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ABSTRACT

Two Heads Are Less Bubbly than One: Team Decision-Making in an Experimental Asset Market*

We study the effect of team decision-making on bubbles and crashes in experimental asset markets of the kind introduced by Smith, Suchanek and Williams (1988). We find that populating such markets with teams of size two instead of individuals significantly reduces the severity of mispricing. In particular we observe that under our teams treatment, deviations in prices away from intrinsic value are significantly smaller in magnitude, shorter in duration and associated with lower volume and price volatility. We also find an unexpected gender effect in team composition, manifesting itself in more extreme – though not consistently more profitable – behaviour by all-male teams. Since these effects are not observed among male participants generally, we conjecture that they may be due to factors specific to the psychology of decision-making in male-dominated environments.

Non-Technical Summary:

Many important decisions in both business and government are increasingly being entrusted to small groups as opposed to individuals. Yet economics has remained largely silent on the question of group decision-making, treating the decisions of households and firms as though they were made by unitary decision-makers. This paper uses an experimental asset market to investigate whether trading by teams of size two is less likely to generate market bubbles and crashes. The main result is that bubbles are indeed diminished under team decision-making. In addition, the gender composition of teams has surprising effects upon their performance, with all-male teams adopting more extreme – though not necessarily more profitable – positions.

JEL Classification: C92, D70, G12

Keywords: asset market experiments, price bubbles, group decision-making, gender composition of teams

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1. INTRODUCTION

Financial markets have long been known to exhibit price swings that are difficult to reconcile with fundamental values. Price bubbles and crashes have been documented since the Dutch tulip bubble of 1637, and have come back into prominence following recent developments in global financial markets. Since the seminal paper by Smith, Suchanek and Williams (1988), hereinafter SSW, the bubble and crash phenomenon has also been extensively studied in the experimental laboratory.

To date, this research has focused on the behaviour of experimental markets populated by individuals. However, many important decisions in both business and government – including funds management (Baer, Kempf and Ruenzi 2005) and monetary policy (Blinder and Morgan 2005) – are increasingly being entrusted to small groups as opposed to individuals. Yet, with the exception of the fields of public choice and organisation theory, economics has remained largely silent on the question of group decision-making, treating the decisions of households and firms as though they were made by unitary decision-makers.

In this paper, we adopt the SSW design to investigate whether teams of size two are less susceptible to trading at prices considerably at variance from intrinsic value. In so doing, we set out to make two distinct contributions. Firstly, whereas almost all existing literature on experimental asset markets has examined the robustness of bubbles and crashes to *institutional features of the market environment*, our focus in this paper is on the *characteristics of the traders themselves*, in particular the effect of populating a market with teams instead of individuals. Secondly, we contribute to research on teams by reporting, to the best of our knowledge, the first experimental study of team behaviour in a continuous-time market environment.

Across a full spectrum of measures of the severity of mispricing in a market, we find that our teams treatment results in significantly smaller price bubbles than those that have been documented for most conventional treatment designs. This holds both relative to a set of baseline sessions and to a database of observations compiled from the literature as a whole. It also emerges from our results that the gender composition of teams has a substantial bearing upon their behaviour and performance in the market, with particularly striking differences observed comparing all-male teams to mixed-gender and all-female teams. These results

regarding gender effects within teams are in line with findings from the psychology literature, but are novel to experimental economics and studies of asset markets.

2. REVIEW OF RELATED LITERATURE

Our study is intended to contribute to two distinct bodies of research in experimental economics. The first is the literature on price bubbles in experimental asset markets, which is reviewed in Section 2.1. The second body of research, on behavioural differences in decision-making between individuals and teams, is reviewed in Section 2.2. Finally, it emerges from our results that the gender composition of teams has a substantial bearing upon their behaviour and performance in our experiment. Accordingly, Section 2.3 briefly reviews relevant research on gender differences, including in the context of team decision-making.

2.1. Price Bubbles in Experimental Asset Markets

A bubble in asset prices has been defined as 'trade in high volume at prices that are considerably at variance from intrinsic value' (King et al 1993, p. 183). Such mispricing in asset markets can lead to severe distortions to the allocation of capital, with potentially adverse repercussions for the wider economy, as illustrated for example by the ongoing fallout from the bursting of the United States housing price bubble in the period since 2006.

Whereas in a field setting the true value of an asset is typically impossible to determine, in an experimental market the intrinsic value is under the control of the experimenter. The tendency for experimental asset markets to bubble and crash, even when information on the dividend process is common knowledge, was first documented by SSW. They found that prices in these markets tended to start out below intrinsic value before rising steeply above intrinsic value and then crashing. SSW also observed large volumes of trade during the boom, while the crash was characterised by much lighter volume.

When participants are inexperienced in the market environment, the SSW design has been found to consistently generate this bubble-and-crash pattern. Over the past twenty years, an extensive body of subsequent research has also shown that the pattern is robust to numerous extensions and modifications to the original design. King et al (1993) found that bubbles were not reduced by margin buying, equal initial endowments, a limit price change rule, or the use of professional businesspeople as traders. Van Boening, Williams and LaMaster (1993) continued to observe bubbles when a call market institution was used instead of a

continuous double auction, and when the dividend distribution was modified to have a unique mode that coincided with the mean. It has similarly been found that bubbles are robust to the elimination of uncertainty from the dividend process (Porter and Smith 1995) and the use of tournament compensation for traders (James and Isaac 2000). Caginalp, Porter and Smith (2001) found that the severity of mispricing is influenced by the amount of liquidity in the market, but observed much weaker effects for the deferred payment of dividends and the use of an open order book (in the context of a call market). Noussair, Robin and Ruffieux (2001) induced a constant time path of intrinsic value instead of a diminishing one as in SSW, yet continued to observe bubbles in half of their sessions. In an important contribution, Lei, Noussair and Plott (2001) observed bubbles and crashes in an environment in which speculation was not possible, since the role of each trader was restricted to that of either a buyer or seller with no opportunity for resale.

To date, the only condition that has been widely acknowledged to eliminate bubbles in experimental asset markets is repeated experience from at least two previous repetitions in the same market environment (SSW 1988; Van Boening, Williams and LaMaster 1993; Dufwenberg, Lindqvist and Moore 2005). However, a recent paper by Hussam, Porter and Smith (2008) has shown that even with twice-experienced traders it is possible to rekindle a bubble by shocking the market environment with an increase in liquidity and dividend uncertainty. In addition to these findings with regard to experience, there is also some mixed evidence that bubbles may be diminished by the introduction of short selling (King et al 1993; Haruvy and Noussair 2006) and futures markets (Porter and Smith 1995; Noussair and Tucker 2006).

With the exception of some experiments reported in King et al (1993) in which the participants were real-world business people, the literature to date has examined the robustness of bubbles and crashes to the *institutional features of the market environment*, as opposed to the *characteristics of the traders themselves*. By contrast, in the present study we utilise an environment that adheres closely to the standard design of SSW in order to examine the behaviour of a market in which the decision-makers are teams instead of individuals.

2.2. Decision-Making by Individuals and Teams

Whereas the empirical study of decision-making by teams is a relatively recent development in economics, it has a much longer tradition in psychology. Psychologists define an

'intellective' task as one in which there is a clear normative standard for judging the quality of a decision. Moreover, an intellective task is 'demonstrable' if the normative solution, once identified, is readily grasped as self-evidently correct (Laughlin and Ellis 1986). To give an economic example, Charness, Karni and Levin (2007) suggest that their test of first-order stochastic dominance satisfies both these criteria. For intellective tasks, psychologists generally find that teams perform better than individuals, especially when the task is demonstrable. On the other hand, a 'judgmental' task is one for which there is no single normatively 'correct' answer. Here, an economic example would be a task designed to elicit risk attitudes. For judgmental tasks, there does not appear to be any systematic directional finding regarding the performance of teams compared to individuals.

The limited economic literature on team decision-making can be divided into studies of decision-making in non-strategic settings, and ones involving strategic interaction. Studies of non-strategic environments are dominated by experiments on decision-making under risk. Shupp and Williams (2008) and Baker, Laury and Williams (2008) compare risk attitudes of individuals to teams of three. Shupp and Williams do this by eliciting maximum willingness-to-pay bids for lotteries with different probabilities of winning. They find that teams are significantly more risk averse when the probability of winning is low, but less risk averse when the probability is high. Using a paired lottery choice design, Baker, Laury and Williams find no significant difference in the risk preference of individuals and teams. However they observe that team decisions are more consistent with risk-neutral choices in both the lowest and highest risk lotteries, and in this sense 'less noisy' than decisions by individuals.

Bone, Hey and Suckling (1999) and Rockenbach, Sadrieh and Mathauschek (2007) compare decisions by teams of, respectively, two and three to those of individuals, and find almost no difference in the degree of (in)consistency with expected utility theory. However, Rockenbach, Sadrieh and Mathauschek observe that teams accumulate significantly more expected value than individuals, and at a significantly lower risk, a result they attribute to teams' avoidance of excess risk. Charness, Karni and Levin (2007) study violations of first-order stochastic dominance and Bayes' rule by individuals and teams. They find that teams commit fewer violations than individuals, and that the incidence of violations further decreases as team size increases from two to three.

Blinder and Morgan (2005) compare decisions by individuals and teams of five in two experiments: a framed monetary policy experiment in which the decision-maker controls the

interest rate in an economy, and a context-free probabilistic 'urn' problem. In both contexts, they find no significant difference between individuals and teams in the amount of data they accumulate before making a decision, but that teams make significantly better decisions.

Turning to studies of strategic interaction, Kocher and Sutter (2005) find no difference between the decisions of individuals and teams of three in the first round of a beauty-contest experiment. However as the game is repeated, teams converge significantly faster toward the game-theoretic equilibrium, indicating that teams learn faster than individuals. Cooper and Kagel (2005) compare individuals to teams of two in three entry-deterrence signalling games. They find that teams learn strategic play more rapidly than individuals in all three treatments, and that teams' superior performance increases with the difficulty of the games.

To date, the study that comes closest to ours in experimentally examining team behaviour in a market setting is by Cox and Hayne (2006). They compare bidding behaviour by individuals to teams of five in common-value auctions in which the number of bidders is either three or seven. When both individuals and teams receive a single signal of value, Cox and Hayne find no evidence that the winning bids of teams are either more or less rational than those of individuals. However, when each member of a team receives their own signal, they find that winning teams bid less rationally than individuals in that they fail to discount their bids sufficiently to avoid the winner's curse.

Finally, there are some empirical studies that are pertinent to our research. Baer, Kempf and Ruenzi (2005) analyse data on US mutual funds and find that, controlling for differences in size, age and other characteristics, team-managed funds take on less risk than individually-managed funds, and adjust their risk profile less in response to prior performance. Team-managed funds follow an investment style that is less extreme and more consistent over time. Bliss, Potter and Schwartz (2008) similarly find that team-managed funds have less risk, and that they have lower expenses than individually-managed funds. However, an inherent difficulty with this type of research is that since the intrinsic value of funds' assets is unobservable, it is not possible to evaluate the effect of team management upon the overall performance of the market as a whole.

To the best of our knowledge, the present paper contributes the first experimental study of team behaviour in a continuous-time market environment of the type studied by SSW. We consider that this environment entails both intellective and judgmental elements. The

intellective task consists in correctly apprehending the intrinsic value process of the experimental asset. The judgmental component stems from the fact that a player's optimal choices depend also upon their beliefs as to the extent to which others have attained this same insight – this is the well-known problem of common knowledge of rationality.

2.3. Gender Differences and Interaction Effects

Although we did not set out to explore gender differences in our study, we observe some intriguing gender effects of team composition in our results. Accordingly, we briefly review some relevant economic research on this issue.

A growing body of experimental research explores gender differences in risk preference. Although not all studies report significant effects, the consistent directional finding among those that do is that females tend to be more risk averse than males, and it is very rare that the opposite is found (Eckel and Grossman 2008, Table 1; see also Croson and Gneezy 2008). While many of these findings relate to choices over abstract gambles, similar conclusions emerge from experiments that invoke financial or investment framing and/or market settings. For example, an unpublished manuscript by Levy, Elron and Cohen (1999) (cited in Eckel and Grossman 2008) examines gender differences in a stock market game. They observe a tendency for males to hold more of their wealth in risky assets, to hold riskier stocks, and to make more efficient investments. Although none of these effects is individually significant, their combined effect is that males accrue significantly more wealth.

Evidence from field studies is also consistent with the notion that females tend to be more risk averse than males. For example, Jianakoplos and Bernasek (1998) and Sundén and Surette (1998) find, respectively, that single women hold significantly less of their wealth in risky assets, and choose more conservative asset allocations for their retirement savings, when compared to single men. Finally, Niessen and Ruenzi (2009) report that female mutual fund managers are more risk averse, follow less extreme investment styles, and trade less than their male counterparts. Moreover, although there is no difference in average performance, male fund managers achieve more extreme outcomes.

Of related interest is the observation that males respond positively to competition whereas females do not, and may even find it inhibitive. Gneezy, Niederle and Rustichini (2003) find that males respond to tournament incentives by working significantly harder than they do under piece rate compensation, whereas females do not. In a follow-up study, Niederle and

Vesterlund (2007) allow subjects to choose their preferred compensation scheme. They find that lower-ability males forgo earnings by choosing the tournament, while higher-ability females forgo earnings by choosing the piece rate.

A much smaller literature explores the role of gender in a group context. For example LePine et al. (2002) examine team performance in a task that is stereotypically masculine and (outside of the laboratory) male-dominated in its occupational demography. Traditional psychological research predicts that male-dominated teams would perform particularly well at such a task (Wood 1987). In contrast, LePine et al. find that – relative to an objective benchmark of correct decisions – all-female, female-dominated and balanced teams exhibit slightly overaggressive behaviour, but that male-dominated teams are significantly more aggressive. Moreover, all-male teams perform the worst, behaving in a significantly more overaggressive manner than even male-dominated teams. This effect of the proportion of male team-members indicates that individual characteristics may be compounded in a team context, in this case producing an aggressiveness function that is not additive but exponential.

3. DESIGN AND PROCEDURES

Our team asset market experiments were conducted in the CentERlab at Tilburg University in the Netherlands. This facility comprises both a conventional laboratory with 24 partitioned workstations (the 'A Lab') and a set of ten separated soundproofed cubicles, each large enough to seat two participants side-by-side in front of the computer (the 'B Lab').[1] We implement a version of the classic SSW design, as adapted by Haruvy, Noussair and Powell (2009), hereinafter HNP. In particular, all parameters in our market are identical to Design 4 in SSW except that, consistent with the baseline condition in HNP, every trader's initial endowment of experimental money and stock is doubled.

Whereas each trader in HNP is an individual, in our teams sessions each trader is a randomly-matched team of two participants.[2] In order to facilitate team deliberation, we increased the length of each trading period from four minutes in HNP to five minutes in our teams sessions. At the conclusion of our sessions, we paid out the value of each trader's earnings to *both* team members, using the same exchange rate as in HNP. In other words, each team member received the same earnings as they would have had they executed the same trades as

[1] A floor plan of the CentERlab is available online at http://center.uvt.nl/lab/map1.doc.

[2] Details of the matching procedure and other features of the teams sessions are discussed in Section 3.2.

individuals in HNP (and also faced the same realisations of the dividends). Moreover, we use the same computer software as HNP, and we adapt their instructions. Since HNP conduct experiments using the same laboratory and subject pool in Tilburg, we can thus compare our teams treatment directly to their baseline data, as well as more generally to the broader literature reporting standard measures of the severity of price bubbles in SSW-type markets.

3.1. General Market Design

We implement a market for a single asset that has a life of fifteen trading periods, and which pays a stochastic dividend to its current owner at the end of each period. This dividend may be 0, 8, 28 or 60 units of experimental currency ('francs') per unit of stock ('share'), each with equal probability, such that the expected dividend is 24 francs in each period. The dividends are drawn independently in each period, are the same for all shares in a given period, and are added to the owner's cash balance at the conclusion of each period. A trader's holdings of experimental money and stock carry over from one trading period to the next. At the conclusion of fifteen periods, all shares expire without any terminal value. The intrinsic value of a unit of stock (assuming risk neutrality) is thus 24 times the number of remaining periods, and in particular it is 360 in the first period. The dividend structure of the asset was clearly explained as part of the instructions read aloud at the start of the experiment, and in addition information on its intrinsic value in each period was provided in the form of an average holding value table.[3]

Each experimental market consists of nine traders. At the beginning of the first trading period, three traders are endowed with an initial portfolio consisting of 450 francs and six shares. A further three traders are endowed with 1,170 francs and four shares, and the remaining three traders are endowed with 1,890 francs and two shares. The intrinsic value of each trader's initial endowment is thus the same (namely 2,610 francs), and in particular all endowments are double the ones employed by SSW.[4]

The market operates under continuous double auction rules, and traders are not allowed to buy on margin or sell short. During the course of a trading period, each trader's screen displays their current holdings of experimental money and stock, the history of transaction

[3] Refer to Appendix A for the complete text of the instructions.

[4] Each trader is not aware of the endowments of the other traders as they only know of their own, which they are informed of at the commencement of the first trading period.

prices in the current period, and the open order book of bids and asks. At the conclusion of each period, the screen displays summary information including the realisation of the dividend for the period just concluded.[5] The computerised market was implemented using the z-Tree programming environment (Fischbacher 2007).

A trader's earnings from the experiment are derived from the amount of experimental money they hold at the end of the fifteenth period, after the dividend for that period has been paid. This is equal to their initial endowment of cash, plus earnings from dividends, plus proceeds from sales of shares, minus expenditures on purchases of shares. At the conclusion of the experiment, this balance was converted into Euros at an exchange rate of 100 francs to one Euro, and paid to the participants in cash.

3.2. Teams Sessions

We conducted six teams sessions at the CentERlab in Tilburg, between 5 and 13 February 2009. All sessions were conducted in English, and all participants were currently enrolled students of Tilburg University. We oversubscribed sessions to ensure that there would be eighteen participants (nine teams of two) in each session, for a total of 108 participants. The average age of the participants was 22.7 years, 41 percent were males, and 85 percent were majoring in Economics or Business Administration. No individual was allowed to participate in more than one session.

The average length of each session was 2.5 hours. We used the A Lab to train participants in the use of the trading interface, to conduct a practice period, to read out the instructions and to assign the participants into teams. These tasks together took approximately 35 minutes. Each team was then seated in a separate cubicle in the B Lab where they completed the main experiment. Figure 1 shows a photo of one of the cubicles in the B Lab. The fifteen five-minute trading periods plus summary screens took approximately 85 minutes to complete. The participants then returned to the A Lab to complete a post-experiment questionnaire individually. Finally, given that both members of each team receive the same earnings, we paid the participants in teams, anonymously of the remaining participants. The average earnings per participant were 29.15 Euro (USD 37.53 at the time of the experiments),

[5] Refer to Appendix B for sample screen shots.

inclusive of a five Euro show-up fee.[6] The questionnaire and payments together took up the final 30 minutes of the session.

[Figure 1 about here.]

In particular, after participants had signed in, we directed them to sit at any available terminal in the A Lab. We then distributed and read aloud the first section of the instructions, dealing with the mechanics of using the trading interface to post offers and to buy and sell shares.[7] These were identical to the corresponding instructions used by HNP. The participants were then given approximately ten minutes in which to practice trading using the interface. The participants completed this practice period individually, and it did not count toward their earnings. It is worth emphasising that the participants completed the practice task before they had been told about the dividend structure of the asset, how their earnings would be determined, or that they would undertake the main part of the experiment in teams.

We next circulated and read aloud the remaining sections of the instructions, dealing with the team design of the experiment, dividend structure of the asset, average holding value table and calculation of earnings. These were adapted from the corresponding instructions from HNP by emphasising that all dividends and cash balances accrue to *both* members of each team. To assign participants into teams we used a bucket containing eighteen slips of paper, two with each number from one to nine. Each participant drew one slip from the bucket and the two participants who drew the same number were paired together as a team. The participants were then escorted to the appropriate cubicles in the B Lab. When all teams were ready, the doors to the cubicles were closed and the experiment commenced.[8]

Upon completion of the experiment, the participants were told to return to their original seats in the A Lab, where they completed a post-experiment questionnaire individually.[9] This included basic demographic items such as age, gender, native language, major field of study and income. It also included questions regarding the team decision-making process, and asked participants to self-assess their own ranking out of the nine teams with respect to their

[6] The range of payments was from 9.3 to 109.6 Euro inclusive of the show-up fee, and the standard deviation was 16.42 Euro. These figures exclude an experimenter error that resulted in participants in one session receiving excess payments (participants only learned of this after the experiment had concluded).

[7] The same experimenter was responsible for reading out the instructions in all six teams sessions.

[8] There was a call button in each cubicle, which the participants could use to alert the experimenters in the event of any questions or other difficulties.

[9] Refer to Appendix C for the list of items included in the post-experiment questionnaire.

earnings. Finally, it included a ten-item test of financial literacy derived from van Rooij, Lusardi and Alessie (2007). When all participants had completed the questionnaire, we called each team out one-at-a-time to receive their earnings in privacy in an adjoining office.

4. RESULTS

Our main result is that bubbles are indeed diminished under our teams treatment. This holds both relative to the 'narrow' baseline provided by the HNP data as well as the much larger literature on SSW-type markets generally. We document the support for this result in Section 4.1. In addition to this primary result, we observe additional unanticipated results regarding the gender composition of our two-person teams and in particular the performance of all-male teams. We report these findings in Section 4.2.

4.1. Market Performance under the Teams Treatment

Figure 2 presents an initial impression of the trajectory of market prices under our teams treatment. It shows the median transaction price in each trading period for each of our teams sessions, with the stepped line representing the time path of intrinsic value. From this, it can be seen that price bubbles are not completely eliminated under the teams treatment: Sessions 3 and 6 display bubble and crash patterns that are broadly similar to those that have been observed in previous studies. In each of our remaining four sessions, prices do briefly rise above intrinsic value, but the magnitude of the discrepancy is comparatively small and prices track intrinsic values closely over the final one-third of the session. To provide an initial comparison of the teams treatment to the individuals data from HNP, Figure 3 plots the corresponding price trajectories from their sessions. Four of their sessions exhibit the bubble and crash pattern, while a pronounced 'negative bubble' is observed in a fifth session. In only one of the six individuals sessions do we observe prices tracking broadly in line with intrinsic value through the middle to later stages of the market.

[Figures 2 and 3 about here.]

To facilitate a more formal comparison, we follow previous studies in computing a range of well-established measures of the magnitude and volume of mispriced transactions. These bubble measures allow us to compare our teams treatment not only against the 'narrow' baseline provided by HNP but also against the broader literature on SSW-style markets, since the measures normalise for differences in parameterisation across studies. For each of the

measures, which will be defined in the discussion below, a larger value indicates a more pronounced price bubble.[10] We report our analysis of these bubble measures in Table 1.

[Table 1 about here.]

The first two sections of Table 1 report values for each of the measures in each of the six sessions of the teams and HNP baseline treatments respectively, along with treatment means. The next two rows report *p*-values for tests of the null hypothesis of equality of central tendency between the individual and teams treatments, in parametric and nonparametric tests respectively. The final two rows are derived from a database of bubble measure observations that the second author has assembled for another paper. The second-to-last row reports mean values of each measure for all available observations in the database for which participants were inexperienced in the experimental market. In the final row, we narrow this set of observations down to inexperienced 'baseline' sessions that conform particularly closely to the classic SSW design. These are limited to markets in which the intrinsic value of the experimental asset is diminishing over time, which employ a double auction institution, and in which there is no short selling or futures market. The list of inexperienced baseline observations is itemised in the note to Table 1.

Our bubble measure analysis is based upon one measure of the volume of trade in the market, six measures of different aspects of the deviation of transaction prices from intrinsic value, and one measure of price volatility.

Turnover (King et al. 1993) is a measure of the volume of share transactions relative to the number of shares on issue in the market:

$$Turnover = \sum_{t=1}^{T} q_t \Big/ TSU$$

where T is the number of trading periods, q_t is the number of transactions in period t and TSU (Total Stock of Units) is the total number of shares in the market.

Amplitude is a measure of the overall magnitude of peak-to-trough deviations in the mean transaction price in a period from intrinsic value. In the version of this measure defined by Haruvy and Noussair (2006), the maximum and minimum price deviations are evaluated relative to intrinsic value in the current period, such that:

[10] For *Average Bias*, strongly negative values indicate a negative bubble, i.e. prices below fundamental value.

$$Amplitude = \max_t \left[\left(\overline{P}_t - f_t \right) / f_t \right] - \min_t \left[\left(\overline{P}_t - f_t \right) / f_t \right]$$

where $\overline{P}_t$ is the mean transaction price in period t and f_t is intrinsic value in period t. A high value of this measure indicates large price swings relative to intrinsic value.

Duration (Porter and Smith 1995) is defined as the length of the longest sequence of periods over which the difference between the mean transaction price and the intrinsic value increases consecutively from one period to the next:

$$Duration = \max \left(m : \overline{P}_t - f_t < \overline{P}_{t+1} - f_{t+1} < \ldots < \overline{P}_{t+m} - f_{t+m} \right)$$

Average Bias (Haruvy and Noussair 2006) is a measure of the average strength and direction of the deviation of the median transaction price in a period from intrinsic value in that period:

$$Average\ Bias = \sum_{t=1}^{T} \left(\tilde{P}_t - f_t \right) \Big/ T$$

where $\tilde{P}_t$ is the median transaction price in period t.

Average Dispersion (Haruvy and Noussair 2006) measures the average *absolute* discrepancy between the median transaction price in a period and intrinsic value. It differs from *Average Bias* in that it penalises both positive and negative deviations, where these may potentially cancel out in the expression for *Average Bias*. The *Average Dispersion* is defined as:

$$Average\ Dispersion = \sum_{t=1}^{T} \left| \tilde{P}_t - f_t \right| \Big/ T$$

Overpriced Transactions (Palan 2009) is the percentage of all transactions that occur at prices in excess of the maximum remaining dividend value of a share. It is defined as:

$$Overpriced\ Transactions = 100 \times \sum_{t=1}^{T} \sum_{i=1}^{q_t} I_{it}^{\max} \Big/ \sum_{t=1}^{T} q_t$$

where $I_{it}^{\max}$ is an indicator variable that takes the value 1 if $P_{it} > f_t^{\max}$ (where P_{it} is the price of the ith transaction in period t and $f_t^{\max}$ is the maximum possible return to holding a share from period t until the end of the market), and $I_{it}^{\max} = 0$ otherwise. This measure provides a strong indication of speculative trade, since speculation is the only rationale (short of irrationality) that can explain why a trader would be willing to purchase shares at a price in excess of $f_t^{\max}$.

Normalised Deviation (King et al. 1993) measures the aggregate absolute deviation of individual transaction prices from intrinsic value, normalised by the Total Stock of Units:

$$Normalised\ Deviation = \sum_{t=1}^{T} \sum_{i=1}^{q_t} \left| P_{it} - f_t \right| \Big/ \left(100 \times TSU \right)$$

Since it combines both volume and price information into a single measure that penalises high turnover at prices that deviate from intrinsic value, *Normalised Deviation* can be considered to be the most comprehensive of the measures of mispricing that we report.[11]

Finally, *Dispersion Ratio* (Palan 2009) is a measure of price volatility, which has been designed to normalise for differences in both the level and change over time in the variability of the outstanding dividend stream remaining on a share. It is defined as:

$$Dispersion\ Ratio = \frac{1}{T} \sum_{t=1}^{T} \frac{\hat{\sigma}_{P_{it}}}{\sigma_{f_t}}$$

where $\hat{\sigma}_{P_{it}}$ is the sample standard deviation of transaction prices in period *t*, and σ_{f_t} is the population standard deviation of the remaining dividend stream on a share in period *t*. A value of the *Dispersion Ratio* equal to unity thus indicates that transaction prices are on average exactly as variable as the dividend stream on a share.

The mean bubble measures reported in Table 1 indicate that on average we attain smaller values of all but one of these eight bubble measures under our teams treatment than in the baseline data from HNP. Moreover, the formal tests reported in the table confirm that with one additional exception, these differences are at least marginally significant in both the parametric and nonparametric tests.[12] Although the significance levels of the individual test statistics are inhibited by the limited number of observations, the strength of our result is reinforced by the fact that it holds across the full spectrum of bubble measures which have been designed to capture a broad range of volume, temporal, price and volatility characteristics of an experimental market.

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[11] The reason for dividing by 100 in the expression for *Normalised Deviation* is to make the results of our study, in which the dividends are expressed as 0, 8, 28 or 60 experimental 'cents' comparable to earlier studies in which the dividends were expressed as 0.00, 0.08, 0.28 or 0.60 experimental 'dollars'.

[12] The exception is *Amplitude*, for which we just fail to attain a conventional significance level in the nonparametric Wilcoxon rank-sum test ($p = 0.109$).

Our strongest result is for *Duration*: in every one of our teams sessions, we observe *Duration* less than or equal to that of the lowest value observed in the HNP sessions. The measure for which we clearly fail to obtain a result is *Average Bias*. Recall however that the definition of this measure allows periods of negative deviation from intrinsic value to cancel with periods of positive deviation, and that the HNP data includes sessions with both very large positive and negative deviations. By contrast, the measure of *Average Dispersion* penalises all absolute deviations, both positive and negative. Given that we observe a lower *Average Dispersion* under our teams treatment ($p = 0.063$ in a *t*-test and $p = 0.078$ in a rank-sum test), we confirm that prices do indeed track intrinsic values more closely in an absolute sense under the teams treatment.

In addition to observing prices that track more closely to intrinsic value, we also observe lower *Turnover* under our teams treatment ($p = 0.045$ in a *t*-test and $p = 0.055$ in a rank-sum test). Figure 4 sheds further light on this by plotting the mean number of transactions per period for the six sessions of the teams and HNP baseline treatments respectively. It shows that the average number of transactions is lower under the teams treatment in all but one of the fifteen periods, with the most pronounced differences seen at the beginning of the market. This lower volume of trade is observed despite the fact that we increased the length of the trading periods from four minutes in the individuals sessions to five in the teams sessions.

We also observe lower price volatility under our teams treatment as measured by the *Dispersion Ratio* ($p = 0.071$ in a *t*-test and $p = 0.055$ in a rank-sum test). Figure 5 provides further support for this result by plotting the mean of the sample standard deviation of transaction prices in each period for the six sessions of the teams and HNP baseline treatments respectively. It shows that the average volatility in transaction prices in a period is lower under the teams treatment for all but one out of fifteen trading periods.

On the basis of the above results, we conclude that our teams markets are characterised by price deviations that are smaller in magnitude, shorter in duration, and associated with lower volume and price volatility. Several of these dimensions are combined in the measure of *Normalised Deviation*, which penalises absolute price deviations from intrinsic value at the level of individual transactions. As such, this measure penalises both the number of mispriced transactions and the (absolute) extent of mispricing, effectively combining the information from *Turnover* and *Average Dispersion*. Since we observe lower values for both *Turnover* and *Average Dispersion* under our teams treatment, it comes as no surprise that we also

observe significantly lower *Normalised Deviation* ($p = 0.030$ in a *t*-test and $p = 0.037$ in a rank-sum test). Since we regard the *Normalised Deviation* as the most comprehensive of the bubble measures in Table 1, we also consider this result to be our central finding with respect to the effect of our teams treatment.

4.2. Gender Effects

Although we did not specifically design our study to investigate gender effects, an initial exploration of our questionnaire and earnings data indicated that further examination of such effects might be warranted. Table 2 shows some relevant summary statistics for the 108 participants in our teams sessions.[13] The first three columns present summary data organised according to the gender composition of our 54 teams – either all-male, all-female or mixed. In the next two columns the data is organised according to the gender of the individual participants, and in the final column it is presented for the sample as a whole.

[Table 2 about here.]

A participant's *Normalised Earnings* is derived by subtracting from their earnings the mean earnings in their session, and dividing the result by the session mean earnings. The resulting variable has a mean of zero and can be interpreted as a measure of earnings over- or under-performance relative to the average in a session. *Estimated Rank* is an *individual participant's* estimate of their *team's* ranking out of nine teams in their session with respect to earnings, where a value of one signifies the top rank. *Actual Rank* is a team's actual ranking. *Financial Literacy* is a participant's score on a ten-item test of financial literacy.[14]

The results in Table 2 point to some weak evidence of higher earnings by male teams. In an OLS regression of *Normalised Earnings* on dummies for all-male and all-female teams, male teams have a factor loading of 0.719 ($p = 0.009$), while neither the intercept nor the coefficient for female teams is significantly different from zero. Although this result is consistent with an analysis of the earnings of individual males and females in the HNP sessions, it is not very robust. It ceases to be significant when we remove an outlier in the all-

[13] Appendix C contains the full text of the post-experiment questionnaire, including the coding of the categorical response items.

[14] We derived this measure from van Rooij, Lusardi and Alessie (2007), who construct measures of financial literacy for the general Dutch population. Their measures consist of five basic literacy questions and eleven advanced literacy questions. For our ten-item score we utilised three of their basic literacy questions (items 1, 3 and 5) and seven of their advanced literacy questions (items 6 through 12).

male teams.[15] We trace the low power of this test to our treatment design: we did not design our study to explore gender effects but recruited and assigned participants into teams at random. Given the high proportion of our sample that is female, the result is that we have only seven all-male teams in our data.

With this in mind, it is striking that a number of other analyses nonetheless turn out to be highly significant. In particular, we find a significant and robust difference in the *variability* of *Normalised Earnings* between all-male teams and other teams ($p = 0.000$ both in a two-sided variance ratio test and in Levene's robust equality of variance test; remaining significant after removing the outlier, with variance ratio $p = 0.024$ and Levene $p = 0.004$).

Regressing a normalised version of a participant's *Estimated Rank* on their normalised *Actual Rank* and dummies for male and female teams, we find that members of all-male teams exhibit significant overconfidence (OLS coefficient $= -1.487$ with $p = 0.007$, remaining significant at $p = 0.025$ after removing the outlier), while the coefficient on the female team dummy is not significant. Neither an individual participant's gender nor financial literacy is significant if added to the regression. Thus we find that members of all-male teams overestimate their team's performance, while males generally (i.e. including those in mixed teams) do not. This is particularly telling given that each participant reports their *Estimated Rank* individually and separately from their partner.

To investigate the causes of the higher earnings variability (and weak evidence of higher earnings) for all-male teams, we analyse the pattern of changes in their stock holdings over time. A team that increases its holdings of stock when shares are undervalued and decrease its holdings when they are overvalued will on average have higher earnings than one that does the opposite. Figure 6 shows that such an effect may contribute to our results. It shows that the average all-male team increases its holdings considerably over periods one to four when prices tend to be below intrinsic value (as indicated by the bars in the bottom part of the chart). It then decreases its holdings between periods five and eight, when prices typically

[15] One male team achieved *Normalised Earnings* of 4.24, compared to a mean of 1.22 (standard deviation of 0.74) for the other male teams. Nonetheless, as noted in the text, our remaining gender results are robust to removing this outlier.

exceed intrinsic value. There is a mirrored pattern for female teams, and no material change in the average holdings of mixed teams over time.[16, 17]

[Figure 6 about here.]

The correlation over time between the aggregate stock holdings of male teams and the period median price deviation from intrinsic value is −0.44, while for female teams it is 0.57 and for mixed teams it is −0.03. However, when we examine the correlation between stock holdings and price deviations from intrinsic value at the level of each individual team, we find a more nuanced picture. For neither male nor mixed teams is the mean correlation significantly different from zero, and while the mean correlation coefficient of 0.204 for female teams is positive and significant ($p = 0.012$), it is not significantly different from the other teams'.

Even more interesting than the size of the individual correlation coefficients is their distribution as documented in Figure 7. It shows that while there is no clear evidence of all-male teams following more *profitable* strategies (i.e. negative correlation), there is a clear pattern of male teams following more *extreme* strategies. Taking the absolute value of the correlation coefficient (i.e. isolating those teams that condition their stock holdings most strongly on price deviations from intrinsic value in an absolute sense), the top fifteen teams contain all seven all-male teams (100%), but only seven out of the thirty mixed teams (23%), and one out of the seventeen female teams (6%). We thus find that – whether rightly or wrongly – our all-male teams condition much more strongly on price in their trading behaviour. This tendency toward extremes is also reflected in the earnings of the seven all-male teams: four of them attain an *Actual Rank* of first or second in their session; however the remaining three teams rank either eighth or last.

[Figure 7 about here.]

To summarise, we find that all-male teams follow more extreme strategies, thereby attaining more *variable* earnings. However it is not so clear that these strategies result in consistently

[16] A Kruskal-Wallis test of normalised stock holdings by all-male, all-female and mixed teams rejects the null hypothesis of equal distributions with a p-value of 0.048. On average, male teams hold somewhat more stock than mixed teams over the duration of the market (mean = 1.305 for male teams vs. 0.053 for mixed, $p = 0.034$ in a t-test, but Wilcoxon rank-sum $p = 0.786$), while female teams hold significantly less than mixed teams (mean = −0.631 for female teams, $p = 0.009$ in a t-test, and $p = 0.012$ in a Wilcoxon test).

[17] There were seven male and seventeen female teams, which explains why the average stock holdings of male teams increased by more than a factor of 2, while the corresponding female teams' holdings decreased by a factor of less than 0.5, with mixed teams holding their average stock inventory largely constant.

superior earnings. We also find that members of all-male teams are overconfident whereas males generally are not. Finally, it is worth remarking that although we find that males score higher on our test of financial literacy, this cannot explain why mixed teams do not outperform female teams, why financial literacy has no explanatory power in a regression of *Estimated Rank*, or why some of our all-male teams adopt strategies that are unprofitable in the extreme. We thus conjecture that, consistent with the findings of LePine et al (2002), our results may be driven by factors specific to the psychology of decision-making in all-male (or more generally, male-dominated) environments. However a deeper understanding of these factors must await future research designed specifically for this purpose.

5. CONCLUSION

Differences in decision-making between individuals and teams have long been the subject of research in psychology, but have not been studied to nearly the same extent in economics – and especially not in market settings. At the same time, institutional investors such as mutual funds increasingly rely on teams as opposed to individuals to make decisions regarding the allocation of capital. Conversely, research on experimental asset markets has focused on features of the market environment as opposed to the characteristics of market participants.

In this paper, we investigate the effect of team decision-making in an experimental asset market that has long been known to reliably generate price bubbles and crashes when populated with individuals. We find that our teams treatment significantly reduces the severity of this phenomenon, as measured by a full spectrum of measures designed to capture a broad range of dimensions of a price bubble. Thus our teams markets are characterised by price deviations that are significantly smaller in magnitude, shorter in duration, and associated with lower volume and price volatility.

In addition to these results concerning our primary research question, we report some unanticipated results concerning gender effects in team composition. In particular, we find that all-male teams condition more strongly on price deviations from intrinsic value in an absolute sense, but not consistently in the direction that would imply greater profitability. As a result, their earnings are more variable, but not necessarily superior. We find that members of all-male teams are overconfident whereas males generally are not. These results cannot be explained by males' higher average financial literacy. The distinctive behaviour of all-male teams warrants further research. Furthermore, and in line with Croson and Gneezy (2008), we

urge experimenters to routinely record the gender of their subjects where possible in order to permit further investigation of the role of gender in economic decision-making.

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TABLE 1: BUBBLE MEASURES

	Turnover	*Amplitude*	*Duration*	*Average Bias*	*Average Dispersion*	*Overpriced Transactions*	*Normalised Deviation*	*Dispersion Ratio*
Teams Sessions								
Session 1	5.17	1.09	7	−45.20	72.27	0.00	7.11	0.17
Session 2	4.17	0.76	7	−5.57	40.83	0.00	2.73	0.23
Session 3	5.31	3.15	6	57.57	145.90	9.95	9.69	0.54
Session 4	3.22	1.12	7	1.80	49.40	0.00	1.79	0.14
Session 5	1.11	0.84	7	10.18	31.27	0.00	0.44	0.10
Session 6	3.03	2.27	7	73.30	87.23	8.26	2.05	0.30
Treatment Average	3.67	1.54	6.83	15.35	71.15	3.03	3.97	0.25
HNP Baseline Sessions								
Session 1	6.38	0.91	10	−60.47	61.53	0.00	7.62	0.39
Session 2	6.56	4.30	7	153.13	281.93	12.11	18.13	1.88
Session 3	11.25	1.21	13	−125.23	126.97	0.00	19.03	0.24
Session 4	4.31	3.94	7	33.80	84.33	21.29	5.89	0.83
Session 5	5.50	3.54	9	19.57	170.50	18.69	10.37	0.49
Session 6	3.19	2.22	9	57.50	87.37	11.76	3.18	0.45
Treatment Average	6.20	2.69	9.17	13.05	135.44	10.64	10.70	0.71
t-test, unequal variances (one-sided *p*-values)	0.045**	0.070*	0.025**	0.520	0.063*	0.054*	0.030**	0.071*
Wilcoxon rank-sum test (*p*-value)	0.055*	0.109	0.020**	1.000	0.078*	0.087*	0.037**	0.055*
All inexperienced markets in database (no. of observations)	7.68 (266)	3.40 (166)	8.59 (254)	61.01 (148)	110.36 (166)	25.40 (94)	14.04 (148)	0.37 (27)
All inexperienced baseline markets (no. of observations)	5.57 (101)	2.81 (5)	8.31 (72)	77.45 (5)	112.79 (8)	n/a (0)	5.73 (31)	n/a (0)

*/**/*** denotes significance at the 0.1/0.05/0.01-level respectively. For *t*-tests, we report one-sided *p*-values for the null hypothesis that the mean under the teams treatment is closer to zero. The entries in the bottom two rows are derived from a database of bubble measure observations compiled for publication by the second author. The set of observations included in the inexperienced baseline classification are derived from Ackert and Church (2001): Inexperienced baseline (IB) treatment, Table 3, p. 17; Corgnet, Kujal and Porter (2008): Baseline treatment, Table 10, p. 26, Table A1, p. 31, and using data from Corgnet et al. (2007); Davies (2006): Decreasing fundamental value treatments: Annex 4, pp. 31-3; Dufwenberg, Lindqvist and Moore (2005): Markets 1-3, Table 1, p. 1734, Table 4A, p. 32; Haruvy and Noussair (2006): NSS treatments, Table II, p. 1132; Hussam, Porter and Smith (2008): Inexperienced treatment, Table 4, p. 934; King et al. (1993): Inexperienced baseline treatment, Table 13.1, p. 185; Lei, Noussair and Plott (2001): One market treatment, Table I, p. 836 and Table IV, p. 850; Porter and Smith (1994): Baseline treatment, Table 2, p. 116; Porter and Smith (1995): Baseline treatment, Table 5, p. 521; Smith, Van Boening and Wellford (2000): Markets A2-1 to A2-6, Appendix Table 1, p. 582; and SSW: Experiments 26, 41 and 90, Table 1, p. 1126, Figure 7, p. 1131, Figure 11 and Figure 13, pp. 1134-35.

TABLE 2: SUMMARY STATISTICS OF PERFORMANCE IN TEAMS SESSIONS

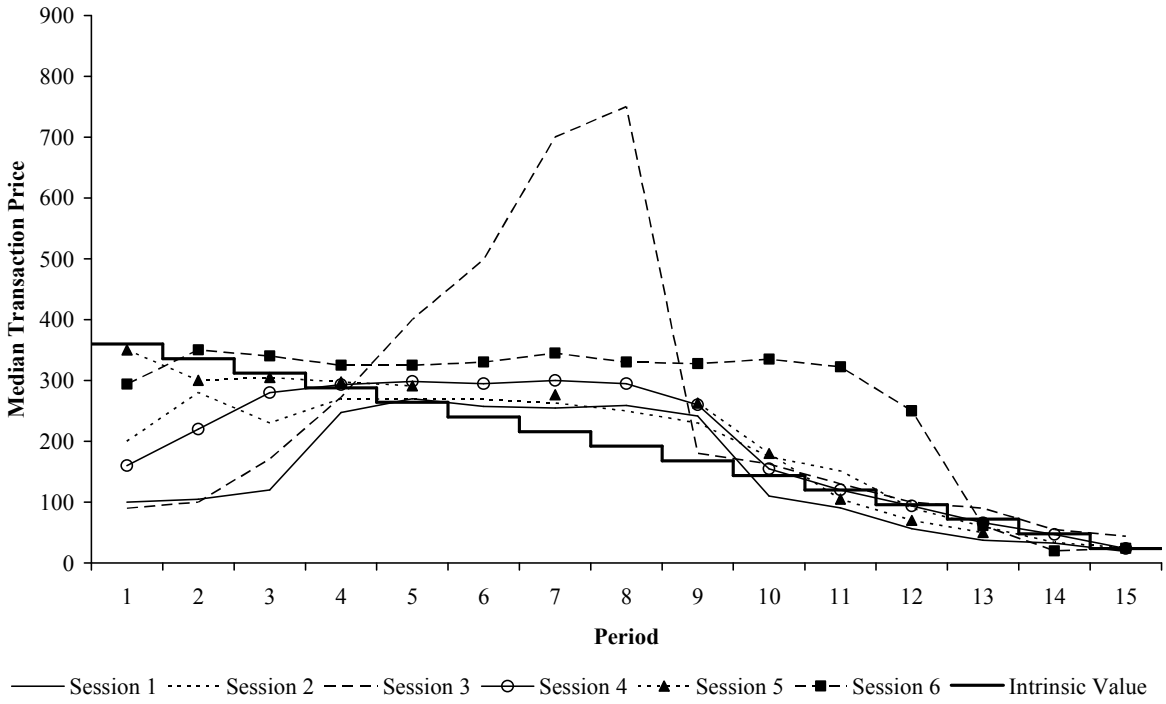
	Teams			Individuals		
	Male (n = 7)	Female (n = 17)	Mixed (n = 30)	Male (n = 44)	Female (n = 64)	All (n = 108)
Normalised Earnings	0.65* (1.31***)	–0.16* (0.56)	–0.06 (0.36***)	0.16* (0.85***)	–0.11* (0.48***)	0.00 (0.67)
Estimated Rank (1–9)	3.07*** (2.09)	5.24* (2.16)	4.72 (1.88)	4.25* (2.15)	4.95* (2.01)	4.67 (2.09)
Actual Rank (1–9)	4.29 (3.67**)	5.71** (2.41)	4.77 (2.35)	4.61 (2.81)	5.27 (2.42)	5.00 (2.59)
Financial Literacy (0–10)	8.07 (2.02)	7.32 (2.24)	7.85 (1.76)	8.36*** (1.45***)	7.27*** (2.14***)	7.71 (1.96)

The table shows means (standard deviations in brackets) at the subject level, grouped by team composition and gender for participants in the teams sessions. */**/*** denotes significance of a two-sample *t*-test with unequal variances (a two-group variance ratio test in case of the standard deviations) at the 0.1/0.05/0.01-level (comparing e.g. male teams with all non-male teams, or male individuals with all female individuals).

FIGURE 1

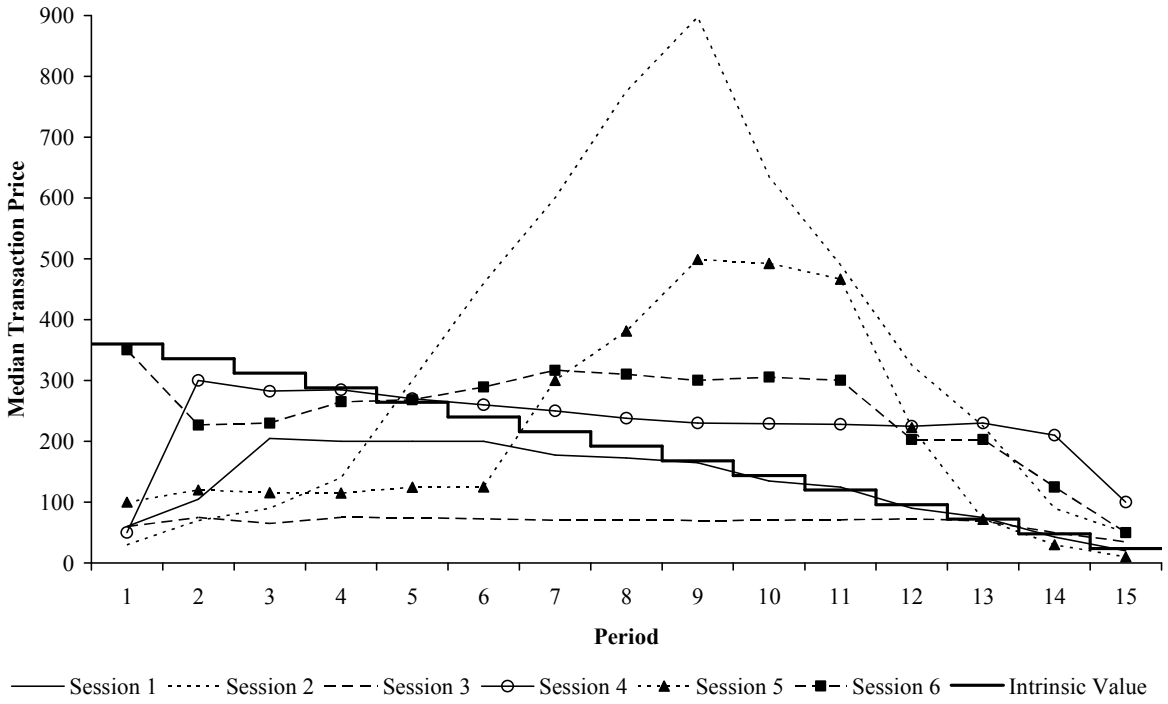
Photo of a cubicle in the ‘B Lab’

FIGURE 2



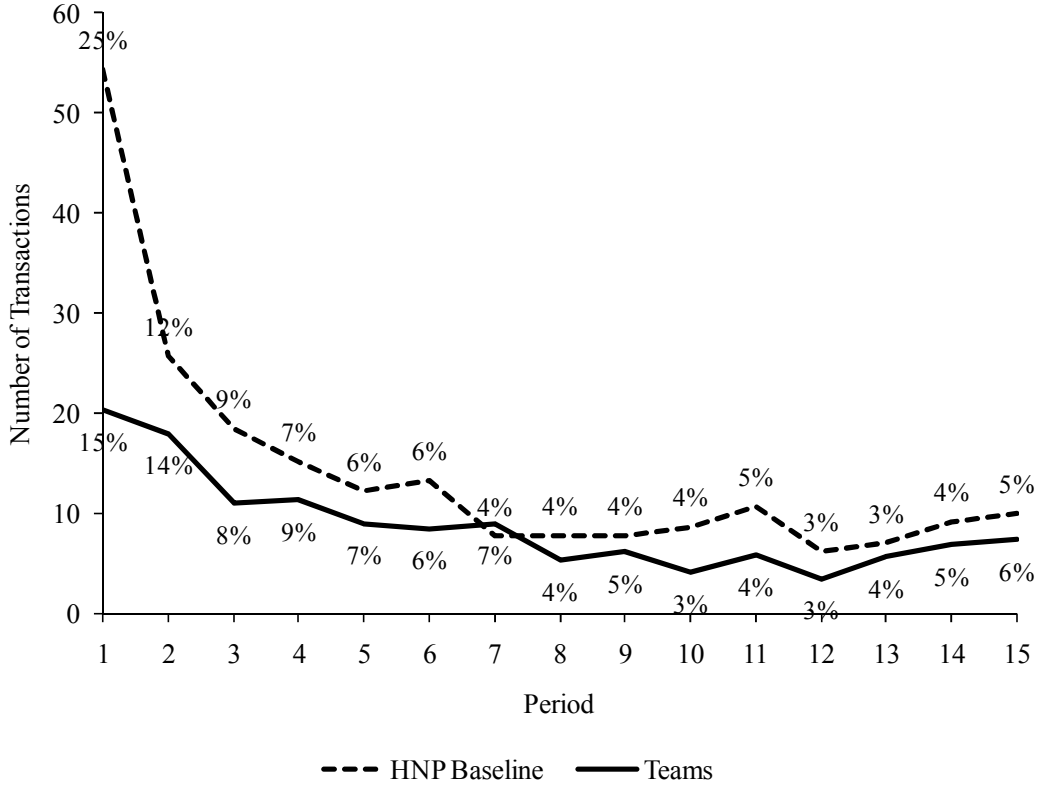
Median price trajectories in teams sessions

FIGURE 3



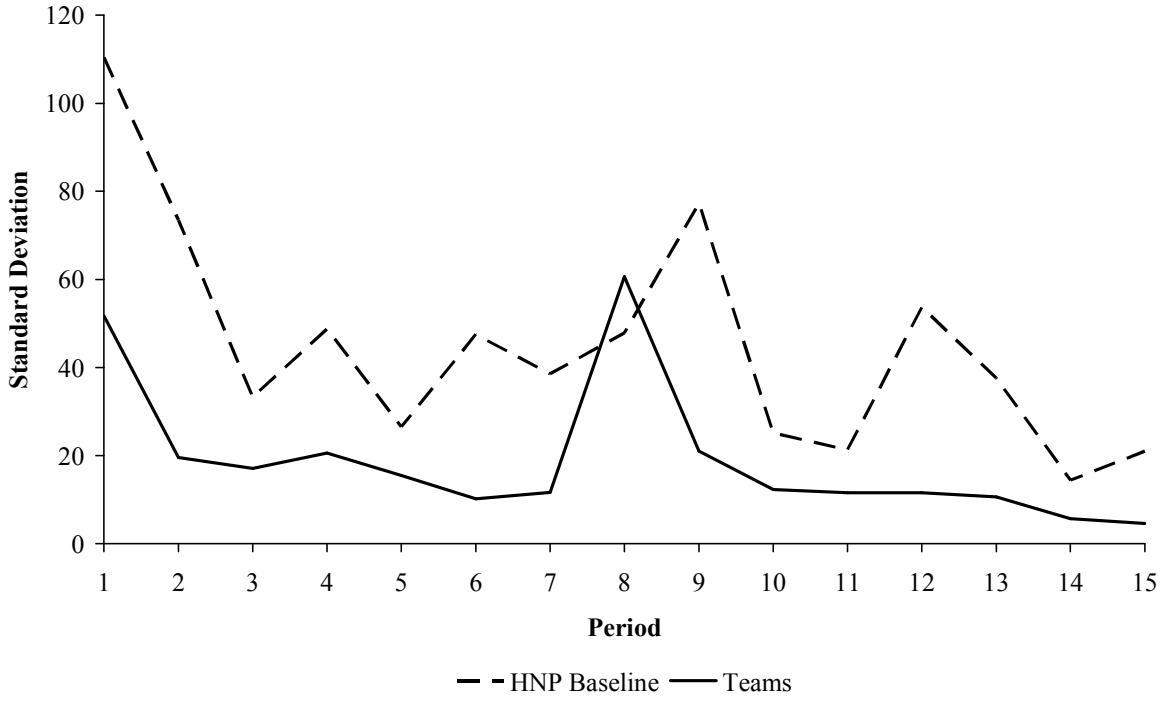
Median price trajectories in HNP baseline sessions

FIGURE 4



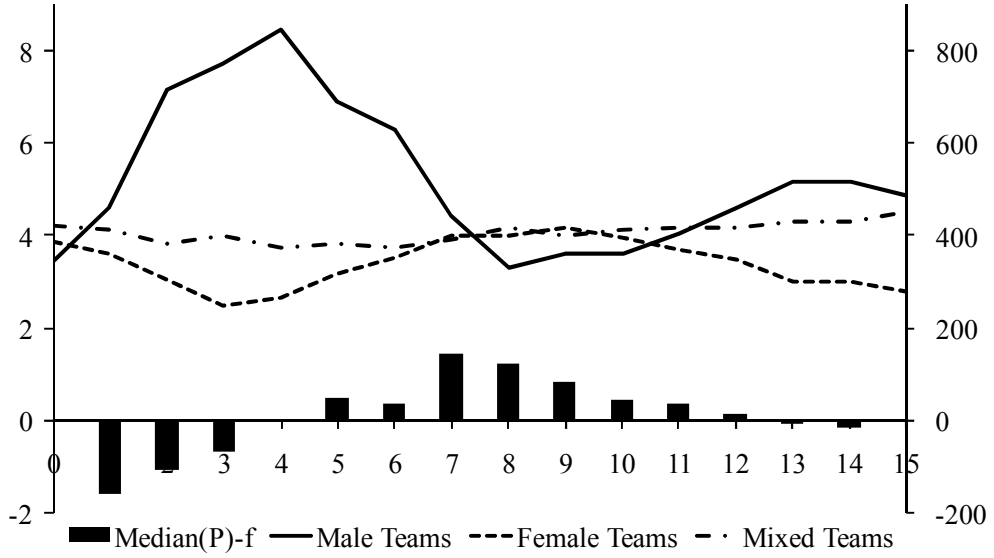
Volume per period, means over sessions by treatment. The percentage of the total volume transacted in a given period is noted above (below) the line for the individuals (teams) treatment.

FIGURE 5



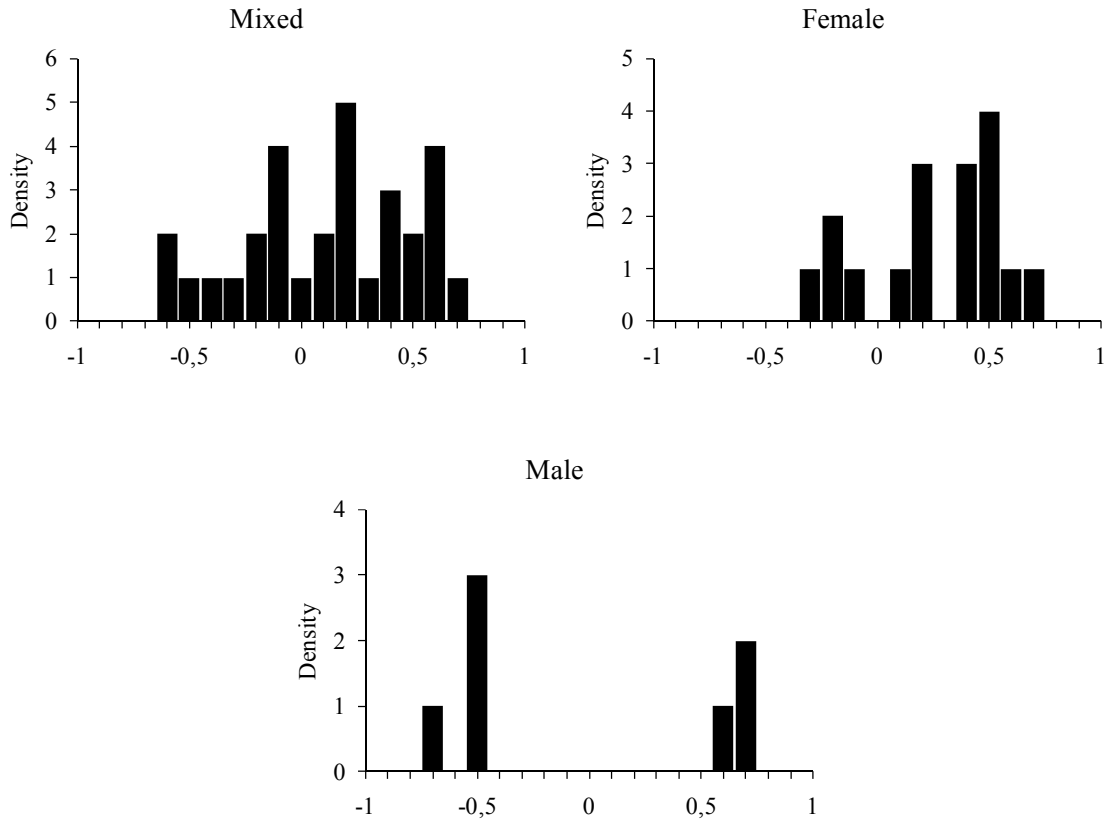
Standard deviation of period transaction prices, means over sessions by treatment

FIGURE 6



Mean stock holdings by team composition (lines, left-hand scale), and mean deviation of median period transaction prices from fundamental value (bars, right-hand scale). Since the initial endowment of each team was randomly drawn, the intercept of each line (period "0") shows the average starting endowment for that type of team.

FIGURE 7



Distributions of the coefficients of correlation between changes in individual team stock holdings and median period stock price deviation, by type of team.

APPENDIX A: INSTRUCTIONS FOR TEAMS SESSIONS

1. General Instructions

This is an experiment on decision making in a market. The instructions are simple and if you follow them carefully and make good decisions, you might earn a considerable amount of money, which will be paid to you in cash at the end of the experiment. The experiment consists of a sequence of trading Periods in which you will have the opportunity to buy and sell in a market. The currency used in the market is francs. All trading will be done in terms of francs. The cash payment to you at the end of the experiment will be in euros. The conversion rate is: **100 francs to 1 Euro**.

2. How to use the Computerized Market

In the top right hand corner of the screen you see how much time is left in the current trading Period. The goods that can be bought and sold in the market are called Shares. In the center of your screen you see the number of Shares you currently have and the amount of Money you have available to buy Shares.

If you would like to offer to sell a share, use the text area entitled "Enter offer to sell" in the first column. In that text area you can enter the price at which you are offering to sell a share, and then select "Submit Offer To Sell". Please do so now. Type in a number in the appropriate space, and then click on the field labeled "Submit Offer To Sell". You will notice that eighteen numbers, one submitted by each participant, now appear in the second column from the left, entitled "Offers To Sell". Your offer is listed in blue. Submitting a second offer will replace your previous offer.

The lowest offer-to-sell price will always be on the bottom of that list. You can select an offer by clicking on it. It will then be highlighted. If you select "Buy", the button at the bottom of this column, you will buy one share for the currently selected sell price. Please purchase a share now by selecting an offer and clicking the "Buy" button. Since each of you had offered to sell a share and attempted to buy a share, if all were successful, you all have the same number of shares you started out with. This is because you bought one share and sold one share. Please note that if you have an offer selected and the offer gets changed, it will become deselected if the offer became worse for you. If the offer gets better, it will remain selected.

When you buy a share, your Money decreases by the price of the purchase. When you sell a share your Money increases by the price of the sale. You may make an offer to buy a unit by selecting "Submit offer to buy." Please do so now. Type a number in the text area "Enter offer to buy", then press the red button labeled "Submit Offer To Buy". You can replace your offer-to-buy by submitting a new offer. You can accept any of the offers-to-buy by selecting the offer and then clicking on the "Sell" button. Please do so now.

In the middle column, labeled "Transaction Prices", you can see the prices at which Shares have been bought and sold in this period. You will now have about 10 minutes to buy and sell shares. This is a practice period. Your actions in the practice period do not count toward your earnings and do not influence your position later in the experiment. The only goal of the practice period is to master the use of the interface. Please be sure that you have successfully submitted offers to buy and offers to sell. Also be sure that you have accepted buy and sell offers. If you have any questions, please raise your hand and the experimenter will come by and assist you.

3. Specific Instructions for this Experiment

In this experiment you will be randomly paired with a partner, with whom you will be making decisions jointly as a team of two. It is important that both you and your partner agree on each of the decisions you make over the course of the experiment, as they may influence the earnings that you both receive at the conclusion of the experiment. ***At the end of the experiment both you and your partner will each receive the total value of your team's cash balance, converted into Euros at the conversion rate specified at the beginning of these instructions.***

The experiment will consist of 15 trading periods. In each period, there will be a market open for 5 minutes, in which your team may buy and sell shares. Shares are assets with a life of 15 periods, and your team's inventory of shares carries over from one trading period to the next. Your team may receive dividends for each share in its inventory at the end of each of the 15 trading periods.

At the end of each trading period, including period 15, the computer will randomly determine the dividend value for all shares in that period. Each period, each share your team holds at the end of the period:

- earns a dividend of 0 francs for both you and your partner with probability 1/4
- earns a dividend of 8 francs for both you and your partner with probability 1/4
- earns a dividend of 28 francs for both you and your partner with probability 1/4
- earns a dividend of 60 francs for both you and your partner with probability 1/4

Each of the four dividend values is equally likely, thus the average dividend in each period is 24. Dividends are added to your team's cash balance automatically.

After the dividend is paid at the end of period 15, there will be no further earnings possible from shares.

4. Average Holding Value Table

You can use your **AVERAGE HOLDING VALUE TABLE** to help you make decisions. There are 5 columns in the table. The first column, labeled Ending Period, indicates the last trading period of the experiment. The second column, labeled Current Period, indicates the period during which the average holding value is being calculated. The third column gives the number of holding periods from the period in the second column until the end of the experiment. The fourth column, labeled Average Dividend per Period, gives the average amount that the dividend will be in each period for each unit held in your team's inventory. The fifth column, labeled Average Holding Value Per Unit of Inventory, gives the average value for each unit held in your team's inventory from now until the end of the experiment. That is, for each share your team holds for the remainder of the experiment, both you and your partner will each earn on average the amount listed in column 5.

Suppose for example that there are 7 periods remaining. Since the dividend on a Share has a 25% chance of being 0, a 25% chance of being 8, a 25% chance of being 28 and a 25% chance of being 60 in any period, the dividend is on average 24 per period for each Share. If your team holds a Share for the remaining 7 periods, the total dividend for the Share over the 7 periods is on average $7 \times 24 = 168$. Therefore, the total value of holding a Share over the 7 periods is on average 168.

AVERAGE HOLDING VALUE TABLE

Ending Period	Current Period	Number of Holding Periods	×	Average Dividend Per Period	=	Average Holding Value Per Share in Inventory
15	1	15		24		360
15	2	14		24		336
15	3	13		24		312
15	4	12		24		288
15	5	11		24		264
15	6	10		24		240
15	7	9		24		216
15	8	8		24		192
15	9	7		24		168
15	10	6		24		144
15	11	5		24		120
15	12	4		24		96
15	13	3		24		72
15	14	2		24		48
15	15	1		24		24

5. Your Earnings

Your earnings for the entire experiment will equal the amount of cash that your team has at the end of period 15, after the last dividend has been paid. The amount of cash you will have is equal to:

The cash (called "Money" on your screen) your team has at the beginning of the experiment

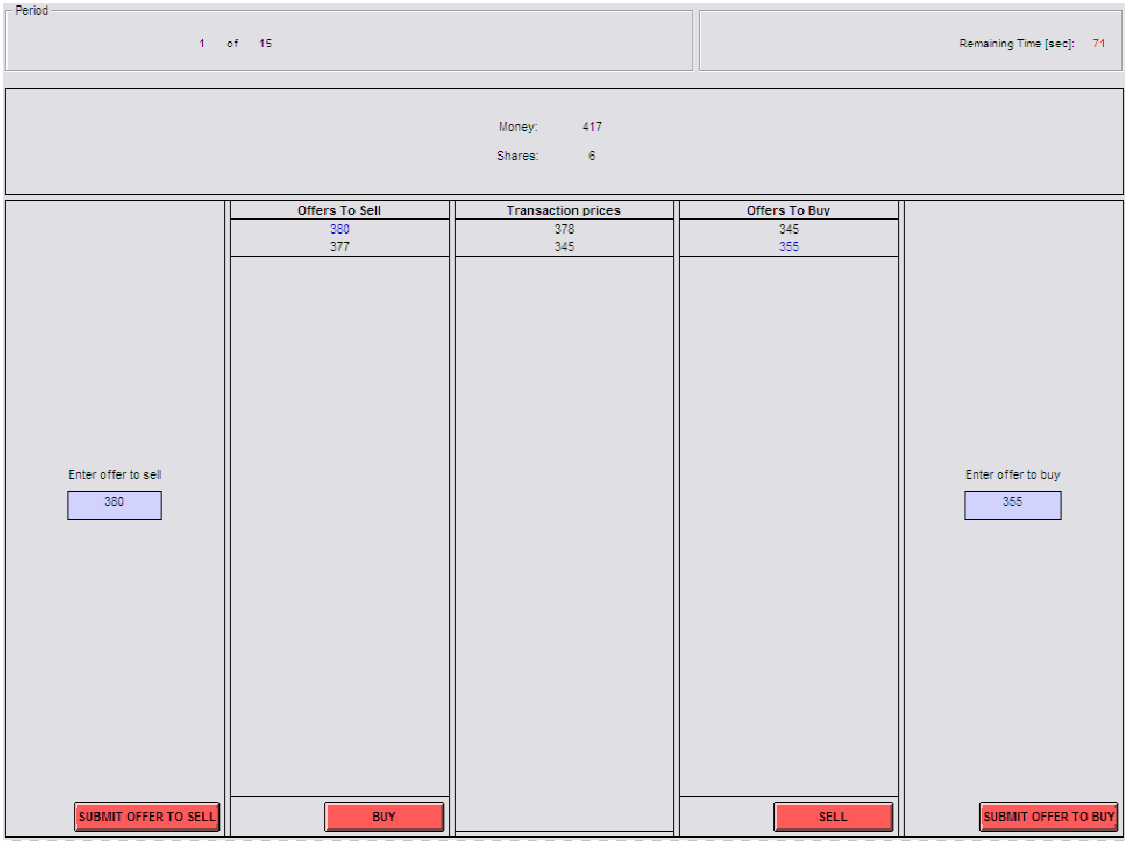
+ dividends your team receives

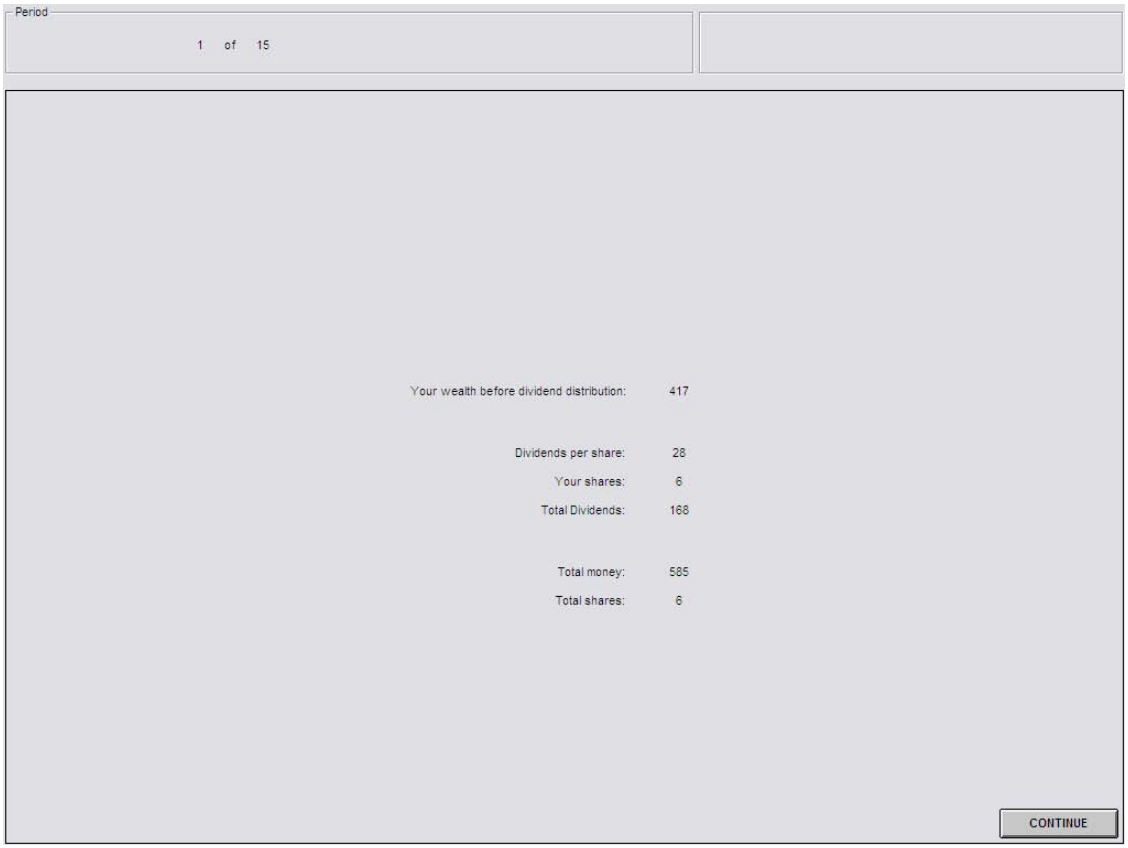
+ money received by your team from sales of shares

– money spent by your team on purchases of shares

Both you and your partner will each receive the total value of this cash balance, converted into Euros at the conversion rate specified at the beginning of these instructions.

APPENDIX B: SCREEN SHOTS OF THE TRADING PROGRAM





APPENDIX C: POST-EXPERIMENT QUESTIONNAIRE ITEMS

Team-ID:

Are you:

[0. female; 1. male]

Your age:

Are you a:

[0. domestic student; 1. international student]

Your native language:

[0. Dutch; 1. other (please specify)]

In what level of degree program are you currently enrolled?

[0. Bachelor's; 1. Master's; 2. M.Phil; 3. PhD; 4. other (please specify)]

What is your current year of enrolment in this degree?

What is your major field of study?

What is your annual income in Euro? (Consider all forms of income, including salaries, tips, interest and dividend payments, scholarship support, student loans, parental support, social security, alimony, child support and others.)

[0. Less than 7,500; 1. 7,501 to 12,500; 2. 12,501 to 17,500; 3. 17,501 to 22,500; 4.More than 22,500]

What is the combined annual income of yourself and all of your family members who live with you at the same residence in Euro? (Consider all forms of income as defined above.)

[0. Less than 20,000; 1. 20,001 to 40,000; 2. 40,001 to 60,000; 3. 60,001 to 80,000; 4. More than 80,000]

What was your strategy during the experiment?

Do you believe that you acted rationally and that you maximized your profit?

[0. Do not agree at all; through to 4. Agree completely]

Did you ever make a mistake in entering a price, or clicked a wrong button? If so, please tell us exactly what went wrong and in what period!

Out of the 9 teams, which rank do you think your team has attained with regard to your earnings ("1" signifying the best, "9" the worst result)?

Do you think your decisions were better or worse than if you had had to reach your decisions alone?

[0. Much worse than alone; through to 4. Much better than alone]

How much did you contribute to the joint decision?

[0. 0%; through to 10. 100%]

Was it easy for you to come to a joint decision?

[0. Not at all easy; through to 4. Very easy]

How did you solve conflicts if you could not agree?

Financial Literacy Questions

Suppose you had €100 in a savings account and the interest rate is 20% per year and you never withdraw money or interest payments. After 5 years, how much would you have on this account in total?

- ☑ More than €200;
- ☐ Exactly €200;
- ☐ Less than €200;
- ☐ Do not know.

Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?

- ☐ More than today;
- ☐ Exactly the same;
- ☑ Less than today;
- ☐ Do not know.

Suppose that in the year 2010, your income has doubled and prices of all goods have doubled too. In 2010, how much will you be able to buy with your income?

- ☐ More than today;
- ☑ The same;
- ☐ Less than today;
- ☐ Do not know.

Which of the following statements describes the main function of the stock market?

- ☐ The stock market helps to predict stock earnings;
- ☐ The stock market results in an increase in the price of stocks;
- ☑ The stock market brings people who want to buy stocks together with those who want to sell stocks;
- ☐ None of the above;
- ☐ Do not know.

Which of the following statements is correct? If somebody buys the stock of firm B in the stock market:

- ☑ He owns a part of firm B;
- ☐ He has lent money to firm B;
- ☐ He is liable for firm B's debts;
- ☐ None of the above;
- ☐ Do not know.

Which of the following statements is correct?

- ☐ Once one invests in a mutual fund, one cannot withdraw the money in the first year;
- ☑ Mutual funds can invest in several assets, for example invest in both stocks and bonds;
- ☐ Mutual funds pay a guaranteed rate of return which depends on their past performance;
- ☐ None of the above;
- ☐ Do not know.

Which of the following statements is correct? If somebody buys a bond of firm B:

- ☐ He owns a part of firm B;
- ☑ He has lent money to firm B;
- ☐ He is liable for firm B's debts;
- ☐ None of the above;
- ☐ Do not know.

Considering a long time period (for example 10 or 20 years), which asset normally gives the highest return?

- ☐ Savings accounts;
- ☐ Bonds;
- ☑ Stocks;
- ☐ Do not know.

Normally, which asset displays the highest fluctuations over time?

- ☐ Savings accounts;
- ☐ Bonds;
- ☑ Stocks;
- ☐ Do not know.

When an investor spreads his money among different assets, does the risk of losing money:

- ☐ Increase;
- ☑ Decrease;
- ☐ Stay the same;
- ☐ Do not know.