Disclosure of Verifiable Information under Competition: An Experimental Study*

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Abstract

This study investigates experimentally the revelation of verifiable information in settings with and without seller competition. A higher level of competition has a positive and significant effect on the revelation of information. Throughout, sellers often choose to report a selected set of information and buyers on average account for this by bidding less than the reported average. However, buyers are on average not fully compensating the sellers' selection of evidence and, surprisingly, do particularly poorly in the competitive setting. Further, we investigate the sellers' option to purchase additional information, unobserved by the buyers. Here, the stronger selection upon purchase is counterbalanced by an overall stronger compensation on the buyer side, on average lowering buyers' overbidding compared to the benchmark cases.

Keywords: Verifiable information, competition, conflict of interest

JEL Classification: D40, D83

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1 Introduction

Many times per day, consumers are confronted in advertisements, on packages, and in the media with verifiable product information that producers choose to convey. This might be a microwave oven's "very good" result in an independent test, the certified absence of a chemical in a plastic container, or the scientifically proven tolerance of humans to cholesterol from egg. How useful the presence and in particular the absence of such information is to the consumer often depends on her skill to judge the selection of disclosed information.

In order to investigate both the seller's selection and the appropriateness of consumer's inference, this study establishes a rich experimental framework with varying market and information structure. In particular, the framework enables us to see how seller competition as well as the seller's ability to purchase further verifiable information change the disclosure behavior of sellers and the inference of buyers.

In contrast to cheap talk games, the verifiability of the information provides a clear link to the underlying state of the world, so that such disclosure games often feature full information revelation. However, for this to work, the seminal theoretical treatments emphasize the important role of the buyer's sophistication in the form of "skepticism" in the inference process (Grossman, 1981; Milgrom and Roberts, 1986). Recent experimental studies suggest that the level of sophistication is often low enough to cause harmful inferences on the receiver end of the information (Jin, Luca and Martin, 2016; Benndorf, Kübler and Normann, 2015).

Looking at the examples above, a likely aid in favor of the consumer is the competition between sellers. Indeed, for the case of incomplete sophistication, Milgrom and Roberts (1986) show that competition among parties with strongly-opposed interests reestablishes full information revelation as sellers increase disclosure. Although not studied theoretically, competition and choice of seller might also change buyers' sensitivity to a given level of non-disclosure.

On the other hand, a complicating factor for consumers is usually the uncertainty about the size of the set of verifiable information available to the seller. For example, a favorable subset of verifiable information from nutrition science might shape consumers' view of food items such as eggs more than it should if they think that no other evidence exists.[1] Theoretical studies show that uncertainty about the set of evidence makes information transmission more difficult and can inhibit the unraveling of infor-

[1]For example, in a recent influential meta-study of randomized-controlled trials on the effect of dietary cholesterol on blood cholesterol, 11 out of 12 studies chosen to be analyzed were funded by the egg or fish industry (Griffin and Lichtenstein, 2013). The study disregarded a number of studies with different results (McDougall, 2016).)

mation (Dziuda, 2011; Felgenhauer and Schulte, 2014).

Our experimental framework is designed to investigate in detail seller disclosure and buyer inference in a versatile setting with varying market and information structure. The setup naturally reflects the rich informational setting of product markets as well as the conflict of interest that arises from sellers' incentives to increase buyers' willingness to pay and buyers' incentives to evaluate the product correctly. Sellers have 10 pieces of noisy evidence about the product quality, whose true value only they know precisely. For each one, they can decide whether or not to reveal it. The bidding mechanism gives buyers incentives to bid their true valuation of the product.

One dimension of our 2×2 experimental design relates to the number of sellers in a market, which is 1 in the monopolistic setting M and 4 in the competitive setting C. In the latter setting, buyers choose 1 seller and bid for her product. In the other dimension, the benchmark of 10 pieces of evidence is extended by the sellers' option to purchase for a small fee an additional set of 5 evidences about the product quality. Buyers are aware of the option, but cannot observe whether it was exercised.

Across settings, we find that sellers frequently report only a selected set of evidences which predominantly contains the most favorable evidences. Buyers compensate for that selection, but – in accordance with previous findings of limited sophistication – often to an insufficient degree. Although buyers' correct inferences could impose equality of payoffs, sellers gain more than buyers across all 4 games. Competition increases transparency throughout, albeit not to the level of full disclosure. Despite the increased transparency, buyers compensate surprisingly little for the selection in the competitive settings. Indeed, they almost undo the potential benefit of competition as they earn on average only slightly more when choosing one seller out of four than when not. The influence of the competitive setting on the buyer's inference is thus as important as the sellers' increased disclosure.

The option to purchase additional information on average leads to more evidences being published. However, it does not change the bias in the published evidence because this increase is mostly due to the larger set of evidences to select from. Further, the buyer's skepticism is increased in the monopoly setup, leading to an average bid that almost coincides with the product value. In the competitive setup, the skepticism increases but does not reduce the gap between the bid and the true product value. In both cases, the investment in the additional evidences is worthwhile for sellers.

Overall, we deliver a detailed account of sellers' selection of favorable evidences and buyers' insufficient compensation for it. Full disclosure is rare since the compensatory buyer behavior favors opacity. We see that competition decreases buyers' skepticism surprisingly strongly, while the uncertainty about the available set of evidences

increases it moderately.

Thanks to the nature of our games, we not only observe that skepticism is insufficient in the baseline setting, we further observe that it changes in response to the institutional setting. Our results imply that skepticism is a very useful feature of consumers postures, if applied in the given context correctly. Johnson, Meier and Toubia (2015), for example, study a context in which skepticism is too strong and turns out costly for consumers. Conversely, the persistence of objectively misguided consumer myths arising from business-related information provision, such as the perceived consumption necessity of dairy products for bone strength and for coverage of calcium and protein needs, suggests the existence of areas of insufficient skepticism. Overall, the recent investigations in the topic suggest that consumers have potential to improve the calibration of their skepticism and increase their welfare by dealing better with information that is provided by interested parties.

The paper is structured as follows. Section 2 shows how our study relates and contributes to different strands of literature. Section 3 presents our experimental games and discusses theoretical considerations and the related literature. Section 4 reports the results before section 5 discusses them and concludes.

2 Related Literature

In economics, the understanding of the negative consequences of information asymmetries motivates the investigation of information disclosure (Akerlof, 1970; Viscusi, 1978). In particular, the potential of voluntary disclosure of information is investigated in order to evaluate the need for mandatory disclosure policies (Grossman and Hart, 1980; Grossman, 1981). The prediction of full voluntary disclosure of verifiable information due to unraveling is important, but also dependent on assumptions such as negligible disclosure costs, sufficient competition, or rationality of the consumer (Milgrom, 1981; Milgrom and Roberts, 1986).[2] The endogenous provision of evidence is a characteristic feature of the large class of persuasion games that have been studied extensively (Glazer and Rubinstein, 2001, 2004, 2006; Kamenica and Gentzkow, 2011)

Apart from reasons for incomplete disclosure such as the large amounts of information available to the consumer and strategic considerations not to disclose information (Dranove and Jin, 2010), recent studies have investigated the sophistication of consumers in more detail. Brown, Camerer and Lovallo (2012, 2013) show that the

[2]The large theoretical and experimental literature on cheap talk considers situations in which statements are not bound to relate to the true seller type (Crawford and Sobel, 1982; Cai and Wang, 2006; Wang, Spezio and Camerer, 2010).

preventing of movie previews by critics is associated with lower movie quality, a relationship which is possibly underestimated by customers.

Experimental studies such as ours allow to cleanly study simplified situations in order to understand the underlying mechanism more deeply. Forsythe, Isaac and Palfrey (1989) study information disclosure in blind-bid auctions and see that – as theory predicts – all sellers eventually disclose the true value of their product. The auction format and the consequent strategic considerations make it difficult to clearly identify the role and extent of bidders' sophistication.

In a recent study, Jin, Luca and Martin (2016) experimentally implement a simple stylized disclosure game similar to the original setup in Milgrom and Roberts (1986) which is suitable to cleanly investigate buyers' sophistication. They find that unraveling is incomplete due to a lack of skepticism in buyers, which persists over a large number of rounds and under the provision of detailed feedback. This study is the most detailed investigation of buyer behavior in this standard setting. In slightly different settings, two recent studies support the finding of limited sophistication on the buyer's side. Hagenbach and Perez-Richet (2015) experimentally investigate disclosure when types are not monotonically ordered, a case considered theoretically in Hagenbach, Koessler and Perez-Richet (2014). Benndorf, Kübler and Normann (2015) consider disclosure of information in labor markets with the focus on privacy concerns.

In our study, we extend this literature by proposing a simple and flexible market framework of information disclosure which is directly informative about seller and buyer behavior. Thanks to its flexibility, we can investigate behavior across market and information structures and therefore uncover whether the sophistication of buyers' and its anticipation by sellers changes between them.

Milgrom and Roberts (1986) show that the skepticism of buyers leads to unraveling even in monopolistic markets. Further, competition among sellers with strongly opposed interests is able to compensate for lacking skepticism on the buyer side by the existence of incentives to reveal the truth about products. Empirical studies support the view that competition matters, although it is not clear in which direction. Jin (2005) studies health organizations and shows that competition gives stronger incentives to differentiate in disclosure decisions. Burks, Cuny, Gerakos and Granja (2015) find an increase in competition between banks to raise the level of voluntary disclosure and in particular of negative information.

Our experiment allows us to cleanly observe how competition changes transparency. So far, there is little understanding of whether and how the subjective perception of competition influences beliefs and sophistication of the consumer (Huck and Zhou, 2011).

The possibility of extending the set of evidences relates our study to the literature on strategic experimentation and the trade-off between benefits from exploration and exploitation in bandit problems (Rothschild, 1974; Aghion, Bolton, Harris and Jullien, 1991). Here, the trade-off is simpler since the seller only has to weigh the fixed costs of additional evidence against the transparency and selection benefits of more evidences. In the persuasion context, the buyer's uncertainty with respect to the seller's pool of evidences increases the burden on the evidences and makes partial communication less informative. In a model with an exogenously given set of evidences, Dziuda (2011) shows that persuasion is feasible if the persuader has a high number of favorable evidences. Felgenhauer and Schulte (2014) find the same with private acquisition of new evidences and show that a limit on the number of evidences acquired makes persuasion impossible if the seller's stakes are too high.

Our experiment illuminates sellers' propensity to extend the evidence set and whether this results in increased transparency and/or stronger selection of evidences. Furthermore, we show whether and to which extent the uncertainty increases the skepticism with which evidences are received.

Finally, the determinants and the right level of skepticism is an increasingly covered topic in economics (Johnson et al., 2015). Burdea, Montero and Sefton (2016) show in an experimental study of disclosure of partially verifiable information that receivers' skepticism decreases when they have more control about verification, holding constant the amount of and selection of information revealed. Due to the importance of unbiased information for consumer welfare, we believe that the empirical study of skepticism and its determinants is a topic of high importance.

3 Experimental Games

We investigate the effects of competition and of additional disclosable information in a 2×2 experimental design as shown in table 1. In the first dimension, we implement two market structures, monopoly and competition. In the second dimension, on top of the standard number of 10 evidences, the option to purchase 5 additional evidences exists.

		Monopoly M	Competition C
10 Evidences	(X10)	M10	C10
10+5 Evidences	(X10+5)	M10+5	C10+5

Table 1: 2×2 experimental design.

Monopoly (M10) The most basic game features one seller and one buyer. The seller offers a good of value v, which is uniform-randomly drawn from $[200, 1000]$. While this distribution is common knowledge, the realization is private information to the seller. The seller cannot communicate the true value of the good to the buyer, but he receives a disclosable set E of 10 informative but noisy evidences e_i. The evidences are normally distributed with a standard deviation of $\sigma = 100$ and a mean of $\mu = v$. The number and distribution of evidences is common knowledge. The seller decides which of those evidences, if any, to report to the buyer and thus determines a message $M \subseteq E$. Due to the verifiability of information, the seller cannot change or manipulate the evidences' values. Evidences outside of M remain his private information.

The buyer observes M and bids $b \in [0, 1200]$ to buy one unit of the seller's good. The design of the price mechanism is equivalent to a Becker, DeGroot and Marschak (1964) mechanism: The price for one unit of the good, $p > 0$, is uniform-randomly drawn from the interval $[v - 200, v + 200]$. p is disclosed only after the buyer places her bid. If $b < p$, the transaction does not take place, leaving both parties with a payoff of 0. If $b \geq p$, the transaction takes place and the buyer gets the value v for the price p. The seller obtains the bid b and incurs costs of $c = v - 50$ upon production of one unit.[3]

In summary, the seller's payoff is

$$\Pi_S(b, p, c) = \begin{cases} (b - c) & \text{if } b \geq p, \\ 0 & \text{otherwise.} \end{cases}$$

and the buyer's payoff is

$$\Pi_B(b, p, v) = \begin{cases} (v - p) & \text{if } b \geq p, \\ 0 & \text{otherwise.} \end{cases}$$

It can be shown that – similar to a second price auction – it is a dominant strategy for the buyer to bid what she believes to be the true value of the good. Therefore, this rich setup cleanly implements the natural conflict of interest between the seller that wants the buyer's bid to be as high as possible and the buyer that wants her evaluation of the good to be as accurate as possible.

Competition (C10) The competition game features four sellers and four buyers in each market. Sellers are denoted by $j \in \{A, B, C, D\}$. Each seller offers a good with a value v_j that is independently drawn and private information as before. All aspects of E remain the same. The decisions of each seller to determine $M \subseteq E$ are made

[3] For examples of possible outcomes see Appendix A.1.

simultaneously. Subsequently, the buyers as well as the sellers observe the published evidences of all four sellers.

In contrast to before, buyers choose from which seller to buy before they place their bid b for the chosen seller's product. Prices p_{j^*} and payoffs are determined in the same fashion as before for the transaction between the buyer and her chosen seller j^*. There is no competition among the buyers because a seller can sell up to four units of his good.

Note that the absolute magnitude of v_j is not important to the buyer due to the price mediation. In that sense, the setting is symmetric across sellers. A rational buyer should always decide to purchase from the seller whose good's true value she can estimate most accurately. All sellers have thus the same incentives to reveal evidences.

10+5 Evidences (M10+5 and C10+5) In the X10+5 games, the possibility of purchasing additional evidences is introduced as sellers can – in addition to the initial set of 10 evidences – purchase 5 more evidences for a price of $P_e = 15$ points. The additional evidences are independently distributed in the same way as the initial evidences. Sellers make the purchasing decision after they observe their initial set of 10 evidences. Buyers know that sellers have the possibility to purchase these additional 5 evidences but cannot observe a seller's purchase. Apart from the price P_e which sellers pay upon purchase independently of any transaction, the payoff structure is not different from before.

In the X10+5 games, sellers are given the opportunity to disclose more information to the benefit of the accuracy of the buyers' inference. Depending on the competitive pressure and the price P_e, sellers potentially purchase and disclose additional information. Alternatively, the additional information might lead to stronger selection of disclosed information with buyers not being able to infer whether a purchase was made.

3.1 Theoretical considerations

In order to create a multifaceted and versatile framework of information disclosure, we implement a rich setting with multiple normal signals and the usual conflict of interest between the two market sides. Many of the usual intuitions about voluntary information disclosure as discussed in the literature hold to be true here. Some aspects of the context are more unusual and will deserve particular mentioning.

Compared to other market settings, the price mechanism in form of the Becker-deGroot-Marschak mechanism provides the buyer with incentives to reveal her will-

ingness to pay and thus her precise inferred expected value of the product. Since the reaction to this mechanism is not subject of our investigation, we explain participants that the bidding of their expected value is optimal.[4] This mechanism further allows us to use the price as a mediating factor for the sellers' different v's without it being endogenously determined in the market and thus without introducing non-trivial strategic considerations. The price's mediation implies that a low-v product can be more interesting to the buyer than a high-v product if its value can be more accurately assessed. In competition, firms still compete on a level playing field despite their different v's.

The buyers' way of inferring the true value of the item is important for our study as it determines in large parts the equilibrium outcome. The early literature of Milgrom (1981) and Milgrom and Roberts (1986) emphasizes the importance of buyer sophistication or, in other words, skepticism for the information revelation in the monopolistic setting. In our setting, skepticism in the face of partial disclosure implies the belief that the disclosed information is the most favorable from the seller's perspective. The nature of the evidences further implies that any disclosed information is always useful and allows to form a posterior belief about the true value. The more information is disclosed, the more accurate the belief will be. The possibility that the seller has preferred to reveal k rather than fewer pieces of information because of k particularly favorable realizations might induce the buyer to further reduce the inferred value. In the face of the skeptical buyer's markdown applied to the nominal value of partially disclosed information, the seller maximizes the buyer's bid by revealing all pieces of information if they are not too extreme.

By the nature of the normal draws, extremely low or high realizations of E occur with very small probability. Very low realizations might reduce the chance of a profitable transaction so much that the seller prefers to not disclose or to only disclose low realizations, practically refraining from the initiation of a transaction. Conversely, very high realizations might lead to partial disclosure if the corresponding markdown is believed to be small compared to the position of the outliers.

As in other settings, the partially disclosing seller always benefits from a less skeptical buyer who might have a different belief about the ranking of the disclosed information in E or who does not measure well the extent to which the disclosure depends on the realizations. In this case, full revelation of information will not be achieved and the seller is expected to make an extra profit at the expense of the buyer.

We implement a setting which does not exhibit "strongly opposed interests" as modelled in Milgrom and Roberts (1986) via an additional pricing stage. All disclosure

[4]The instructions state: "Note that in terms of expected payoff, the Buyer benefits most from bidding what he believes the Value of the item is."

incentives are derived from the relative amount of disclosure. Intuitively, this setting is closer to the more commonly observed nature of competition since companies do not frequently reveal information about competitors' products. More importantly, it is interesting to quantify the effect of moderate competition. If it leads to full transparency this is an interesting insight. If it does not, the observation of whether and how buyer sophistication changes in the face of competition with incomplete transparency is equally interesting.

3.2 Experimental Procedures

We conducted the experiments in the Experimental Economics Laboratory at the University of Mannheim (mLab).[5] Across ten sessions, a total of 160 students participated. We recruited all students from the general student population of the University of Mannheim.

At the beginning of each session, the instructions are read out aloud and explained to all participants. Subsequently, subjects have three attempts to complete an understanding test of four comprehension questions about the payoff structure. Those who fail get an individual short briefing on the points they did not understand. Finally, subjects have three minutes to generate draws from normal distributions with standard deviation of 100 in order to get familiar with the kind of draws occurring in the experiment.[6]

Participants play two of the four different games sequentially in each session as shown in table 2. To control for order effects, we vary the order of the games between sessions. Apart from the pilot sessions 1 and 2, each game is played twice as game 1 and game 2 of the session, respectively, following a latin square design.

Each game is played for 10 rounds with two unpaid practice rounds before the start. Participants are randomly matched into markets and randomly assigned the role of seller or buyer. While their market counterparts change randomly in each round, participants keep their role of seller or buyer for 5 rounds. For the last 5 rounds, roles are switched and maintained until the end, while counterparts keep changing.

At the end of each round, the feedback in M games consists of the true item value, the price, the bid, the realization of a transaction and own payoffs. In C games, sellers are further informed about the published messages of all other sellers, their own number of realized transactions and the total amount bid for their good.[7]

Participants are compensated on the basis of the outcomes in the 20 paid rounds.

[5] The experiment was programmed and conducted with the software z-Tree Fischbacher (2007) and subjects were recruited with ORSEE (Greiner, 2004).

[6] Appendix A.3 provides screenshots of the games and of this tool.

[7] In the two pilot sessions, sellers were not able to see what the other sellers decided to report.

Session	Game 1	Game 2	Session	Game 1	Game 2
1	M10	C10	6	C10	C10+5
2	C10	M10	7	M10	M10+5
3	C10	M10	8	C10+5	C10
4	M10+5	C10+5	9	M10	C10
5	C10+5	M10+5	10	M10+5	M10

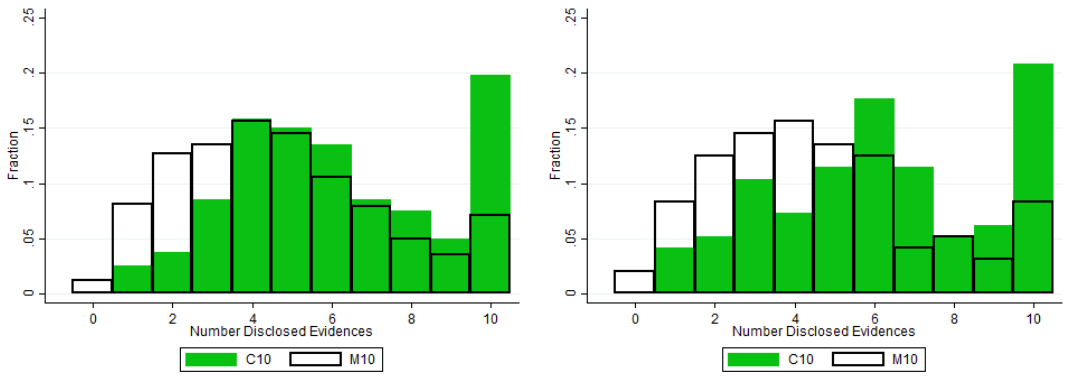
Table 2: Games in 10 sessions.

Individual payoffs are in points and are converted to cash at an exchange rate of 1 EUR for 60 points.[8] The average payoff per subject was 10 EUR. Since payoffs can be zero and even negative in a given round, we established a minimum payoff for the session of 2 EUR which was not binding for any participant.

4 Results

4.1 The effect of competition

A basic indicator of the effect of competition is the number of evidences that sellers disclose, $\#M$. Figure 1a shows that this number is fairly symmetrically distributed around 4 and 5 and shifts slightly right in competition, with a pronounced spike at full disclosure of 10 evidences. Figure 1b shows a slightly stronger difference in later rounds 5+10, suggesting that the competitive pressure leads to even more disclosure over time.[9]



(a) All rounds.

(b) Rounds 5+10.

Figure 1: Number of disclosed evidences, $\#M$.

Throughout games and rounds, panel (a) of table 3 shows significant differences in

[8] All values are restricted to integers and given in experimental points.

[9] By considering the 5th and the 10th round we can check for possible learning effects over time and we make sure that each participant is only accounted for once in each role.

the average number of disclosed evidences between M and C. In M10, over all rounds, 1.47 pieces of evidences less are disclosed compared to C10. The difference is 1.60 in the last rounds of being a seller.

		All rounds			Rounds 5+10		
		M		C	M		C
(a)	10	4.71	***	6.18	4.65	***	6.25
Nr Published evidences		***		***	[0.24]		**
$\#M$	10+5	5.31	***	6.91	5.16	***	7.38
(b)	10	75.05	***	45.61	82.83	***	42.21
Publication bias		[0.94]		[0.49]	[0.59]		[0.49]
$\frac{1}{\#M}\sum_{e_i \in M}(e_i - v)$	10+5	75.40	***	43.15	77.35	***	47.24
N	10	480		480	96		96
	10+5	320		320	64		64

Notes: t-tests for equal means, significance level indicated by: *** p <0.01, ** p <0.05, * p ≤0.1, [$p > 0.1$].

Table 3: Means of number of disclosed evidences and publication bias.

The selection of evidences leads to a "publication bias" of $\frac{1}{\#M}\sum_{i:e_i \in M}(e_i - v)$ because the mean of the disclosed evidences exceeds the true value of the good. Panel (b) of table 3 shows that the reduced disclosure in M leads to a higher publication bias than in C, as expected when sellers publish the highest evidences. This difference is significant across games and even more pronounced in the last rounds between M10 and C10. Overall, the data show that sellers' disclosure in monopoly is quite low but improves significantly due to competition.

The publication bias and sellers' decisions of which evidences to disclose can be analyzed in further detail when reporting it by the number of published evidences $\#M$ as in table 4. Panel (a) gives benchmark magnitudes from simulations of 10000 draws of 10 evidences. The first line indicates the mean difference to the true value for the kth ranked draw, $e_k - v$, and the second indicates the mean publication bias for the k highest draws, $\frac{1}{k}\sum_{i \in \{1,\ldots,k\}}(e_i - v)$.[10]

Panel (b) reports the observed publication bias overall (X10) as well as split up between M10 and C10. Across games, for $k \leq 6$, the magnitudes of the publication bias are below the levels theoretically expected under a "top k evidences" disclosure strategy, and above for $k > 6$. This suggests that for $k \leq 6$, sometimes evidences other than the top k are disclosed, possibly to avoid a transaction after a low realization of evidences. The numbers for $k > 6$ witness a selection into disclosing many evidences

[10]These calculations give a good indication of the expected publication bias, but do not take into account the interval boundaries of v, which influence the rational inference in the experiment. Simulations in Appendix A.2 show that the boundary only matters in a limited range above the lower interval boundary.

as a result of favorable evidence realizations. Otherwise, for example, a publication bias of 12.5 for $k = 10$ in X10 is statistically very unlikely. Furthermore, with one exception, the bias is slightly smaller in C10 than in M10, suggesting that evidences other than the top k are disclosed more often in C10. Similar patterns can be observed for X10+5 in table 10 on page 20.

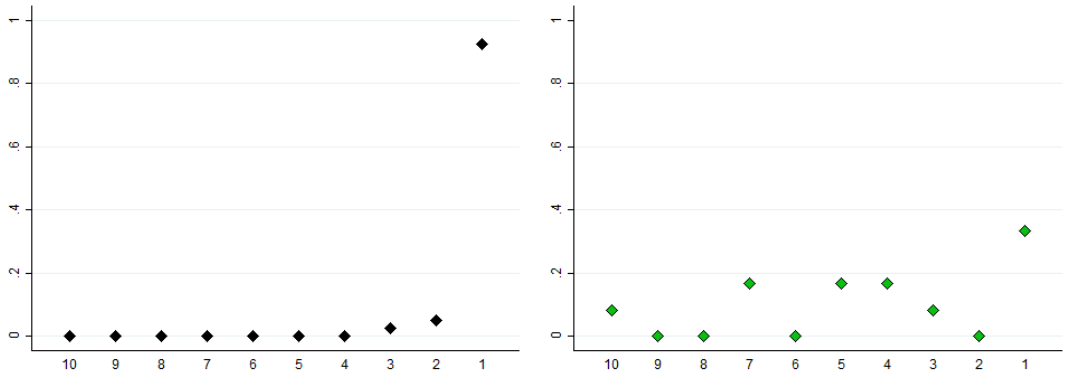
		$\#M$ / Rank k										
		10	9	8	7	6	5	4	3	2	1	0
(a) Mean	k	-154.2	-100.4	-65.8	-37.8	-12.5	12.0	37.5	65.5	100.1	153.7	
	Top k	-0.2	16.9	31.6	45.5	59.4	73.8	89.2	106.4	126.9	153.7	
(b) Pub. bias	X10	⁞12.5	⁞25.8	⁞43.7	⁞50.6	46.8⁞	59.9⁞	70.8⁞	81.4⁞	113.0⁞	117.6⁞	
	N	129	41	60	79	116	142	151	106	79	51	6
	M10	⁞10.4	⁞31.6	⁞53.2	⁞57.1	52.4⁞	65.0⁞	72.7⁞	90.2⁞	117.8·	141.3	
	N	34	17	24	38	51	70	75	65	61	39	6
	C10	⁞13.2	21.7	⁞37.3	44.6	42.5⁞	54.9⁞	69.0⁞	67.3⁞	96.5⁞	40.6⁞	
	N	95	24	36	41	65	72	76	41	18	12	0
(c) Mark-down	X10	-12.3	-13.3	-21.9	-31.6	-35.2	-30.7	-40.7	-58.9	-96.0	-162.2	
	N	208	38	59	85	104	130	133	87	69	41	6
	M10	-39.8	-16.8	-29.5	-35.1	-45.3	-40.2	-59.8	-75.1	-116.2	-170.4	
	N	34	17	24	38	51	70	75	65	61	39	6
	C10	-7.0	-10.5	-16.7	-28.8	-25.4	-19.6	-16.1	-11.0	57.8	-1.8	
	N	174	21	35	47	53	60	58	22	8	2	0

Notes: Average publication bias being ⁞above (below⁞) the simulated confidence interval of N Top k draws is denoted with Maya numerals ⁞ (99%), ⁚ (95%), and · (90%) to the left (right) of the average.

Table 4: Summary by number $\#M$ and rank k of disclosed evidences (X10 games).

To better understand the sellers' strategies, we can take a closer, exemplary look behind these averages. For $k = 1$, consider the publication bias of 141.3 in M10 and the significantly lower value of only 40.6 in C10. Figure 2a shows that almost all sellers in M10 disclose their highest evidence while less than 40% of sellers do so in C10 (2b). The latter figure shows that further strategies used may be to disclose the single evidence that is closest to the true product value or to disclose the lowest evidence to avoid a loss-making transaction. The smaller publication bias in C suggests that competition increases the incidence of such strategies.

The buyer now observes the disclosed evidences with a mean of $\bar{e}^M = \sum_{i:e_i \in M} e_i$ and – in order to bid approximately the true value v – should account for the selection by bidding this mean minus a "markdown", $\bar{e}^M - b$. For correct inferences of v, the buyer's markdown and the seller's publication bias should be the same in absolute value. In C, we always refer in the following to the evidences of the seller j^* chosen by the buyer for a transaction. As expected, panel (a) of table 5 shows that the markdown is lower in competition than in monopoly. Surprisingly, the magnitude of the markdown



(a) M10 ($N = 39$). (b) C10 ($N = 12$).

Figure 2: Fraction of disclosure for k-ranked evidences.

in competition is very small: in C10 it is only 21% of the publication bias, suggesting that buyers are much less skeptical than in monopoly. We can judge the appropriateness of the markdown by calculating the precision of the bid, $b-v$. Panel (b) of table 5 shows some overbidding in M10 but five times the overbidding in C10, the absolute difference remaining stable over time.

		All rounds			Rounds 5+10		
		M		C	M		C
(a)	10	-67.30	***	-13.78	-67.68	***	-9.60
Markdown		[0.46]		[0.42]	[0.77]		[0.63]
$\bar{e}^M - b$	10+5	-73.23	***	-19.28	-72.67	***	-16.44
$\neq 0$	10	***		**	***		[0.33]
	10+5	***		***	***		*
(b)	10	5.63	***	25.22	8.13	[0.22]	26.43
Precision		[0.63]		[0.41]	[0.71]		[0.90]
$b - v$	10+5	1.63	**	19.14	1.30	[0.15]	28.31
$\neq 0$	10	[0.32]		***	[0.45]		***
	10+5	[0.79]		***	[0.93]		**

Notes: t-tests for equal means, significance level indicated by: *** p <0.01, ** p <0.05, * $p \leq$0.1, [$p > 0.1$].

Table 5: Buyers' markdown and bidding precision.

This difference is maintained when conditioning on the observed number of evidences. Panel (c) of table 4 shows the markdown by the number of disclosed evidences and by M10 and C10. The markdown is generally smaller in magnitude than the publication bias. In particular, the minor markdowns even for small $\#M$ are surprising and contribute to the low precision in C10. A very similar picture emerges for the 10+5 settings in panel (e) of table 10 on page 20.

The buyers' overbidding is reflected in an elevated transaction probability and in relatively low payoffs. Panel (a) of table 6 shows that transaction probabilities are mostly above 0.5, significantly so in M10 and C10. Throughout all games, the sellers' payoffs are higher than the buyers' payoffs as seen in panel (b). Importantly, buyers do not benefit from competition as their payoff in C10 is almost the same as in M10.

		M10	M10+5	C10	C10+5
(a) Transaction probability	All rounds	0.54	0.53	0.54	0.52
	$\neq 0.5$	*	[0.32]	***	[0.21]
	N	480	320	480	320
	Rounds 5+10	0.60	0.55	0.59	0.53
	$\neq 0.5$	**	[0.46]	***	[0.38]
	N	96	64	96	64
(b) Payoff All rounds	Seller	58.73	46.53	59.26	50.08
	Δ	18.24	4.45	16.56	8.33
	$\Delta \neq 0$	***	[0.47]	**	[0.23]
	Buyer	40.49	42.08	42.70	41.75
	Seller, gross		51.31		55.23
	Δ		9.23		13.48
	$\Delta \neq 0$		[0.14]		*

Notes: t-tests for equal means, significance level indicated by: *** p <0.01, ** p <0.05, * p ≤0.1, [$p > 0.1$]. "Gross" refers to the payoffs before cost of purchasing additional evidences is subtracted.

Table 6: Transaction probability and payoffs.

In addition to the bidding behavior, in competition, the buyers' choice of seller can discipline the seller. Table 7 reports the difference in disclosure characteristics x_{j^*} between the chosen seller and the other 3 sellers $\frac{1}{3}\sum_{j\neq j^*} x_j$. The chosen seller on average reports 1.51 pieces of evidence more than the average competing seller. A higher number of disclosed evidence thus increases the seller's probability of being selected. The mean and median of the disclosed evidence of the chosen seller are relatively higher in C10, reflecting that their nominal magnitude has a positive and significant effect on the buyer's choice of the seller. That this effect is not significant in C10+5 might be due to the stronger reliance on differences in $\#M_j$. The standard deviation of disclosed evidence is slightly higher for the chosen sellers, an effect that is fully attributable to their higher number of evidences.

Characteristic x	C	C10	C10+5
$\#M_j$	1.51***	1.40***	1.67***
$\bar{e}^{M_j}$	32.24***	49.17***	6.83
SD M_j	7.31***	7.15***	7.55***
Median M_j	30.73***	48.03***	4.78
N	800	480	320

Table 7: Numbers for chosen seller relative to other three sellers.

4.2 The effect of purchasing additional information

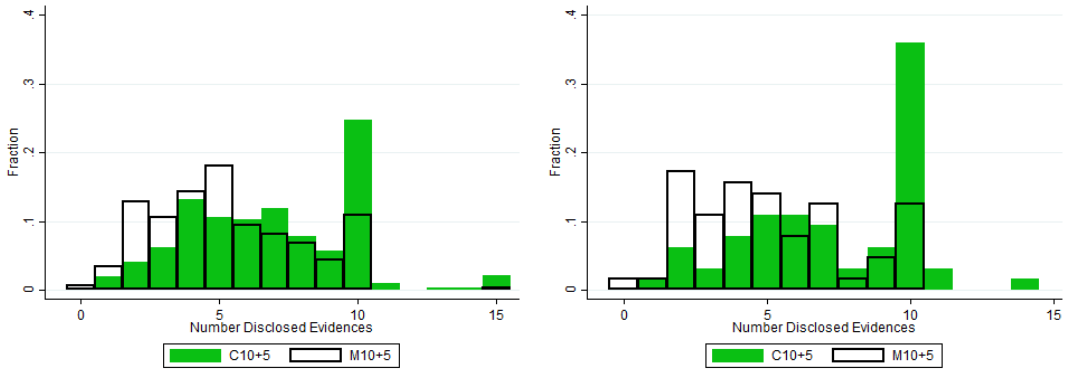
When sellers have the option to purchase additional evidences, panel (a) of table 8 indicates that roughly one-third of the time they do so. Competitive pressure in C10+5 increases this fraction slightly, but not significantly. In the last rounds, this fraction increases throughout, an effect that can be attributed to the payoff benefits that purchasing brings. Panel (b) shows that – across settings – purchasing (+5) leads to a higher payoff than not purchasing further evidences (+0), a difference that even increases over time.

			10+5	M10+5	C10+5
(a)	All rounds		33.13	31.88	34.38
				[0.56]	
Purchase +5 (%)	N		640	320	320
	Rounds 5+10		39.84	35.94	43.75
				[0.47]	
	N		128	64	64
(b)	All rounds	+5	62.16	53.99	69.74
		$\Delta \neq 0$	***	[0.28]	**
Payoff		+0	41.44	43.04	39.78
	Rounds 5+10	+5	72.04	47.00	90.79
		$\Delta \neq 0$	*	[0.96]	**
		+0	38.19	45.76	29.58

Table 8: Sellers' purchasing decisions and average payoffs.

Distributions of disclosed evidences are very similar to the ones before with the difference of a more pronounced fraction of disclosure of 10 evidences across games and rounds, see figure 3. Throughout, very few sellers reveal that they made a purchase by disclosing more than 10 evidences. Panel (a) of table 3 shows average numbers of disclosed evidences in X10+5 games that are throughout roughly 0.5 higher than in the 10 benchmark. Interestingly, this happens at a maintained level of publication bias. The previously observed differences between monopoly and competition in X10 are approximately replicated.

The results so far suggest that purchases were mostly made to enable even more

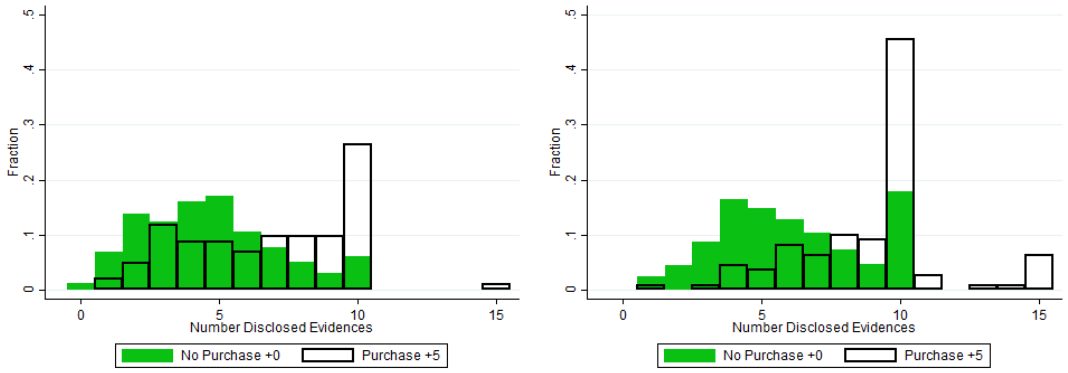


(a) All rounds.

(b) Rounds 5+10.

Figure 3: Number of disclosed evidences, $\#M$, in C10+5 and M10+5.

selection. Figure 4 supports this view graphically and illustrates disclosure as a function of the purchasing decision. Among purchasers, disclosing 10 evidences is most common, by far so in competition. This way they leave the buyer in the unknown about their purchasing decision while still selecting and appearing transparent.ü



(a) M10+5.

(b) C10+5.

Figure 4: Number of disclosed evidence $\#M$ by purchasing decision.

The uncertainty about the seller's pool of evidences makes buyers more skeptical, they increase the size of their markdown compared to the benchmark X10 settings, as table 5 shows. While this leads to an almost perfect precision in the M10+5 game, the markdown change in C10+5 is not sufficient to improve the precision by much. In the last rounds, the precision deteriorates as the markdown – in contrast to the publication bias – is even smaller in absolute terms.

Table 6 shows that the overall payoffs of sellers is reduced in 10+5, in terms of both net payoff including the fee and gross payoff. Since the payoffs of purchasing sellers

are much higher, this loss comes from non-purchasing sellers. The payoffs of buyers are not changed much and differences between buyers' and sellers' net payoff are not significant anymore.

Fixed-effects panel regressions in table 9 summarize how the behavior of sellers ($\#M$, Pub. bias) and of buyers depend on game characteristics. Importantly, the effect of competition on the number of disclosed evidences and the publication bias is clearly and significantly emerging. Further, the increase in markdown due to competition is larger in absolute terms than the decrease of the publication bias.

Regressions (1) to (4) show that the effect of X10+5 is strongly influenced by the possibility to purchase additional evidences. While X10+5 has a positive, non-significant effect on the number of disclosed evidences, controlling for the purchasing decision in regression (2) reverses this sign. The effect of subjects' role-switching is minor as the buyers' markdown improves only slightly and marginally significantly in rounds 6-10 (p-value=0.12, regression 5). Regressions (1)-(4) further show that a higher value v increases the number of disclosed evidences significantly and reduces the publication bias. At the same time, a higher absolute value of observed evidences $\bar{e}^M$ decreases the markdown (regression 5).[11] Further, the characteristics of the set of 10 evidences E are relevant. A higher mean of the evidences relative to the value increases significantly the number of reported evidences. Still, this higher mean and a higher standard deviation lead to an increased publication bias. This reflects the selection into more disclosure when E consists of high evidences in the high ranks.[12]

[11] This relationship exists close to the lower bound of v as well as over the whole interval. See Appendix A.2 for a discussion of the optimal increase in the markdown close to v's lower bound.

[12] Neither gender nor an economics-related field of study have a significant effect on any of these dependent variables.

	$\#M$	$\#M$	Pub. bias	Pub. bias	Markdown
	(1)	(2)	(3)	(4)	(5)
Competition	0.87***	0.87***	-22.58***	-22.53***	40.32***
	(0.21)	(0.21)	(3.82)	(3.82)	(7.80)
X10+5	0.31	-0.30	7.23	2.05	3.43
	(0.27)	(0.26)	(5.81)	(6.66)	(11.68)
Competition	-0.16	-0.20	6.69	6.39	-9.82
$\times$ X10+5	(0.29)	(0.28)	(5.56)	(5.55)	(10.25)
Rounds 6-10	-0.13	-0.03	-0.46	0.37	-9.52
	(0.20)	(0.19)	(3.37)	(3.37)	(6.13)
Value v	0.0007***	0.0007***	-0.01*	-0.01**	
	(0.00)	(0.00)	(0.00)	(0.00)	
Mean $E - v$	0.01***	0.01***	0.67***	0.67***	
	(0.00)	(0.00)	(0.04)	(0.04)	
SD E	-0.01***	-0.01***	0.60***	0.60***	
	(0.00)	(0.00)	(0.05)	(0.05)	
Purchase +5		1.79***		15.21***	
		(0.27)		(4.93)	
$\bar{e}^M$					-0.09***
					(0.01)
Constant	5.43***	5.42***	12.20*	12.04*	2.08
	(0.31)	(0.30)	(6.93)	(6.91)	(9.60)
N	1600	1600	1592	1592	1592
Subjects	160	160	160	160	160
R^2 overall	0.10	0.19	0.26	0.26	0.11

Notes: Panel fixed-effects regressions. Cluster-robust standard errors (subject level) are provided in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level. In 7 instances, sellers choose $\#M = 0$ and do not feature in (3)-(5).

Table 9: Determinants of $\#M$.

		$\#M$ / Rank k															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(a)	k	-173.5	-124.7	-94.7	-71.4	-51.4	-33.4	-16.3	0.2	16.7	33.7	51.7	71.7	95.0	125.1	173.8	
Mean	Top k	0.2	12.6	23.1	33.0	42.4	51.8	61.3	71.0	81.1	91.8	103.5	116.4	131.3	149.5	173.8	
(b) Pub. bias Purchase	X10+5	:7.4	-2.5	-10.6⁝		52.5	53.7	46.9⁝	51.5⁝	70.2⁝	74.0⁝	89.0⁝	77.2⁝	134.7	125.6	166.6	
	N	8	1	1	0	3	77	20	21	17	16	13	14	13	5	3	
	M10+5	:20.2					:59.8	49.2⁝	59.6⁝	79.2	93.4	95.6	108.4	138.7	125.6	143.8	
	N	1	0	0	0	0	27	10	10	10	7	9	9	12	5	2	
	C10+5	5.5	-2.5	-10.6⁝		52.5	50.5	44.7⁝	44.1⁝	57.4⁝	58.9⁝	74.0⁝	21.1⁝	86.3·		212.1	
	N	7	1	1	0	3	50	10	11	7	9	4	5	1	0	1	
(c)	k						-154.2	-100.4	-65.8	-37.8	-12.5	12.0	37.5	65.5	100.1	153.7	
Mean	Top k						-0.2	16.9	31.6	45.5	59.4	73.8	89.2	106.4	126.9	153.7	
(d) Pub. bias No Purchase	X10+5						⁝6.3	:27.8	32.3	41.5·	43.5⁝	53.2⁝	62.2⁝	75.4⁝	102.8⁝	113.7⁝	
	N						37	12	26	47	47	79	74	41	49	14	2
	M10+5						-9.5·	24.4	21.3:	40.4	61.6	61.1⁝	79.2:	78.8⁝	111.5:	153.4	
	N						8	4	12	16	23	49	37	22	36	9	2
	C10+5						⁝10.6	:29.6	:41.8	42.0	26.1⁝	40.3⁝	45.2⁝	71.5⁝	78.8⁝	42.2⁝	
	N						29	8	14	31	24	30	37	19	13	5	
(e) Markdown	X10+5	4.1	43.8	-69.9		-5.5	-27.1	-23.1	-25.3	-39.4	-47.3	-60.3	-50.6	-78.5	-99.1	-119.7	
	N	17	3	2	0	6	159	34	52	54	47	79	76	47	48	14	2
	M10+5	0.9					-26.1	-34.2	-19.8	-73.6	-49.7	-74.7	-80.0	-95.7	-120.9	-166.7	
	N	1	0	0	0	0	35	14	22	26	30	58	46	34	41	11	2
	C10+5	4.3	43.8	-69.9		-5.5	-27.4	-15.4	-29.3	-7.6	-43.1	-20.5	-5.5	-33.4	28.8	52.8	
	N	16	3	2	0	6	124	20	30	28	17	21	30	13	7	3	

Notes: Average publication bias being ⁝above (below⁝) the simulated confidence interval of N Top k draws is denoted with Maya numerals ⁝ (99%), : (95%), and · (90%) to the left (right) of the average.

Table 10: Summary by number $\#M$ and rank k of disclosed evidences (X10+5 games).

5 Conclusion

In this study, we establish a rich experimental market framework to study disclosure of verifiable information by interested parties as well as the inference behavior on the consumer side. The setup cleanly implements the natural conflict of interest inherent in any seller-buyer interaction without adding further confounding strategic elements. In particular, changes in the market and in the informational structure allow us to investigate behavioral responses to those institutional variations. In the monopolistic baseline setting, we replicate previous findings of insufficient skepticism on the buyer's side and resulting incomplete disclosure on the seller side.

Competition raises the amount of information disclosed and should help consumers' inference. However, the skepticism of buyers turns out so low that it nearly compensates the potential payoff improvements and leaves buyers as well off as under monopoly. This suggests that buyers feel protected by competition to an extent that they act less cautiously.

Introducing the possibility for sellers to purchase additional evidences creates uncertainty about the amount of information available to the sellers. Buyers account for this uncertainty and bid more skeptically, particularly in monopoly.

The suggested framework can be extended in order to understand further influences on behavior that have been discussed theoretically. For example, it would be interesting to investigate disclosure about outside options that sellers know more about than consumers. Milgrom and Roberts (1986) predict that cigarette companies would not reveal information about the benefits of not consuming any cigarettes. Further interesting aspects could be partial verifiability and costly influence on the realization of evidence. For example, Lesser et al. (2007) show in the context of nutrition-related research that funding sources are predictable of the study outcome.

The recent investigations of skepticism in the literature show that it is an important feature of consumer behavior which can be very useful when it is calibrated well to the disclosure behavior and driving interests. We believe that it will be a very relevant and important field of study which can increase consumer welfare significantly. This is especially true for products whose full effects on welfare are understood only via complex investigations, such as cigarettes and food items.

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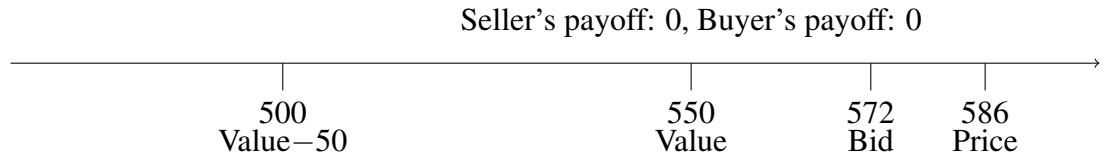
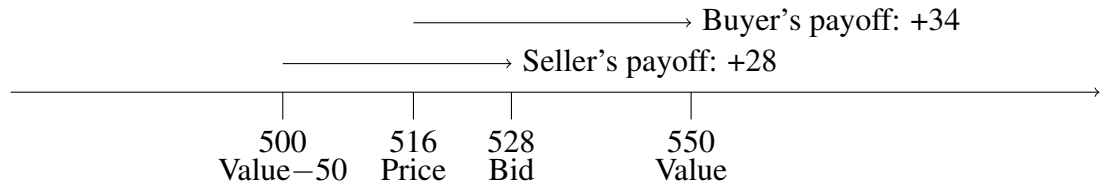
A Appendix

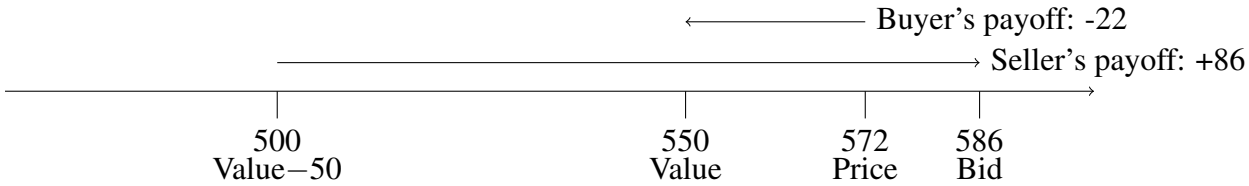
A.1 Examples of Possible Outcomes



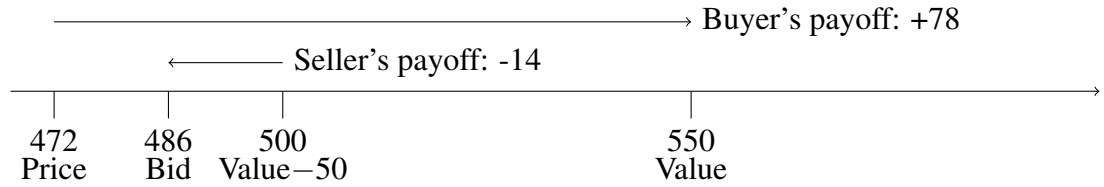
(a) Price>Bid: No transaction. Payoffs=0.



(b) Transaction scenario 1.



(c) Transaction scenario 2.



(d) Transaction scenario 3.

Figure 5: Transaction scenarios.

A.2 Simulation of Publication Bias

The benchmark values of the difference between the kth-highest evidence and the true value v in the first line of panel (a) in table 4 do not take into account that $v \in [200, 1000]$. In order to analyze the effect of such boundaries on the inference, we simulate the distribution of the true value given the realization of a certain kth highest evidence with the help of a set of 10000 draws of 10 evidences for each true value between 200 and 1000.

For each realization of kth highest evidence between 200 and 500, we calculate the difference between the true means in this simulation and the benchmark value. If the deviation is different from 0 the boundaries for the true values are still at play, causing a skewed distribution of the true means underlying the observed kth evidence. The results of these simulations are depicted in figure 6.

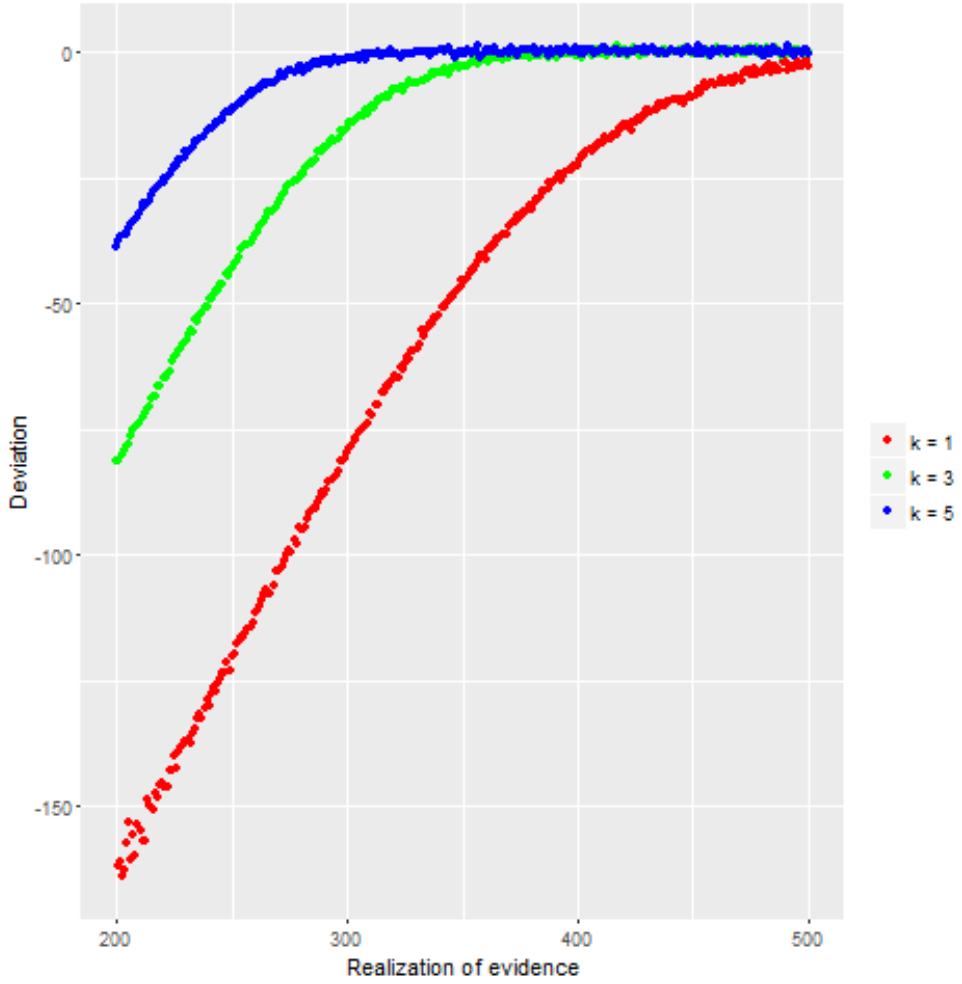


Figure 6: Deviation from benchmark value for realized levels of the kth evidence close to the lower bound of v, 200.

A.3 Screenshots

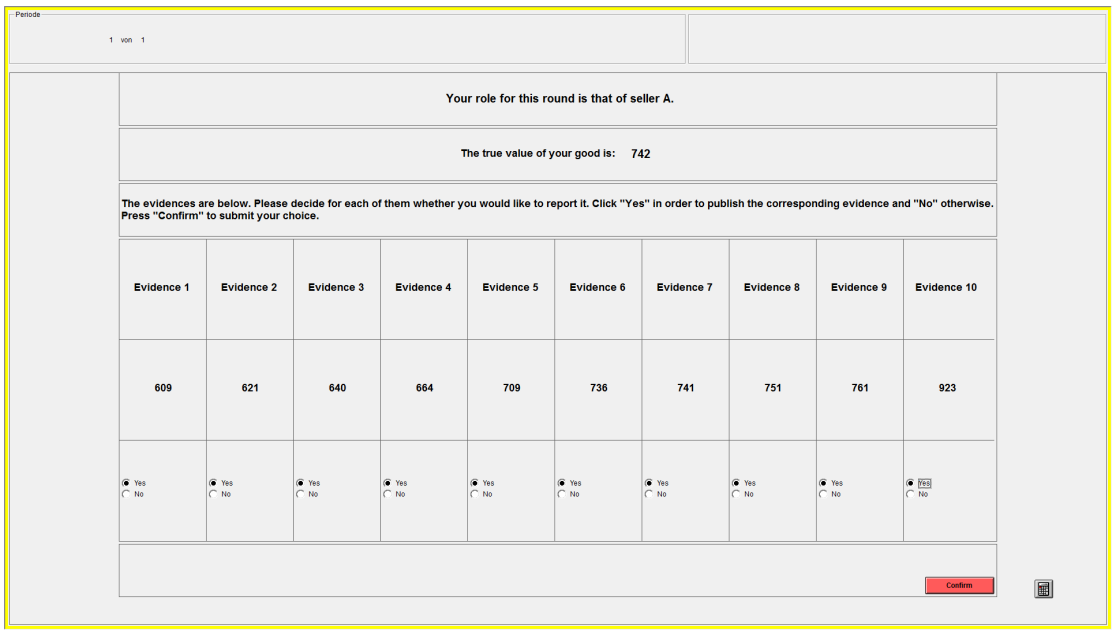


Figure 7: Sellers' screen in C10.

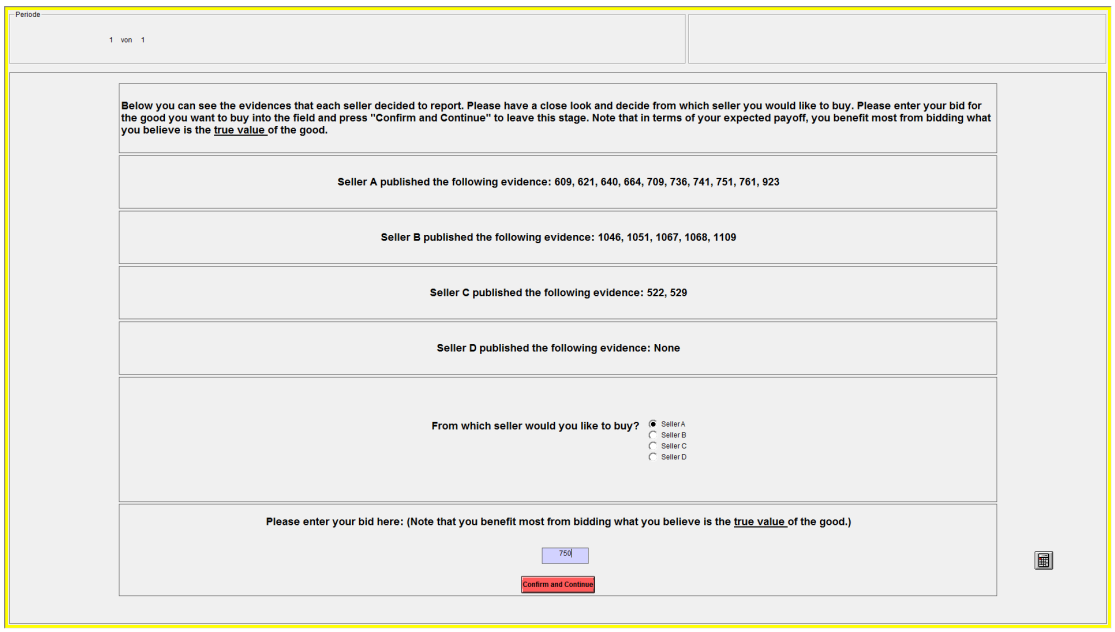


Figure 8: Buyers' screen in C10.

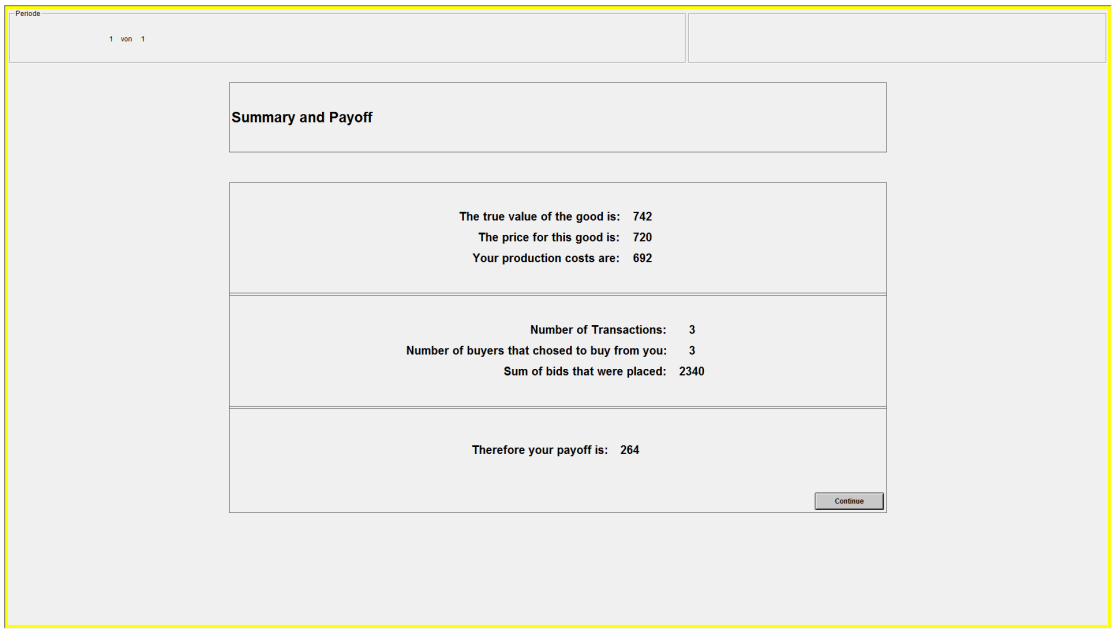


Figure 9: Sellers' feedback screen in C10.

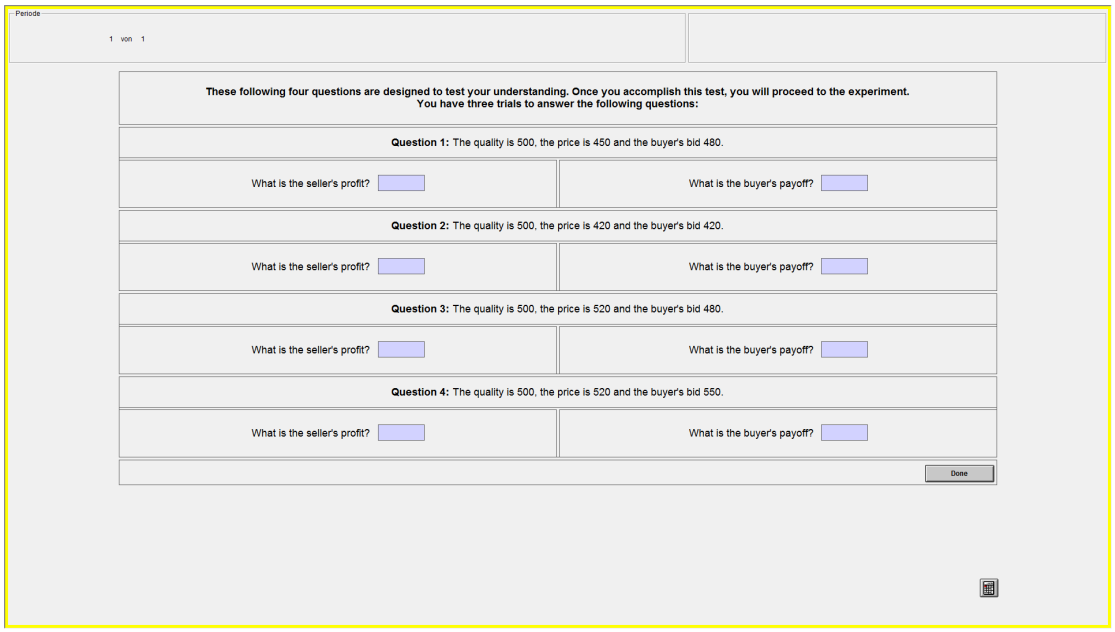


Figure 10: Screen of the understanding test.

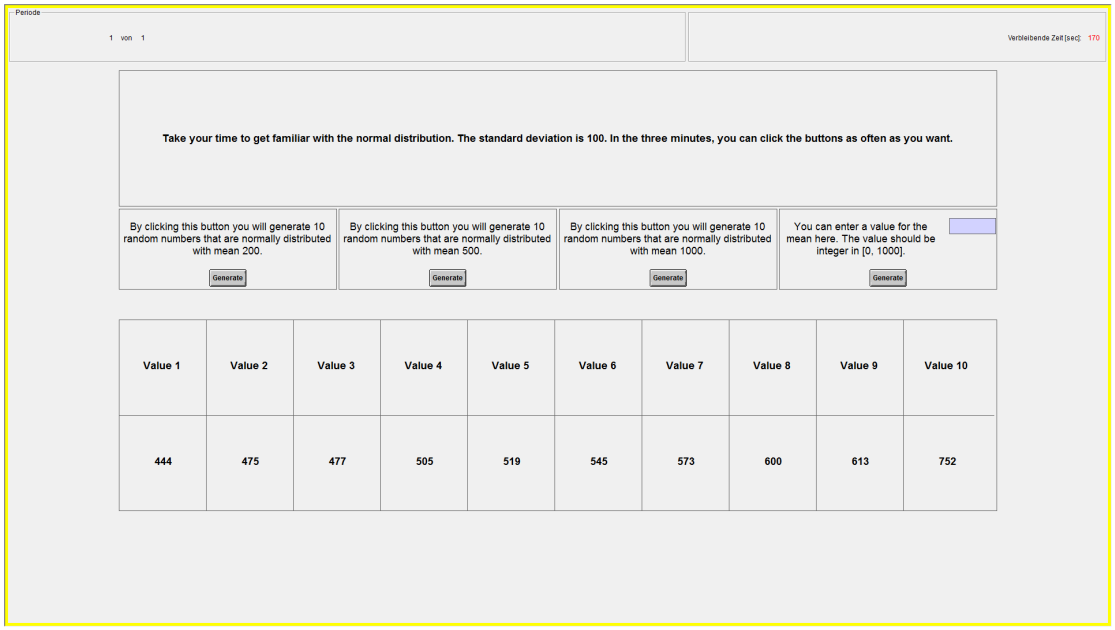


Figure 11: Tool to generate 10 draws from a normal distribution $N(v, 100)$, $v \in [0, 1000]$. Here, $v = 500$.

B Instructions

B.1 Instructions for C10 - M10

You are about to participate in an experiment in a market setting. You may earn a considerable amount of money. The amount you earn will depend on your decisions and the decisions of others, so please follow the instructions carefully. All that you earn is yours to keep, and will be paid to you in private, in cash, at the end of today's session.

During the experiment your payoffs are denominated in points. Your point earnings will be converted to cash at the end of today's session at an exchange rate of 60 points = 1 Euro. No matter what your payoffs are in the experiment, you will be paid at least 2 Euro.

It is important to us that you remain silent and do not look at other people's screens. If you have any questions or need assistance of any kind, please raise your hand, and an experimenter will come to you. If you talk, exclaim out loud, etc., you will be kindly asked to leave.

The experiment consists of two parts (**Part I**, **Part II**) which are independent of each other. Each of these parts, in turn, consists of up to 12 rounds.

Part I

In this part of the experiment, four Sellers and four Buyers form a market. The Seller knows the Value (in points) of his/her good but cannot report it to the Buyers. The Seller has requested 10 external test institutes to officially evaluate the Value of the good and can indeed report these 10 official "Evidences" about the Value to the Buyers. The external Evidences are informative about the good's Value but noisy. In particular, they follow a normal (Gaussian) distribution around the Value with a constant standard deviation of 100. The standard deviation measures the dispersion of the Evidences, how far away they are from the Value. Figure 12 shows that Evidences are more likely to be close to the Value than far away. You will be able to get familiar with this distribution later.

At the beginning of a round, each Seller is informed about the true Value of her/his good. The true Value lies between 200 and 1000 points, each Value level in this interval is equally likely. As we said, the Seller cannot report the true Value to the Buyers, but she/he can choose for each of the 10 Evidences whether to report it to the Buyers or not. The Seller cannot change or manipulate the Evidences in any way.

After the Sellers' choice, the Buyers will see the reports of all 4 Sellers. Sellers as well will be informed about the reports of the other Sellers. Before the Buyers place

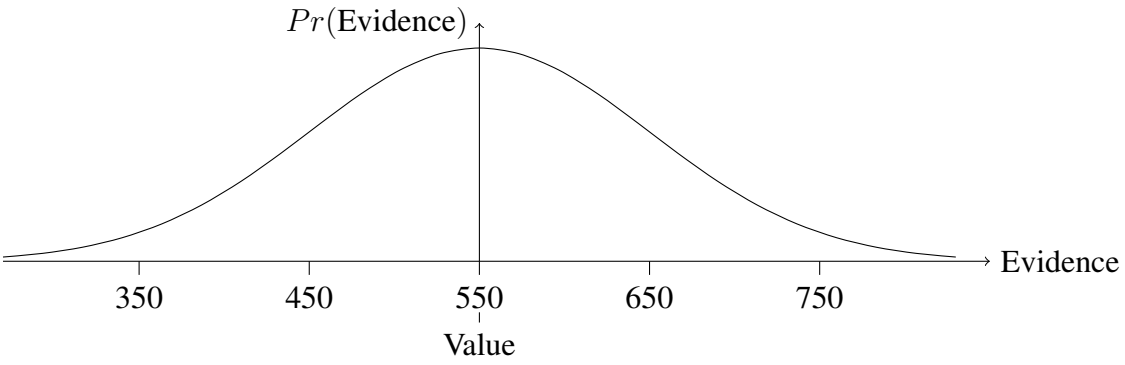


Figure 12: Normal probability distribution with a Value of 550 and a standard deviation of 100, indicating the probability of Evidences.

their bid, they have to chose from which Seller to buy. For the chosen Seller's good, the Buyer places a Bid. The Bid has to be an integer value between 0 and 1200.

When does the transaction take place? The computer generates randomly a Price of the Seller's good. Neither Seller nor Buyer will be informed about the Price when they take their decisions. The Price takes integer values between the Value minus 200 and the Value plus 200, with each Price level being equally likely (figure 13). The transaction takes place whenever the Buyer's Bid is greater than or equal to the Price.

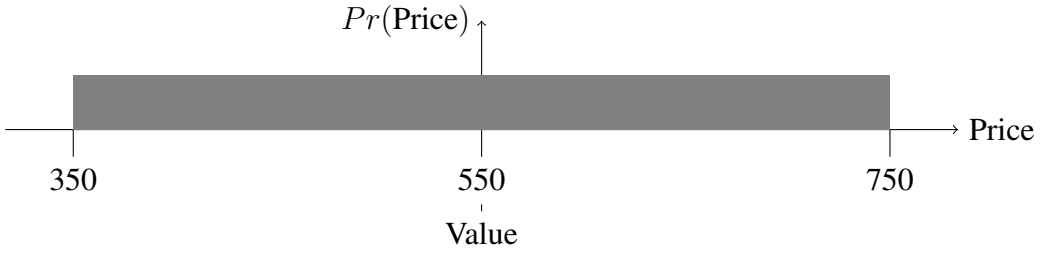


Figure 13: Price distribution around the Value of 550.

So, in our example, a Bid of

1. 349 will never lead to a transaction, since the Price is certainly above.

2. 750 will always lead to a transaction since the Price is certainly below or the same.

3. 550 corresponding to the Value will lead to a transaction with 50% chance.

How are the Seller's and the Buyer's payoff determined? First, if no transaction takes place, both Seller and Buyer get a payoff of 0 points. If a transaction takes place, as we said depending on the Buyer's Bid and the random Price, the Seller produces the good at the cost of the Value minus 50. The Seller sells one item of their good to each

Buyer whose Bid exceeds the Price. A Seller might sell to none, one, two, three, or four Buyers. The Seller's payoff per transaction at the end of the round will be the Bid placed by the Buyer minus the cost:

$$\textbf{Payoff}_{\textbf{Seller}} = \textbf{Bid}_{\textbf{Buyer}} - (\textbf{Value} - \textbf{50}).$$

The Buyer's payoff is the true Value of the good minus the Price:

$$\textbf{Payoff}_{\textbf{Buyer}} = \textbf{Value} - \textbf{Price}.$$

Notice that a Bid equal to the Value will ensure the Buyer to never make losses. If the Price was higher than the Bid=Value, the transaction would not take place. Recall from 3. that under a Bid=Value, the transaction does not take place half the times. Further, note that in terms of expected payoff, the Buyer benefits most from bidding what he believes the Value of the item is. The bids are limited to be between 0 and 1200. Figures 14a to 14d present various scenarios.

Part I of this experiment consists of 2 practice rounds and 2 blocks of 5 experiment rounds. At the beginning of each round, you will be informed about the randomly chosen role (Seller or Buyer) that you take. You keep this role in the first block of 5 rounds, and take on the other role in the second block. You will keep the same role within a block, but you will face randomly chosen market counterparts. Throughout, four Sellers and four Buyers will form a market.

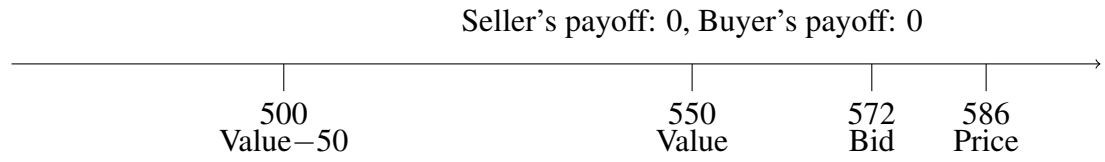
In order to participate in the experiment, you will go through a brief understanding test. Here and throughout the experiment, you can access a calculator via a button in the right bottom corner of your screen. Once everybody accomplishes this test, you can get more familiar with the normal distribution with standard deviation of 100. For that purpose, you will have three minutes to simulate as often as you want the process of generating 10 Evidences for different Values. The experiment will start with the 2 practice rounds that are not paid. Finally, you proceed to the paid rounds.

Are there any questions? If not, please turn to your screens and follow carefully the instructions there.

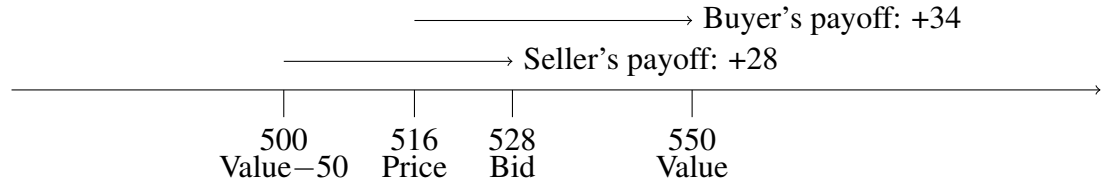
Part II

You are about to start Part II of the experiment, which consists of no practice rounds and 2 blocks of 5 experiment rounds. Like before, in each block of 5 rounds you will take the same role, and you will face randomly chosen market counterparts.

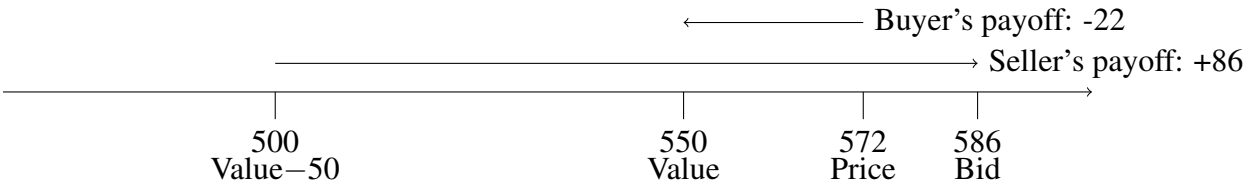
In this part, one market will consist of one Seller and one Buyer. Just like before, the Seller first chooses the Evidences s/he wants to report. The Buyer will observe only



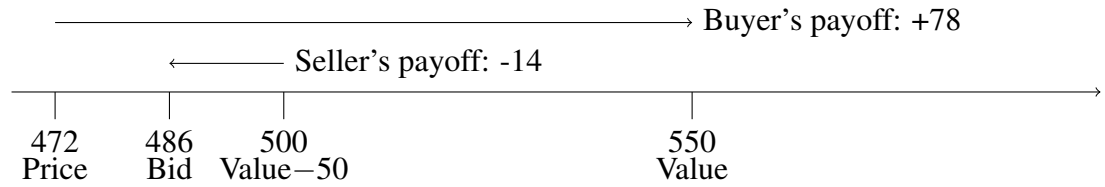
(a) Price>Bid: No transaction. Payoffs=0.



(b) Transaction scenario 1.



(c) Transaction scenario 2.



(d) Transaction scenario 3.

Figure 14: Transaction scenarios.

the Evidences that the Seller chose to report. S/He then places a bid for the good. The Buyer's and the Seller's payoffs are determined in the same fashion as before.

B.2 Instructions for M15 - C15

You are about to participate in an experiment in the economics of decision making in a market setting. You may earn a considerable amount of money. The amount you earn will depend on your decisions and the decisions of others, so please follow the instructions carefully. All that you earn is yours to keep, and will be paid to you in private, in cash, at the end of today's session.

During the experiment your payoffs are denominated in points. Your point earnings will be converted to cash at the end of today's session at an exchange rate of 60 points = 1 Euro. No matter what your payoffs are in the experiment, you will be paid at least 2 Euro.

It is important to us that you remain silent and do not look at other people's screens. If you have any questions or need assistance of any kind, please raise your hand, and an experimenter will come to you. If you talk, exclaim out loud, etc., you will be kindly asked to leave.

The experiment consists of two parts (**Part I**, **Part II**) which are independent of each other. Each of these parts, in turn, consists of up to 12 rounds.

Part I

In this part of the experiment, one Seller and one Buyer form a market. The Seller knows the Value (in points) of his/her good but cannot report it to the Buyer. The Seller has requested 10 external test institutes to officially evaluate the Value of the good and can indeed report these 10 official "Evidences" about the Value to the buyer. Additionally, the Seller has the possibility to ask 5 more test institutes to evaluate the Value of his/her good at a package price of 15 points. These 5 additional Evidences can also be reported to the Buyer. The external Evidences are informative about the good's Value but noisy. In particular, they follow a normal (Gaussian) distribution around the Value with a constant standard deviation of 100. The standard deviation measures the dispersion of the Evidences, how far away they are from the Value. Figure 15 shows that Evidences are more likely to be close to the Value than far away. You will be able to get familiar with this distribution later.

At the beginning of a round, the Seller is informed about the true Value of her/his good. The true Value lies between 200 and 1000 points, each Value level in this interval is equally likely. After observing the initial 10 Evidences, the Seller has the opportunity to get 5 additional Evidences for a price of 15 points. As we said, the Seller cannot report the true Value to the Buyer, but s/he can choose for each of the 10 (or 15) Evidences whether to report it to the Buyer or not. The Seller cannot change or manipulate

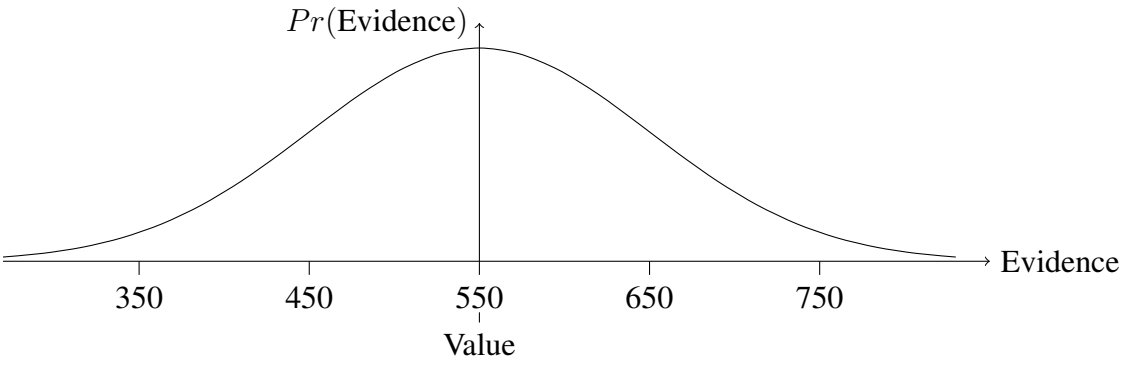


Figure 15: Normal probability distribution with a Value of 550 and a standard deviation of 100, indicating the probability of Evidences.

the Evidences in any way.

After the Seller's choice, the Buyer observes only the Evidences that the Seller chose to report. S/He then places a Bid for the good. The Bid has to be an integer value between 0 and 1200.

When does the transaction take place? The computer generates randomly a Price of the Seller's good. Neither Seller nor Buyer will be informed about the Price when they take their decisions. The Price takes integer values between the Value minus 200 and the Value plus 200, with each Price level being equally likely (figure 16). The transaction takes place whenever the Buyer's Bid is greater than or equal to the Price.

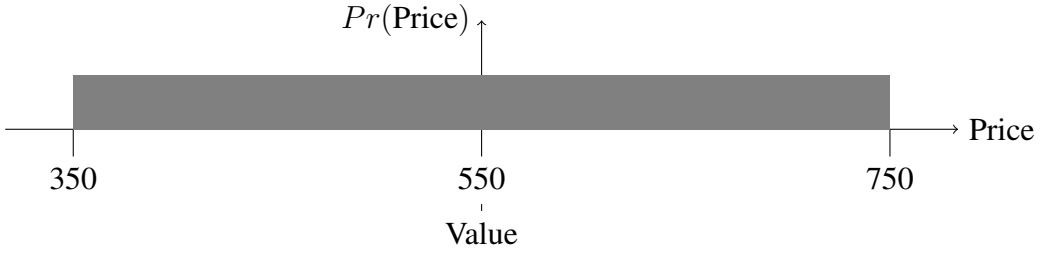


Figure 16: Price distribution around the Value of 550.

So, in our example, a Bid of

1. 349 will never lead to a transaction, since the Price is certainly above.
2. 750 will always lead to a transaction since the Price is certainly below or the same.
3. 550 corresponding to the Value will lead to a transaction with 50% chance.

How are the Seller's and the Buyer's payoff determined? First, if no transaction takes place, the Buyer gets a payoff of 0 points. In case the Seller didn't purchase

additional Evidences her/his payoff is 0 points as well. Otherwise her/his payoff is -15 points. If the transaction takes place, as we said depending on the Buyer's Bid and the random Price, the Seller produces the good at the cost of the Value minus 50. The Seller's payoff at the end of the round will be the Bid placed by the Buyer minus the cost (production cost and possibly cost from purchasing 5 additional Evidences):

$$\textbf{Payoff}_{\textbf{Seller}} = \begin{cases} \textbf{Bid}_{\textbf{Buyer}} - \textbf{(Value} - \textbf{50)} & \text{without purchase of additional Evidences} \\ \textbf{Bid}_{\textbf{Buyer}} - \textbf{(Value} - \textbf{50)} - \textbf{15} & \text{with purchase of additional Evidences} \end{cases}$$

The Buyer's payoff is the true Value of the good minus the Price:

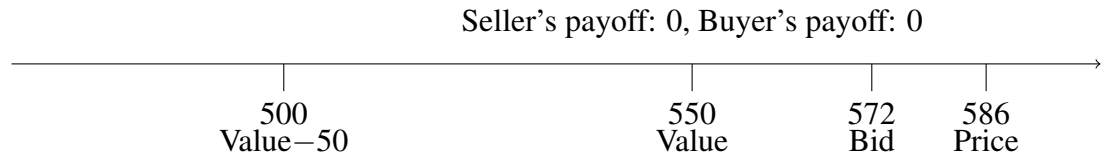
$$\textbf{Payoff}_{\textbf{Buyer}} = \textbf{Value} - \textbf{Price.}$$

Notice that a Bid equal to the Value will ensure the Buyer to never make losses. If the Price was higher than the Bid=Value, the transaction would not take place. Recall from 3. that under a Bid=Value, the transaction does not take place half the times. Further, note that in terms of expected payoff, the Buyer benefits most from bidding what he believes the Value of the item is. The bids are limited to be between 0 and 1200. Figures 17a to 17d present various scenarios. In these scenarios the purchasing of additional Evidences is not considered.

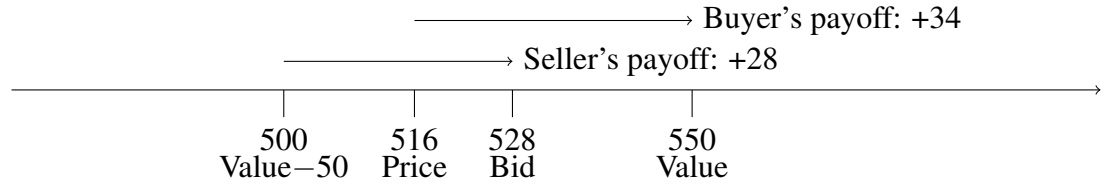
Part I of this experiment consists of 2 practice rounds and 2 blocks of 5 experiment rounds. At the beginning of each round, you will be informed about the randomly chosen role (Seller or Buyer) that you take. You keep this role in the first block of 5 rounds, and take on the other role in the second block. You will keep the same role within a block, but you will face randomly chosen market counterparts. Throughout, one seller and one buyer will form a market.

In order to participate in the experiment, you will go through a brief understanding test. Here and throughout the experiment, you can access a calculator via a button in the right bottom corner of your screen. Once everybody accomplishes this test, you can get more familiar with the normal distribution with standard deviation of 100. For that purpose, you will have three minutes to simulate as often as you want the process of generating 10 Evidences for different Values. The experiment will start with the 2 practice rounds that are not paid. Finally, you proceed to the paid rounds.

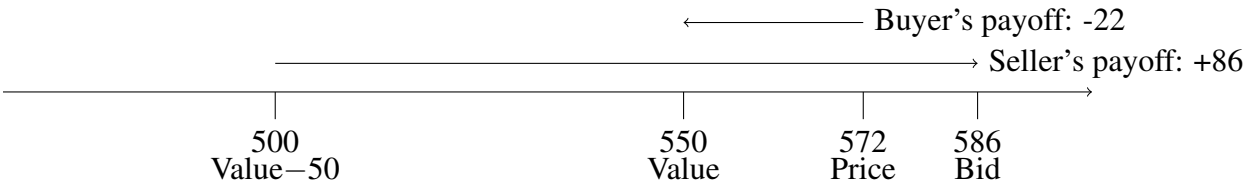
Are there any questions? If not, please turn to your screens and follow carefully the instructions there.



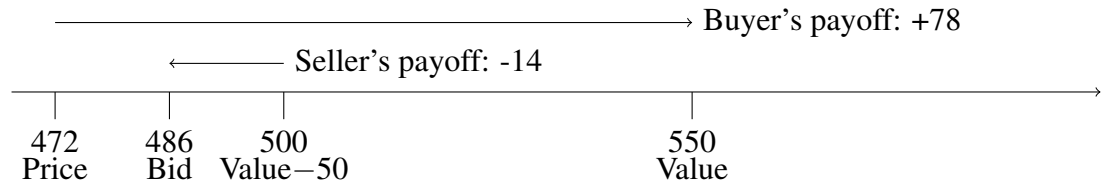
(a) Price>Bid: No transaction. Payoffs=0.



(b) Transaction scenario 1.



(c) Transaction scenario 2.



(d) Transaction scenario 3.

Figure 17: Transaction scenarios.

Part II

You are about to start Part II of the experiment, which consists of no practice rounds and 2 blocks of 5 experiment rounds. Like before, in each block of 5 rounds you will take the same role, and you will face randomly chosen market counterparts.

In this part, one market will consist of 4 Sellers and 4 Buyers. Just like before, the Sellers first decide whether they want to purchase 5 additional Evidences. Then they choose the Evidences they want to report. The Buyers will see the reports of all 4 Sellers. Sellers as well will be informed about the reports of the other Sellers. Before the Buyers place their bid, they have to chose from which Seller to buy. For the chosen Seller's good, the Buyer places a bid and the Buyer's payoff is determined in the same fashion as before. The payoff of the Sellers is as well determined in the same fashion as before. The Seller sells one item of their good to each Buyer whose Bid exceeds the

Price. A Seller might sell to none, one, two, three, or four Buyers.