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Confusopoly: competition and obfuscation in markets

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Abstract This paper examines the effects of competition in experimental posted-offer markets where sellers can confuse buyers. I report two studies. In one, the sellers offering heterogeneous goods can obfuscate buyers by means of spurious product differentiation. In the other study, sellers offer identical goods and make their prices unnecessarily complex by having multi-part tariffs. I vary the level of competition by having treatments with two and three- sellers in both studies, and having an additional treatment with five-sellers in one study. The results show that average complexity created by a seller is not different for the treatments with two, three and five sellers. In addition, market prices are highest and buyer surplus is lowest when there are two sellers in a market.

Keywords Experiment · Bounded rationality · Buyer confusion · Price complexity · Product complexity · Oligopoly

JEL Subject Classification C9 , D03 , D12 , L13

1 Introduction

Competition has been widely regarded as the best protector of consumer interests. This view has led governments to liberalize markets that used to be state monopolies and encourage entry of more firms, sometimes even at the expense of duplicate infrastructure investments (Armstrong 2008). Recently however, governments have raised concerns regarding the consumers' ability to reap full benefits of

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competition due to complexity and intransparency of certain markets. In a Common Position document regarding electronic communications networks and services the European Commission (2009) states that "In order to take full advantage of the competitive environment, consumers should be able to make informed choices and to change providers when it is in their interests. It is essential to ensure that they can do so without being hindered by legal, technical or practical obstacles, including contractual conditions, procedures, charges and so on". Similar concerns has been an important motivation in the Obama Administration's Health Care Reform[1] and Credit Card Act.[2] The recent literature in behavioral economics offers support for such concerns. For example, Choi et al. (2010) show in an experiment that investors fail to minimize on mutual fund fees. Similarly, Brown et al. (2010) show in a field experiment that buyers underestimate the shipping costs on eBay auctions. This literature also suggests that when some consumers are boundedly rational, firms in a competitive market might have an incentive to take advantage of this bounded rationality (Gabaix and Laibson 2006; Carlin 2009). Kalaycı and Potters (2011) and Kalaycı (2015) demonstrate experimentally that sellers in a duopoly market use product and price complexity (PC) to confuse buyers, and that market prices are higher in markets where buyers are susceptible to confusion than in markets with perfectly rational (robot) buyers.

A striking theoretical result in this literature is that increased competition may be detrimental for consumers when firms can confuse buyers (Gabaix and Laibson 2004; Carlin 2009). The intuition, according to Carlin (2009) is as follows[3]: If the consumer base is divided between expert buyers who always buy from the cheapest seller and uninformed buyers who just shop randomly, there will be only one (low-priced) seller who will be serving the experts whereas the other (high-priced) sellers will share the demand from uninformed buyers. Therefore, if the number of sellers in a market increases the portion of informed buyers per seller will fall and this will increase the sellers' incentives to create more confusion to raise the share of uninformed buyers in the market. In this way, increased competition might lead to more complexity and more confused buyers.

In this vein, the goal of this paper is to examine empirically how increasing the number of sellers affects market outcomes when sellers can confuse buyers. Specifically, I look at how increased competition affects the amount of complexity generated by sellers and the consequences for buyer surplus. In principle, one would expect that increased competition would lead to a fiercer price competition. This would result in lower prices and higher buyer surplus. However, if the sellers make their goods more complex in response to increased competition the buyers may not be able to identify the best deal in an increasingly complex market. If increased competition leads to more complexity and consumer confusion sellers may not compete in prices fiercely. As a result market prices may not fall.

[1] http://www.whitehouse.gov/assets/documents/CEA_Health_Care_Report.

[2] http://www.whitehouse.gov/the_press_office/Fact-Sheet-Reforms-to-Protect-American-Credit-Card-Holders/.

[3] See Huck and Zhou (2011) for a more complex intuition and a review of the theoretical literature where increased competition might lead to more obfuscation.

I examine two questions regarding the effects of increasing the number of sellers in a market. First, does increased competition lead to more obfuscation by sellers? And second, how is the buyer surplus affected by increasing the number of sellers in a market? To answer these questions, I use laboratory experiments, designing a setup in which sellers can confuse buyers using product or price complexity. The market institution employed in the experiment is a posted-offer market where the sellers are setting prices and complexity level for their goods and then the buyers make their purchasing decisions. I conduct two studies: A quality complexity (QC) study based on Kalaycı and Potters (2011) and a PC study based on Kalaycı (2015). In the QC study the sellers have vertically differentiated goods with different quality levels. Each seller first chooses the number of attributes for her good which affects the complexity of buyers' evaluation of the good. Then the sellers decide on prices and after that the buyers make purchases given the complexity and price choices of the sellers. In the PC study the sellers are offering an identical good and they decide on the price and the number of fees for their good, where a higher number of fees potentially makes it harder for the buyer to calculate the price of the good. In both studies, the treatment variable is the number of sellers; there are treatments with two and three sellers in each study, as well as a treatment with five sellers in the PC study.

In both QC and PC studies I find that sellers use complexity and this leads buyers to make suboptimal choices. I find that increased competition, in the form of increasing the number of sellers from two to three (and to five in PC study), has no effect on the number of attributes or the number of fees chosen by the sellers, suggesting the incentives to confuse are not affected by the number of sellers in my experiments. Moreover, I find that buyer surplus in the treatments with three sellers is significantly higher than buyer surplus in treatments with two sellers in both studies, and it is highest in the treatment with five sellers in the PC study. The results indicate that, although buyer confusion induced by sellers might be a concern, increased competition does not necessarily exacerbate such concerns and still might benefit buyers through lower prices and higher buyer surplus.

This article also contributes to the literature on the number effects in experimental oligopolies. Dufwenberg and Gneezy (2000) find in markets with Bertrand competition that prices are lower when there are four rather than two sellers in a market. Huck et al. (2004) examine the effect of number of sellers on collusion in Cournout oligopolies. They find some collusion with two firms, whereas there is no evidence of collision in markets with three, four and five firms. Orzen (2008) examines the effect of competition on prices in markets where a large portion of the buyers (convenience shoppers) are simulated to purchase randomly. He finds that transaction prices are lower in markets with four sellers than with two sellers under a fixed matching protocol but no difference is observed when random matching is used. Abbink and Brandts (2008) find that prices decrease with the number firms in Bertrand competition with decreasing returns. Articles in this literature use simulated demand schedules. The main methodological difference of my article however is that human buyers are used, which can potentially be confused by sellers.

2 The experiment

The experiment is a posted offer market experiment with human buyers and sellers as participants. Each seller is offering a good the quality of which is exogenously determined and is common knowledge to sellers. Sellers decide on the price and the complexity of their good, details of which I will explain below. Then, given the goods offered by sellers the buyers make their choice among the goods in the market under a strict time limit. Each buyer can purchase one good and his surplus equals the quality minus the price of the good he chooses.

In the experiment I endogenize complexity using two different methods. In the QC study each seller can make her good more complex by choosing the number of attributes of her good, which can potentially affect the buyers' evaluation of the quality of the good. In the PC study each seller chooses the number of tariffs for the price of her good, which can potentially hinder the buyer's evaluation of the price of the good.

Although the basic design of the two studies are quite similar, there are a number of differences as well. I will explain first the QC study then the PC study.[4] You can find a summary of the treatment differences in Table 1.

2.1 Quality complexity (QC) study

I first describe the buyers' decision problem. There are two buyers in a market. Each buyer can choose to buy one of the goods in his market, or to refrain from buying. Each buyer's surplus is equal to the quality minus the price of the good he chooses. However, the buyer doesn't directly observe the quality. Each good in the market has five so-called attributes and each attribute has a different weight. The buyer's surplus from buying a particular good is:

$$Surplus = 5 * q_5 + 4 * q_4 + 3 * q_3 + 2 * q_2 + 1 * q_1 - Price$$

where q_i is the quality level of the i'th attribute of the good that is chosen. The information is presented to the buyer on screen as follows:

In this example, if the buyer chooses good A his surplus equals to: $5 * 0 + 4 * 4 + 3 * 4 + 2 * 11 + 1 * 36 - 50 = 16 + 12 + 22 + 36 - 50 = 36$, whereas if he chooses good B his surplus equals to $73 - 45 = 28$. The buyer has 15 seconds to make his choice and this time limit is binding. If the buyer does not make a choice within the time limit, he does not buy a good and earns a surplus of 0.

As you may notice, evaluating the surplus from a good that has fewer attributes is easier given the time limits. As I will explain below the number of attributes is a decision variable for sellers in the experiment.

In the first stage, sellers are informed about the quality of each others' goods, which is a number between 60 and 100. The quality level of each good is determined by a random draw at the beginning of the game. There is a separate and

[4] The instructions for the experiments can be found in the Appendices of Kalaycı and Potters (2011) and Kalaycı (2015).

Table 1 Main properties of the treatments

	Quality complexity		Price complexity		
	QC2	QC3	PC2	PC3	PC5
Number of sellers	2	3	2	3	5
Number of buyers	2	2	3	3	3
Quality of goods in a market	Heterogeneous	Heterogeneous	Identical	Identical	Identical
Decision time for buyers	15 s	15 s	10 s	10 s	10 s
Complexity and price choice	Sequential	Sequential	Simultaneous	Simultaneous	Simultaneous
Size of a matching group	4 sellers and 4 buyers	6 sellers and 4 buyers	4 sellers and 6 buyers	6 sellers and 6 buyers	10 sellers and 6 buyers
Number of matching groups	6	6	6	7	4
Number of periods	30	30	30	30	30
Total number of subjects	48	60	60	84	64

independent draw for each seller, therefore the sellers' quality levels are (potentially) different.

After being informed about the quality levels the sellers make decisions about the number of attributes and the price for their good. In this study, these decisions are made sequentially. Each seller first decides on the number of attributes for her good. Upon being informed about each others' number of attributes each seller chooses a price for her good.

The sellers can choose a number of attributes from 1 up to 5. Depending on the number of attributes that a seller chooses, the exogenous quality of the good is randomly allocated over the attributes such that the following is satisfied:

$$5 * q_5 + 4 * q_4 + 3 * q_3 + 2 * q_2 + 1 * q_1 = Quality$$

If the number of attributes chosen is 1 then $q_1 = Quality$ and $q_2 = q_3 = q_4 = q_5 = 0$. If the number of attributes chosen is 2 then the quality is randomly allocated over q_1 and q_2, such that $2 * q_2 + 1 * q_1 = Quality$ and $q_3 = q_4 = q_5 = 0$. And so on when the number of attributes chosen is 3, 4 or 5. In all cases, the algorithm makes sure that the quality levels of all attributes are integers. In one page of the instructions which is exclusively for the sellers, this procedure is explained. Moreover, it contains the following text: "Notice that the number of attributes you choose will not affect the surplus of the buyers since the quality of your good is unaffected by it. However, the calculation of surpluses may get harder or easier depending on the number of attributes of your good." After choosing the number of attributes the sellers decide on the price of their good given the quality and the number of attributes of each good. The sellers have zero cost and profits are equal to the price of a good times the number of sales (0, 1 or 2). Note that the number of attributes has no direct impact on sellers' profits (Fig. 1).

There are two treatments in this study; one with two sellers (QC2) and one with three sellers (QC3).

2.2 Price complexity (PC) study

There are three buyers in a market in the PC study. The buyer directly observes the quality but not the price of the goods. Instead the price is presented in the form of multiple fees. Each good's price has three so-called fees and each fee has a different weight. The buyer's surplus from buying a particular good is:

$$Surplus = Quality - (Fee1 + 2 * Fee2 + 3 * Fee3)$$

The information was presented to the buyer on screen as in the example in Fig. 2. In this example, if the buyer chooses good A her surplus equals: $88 - 37 = 51$, whereas if she chooses good B her surplus equals to $88 - (1 * 4 + 2 * 7 + 3 * 9) = 43$. The buyer has 10 seconds to make this choice and this time limit is binding. If the buyer does not make a choice within the time limit, she does not buy a good and earns a surplus of 0.

In contrast to the QC study, in this study there is only one quality draw, therefore the sellers are offering an identical good. Also, the sellers choose the number of fees and the price of their good simultaneously.

Each seller has to decide on the price, which has to be a non-negative integer and the number of fees. For the number of fees the sellers have three options; One Fee, Two Fees or Three Fees. Depending on the number of fees they choose their price is randomly distributed among the fees such that $Fee\_1 + 2 * Fee\_2 + 3 * Fee\_3 = Price$. If a seller chooses One Fee then the price she chose equals Fee_1. If she chooses Two Fees then the Price is randomly distributed among Fee 1 and Fee 2 such that $Price = Fee\_1 + 2 * Fee\_2$ whereas Fee 3 equals zero. If she chooses Three Fees, then her price is distributed among Fee 1, Fee 2 and Fee 3 such that $Price = Fee\_1 + 2 * Fee\_2 + 3 * Fee\_3$. Similar to the QC study the number of fees and the quality of a good do not effect the profit of the sellers directly. The profit of a seller is the price of her good times the number of buyers (0, 1, 2 or 3) that choose her good. The sellers have no costs and are able to serve all the buyers if the buyers choose their good.

In PC study, there are three treatments; one with two sellers (PC2), one with three sellers (PC3) and one with five sellers (PC5).

2.3 Procedure

Four sessions of QC studies were conducted at CentERLab of Tilburg University and two sessions were run at the University of Queensland (UQ). Four sessions of the PC studies were run at the Experimental Economics Laboratory at the University of Melbourne and seven sessions were run at UQ. The experiment was programmed and conducted with the software zTree (Fischbacher 2007).

Product / Weight	5	4	3	2	1	Price
Good A	0	4	4	11	36	50
Good B	0	0	0	0	73	45

Fig. 1 Example quality complexity

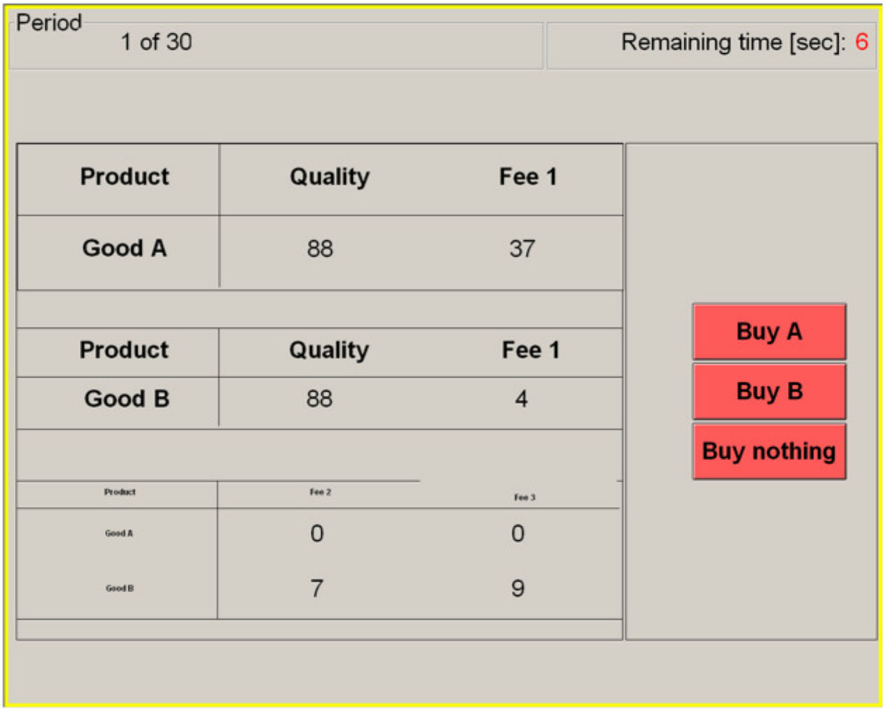


Fig. 2 Example price complexity

At the beginning of a session subjects were placed behind computer terminals where they could find the written instructions. The instructions including the buyers' decision were read out loud by the experimenter, whereas some details about the sellers' decision were left for them to be read on their own. After the subjects finished reading the instructions a short quiz was run to make sure the participants understood the instructions. At the end of the experiment subjects were paid their accumulated earnings in cash and in private.

The game was played by subjects for 30 periods and subjects were informed about this. At the beginning of the experiment subjects were randomly assigned to be either a buyer or a seller and they retained this role for all periods. In addition, matching groups consisting of 4 (6 or 10) sellers and 4 (6) buyers were formed randomly. In each period, the subjects in a matching group were allocated to two markets using a stranger matching protocol. The subjects' identities were kept anonymous, a seller could not know which of the other sellers she was matched with or what the decisions of any particular seller or buyer were in previous periods.

The experimental sessions lasted about 90 minutes. 316 student subjects participated in the experiments. The subjects in the QC study earned 12 Euros in Tilburg and at 33 dollars at UQ. The subjects in the PC study earned on average 32 Australian dollars, which was about 20 Euros at the time of the study.

2.4 Research questions

The main research question in this article is the effects of increased competition on the amount of obfuscation created by the sellers.

In addition I am interested in what happens to the buyer surplus. This a more intriguing question as it is determined by both the prices that sellers post and the accuracy of decisions that buyers make. It is possible that increased competition does not affect the prices but lead to more decision errors or lower the prices without affecting the decision errors. In this regard the following questions guide the analysis of the results that are presented in Sect. 3:

(1) How will increased competition affect the number of attributes and fees chosen by sellers?
(2) Will the buyers make more or less errors when the number of sellers is higher?
(3) How will the number of sellers affect market prices?
(4) And finally how will the buyer surplus be affected by the number of sellers?

These questions will guide the analysis and lead to the results presented in the following section.

3 Results

In this section, I present the results from both of the studies. All the analysis are based on data from all 30 periods unless otherwise noted. Treatment effects are examined with a Wilcoxon rank-sum test using the averages of a matching group as the unit of observation. Reported p values in parenthesis are two-sided. First, I examine the effects of increased competition on the level of complexity the sellers choose and the rate of buyer mistakes. Then, I look at buyer heterogeneity in making mistakes and the foregone surplus due to mistakes. Lastly, I examine the net effect of increased competition on transaction prices and buyer surplus.

3.1 Obfuscation and buyer mistakes

I start with examining the effect of increased competition on the average complexity in a market, which is the main research question in this paper. Figure3a shows the *average number of attributes* in QC and Fig. 3b shows the *average number of fees* in the PC treatments.

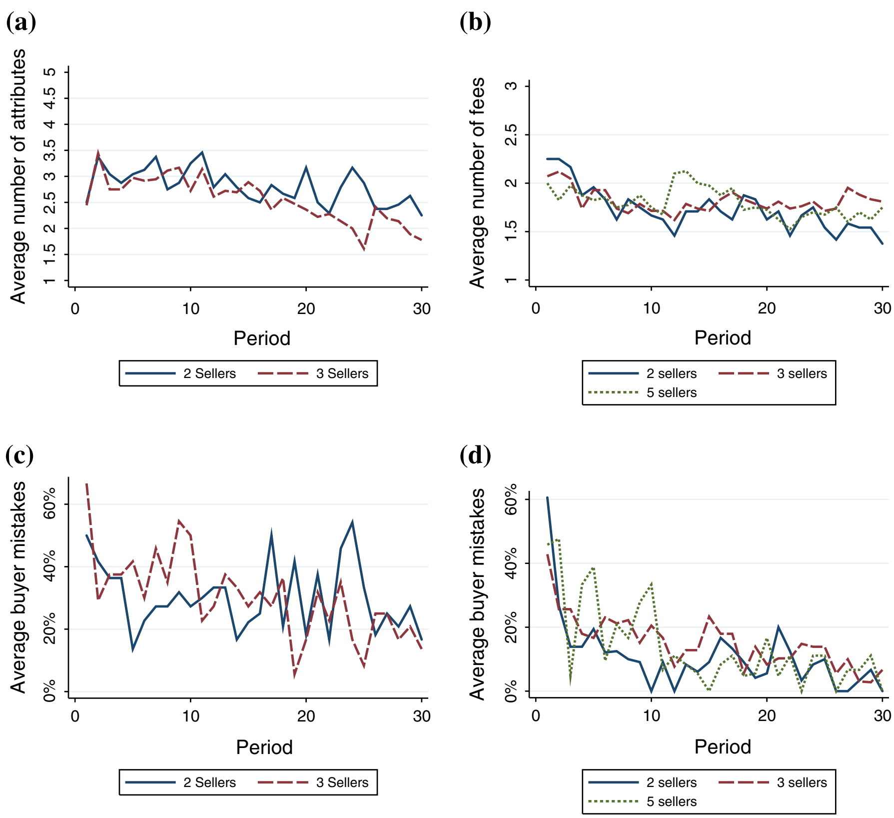


Fig. 3 Obfuscation and buyer mistakes. **a** Quality complexity, **b** price complexity, **c** quality complexity, **d** price complexity

Result 1 Average complexity in a market is not different for two-, three- and five-seller markets.

The sellers in the QC2 treatment choose 2.8 attributes on average, whereas in QC3 treatment the average number of attributes is 2.6. The difference between the average number of attributes in QC2 and QC3 is not significant (p value = 0.42). In the PC2 treatment the sellers on average choose 1.7 fees whereas in both the PC3 and PC5 treatments average number of fees chosen by the sellers are 1.8. None of the treatment differences in PC study are statistically significant (p values: PC2 vs PC3 = 0.56, PC2 vs PC5 = 0.39, PC3 vs PC5 = 0.85).

Columns 1 and 2 in Table 2 display results from OLS regressions for QC and PC studies.[5] The dependent variables are the number of attributes and the number of fees chosen by a seller in QC and PC studies, respectively. The dummy variable *Three sellers* takes value 1 if the treatment is with three sellers and 0 otherwise. *Three sellers* has no significant effect on the number of attributes as can be seen in column 1 of Table

[5] Ordered probit regressions and random-effects GLS regressions produce qualitatively similar results.

Table 2 Regression analysis on obfuscation, buyer mistakes and buyer surplus

	Number of attributes/fees		Buyer mistakes		Buyer surplus	
	QC	PC	QC	PC	QC	PC
Constant	4.48 (0.65)**	1.77 (0.28)**	−0.48 (0.20)**	−3.13 (0.54)**	−11.81 (6.50)*	−19.04 (2.58)**
Period	−0.02 (0.02)	−0.02 (0.00)**	−0.02 (0.01)**	−0.08 (0.02)**	0.94 (0.11)**	0.96 (0.14)**
Three sellers	0.30 (0.88)	−0.50 (0.36)	−0.13 (0.36)	−0.07 (0.60)	15.86 (5.43)**	15.18 (4.43)**
Five sellers	–	0.19 (0.29)	–	4.28 (0.86)**	–	14.64 (3.70)**
Quality	−0.02 (0.01)**	0.00 (0.00)	–	–	–	–
Quality difference	0.00 (0.00)	–	–	–	–	–
Surplus difference	–	–	−0.03 (0.01)**	−0.06 (0.02)**	–	–
Average number of fees	–	–	–	1.22 (0.28)**	–	−3.34 (0.58)**
Average number of attributes	–	–	0.06 (0.08)	–	−1.34 (1.32)	–
Best offer has higher attributes	–	–	0.53 (0.23)**	–	–	–
Best offer has higher fees	–	–	–	0.26 (0.20)	–	–
Highest quality level	–	–	–	–	0.55 (0.05)**	0.83 (0.03)**
Period × Three sellers	−0.02 (0.02)	0.01 (0.01)*	−0.03 (0.02)	0.01 (0.03)	−0.11 (0.16)	−0.08 (0.22)
Period × Five sellers	–	0.01 (0.00)*	–	−0.04 (0.03)	–	−0.14 (0.21)
Quality diff. × Three sellers	0.00 (0.01)	–	–	–	–	–
Quality × Three sellers	−0.01 (0.01)	0.00 (0.00)	–	–	–	–
Quality × Five sellers	–	−0.00 (0.00)				
Surplus diff. × Three sellers	–	–	0.01 (0.01)	0.01 (0.04)	–	–
Surplus diff. × Five sellers	–	–	–	0.02 (0.03)	–	–
Av. # of attributes × Three sellers	–	–	0.17 (0.10)*	–	−0.00 (1.80)	–
Av. # of fees × Three sellers	–	–	–	0.12 (0.36)	–	−3.15 (1.26)**
Av. # of fees × Five sellers	–	–	1368	−1.90 (0.37)**	–	2.06 (0.90)**

Table 2 continued

	Number of attributes/fees		Buyer mistakes		Buyer surplus	
	QC	PC	QC	PC	QC	PC
# of observations	1800	3180	1368	2514	1440	3060

Columns (1) and (2) are linear regression models, Columns (3) and (4) are logit model with random effects, Columns (5) and (6) are random-effects GLS regression models; standard errors are clustered at the independent group level; * indicates statistical significance at %10, ** indicates statistical significance at %5. Standard errors are in parentheses

2. Similarly, in PC the coefficient for *Three sellers* is not significantly different from zero as seen in column 2. Similarly, the coefficient for the dummy variable *Five sellers*, which takes value 1 if the treatment is with five sellers and 0 otherwise, is not significant. Figure 3 suggests that both the average number of treatments in QC and the average number of fees in PC are declining over time. The regression results displayed in Table 2 confirm this for PC but not for QC. The *Period* number is negatively related with the number of fees chosen in PC, but not with the number of attributes chosen in QC. The *Quality* of the goods in a market has a negative effect on the number of attributes chosen in QC, but not on the number of fees chosen in PC. The *Quality difference* between the seller with the highest quality and the seller with the second highest quality has no effect on the number of attributes chosen, suggesting that having a higher quality good doesn't make a seller less likely to obfuscate.[6] The interaction variables that interact *Three sellers* with *Period*, *Quality* and *Quality difference* in QC are not significant, suggesting no differential effect of increased competition on complexity choice. The interaction variables that interact *Three sellers* and *Five sellers* with *Period* are positive and significant, suggesting that the decline in the number of attributes in PC over time is mainly in PC2.

One of the key aspects of the experiment was to create an environment where the buyers can potentially make mistakes and the sellers can affect the amount of mistakes using the complexity mechanism. Figure 3c and d display the development of average buyer mistakes over time for each treatment. A mistake is defined as the buyer purchasing a good that offers a surplus lower than one of the other goods in the market or refrains from buying whereas there is a good with a positive surplus.

Result 2 Average buyer mistakes in a market is not different for two-, three- and five-seller treatments.

In QC2 the buyers make a mistake around 30 % of the time whereas in QC3 they make a mistake 31 % of the time. The difference between the average buyer mistakes in these two treatments is not significant (p value = 0.87). In PC study the buyers also make a significant amount of mistakes. In PC2 the buyers make a mistake around 11 % of the time whereas in both PC3 and PC5 they make a mistake in 15 % of the time. None of the treatment differences in PC study are statistically significant (p values: PC2 vs PC3 = 0.32, PC2 vs PC5 = 0.39, PC3 vs PC5 = 1.00). Note, however, that one would expect the mistake rate to increase with the number of sellers, as subjects have more ways to make a mistake when there are more options to choose from. One benchmark to measure buyers' performance is subjects' mistake rate relative to the expected mistake rate of a randomizer, i.e. a buyer who would randomly choose one of the available options. A randomizer would on average make a mistake 50 % of the time when there are two sellers, 67 % of the time when there are three sellers and 80 % of the time when there are five sellers.[7] The *relative mistake rate* of buyers (mistake rate/randomizer's expected mistake rate) is 46 % in QC2 while it is 60 % in QC3.

6 An alternative model that uses a dummy variable for seller with the highest quality seller produces similar results, indicating no difference in obfuscation levels between high and low quality sellers.

7 Here, I assume a randomizer would not consider abstaining from buying.

The difference is significant (p value = 0.05). The *relative mistake rate* is 22 % in PC2, 23 % in PC3 and 18 % in PC5. None of the treatment differences in the *relative mistake rate* in PC study are statistically significant (p values: PC2 vs PC3 = 0.88, PC2 vs PC5 = 0.52, PC3 vs PC5 = 0.57).

Columns 3 and 4 in Table 2 display regression results for the relationship between the number of mistakes and the complexity choices of the sellers. The dependent variable in both of these regressions in Table 2 is a binary variable that takes value 0 if the buyer purchases the good that offers the highest surplus and value 1 if the buyer chooses a good with lower surplus or refrains from buying although there is a good with a positive surplus.

Column 3 shows regression results for the QC study. The variable *Period* has a negative coefficient, indicating some learning throughout the sessions. *Three sellers* has no significant effect on the mistakes the buyers make. Increasing the *Average number of attributes* leads to more mistakes only in QC3. Buyer mistakes are negatively related with the variable *Surplus Difference*, the surplus difference between the best two goods in a market, suggesting that buyers make fewer mistakes if the goods in the market are noticeably different from one another. The dummy variable *Best offer has higher attributes* takes value 1 if the good that offers the highest surplus in the market has higher number of attributes than the second best deal in the market and zero otherwise. The coefficient for *Best offer has higher attributes* is positive and significant, suggesting that sellers that obfuscate relatively more are punished by buyers to some extent.

Column 4 shows regression results for the PC study. As in QC, buyer mistakes are negatively related with *Period*. Buyer mistakes are not affected by *Three sellers* or *Five sellers*; increasing the number of sellers in a market doesn't affect the rate of mistakes buyers make. As in regressions for QC study the variable *Surplus Difference* is negatively related with the buyer mistakes, suggesting that buyers make fewer mistakes when the mistakes are more costly. The buyer mistakes are positively related with the *Average number of fees* in a market, whereas average number of fees have a significantly larger effect in PC3 relative to PC2. Unlike in QC study, the coefficient for *Best offer has higher fees* is positive but not significant, suggesting no evidence for buyers' punishment of high obfuscators.

There is considerable heterogeneity in the performance of the buyers in their ability to choose the optimal offer in their market. Table 3 displays the percentage of buyers according to their percentage error rate. In the QC study the largest group of buyers is at the 20–30 % error rate interval, while in the PC study the largest group is around the 10–20 % error rate interval. While there is a small group of people in the PC study who never makes a mistake, every subject in the QC study makes a mistake at least once. There is no visible shift in the distribution of buyers with changes in the number of sellers in the markets.

Table 3 also illustrates the direct cost of making mistakes in QC and PC studies, respectively. In QC2 buyers on average lose 3.9 points by making a suboptimal choice, while a randomizer who randomly picks one of the two goods would on average forego 6 points.[8] In QC3, buyers on average forego a surplus of 4.52 points

[8] Here, I again assume a randomizer would not consider abstaining from buying.

Table 3 Buyer heterogeneity in errors and foregone payoff

Error rate	Quality complexity		Price complexity		
	QC2	QC3	PC2	PC3	PC5
No mistake	0 %	0 %	5.56 %	7.14 %	12.50 %
0–10 %	0 %	4.17 %	50 %	33.33 %	25.00 %
10–20 %	12.50 %	8.33 %	0.56 %	42.86 %	29.17 %
20–30 %	45.83	37.50 %	8.33 %	7.14 %	25.00 %
30–40 %	25 %	37.50 %	5.56 %	2.38 %	4.17 %
>40 %	16.67 %	12.50 %	0 %	7.14 %	4.17 %
Total	100 %	100 %	100 %	100 %	100 %
Foregone surplus	3.9	4.52	1.54	2.90	2.44
Maximum possible loss	12.1	23.22	8.9	22.2	90.14
Expected loss by a randomizer	6.04	10.9	4.43	9.32	25
Loss relative to randomizer	65 %	43 %	51 %	32 %	12 %

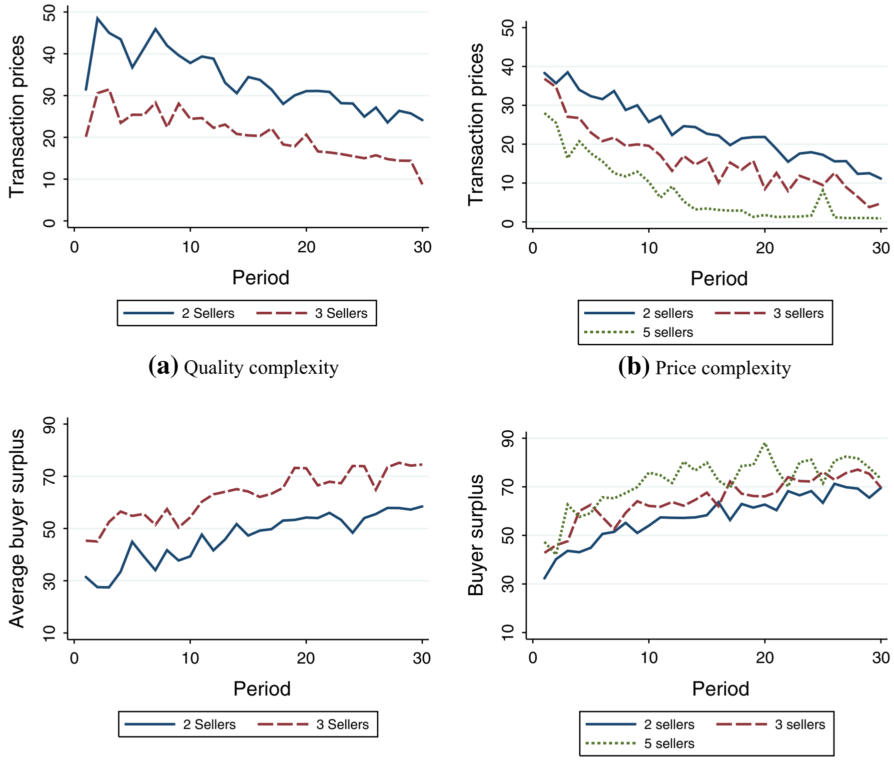
while a randomizer would forego 10.9 points. The difference between average *foregone surplus* in QC2 and QC3 is not significant (p value = 1), while the buyers lose relatively less compared to a randomizer in QC3 (43 %) than they do in QC2 (65 %). This can be interpreted as an improvement in the buyers' decision performance in QC3 compared with QC2 (p value = 0.02). In the PC study, buyers on average forego 1.54 points in PC2, 2.9 points in PC3 and 2.44 points in PC5. The differences between average *foregone surplus* in PC treatments are not significant (p values: PC2 vs PC3 = 0.47, PC2 vs PC5 = 0.39, PC3 vs PC5 = 1.00). However, as in the QC study, the buyers' lose relatively less compared to what a randomizer would lose when there are five sellers (12 %), than when there are three sellers (32 %) and when there are two sellers (51 %) (p values: PC2 vs PC3 = 0.47, PC2 vs PC5 = 0.03, PC3 vs PC5 = 0.06).

3.2 Prices and buyer surplus

Figure 4a and b displays average transaction prices for QC and PC treatments, respectively. The solid lines in Fig. 4 show the average transaction prices for treatments with two sellers, the dashed lines show the average transaction prices for treatments with three sellers, and the dotted line shows the average transaction prices for the PC treatment with five sellers. The prices in all treatments display a negative time trend, which is common in posted offer markets with random matching (Bruttel 2009).

Result 3 In PC study, average prices in a market is higher when the number of sellers in a market is three than when the number of sellers is five, and in both studies the average price is highest when the number of sellers is two.

On average the transaction prices are 33.6 points in QC2 and 20.9 points in QC3. The difference between the average transaction prices is significant (p value = 0.02). Similarly, the average transaction prices are significantly higher in PC2,



(a) Quality complexity **(b)** Price complexity

(c) Quality complexity **(d)** Price complexity

Fig. 4 Transaction prices and buyer surplus. **a** Quality complexity, **b** price complexity, **c** price complexity and **d** price complexity

23.9 points, than in PC3 treatment, 16.2 points (p value = 0.02). The average transaction prices are 8.3 points in PC5, which is significantly lower than the prices in PC3 (p value = 0.02) and that is in PC2 (p value = 0.01).

Lastly, I examine the effects of increased competition on buyer surplus. So far, we have observed that transaction prices are lower when there are higher number of sellers in a market and buyers make similar amount of mistakes in treatments with two, three and five sellers. Figure 4c and d shows that the net effect of increased competition is advantageous for buyers.

Result 4 Buyer surplus is higher when the number of sellers in a market is three than when the number of sellers is two. In the PC study, the buyer surplus is highest when the number of sellers is five.

Figure 4c and d displays the development of average buyer surplus over time for QC and PC studies, respectively. The solid lines show the average buyer surplus for treatments with two sellers, the dashed lines shows the average buyer surplus for treatments with three sellers, and the dotted line shows the average buyer surplus for the PC treatment with five sellers. On average the buyer surplus is 46.8 points in

QC2 and 63 points in QC3. The difference between the average buyer surpluses is significant (p value = 0.01). Similarly, the average buyer surplus is significantly lower in PC2, 57.8 points, than in PC3 treatment, 64.71 points (p value = 0.03). The average buyer surplus is 72 points in PC5, which is significantly higher than the average buyer surplus in PC3 (p value = 0.03) and than it is in PC2 (p value = 0.01).

Columns 5 and 6 in Table 2 reports regression results on buyer surplus. Column 5 shows that in QC, buyer surplus increases with increasing the number of sellers from two to three. Also, we observe a positive time trend in buyer surplus. *Average number of attributes* has no impact on the buyer surplus in QC. Column 6 displays regression results for the PC study. Similar to QC study, increasing competition increases the average buyer surplus. Buyer surplus increases over time and *average number of fees* has a negative effect on the buyer surplus, particularly in the treatment with five sellers.

There is one confound that potentially inflates the surplus difference between QC2 and QC3, that due to the higher number of draws in QC3 the highest *Quality* in the market is likely to be higher in QC3 than in QC2. Indeed, on average the highest *Quality* in QC3 is 89.29 points whereas it is 86.3 points in QC2. However, this difference (2.99 points) is small relative to the difference in buyer surplus (16.02) and the main treatment effects in Table 2 are robust to controlling for the *highest quality level* in a market.[9]

4 Conclusion

In two studies of experimental posted offer markets I show that increased competition, in the form of increasing the number of sellers from two to three (and than to five in one study) has no effect on the sellers' propensity to confuse buyers. In addition, prices are lower and buyer surplus is higher when the number of sellers in a market is higher. These results suggest that sellers' ability to confuse buyers may not necessarily be a concern against increasing competition in markets.

Previous theoretical work, such as Gabaix and Laibson (2004) and Carlin (2009), show that increasing the number of sellers in a market might lead to more obfuscation. The results from my experiments demonstrate two environments where increasing the number of sellers from two to three (and to five in PC study) does not lead to more obfuscation. Pinning down exactly where these models depart from the actual behavior of buyers and sellers in my experiments require further research. One key issue seems to be in the specifications of the behavior of confused buyers. Even though buyers in my experiments get confused due to complexity, they avoid making very costly mistakes.[10] There is also some evidence, though only in the QC

[9] I thank Eric van Damme for pointing out this issue.

[10] Notice, however, that most models of obfuscation in markets assume that buyer errors are independent of payoff differences of the goods in the market (See for example Carlin 2009; Piccione and Spiegler 2012; Chioveanu and Zhou 2013; Gu and Wenzel 2014). A notable exception is Basov and Danilkina (2015), who adopt Luce (1959)'s choice model where the probability of choosing a good depends on the utilities offered by the goods in the market and the level of aggregate obfuscation. They show in their

study, that buyers sellers with relatively high number of attributes. Such buyer behaviour probably puts a bound on how much sellers can abuse their ability to confuse by charging high prices.

An additional, and arguably a counterintuitive, result that possibly plays a role in affecting the sellers' behavior is that the buyers' relative choice performance improves when there are more sellers. The underlying factors behind this result is difficult to disentangle in the present paper, as while the level of obfuscation is similar in markets with different numbers of sellers both the level and standard deviation of offer prices differ dramatically.

Naturally, the findings in my experiments are limited to the comparative statics in markets with two, three and five sellers. It is possible that competition has a non-monotonic or maybe a U shaped affect on confusion and prices in markets. This may especially be true in markets with very large number of competitors as the amount of confusion is likely to be much larger in those environments. For example in insurance markets Frank and Lamiraud report that consumers are less likely to switch between insurers, and leave money on the table, in areas with higher number of (55 or more) plans on offer. In similar vein, in financial markets, Hortacsu and Syverson (2004) find that entry into the S&P index fund industry in 1995–1999 was associated with a rightward shift in the distribution of prices. However, it remains an open empirical question whether these effects are related to consumer confusion and intentional complexity in these markets.

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Footnote 10 continued
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