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by

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Choosing whether to compete: Price and format competition with consumer confusion*

Paolo Crosetto[†] and Alexia Gaudeul^{‡§}

November 3, 2014

Abstract

We run a market experiment where firms can choose not only their price but also whether to present comparable offers. They are faced with artificial demand from consumers who make mistakes when assessing the net value of products on the market. If some offers are comparable however, some consumers favor the best of the comparable offers vs. non-comparable offers. We vary the number of such consumers as well as the strength of their preferences for the best of the comparable offers. In treatments where firms observe the past decisions of their competitors, firms learn not to present comparable offers especially when many consumers prefer comparable offers. This occurs after initial periods with strong competition and leads to lower welfare for all consumers. In treatments where firms cannot monitor the competition, firms end up having to present comparable offers, which leads to an improvement in welfare for all consumers.

Keywords: asymmetric dominance, attraction effect, collusion, competition, confusopoly, experiment, framing, industrial organization, obfuscation, oligopoly, price comparison, shrouding, spurious complexity, standardization, transparency.

JEL Codes: C92, D18, D43, L13, L15.

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1 Introduction

We present a market experiment where firms sell a homogeneous product but can choose to make it easy or hard for consumers to compare their offer with the competition. Firms are faced with demand from artificial consumers who are programmed to make mistakes in their choice among offers. However, if some offers are easy to compare – we call those “*comparable offers*” – then some consumers can identify the best of those and tend to favor it. We examine whether the presence of such consumers can lead firms to standardize their offers in terms of price format, design, presentation or specification, *i.e.* to make their offers easier to compare.

Our goal with this experiment is to inform regulation of consumer markets by exploring the ability of firms to conspire against consumers. Our experiment puts the belief in the self-regulating nature of competitive markets to the test. If firms choose not to compete by making it hard for consumers to find the best offer, then the regulator may wish to intervene and prevent firms from exploiting the cognitive limitations of consumers. This can be done by for example subsidizing services that help consumers in making choices or mandating the provision of a specific set of information to consumers (Beales *et al.*, 1981; Garrod *et al.*, 2009, in particular III.B.i. and ii. and IV.B.i.).

Our experiment relies on an extension of the standard Perloff and Salop (1985) model of competition with differentiated products. Firms face two types of consumers, whom we call “naive” and “savvy” as in Salop and Stiglitz (1977).¹ Naive consumers are prone to make mistakes in their evaluation of the available products so they do not always buy the product with the highest net value. Savvy consumers, like naive consumers, make mistakes if no offers are comparable. However, if two or more offers are comparable, then they notice this is the case and they favor the best comparable option over all others. They are thus subject to the attraction effect, which is a commonly observed bias towards choosing the dominant option among comparable offers over the options that stand on their own (Huber *et al.*, 1982; Huber and Puto, 1983; Simonson, 1989; Tversky and Simonson, 1993). This effect is also called *asymmetric dominance editing* because such consumers not only eliminate dominated offers from their consideration set but also tend to avoid non-comparable offers, unless those are obviously better than the best of the comparable offer.

We invited laboratory subjects to take the role of manager of a firm. They had to choose a price for their product and decide whether to make their offer transparent by choosing the same format as another firm or *obfuscate* by adopting a different format than other firms. By *format* we mean any product characteristic that may differ across products but does

¹See Mehta (2013) for a critique of those terms.

not affect its intrinsic value. Obfuscation is the act of “intentionally obscuring the meaning of something to make it more difficult to grasp” (Wiktionary, 2014b). A higher priced firm benefits from making its offer difficult to compare as this increases the likelihood that a consumers will make a mistake in his choice and select it anyway. Our experiment explores, among other topics, how many savvy consumers are needed to get firms to compete by presenting comparable offers, and how strong the preference of those consumers for comparable offers needs to be.

Literature Starting with Scitovsky (1950), economists have considered whether the *cognitive limitations of consumers* can help firms restrain competition. Such limitations include for example limits on the ability to consider all options due to search costs (Carlin, 2009; Wilson, 2010; Ellison and Wolitzky, 2012), difficulties in evaluating and comparing products (Spiegler, 2006; Piccione and Spiegler, 2012; Gaudeul and Sugden, 2012; Chioveanu and Zhou, 2013; Spiegler, 2014), or naivety in not considering the hidden costs of using a product (Ellison, 2005; Gabaix and Laibson, 2006; Heidhues *et al.*, 2012; Wenzel, 2014). The literature generally argues that firms can exploit the limitations of consumers even when market conditions are otherwise competitive. Exceptions include Gaudeul and Sugden (2012), which shows that markets become more transparent if consumers learn to make better choices over time, and Wenzel (2014), which shows that markets with more firms are also more transparent. A number of bodies involved in consumer protection have reported concerns about the lack of transparency in consumer markets. The OFT and Ofcom in the UK, the Consumer Financial Protection Bureau in the US, the Australian Competition and Consumer Commission and the OECD Committee on Consumer Policy have adopted the term “confusopoly” from Adams (1997) for such situations “in which the market forces of competition are evaded via intentional obfuscation” (Wiktionary, 2014a).

The literature about *price competition in experimental markets* shows that Bertrand competition is remarkably robust to *asymmetries* among firms, variations in the *number* of firms and in the ability for firms to *monitor* each other (Boone *et al.*, 2012; Bruttel, 2009; Davis, 2011; Dufwenberg and Gneezy, 2000; Dugar and Mitra, 2009; Huck *et al.*, 2000, 2004; Keser, 1993, 2000). However, it is less robust to strategies that enforce collusion (Aoyagi and Fréchette, 2009; Wright, 2013). In our experiment, firms are *symmetric*, that is, all are given the same parameters and can choose the price and format in which to sell their good. A slight asymmetry is introduced in that one of the firms, which we call firm A, is not able to choose its own format. This slight asymmetry ensures that other firms have a clear choice: either imitate the format of firm A or adopt their own individual format. We thereby avoid difficulties for firms in coordinating on one format as

this is not our research question. We set the *number* of competing firms at three, not only because “two are few and four are many” (Huck *et al.*, 2004) but also because this is the minimum number where one obtains the interesting case where consumers have the choice between comparable and non-comparable offers. Finally, in terms of *information*, we consider both cases with full information and with limited information about competitors. Our experiment differs most notably from existing ones in that – to borrow the title of Besen and Farrell, 1994 in a different context – we let firms “choose how to compete”. Firms can choose to compete head-on by standardizing the way they present their products or employ obfuscatory tactics by avoiding the use of common price formats or common technical standards that make offers easy to compare.

Empirical work that is relevant for our purposes includes Hossain and Morgan (2007); Ellison and Ellison (2009); Célérier and Vallée (2013); McDonald and Wren (2013); Muir *et al.* (2013); Wenzel (2013). Those papers find evidence consistent with firms artificially increasing search costs, making comparisons across products difficult, concealing the full price of their products or making them so complex that an evaluation of their benefit is difficult. There are also a few experiments which like ours test the functioning of markets when consumers are less than rational and/or perfectly informed. Kalayci and Potters (2011) varies complexity exogenously by manipulating the time pressure for consumers to make choices, while Sitzia and Zizzo (2011) does so via lottery compounding. Sluijs *et al.* (2011) goes a step further by letting firms vary complexity by offering different product qualities, while Kalayci (2011) and Shchepetova (2012) let firms choosing the number of parts in a tariff. Those later studies corresponds to how we let firms choose whether to make their offer comparable or not. Finally, Ericson and Starc (2013) deals specifically with how product standardization affected choice in an health insurance market and shows it increased consumer welfare.

Motivation We wish in this paper to investigate the role of collusion in maintaining a situation where consumers find it unnecessarily difficult to identify the best product for them. The theory of repeated games shows that repeated interactions can support collusion between firms even when that would not be possible in a one-shot game. In a one shot game, making at least a portion of consumers better able to choose the best offer leads to lower prices and profits for firms. However, punishment periods that are triggered when a firm stops colluding rely on the use of the one-shot equilibrium, so that lower payoffs in that equilibrium make it easier to maintain collusion. Firms may thus rely on the existence of a high number of savvy consumers as a threat, as those would choose correctly among products if it was possible to compare them. The threat of making one’s offer comparable

with others may therefore sustain “confusopolies”, whereby offers remain difficult to compare. In such a market, “spurious complexity”, or “spurious product differentiation” arises, whereby differentiation is primarily designed to make offers difficult to compare.

Existing experiments listed above focus on the impact of choice complexity on competition. The innovation in our design is that we investigate the issue of comparability rather than that of complexity. We focus on the issue of comparability because it is easier to operationalize than the issue of complexity in consumer choice. A great many products that are in common use nowadays are very complex, to an extent that it is often impossible for a consumer to understand how they work. However, even a very complex product can still be compared to a product in the same category sold by another firm. Furthermore, while it is difficult to determine by how much a two part tariff is more complex than a three part tariff, it is easy to see that they are not directly comparable, in the same way that a price in € is not directly comparable to a price in ¥. In contrast to this, investigating the issue of complexity leaves one with the issue of defining what form of complexity one is interested in, and on what basis. Generalization on the basis of complexity experiments is therefore not obvious, while it follows naturally in the case of comparability.

Another innovative aspects of our design is that we differentiate the effect of *how many* consumers are able to compare products vs. by *how much* they prefer comparable offers to non-comparable offers. This is something that has no equivalent in the complexity experiments mentioned above, whereby no difference is made between the spread and the magnitude of the aversion of consumers to complexity.

A further advantage of our paper is that our parametrization of consumer behavior relies on well-studied and robust empirical evidence, including a previous study on comparability and consumer choice that was specially designed for the purpose (Crosetto and Gaudeul, 2014).

Finally, our study varies how much information firms have about each other’s actions, a factor that is absent in other studies even though it is a major topic of study in research on collusion. This factor turns out to have important and original implications in our setting.

Outline We first present our model of competition between firms and then show how we implement this model experimentally. We motivate our choice of treatments in terms of the proportion of savvy consumers, strength of their preference for dominant offers and information available to firms, and we provide predictions of the outcomes of our experiment. We then present our empirical results, focusing first on the price levels in our experimental markets, then on the prevalence of collusion, and finally on welfare considerations. Our conclusion summarizes our findings and

discusses their consequences in terms of policy.

2 A model of competition with spurious differentiation

2.1 The model

We analyze a Bertrand triopoly in which firms choose both price and whether to imitate or not the format of a given firm. The three firms $i \in \{A, B, C\}$ sell an undifferentiated product. They set their own prices p_i , independently and without knowing the choice of others. At the same time, firms B and C choose whether to adopt their own format (format B for firm B and format C for firm C) or adopt the format of firm A. Firm A cannot choose another format than its own.

Consumers are heterogeneous with respect to their preferences for a specific *firm*. There are three types of consumers $j \in \{A, B, C\}$. Type j values the product of firm i at $v_{ij} = v + \epsilon_{ij}$, whereby ϵ_{ij} takes the value $e > 0$ if $i = j$ and 0 otherwise. ϵ_{ij} is a noise component in the consumer's perception of the value of goods on the market. e measures how different the products appear to consumers. Consumers of type A perceives the product of firm A to be superior, type B the product of firm B, type C the product of firm C. This demand specification is a simplified, discontinuous version of models with continuous product differentiation. Indeed, one could apply our model to real product differentiation if instead of *format* we spoke of *model* or *type* of good.

There is a mass of size 1 of each type of consumer $j \in \{A, B, C\}$. Within each type, there is proportion μ of *savvy* and $1 - \mu$ of *naïve* consumers, $0 \leq \mu \leq 1$.

- *Naïve* consumers are unable to make *format* comparison of products; that is, they simply choose to buy from the firm that is offering them the highest perceived net value, regardless of the format chosen by the firm. That is, they choose:

$$\arg \max_i \{v + \epsilon_{ij} - p_i\}, i \in \{A, B, C\} \quad (1)$$

- *Savvy* consumers are able to make format comparisons, can edit out dominated offers, and have a preference for comparable offers. If firms B or C or both decide to imitate the format of firm A, *savvy* consumers will disregard the dominated offer - i.e., the firm with the highest price amongst those adopting format A. Moreover, they will apply a price penalty to the firm not adopting the common format A. Formally, *savvy* consumers will choose:

$$\arg \max_i \{v + \epsilon_{ij} \times NCO_i - (1 + \lambda \times NCO_i) \times p_i\}, i \in \{A, B, C\} \quad (2)$$

whereby $NCO_i = 1$ if i 's offer is **not comparable** with the offer of firm A, 0 else.

$\lambda > 0$ measures the penalty applied by savvy consumers to non-comparable offers. We give several interpretations for such a penalty in Crosetto and Gaudeul (2014). In particular, it reflects behavior under the attraction effect and is optimal behavior when a consumer is not sure of the value of each product. The case with $\mu > 0$ and $\lambda = 0$ corresponds to savvy consumers doing dominance editing, *i.e.* eliminating dominated offers and then comparing remaining offers. The case with $\lambda > 0$ corresponds to savvy consumers performing asymmetric dominance editing, that is, not treating the dominant offers and the non-comparable offers equally. Rather, a penalty is imposed on non-comparable offers.

Appendix A offers a visual representation of the market along with explanations. We also give two examples below:

Example 1. Firm B chooses format A and Firm C chooses format C. Then a savvy consumer of type C chooses to buy from $\arg \max_{A,B,C} [v - p_A, v - p_B, v + e - p_C(1 + \lambda)]$. The savvy consumer of type C thus maintains a preference for firm C (measured by e) which is partially or totally counterbalanced by his preference for comparable offers, whereby a penalty of λ is applied to price p_C .

Example 2. Firm C chooses format A and Firm B chooses format B. Then a savvy consumer of type C chooses to buy from $\arg \max_{A,B,C} [v - p_A, v - p_B(1 + \lambda), v - p_C]$. The savvy consumer of type C compares A and C based on their true value ("unshrouded") and penalizes the non-comparable offer of firm B by applying a penalty of λ to price p_B .

2.2 Predictions

We focus on the impact of two parameters: the share μ of *savvy* consumers, and the strength of their preference for comparable offers, measured by the penalty assigned to non-comparable offers λ . We consider predictions from a mixed strategy equilibrium, which would apply to an environment with less information about competitors, and predictions from a model of myopic price adjustments that applies best to an environment with more information about competitors since it requires adopting best responses to the action of others in the preceding period.

One stage equilibrium

There are no pure strategy one-stage Nash equilibria in the game presented above for any value of the parameters λ and μ (see appendix B). Nash equilibria of the one stage version of our game must therefore be in mixed strategies.² We used Gambit, a software tool for game theory (McKelvey *et al.*, 2014), to find the distribution of prices in a Nash equilibrium. We set $p_i \in [0, 5]$, $v = 5$, $e = 1$ as in the experiment. We consider three values for the share of *savvy* consumers μ : $\mu = 0$ as a benchmark, $\mu = 10\%$ and $\mu = 20\%$. We also vary λ , the penalty assigned by *savvy* consumers to non-comparable offers, either $\lambda = 10\%$ or $\lambda = 20\%$. Those values correspond to the proportion of experimental subjects who preferred comparable offers in Crosetto and Gaudeul (2014) and to the penalty they assigned to non-comparable offer. Another reason for choosing such small values is that we are interested in the impact of small deviations from a standard model with product differentiation, where the impact of our modifications is not obvious.

Figure 5 in appendix C shows the cumulative distribution of prices set by firm B in the different treatments. Table 4 gives us the average effective price in each treatment as well as the frequency with which format A is a common standard. Effective price is a weighted average of the price at which goods were effectively sold; it is derived from average profits of firms and does not therefore take account of the prices charged by firms that did not sell. We find that the level of λ does not affect the equilibrium and that the effect of μ is ambiguous. Prices are set in a range between 0.7 and 2.6 ECU and (not shown in the graphs) prices when a firm chooses its own format are higher on average than when it adopts format A.

Dynamics under myopic best response

Another reasonable benchmark in the absence of Nash equilibrium in pure strategies is that firms adopt myopic best response to the decisions by other firms. They choose their actions (price and format) as to maximize their own payoff, assuming the other firms do not change their behavior. If there was no differentiation, then this process would converge towards a Bertrand equilibrium. In our case, this process does not converge because if prices drop too low then a firm can always make some profit by setting its price at the level of the minimum price in the market plus differentiation parameter e , and sell to its own naive consumers. There is thus a constant cycle of price wars followed by abrupt unilateral increases in prices, as in Varian (1980).

²The problem is similar to that in Shaked (1982) for a location model with three firms. That model was tested experimentally in Collins and Sherstyuk (2000).

We ran our simulations for 100 000 periods. Firms play sequentially. Each period, one of the firms that did not change its price last period is randomly chosen to play. Figure 6 in appendix D shows a snippet of the simulation output in the scenario where $\mu = \lambda = 20\%$. The snippet was chosen randomly and it represents recurrent behavior in the simulations. The figure gives a general overview of the stylized facts of myopic best response in our model. First, prices of firms with comparable offers are generally lower (except for firm A which is sometime caught out with a high price while a firm adopts its format and undercuts it). Second, periods with adoption of format A alternate with periods of no adoption. Third, prices are never higher than 3 and never fall to 0. Finally, firms are caught in competitive price undercutting that may or may not involve use of format A. Those downward price spirals are broken when one firm decides to raise its price, adopt its own standard and focus on its naive customers.

While the general pattern of the simulations is rather similar across different values of the parameters, the number of *savvy* consumers and their preference for comparable offers impact aggregate statistics. Figure 7 in appendix E shows the cumulative distribution of prices set by firm B in the different treatments. We find that increases in either λ or μ decrease prices. As in the mixed strategy Nash equilibrium, prices are set in a range between 0.7 and 2.9 and (not shown in the graphs) prices when a firm chooses its own format are higher on average than when it adopts format A.

Table 5 gives us the average and standard deviation of effective prices in each treatment if firms follow myopic best response, as well as the frequency with which format A is a common standard. The number of periods with comparable offers is about the same whenever $\lambda = 10\%$ or $\mu = 10\%$, but is higher when both μ and λ are 20%. Average effective prices become lower with higher μ and λ but the effect of μ is the stronger.

Collusive equilibrium

Denote C the maximum profit attainable under a Nash equilibrium in the one-stage game. The repeated game admits a range of pure strategy Nash equilibria because any collusive payoff profile that gives profit more than C can be sustained given a sufficiently large discount factor. It is however reasonable to expect that colluding firms will converge towards all setting the maximum allowed price (5 in our simulations and experiment). Consider indeed a collusive pure strategy equilibrium of the repeated game with price profile (p_A, p_B, p_C) . If one of those prices is less than 5 then that price can be increased so as not to exceed the minimum existing price by more than ϵ and the firm increases its profits while not lowering profits of others. Other firms are unlikely to retaliate to such a move by breaking away from collusion. Rather, they will follow such a move by themselves increasing their price. As long as all firms do not at any point increase

prices by more than e over the minimum price last period, and as long as any drop in price is punished by a return to a one-stage Nash equilibrium, then firms run no risk to either make zero sales or taking sales away from other firms.

Whether firms can monitor each other will affect their ability to maintain collusion. In a limited information environment, where firms only know their own decisions, breaks in collusion have to be inferred from one's own sales. Sustaining collusion in that case involves not reacting too harshly to drops in sales as those can be due to miscoordination on prices (see Stigler, 1964, for seminal reflections on the theme). Collusion should therefore be more difficult to maintain in a limited information environment. Note however that Vega-Redondo (1997) argues that if firms imitate each other, then more information can lead to more competitive outcomes. Huck *et al.* (2000) provides experimental evidence that supports such an alternative hypothesis.

Summary

In summary, we expect that prices will vary in a range between 0.7 and 2.9 unless collusion establishes itself. Prices are expected to be lower on average in treatments with high μ and λ . Collusion will be indicated by a progressive increase in prices in the market up to the upper allowed limit of 5 and/or prices remaining high (between 3 and 5 ECU) for a number of successive periods. Prices when firms adopt common formats will be lower than when there are no comparable offers and firms initiating the adoption of a common format will price lower than the competition.

3 Experiment

The experiment replicated as closely as possible our model of competition with spurious differentiation. We framed the experiment as a market game whereby firms can produce different models of the same good. The participants were divided in groups of three and acted as managers of one of three firms. They had to decide what price p_i to set for their product, between 0 and 5 in steps of 1¢. Managers of firms B and C also had to decide whether to produce their own model or imitate model A. The demand side of the economy was computerized according to our model. There were 100 virtual consumers of each type, for a grand total of 300 consumers, each buying one unit from one firm. The other parameters were the same as in the simulations, that is $v = 5$, $e = 1$. The different behavior of *naive* and *savvy* consumers followed equations 1 and 2.

Treatments

Our treatments covered two dimensions. First, we wanted to explore behavior faced with different shares μ of *savvy* consumers and with different intensities λ of their preferences for comparable offers. Second, we wanted to explore the effect of the availability of information about prices and sales of the other firms on behavior, especially collusion.

We first replicated the standard market, with $\mu = 0$, as the baseline. The subjects in this baseline treatment could still choose the model for their product but were told that consumers did not care about models. We then set $\mu = 10\%$ or $\mu = 20\%$ and $\lambda = 10\%$ or $\lambda = 20\%$ depending on the treatment. Subjects were aware of the value and significance of those numbers as those were conveyed to them in the instructions (Appendix I), and their understanding was checked with control questions before the experiment could go ahead.

The information manipulation covered two different regimes: *full information* about the past prices, choice of model, sales and profits of their competitors in the present market, or *information limited* to one's own prices, model choice, sales and profit in previous periods in the present market.

There were thus 10 treatments in total, as summarized in the table below along with their labels which we will use for the rest of the exposition. L treatments feature Limited information; F treatments Full information; the numbers in subscript indicate the values of μ and λ .

| | | | | μ | | |
|---------------------|-----------|-----|-------|----------|----------|-----|
| | | | | 0% | 10% | 20% |
| Limited information | λ | 10% | L_0 | L_{11} | L_{21} | |
| | | 20% | | L_{12} | L_{22} | |
| Full information | λ | 10% | F_0 | F_{11} | F_{21} | |
| | | 20% | | F_{12} | F_{22} | |

Table 1: Treatments in the experiment, with labels

Procedure

We ran the experiment in November and December 2013 at the laboratory of the Max Planck Institute in Jena. The experiment involved 300 subjects over 10 sessions, corresponding to each treatment, each with 30 subjects. The experiment lasted about 1 hour and 30 minutes and participants earned 12 euro on average. The experiment was computerized using the Zurich Toolbox for Ready-made Economic Experiments (z-Ttree, Fischbacher, 2007) and subjects were recruited via the Online Recruitment System for Economic Experiments (ORSEE, Greiner, 2004). 92% of our participants were German, the rest mainly coming from East European and

former Soviet Union countries. 58% of the subjects were women. Age was 24 on average and ranged from 17 to 41. 81% of our subjects were full-time students, about half of whom studied social sciences. There were no noticeable differences in the composition of our subject pool across treatments.

We provide an English translation of the original German instructions in appendix I. We made sure that subjects understood the functioning of the market, by letting them experiment various simulated market situations before playing for real. They also had to answer control questions correctly before going on.

The subjects played the game repeatedly, in fixed groups of three, over an indefinite number of periods. We chose an indefinite horizon to avoid endgame effects. At the end of each period, the game continued with the same group with 90% probability; with 10% probability the game ended. The subjects played this indefinite horizon game three times. On each repetition of the game, they were re-matched in a new group of three. To prevent contagion of behavior across repetitions, we implemented perfect stranger matching, which ensured that subjects never played with the same opponents twice and that the opponents they met would not meet each other in subsequent matches. We ran the random mechanism determining the number of periods before the experiment. This resulted in the first matching lasting 22 periods, the second lasting 9 periods and the third lasting 16 periods. With 30 subjects in each session re-matched three times, we therefore observed $10 \text{ markets} \times \text{three matches} = 30 \text{ markets}$ for each of the 10 treatments.

4 Results

Before presenting aggregate statistics, we first give a feeling for the data by looking directly at the prices and formats chosen by subjects over time. Figures 8 and 9 in appendix F show the evolution of prices and adoption of format A in the last matching of treatments F_{22} and L_{22} .

In the treatment with full information, prices are within a narrow range and there are episodes where all prices increase over time. This does not correspond to simulated myopic best response behavior (Figure 6 in appendix D), whereby prices decrease in stages until one firm decides to raise its price. In groups 3 and 6, the maximum price of 5 is reached and maintained at that level until the end. Those groups maintaining high prices also did not adopt format A. This is what we expected to happen if firms colluded. In other groups, at least one firm broke from others and decreased its price once the price of others reached some high level. This is most obvious in Groups 5, 7 and 8. Those breaks usually come with adoption of format A by the firm(s) initiating the decrease in price. The dynamics is less clear in other groups, where firms appear to have less trust in each

other and therefore lower prices even before prices reach higher levels. Some initiate increases in prices without being followed, often because the price increase is too abrupt and thus benefits others without those others having to follow the price increase. From feedback of subjects, some complained indeed of not being followed in their price increases, berating their competitors for not understanding their signal to increase prices. Other, savvier, types underlined how price increases had to be gradual to be followed. Indeed, an abrupt price increase would only signal folly on the part of a manager, while increasing prices gradually indicates prudence, which is more conducive to trust.

In the treatment with limited information, price levels were consistently lower than in the treatment with full information, and there was wider use of format A. Variations in price were also less pronounced.

Having made those observations, we consider how they translate in terms of numbers and interpret the results.

4.1 Treatment effects on prices and adoption of common format

Experimental findings are summarized in table 2, which shows average effective price in each treatment as well as its standard deviation, and the percentage of periods with comparable offers. For this table, we consider each period in each group as one observation, which gives us 470 observations per treatment (47 periods with 10 groups of 3 subjects each period). Figure 10 in appendix G shows the cumulative distribution of prices by treatment.

Table 2: Experimental results, effective price (mean, sd) and share of periods with comparable offers (one period is one observation).

| | | | μ | | |
|---------------------|-----------|-----|-------------|-------------------------------|-----------------------------|
| | | | 0% | 10% | 20% |
| Limited information | λ | 10% | 1.76 (0.62) | 1.71 ⁻⁽⁻⁾ (0.57) | 1.62 ^{*(-)} (0.66) |
| | | 40% | | 48% ^{**(**)} | 54% ^{*(***)} |
| | | 20% | | 1.67 [*] (0.55) | 1.66 ⁻ (0.60) |
| | | | | 57% ^{***} | 68% ^{***} |
| Full information | λ | 10% | 1.86 (0.85) | 1.95 ^{*(***)} (0.83) | 2.05 ⁻⁽⁻⁾ (0.90) |
| | | 33% | | 42% ^{***(-)} | 44% ^{-(*)} |
| | | 20% | | 1.77 ⁻ (0.83) | 2.14 ^{***} (1.06) |
| | | | | 40% ^{**} | 37% ⁻ |

Wilcoxon rank-sum test for effective price, 1-sided Fisher's exact test for periods with comparable offers.

Significance of difference w.r.t. value on the left (difference w.r.t. value below in parenthesis), - (p>0.05), * (p<0.05), ** (p<0.01), *** (p<0.001).

In the *full information* case, we find that prices were higher than simu-

lated under myopic best response (table 5), and prices also exhibited higher variance. The number of periods with comparable offers was slightly higher than in our simulations. Effective prices were higher in treatments with higher μ and λ , with the exception of treatment F_{12} .

In the *limited information* treatments, we find that prices were lower on average than in the full information treatment, and the frequency with which comparable offers were presented was higher. Standard deviation in prices was also lower. Prices were lower and common formats were more frequent in treatments with higher μ and λ .

We consider an alternative statistic, the group means of price and format adoption, which results in 30 observations per treatment (table 6, appendix H). We also consider results in the third and last matching, which lasted 16 periods (table 7, appendix H). We see what results are robust from a qualitative point of view: higher prices in treatments with higher μ if there was full information, more use of format A in treatments with higher μ and λ when there was limited information,

The presence of savvy consumers thus appears not to have had a robust effect on prices in the case of limited information, but it increased prices in the case of full information. In terms of format adoption, higher portions of savvy consumers with stronger preferences for comparable offers increased the frequency with which comparable offers were available in the case of limited information. This was not the case however when there was full information, where the tendency was rather towards less frequent availability of comparable offers.

In the following, we will defend the hypothesis that in the *full information* case firms were able to collude and thus raise their prices. We will show that low prices in periods in which comparable offers were available made supporting collusion easier in treatments with high μ and λ . This is because high μ and λ led to lower prices in periods with comparable offers.

In treatments with *limited information* on the other hand, firms were prevented from colluding as effectively as in the full information case. Firms adopted format A mainly as a preventive measure in order to be less vulnerable to being undercut by others.

Our main result will be that having more savvy consumers lowered welfare in treatments with full information, while it improved welfare in treatments with limited information, though mainly only for savvy consumers. This result will be interpreted in view of two counter-acting factors: one is that periods with comparable offers became more competitive and/or more frequent as μ and λ increased, the other being that periods with collusion and thus higher prices also became more frequent.

Adopting format A was made more dangerous for the competition when μ and λ were higher, which made its use more effective as a punishment for breaking collusion. Refraining from adopting format A in the treatments

with full information, on the other hand, gave a clear signal of not wanting to compete. This therefore made non-adoption of format A a good signal for wanting to collude. In treatments with limited information, adoption or non-adoption of format A was not public so it could not act as a coordination tool. When prices were high, not adopting format A enabled firms to avoid inadvertently stealing away consumers from the competition and thus triggering a price war. When prices were low, adopting format A was a way to ensure not losing savvy consumers to lower priced rivals.

4.2 The prevalence of collusion

Definition. We say a firm is colluding if it could have increased its profit *and* lowered the profit of at least another firm by changing its decisions given the decisions of its competitors in the given period.

This definition of collusion assumes perfect foresight on the part of managers and is therefore not realistic. On the other hand, if firms are indeed setting prices and formats in a collusive way, then they ought to be able to predict the behavior of their competitors in the next period.

Table 3 gives the share of periods in each treatment in which three firms colluded and the average effective price in those periods. Almost all periods exhibited collusion by two or more firms under our definition. Indeed, firms can almost always increase their profit at the expense of another firm by adopting its format and undercutting it, and not doing so is deemed collusive under our definition. We therefore consider only periods in which all three firms colluded as exhibiting established collusion.

Table 3: Experimental results, prices (mean, sd) and share of periods with all firms colluding during those periods.

| | | | μ | | |
|---------------------|-----------|-----|-------------|-------------|-------------|
| | | | 0% | 10% | 20% |
| Limited information | λ | 10% | 2.19 (0.56) | 2.02 (0.46) | 2.01 (0.56) |
| | | 20% | 42% | 1.98 (0.47) | 1.84 (0.58) |
| | | | | 56% | 53% |
| | | | | 52% | 69% |
| Full information | λ | 10% | 2.46 (0.87) | 2.29 (0.79) | 2.33 (0.90) |
| | | 20% | 43% | 2.28 (0.83) | 2.51 (1.09) |
| | | | | 60% | 70% |
| | | | | 47% | 65% |

There was a high prevalence of collusion and the prevalence of collusion was higher in treatments with $\mu > 0$ than in treatments with $\mu = 0$. Prices during collusion periods were higher than average prices. We show

in the following the correlation between collusion and not adopting format A (Section 4.2.1), and the correlation between low prices and adopting format A (Section 4.2.2). There was a close link between collusion and not adopting format A since adopting format A makes sense only if one wishes to undercut another firm. Indeed, we think that not adopting format A was seen by other firms as a signal that one did not wish to compete, and therefore the possibility of adopting format A may have made it easier for firms to coordinate on collusion in the markets with full information.

4.2.1 Collusion and adoption of format A

We relate in figure 1 format adoption by firms and the number of firms deemed to be colluding under our definition. The pattern is the same in every treatment, so we aggregate all treatments with limited information and all those with full information.

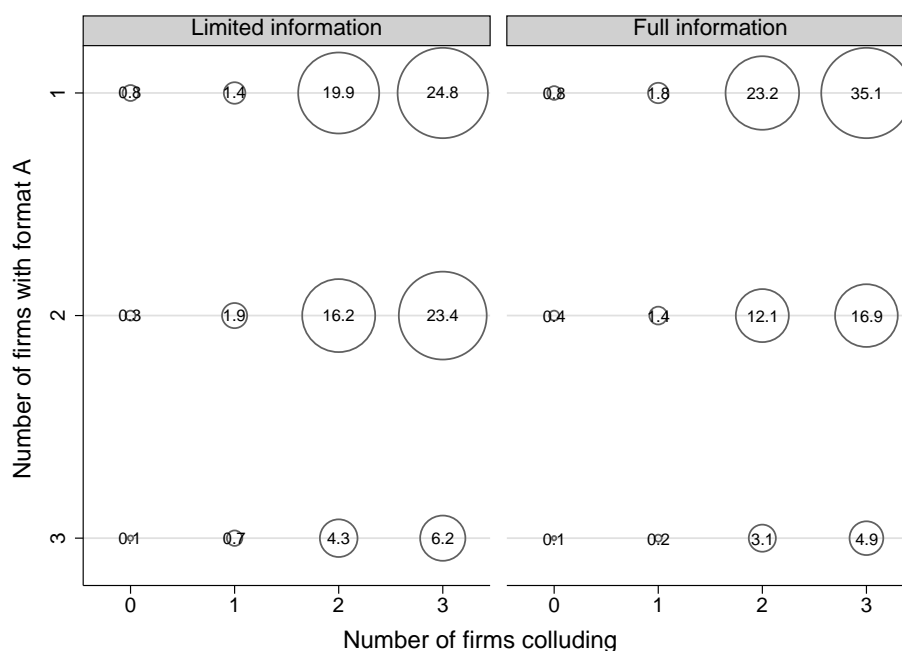


Figure 1: Correlation between not adopting format A and collusion, by informational condition.

Figure 1 shows a clear correlation between periods with collusion and periods with no common formats (only firm A with format A). This indicates that firms could make a clear association between being willing to

collude and not adopting format A, so that not adopting format A might have been used as a signal of the willingness to collude.

4.2.2 Competition in the presence of comparable offers

Table 2 shows prices when there were no comparable offers – that is, the offered formats were (A,B,C) –, two comparable offers – that is, chosen formats were (A,A,C) or (A,B,A) –, and three comparable offers – (A,A,A) –, by treatment.

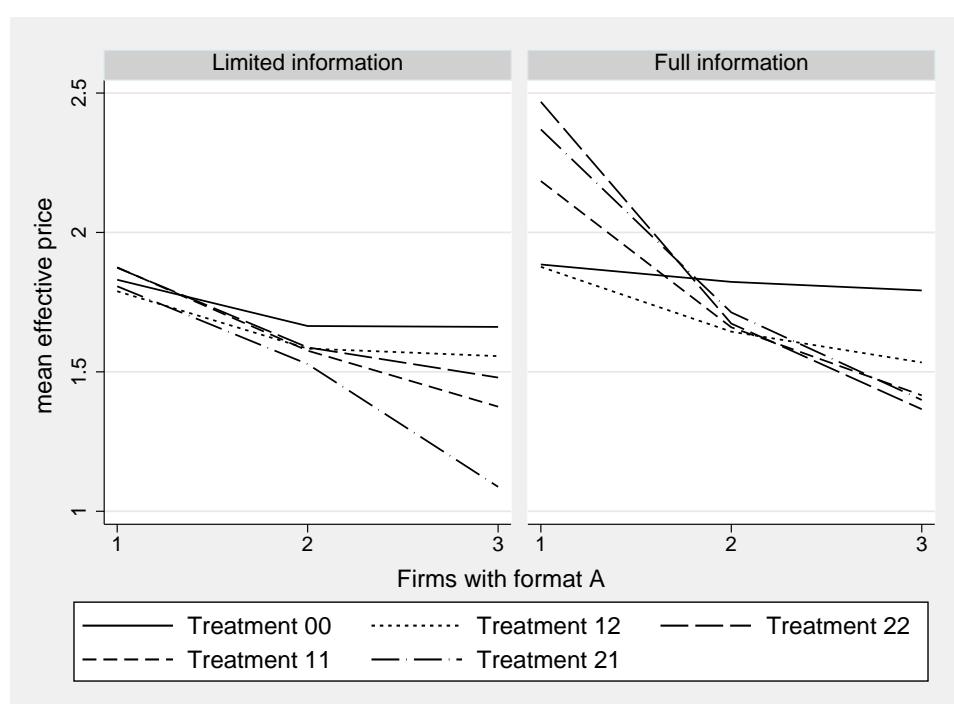


Figure 2: Mean effective prices, by adoption of format A and by treatment.

Considering treatments where $\mu = 0$, adopting format A was associated with slightly more competition in terms of price in the case with limited information. Some subjects may have thought that adopting format A would help them gain sales even though it was stated that this was not the case, or adopting format A was used to reinforce the message sent when lowering one's price, i.e. "not only do I take your customers, but I also imitate your product".

The difference between prices with no comparable offers and with comparable offers was however higher in treatments with $\mu > 0$, which means

that periods with comparable offers were associated with comparatively stronger competition. Subjects adopted format A along with decreasing their prices and/or adopted format A in periods with low prices. We also observe that the difference in price between periods with and without comparable offers was particularly high in treatments with full information, and this difference increased with higher μ and λ . This supports our view whereby adoption of format A was associated with punishment periods, while periods without comparable offers were periods of tacit collusion. The more the adoption of format A was dangerous for the competition, the more not adopting format A may have been seen as a sign that one wished to collude. The availability of format A thus provided a coordination mechanism that supported higher levels of collusion in full information treatments. In the case of treatments with limited information, not adopting format A could not be used as a signal to other firms one wished to collude, but it could still be used to lower the probability that one would inadvertently steal consumers away from the competition and thus trigger a period of intense price competition.

4.3 Welfare analysis

We discuss in this part the impact of increases in λ and μ on savvy vs. naive consumers. One of the main ideas in Gaudeul and Sugden (2012) is that periods of strong competition and low prices will be periods with common formats, and that firms with common formats will have lower prices than others. The paper then suggests that even a small proportion of savvy consumers in the market would encourage firms to adopt format A when there is strong competition, so that consumers would learn to associate common formats with low prices and thus learn to buy from firms with comparable offers. We therefore check that savvy consumers were indeed better off than naive consumers in our experiment. Figure 3 shows the average price paid by a savvy consumer *vs.* the average price paid by a naive consumer, by treatment. There were no savvy consumers when $\mu = 0$, but this does not prevent us from determining which firm a savvy consumer would have bought from in that treatment.

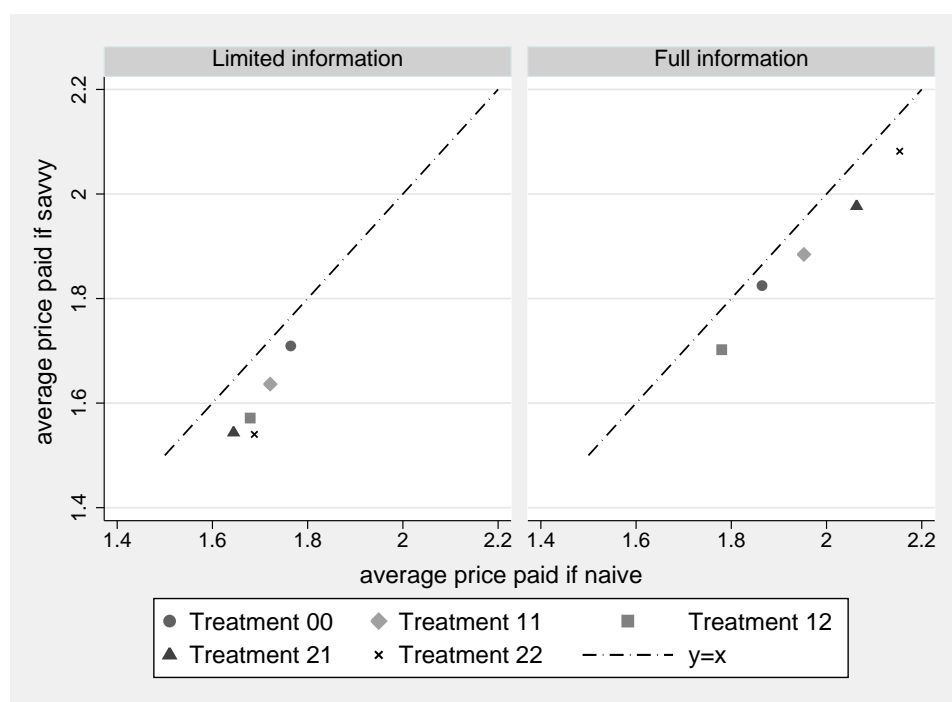


Figure 3: Price paid by savvy and by naive consumers, by treatment.

Prices paid by savvy consumers were lower on average than those paid by naive consumers. However, when only two firms adopted format A, it was sometime the case that the dominant comparable offer was more expensive than the non-standard product (16% of the cases), in which case a savvy consumer could end up paying more than a naive one. In treatments with limited information, both savvy and naive consumers benefited as μ and λ increased, but the difference in the average price paid by both types increased, meaning that savvy consumers benefited more. In treatments with full information, both savvy and naive consumers suffered as μ and λ increased, and the difference in the prices they paid did not increase or decrease.

4.4 Further research

Further research could focus on understanding the different role of parameters μ and λ in encouraging or discouraging collusion. μ is the proportion of savvy consumers – those who prefer comparable offers – and λ is the strength of their dislike for non-comparable offers. μ high and λ low can encourage a firm not to present comparable offers when comparable offers are already on the market. Indeed, with only two comparable offers, savvy

consumers are split between two offers, the dominant comparable offer and the non-comparable offer. Switching to the common format then leads to a drop in one's share of savvy consumers if λ is low enough. It would therefore be interesting to investigate the cases with $\lambda = 0$ and $\mu > 0$ whereby consumers perform only dominance editing (see page 7).

Another area of interest is the different impact of an increase in μ and λ depending on the informational context. Intuitively, what matters in the full information environment is μ , the share of consumers who can be gained by adopting a common format. Indeed, since firms can infer each other's prices more accurately, they are better able to set their price so that savvy consumers of the non-comparable firm also buy from them – this depends on the level of λ . In the limited information environment on the other hand, the level of λ is more important because firms have less precise information about the prices of their competitors so that a high λ is necessary to ensure reasonable chances to gain all savvy consumers to one's product. We did not observe such differences in the impact of μ and λ across our two informational environments, but this may be due to those parameters not varying much across sub-treatments.

5 Conclusion

We analyzed a model of competition with shrouding by varying the degrees of sophistication of consumers and the amount of information managers had about their competitors. We found that firms were able to collude in shrouding their offers if information about their competitors was available. They were then able to avoid the low prices and profits that were triggered when they made their offers comparable. We underlined the paradoxical result whereby being able to choose to make prices transparent could help sustain collusion. This was the result of two concurrent effects: 1) Not presenting comparable offers served as a signal that one wished to make peace with others (in a context with full information), or made it less likely one would take customers from others (in a context with limited information). 2) Presenting comparable offers made the punishment phases harder on the deviating firm(s), thereby making collusion easier to sustain. The effect was more pronounced in a context with full information about the action of competitors, due to the signaling aspect of not adopting a common format and the possibility to quickly spot deviations from a tacit collusive agreement.

Overall, we found that the presence of savvy consumers enhanced consumer welfare only in treatments where firms could not monitor each other. This is because collusion was more difficult to sustain in that environment. Treatments with higher proportion of savvy consumers had more competitive outcomes; and while savvy consumers benefited more than naive ones

from this, naive consumers also benefited.

In treatments where firms could monitor each other, however, collusion was easier to sustain in treatments with higher number of savvy consumers. This was because the alternative to collusion was then correspondingly harsher punishment. Both savvy and naive consumers suffered in treatments with higher number of savvy consumers.

This experiment underlines the two-faced nature of competition when firms can choose how hard to compete. On the one hand, being able to choose a common format can induce firms to make their offers comparable if they are not able to monitor each other closely. On the other hand, if firms can monitor each other, then refraining from adopting a common format can be used as a signal that one is willing to collude, thus facilitating collusion, while choosing a common format can be used to punish harder those firms that do not collude.

From a practical point of view, encouraging consumers to favor comparable offers can therefore have an adverse effect if one does not also limit the ability of firms to check each other's prices and choice of formats. Such limitations, whereby firms are prevented from checking that their competitor does not help consumers compare their product with the competition, ought to be sufficient to break up a confusopoly. Those limitations are however difficult to enforce in consumer markets: There is no one-to-one negotiation between firms and consumers, and firms often do not even know to whom they sell. Firms can therefore simply shop the product of competitors and investigate their sales pitch without having to reveal their identity. This makes it very difficult to make one's product comparable with others without this being noticed and retaliated against.

Consumer protection may therefore involve forcing firms to present prices in a common format. Unit price information is already generally available or even mandated in supermarkets. Some standardization is also present at the national level for presenting lending rates in terms of annual percentage rate of charge. There is however a lot of progress to be made for example in the automobile market, where fuel economy information is often misleading and wrongly conveyed. Agreeing on common formats for measuring the performance and prices of different type of relatively undifferentiated products could therefore be a valuable extension to the efforts that have led to the progressive spread of the metric system for physical measurements.

References

- Adams, S. (1997). *The Dilbert Future: Thriving on Stupidity in the 21st Century*. HarperCollins Publishers.
- Aoyagi, M. and Fréchette, G. (2009). Collusion as public monitoring be-

- comes noisy: Experimental evidence. *Journal of Economic Theory*, **144** (3), 1135–1165.
- Beales, H., Craswell, R. and Salop, S. (1981). Information remedies for consumer protection. *American Economic Review*, **71** (2), 410–413.
- Besen, S. M. and Farrell, J. (1994). Choosing how to compete: Strategies and tactics in standardization. *Journal of Economic Perspectives*, **8** (2), 117–131.
- Boone, J., Aylwin, M. J. L., Müller, W. and Chaudhuri, A. R. (2012). Bertrand competition with asymmetric costs: Experimental evidence. *Economics Letters*, **117** (1), 134–137.
- Bruttel, L. V. (2009). Group dynamics in experimental studies—The Bertrand Paradox revisited. *Journal of Economic Behavior & Organization*, **69** (1), 51–63.
- Carlin, B. I. (2009). Strategic price complexity in retail financial markets. *Journal of Financial Economics*, **91** (3), 278–287.
- Célérier, C. and Vallée, B. (2013). What drives financial complexity?: A look into the european retail structured products market. *HEC Paris Research Paper*, FIN-2013-1013.
- Chioveanu, I. and Zhou, J. (2013). Price competition with consumer confusion. *Management Science*, **59** (11), 2450–2469.
- Collins, R. and Sherstyuk, K. (2000). Spatial competition with three firms: an experimental study. *Economic Inquiry*, **38** (1), 73–94.
- Crosetto, P. and Gaudeul, A. (2014). Testing the strength and robustness of the attraction effect in consumer decision making. *Jena Economics Research Paper*, #2014-021.
- Davis, D. (2011). Behavioral convergence properties of Cournot and Bertrand markets: An experimental analysis. *Journal of Economic Behavior & Organization*, **80** (3), 443–458.
- Dufwenberg, M. and Gneezy, U. (2000). Price competition and market concentration: An experimental study. *International Journal of Industrial Organization*, **18** (1), 7–22.
- Dugar, S. and Mitra, A. (2009). The size of the cost asymmetry and Bertrand competition: Experimental evidence. *Working Paper*, University of Calgary and University of Arizona.
- Ellison, G. (2005). A model of add-on pricing. *Quarterly Journal of Economics*, **120** (2), 585–637.

- and Ellison, S. (2009). Search, obfuscation, and price elasticities on the Internet. *Econometrica*, **77** (2), 427–452.
- and Wolitzky, A. (2012). A search cost model of obfuscation. *The RAND Journal of Economics*, **43** (3), 417–441.
- Ericson, K. M. M. and Starc, A. (2013). How product standardization affects choice: Evidence from the Massachusetts Health Insurance Exchange. *NBER Working Paper*, **19527**.
- Fischbacher, U. (2007). z-Tree: Zurich toolbox for ready-made economic experiments. *Experimental Economics*, **10** (2), 171–178.
- Gabaix, X. and Laibson, D. (2006). Shrouded attributes, consumer myopia, and information suppression in competitive markets. *The Quarterly Journal of Economics*, **121** (2), 505–540.
- Garrod, L., Hviid, M., Loomes, G. and Price, C. W. (2009). Competition remedies in consumer markets. *Loyola Consumer Law Review*, **21** (4), 439–495.
- Gaudeul, A. and Sugden, R. (2012). Spurious complexity and common standards in markets for consumer goods. *Economica*, **79** (314), 209–225.
- Greiner, B. (2004). An online recruitment system for economic experiments. In K. Kremer and V. Macho (eds.), *Forschung und wissenschaftliches Rechnen, GWDG-Bericht Nr. 63*, Gesellschaft für Wissenschaftliche Datenverarbeitung, Göttingen, pp. 79–93.
- Heidhues, P., Koszegi, B. and Murooka, T. (2012). The market for deceptive products. *Working Paper*, University of California, Berkeley.
- Hossain, T. and Morgan, J. (2007). ...plus shipping and handling: Revenue (non) equivalence in field experiments on eBay. *The B.E. Journal of Economic Analysis & Policy*, **6** (2).
- Huber, J., Payne, J. W. and Puto, C. (1982). Adding asymmetrically dominated alternatives: Violations of regularity and the similarity hypothesis. *Journal of Consumer Research*, **9** (1), 90–98.
- and Puto, C. (1983). Market boundaries and product choice: Illustrating attraction and substitution effects. *Journal of Consumer Research*, **10** (1), 31–41.
- Huck, S., Normann, H.-T. and Oechssler, J. (2000). Does information about competitors' actions increase or decrease competition in experimental oligopoly markets? *International Journal of Industrial Organization*, **18** (1), 39 – 57.

- , — and — (2004). Two are few and four are many: number effects in experimental oligopolies. *Journal of Economic Behavior & Organization*, **53** (4), 435 – 446.
- Kalayci, K. (2011). Price complexity and buyer confusion in markets. *Netspar Discussion Paper*, no. 10/2011-082.
- and Potters, J. (2011). Buyer confusion and market prices. *International Journal of Industrial Organization*, **29** (1), 14–22.
- Keser, C. (1993). Some results of experimental duopoly markets with demand inertia. *The Journal of Industrial Economics*, **41** (2), 133–151.
- (2000). Cooperation in symmetric duopolies with demand inertia. *International Journal of Industrial Organization*, **18** (1), 23–38.
- McDonald, S. and Wren, C. (2013). Multiple price posting and consumer search obfuscation: Evidence from an online market. *Working Paper*, Newcastle University Business School.
- McKelvey, R. D., McLennan, A. M. and Turocy, T. L. (2014). Gambit: Software tools for game theory, version 14.0.2.
- Mehta, J. (2013). The discourse of bounded rationality in academic and policy arenas: Pathologising the errant consumer. *Cambridge Journal of Economics*, **37** (6), 1243–1261.
- Muir, D., Seim, K. and Vitorino, M. (2013). Price obfuscation and consumer search: An empirical analysis. *Working Paper*, University of Pennsylvania and University of Minnesota.
- Perloff, J. M. and Salop, S. C. (1985). Equilibrium with product differentiation. *The Review of Economic Studies*, **52** (1), 107–120.
- Piccione, M. and Spiegler, R. (2012). Price competition under limited comparability. *The Quarterly Journal of Economics*, **127** (1), 97–135.
- Salop, S. and Stiglitz, J. (1977). Bargains and ripoffs: A model of monopolistically competitive price dispersion. *The Review of Economic Studies*, **44** (3), 493–510.
- Scitovsky (1950). Ignorance as a source of oligopoly power. *American Economic Review*, **40** (2), 48–53.
- Shaked, A. (1982). Existence and computation of mixed strategy Nash equilibrium for 3-firms location problem. *The Journal of Industrial Economics*, **31** (1/2), 93–96.

- Shchepetova, A. (2012). Strategic limitation of price comparison by competing firms: An experimental study. *Working Paper*, Toulouse School of Economics.
- Simonson, I. (1989). Choice based on reasons: The case of attraction and compromise effects. *Journal of Consumer Research*, **16** (2), 158–174.
- Sitzia, S. and Zizzo, D. (2011). Does product complexity matter for competition in experimental retail markets? *Theory and Decision*, **70** (1), 65–82.
- Sluijs, J. P., Schuett, F. and Henze, B. (2011). Transparency regulation in broadband markets: Lessons from experimental research. *Telecommunications Policy*, **35** (7), 592–602.
- Spiegler (2006). Competition over agents with boundedly rational expectations. *Theoretical Economics*, **1** (2), 207–231.
- Spiegler, R. (2014). Competitive framing. *American Economic Journal: Microeconomics*, **6** (3), 35–58.
- Stigler, G. J. (1964). A theory of oligopoly. *Journal of Political Economy*, **72** (1), 44–61.
- Tversky, A. and Simonson, I. (1993). Context-dependent preferences. *Management Science*, **39** (10), 1179–1189.
- Varian, H. (1980). A model of sales. *American Economic Review*, **70** (4), 651–659.
- Vega-Redondo, F. (1997). The evolution of Walrasian behavior. *Econometrica*, **65** (2), 375–384.
- Wenzel, T. (2013). Naive consumers, banking competition, and ATM pricing. *Review of Network Economics*, **12** (3), 271–286.
- (2014). Consumer myopia, competition and the incentives to unshroud add-on information. *Journal of Economic Behavior & Organization*, **98**, 89–96.
- Wiktionary (2014a). Confusopoly. Accessed on 06/10/2014.
- (2014b). Obfuscation. Accessed on 11/10/2014.
- Wilson, C. (2010). Ordered search and equilibrium obfuscation. *International Journal of Industrial Organization*, **28** (5), 496–506.
- Wright, J. (2013). Punishment strategies in repeated games: Evidence from experimental markets. *Games and Economic Behavior*, **82**, 91–102.

A Visual representation of the market

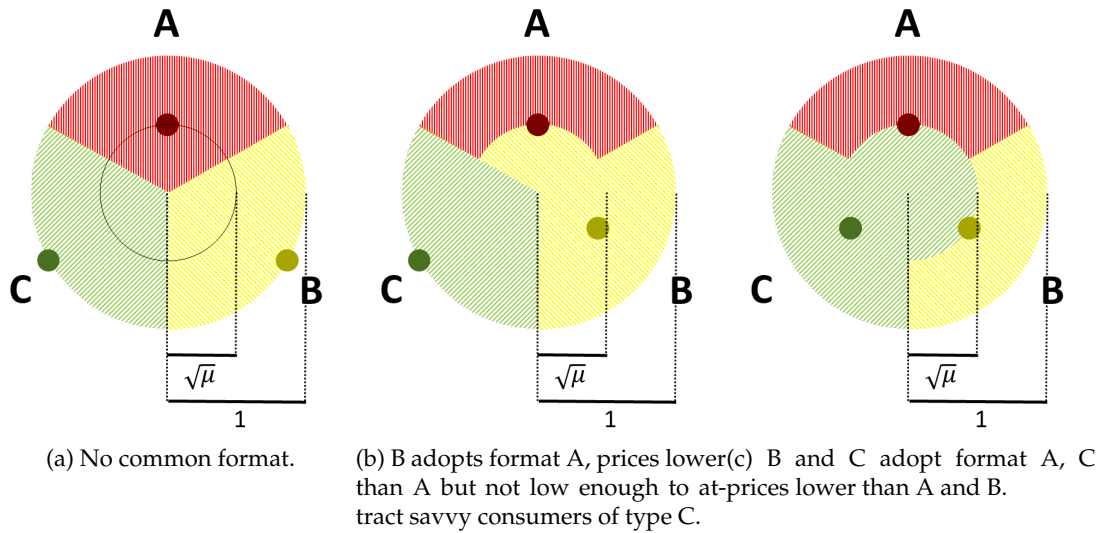


Figure 4: Different configurations of a Chrome™ market.

We show areas covered by each firm within two concentric circles. The inner circles contains savvy consumers and has radius $\sqrt{\mu}$. Each firm is favored by a third of the consumers. Firms that adopt their own format are represented by a point on the outer circle and firms that adopt format A by a point on the inner circle. Denote $p = \{p_A, p_B, p_C\}$. The first figure shows the case with no common format when $\max p - \min p \leq e$ (condition 1). The second figure shows the case where only firm B adopts standard A, $p_C(1 + \lambda) - e < p_B < p_A$ and condition 1 is verified. The third figure shows the case where all firms adopt standard A, $p_C < \min \{p_A, p_B\}$ and condition 1 is verified.

B Equilibria of the price and format setting game

Proposition 3. *There is no pure strategy Nash equilibrium if firms all must adopt their own standard and can choose only prices.*

Proof. Suppose there is no possibility to imitate the format of firm A - i.e., firms can choose only their price. For simplicity, assume that a consumer who is indifferent between two goods will buy from his preferred firm. Denote ζ the lowest currency unit. Note first that all firms must be making sales (condition A). Indeed, a firm can always set price $p = e$ and sell to its own customers and no firm can profitably undercut that price. Consider now a candidate Nash equilibrium in pure-strategies with prices

$p = (p_A, p_B, p_C)$, and denote p_{\min} the lowest price of firm B's rivals in the market and p_{\max} the highest. Note that $p_{\max} - p_{\min} \leq e$ (condition B) otherwise one of those two firms is not making sales, which contradicts condition A. Firm B's best response is to set either $p' = p_{\min} - e - \zeta$ and sell to $3N$ consumers, or $p' = p_{\max} - e - \zeta$ and sell to $2N$ consumers if $p_{\max} - p_{\min} > \zeta$, $3N$ else, or $p' = p_{\min} + e$ and sell to N consumers. By condition A, firm B's price must be $p_{\min} + e$. Therefore prices in equilibrium must have elements $p = (p_{\min}, p_{\max}, p_{\min} + e)$ in any order. By the same reasoning, we must have $p_{\max} = p_{\min} + e$ (best response). However, the lowest priced firm then has an incentive to either increase its price by e or lower it by ζ . \square

Proposition 4. *There is no pure strategy Nash equilibrium if firms can choose both prices and format.*

Proof. Suppose there is the possibility for firms B and C to adopt format A as well as to choose prices. Consider as before a candidate Nash equilibrium in pure-strategies with prices $p = (p_A, p_B, p_C)$ and suppose that firm C adopted format A. Firm C's price must be p_{\min} because otherwise it is not selling to its own savvy consumers and would therefore be better off keeping its own format. Firm A's price is therefore p_{\max} . The only case under which firm B adopts format A is if it sets $p_B = p_{\min} - \zeta$ but then firm C would be better off keeping its own format. Firm B must therefore be keeping its own format. By the same reasoning as before, the vector of prices in equilibrium must have elements $(p_{\min}, p_{\min} + e, p_{\min} + e)$ with only one firm other than firm A adopting format A and setting price p_{\min} . However in that case, the lowest priced firm has an incentive to either increase or decrease prices. \square

C Prices set by firm B under mixed strategies.

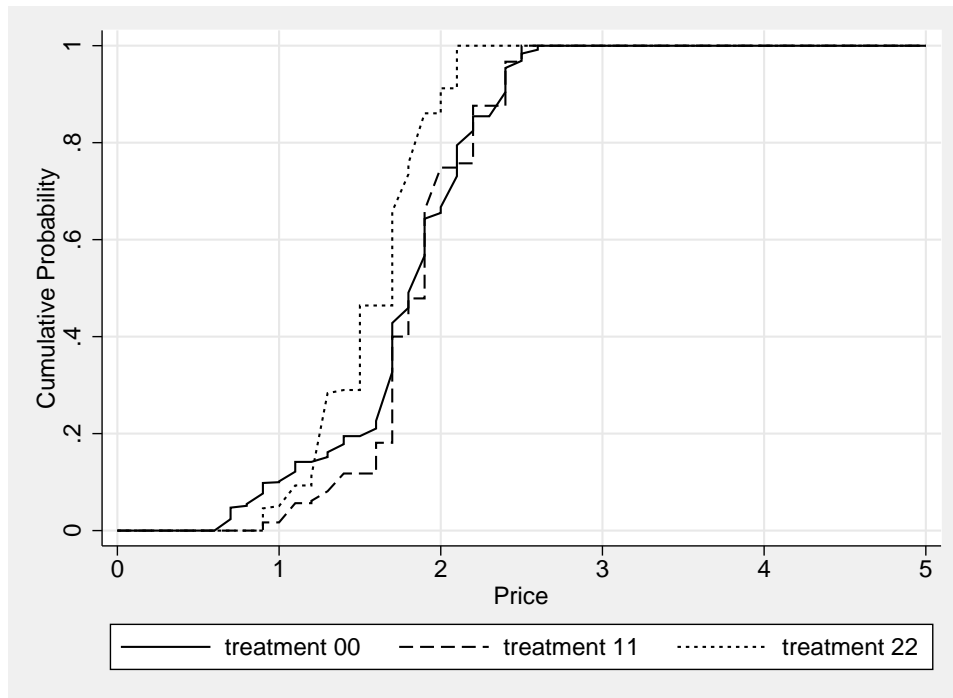


Figure 5: Cumulative distribution of prices set by firm B under mixed strategies, by treatment.

Table 4: Mixed strategies, effective price (mean) and share of periods with comparable offers.

| | | μ | | |
|-----------|-----|-------|------|------|
| | | 0% | 10% | 20% |
| λ | 10% | 1.61 | 1.74 | 1.49 |
| | 75% | | 48% | 33% |
| | | | 1.74 | 1.49 |
| | 20% | | 48% | 33% |

D Simulated price evolution and format adoption under myopic best response.

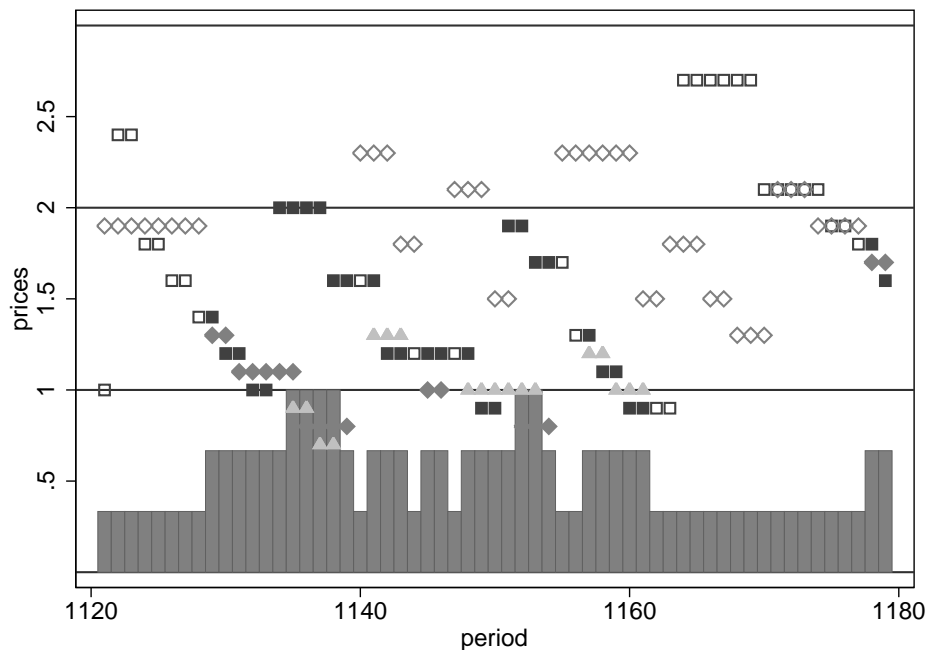


Figure 6: Simulated evolution of prices and fraction of firms with format A.

The figure shows (on abscissa) the price chosen by each firm in periods 1120 to 1180 of the simulation for treatment ($\mu = \lambda = 20\%$). Each shape (square, lozenge, triangle) corresponds to a firm, with firm A corresponding to the squares. Full shapes indicates the firm chose format A (in the case of firm B and C) or format A was a common format (in the case of firm A). Empty shapes indicate the firm chose its own format (firms B and C) or only firm A adopted format A (firm A). The grey bars represent the proportion of firms with format A in each period (from 1/3 - firm A only - to 1 - all firms) over time.

E Distribution of prices under myopic best response.

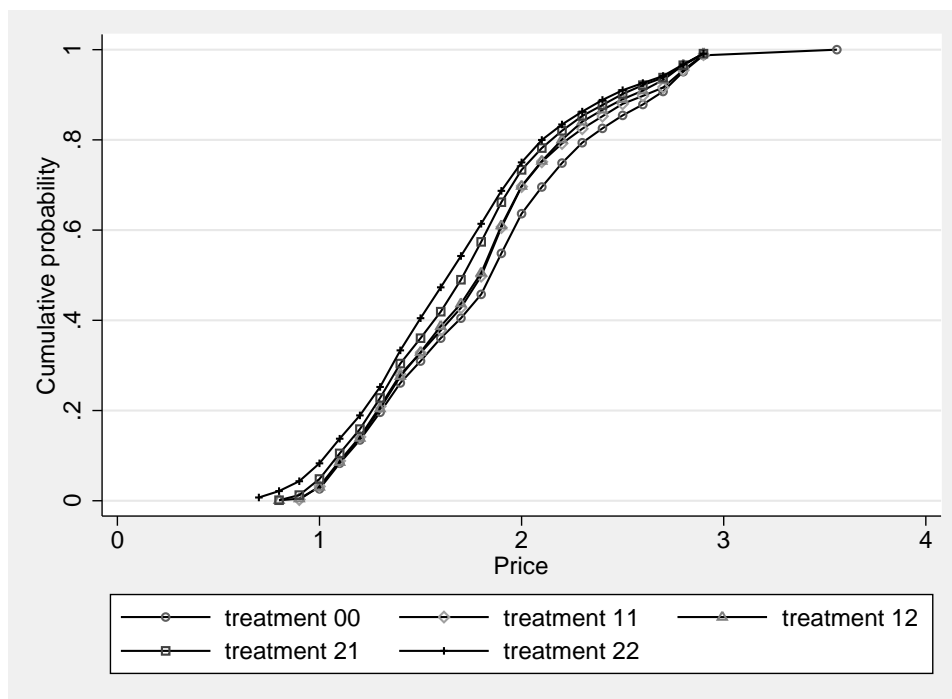


Figure 7: Cumulative distribution of simulated prices set by firm B, by treatment.

Table 5: Myopic best response, effective price (mean, sd) and share of periods with comparable offers.

| | | 0% | μ 10% | 20% |
|-----------|-----|-------------|--------------|-------------|
| λ | 10% | 1.63 (0.34) | 1.62 (0.34) | 1.56 (0.35) |
| | | NA | 41% | 42% |
| | 20% | | 1.59 (0.34) | 1.53 (0.36) |
| | | | 40% | 45% |

F Empirical price evolution and format adoption.

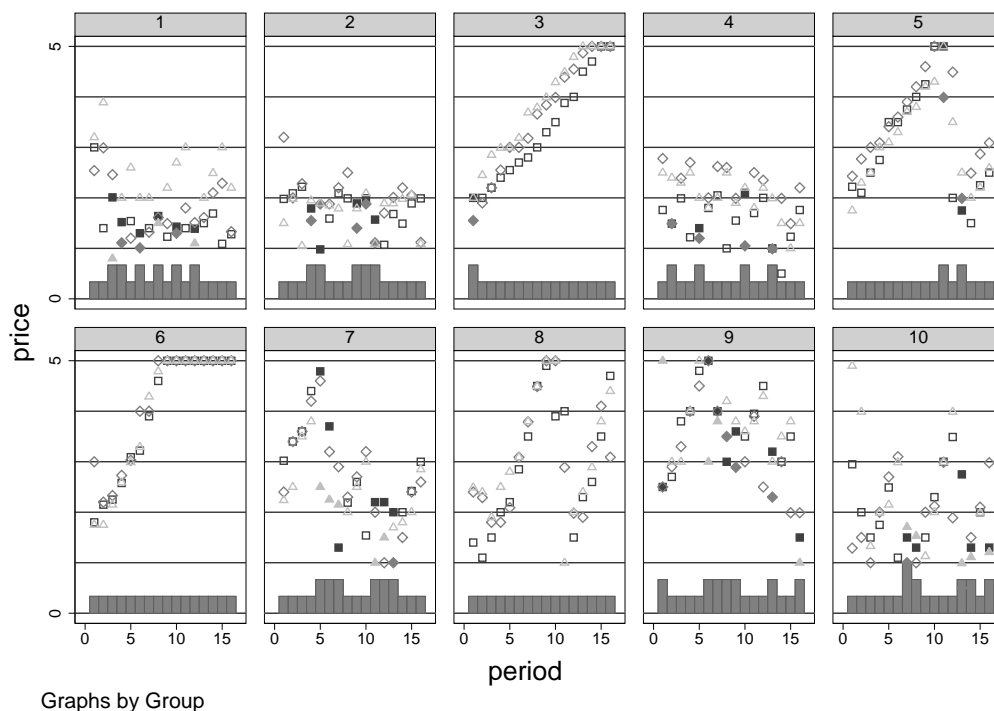


Figure 8: Prices and fraction of firms with format A, Phase 3, Treatment F_{22} . Each shape (square, lozenge, triangle) corresponds to a firm, with firm A corresponding to the squares. Full shapes indicates the firm chose format A (in the case of firm B and C) or format A was a common format (in the case of firm A). Empty shapes indicate the firm chose its own format (firms B and C) or only firm A adopted format A (firm A). The grey bars represent the proportion of firms with format A in each period (from 1/3 - firm A only - to 1 - all firms).

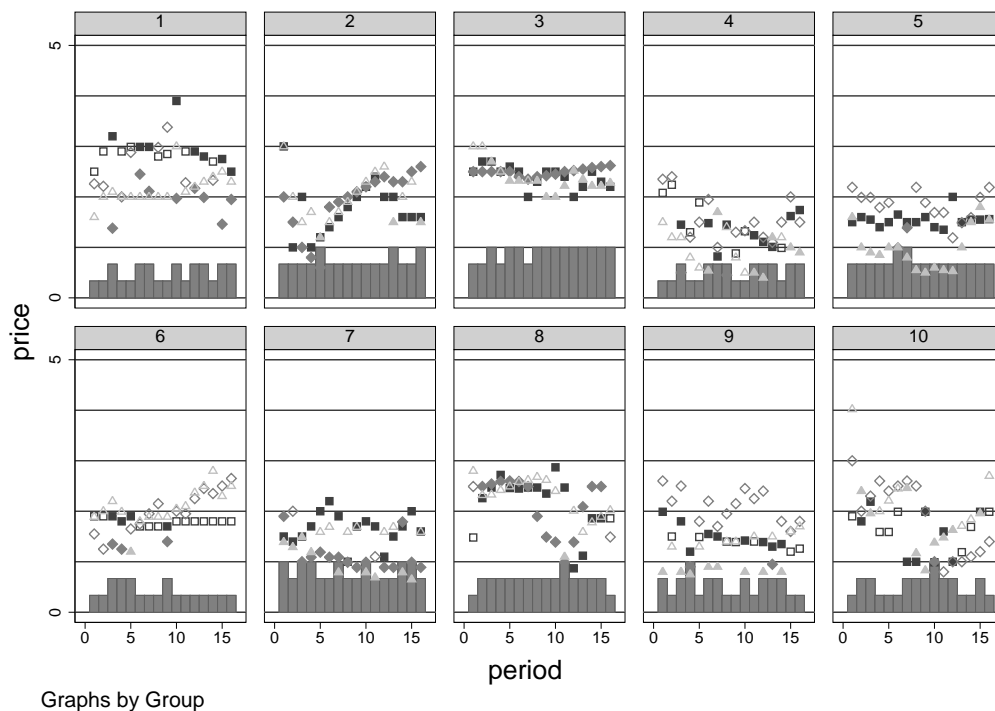
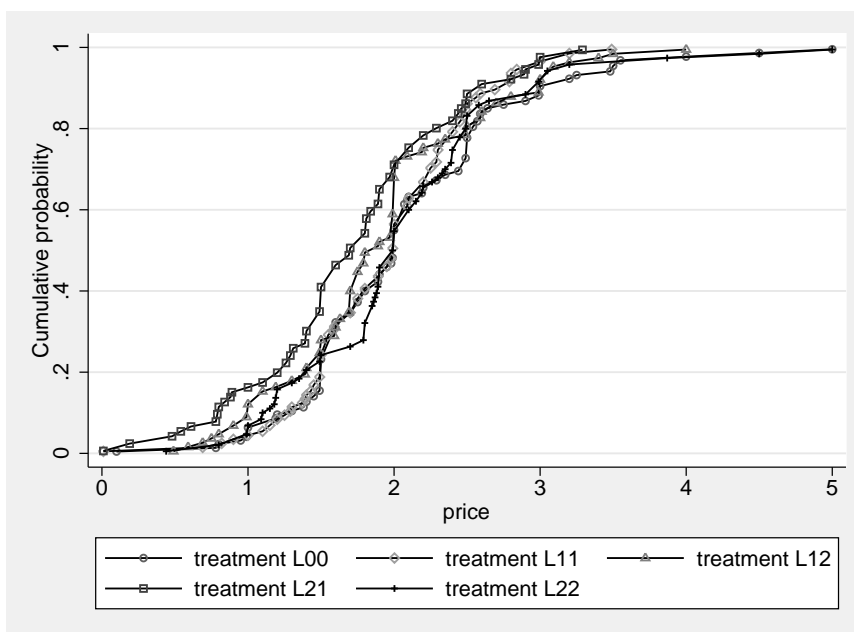
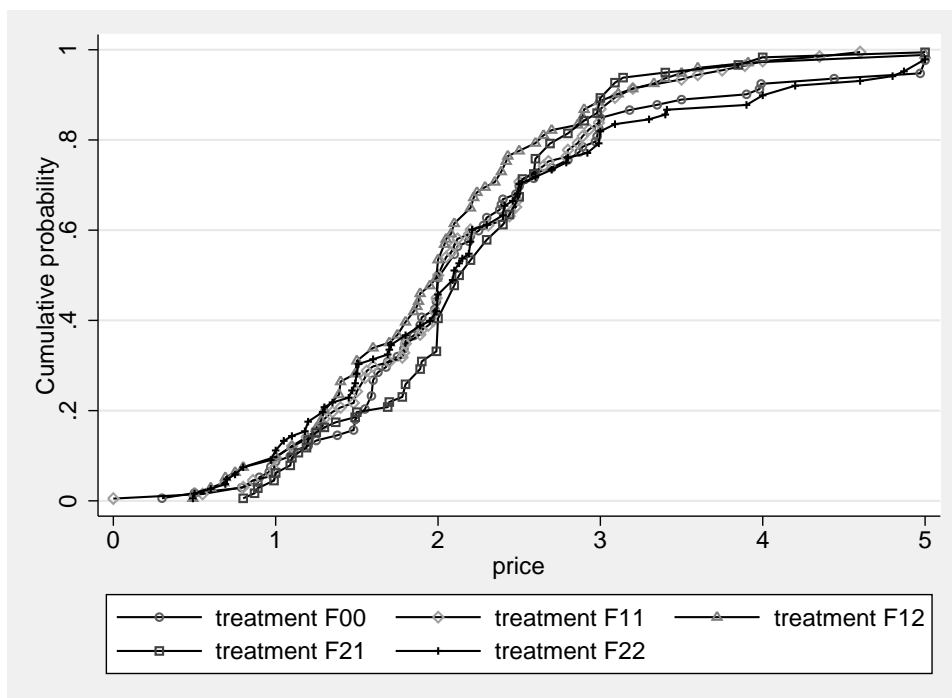


Figure 9: Prices and fraction of firms with format A, Phase 3, Treatment L_{22} . Each shape (square, lozenge, triangle) corresponds to a firm, with firm A corresponding to the squares. Full shapes indicates the firm chose format A (in the case of firm B and C) or format A was a common format (in the case of firm A). Empty shapes indicate the firm chose its own format (firms B and C) or only firm A adopted format A (firm A). The grey bars represent the proportion of firms with format A in each period (from $1/3$ - firm A only - to 1 - all firms).

G Empirical distribution of prices.



(a) Limited information



(b) Full information

Figure 10: Cumulative distribution of prices set by firm B, by treatment and information condition.

H Robustness checks

Table 6: Experimental results, effective price (mean, sd) and share of periods with comparable offers, one group is one observation.

| | | | 0% | μ 10% | 20% |
|---------------------|-----------|-----|--------------------------|--|--|
| Limited information | λ | 10% | 1.79 (0.43) 30% (22%) | 1.72 (0.34) ^{-(⁻)} 36% ^{-(⁻)} | 1.68 (0.49) ^{-(⁻)} 38% ^{-(⁻)} |
| | | 20% | | 1.68 (0.37) ⁻ 44%** | 1.70 (0.51) ⁻ 49% ⁻ |
| Full information | λ | 10% | 1.88 (0.57) 21% (23%) | 1.97 (0.59) ^{-(⁻)} 29%* ^(⁻) | 2.09 (0.77) ^{-(⁻)} 32% ^{-(⁻)} |
| | | 20% | | 1.76 (0.60) ⁻ 28% ⁻ | 2.20 (0.84)* 26% ⁻ |

Wilcoxon rank-sum test, significance of difference w.r.t.value on the left (difference w.r.t. value below in parenthesis), - (p>0.05), * (p<0.05), ** (p<0.01), *** (p<0.001).

Table 7: Experimental results, effective price (mean, sd) and share of periods with comparable offers, last matching in the experiment.

| | | | 0% | μ 10% | 20% |
|---------------------|-----------|-----|--------------------|--|--|
| Limited information | λ | 10% | 1.68 (0.46) 24% | 1.75 (0.64) ^{-(⁻)} 39%** ^(**) | 1.78 (0.70) ^{-(⁻)} 53%** ^(***) |
| | | 20% | | 1.72 (0.56) ⁻ 55%** ^(***) | 1.65 (0.56) ⁻ 73%** ^(***) |
| Full information | λ | 10% | 1.82 (0.78) 29% | 1.82 (0.78) ^{-(⁻)} 39%* ^(⁻) | 2.30 (1.11) ^{***(⁻)} 23% ^{***(⁻)} |
| | | 20% | | 1.82 (1.03) ⁻ 33% ⁻ | 2.52 (1.20) ^{***} 23%* ⁻ |

Wilcoxon rank-sum test, significance of difference w.r.t.value on the left (difference w.r.t. value below in parenthesis), - (p>0.05), * (p<0.05), ** (p<0.01), *** (p<0.001).

I Instructions

Welcome and thank you for your participation! You can earn an amount of money which depends on your decisions and the decisions of the other participants in this experiment. It is therefore very important that you thoroughly read through these instructions.

From now on, all communication with other participants is prohibited. If you have a question, please raise your hand. We will then come to you and answer your question. If you violate this rule, we will be forced to exclude you from the experiment.

PLEASE TURN OFF YOUR MOBILE PHONE NOW!

You will make decisions in the course of the experiment. There are no right or wrong decisions. Decide the way you think is best. All results of the study will be kept strictly confidential.

Your earnings will be calculated in ECU (Experimental Currency Units). 1 ECU corresponds to 0.05€. That is 100 ECU is equivalent to 5€. At the end of the experiment your total earnings will be converted in euros and paid to you confidentially and in cash.

For your punctual arrival you will receive a base payment of 50 ECU (2.5€).

EXPLANATIONS

The experiment consists of four phases.

1. Phase 1: In this phase, we will read the instructions aloud and make sure that all participants understand the rules of the experiment.
After reading the instructions completely, you will answer control questions to check your understanding of the experiment. Only when all participants have answered the control questions correctly will you be able to move to the next phase of the experiment.
2. Phase 2: You will have the opportunity to explore how different combinations of your decisions and those of other participants impact on your earnings. There will be four different scenarios. You will have three minutes time to go to each scenario.
3. Phase 3: When phase 2 and thereby the scenario exploration is completed, the main part of the experiment start. The next sections explains how Phase 3 works.
4. Phase 4: In phase 4, you will fill in two questionnaires.

Your earnings will be determined at the end of the experiment. Right after this we will pay your earnings in cash and confidentially and you will be able to leave.

EXPLANATION OF THE MAIN PART OF THE EXPERIMENT (PHASE 3)

In the experiment, you assume the role of a manager. You are matched with two other randomly selected participants. Each of you is assigned to be the manager of one company. The three companies in your market area are called A, B, C and manufacture different models of the same type of product. Company A manufactures Model A, Company B manufactures Model B or Model and Company C manufactures Model C or Model A.

There are a total of 300 customers who want to buy a product in this market. As managing director of your company, your job is to maximize profit. You make a profit by selling your product in your market area. It is your responsibility to decide how you want to market your product in order to maximize profit. You can choose the price of your product and the model you manufacture.

1. Price: You can select the price for your product. You can set any price between 0 and 5, with an accuracy of up to two decimal places.
2. Model: If you manage business B or C, you can decide whether you want to either make your own model (Model B and Model C) or whether you want to produce the same model as Company A (Model A). If you manage business A, you cannot decide which model to produce. You need to produce your own model A.

You will make both of these decisions on your own and at the same time as the other two companies in your market area. You will not see the decisions of others when you make your decisions. Likewise, the others can not see your choices. Once choices are made, then consumers choose among your products. Your profit is derived from the number of units you sold multiplied by the price you set. There are no costs in producing your product.

In choosing their products, not all of the 300 clients have the same preferences. 100 of 300 customers prefer to buy from company A. 100 customers prefer to buy from companies B and 100 customers prefer to buy from Company C.

- If all companies produce their own model, customers would rather pay 1 ECU more to obtain the product of their preferred company than buying from another company. In other words, the customers buy from their favorite business as long as its price is not more than 1 ECU higher than the lowest price at the other companies. If the

product of their preferred company is more than 1 ECU more expensive than the cheapest product at the competition, then they prefer to buy the cheapest product rather than the product of the preferred company.

- If two or more companies produce Model A, Model A is the standard in the market. In this case, 20% of customers (20 per company) tend to buy the cheapest model A rather than a non-standard model. For example:
 - If all firms produce the Model A, those 20% of customers buy the cheapest model A, even if it is not made by their preferred company.
 - If only two companies produce model A, those 20% of customers compare the cheapest model A and the non-standardized product. They never buy the more expensive model A. Those customers are willing to pay 20% more for the cheapest model A than for a non-standard model. This is the extent by which these customers dislike the non-standard model.
 - If every company produces its own model, those 20% of customers behave exactly like the other 80% of customers
 - The rest of the customers (80 per company) are not interested in whether another company sells the same model as their preferred firm or not. They keep on buying from their favorite business as long as its price is not more than 1 ECU above the lowest price at the other companies.

In summary: Every company has 100 customers who are willing to pay more for their product than for the product of another company. However, if two or more firms produce model A, 20% of those customers tend to buy the cheapest model A instead of a non-standard model. The remaining 80% of customers do not care whether some companies manufacture the same model or not.

Once all companies have made their pricing decision and their model selection, the customers look at the prices and models on the market and make their purchase decision. The decisions of the 300 customers are made by the computer according to the rules described above.

Once the computer has calculated your sales and profits, you will see reminder information on the screen showing your chosen price and model, along with your sales and profits as well as the prices, model, sales and profits of your competitors. The other participants in your group will receive the same information as you.

Once all of the companies in the market have had the chance to look at the results, the market closes with a probability of 10%, otherwise there

is a new market period with the same competitors in your marketplace. If the market closes, then you enter a new market with new participants and manage a new company.

- If the market continues, you will enter a new period with the same competitors as in the last round and act as manager of the same company. The new market period works just like the previous one. You will see the progress of the past actions, the sales and profits of all three companies on the market when you make your decisions.
- If the market closes, you will be randomly assigned to a new market with two new participants and manage a new business. This random assignment guarantees that you never meet again the same two managers in the course of the experiment. In other words, the members of each market to which you are assigned are people with whom you never were in competition previously in this experiment. In addition, none of the competitors with whom you have interacted in a market will ever meet a competitor you also met.

In the course of the experiment you will participate in three different markets, each time with all-new competitors, and without knowing which company you will be assigned to (A, B or C).

DETERMINATION OF PAYOUTS

At the end of the experiment, the computer will randomly select a time period of one of the three markets you took part in as relevant. You will not know in advance which period and which market will determine your payout. You should therefore make your decisions in all three markets and all periods carefully, as each of them could decide on the amount of your payment at the end of the experiment.

Once a period has been selected from a market for payment, the program will show your choices in that period and how much revenue and profit you made in that period. You will see as well the decisions, sales and profits of your competitors in that period.

The profits that you made in the selected period will be converted into euro and paid to you in cash and confidentially at the end of the experiment.

SUMMARY

1. After reading the instructions you will answer quiz questions and will have the opportunity to consider four market scenarios.
2. You will then participate in three different markets. Each market will last a certain number of periods. Each period has a probability of 10%

of being the last period of the market. This means that you do not know how long each market will last. In addition, not every market lasts the same number of periods. You will be assigned to a completely new group of competitors in each market.

3. You will be asked a series of background questions and questions regarding your choices at the end of the experiment.
4. Once all decision-making situations are over and you have answered all questions, then the computer will determine which market and which period in that market will be relevant for your payout. Thereupon details of your payoff calculation will be displayed.
5. Your profits in the randomly selected market and period will be paid to you at the end of the experiment in cash and confidentially.