

# 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 M&Ms 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.

Preliminary and incomplete: Please, do not circulate.

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.<sup>1</sup> 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 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. Trading takes place in two consecutive periods. The first security pays a cash dividend of 100 experimental currency units at the end of the first period, and an uncertain liquidating dividend. The second security pays no dividends in the first period and pays a liquidating dividend which is always exactly 100 units higher than the corresponding dividend of the first security. The market is populated with two types of traders: type N (unconstrained) and type C (constrained). Type N traders, or arbitrageurs, have no

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<sup>1</sup>For a comprehensive survey of the research on payout policy see Allen and Michaely (2002).

intermediate consumption needs and trade only to maximize their final wealth. Traders of this type act as liquidity providers. Type C traders have an 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 and other attributes of the market. Given this setting, the arguments of M&M would suggest that competition between the type N traders should equalize the prices of the two securities and that type C traders should be indifferent between the two securities. Alternatively, we conjecture that if the type C investors are uncertain about the prices at which they can sell securities in the second period in order to finance their consumption needs then cash dividend payments will be valued more highly than homemade dividends by these investors.

Our evidence suggests that the type C investors are not indifferent toward payout policy. We find in the first trading period that there is significant net buying pressure by C traders in the dividend paying security. This evidence is consistent with the idea that the C traders accumulate dividends in order to finance their consumption needs in the second period. More importantly, our results suggest that this buying pressure serves to drive up the price of the dividend paying security relative to that of the non-dividend paying stock. Thus, C traders 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.

An outstanding question is why the N traders in our market do not eliminate price discrepancies between the two classes of shares. One possibility is that all investors (both N and C traders) exhibit an inherent preference for dividends (e.g., Shefrin and Statman (1984)). In this case, market clearing prices will reflect these preferences. Alternatively, it is possible that competition among the N traders is

inadequate to eliminate the pricing discrepancies. In our laboratory setting, however, it is unlikely that arbitrage activity is limited by either risk aversion or wealth constraints in meaningful ways.

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 demand is investor demand is low.

The remainder of the paper is structured as follows. Section 1 is dedicated to a simple theoretical model, Section 2 describes our experimental setup, while Section 3 presents some conjectures based on the theoretical model to be tested using the experimental data. Section 4 summarizes the experimental sessions, and Section 5 analyzes the data. Section 6 concludes with a brief summary.

## 1 The Baseline Model

In this section we present a simple two-period model that serves as a theoretical baseline for our experimental results.

Consider an economy populated by two types of agents, which we call type N and type C. Both have identical (concave) preferences over final consumption of the single good in the economy. Consumption takes place only at the end of the second period. There are two assets in positive net supply, called Alpha and Beta. A time-line for the economy is presented in Figure 1. Asset Alpha pays a dividend of 100 units of the consumption good at the end of period 1 at time  $t_1$ , and a liquidating stochastic dividend at the end of period 2, at time  $t_2$ . Asset Beta pays no dividend at the end of period 1 and a stochastic dividend at the end of period 2. The end-of-second-period dividend payments of both assets depend on the realization of a state variable with two equally likely states, H and T. If the realization is H then

asset Alpha pays a dividend of 100 consumption units while Beta pays 200. If the realization is T the payoffs from the two assets are 0 and 100 respectively.

Both types of agents have access to a free storage technology. N-type agents can access the storage technology both at the beginning and at the end of each of the two trading periods. C-type agents have limited access to the storage technology, details of which are provided below.

At time  $t_0$  all agents receive initial endowments consisting of some units of Alpha, units of Beta, and units of the consumption good. The prices of the two assets are expressed in units of the consumption good. Agents trade between times  $t_0$  and  $t_1^-$  at prices  $p_1 = (p_{\alpha,1}, p_{\beta,1})$ . After trading, at time  $t_1^-$ , both types of agents have access to the storage technology. Any units of the good not stored in the technology are lost. Next, at time  $t_1$  each unit of security Alpha pays a dividend of 100, also expressed in units of the consumption good. The dividend can be utilized as means for payment in the subsequent trading period. In addition, at time  $t_1^+$ , type N traders have access to the storage technology and can take out any amount of the good they have stored to use in the subsequent period of trading which is between times  $t_1^+$  and  $t_2^-$ . Type C traders have no access to the storage technology at that time. Prices in the second trading period, expressed in units of the consumption good, are  $p_2 = (p_{\alpha,2}, p_{\beta,2})$ . After trading, at  $t_2^-$ , as in the end of the first trading period, all agents have access to the storage technology. Again, units of the good not deposited there are lost. C-type traders have a minimum requirement of depositing at least  $K$  units of the consumption good into the storage technology (similarly one can think of C-traders as having a known consumption need at that time). Final consumption is reduced by 1 unit for each one unit short of the required  $K$  units (where the reduction is referred to as a consumption penalty). In the end, at  $t_2$ , securities pay their liquidating dividends, and consumption (equal to the total dividends plus the amount stored minus the consumption penalty) takes place.

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,  $z_1^i = (z_{\alpha,1}^i, z_{\beta,1}^i)$ , period-1 predictions for prices that will prevail in period 2,  $\hat{p}_2$ , along with net trade plans for period 2,  $\hat{z}_2^i = (\hat{z}_{\alpha,2}^i, \hat{z}_{\beta,2}^i)$ , prices for period 2,  $p_2$  and net trades for that period,  $z_2^i = (z_{\alpha,2}^i, z_{\beta,2}^i)$  s.t.

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

(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 budget constraints.

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

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

One should note that the storage technology enters into the equilibrium definition through the budget constraints of the agents.

We characterize the equilibrium relation between the prices of Alpha and Beta when the N-type of traders have no short sale (borrowing) constraints imposed. In this case, via a simple arbitrage argument, it is straightforward to deduce that in the second period the two prices should be related by  $p_{\alpha,2} + 100 = p_{\beta,2}$ .<sup>2</sup> Similarly, it must be that in the first period  $p_{\alpha,1} = p_{\beta,1}$ .<sup>3</sup> Therefore prices of the two assets in the first period should be equal independent of the demand from the C-traders.

## 2 Experimental Design

The laboratory experiment was designed to closely match the situation in the theoretical model of the previous section. Each round in the experimental sessions represents a single replication of the two period model above. Each round consists of two trading periods with a short break between them. The experimental consumption good is called “widgets.” Trading, however, is done using an artificial experimental currency, called “francs.” The usage of this currency makes the implementation of the storage technology and the trading itself more intuitive and closer to the participants’ every day experience with financial markets. Francs and widgets can be exchanged one for one, and the restrictions regarding this exchange correspond to the restrictions imposed by the storage technology. Details on the workings of our experimental market follow, and the instructions given to the subjects are shown in Appendix B.

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<sup>2</sup>Whenever  $p_{\alpha,2} + 100 > p_{\beta,2}$ , an N-trader can make an infinite profit by selling Alpha, borrowing from the consumption unit, and buying Beta. The opposite position is to be taken if the inequality is reversed.

<sup>3</sup>When short sale constraints are imposed the relation between the two prices can potentially change. For example in an economy with two agents (agent 1 being of the C type, and agent 2 being of the N type) and beginning of second-period holdings  $(z_{\alpha}^1, z_{\beta}^1, z_c^1) = (7, 9, 1200)$ ,  $(z_{\alpha}^2, z_{\beta}^2, z_c^2) = (7, 5, 1800)$ , mean variance preferences with risk aversion coefficients  $b^1 = 0.0001$ ;  $b^2 = 0.0002$ , and depositing constraint of  $K = 2000$ , the equilibrium prices are 45.38 for Alpha, and 143.7 for Beta. The optimal demands are  $(z_{\alpha}^{1*}, z_{\beta}^{1*}, z_c^{1*}) = (14, 1.4, 2000)$ ,  $(z_{\alpha}^{2*}, z_{\beta}^{2*}, z_c^{2*}) = (0, 12.6, 1000)$ . The difference in prices is due to the low risk aversion of the C-traders who are forced to hold more of the risk-free consumption good than they would like.

Each trader starts a round with an endowment of some units of the two securities, Alpha and Beta, and some units of the experimental trading currency.<sup>4</sup> Security Alpha pays a dividend of 100 francs before the start of the second trading period while security Beta does not pay a dividend at that time. Both securities pay liquidating dividends (expressed in francs) at the end of the second period.

The liquidating payoffs are governed by the two states, H and T. All participants are informed that the two states are equally likely, and that their realization is independent across rounds. Security Alpha pays 100 francs if the state at the end of the second period is H, and 0 otherwise. Security Beta pays a dividend of 200 or 100 francs if the state is H or T, respectively. Experimental francs are exchanged for “widgets,” which are sold back to the experimenters at the end of the session at a pre-announced (dollar-denominated) price. Because selling widgets back to the experimenter is the only way for the subjects to make money, the goal of each trader during the session is to maximize his/her total widget inventory.

As in the model, two types of traders, called N-type and C-type, populate the experimental markets. In the beginning of each round traders are assigned their type.<sup>5</sup> The assignment is not random—each trader alternated between C and N type, so that in each round half of the traders are of type N and the other half are type C. The only difference between the N and C type traders is in the timing of the francs-to-widgets conversion.

During the break following the first trading period all C-traders’ available francs are automatically converted to widgets and are not available to them in the second trading period. Converting all their available francs to widgets corresponds to the C-traders depositing all of their consumption good in the storage technology and not having access to the deposited goods before the end of the second trading period. All N-traders carry their end-of-first-period francs forward. Before the second trading period begins, a dividend of 100 francs (per unit) is distributed to all holders of security Alpha. At the end of the second trading period the francs of all traders (both N and C) are automatically converted to widgets. If at this point C traders have less than 1200 francs they incur a penalty equal to the shortfall.<sup>6</sup> At the end of a round both securities pay liquidating dividends (depending on the state) and expire worthless.

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<sup>4</sup>Half of the traders started with seven units of Alpha, nine units of Beta and 500 francs. The other half started with seven units of Alpha, five units of Beta and 1100 francs.

<sup>5</sup>More on the types follows below.

<sup>6</sup>For example, if a C-trader deposits 1000 francs, for a shortfall of 200, only 800 (=1000-200) widgets are available for consumption at the end of the round. C-traders can potentially end up with a negative number of widgets in the storage technology if they incur a large enough penalty.

The final dividends are automatically converted to widgets at the end of each round. Thus, both N and C type traders finish each trading round with only widgets in their accounts. A short break follows each trading round, after which the types are re-assigned, endowments are renewed, and a new round begins. Each experimental session consists of eight rounds, or eight replications of the same situation.

Lastly, we do not permit short sales in four out of the five sessions. A portfolio choice that is optimal subject to the constraint need not be optimal absent this constraint. However, pricing will only be affected if there are enough shortsale-constrained subjects. As we discuss in Section 5 this does not appear to be the case in our experiments.

### 3 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.  $p_{\alpha,1} = p_{\beta,1}$ .

(B) The two securities' transaction prices differ by 100 francs in the second trading period, i.e.  $p_{\alpha,2} = p_{\beta,2} - 100$ .

(C) All traders should be indifferent between the relative proportions of Alpha and Beta 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.

### 4 Summary of the Sessions

The experiment consisted of five sessions conducted at the University of Utah Laboratory for Experimental Economics and Finance (UULEEF), with eight identical trading rounds within each session.<sup>7</sup>

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

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<sup>7</sup>Only Session 1 had seven trading rounds due to a software problem in the end of the eighth round.

subjects participated in three practice rounds before proceeding to the eight trading rounds. The market mechanism used for trading was a continuous time electronic double auction. It was implemented by a software called eTradeLab. A snapshot of the screen is provided Figure 2.<sup>8</sup> When the markets were open for trading individuals could submit both limit and market orders. Each limit order specified bid or ask prices for the security along with the desired quantity. All limit orders were collected in a market book, which was public but anonymous.

Including instructions, sessions lasted approximately two and a half hours. Total earnings ranged between \$15 and \$50 per subject, with an average of \$36. Each session employed from 14 to 21 traders (21, 16, 16, 14, and 19 for the five sessions respectively). The first four sessions used inexperienced subjects. The subjects consisted of a mixture of both undergraduate and graduate students from both within and outside the business school. During the first four experiments approximately 50% of the C-type traders incurred penalties (some of them large) because they did not accumulate sufficient cash in the second trading period to fulfill their consumption needs. The most likely explanation for this was that despite the extensive instruction period these subjects did not fully understand the structure of the trading environment. To address this issue we conducted a fifth session with experienced subjects drawn from the subject pool that had participated in one of the first four experiments. In the experimental session using experienced subjects only two subjects incurred penalties and the magnitude of the penalties was relatively small. A summary of the sessions is presented in Table 1.

## 5 Empirical Results

Figures 3 and 4 present the average transaction prices of the two securities, Alpha and Beta for the first and second periods of each experimental round, respectively. In all price graphs 100 is added to the price of Alpha in the second trading periods to ease the comparison across the two securities. It is apparent from Figure 3 that in the first trading periods, more often than not, the average price of Alpha is higher than the average price of Beta. The opposite tends to be observed for the second trading periods. The exception is in experiment four, in which the price of security Alpha tends to be below the price of security Beta in both periods. Experimental session four also allowed for short selling of securities, but we find

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<sup>8</sup>Or, alternatively, one can visit <http://uuleef.business.utah/exp/eTradeLab28> for more information.

no evidence that short selling had any effect on prices.<sup>9</sup> Thus, the difference in the results is unlikely to be attributable to the existence of short selling. Finally, there is potentially some evidence that the first period prices of Alpha and Beta converge in later rounds of the experiment, although this is not the case in experiment five (the experienced subjects), in which the price differentials are fairly consistent across all eight rounds.

To provide additional evidence on the relation between the prices of the two securities, Figure 5 plots the logarithms of the ratios of the transaction prices of the two securities,  $p_\alpha/p_\beta$  for each trading round.<sup>10</sup> The data from the first trading periods in all rounds is plotted as circles, while the data from the second trading periods is plotted as “plus” signs. The price ratio plot provides visual evidence that the log price ratio is greater than one in the vast majority of first-period replications. Based on the same graph, the evidence is inconclusive with regard to the relative prices of the two securities in period two.

Finally, Table 2 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. We report the values for each session in two rows, one in which all rounds are included, and one in which the first two rounds are excluded (as the price levels are the most noisy in those first two rounds). When all rounds are included, the null hypothesis that the prices of Alpha and Beta are equal in the first trading periods is rejected in favor of the alternative that the price of Alpha is higher in three of the five experimental sessions. When the first two rounds are excluded, the null is rejected in favor of the alternative in all experimental sessions except Session four. Examining the second trading periods, the null that the prices of the two securities (after adding 100 to the price of Alpha) are equal cannot be rejected, regardless of the number of rounds included, except in experimental session one.

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 contains a unit

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<sup>9</sup>When short selling was not allowed (in Sessions 1, 2, 3, and 5) only occasionally a subject or two would bump into the constraint. When we did allow for short selling, only a few subjects ever sold short and then only in very small quantities.

<sup>10</sup>Since only 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  $p_\alpha^1 = 155$ ,  $p_\beta^2 = 153$ ,  $p_\beta^3 = 155$ ,  $p_\beta^4 = 140$ ,  $p_\alpha^5 = 158$ ,  $p_\alpha^6 = 150$  etc., then the first points on the plot would represent  $\log p_\alpha^1/p_\beta^2$ ,  $\log p_\alpha^5/p_\beta^4$ , 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.

root. Tables 3 and 4 present the results of the Dickey-Fuller cointegration tests for the first and the second trading periods correspondingly. Out of the 39 first trading periods, the cointegration coefficient is greater than one in 26 of the cases, and significantly greater than one at the 0.05 level in 20 of the cases. From the 13 smaller than one coefficients 6 are significantly smaller at the 0.05 level. Using a binomial test the probability of observing at least 26 greater than one coefficients is 0.027 (or if only the significantly different than one test statistics are taken, the p-value is 0.005). When the second trading periods are considered, the number of greater (less) than one cointegration coefficients is 17(22). Using binomial tests, the probability that at least 22 coefficients are less than one is equal to 0.26. The corresponding numbers for the significant coefficients are 11 and 16, respectively. The p-value from the binomial test is equal to 0.22. Based on the above analysis one can conclude that the price of Alpha is higher than the price of Beta in the first trading periods, but that there is no evidence of a significant pricing differential between the two securities in the second trading periods.

Overall, the evidence refutes hypothesis (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 Citizens Utilities. We find no evidence refuting hypothesis (B). In the second trading periods the equality of the prices of the two securities cannot be rejected.

To provide further evidence on the apparent preference for dividends documented above we examine the net trades of the C-traders across the trading periods. Figures 6 and 7 present the net trades of the C-traders for the first and the second trading periods, respectively. The figures clearly indicate that in the first periods C-traders are net buyers of asset Alpha. The first period behavior of the C-traders shows mixed results with respect to asset Beta, although more often than not C-traders are net sellers of security Beta. Moreover (not reported in a Table) we also find evidence that the C-traders use market orders to purchase securities in market Alpha, while the N-traders provide liquidity in the form of limit orders.<sup>11</sup> In the second periods the C-traders are net sellers in both markets. This is consistent with the

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<sup>11</sup>In four out of the five sessions (sessions 1, 3, 4, and 5) in the first periods the majority of the trades in asset Alpha were initiated by the buyers, the majority of whom were C-traders (placing a market or a marketable limit order). The liquidity suppliers in those trades in the majority of cases were N-type of traders. The trades that were initiated by the sellers, had mostly N-traders as initiators, and C-traders were the buyers. Thus, when on the buying side in market Alpha, the C-traders tended to use market orders. Market Beta shows no clear pattern aside from the fact that the majority of trades in this market were also initiated by the buyers.

C-traders funding a portion of their liquidity needs through the sale of securities.<sup>12</sup> Finally, the volume in market Alpha is significantly higher than the volume in market Beta in both the first and the second periods.

We are left with two puzzles. The first is that while theory does not predict systematic preference for either of the assets, the C-traders consistently buy more of security Alpha in the first period. In short, the evidence supports the view that C-traders do not view homemade dividends as substitutes for cash dividend payouts. One possible explanation for why the C-type investors might prefer the dividend-paying security 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 C-traders have a preference for the dividend-paying stock Alpha, this preference should not be reflected in the first-period prices (unless the N-traders have an inherent preference for the dividend-paying stock as well). It seems that the competition among the N traders is inadequate to eliminate the pricing discrepancies.

## 6 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.

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<sup>12</sup>In the second periods, most of the trades were again initiated by the buyers, who were predominantly the N-traders. The C-traders in the vast majority of those trades acted as liquidity suppliers. The trades initiated by the sellers, had mostly C-traders as initiators, while the limit-buyers were equally distributed among the two types.

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.

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## Appendix A. Tables and Figures

Table 1: Summary of the Sessions

Exp.#	Date	Number of Traders	Average Payoff	Experienced
1	2/22/05	21	\$38	N
2	4/1/05	16	\$31	N
3	6/16/05	16	\$32	N
4	7/14/05	14	\$37	N
5	7/21/05	19	\$39	Y

Table 2: Results from the Signed-Rank Tests<sup>a</sup>

Exp.#	Date	Rounds Included	First Periods	Second Periods
1	2/22/05	1-7	5.27 ( $p < 0.001$ )	4.56 ( $p < 0.001$ )
		3-7	3.75 ( $p < 0.001$ )	3.13 (0.01)
2	4/1/05	1-8	8.87 ( $p < 0.001$ )	0.25 (0.69)
		3-8	6.88 ( $p < 0.001$ )	-1.27 (0.95)
3	6/16/05	1-8	-1.83 (0.13)	1.82 (0.77)
		3-8	4.82 ( $p < 0.001$ )	-2.75 ( $p > 0.999$ )
4	7/14/05	1-8	-4.73 (0.99)	-8.14 ( $p > 0.999$ )
		3-8	-4.98 (0.99)	-8.32 ( $p > 0.999$ )
5	7/21/05	1-8	8.73 ( $p < 0.001$ )	-4.89 ( $p > 0.999$ )
		3-8	10.67 ( $p < 0.001$ )	-5.01 ( $p > 0.999$ )

<sup>a</sup>The table presents the average transaction price difference between Alpha and Beta. The p-value of the Signed-Rank statistic ( $W_+$ ) is presented in the parenthesis.

Table 3: Co-integration Results, First Periods<sup>a</sup>

		1	2	3	4	5	6	7	8
1	Coef.	1.06	1.04	1.05	1.02	0.99	1.04	0.99	n.a.
	t-stat	(3.31)	(3.4)	(3.0)	(1.8)	(-0.7)	(7.4)	(-0.8)	(n.a.)
2	Coef.	1.13	1.13	1.09	1.04	1.06	1.07	0.96	0.98
	t-stat	(4.73)	(8.4)	(4.5)	(1.9)	(3.9)	(8.8)	(-3.8)	(-1.7)
3	Coef.	0.83	1.07	1.12	1.01	1.01	1.00	1.00	1.00
	t-stat	(-8.79)	(3.4)	(4.7)	(1.4)	(0.7)	(0.4)	(-0.2)	(-0.1)
4	Coef.	1.02	0.93	1.04	0.99	0.88	0.84	0.99	1.00
	t-stat	(2.10)	(-8.0)	(1.5)	(-0.4)	(-16.1)	(-8.1)	(-3.3)	(-0.2)
5	Coef.	1.02	1.03	1.09	1.06	1.09	1.06	1.04	1.02
	t-stat	(4.24)	(5.3)	(10.6)	(13.9)	(18.34)	(11.5)	(11.2)	(2.8)

<sup>a</sup>The estimated model is  $p_{\alpha,i} = Cp_{\beta,i} + \epsilon_i$ . The table reports the estimates of the coefficient  $C$  along with the t-statistics.

Table 4: Co-integration Results, Second Periods<sup>a</sup>

		1	2	3	4	5	6	7	8
1	Coef.	1.04	1.04	0.99	1.03	1.04	1.01	0.99	n.a
	t-stat	(3.2)	(5.8)	(-1.6)	(3.0)	(5.9)	(3.3)	(-2.0)	(n.a)
2	Coef.	1.06	1.00	1.05	0.96	0.97	0.96	1.01	0.98
	t-stat	(4.8)	(0.6)	(4.1)	(-14.7)	(-6.4)	(-7.9)	(1.6)	(-2.4)
3	Coef.	1.10	1.00	0.99	0.96	0.99	0.96	1.01	0.98
	t-stat	(4.2)	(0.3)	(-1.1)	(-4.3)	(-1.1)	(-9.0)	(1.4)	(-2.4)
4	Coef.	1.10	0.93	1.02	0.89	0.99	0.94	0.91	0.99
	t-stat	(4.6)	(4.2)	(1.3)	(-13.7)	(-1.2)	(8.8)	(-16.9)	(-1.6)
5	Coef.	0.97	0.97	0.91	1.0	0.96	0.99	0.95	0.97
	t-stat	(-5.6)	(-7.1)	(-25.2)	(0.4)	(-15.2)	(-1.0)	(-43.8)	(-21.5)

<sup>a</sup>The estimated model is  $p_{\alpha,i} = Cp_{\beta,i} + \epsilon_i$ . The table reports the estimates of the coefficient  $C$  along with the t-statistics.

Figure 1: Time-line for the Economy

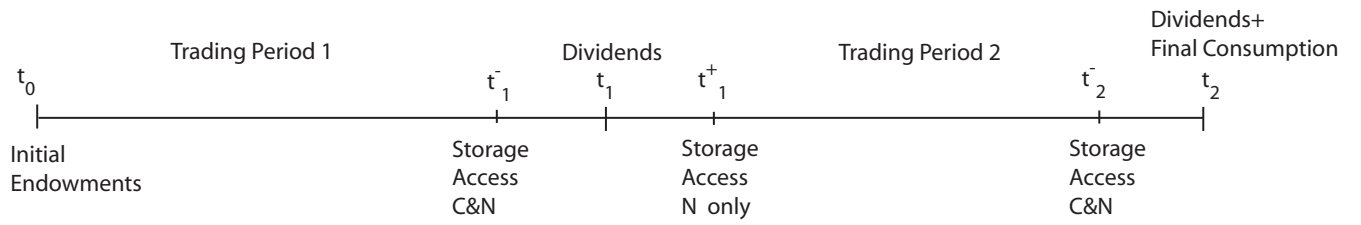


Figure 2: Snapshot of the Trading Screen

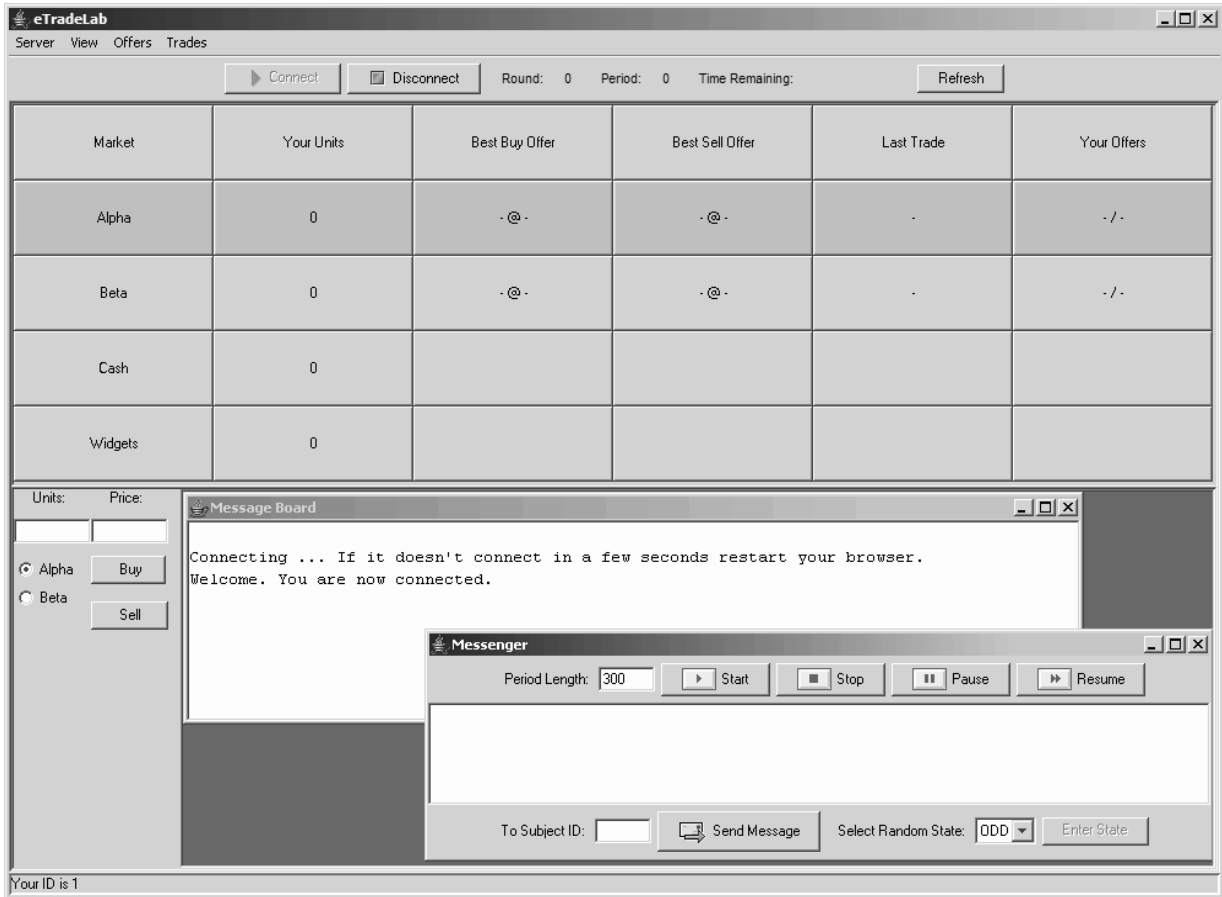


Figure 3: The natural log of  $(P_\alpha/P_\beta)$  plotted for each transaction.

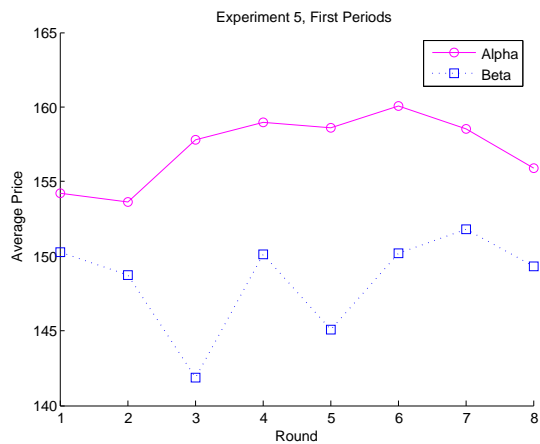
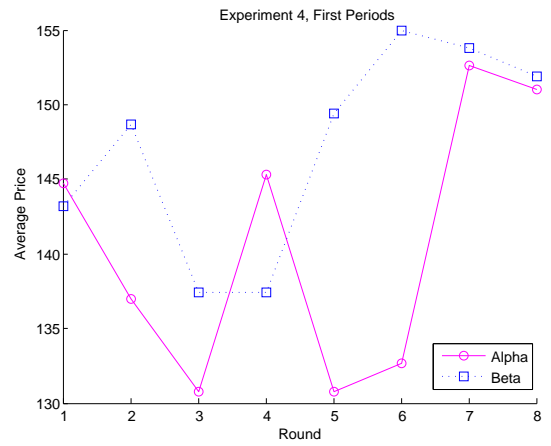
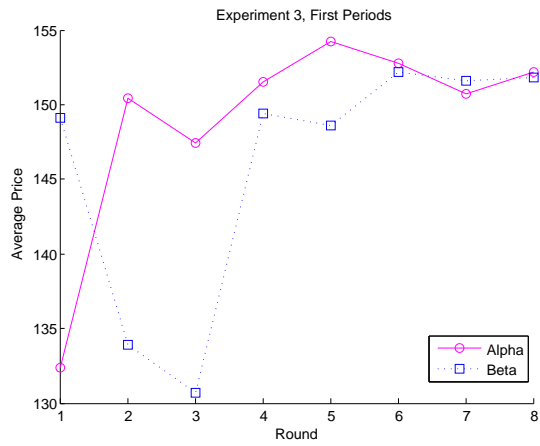
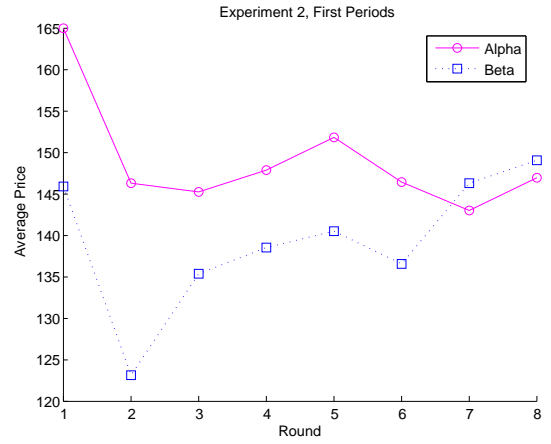
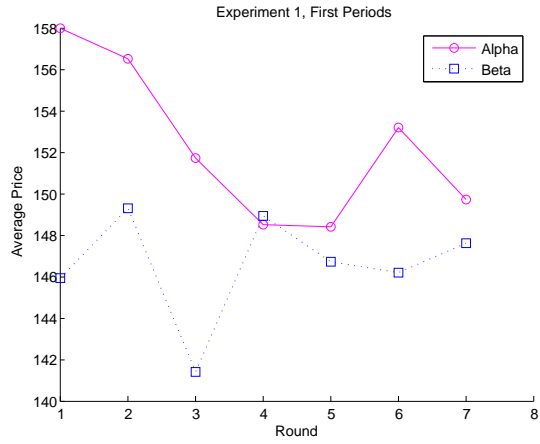


Figure 4: Average Transaction Prices, First Periods

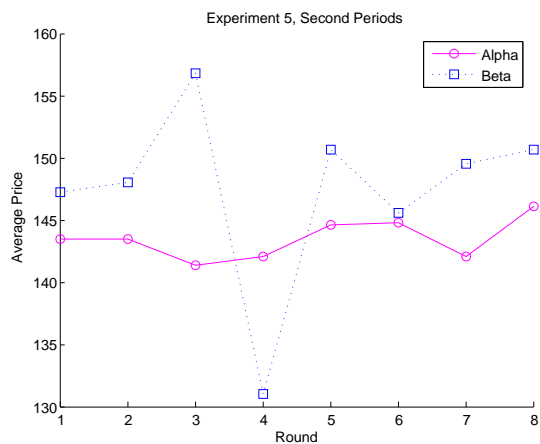
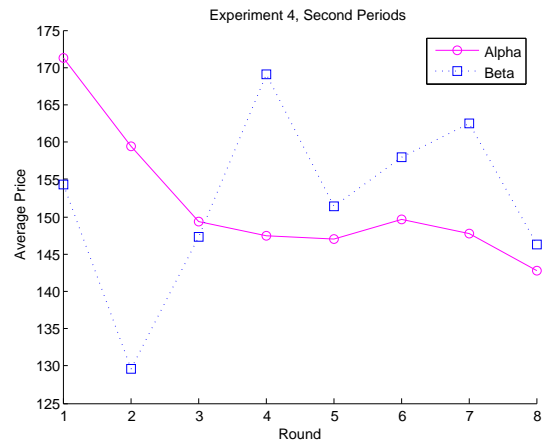
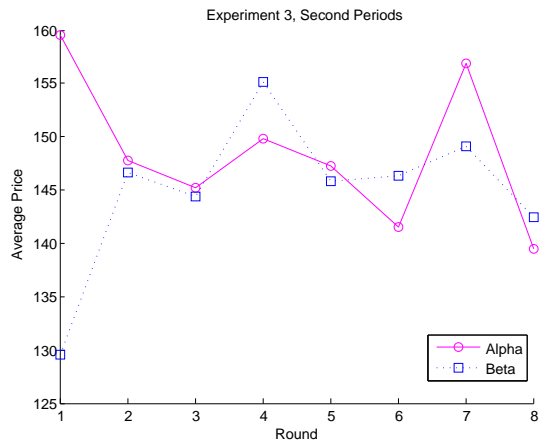
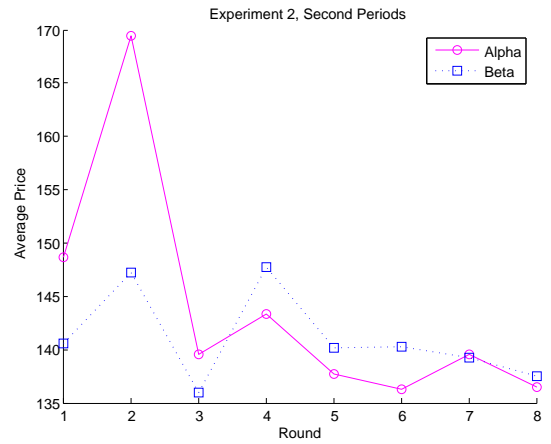
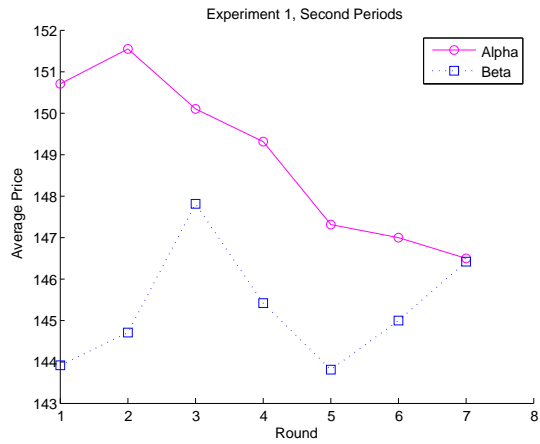


Figure 5: Average Transaction Prices, Second Periods

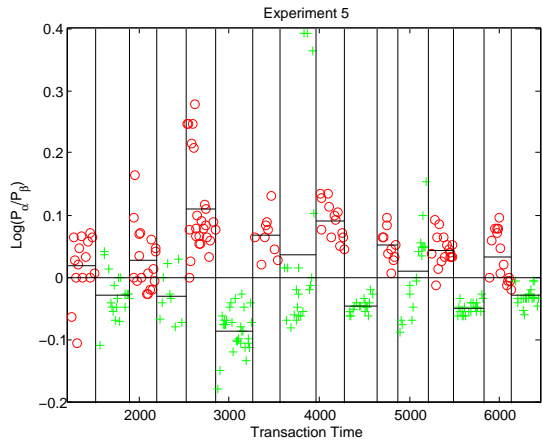
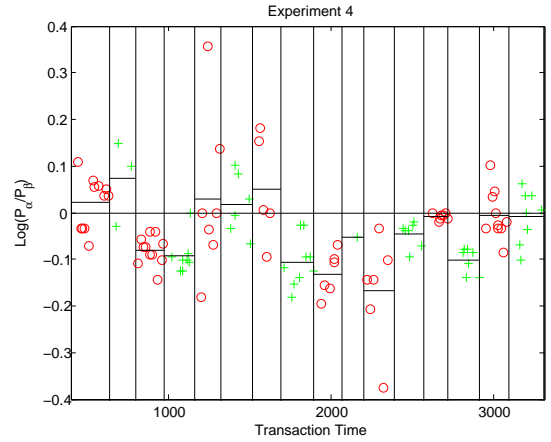
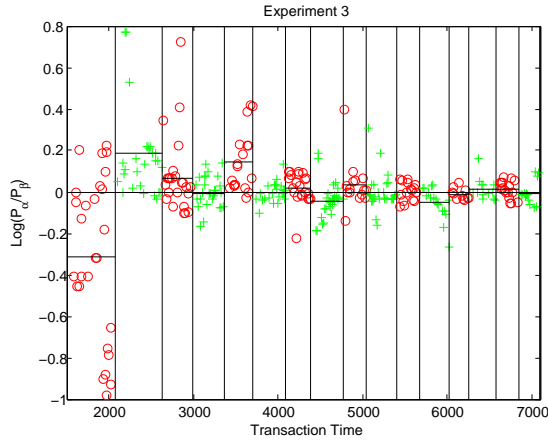
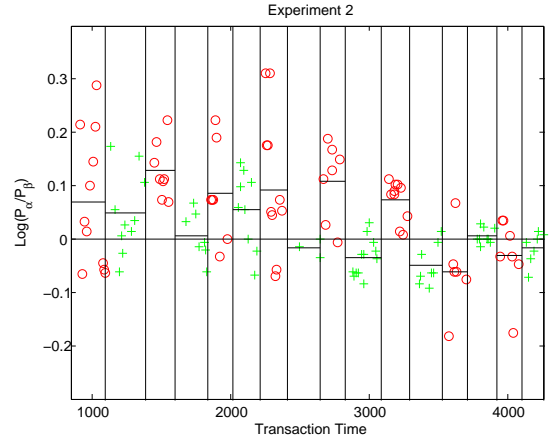
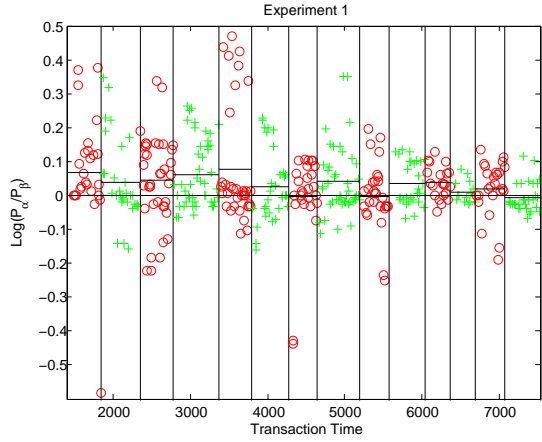


Figure 6: Net Trades of the C-traders, First Periods

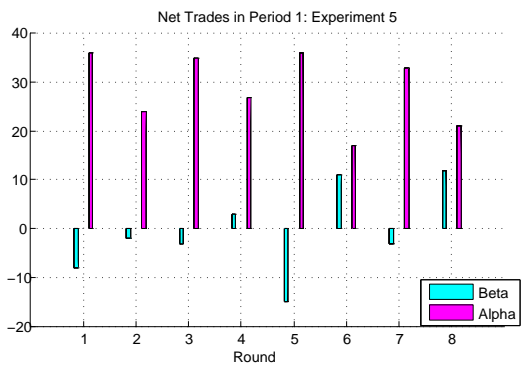
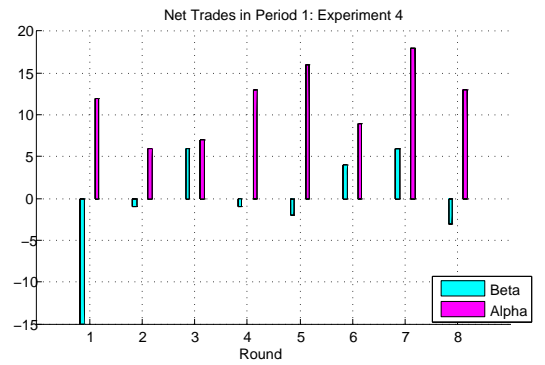
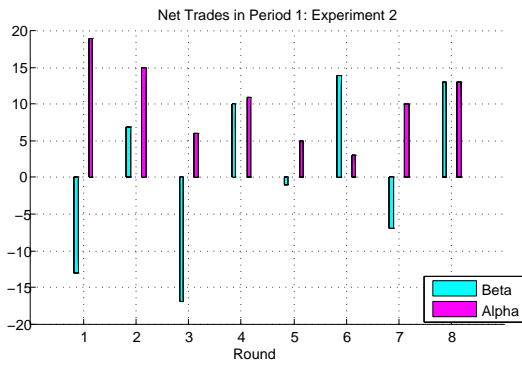
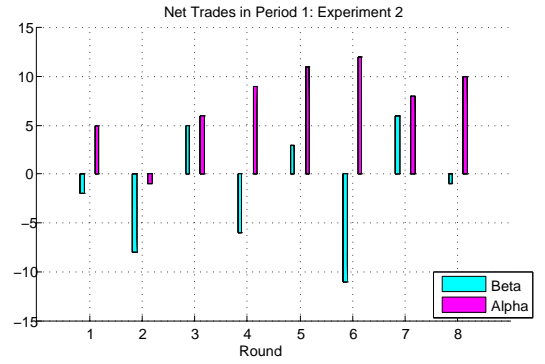
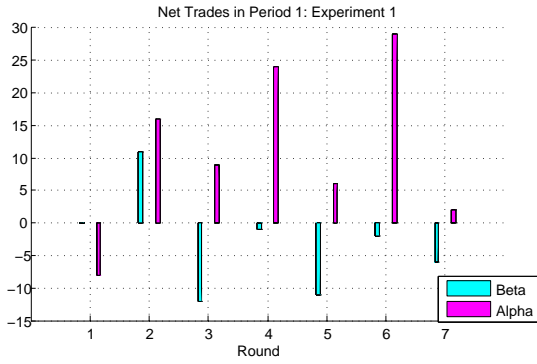
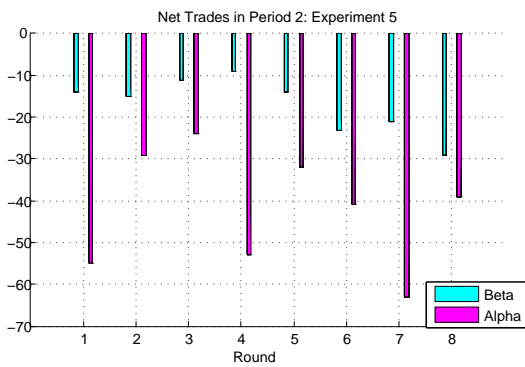
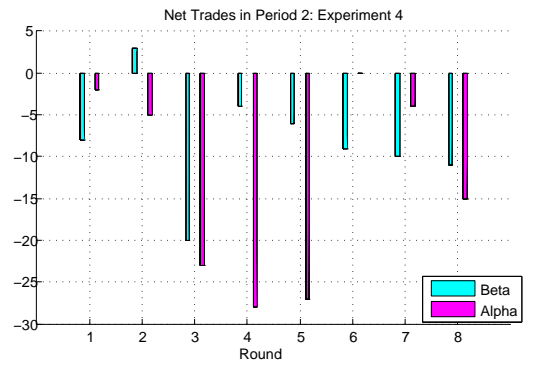
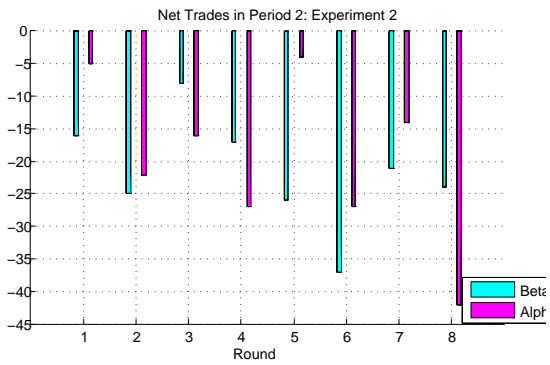
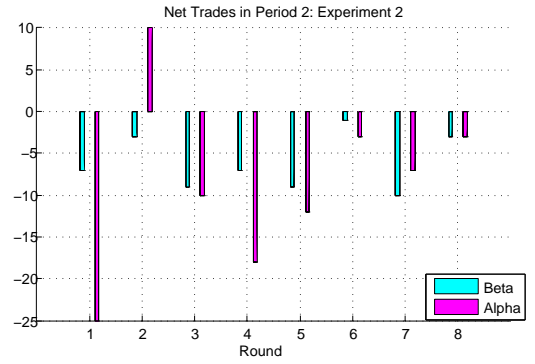
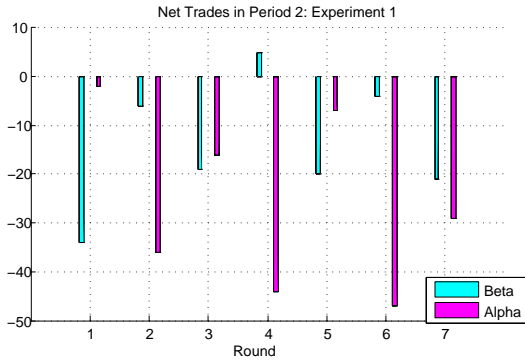


Figure 7: Net Trades of the C-traders, Second Periods



# Appendix: Instructions

## I. OVERVIEW

This is an experiment in financial decision making and trading. You will be paid for your participation. The exact amount you receive will be determined during the experiment and will depend on your decisions and the decisions of others. This amount will be paid to you in cash at the end of this experimental session. If you have a question during the experiment, raise your hand and one of us, the experimenters, will come and assist you.

### 1. The Market and Securities

eTradeLab is an electronic market in which you will trade two types of securities, or stocks, called ALPHA and BETA.

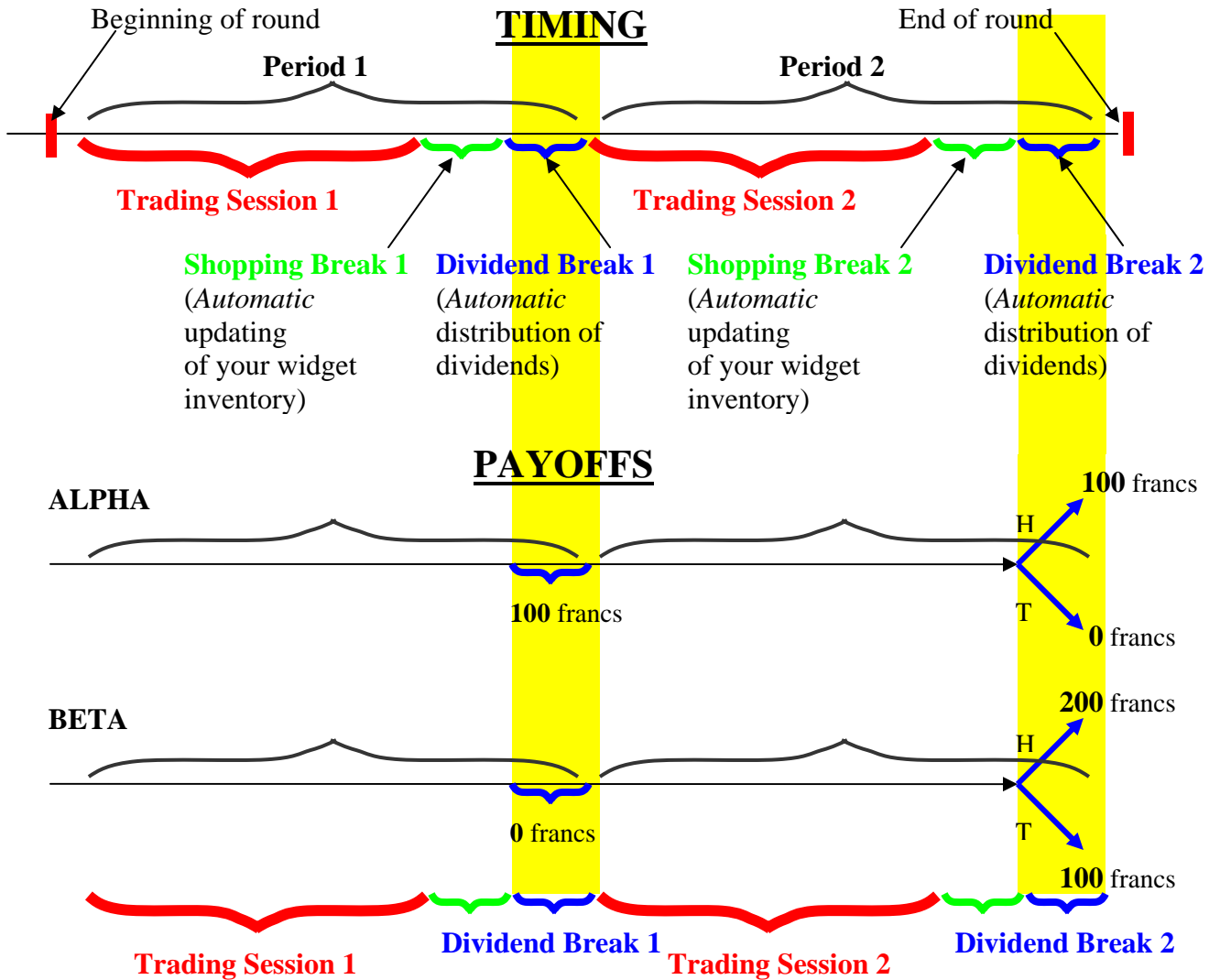
Trading will be conducted in a series of rounds. You will begin each round with working capital consisting of some units of ALPHA, BETA, and some cash. Markets will open and you will be free to trade your securities. You buy securities with cash and you get cash if you sell securities. All cash that you accumulate during and/or at the end of each round will *automatically* be used to buy widgets.

Each trading round will be independent from the other trading rounds, so your profits in each round will be evaluated separately. At the end of the experimental session the experimenters will buy all of your accumulated widgets back from you at a price of \_\_\_\_ per widget. The collected \$\$\$ will be yours to keep. Selling widgets back to the experimenters is the *only* way you will be able to make money in this experiment. **Thus, your goal should be to accumulate as many widgets as possible in each round.**

In addition, you will be given \$5 for coming here on time and listening to the instructions. You are entitled to the \$5 even if you decide to leave the experiment after the instruction period.

During the experiment, accounting is done in a fictitious currency called francs.

Each round has two periods, Period 1 and Period 2. Each Period consists of a Trading Session, and two breaks—a “Shopping Break,” and a “Dividend Break.” You will be active only during the Trading Sessions. The Breaks will be utilized for *automatic* updating of your widget and cash inventories. Below is the time line of each experimental round:



The two securities, ALPHA and BETA, each have a two-period life. Both pay the same total amount in dividends, but they differ in the timing of the dividend payments.

ALPHA pays a dividend of 100 francs in Dividend Break 1. BETA pays no dividend in Dividend Break 1.

In Dividend Break 2 both securities pay dividends that are determined by a coin toss of a *fair* coin. The two equally-likely outcomes of the coin toss are Heads (H) and Tails (T). ALPHA pays a dividend of 100 francs if the outcome is H, and 0 francs if it is T. BETA pays 200 francs if the outcome is H, and 100 francs if the outcome is T. The payoffs of are shown above. Note that the total amount you receive from each security is identical regardless of whether H or T occurs; only the timing of the payments differs across securities. **After paying dividends in Dividend Break 2, both securities expire worthless at the end of the round.**

**Example:** Imagine that you have 5 units ALPHA, and 7 units of BETA at the end of Trading Session 1. BETA will not pay any dividends in Dividend Break 1. You will get 100 francs for each unit of ALPHA held. Thus, you will receive  $5 \times 100 = 500$  francs from your ALPHA holdings. Even if you decide to sell some of your holdings of ALPHA in Trading Session 2, the dividends collected in Dividend Break 1 are yours to keep.

If you happen buy units of ALPHA in Trading Session 2, each such unit pays 100 francs if H, and 0 francs if T in Dividend Break 2. Units of ALPHA purchased during Trading Session 2 are *no longer* entitled to the dividends that were paid during Dividend Break 1.

Further, imagine that after some trading you finish Trading Session 2 with 3 units of ALPHA, and 5 units of BETA. If the outcome of the coin toss is H, ALPHA will pay dividends of 100 francs for each unit held; BETA's dividend will be 200 francs per unit held. In this case you will receive  $3 \times 100 = 300$  francs in dividends from ALPHA, and  $5 \times 200 = 1000$  francs in dividends from BETA for a total of  $300 + 1000 = 1300$  francs from dividends. If the realization of the coin toss is T then ALPHA pays 0 francs while BETA pays 100 francs per unit held. In this case you will receive  $3 \times 0 = 0$  francs from ALPHA and  $5 \times 100 = 500$  francs from BETA. In total, you will have  $0 + 500 = 500$  francs from dividends if the realization of the coin toss is T.

### **Questionnaire about the Dividend Structures of the Two Securities**

**Question 1** In Trading Session 1 you purchase a unit of ALPHA and a unit of BETA and do not plan on selling those units until the end of the round.

- 1.1 How much do you expect to collect from your unit of ALPHA on average?
- 1.2 How much do you expect to collect from your unit of BETA on average?

**Question 2** You end Trading Session 1 with 10 units of ALPHA and 2 units of BETA:

- 2.1 How much dividends will you collect from your holdings of ALPHA in Dividend Break 1?
- 2.2 How much dividends will you collect from your holdings of BETA in Dividend Break 1?

**Question 3** In Trading Session 2 you purchase a unit of ALPHA and a unit of BETA and you do not plan on selling those units until the end of the round.

- 3.1 How much do you expect to collect from your unit of ALPHA on average?
- 3.2 How much do you expect to collect from your unit of BETA on average?

**Question 4** You end Trading Session 2 with 4 units of ALPHA and 2 units of BETA. The outcome of the coin toss is T:

- 4.1 How much will you collect in dividends from your holdings of ALPHA in Dividend Break 2?
- 4.2 How much will you collect in dividends from your holdings of BETA in Dividend Break 2?

## 2. Trading

At the beginning of the each round you will be given, as “working capital,” a portfolio of units of ALPHA, units of BETA and some francs (cash). A portion of the working capital that you are given must be repaid at the end of the round. At the end of each round we will collect 1000 widgets from you as a repayment for the securities and cash that you received in the beginning of the round.

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). What distinguishes the two types of traders is their timing and requirements for purchasing of widgets. *Widgets cost 1 franc each independent of the timing of the purchase.*

### 2.1 N-Traders

N-traders do not participate in either shopping break. N-traders can purchase widgets only after an entire round is over (i.e. after Dividend Break 2). The purchasing of widgets is automatic once the round concludes. N-traders trade in Trading Session 1, Shopping Break 1 does not affect them; they then receive dividends in Dividend Break 1. The dividends from Dividend Break 1 are automatically added to their cash holdings.

N-traders start Trading session 2 with the same number of securities ALPHA and BETA with which they finished Trading Session 1, and cash amount equal to the amount they had at the end of Trading Session 1 plus the dividends received in Dividend Break 1. After the end of Trading Session 2, N-traders do not participate in Shopping Break 2, but receive dividends from their holdings in Dividend Break 2. Thus, at the end of the round the N-traders have only cash (all securities are converted to cash dividends). This cash is automatically used to purchase widgets. Therefore, a N-trader’s goal should be to buy and sell securities to maximize the total amount of cash plus dividends received during the round to purchase the maximum number of widgets. Put another way, you should attempt to purchase securities you believe are undervalued and sell securities you believe are overvalued in order to maximize your profits.

### Practice Round

Rounds 1 will be for practice only. Everyone will be an N-trader in this round. Since it is for practice only, the widgets that you accumulate during this round will not count towards your total widget inventory.

**<http://uuleef.business.utah.edu/exp/eTradeLab25>**

Click on “Connect” and enter the ID and password on the upper left corner of your slip.

## 2.2 Type C Traders

C-traders cannot carry over cash from Trading Session 1 to Trading Session 2, and from Trading Session 2 to the end of the round. All cash (if any) must be immediately spent during each Shopping Break to purchase widgets.

C-traders start a round by trading in Trading Session 1. Upon entering Shopping Break 1 all their cash (if any) is *automatically* converted to widgets and is thus no longer available to them as “cash”. Dividend Break 1 is the same as for the N-traders. C-traders start Trading Session 2 with the same number of securities as they finished Trading Session 1, and *with cash equal only to the dividends* collected in Dividend Break 1.

Similarly, C-traders must use all of their available cash to purchase widgets during Shopping Break 2. Shopping Break 2 differs from Shopping Break 1 in that there is a minimum quantity of 1200 widgets that has to be purchased (you can think of this as a purchase that you *must* make at this time).

Since widgets cost one franc each, if a C-trader has more than 1200 francs in cash upon entering Shopping Break 2, then the minimum requirement is automatically satisfied. If, however, a C-trader has less than 1200 francs, she must borrow cash in order to be able to purchase exactly 1200 widgets. eTradeLab will automatically administer a loan for the necessary amount. For example if a C-trader has 1000 francs in the end of Trading Session 2, she needs to borrow 200 francs, so that the total cash is 1200 francs, just enough to purchase 1200 widgets. For each widget bought with borrowed money in Shopping Break 2, the C-trader has to repay back **two** widgets in the end of the round. Note that the 1200 widgets in Shopping Break 2 must be purchased *prior* to receiving dividends in Dividend Break 2.

This is a *costly* loan, and a C-trader should attempt to procure sufficient cash to avoid having to borrow. Below are some strategies that a C-trader might use to accumulate sufficient cash to avoid a loan.

- (1) Accumulate units of ALPHA and BETA in Trading Session 1 and sell some units of them during Trading Session 2 for Cash.
- (2) Accumulate units of security ALPHA in Trading Session 1. Dividends from security ALPHA in Dividend Break 1, are cash that is carried over to Trading Session 2.
- (3) Some combination of (1) and (2) above.

The loan repayment takes place immediately after the end of the round in which the loan was taken. Note that it is possible to have negative widget inventory at the end of the round.

### Examples:

- (1) You are a C-trader. You end Trading Session 2 with some units of ALPHA and BETA, and 1340 francs. You will then (automatically) purchase 1340 widgets in

Shopping Break 2 (the minimum requirement of 1200 widgets is satisfied, so you will not have to borrow) and will proceed to Dividend Break 2 where you will collect the dividends from the two securities. The collected dividends become your “cash” for the next Trading Session.

(2) You finish Trading Session 2 with some units of ALPHA and BETA, and 1070 francs. You are 130 francs short of the 1200 francs needed to purchase 1200 widgets. Thus, you have to borrow 130 francs to purchase the required minimum of 1200 widgets. 1200 widgets are automatically added to your existing widget inventory. You then proceed to Dividend Break 2. After receiving dividends in Dividend Break 2 (whatever the realization of the coin toss) and converting these dividends to widgets, you have to repay  $130 \times 2 = 260$  widgets for having taken a loan of 130 francs plus the 1000 widgets for your initial working capital.

## Practice Rounds

Rounds 2 and 3 will be for practice only. Everyone will be an C-trader in one of those two rounds, and an N-trader in the other. Since rounds 2 and 3 are for practice only, the widgets that you accumulate during those two rounds will not count towards your total widget inventory.

## II. HIGHLIGHTS OF eTradeLab, THE MARKET INTERFACE WINDOW

### 1. View Menu

When choosing any of the options on the View menu, the corresponding item will appear in the message board. The menu items are self-explanatory. Click on *Your Earnings* to see how you did in the past and what your present cumulative earnings are. Etc.

### 2. How to Buy and Sell, or to Cancel an Order

On the left of eTradeLab, choose the *Market* in which you want to buy or sell. Enter a quantity (units) and the maximum price (per unit) you're willing to pay (if buying) or the minimum price you're asking (if selling). Then hit *buy* or *sell*. For example, if you are willing to sell 3 units of Beta at \$155, you click on Beta, enter “3” for the units, and enter “155” for the price, and then click “Sell”. Note that with such an order, your trade will only take place if someone else agrees to trade with you at that (or better for you) price.

To cancel orders, go to *Your Orders* in the View menu, highlight the orders you'd like to cancel, and click *Cancel Offer*.