Online Appendix for "Benchmarking Information Aggregation in Experimental Markets"

A. Albertazzi, F. Mengel, R. Peeters

Contents

A Experimental Instructions

In the following we provide the experimental instructions for the *Market* treatment under *Public information* without bid-ask feedback and for the *BDM* treatment under *Private information* with bid-ask feedback. All other treatments are a combination of these instructions.

A.1 *Market* under *Public information* without bid-ask feedback

Instructions

Welcome and thanks for participating in this experiment. Please, read these instructions carefully. They are identical for all the participants with whom you will interact during this experiment. If you have a question, please, raise your hand. One of the experimenters will come to you and answer your questions. From now on communication with other participants is not allowed. If you do not conform to these rules we are sorry to have to exclude you from the experiment. Please do also switch off your mobile phone at this moment. At the end of the experiment you will receive a payment. How much you get depends on your decisions and those of other participants. During the experiment the earnings are expressed in ECU (Experimental Currency Units). At the end of the experiment the ECUs collected are converted into Euros according to the exchange rate 1 ECU = 5 Eurocents. In addition there is the 5 Euro show up fee. All your decisions will be treated confidentially.

The experiment

There will be two different assets in this experiment, which will be labeled with different colors. In these instructions we will talk about the BLACK asset and the WHITE asset. In the experiment, however, different colors will be used.
Both assets have one of the following three possible **returns**: 50 ECU, 100 ECU or 150 ECU. The difference between the two assets is the **probabilities** with which these possible returns realize. One of the assets returns the values 50, 100 and 150 with probabilities 3/5, 1/5 and 1/5; while the other asset returns these values with probabilities 1/5, 1/5 and 3/5, respectively.
One way to think about this is that both the BLACK and the WHITE asset represent an envelope with money containing bills of 50 ECU, 100 ECU and 150 ECU. The difference is that the BLACK and WHITE envelope might contain different numbers of each of these bills. One envelope contains 3 bills of 50, 1 bill of 100 and 1 of 150, the other has 1 bill of 50, 1 bill of 100 and 3 of 150. The value of an asset is determined by randomly picking one bill from the envelope. In total the experiment consists of three **repetitions**. In each repetition there will be different assets. You can buy or sell assets in each repetition for ten **trading periods**.

The trading

You will be matched with four other participants in a **group**. In each trading period, you have one share of each asset (BLACK and WHITE) in stock. You will tell us two numbers:

(i) your **buying price**: this is the maximum price at which you are willing to buy one more share of this asset, and

(ii) your **selling price**: this is the minimum price at which you are willing to sell your share of this asset.

Hence, in total you will tell us four numbers, two for each asset.
All group members will tell us their four numbers simultaneously. Afterwards, for each asset BLACK and WHITE, the buying prices of all group members are ranked highest to lowest and the selling prices of all group members are ranked lowest to highest. The **market price** of each asset is determined as follows:

1. First we compare the lowest selling price with the highest buying price.
   - If this selling price is higher than this buying price, then there is no market price (which we will mark with xxx).
   - Otherwise, we proceed to 2.
2. Compare the second-lowest selling price with the second-highest buying price.
   - If this selling price is higher than this buying price, then the market price is the average of the lowest selling price and the highest buying price.
   - Otherwise, we proceed to 3.
3. Compare the third-lowest selling price with the third-highest buying price.
   - If this selling price is higher than this buying price, then the market price is the average of the second-lowest selling price and the second-highest buying price.
   - Otherwise, we proceed to 4.
4. Compare the fourth-lowest selling price with the fourth-highest buying price.
   - If this selling price is higher than this buying price, then the market price is the average of the third-lowest selling price and the third-highest buying price.
   - Otherwise, we proceed to 5.
5. Compare the fifth-lowest (or highest) selling price with the fifth-highest (or lowest) buying price.
   - If this selling price is higher than this buying price, then the market price is the average of the fourth-lowest selling price and the fourth-highest buying price.
   - Otherwise, the market price is the average of this fifth-lowest selling price and this fifth-highest buying price.

For example, assume that, for some asset, the five buying prices are (5400, 100, 21, 7, 1) and the selling prices are (8, 24, 65, 201, 300). The lowest selling price of 8 is lower than the highest buying price of 5400. Hence, we proceed to step 2. The second-lowest selling price of 24 is lower than the second-highest buying price of 100. Hence, we proceed to step 3. The third-lowest selling price of 65 is higher than the third-highest buying price of 21. Hence, two shares are traded in your group and the market price is the average between the second-lowest selling price of 24 and the second-highest buying price of 100, which is 62.
Once the market price is determined, all group members with buying prices above the market price and with selling prices below the market price will trade one share of the asset (at the market price). In case there is excess demand or excess supply, group members with higher buying prices and lower selling prices will trade first. In case of ties (equal buying prices or equal selling prices) between group members, a random selection of these will be trading.

Information

At the end of each period you will observe for each asset (BLACK and WHITE):

- the market price;
- whether you sold the asset, you bought the asset, or did not make any trade at all.

Your earnings in the experiment

At the end of the experiment one period is randomly drawn. Your earnings in the experiment are based on your payoff from that randomly drawn period.
First the return of the BLACK and the WHITE asset (either 50, 100 or 150) are determined according to the respective probabilities. In terms of our envelope example you can think of one bill being randomly drawn from the BLACK and one from the WHITE envelope. Recall here that one of the assets returns the values 50, 100 and 150 with probabilities 3/5, 1/5 and 1/5; while the other asset returns these values with probabilities 1/5, 1/5 and 3/5, respectively. All group members know at any point during the experiment which asset has which return probabilities.
Your payoff in this period is then computed as follows:

$$\begin{aligned}\text{Payoff} = {} & \text{Number of shares of BLACK asset} \times \text{Return of BLACK asset} \\ & + \text{Number of shares of WHITE asset} \times \text{Return of WHITE asset} \\ & - \text{Market price BLACK asset } \textit{if} \text{ a share of this asset is bought} \\ & + \text{Market price BLACK asset } \textit{if} \text{ a share of this asset is sold} \\ & - \text{Market price WHITE asset } \textit{if} \text{ a share of this asset is bought} \\ & + \text{Market price WHITE asset } \textit{if} \text{ a share of this asset is sold}\end{aligned}$$

Questionnaire

At the end of the experiment there will be a short questionnaire for you to fill in.
If you have any questions about these instructions or the experiment, then please raise your hand now and someone will come and answer them.
Once everyone has finished reading the instructions some control questions will appear on your screen that will allow you to test your understanding of the instructions.

A.2 *BDM* under *Private information* with bid-ask feedback

Instructions

Welcome and thanks for participating in this experiment. Please, read these instructions carefully. They are identical for all the participants with whom you will interact during this experiment. If you have a question, please, raise your hand. One of the experimenters will come to you and answer your questions. From now on communication with other participants is not allowed. If you do not conform to these rules we are sorry to have to exclude you from the experiment. Please do also switch off your mobile phone at this moment. At the end of the experiment you will receive a payment. How much you get depends on your decisions and those of other participants. During the experiment the earnings are expressed in ECU (Experimental Currency Units). At the end of the experiment the ECUs collected are converted into Euros according to the exchange rate 1 ECU = 5 Eurocents. In addition there is the 5 Euro show up fee. All your decisions will be treated confidentially.

The experiment

There will be two different **assets** in this experiment, which will be labeled with different colors. In these instructions we will talk about the BLACK asset and the WHITE asset. In the experiment, however, different colors will be used.
Both assets have one of the following three possible **returns**: 50 ECU, 100 ECU or 150 ECU. The difference between the two assets is the probabilities with which these possible returns realize. In other words the chance to get 50 or 100 or 150 is different for the BLACK compared to the WHITE asset. The only thing you know is that each of these returns is possible with positive probability for both assets.
One way to think about this is that both the BLACK and the WHITE asset represent an envelope with money containing bills of 50 ECU, 100 ECU and 150 ECU. The difference is that the BLACK and WHITE envelope might contain different numbers of each of these bills. The only thing you know is that in each envelope there is at least one bill of each kind.
In total the experiment consists of three **repetitions**. In each repetition there will be different assets. You can buy or sell assets in each repetition for ten **trading periods**.

Signal

At the beginning of each repetition you receive a **signal**. A signal is a piece of information for you about each of the assets. You will receive the following signal. For each asset we will tell you one number 50, 100 or 150. The probability with which we tell you each of these numbers corresponds to the probability with which the asset has this return. Hence the higher the probability that the asset has a certain return, the higher the chance that we show you this number.
In terms of our envelope example you can think about your signal as follows. We randomly draw one bill out of each envelope and show it to you. Hence the more bills of a certain type an envelope contains, the more likely it is that we draw one of these.
In the experiment you will be matched with four other participants in a **group**. Not only you, but also all of the other group members will receive a signal in the same manner as you. Note, however, that different participants might receive different signals.

The trading

In each trading period, you have one share of each asset (BLACK and WHITE) in stock. You will tell us two numbers:

(i) your **buying price**: this is the maximum price at which you are willing to buy one more share of this asset, and

(ii) your **selling price**: this is the minimum price at which you are willing to sell your share of this asset.

Hence, in total you will tell us four numbers, two for each asset.
For each asset (BLACK and WHITE), the central computer will draw a random number between 50 and 150–all numbers in this interval are equally likely to be drawn. The numbers drawn are the random price of the assets.
For each asset (BLACK and WHITE):

- you buy one more share at the random price if your buying price is above this random price;
- you sell your share at the random price if your selling price is below this random price;
- you will neither buy nor sell if the random price is above your buying price and below your selling price;

All group members will tell us their four numbers simultaneously. Afterwards, for each asset BLACK and WHITE, the buying prices of all group members are ranked highest to lowest and the selling prices of all group members are ranked lowest to highest.
The **group value** of each asset is determined as follows:

1. First we compare the lowest selling price with the highest buying price.

- If this selling price is higher than this buying price, then there is no market price (which we will mark with xxx).
- Otherwise, we proceed to 2.

2. Compare the second-lowest selling price with the second-highest buying price.
    - If this selling price is higher than this buying price, then the market price is the average of the lowest selling price and the highest buying price.
    - Otherwise, we proceed to 3.
3. Compare the third-lowest selling price with the third-highest buying price.
    - If this selling price is higher than this buying price, then the market price is the average of the second-lowest selling price and the second-highest buying price.
    - Otherwise, we proceed to 4.
4. Compare the fourth-lowest selling price with the fourth-highest buying price.
    - If this selling price is higher than this buying price, then the market price is the average of the third-lowest selling price and the third-highest buying price.
    - Otherwise, we proceed to 5.
5. Compare the fifth-lowest (or highest) selling price with the fifth-highest (or lowest) buying price.
    - If this selling price is higher than this buying price, then the market price is the average of the fourth-lowest selling price and the fourth-highest buying price.
    - Otherwise, the market price is the average of this fifth-lowest selling price and this fifth-highest buying price.

For example, assume that, for some asset, the five buying prices are (5400, 100, 21, 7, 1) and the selling prices are (8, 24, 65, 201, 300). The lowest selling price of 8 is lower than the highest buying price of 5400. Hence, we proceed to step 2. The second-lowest selling price of 24 is lower than the second-highest buying price of 100. Hence, we proceed to step 3. The third-lowest selling price of 65 is higher than the third-highest buying price of 21. The group value is hence determined as the average between the second-lowest selling price of 24 and the second-highest buying price of 100, which is 62. At a price equal to this group value of 62, two individuals buy a share and two individuals sell a share.

Information

At the end of each period you will observe for each asset (BLACK and WHITE):

- the group value;

- the random price;
- whether you sold the asset, you bought the asset, or did not make any trade at all.

Your earnings in the experiment

At the end of the experiment one period is randomly drawn. Your earnings in the experiment are based on your payoff from that randomly drawn period.
First the return of the BLACK and the WHITE asset (either 50, 100 or 150) are determined according to the respective probabilities. In terms of our envelope example you can think of one bill being randomly drawn from the BLACK and one from the WHITE envelope.
Your payoff in this period is then computed as follows:

$$\begin{aligned} \text{Payoff} = & \text{ Number of shares of BLACK asset} \times \text{Return of BLACK asset} \\ & + \text{Number of shares of WHITE asset} \times \text{Return of WHITE asset} \\ & - \text{Market price BLACK asset } \textit{if} \text{ a share of this asset is bought} \\ & + \text{Market price BLACK asset } \textit{if} \text{ a share of this asset is sold} \\ & - \text{Market price WHITE asset } \textit{if} \text{ a share of this asset is bought} \\ & + \text{Market price WHITE asset } \textit{if} \text{ a share of this asset is sold} \end{aligned}$$

Questionnaire

At the end of the experiment there will be a short questionnaire for you to fill in.
If you have any questions about these instructions or the experiment, then please raise your hand now and someone will come and answer them.
Once everyone has finished reading the instructions some control questions will appear on your screen that will allow you to test your understanding of the instructions.

B Sample Information and Questionnaire

Table B.1 provides some descriptive statistics about our experimental sample that we elicited in the post-experimental questionnaire. Apart from demographics (Gender, Age, Origin, Field of studies and years of graduate education), we elicited risk attitudes using a self-assessed measure as in Dohmen et al. (2011). Participants answered the question *"Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks?"* on a ten-point scale ranging between "Not at all willing to take risks" and "Very willing to take risks".

We assessed the Machiavellianism score using the Likert-Type Mach Scale (IV) developed in Christie and Geis (1970). We measure the individual propensity to compete with others using the Revised Competitiveness Index (RCI) developed in Houston, Harris, McIntire, and Francis (2002). This 14-items aggregate index can be subdivided in order to capture the individual "Enjoyment of Competition" and "Contentiousness". We elicited participants' degree of optimism using a revised Life Orientation Test as in Scheier, Carver, and Bridges (1994). For each of these three dimensions participants indicated how much they personally agreed or disagreed with some statements using a five-point Likert scale ranging from "strongly disagree" to "strongly agree".

Finally, the Big-5 test assesses five personality traits: Openness, Consciousness, Extraversion, Agreeableness and Neuroticism. These personality dimensions were elicited using a 15-item questionnaire evaluated on a five-point Likert scale running from "strongly disagree" to "strongly agree" (Costa & McCrae, 1992).

	Public information		*Private information*	
	BDM	*Market*	*BDM*	*Market*
Female	0.50	0.54	0.60	0.56
	(0.50)	(0.50)	(0.49)	(0.49)
Age	20.63	20.69	21.94	21.30
	(2.46)	(3.08)	(2.38)	(2.15)
Years of study	2.02	2.50	2.57	2.25
	(1.22)	(1.74)	(1.54)	(1.18)
Risk	6.05	6.49	6.15	6.20
	(1.79)	(1.87)	(1.97)	(1.87)
Machiavellianism	60.76	61.30	59.82	59.50
	(7.02)	(8.09)	(6.14)	(7.76)
RCI	50.00	47.40	46.91	46.30
	(7.27)	(10.06)	(8.38)	(7.55)
Optimism	20.52	20.32	19.90	20.39
	(4.13)	(4.23)	(3.95)	(3.73)
Big-5:				
Openness	10.94	11.10	10.95	10.52
	(2.26)	(2.60)	(1.97)	(2.25)
Consciousness	10.66	10.64	10.19	10.69
	(2.24)	(2.07)	(2.16)	(1.98)
Extraversion	10.85	10.81	10.52	10.68
	(2.32)	(2.46)	(2.41)	(2.41)
Agreeableness	11.11	11.54	11.20	11.34
	(2.03)	(2.21)	(1.83)	(1.95)
Neuroticism	8.72	9.32	9.40	9.02
	(2.99)	(2.81)	(2.52)	(2.39)
Origin:				
Africa	0.00	0.01	0.02	0.03
Asia	0.07	0.07	0.04	0.05
Dutch	0.20	0.20	0.10	0.21
German	0.39	0.35	0.41	0.35
Middle or South America	0.05	0.03	0.04	0.01
North America	0.01	0.04	0.04	0.00
Oceania	0.00	0.01	0.01	0.01
Other in Europe	0.28	0.29	0.34	0.34
Study:				
Econometrics and Op. Research	0.01	0.00	0.05	0.03
Economics and Business Economics	0.17	0.09	0.08	0.09
Exchange Student	0.05	0.00	0.04	0.02
Fiscal Economics	0.01	0.04	0.00	0.03
Infonomics	0.00	0.00	0.01	0.02
International Business	0.59	0.49	0.34	0.44
Int. Business Economics	0.04	0.06	0.01	0.06
Int. Economic Studies	0.05	0.00	0.01	0.02
Other	0.08	0.27	0.46	0.29
Observations	80	80	80	80

Table B.1: Sample statistics.

Note: Means and standard deviations (in parenthesis) of questionnaire variables.

C Additional Theoretical Background and Proofs

C.1 Equilibrium with a More General State Space

In this appendix we reconsider the theoretical predictions derived in Section 2.2 for the case where agents perceive a more general state space. As before we derive the theoretical predictions for the *Market* treatment with *Private information* and without bid-ask feedback for signal ρ_1.[1] Let A and B be two assets/urns and assume that all agents have the same beliefs about the number of balls, k, contained into each urn. Given that every outcome has positive probability, each urn must contain at least four balls in order for ambiguity to be possible: $k \geq 4$. Then, agents know that the state space is given by $\Omega = \Omega_A \times \Omega_B$, where

$$\Omega_i = \left\{ \left(\tfrac{1}{k}, \tfrac{1}{k}, \tfrac{k-2}{k}\right), \left(\tfrac{1}{k}, \tfrac{2}{k}, \tfrac{k-3}{k}\right), \ldots, \left(\tfrac{1}{k}, \tfrac{k-2}{k}, \tfrac{1}{k}\right), \ldots, \left(\tfrac{k-3}{k}, \tfrac{2}{k}, \tfrac{1}{k}\right), \left(\tfrac{k-2}{k}, \tfrac{1}{k}, \tfrac{1}{k}\right) \right\}, \; i = A, B.$$

Assume agents have prior beliefs uniformly distributed on all $N_A \times N_B$ possible states contained in Ω where $N_i = \frac{(k-1)(k-2)}{2}$.

Let $r_i \in \{50, 100, 150\}$ be the signal received by one agent for asset i and the function $p(\cdot|r_i) : r_i \to \Omega_i$ be her posterior beliefs. Then, posterior beliefs for an agent with signal $(150, 50)$ can be calculated as follows, where we directly report marginal distributions:

$$p\left(\omega_A = \left(\cdot, \cdot, \tfrac{k-\ell}{k}\right) \middle| 150\right) = (\ell - 1)\frac{\frac{1}{N}\frac{(k-\ell)}{k}}{\frac{1}{N}\frac{\sum_{j=1}^{k-1}(j-1)(k-j)}{k}} = (\ell - 1)\frac{(k-\ell)}{\alpha}$$

for $\ell = 2, \ldots, k-1$ and $\alpha = \frac{k(k-1)(k-2)}{6}$. Analogously the posterior beliefs on states ω_B can be computed. This implies that an agent with signal $(150, 50)$ will have an expected value for assets A and B respectively of:

$$\begin{aligned} E[A|150] &= 150\left[\frac{1}{\alpha k}\sum_{\ell=1}^{k-1}(\ell-1)(k-\ell)^2\right] + 100\left[\frac{1}{\alpha k}\sum_{\ell=2}^{k-1}\left[(k-\ell)\sum_{j=1}^{\ell-1} j\right]\right] + 50\left[\frac{1}{\alpha k}\sum_{\ell=2}^{k-1}\left[(k-\ell)\sum_{j=1}^{\ell-1} j\right]\right] \\ &= 150\frac{(3k-1)}{4k} \end{aligned}$$

and

$$\begin{aligned} E[B|50] &= 150\left[\frac{1}{\alpha k}\sum_{\ell=2}^{k-1}\left[(k-\ell)\sum_{j=1}^{\ell-1} j\right]\right] + 100\left[\frac{1}{\alpha k}\sum_{\ell=2}^{k-1}\left[(k-\ell)\sum_{j=1}^{\ell-1} j\right]\right] + 50\left[\frac{1}{\alpha k}\sum_{\ell=1}^{k-1}(\ell-1)(k-\ell)^2\right] \\ &= 50\frac{(7k+3)}{4k}. \end{aligned}$$

In the same fashion, agents with signal $(50, 150)$ will have posterior beliefs that imply an expected value of $50\frac{(7k+3)}{4k}$ for asset A and $150\frac{(3k-1)}{4k}$ for asset B. Agents with signal $(100, 50)$ will have an expected value for asset A of 100 and an expected value for asset B of $50\frac{(7k+3)}{4k}$, and agents with

[1] Note that as long as both signals ρ_1 and ρ_2 reflect exactly assets distribution over outcomes, the theoretical predictions are independent of the signals distribution.

signal $(150, 100)$ will have an expected value of $150\frac{(3k-1)}{4k}$ and 100 for asset A and B respectively. Note that $150\frac{(3k-1)}{4k} > 100 > 50\frac{(7k+3)}{4k}$ for every $k \geq 4$.

Under our setting it is straightforward to show that a fully revealing rational expectations equilibrium exists and it is unique. Indeed, in the first period the ordered bids for asset A will be

$$\left(\frac{150(3k-1)}{4k}, \frac{150(3k-1)}{4k}, \frac{150(3k-1)}{4k}, 100, \frac{50(7k+3)}{4k}\right)$$

and the ordered asks will be

$$\left(\frac{50(7k+3)}{4k}, 100, \frac{150(3k-1)}{4k}, \frac{150(3k-1)}{4k}, \frac{150(3k-1)}{4k}\right)$$

which means that asset A will trade at a price of $\frac{150(3k-1)}{4k} \in [103.125, 112.5)$. Analogously, asset B will trade at a price of $\frac{50(7k+3)}{4k} \in (87.5, 96.875]$.

Given these prices agents recognize that at least three agents have received a signal of 150 for asset A (and 50 for asset B), respectively. If further asks and bids are observed (as in the treatments with bid-ask feedback) then all private information is revealed in the first round. In this case while the price reveals all private information of each individual, it is possible that some residual uncertainty about the state remains as in Radner (1979). To eliminate all residual uncertainty we would need an infinite number of traders. Note, though, that with a uniform prior the posterior will be concentrated on the true state. Without bid-ask feedback more than one period of trading is needed to reveal all private information (depending on k), but only one period is needed to rank the assets correctly.

C.2 Strategic Behaviour: Shading Bids and Asks

Let relative to the previous section, traders shading their bid and asks by ε. less and ask ε more. For asset A this results in bids

$$\left(\frac{150(3k-1)}{4k} - \varepsilon, \frac{150(3k-1)}{4k} - \varepsilon, \frac{150(3k-1)}{4k} - \varepsilon, 100 - \varepsilon, \frac{50(7k+3)}{4k} - \varepsilon\right)$$

and asks

$$\left(\frac{50(7k+3)}{4k} + \varepsilon, 100 + \varepsilon, \frac{150(3k-1)}{4k} + \varepsilon, \frac{150(3k-1)}{4k} + \varepsilon, \frac{150(3k-1)}{4k} + \varepsilon\right),$$

leading to a price of

$$p = \frac{1}{2}\left(\frac{150(3k-1)}{4k} - \varepsilon + 100 + \varepsilon\right) = \frac{950k - 150}{8k}$$

which is in $[114.06, 118.75)$. Similarly, for asset B we obtain a price of

$$p = \frac{1}{2}\left(100 - \varepsilon + \frac{50(7k+3)}{4k} + \varepsilon\right) = \frac{750k + 150}{8k}$$

which is in $(93.75, 98.4375]$. For both assets we find two units being traded.

C.3 Ambiguity Aversion

Let $m_A(\omega)$ be the return obtained with asset A in state ω and denote by $\mathbb{E}_p(m_A) = \sum_{\omega\in\Omega} p(\omega)m_A(\omega)$ be the expected return given posterior p. Following Gilboa and Schmeidler (1989) and Cerreia Vioglio (2009) we model agents' utility from holding asset A by

$$u(A) = \inf_{p\in\mathbf{P}} \mathbb{E}_p(m_A),$$

where $\mathbf{P}$ is the set of beliefs the ambiguity averse agent entertains. Further, denote by $\widehat{p}$ the posterior of an agent who does *not* perceive ambiguity.

Proposition 1. *If* $\mathbf{P}$ *includes beliefs* p *such that* $\mathbb{E}_p(m_A) < \mathbb{E}_{\widehat{p}}(m_A)$*, then the ambiguity averse agents will bid less for asset* A *than the agent who does not perceive ambiguity.*

Proof: Since there is a belief $p \in \mathbf{P}$ such that $\mathbb{E}_p(m_A) < \mathbb{E}_{\widehat{p}}(m_A)$, it follows that $\inf_{p\in\mathbf{P}} \mathbb{E}_p(m_A) < \mathbb{E}_{\widehat{p}}(m_A)$. Hence, the agent perceiving ambiguity will perceive asset A as less valuable. □

C.4 Social Comparison Model from Section 4.2.

We expand here on the model discussed in Section 4.2 and show how a swap affects agent i's utility. Before the swap, when agent i holds asset H and agent j holds asset L, agent i's utility is given by

$$V(H,L) = \eta\, EU(H) + \psi\, [\, \tfrac{3}{25}v(u_{21}) + \tfrac{1}{25}v(-u_{21}) + \tfrac{3}{25}v(u_{32}) + \tfrac{1}{25}v(-u_{32}) + \tfrac{9}{25}v(u_{31}) + \tfrac{1}{25}v(-u_{31})\,],$$

where $u_{21} \equiv u(100) - u(50)$, $u_{32} \equiv u(150) - u(100)$ and $u_{31} \equiv u(150) - u(50)$ are all positive. Agent i's utility after the swap is given by

$$V(L,H) = \eta\, EU(L) + \psi\, [\, \tfrac{1}{25}v(u_{21}) + \tfrac{3}{25}v(-u_{21}) + \tfrac{1}{25}v(u_{32}) + \tfrac{3}{25}v(-u_{32}) + \tfrac{1}{25}v(u_{31}) + \tfrac{9}{25}v(-u_{31})\,].$$

Hence, the swap between assets leads to a decrease in utility of

$$\begin{aligned} V(H,L) - V(L,H) = {} & \eta\, [\, EU(H) - EU(L)\,] \\ & + \tfrac{2}{25}\, \psi\, [\, (v(u_{21}) - v(-u_{21})) + (v(u_{32}) - v(-u_{32})) + 4\, (v(u_{31}) - v(-u_{31}))\,] \end{aligned}$$

for agent i. Since $v(y) - v(-y) > 0$ for all $y > 0$, this decrease is increasing in ψ.

D Additional Tables

Matching group	Repetition 1 Ranking	Repetition 1 Signal	Repetition 2 Ranking	Repetition 2 Signal	Repetition 3 Ranking	Repetition 3 Signal
MG 1–2	Red > Green	ρ_1	Yellow < Purple	ρ_2	Blue < Orange	ρ_1
MG 3–4	Red < Green	ρ_1	Yellow > Purple	ρ_1	Blue > Orange	ρ_2
MG 5–6	Red > Green	ρ_2	Yellow < Purple	ρ_1	Blue > Orange	ρ_2
MG 7–8	Red < Green	ρ_2	Yellow > Purple	ρ_2	Blue < Orange	ρ_1

Table D.1: Composition of repetitions over matching groups.

Ranking of the assets (labelled by colors) and signal distributions for the different matching groups.

	Female	*Age*	*Risk*	*Machiav.*	*Optimism*
Constant	0.500***	23.137***	6.050***	60.763***	20.525***
	(0.056)	(1.309)	(0.210)	(0.816)	(0.449)
Private info	0.100	−1.200	0.100	−0.938	−0.625
	(0.079)	(1.851)	(0.297)	(1.154)	(0.635)
Market	0.037	−2.450	0.437	0.537	−0.200
	(0.079)	(1.851)	(0.297)	(1.154)	(0.635)
Private info × Market	−0.075	1.813	−0.387	−0.862	0.687
	(0.112)	(2.617)	(0.420)	(1.631)	(0.898)
Observations	320	320	320	320	320

Table D.2: Balancing check.

Note: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	LPM			Probit (dy/dx)		
Prob(Price H > Price L)	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.966***	0.966***	0.949***			
	(0.017)	(0.017)	(0.030)			
Private info (β)	−0.213***	−0.297***	−0.302***	−0.285***	−0.336***	−0.338***
	(0.056)	(0.100)	(0.099)	(0.081)	(0.094)	(0.093)
Market (γ)	−0.047	−0.047	−0.048	−0.007	−0.007	−0.001
	(0.073)	(0.074)	(0.075)	(0.135)	(0.133)	(0.134)
Private info × Market (δ)	−0.038	0.018	0.020	−0.042	−0.005	−0.007
	(0.112)	(0.170)	(0.164)	(0.149)	(0.166)	(0.163)
BAF	−0.072	−0.072	−0.088*	−0.127	−0.125	−0.133
	(0.050)	(0.050)	(0.048)	(0.099)	(0.098)	(0.098)
BAF × Private info	0.022	0.130	0.144	0.100	0.167	0.168
	(0.095)	(0.131)	(0.131)	(0.119)	(0.131)	(0.129)
BAF × Market	0.139	0.139	0.153*	0.189	0.187	0.194
	(0.088)	(0.088)	(0.089)	(0.166)	(0.165)	(0.165)
BAF × Market × Private info	−0.131	−0.248	−0.256	−0.190	−0.260	−0.261
	(0.162)	(0.232)	(0.231)	(0.193)	(0.219)	(0.217)
ρ_1		0.168	0.168		0.118	0.123
		(0.132)	(0.127)		(0.097)	(0.088)
ρ_1 × Market		−0.115	−0.117		−0.081	−0.088
		(0.224)	(0.211)		(0.154)	(0.137)
ρ_1 × BAF		−0.219	−0.211		−0.149	−0.131
		(0.210)	(0.201)		(0.145)	(0.134)
ρ_1 × BAF × Market		0.238	0.225		0.154	0.142
		(0.324)	(0.316)		(0.219)	(0.205)
Repetition 1			0.101**			0.104**
			(0.045)			(0.047)
Repetition 2			−0.034			−0.029
			(0.049)			(0.044)
$\beta + \delta$	−0.251	−0.279	−0.282	−0.327	−0.341	−0.345
p-value test $\beta + \delta = 0$	0.009	0.042	0.031	0.006	0.009	0.007
p-value test $\lvert\beta + \delta\rvert \leq \lvert\beta\rvert$	0.365	0.543	0.549	0.390	0.487	0.483
$\gamma + \delta$	−0.086	−0.029	−0.028	−0.048	−0.012	−0.008
p-value test $\gamma + \delta = 0$	0.310	0.851	0.847	0.459	0.903	0.927
Mkt−BDM [Public info, BAF] (τ)	0.092	0.092	0.105	0.182	0.181	0.193
p-value test $\tau = 0$	0.054	0.055	0.018	0.048	0.048	0.032
Mkt−BDM [Private info, BAF] (ϕ)	−0.078	−0.138	−0.131	−0.050	−0.085	−0.076
p-value test $\phi = 0$	0.463	0.360	0.400	0.516	0.412	0.468
Observations	1572	1572	1572	1572	1572	1572

Table D.3: Ranking with bid-ask feedback.

Note: Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	Price asset H			Price asset L		
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	97.729***	97.730***	96.020***	76.183***	76.183***	74.874***
	(2.253)	(2.255)	(2.489)	(0.937)	(0.938)	(1.042)
Private info (β)	−5.717	−6.920	−7.131	6.304	6.710	6.570
	(4.123)	(4.712)	(4.468)	(4.253)	(4.632)	(4.451)
Market (γ)	3.371	3.371	3.269	−5.073*	−5.073*	−5.158*
	(4.989)	(4.994)	(5.030)	(2.865)	(2.868)	(2.890)
Private info × Market (δ)	−14.947**	−14.648*	−14.588*	−8.438	−7.669	−7.583
	(7.233)	(7.756)	(7.471)	(5.777)	(6.486)	(6.354)
BAF	1.202	1.204	0.918	−0.716	−0.718	−0.925
	(5.371)	(5.376)	(5.313)	(3.077)	(3.083)	(3.076)
BAF × Private info	−4.844	−5.336	−4.934	−1.352	−2.194	−1.915
	(6.643)	(7.319)	(7.057)	(5.593)	(6.184)	(5.955)
BAF × Market	6.023	6.023	6.304	5.470	5.471	5.577
	(8.411)	(8.420)	(8.383)	(4.787)	(4.794)	(4.761)
BAF × Market × Private info	−12.844	−12.044	−12.226	−12.605	−13.818	−13.979
	(10.662)	(11.304)	(11.017)	(8.029)	(9.019)	(8.924)
ρ_1		2.434	2.431		−0.801	−0.754
		(2.884)	(2.341)		(2.893)	(2.681)
ρ_1 × Market		−0.625	−0.624		−1.506	−1.532
		(6.367)	(5.908)		(3.826)	(3.456)
ρ_1 × BAF		0.751	1.252		1.708	1.519
		(5.411)	(5.066)		(4.083)	(3.697)
ρ_1 × BAF × Market		−1.392	−2.005		2.400	2.643
		(8.607)	(7.981)		(5.799)	(5.422)
Repetition 1			5.997***			1.545
			(1.773)			(1.152)
Repetition 2			−0.256			2.715**
			(1.226)			(1.062)
$\beta + \delta$	−20.664	−21.568	−21.719	−2.134	−0.959	−1.013
p-value test $\beta + \delta = 0$	0.001	0.000	0.000	0.585	0.833	0.823
p-value test $\lvert\beta + \delta\rvert \leq \lvert\beta\rvert$	0.019	0.029	0.025	0.765	0.812	0.809
$\gamma + \delta$	−11.577	−11.278	−11.319	−13.511	−12.743	−12.741
p-value test $\gamma + \delta = 0$	0.027	0.057	0.041	0.007	0.028	0.024
Mkt−BDM [Public info, BAF] (τ)	9.393	9.393	9.573	0.397	0.398	0.420
p-value test $\tau = 0$	0.165	0.166	0.153	0.918	0.918	0.912
Mkt−BDM [Private info, BAF] (ϕ)	−18.398	−17.299	−17.241	−20.646	−21.090	−21.142
p-value test $\phi = 0$	0.000	0.000	0.000	0.000	0.000	0.000
Observations	1761	1761	1761	1653	1653	1653

Table D.4: Perfect aggregation with bid-ask feedback.
Note: Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	Asset H		Asset L	
	Public information	*Private information*	*Public information*	*Private information*
BDM	1.214	1.435	0.852	1.287
Market	1.389	1.683	1.345	1.658
Difference	−0.175***	−0.247***	−0.493***	−0.370***
Observations	960	960	960	960

Table D.5: Average number of assets traded.
Note: Statistical significance is determined using a t-test between institutions under the same information condition. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

E Additional Figures

E.1 Additional Figures Section 3

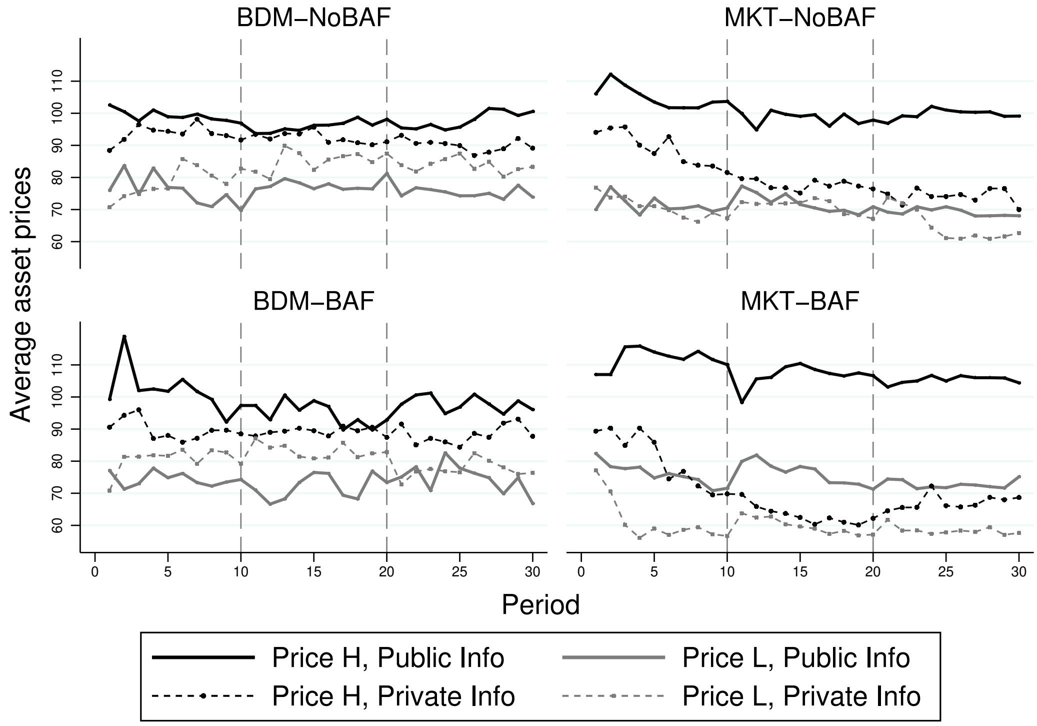

Figure E.1: Average prices of both assets by institution and bid-ask feedback.

E.2 Simulation of Prices if All Traders are Price-sensitive

This subsection contains simulations illustrating the price dynamics in artificial samples of only price sensitive traders. We focus on the sample of price-sensitive traders and ask how prices would have looked like if only the price-sensitive traders were trading. To do so we create a market price $p^{t=1}$ from the bids and asks submitted in the first period $t = 1$, of each repetition, by these traders only. We then simulate a price p^t for all $t > 1$ by using the average bids and asks of price-sensitive traders in periods following a price in the window $[p^{t-1} - 2.5, p^{t-1} + 2.5]$.[2] We do this exercise separately for assets H and L and for both the treatments with public and private information to avoid sample selection biases in this comparison. Figure E.2 reproduces Figure 1 by focusing on market prices in the full sample on the left (this part is identical to the right panel in Figure 1) and in the sample of price-sensitive traders on the right.

[2]The reason that we use this window and not just the price p^{t-1} is that not all simulated prices also occur in the experimental data. The window chosen ensures that at least one observation for each of the simulated prices is generated. Also note that we cannot do this exercise for price-insensitive traders as, by definition, they do not react to past prices.

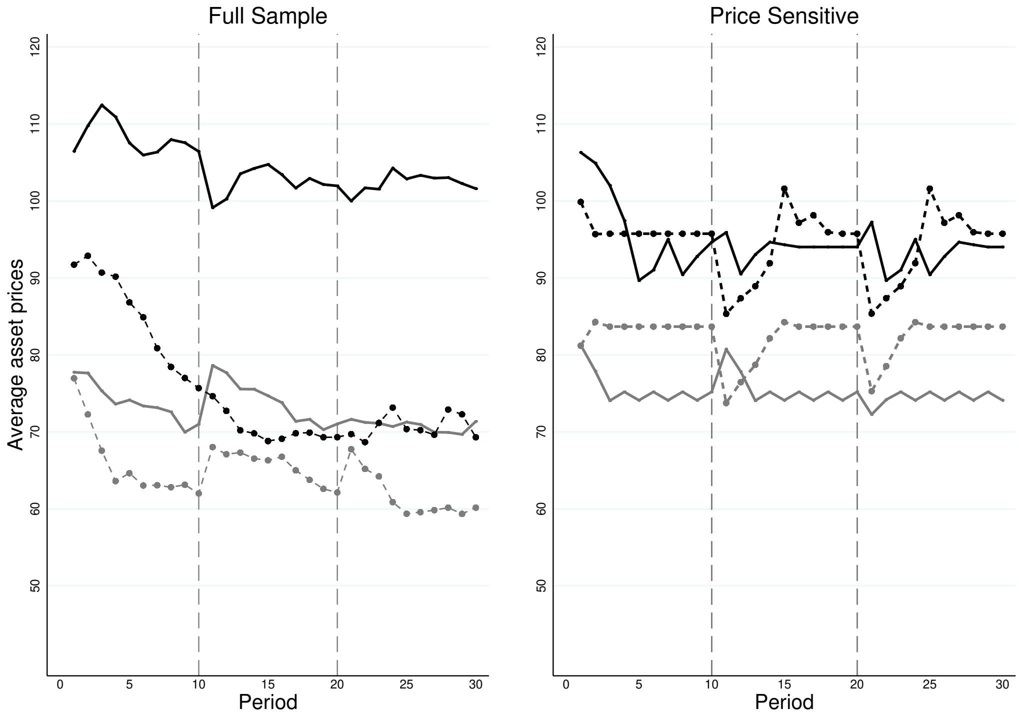

Figure E.2: Actual and simulated average market prices.
Note: Market prices for the whole sample (left panel) and simulated market prices for price sensitive traders only (right panel). Prices of asset H (black) and asset L (grey) are represented under both *Public information* (solid line) and *Private information* (dashed line).

The figure shows that the gap between market prices under public and private information almost disappears for price-sensitive traders for asset H. For asset L the gap persists but in the opposite direction, resembling the BDM treatment shown in Figure 1. Hence despite the fact that the presence of so many price-insensitive traders should make it difficult to learn for those who are price-sensitive, they are able to learn quite well. The predominant effect explaining the failure of information aggregation in the market seems to be the direct effect of price-insensitive traders on the market price. However, price-insensitive traders could also have an indirect effect on others' ability to make correct inference from prices, especially when their presence shifts prices "too much" (outside the range studied in Figure 1). Comparing prices in the public information condition between the full sample and that of price-sensitive traders shows only small differences. This suggests that the two samples differ indeed mostly in their ability to learn from prices and not e.g. in preferences which should also lead to differences with public information.