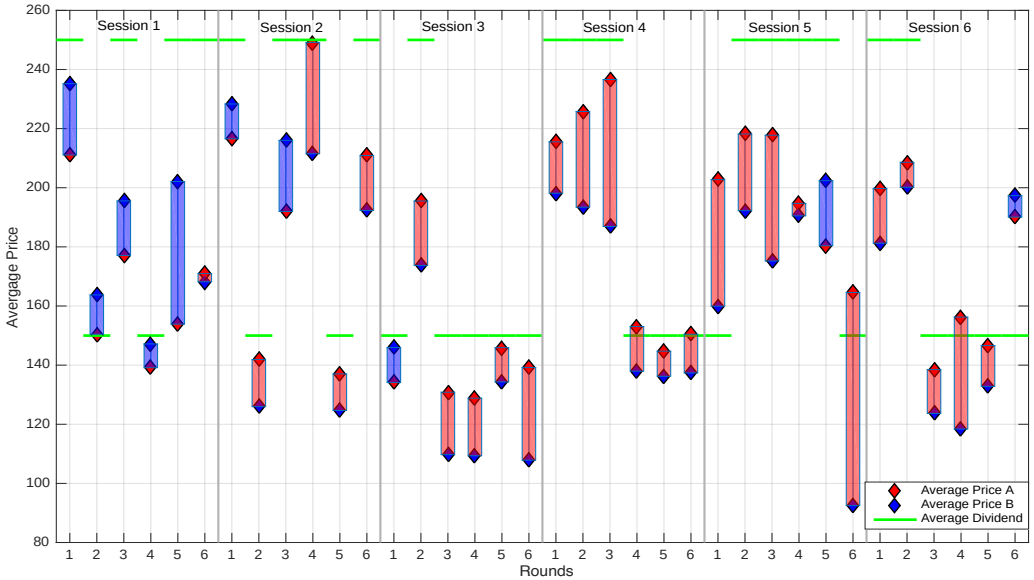
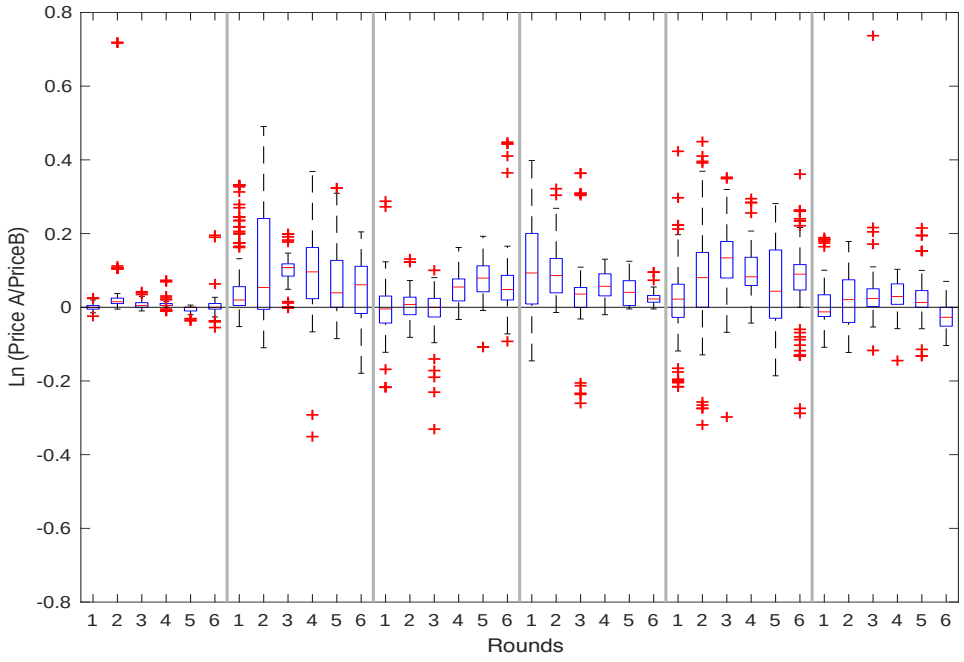
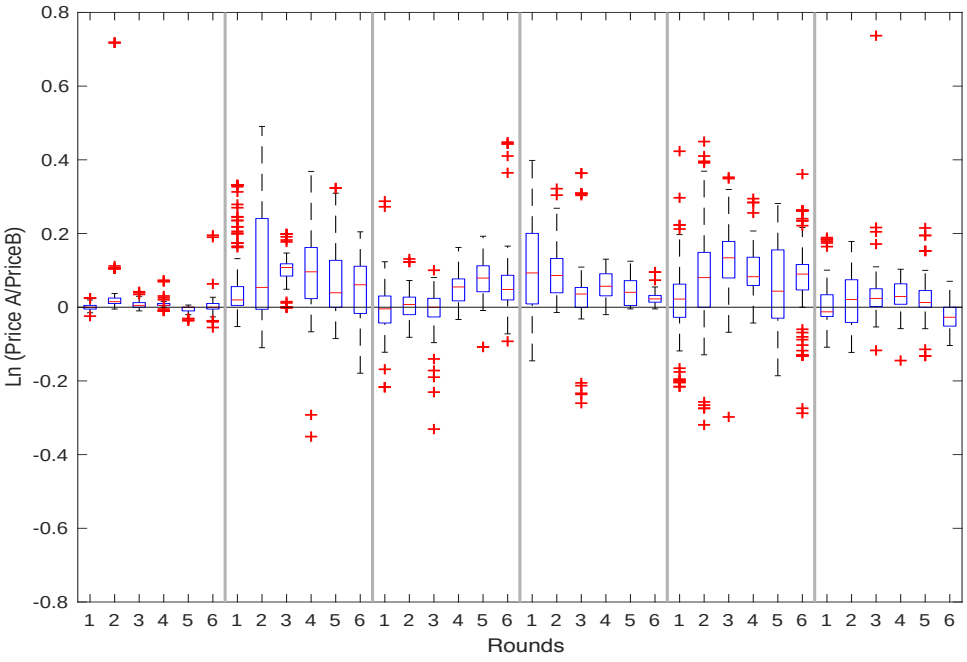


Figure 5. Box Plots for the Natural Logarithm of the Ratio of Price A to Price B.

(a) First Periods of Trading



(b) Second Periods of Trading



Tables

Table I
Summary of the Experimental Sessions: The first session was a control session, with no hedgers. The rest of the sessions were with treatment.

Session	Type Session	Date	Number of Participants	Number of Hedgers	Average Earnings
1	Control	5/19/15	20	0	$53.15
2	Treatment	5/20/15	24	16	$73.15
3	Treatment	5/26/15	22	14/15	$72.80
4	Treatment	5/27/15	24	16	$71.60
5	Treatment	6/3/15	21	13/14/15	$73.25
6	Treatment	6/9/15	24	16	$64.90

Table II
Results from the Signed-Rank Tests. First Periods. The table presents the average transaction price difference between A and B. The p-value of the Signed-Rank statistic (W_+) is presented in the parenthesis.

Session		Round					
		1	2	3	4	5	6
1	Coef.	0.26	8.62	1.62	1.83	-1.11	1.12
	p-value	($p = 0.285$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)	($p = 0.056$)
2	Coef.	14.80	30.53	21.58	14.19	14.08	10.07
	p-value	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)
3	Coef.	-1.27	0.98	-1.66	12.12	16.78	12.38
	p-value	($p = 0.407$)	($p = 0.347$)	($p = 0.946$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)
4	Coef.	22.20	19.19	7.66	12.36	9.14	5.48
	p-value	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)
5	Coef.	6.50	20.64	30.28	24.97	12.35	18.98
	p-value	($p = 0.009$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)
6	Coef.	1.58	5.915	8.92	7.25	6.48	-5.96
	p-value	($p = 0.936$)	($p = 0.002$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)

Table III
Results from the Signed-Rank Tests. Second Periods. The table presents the average transaction price difference between A and B. The p-value of the Signed-Rank statistic (W_+) is presented in the parenthesis.

Session		Round					
		1	2	3	4	5	6
1	Coef.	-19.46	-12.60	-14.93	-9.30	-44.16	21.54
	p-value	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)
2	Coef.	-9.79	16.66	-12.74	25.53	12.13	19.50
	p-value	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)
3	Coef.	2.25	22.78	28.04	30.48	6.62	32.04
	p-value	($p = 0.215$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)	($p = 0.127$)	($p < 0.001$)
4	Coef.	14.78	33.98	51.14	5.73	6.76	5.40
	p-value	($p = 0.006$)	($p < 0.001$)	($p < 0.001$)	($p = 0.016$)	($p = 0.013$)	($p = 0.009$)
5	Coef.	53.83	34.86	40.58	2.46	-13.34	64.66
	p-value	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)	($p = 0.122$)	($p < 0.001$)	($p < 0.001$)
6	Coef.	26.84	-4.26	20.50	36.17	12.69	-6.88
	p-value	($p < 0.001$)	($p = 0.011$)	($p < 0.001$)	($p < 0.001$)	($p < 0.001$)	($p = 0.003$)

Table IV
Co-integration Results, First Periods: The estimated model is $p_{A,i} = Cp_{B,i} + \epsilon_i$. The table reports the estimates of the coefficient C.

Session	Round					
	1	2	3	4	5	6
1	1.00	1.03	1.01	1.01	0.99	1.00
2	1.07	1.12	1.11	1.04	1.06	1.04
3	0.99	1.00	0.99	1.05	1.08	1.06
4	1.02	1.09	1.03	1.06	1.04	1.03
5	1.02	1.08	1.14	1.09	1.06	1.08
6	1.01	1.02	1.03	1.03	1.02	0.98

Table V
Co-integration Results, Second Periods: The estimated model is $p_{A,i} = Cp_{B,i} + \epsilon_i$. The table reports the estimates of the coefficient C.

Session	Round					
	1	2	3	4	5	6
1	0.92	0.91	0.92	0.93	0.78	1.14
2	0.96	1.09	0.94	1.12	1.08	1.09
3	1.00	1.12	1.26	1.30	1.04	1.29
4	1.30	1.18	1.27	1.01	1.00	1.02
5	1.30	1.18	1.23	1.01	0.93	1.64
6	1.15	0.97	1.14	1.30	1.09	0.97