Strategic obfuscation and consumer protection policy in financial markets[*]

Yiquan Gu[1,†]   Tobias Wenzel[2,3,‡]

[1]University of Liverpool
[2]Düsseldorf Institute for Competition Economics (DICE)
[3]Universität Düsseldorf

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Abstract

This paper studies obfuscation decisions by firms in retail financial markets theoretically and experimentally. We show that more prominent firms are more likely to obfuscate. While prominent firms always choose maximum obfuscation, the obfuscation by less prominent firms depends on the degree of asymmetry in prominence and consumer protection policy. We evaluate the impact of a consumer protection policy that limits the scope of obfuscation. We show that such a policy may not be effective as less prominent firms may increase their obfuscation practice.

JEL Classification: G20; D14; D18; C92

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1 Introduction

It is by now well documented that consumers in retail financial markets are susceptible to behavioural biases and suffer from cognitive limitations (e.g., Campbell, 2006; Calvet et al., 2009; Stango and Zinman, 2009, 2011). There is also abundant evidence that financial illiteracy is prevalent (e.g., Lusardi and Mitchell, 2007; Lusardi et al., 2010; van Rooij et al., 2011; Choi et al., 2010). This limited understanding often leads to bad decisions. Also, relying on outside advice may not help in making good decisions as this advice may be biased due to agency problems between financial institutions, their sales agents and consumers (Bolton et al., 2007; Inderst and Ottaviani, 2009, 2011).

It is hardly surprising that financial firms try to exploit these biases and cognitive limitations. Indeed, there is robust evidence for strategies designed to take advantage of consumers' limited understanding of financial markets. For instance, financial institutions might shroud certain elements of their pricing strategies (Gabaix and Laibson, 2005; Campbell, 2006) or highlight irrelevant information (Choi et al., 2010). Firms take advantage of consumers' different information levels regarding price and product attributes leading to price dispersion for almost identical products (Christoffersen and Musto, 2002; Hortacsu and Syverson, 2004). Even worse, firms develop redundant "financial innovations" exclusively designed to attract naive consumers (Henderson and Pearson, 2011). Existing cognitive limitations may also be amplified by deliberately increasing the complexity of price structure or presentation, which is commonly termed obfuscation (Ellison and Ellison, 2009; Ellison and Wolitzky, 2011).

The resulting problems due to the limited understanding and bad choices that arise can be particularly severe in financial markets. Many decisions, such as mortgages or retirement investments, are of high stakes and have long-term consequences and, hence, the impact on welfare can be large (Calvet et al., 2007; Campbell, 2006). The question then is whether there are policies that improve the outcomes. Does competition help? Will education initiatives be successful? These are important questions for policy makers and researchers alike and in recent years much research has focused on such questions.

In this paper, we study whether policies to promote market transparency and to protect consumers are effective given that firms may choose to obfuscate. In particular, we focus on the impact of such policies in asymmetric settings: Firms, competing for retail customers, differ with respect to their level of prominence. The advantage of prominent firms is that they can attract a larger share of naive consumers. Different levels of prominence arise for several reasons. For instance, an established incumbent may be viewed by consumers as more prominent and trustworthy than a newcomer firm.[1] In this setting, firms choose how much to obfuscate the market. We interpret obfuscation rather broadly and define it as to comprise all strategic actions that prevent some consumers to recognize the best offer. In this context, we are interested in the following questions. Which firms have more incentives to obfuscate, prominent firms or less prominent ones? What factors determine firms' obfuscation strategies? And most importantly, what are the effects of policies that aim at protecting consumers from obfuscation? Our research strategy to answer these questions is twofold. To guide ideas we develop a theoretical model in the first part of the paper. In the second part, we then conduct a laboratory experiment to empirically assess the validity of our arguments.

We analyse a two-stage game where two firms offer a homogeneous financial product and sell it to retail consumers. There are two types of consumers: sophisticated and naive consumers. Sophisticated consumers can perfectly evaluate the firms' offers and pick the better one. In contrast, naive consumers are not able to compare the two offers, and thus randomly choose one of the offers. However, consumers are biased towards one firm; naive consumers choose to buy from the more prominent firm with a larger probability. In this setting, firms have two decisions to make. In the first stage, firms simultaneously choose how much to obfuscate. By obfuscating more a firm can increase the number of naive consumers in the market, and the number of sophisticated consumers is accordingly decreased. In the second stage, firms—knowing how many naive and sophisticated consumers are in the market—compete in prices.

In the theory part we show that in equilibrium price dispersion arises due

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[1]Alternatively, prominence may arise due to higher marketing efforts or a better reputation of a firm. Similar in spirit, Armstrong et al. (2009) consider a sequential search model where consumers search prominent firms first.

to the trade-off of charging a high price to naive consumers and competing for sophisticated consumers with a low price (Varian, 1980; Narasimhan, 1988). Thus, the equilibrium in the pricing stage is in mixed strategies. Regarding obfuscation decisions in the first stage, however, we find that the equilibrium is in pure strategies. We demonstrate that the more prominent firm has, in general, larger incentives to obfuscate. In fact, we find that this firm always chooses maximal obfuscation. There are two reasons for this: First, by choosing obfuscation there are more naive consumers and those consumers are particularly likely to buy from the prominent firm. Due to this obfuscation the prominent firm can secure itself a large share of consumers. Second, more obfuscated markets are less competitive and, in consequence, prices and profits are higher. Both effects point to large incentives for prominent firms to engage in obfuscation. In contrast, for the less prominent firm the two effects may point in opposite directions and consequently this firm has less incentive to engage in obfuscation. On the negative side, this firm gives up consumers if it chooses to obfuscate as those now naive consumers are likely to buy from the competitor. This negative effect is more pronounced if the asymmetry in prominence is large. On the positive side, however, the less prominent firm benefits from weaker competition if the number of naive consumers is large. When determining its optimal level of obfuscation, the less prominent firm has to balance these two effects, and, under certain parameters the less prominent firm chooses an interior level of obfuscation. As a result, we show that obfuscation incentives by the less prominent firm is larger if the asymmetry in prominence is small as in this case the first effect is rather small.[2]

The key part of our analysis concerns the effects of a consumer protection policy aimed at increasing market transparency. Specifically, we consider the introduction of a policy that reduces firms' scope to obfuscate the market. In practice, this could be, for instance, a disclosure policy that forces firms to disclose all possible fees or a cap on obfuscation possibilities such as limiting the length of the "footer" section of a credit card contract. Alternatively, this policy could be an educational program to increase financial literacy. Consumers are less likely to be confounded by complex price structures if financial literacy is high. Is such a consumer protection policy effec-

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[2]Indeed, if firms enjoy identical levels of prominence both firms choose maximum obfuscation.

tive? Interestingly, our answer is that such a policy can be much less effective than expected. Indeed, under some circumstances such a policy is not effective at all. Introducing this policy has the intended effect on the prominent firm causing this firm to obfuscate less. However, the introduction of the policy has a second, unintended effect on the obfuscation decisions by the less prominent firm. In fact, we show that the less prominent firm has an incentive to increase obfuscation in response to such a policy. The reason for this effect is that due to the reduced obfuscation by the prominent firm the market has become more competitive than preferred by the non-prominent firm. In consequence, this firm increases its obfuscation efforts. In particular, any marginal reduction in the scope for obfuscation is completely offset by increased obfuscation from the non-prominent firm provided that the non-prominent firm chooses an interior level of obfuscation.

In the second part of the paper, we present a laboratory experiment where subjects participating in the experiment take the roles of firms. Subjects play a simplified version of the theoretical model where the obfuscation decision is a discrete choice variable. A firm can either obfuscate or not (instead of being a continuous variable). We design several treatments in order to test for the main determinants of firms' obfuscation decisions identified in the theoretical model. In particular, we focus on the behaviour of the less prominent firm and consider how that firm's decision is altered if we decrease the scope for obfuscation or change the degree of asymmetry in prominence. It turns out that the main implications of the model are confirmed in the experiment. For instance, we show that prominent firms obfuscate more frequently than less prominent firms. Most importantly, in our laboratory setting, we are able to confirm the adverse effect of introducing the protection policy on the obfuscation strategy by the less prominent firm. This is remarkable given that subjects participating in experiments are known to experience (disadvantageous) inequality aversion (Fehr and Schmidt, 1999), an effect that can also be observed in our study. In our setting, by choosing to obfuscate, the less prominent firm does not only increase its own profits, but also increases the profits of the prominent firm. Indeed, the payoff of the prominent firm rises to a larger extent than the payoff of the less prominent firm. Then, unsurprisingly, the observed strength of this adverse effect is smaller than predicted by the theoretical model where it is assumed that firms' only concern is their own profits. We are also able to confirm that

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asymmetry impacts the less prominent firm's obfuscation decision. Comparing treatments with different levels of asymmetry we show that reducing asymmetry significantly increases the less prominent firm's propensity to obfuscate.

Our analysis—theoretical as well as empirical—yields several important implications for policy decision making. First, we show that more prominent financial institutions are more likely to obfuscate than less prominent ones. Consequently policy makers, aiming at promoting transparency in financial markets, should design policies that target those firms. Second, policy makers should be aware that consumer protection policies that promote transparency may backfire in the sense that it may increase the incentives of less prominent firms to engage in obfuscation strategies. In the theory part, we show that under certain circumstances this may leave the level of transparency in the market unchanged and thus make the policy redundant. In the empirical part, we confirm this adverse effect of regulation. Hence, a conclusion, that one can draw from our analysis, is that policy makers have to be careful when designing policies and should be aware of potentially adverse effects.

In recent years and in particular since the recent financial crisis research in retail financial markets has surged. Especially, research has focused on how to improve market outcomes given consumers' incomplete understanding of financial markets. For instance, Bolton et al. (2007) and Inderst and Ottaviani (2009, 2011) study agency problems between financial institutions, their sales agents and consumers, and what measures policy makers can take to mitigate these agency problems. More closely to our paper, Carlin (2009) and Carlin and Manso (2011) study how financial institutions can exploit consumers' limited sophistication by obfuscation. Carlin (2009) studies a symmetric oligopoly where firms—as in our paper—can increase the share of naive consumers. Most importantly, he shows that more competition in the form of more firms leads to more obfuscation. Carlin and Manso (2011) analyse, in a theoretical model, the timing of obfuscation. They show that small-scale education initiatives, leading to improved learning by naive consumers, may be offset by firms choosing to obfuscate more frequently, resulting in welfare losses and no improvement in market outcomes. With these papers, we share the focus on obfuscation strategies; however, we con-

sider an asymmetric setting caused by firm heterogeneity. We show that asymmetry matters for the effectiveness of regulation. Policies that limit obfuscation are effective in symmetric markets but can be completely ineffective in asymmetric settings. Thus, in our view, when designing policies it is important to take firm heterogeneity into account.

The remainder of the paper is organized as follows. In Section 2, we present our framework and theoretically analyse obfuscation decisions. Section 3 describes and presents the results of our laboratory experiment. Finally, Section 4 concludes.

2 Obfuscation: Theory

2.1 Model

Consider a market where two firms compete to supply a homogeneous product. There is a mass one of consumers each demanding at most one unit of the product if the reservation price of $r > 0$ is not exceeded. Consumers are either sophisticated or naive. Sophisticated consumers understand true offering prices and buy from the firm that offers the lowest price. A tie is broken with an equal probability. Naive consumers, on the other hand, are unable to compare prices and buy at random with a distribution to be specified below.

Shares of respective consumers are influenced by firms' obfuscation choices and the consumer protection policy. More complex pricing and a lower level of consumer protection lead to more naive consumers and accordingly, to less sophisticated consumers. Let $x \in (0, 1)$ be the level of the consumer protection policy and $k_i \in [\underline{k}, \bar{k}] \subset \mathbb{R}_+$, $i = 1, 2$, the firms' obfuscation choices. $\underline{k}$ can be interpreted as no obfuscation at all and $\bar{k}$ as full obfuscation. The proportion of *naive* consumers, $\mu \in (0, 1)$, is given by

$$\mu(x, k_1, k_2) = (1 - x)\theta(k_1, k_2), \tag{1}$$

where $\theta : [\underline{k}, \bar{k}]^2 \to (0, 1)$ measures the effectiveness of firms' obfuscation practice in confusing consumers with $\frac{d\theta}{dk_i} > 0$ for $i = 1, 2$. The proportion of *sophisticated* consumers is thus $1 - (1 - x)\theta(k_1, k_2)$.

A larger x corresponds to a more stringent consumer protection policy and as a result there are fewer consumers susceptible to firms' obfuscation practice. To the extreme of a completely effective consumers protection policy ($x \to 1$), firm obfuscation becomes irrelevant and standard Bertrand competition with only sophisticated buyers arises. This modelling covers both sets of consumer protection policies: raising financial literacy of consumers and restricting the scope of firm obfuscation. With a more financially literate public more consumers are capable of understanding complicated pricing terms. Likewise, if firms' obfuscation possibilities are regulated as in limiting the length of the "footer" section of a credit card contract, comparing true prices becomes easier and more consumers become sophisticated in the sense of the current paper.[3] For a given non-trivial level of consumer protection policy, the more a firm obfuscates, the more naive consumers there are as comparing prices becomes more difficult. Since price comparison requires an understanding of both offers, obfuscation by either firm strictly increases the share of naive consumers.

When unable to compare prices, consumers often resort to factors like past experiences, firm reputation, name recognition, etc. Not all firms are identical in these respects. In this paper we introduce asymmetry in prominence between the two firms to reflect this observation. Namely, Firm 1 is more prominent than Firm 2 and captures a larger share, $\phi \in \left(\frac{1}{2}, 1\right)$, of naive consumers. Firm 2 receives the rest of those naive consumers $1 - \phi$.[4]

We assume that both firms produce the product at constant marginal costs which, for simplicity, are normalized to zero. To focus on strategic effects among firms, the obfuscation choice is costless.

The level of consumer protection is known to both firms at the beginning of this two-player game. In stage 1, the two firms simultaneously and independently decide on its own choice of obfuscation k_i. After knowing each other's obfuscation level, i.e., the share of naive consumers, they compete

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[3] An alternative modelling of this set of consumer protection policies would be to cap obfuscation, k_i. This, however, is identical to the current approach with θ being homogeneous of degree one.

[4] We assume that ϕ is independent of the obfuscation decisions and thus consumers do not have a preference for simple contracts per se. Note however, that the main results of the paper would still hold if we allow for a preference for simple contracts provided that this effects is not too strong. In this case, obfuscation levels would be corrected downwards.

in prices in the second stage.[5] Both firms are standard profit maximizers.

2.2 Equilibrium prices

We start our analysis by writing out firm profits at the end of the game as functions of the share of naive consumers and the two prices. Suppose the share of naive consumers at the second stage is μ. These consumers split between the two firms at a ratio of $\phi : (1 - \phi)$ irrespective of prices. Sophisticated consumers, however, are drawn to the lower priced firm. Firm profits are hence

$$\Pi_1(\mu, p_1, p_2) = \begin{cases} p_1\left[\phi\mu + (1 - \mu)\right] & \text{if } p_1 < p_2 \\ p_1\left[\phi\mu + \frac{1-\mu}{2}\right] & \text{if } p_1 = p_2 \\ p_1\phi\mu & \text{if } p_1 > p_2 \end{cases} \tag{2}$$

and

$$\Pi_2(\mu, p_1, p_2) = \begin{cases} p_2(1 - \phi)\mu & \text{if } p_1 < p_2 \\ p_2\left[(1 - \phi)\mu + \frac{1-\mu}{2}\right] & \text{if } p_2 = p_1 \\ p_2\left[(1 - \phi)\mu + (1 - \mu)\right] & \text{if } p_1 > p_2. \end{cases} \tag{3}$$

This second stage of the game is similar to Narasimhan (1988) although with a different interpretation: our naive consumers are known as loyal consumers in his paper.[6] Narasimhan (1988) shows that there exists no pure strategy pricing equilibrium. The unique equilibrium is in mixed strategies with Firm 1 having a mass point at r equal to $\frac{(2\phi-1)\mu}{\phi\mu+(1-\mu)}$.

Lemma 1 (Narasimhan, 1988). For any given share of naive consumers, $\mu \in (0, 1)$, there exists a unique Nash equilibrium in the pricing stage, in which

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[5]Note that in contrast to Carlin (2009) obfuscation and pricing decision are sequential rather than simultaneously. The reason for this being that pricing is more flexible while financial sophistication is more persistent (Agarwal et al., 2009).

[6]The mass of naive consumers captured by Firm 1, $\phi\mu$, corresponds to Firm 1's loyal consumer α_1 in Narasimhan (1988). Likewise, $(1 - \phi)\mu$ corresponds to α_2, and $(1 - \mu)$ to β.

Firm 1 prices according to the cumulative distribution function

$$F_1(p) = \begin{cases} 0 & \text{if } p < p_0 \\ 1 + \frac{(1-\phi)\mu}{1-\mu} - \frac{\phi\mu(1-\phi\mu)}{[\phi\mu+(1-\mu)](1-\mu)}\frac{r}{p} & \text{if } p_0 \leq p \leq r \\ 1 & \text{if } p \geq r, \end{cases} \tag{4}$$

and Firm 2 prices according to the cumulative distribution function

$$F_2(p) = \begin{cases} 0 & \text{if } p < p_0 \\ 1 + \frac{\phi\mu}{1-\mu} - \frac{\phi\mu}{1-\mu}\frac{r}{p} & \text{if } p_0 \leq p \leq r \\ 1 & \text{if } p \geq r, \end{cases} \tag{5}$$

where

$$p_0 := \frac{\phi\mu r}{\phi\mu + (1-\mu)} \tag{6}$$

is the lower bound of both firms' prices.

It can be shown that the more prominent Firm 1's price p_1 first order stochastically dominates p_2. Therefore, the less prominent Firm 2 on average charges a lower price. The reason being that the opportunity cost of competing for sophisticated consumers is higher for the more prominent firm as it loses more revenue than the other firm for each unit price reduction due to its larger share of naive consumers. As a result of a lower price, sophisticated consumers are more likely to buy from the less prominent firm.

A rise in the share of naive consumers tends to soften price competition as there are less sophisticated consumers to compete for. The same holds true for asymmetry in prominence since with a larger share of naive consumers, the more prominent firm has less incentive in engaging in price competition. These can best be seen from the lower bound of the price distribution p_0. It increases in both μ and ϕ.

2.3   Firm profits

We note that only Firm 1's equilibrium strategy has a mass point at the reservation price r. By the fact that this is a mixed strategy equilibrium, Firm 1

expects to make the same profit as it would by selling only to its own share of naive consumers at the reservation price:

$$E(\Pi_1) = \phi\mu r. \tag{7}$$

Firm 2's expected profit can be found by inspecting the profit associated with $p_2 = p_0$. In this case, Firm 2 expects to receive all sophisticated consumers in addition to its own share of naive consumers:

$$E(\Pi_2) = \frac{(1 - \phi\mu)\phi\mu r}{\phi\mu + (1 - \mu)}. \tag{8}$$

Although the more prominent firm makes a profit equal to the level it could always be by focusing only on its own share of naive consumers, the less prominent firm's profit is higher than it would make by selling only to naive consumers as $E(\Pi_2) > (1 - \phi)\mu r$. In this sense, the less prominent firm benefits from the presence of sophisticated consumers.

An increase in the share of naive consumers has three effects on a firm's profit. First, with more naive consumers market competition is lower and equilibrium price will be higher in the sense of stochastic dominance. Second, demand from naive consumers rises. Third, demand from sophisticated consumers declines. The first two effects are positive while the third is negative. For the prominent firm, the overall effect is strictly positive as it does not have an advantage in competing for sophisticated consumers in the first place. For the less prominent firm, the overall effect is unclear. Therefore, its obfuscation incentive can be different from its more prominent competitor.

Due to the asymmetry between the firms, Firm 1 expects higher profits than Firm 2 and hence there is gap between the firms' profits. Since this asymmetry is in the proportions of naive consumers they receive, the gap is expected to rise as the number of naive consumers increases. This can be seen analytically. Let Δ_Π be the difference between the firms' expected profits, and by equations (7) and (8) we have

$$\Delta_\Pi := E(\Pi_1) - E(\Pi_2) = \frac{\phi(2\phi - 1)\mu^2 r}{\phi\mu + 1 - \mu}. \tag{9}$$

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It can be easily shown that $\frac{d\Delta_\Pi}{d\mu} > 0$. It will turn out that this increasing profit gap between prominent and non-prominent firms will be important in understanding the experimental results. In particular, it will affect Firm 2's obfuscation choice.

2.4 Equilibrium obfuscation

We are now in the position to analyse the firms' choices of obfuscation in the first stage. Since Firm 1's expected profit always increases in the share of naive consumers and increasing obfuscation raises the share of naive consumers, that is,

$$\frac{dE(\Pi_1)}{dk_1} = \phi r (1 - x) \frac{d\theta}{dk_1} > 0, \tag{10}$$

Firm 1 wants to obfuscate as much as possible. Hence, its equilibrium choice of obfuscation is the highest k_1, $\bar{k}$.

The impact of obfuscation on Firm 2's expected profit is more complicated:

$$\frac{dE(\Pi_2)}{dk_2} = [\phi(1 - \phi)\mu^2 - 2\phi\mu + 1] \frac{\phi r}{[\phi\mu + (1 - \mu)]^2} (1 - x) \frac{d\theta}{dk_2}. \tag{11}$$

Depending on asymmetry ϕ and the share of naive consumers μ, Firm 2 could find that an increase in its own obfuscation level increases or decreases its expected profit. As explained before, an increase in the share of naive consumers has three effects on Firm 2's expected profit. Firm 2 weighs an increased demand from naive consumers and a softened price competition against the associated decrease in the demand from sophisticated consumers when deciding on more obfuscation. For Firm 1, the positive effects of more obfuscation always dominate the negative one because it enjoys a larger portion of naive consumers and does not have an advantage in competing for sophisticated consumers anyway.

Let $\underline{\mu_x}$ and $\overline{\mu_x}$ be respectively defined as

$$\underline{\mu_x} = (1 - x)\theta(\bar{k}, \underline{k}) \qquad \text{and} \qquad \overline{\mu_x} = (1 - x)\theta(\bar{k}, \bar{k}).$$

For a given level of consumer protection x and with Firm 1 choosing $\bar{k}$, the share of naive consumers ranges from $\underline{\mu_x}$ to $\overline{\mu_x}$ when Firm 2 obfuscates from

the levels of $\underline{k}$ to $\bar{k}$. In other words, $[\underline{\mu_x}, \overline{\mu_x}]$ is the set of consumer composition Firm 2 can achieve by choosing corresponding obfuscation levels given the policy environment x and Firm 1's optimal strategy $\bar{k}$. Also note that $[\underline{\mu_x}, \overline{\mu_x}]$ is non-empty since $\frac{d\theta}{dk_2} > 0$.

The following proposition states equilibrium obfuscation.

Proposition 1. For a given combination of consumer protection policy x and asymmetry ϕ, equilibrium obfuscation is as follows.

1. The more prominent Firm 1 chooses $k_1^* = \bar{k}$.

2. Define $\tilde{\mu}(\phi) := \frac{\phi - \sqrt{\phi(2\phi-1)}}{\phi(1-\phi)}$.

    (a) If $\tilde{\mu}(\phi) \geq \overline{\mu_x}$, the less prominent Firm 2 chooses $k_2^* = \bar{k}$;

    (b) If $\underline{\mu_x} < \tilde{\mu}(\phi) < \overline{\mu_x}$, Firm 2 chooses the unique k_2^* such that $\mu^* := (1-x)\theta(\bar{k}, k_2^*) = \tilde{\mu}(\phi)$;

    (c) If $\tilde{\mu}(\phi) \leq \underline{\mu_x}$, Firm 2 chooses $k_2^* = \underline{k}$.

Proof: see Appendix A.1.

The intuition behind this result is the following. If it were completely up to Firm 2, it would make the share of naive consumers be $\tilde{\mu}(\phi)$ at which the positive and negative effects of a marginal change in μ on Firm 2's expected profit balance out. However, the share of naive consumers is also influenced by consumer protection policy and Firm 1's choice of obfuscation. The range of μ Firm 2 can choose from is hence only $[\underline{\mu_x}, \overline{\mu_x}]$. When the ideal $\tilde{\mu}(\phi)$ is above $\overline{\mu_x}$, Firm 2 obfuscates fully to make μ as close to $\tilde{\mu}(\phi)$ as possible. When $\tilde{\mu}(\phi)$ is below $\underline{\mu_x}$, even though Firm 2 would like to see an even larger share of sophisticated consumers, no obfuscation is the best it can do. Within the interval, $\tilde{\mu}(\phi)$ is attainable and Firm 2 obfuscates accordingly.

With equilibrium obfuscation, we can derive the equilibrium share of naive consumers for a given combination of x and ϕ.

Proposition 2. The share of naive consumers in equilibrium is

$$
\mu^* = \begin{cases} \overline{\mu_x} & \text{if } \tilde{\mu}(\phi) \geq \overline{\mu_x} \\ \tilde{\mu}(\phi) & \text{if } \underline{\mu_x} < \tilde{\mu}(\phi) < \overline{\mu_x} \\ \underline{\mu_x} & \text{if } \tilde{\mu}(\phi) \leq \underline{\mu_x}. \end{cases} \tag{12}
$$

2.5 Discussion

We note that $\tilde{\mu}(\phi)$ as a function of $\phi \in (\frac{1}{2}, 1)$ strictly decreases in ϕ because

$$
\frac{d\tilde{\mu}(\phi)}{d\phi} = -\frac{(1-\phi)^2 + \left(\phi - \sqrt{\phi(2\phi-1)}\right)^2}{2(1-\phi)^2\phi\sqrt{\phi(2\phi-1)}} < 0. \tag{13}
$$

Since $\lim_{\phi \to 1} \tilde{\mu}(\phi) = \frac{1}{2}$, $\tilde{\mu}(\phi)$ ranges from 2 down to $\frac{1}{2}$ as ϕ goes from $\frac{1}{2}$ up to 1. Note also that as $\tilde{\mu}(\phi)$ strictly decreases in ϕ, the inverse $\tilde{\mu}^{-1}(\mu) : (\frac{1}{2}, 2) \to (\frac{1}{2}, 1)$ exists.

Based on the value of $\tilde{\mu}(\phi)$, further insights can be derived. First, for $\phi \leq \frac{\sqrt{5}-1}{2} \approx 0.62$, $\tilde{\mu}(\phi) \geq 1$. In this region, as $\overline{\mu_x} < 1$, $\tilde{\mu}(\phi) > \overline{\mu_x}$ and Firm 2 obfuscates fully by Proposition 1.

Remark 1. If $\phi \in \left(\frac{1}{2}, \frac{\sqrt{5}-1}{2}\right]$, $k_2^* = \bar{k}$ and $\mu^* = \overline{\mu_x}$.

This result underpins the importance of asymmetry in studying firms' obfuscation incentives. If the two firms are sufficiently close in terms of prominence, both firms will fully obfuscate.

Second, for $\phi > \frac{\sqrt{5}-1}{2}$, the level of consumer protection policy x plays an important role in determining Firm 2's equilibrium obfuscation. For example, for a strong protection policy such that the share of consumers who are susceptible to obfuscation is below $\frac{1}{2}$, $\tilde{\mu}(\phi) > \overline{\mu_x}$ and by Proposition 1, Firm 2 obfuscates fully irrespective of ϕ. When $\overline{\mu_x} > \frac{1}{2}$, under certain ϕ, $\tilde{\mu}(\phi)$ is attainable and Case (2b) in Proposition 1 results.

Remark 2.   1. If $\overline{\mu_x} \leq \frac{1}{2}$, Firm 2 obfuscates fully irrespective of ϕ and the equilibrium share of naive consumers is $\overline{\mu_x}$ for all $\phi \in (\frac{1}{2}, 1)$.
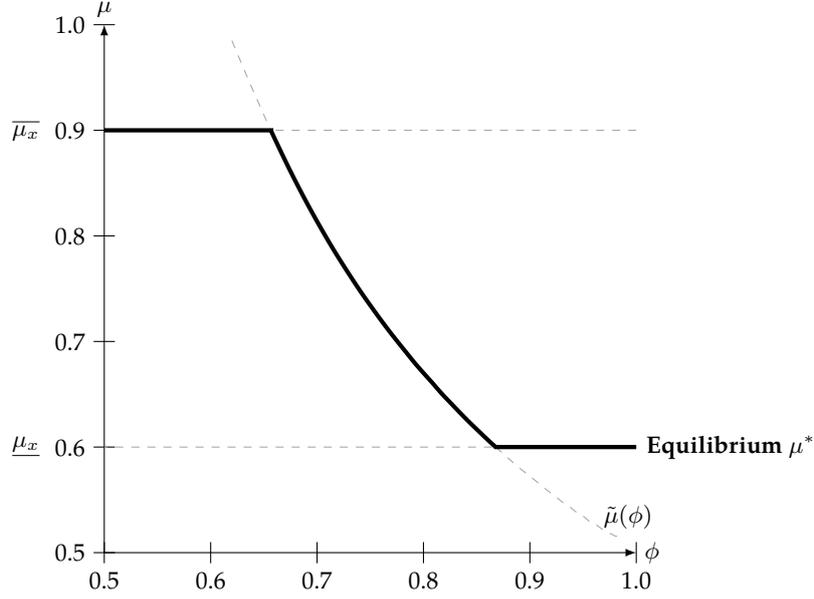
Figure 1: Equilibrium share of naive consumers as a function of asymmetry with $\underline{\mu_x} = 0.6$ and $\overline{\mu_x} = 0.9$

2. If $\underline{\mu_x} \leq \frac{1}{2} < \overline{\mu_x}$, Firm 2 obfuscates fully and the equilibrium share of naive consumers is $\overline{\mu_x}$ for $\phi \in (\frac{1}{2}, \tilde{\mu}^{-1}(\overline{\mu_x}))$. For $\phi \in [\tilde{\mu}^{-1}(\overline{\mu_x}), 1)$, Case (2b) in Proposition 1 results.

3. If $\underline{\mu_x} > \frac{1}{2}$, Firm 2 obfuscates fully and equilibrium share of naive consumers is $\overline{\mu_x}$ for $\phi \in (\frac{1}{2}, \tilde{\mu}^{-1}(\overline{\mu_x}))$. For $\phi \in [\tilde{\mu}^{-1}(\overline{\mu_x}), \tilde{\mu}^{-1}(\underline{\mu_x})]$, Case (2b) in Proposition 1 results. Firm 2 does not obfuscate and the equilibrium share of naive consumers is $\underline{\mu_x}$ for $\phi \in (\tilde{\mu}^{-1}(\underline{\mu_x}), 1)$.

Figure 1 plots a situation covered by Part 3 of Remark 2 in which consumer protection policy x and the obfuscation effectiveness θ lead to $\underline{\mu_x} = 0.6$ and $\overline{\mu_x} = 0.9$. Although Firm 1 always obfuscates as much as possible, the obfuscation choice of Firm 2 stays at $\bar{k}$ for $\phi \in (0.5, 0.66]$, gradually decreases in ϕ to keep μ^* at $\tilde{\mu}(\phi)$ for $\phi \in (0.66, 0.87)$, and stays at $\underline{k}$ for $\phi \in [0.87, 1)$.[7]

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[7]By equating $\tilde{\mu}(\phi)$ to $\overline{\mu_x} = 0.9$ and to $\underline{\mu_x} = 0.6$ we find 0.66 and 0.87, respectively.

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2.6 Comparative static predictions

There are two key parameters in the model, the degree of asymmetry, as measured by the parameter ϕ and the level of consumer protection policy, x. This section provides the comparative static prediction on how equilibrium obfuscation is affected by these two parameters. These comparative statics are used to derive the hypotheses to be tested in the experimental part of the paper. Regarding these predictions we will focus on Firm 2's obfuscation choice as Firm 1 always chooses maximal obfuscation independent of the level of asymmetry and the consumer protection policy (Prop. 1).

In the example of Figure 1, we see Firm 2's equilibrium obfuscation choice and the equilibrium share of naive consumers decrease in asymmetry in certain interval of ϕ. This in fact holds more generally.

Proposition 3. The less prominent Firm 2's equilibrium obfuscation choice and the equilibrium share of naive consumers weakly decrease in asymmetry:

1. If $\tilde{\mu}(\phi) > \overline{\mu_x}$ or $\tilde{\mu}(\phi) < \underline{\mu_x}$, a marginal change in ϕ does not change k_2^* and μ^*;

2. If $\underline{\mu_x} < \tilde{\mu}(\phi) < \overline{\mu_x}$, k_2^* and μ^* strictly decrease in ϕ.

Proof: see Appendix A.2.

Indeed, that Firm 2's obfuscation and the share of naive consumers in equilibrium weakly decrease also applies to a discrete upward jump in ϕ. To avoid discussing too many cases, we present this result in terms of a marginal change in ϕ. When $\tilde{\mu}(\phi)$ is attainable, an increase in asymmetry strictly reduces obfuscation and consequently the share of naive consumers. In a more asymmetric market, the less prominent Firm 2 receives less naive consumers and therefore, it prefers a lower share of naive consumers in the market also to enjoy its advantage in competing for sophisticated consumers. As a result, Firm 2 obfuscates less in a more asymmetric market.

Consumer protection policy reduces the proportion of consumers who are susceptible to obfuscation. Clearly, a larger x shifts the interval $[\underline{\mu_x}, \overline{\mu_x}]$

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downwards. If Firm 2 obfuscates fully before and after a strengthening of consumer protect policy, the policy is effective and the share of naive consumers decreases. The same holds true if Firm 2 chooses not to obfuscate in both cases. Interestingly, a stricter policy may not be effective. If for a level of asymmetry ϕ such that

$$\tilde{\mu}(\phi) \in [\underline{\mu_{x'}}, \overline{\mu_{x'}}] \cap [\underline{\mu_{x''}}, \overline{\mu_{x''}}] \neq \emptyset$$

where $x'' > x'$, $\tilde{\mu}(\phi)$ is attainable before and after the policy change. From Proposition 2, we see that the equilibrium share of naive consumers is unaffected by the policy change. The effect of a larger x is neutralized by an increase in obfuscation by Firm 2. Therefore, an introduction of a consumer protection policy can be ineffective in raising the share of sophisticated consumers in a market. Intuitively, for given obfuscation choices a stricter policy reduces the share of naive consumers. If this share falls short of the desired share of naive consumers Firm 2 reacts by increasing obfuscation. Firm 1 does not react to the policy change as obfuscation is already maximal.

Proposition 4. Suppose consumer protection policy strictly increases from x' to x''.

1. If $\overline{\mu_{x''}} \geq \underline{\mu_{x'}}$ and there exists a ϕ such that $\tilde{\mu}(\phi) \in [\underline{\mu_{x'}}, \overline{\mu_{x''}}]$, then for all such ϕ, the equilibrium share of naive consumers is not affected and Firm 2 obfuscates more.

2. If either $\overline{\mu_{x''}} < \underline{\mu_{x'}}$ or there exists no ϕ such that $\tilde{\mu}(\phi) \in [\underline{\mu_{x'}}, \overline{\mu_{x''}}]$, then the equilibrium share of naive consumers is reduced.

Proof: see Appendix A.3.

In the example of Figure 2, $[\underline{\mu_x}, \overline{\mu_x}]$ change from $[0.6, 0.9]$ to $[0.55, 0.85]$ after x increased from x' to x''. Since they intersect and for $\phi \in [\tilde{\mu}^{-1}(\overline{\mu_{x''}}), \tilde{\mu}^{-1}(\underline{\mu_{x'}})]$, $\tilde{\mu}(\phi)$ is attainable before and after the policy change, this change in policy has no effect on the equilibrium share of naive consumers when ϕ is in this interval.

It is indeed surprising to see that a more stringent consumer protection policy can be rendered completely ineffective by the actions of market partic-
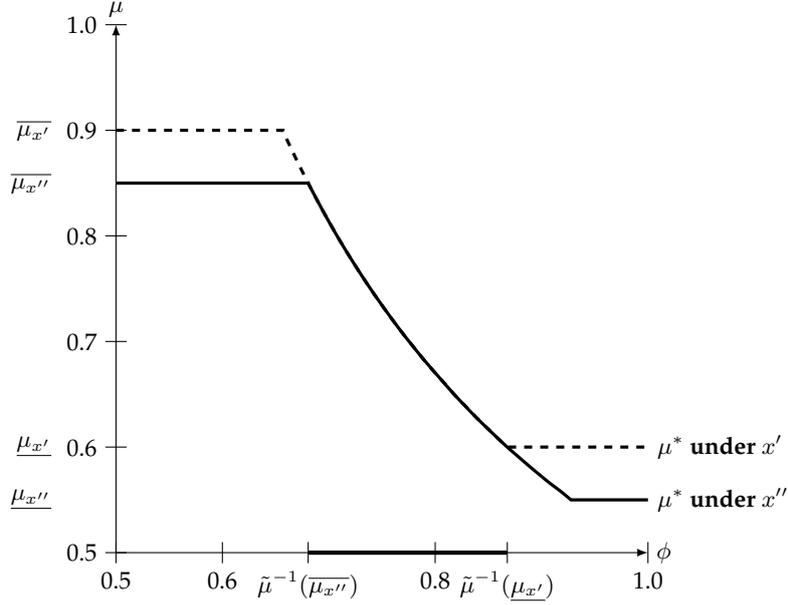
Figure 2: Equilibrium shares of naive consumers before (x') and after (x'') an increase in consumer protection strength: for $\phi \in [\tilde{\mu}^{-1}(\overline{\mu_{x''}}), \tilde{\mu}^{-1}(\underline{\mu_{x'}})]$, μ^* remains the same

ipants. Considering the often substantial costs in implementing and enforcing such policies, more caution is needed in making such policies. It is important to note that a policy change can have different impacts in symmetric and asymmetric industries. If firms are rather symmetric, both firms choose maximal obfuscation before and after the policy change and hence the policy is effective.[8] If, however, firms differ in their level of prominence the policy effect can very different and the policy may be ineffective.

To sum up, in our model a higher level of asymmetry (weakly) decreases Firm 2's incentives to obfuscate. In addition, a stricter consumer protection policy may have the unintended consequence of raising Firm 2' incentives to obfuscate. We will test these predictions in the following experimental part of the paper.

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[8]In particular, if $\phi \in \left(\frac{1}{2}, \frac{\sqrt{5}-1}{2}\right]$, Firm 2 chooses maximal obfuscation independent of the level of consumer protection policy. In this case, policy is effective and reduces the share of naive consumers.

3 Obfuscation: Experiment

3.1 Implementation and procedural details

In order to reduce the complexity in the experiment, we have slightly modified our model with respect to two elements. First, instead of treating the obfuscation decision as a continuous variable, in the experiment, this decision is a discrete one. Subjects can choose between obfuscating and not obfuscating. Second, obfuscation decisions by the two firms enter additively so that the number of informed buyers depends only on the number of firms choosing to obfuscate. Besides, we have chosen the following parametrization: Sellers sell to 100 buyers each of which has a reservation price of $r = 100$ and, in the pricing stage, subjects can choose an integer price between 0 and 100. The share of naive buyers in this simplified setup is then specified as

$$\mu(x, k_1, k_2) = (1 - x)\frac{I_1 + I_2}{2},\tag{14}$$

where $I_i \in \{0, 1\}$ is an indicator variable that takes the value 1 if firm i decides to obfuscate and 0 otherwise. The parameter x is then our measure for the strength of consumer protection policies. The total number of naive buyers is $100\mu(k_1, k_2) = 100(1 - x)\frac{I_1 + I_2}{2}$. In order to make our experimental setup as easy as possible we do not provide participants with the value of consumer protection policy x directly, but rather participants are reported the value $\frac{100(1-x)}{2}$ which can be more easily interpreted as the increase in the number of naive consumer for every obfuscating firm.

The experiment consisted of 25 periods. At the start of each period, sellers are randomly matched into groups of two competing sellers: one subject is randomly assigned the role of Firm 1 and the other subject is assigned the role of Firm 2.[9] This decision is announced to the subjects. Each seller then decides whether he wants to obfuscate which increases the number of naive buyers by 40 (20). The obfuscation decisions are then revealed to the sellers and each seller determines the price which has to be an integer in

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[9]Which firm the subject is assigned to, is drawn randomly each round. Thus, in the course of the experiment, subjects are assigned to play both firms. We choose this setup this setup with random matching and role switching to better mimic the one-shot nature of our model.

[0,100]. Sellers sell to 100 buyers each of whom buys exactly one unit. In our setup, buyers are computerized.[10] Buyers are programmed so that sophisticated buyers choose to buy from the seller charging the lowest price, while each seller receives his share of the naive buyers independent of the price charged. After the sellers have made their pricing decisions, the outcome is revealed. Subjects are informed about the competitor's price and the quantities sold to sophisticated and naive buyers. Finally, sellers learn the profit earned in this period as well as total profit earned so far in the experiment.

The experiment consisted of 12 sessions, all conducted at the University of Düsseldorf during the summer term 2011. For each treatment, we ran 4 independent sessions and in each session 8 subjects participated. The experiment was implemented using the software z-Tree (Fischbacher, 2007). Appendix C contains an English translation of the instructions.[11] Subjects received a show-up fee of 4 Euro and could earn additional amounts depending on the performance in the experiment. On average, subjects received a total amount of 13 Euro for a 60-minute session. The subjects were recruited from undergraduate students at the University of Düsseldorf. No subject participated in more than one session.

3.2 Hypotheses

Our model in Section 2 has provided several predictions about firms' obfuscation choices. Remember from the model that Firm 1 always chooses maximal obfuscation. The behaviour of the less prominent Firm 2 is more interesting as its obfuscation choice depends on the degree of asymmetry (Proposition 3) and on the regulation that limits firms' ability to obfuscate (Proposition 4). Thus, our experiment is designed so as to test these predictions of Firm 2s behaviour.

As our base treatment (BASE), we consider the parametrization with $\phi = 0.9$ and $x = 0.2$. In this treatment, the degree of asymmetry in prominence is

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[10]The advantage of using computerized buyers is that we can focus on the strategic interaction among sellers without introducing additional uncertainty over buyer behaviour. For a study where the role of buyers is also taken by subjects, see Kalayci and Potters (2011).

[11]The original instructions in German are available from the authors upon request.

	SYM	BASE	POL
ϕ	0.6	0.9	0.9
x	0.2	0.2	0.6
$\frac{100(1-x)}{2}$	40	40	20
I_1^*	1	1	1
I_2^*	1	0	1

Table 1: Experimental design

large and consumer protection policy is relatively weak. In the base treatments, the number of of naive buyers is increased by 40 for every obfuscating firm. The model predicts that, in this treatment with large asymmetry and weak policy, it is optimal not to obfuscate for Firm 2.

To test for the impact of a stricter consumer protection policy we have designed the treatment (POL), where we have increased the level of protection policy to $x = 0.6$ leaving the degree of asymmetry at its initial value of $\phi = 0.9$. In this treatment, the number of naive buyers is increased by 20 if an additional firm obfuscates. According to the model, it is now optimal for Firm 2 to choose obfuscation. We can test this prediction by comparing average obfuscation between the treatments BASE and POL by using a one-sided Wilcoxon rank-sum test. We expect obfuscation to be significantly larger in treatment POL. Table 1 summarizes our three treatments and provides the equilibrium obfuscation predictions according to the model.

We have designed a third treatment that is suitable to test for the impact of asymmetry. We have designed a more symmetric treatment (SYM) with $\phi = 0.6$ but leave the strength of the protection policy constant at $x = 0.2$. The optimal strategy predicted by the model is for Firm 2 to choose obfuscation now. We will test the model prediction by comparing the propensity for Firm 2 to obfuscate between the two treatments BASE and SYM. We expect obfuscation to increase from BASE to SYM.

So far the hypotheses derived have focused on the obfuscation decisions. The model delivers also several predictions concerning price setting. For instance, markets with more naive buyers are less competitive and, thus, firms are able to set higher prices which is the prime reason for obfuscating markets in our model. In a recent experiment, this effect has been documented in a setting with symmetric firms. Morgan et al. (2006a) show that

		SYM	BASE	POL
obfuscation propensity	Firm 1	0.94	0.97	0.94
	Firm 2	0.38	0.10	0.35
average price	Firm 1	72.7	78.9	60.9
	Firm 2	65.1	62.8	44.2
average profits	Firm 1	3234	4061	2434
	Firm 2	3139	2579	1868
average number of informed buyers		47.5	57.3	74.2
average number of uninformed buyers		52.5	42.7	25.8

Table 2: Summary statistics

markets with more naive buyers exhibit higher prices on average. In contrast to our approach, however, each firm receives the same share of naive buyers in their setup. Our setup allows to elaborate on this. We can analyze whether this holds also true for asymmetric industries and whether indeed both firms can benefit from more naive buyers.

Another prediction concerning pricing is that due to the asymmetry in the number of naive buyers the equilibrium price distributions of Firm 1 and Firm 2 differ. Firm 1 is predicted to charge higher prices than Firm 2 in the sense of stochastic dominance. This means that Firm 1 is expected to charge on average higher prices than Firm 2.

3.3 Results

This section presents the results of the experiment. We start by reporting on the obfuscation decisions. Then, we will turn to the second-stage, pricing decisions. Table 2 presents some summary statistics in the various treatments.

Obfuscation decisions

The model suggests that Firm 1, being more prominent, has generally larger incentives to obfuscate. In particular, for Firm 1 it is always optimal to choose obfuscation. The incentives for Firm 2 to obfuscate depend on the particular treatment. Table 2 reports the average propensity of both firms to obfuscate in each treatment. The table indicates that the behaviour of Firm

session	1	2	3	4	p-value
SYM	0.44	0.88	0.37	0.44	0.06
BASE	0.82	0.92	0.91	0.86	0.06
POL	0.62	0.75	0.62	0.7	0.06

Table 3: Average difference between firm types in propensity to obfuscate

1 is close to the prediction. In all treatments, subjects chose to obfuscate with a propensity of over 94%. The behavior of subjects playing Firm 2 is more differentiated. In the treatment BASE, observed behaviour is close to the prediction: subjects rarely choose the obfuscation strategy (in only 10% of the cases). In all treatments where theory predicts Firm 2 to obfuscate, we observe much lower rates of obfuscation. For instance, in the treatment SYM, obfuscation is chosen by subjects in 38% of the cases, and in the treatment POL the propensity to obfuscate is 35%. This phenomenon can be well explained by subjects' (disadvantageous) inequality aversion. We have already indicated in the model section that markets with more obfuscation are characterized by more asymmetric profits; thus while choosing obfuscation increases profits of Firm 2, it also widens the profit gap to Firm 1. We will come back to this point in more detail.

Though Firm 2 obfuscates less than predicted, the experiment confirms that the incentives for prominent firms are generally stronger than for less prominent firms. In fact, diverging incentives are larger than predicted. A formal test can be based on Table 3 which contains the difference in average propensity to obfuscate between both firms. In all treatments and in all sessions, we observe that obfuscation by Firm 1 is more likely than obfuscation by Firm 2. We can test this formally by employing a binomial test in each treatment. The p-value of this test is in all treatments 0.06. Thus, we can summarize our first result:

Result 1. Firm 1 obfuscates more frequently than Firm 2.

In the following, we will focus on the determinants of the obfuscation decision by Firm 2. We are, in particular, interested in the impact of a consumer protection policy and in the impact of asymmetry.

We test for the impact of a consumer protection policy by considering the

session	1	2	3	4	p-value
BASE	0.13	0.07	0.07	0.11	–
POL	0.3	0.24	0.55	0.3	0.014
SYM	0.41	0.11	0.5	0.48	0.029

Table 4: Average obfuscation by Firm 2 by session

two treatments BASE and POL. In the base treatment, our theory predicts that Firm 2 has no incentive to obfuscate while with the policy (treatment POL) Firm 2 will obfuscate. To test this prediction, we compare the average propensity to obfuscate between these two treatments. Over all sessions, the average propensity to obfuscate increases from 0.10 to 0.35 (Table 2). The average propensity to obfuscate in the different sessions is reported in Table 4. The data shows that obfuscation is always higher in the treatment with the policy in place, though it falls considerably short of the predicted level. We test this formally by performing an one-sided Wilcoxon rank-sum test over the average obfuscation in the sessions. The null hypothesis that introducing a consumer protection policy has no impact on Firm 2s behaviour or reduces Firm 2's propensity to obfuscate can be rejected at a p-value of 0.014. It is noteworthy that the experiment confirms this, a priori unexpected, effect of the policy even though, subjects in the role of Firm 2 choose obfuscation in much less cases than predicted, compared to the theoretical model. Hence, we conclude:

Result 2. The introduction of a consumer protection policy that decreases the scope for obfuscation increases the propensity of Firm 2 to obfuscate.

The second important determinant of behaviour of Firm 2 identified in the model is the extent of asymmetry between Firm 1 and Firm 2. Thus, we compare the treatments BASE and SYM. Reducing asymmetry increases average obfuscation from 0.1 to 0.38. A formal test is based on Table 4 which reports obfuscation decisions by Firm 2 by session. In all, but one session obfuscation is more likely when the asymmetry is small. Employing a one-sided Wilcoxon rank-sum test we can reject the null hypothesis that asymmetry does not impact or reduces Firm 2's incentives to obfuscate at a p-value of 0.029. We summarize:

Result 3. Increasing the level of asymmetry decreases the incentives for Firm 2 to obfuscate.

Inequality aversion

We have observed in the experiment that the incentives of Firm 2 to obfuscate are much lower than predicted in the model. One possible explanation for this finding is that participants in the experiment may exhibit inequality aversion. Unlike as in our theoretical model where we assume that firms maximize profits, it is well known that subjects may follow other objectives than pure payoff maximization. One "social" deviation from pure material payoff that features prominently is inequality aversion (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000).

Table 5 shows the impact of Firm 2's obfuscation decision on profits of both firms in the treatments SYM and POL, given that Firm 1 has chosen to obfuscate. The table reports the theoretical predictions on profits as well as the realized profits we observe in the experiment for the treatments where—under the assumption of pure payoff maximization—Firm 2 is expected to obfuscate. Consider the effect of Firm 2 choosing obfuscation in the treatment POL for instance. If the subject chooses obfuscation our model predicts that profits of Firm 2 should rise by roughly 900 or 60%. Thus, it is profitable to choose obfuscation. However, there is also a positive effect on profits of Firm 1. This firm's profits rise by 1800 or 100%. Thus, Firm 1 benefits to a much larger extent than Firm 2 and the profit gap between Firm 1 and Firm 2 widens. In fact, if we consider realized profits in the experiment (instead of the theoretical predictions) we see from Table 5 that the observed inequality even rises to a much stronger extent. While profits of Firm 2 increase by only 27%, those of Firm 1 rise by 115%. A similar picture emerges in the treatment SYM. Thus, disadvantageous inequality aversion provides a plausible explanation why obfuscation decisions by Firm 2 are much less frequent than predicted by the model where it is assumed that firms maximize profits.

		SYM		POL	
		theor.	obs.	theor.	obs.
no obfuscation	Firm 1	2400	2541	1800	1797
	Firm 2	2171	3062	1506	1734
obfuscation	Firm 1	4800	4594	3600	3872
	Firm 2	3671	3484	2400	2199
Profit change (abs)	Firm 1	2400	2053	1800	2075
	Firm 2	1500	422	894	465
Profit change (rel)	Firm 1	1.0	0.81	1.0	1.15
	Firm 2	0.69	0.14	0.59	0.27

Table 5: Average profits

Prices

In the following, we will analyse the price choices made in the second stage
of the experiment. There are several interesting issues to study. For in-
stance, the model predicts that Firm 1 charges, on average, a higher price
than Firm 2. In fact, the price distribution of Firm 1 is predicted to stochas-
tically dominate that of Firm 2. The most relevant issue concerning the price
setting stage, however, is that more obfuscated markets are less competitive
on average in the sense that both firms are able to set higher prices if the
number of naive buyers is larger. This is important as relaxed price compe-
tition is a major reason for the firms to obfuscate. This holds, in particular,
for Firm 2 as this firm benefits mostly via this price effect if the distribution
of naive buyers is highly asymmetric.

We deal with the second issue first. We focus our analysis on the treatments,
SYM and POL, the reason being that only in those two treatments we have a
sufficient number of observations in subgames containing a different num-
ber of naive consumers. Table 6 presents average prices charged by both
firms in these two treatments.[12] The table shows that, in both treatments,
average prices rise if the market is more obfuscated. A formal test for this
claim can be based on binomial tests by comparing the average impact of
more obfuscation by session. The necessary data to perform such a test is
reported in Tables 7 and 8 in the Appendix where we report the average
prices for each session. The null hypothesis that obfuscation does not im-

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[12]We only report on the cases where at least one firm obfuscates as there are only very
few observations, where no firm chooses obfuscation.

		SYM	POL
Obfusc. by one firm	Firm 1	68.0	55.3
	Firm 2	57.3	36.3
Obfusc. by both firms	Firm 1	84.2	74.4
	Firm 2	80.6	61.8
Impact of obfusc.	Firm 1	16.2	19.1
	Firm 2	23.3	25.5

Table 6: Average prices by both firms in the treatments SYM and POL

pact on prices can be rejected in each case at a p-value of 0.06.

A similar picture emerges if instead of comparing the average price we compare the entire price distributions. Figure 3 plots the observed cumulative price distributions for the treatment POL. The figure shows that the cumulative price distribution shifts out to the right if the market is more obfuscated and there are more naive buyers. For both firms the price distribution with more obfuscation stochastically dominates the one with a lower level of obfuscation. Indeed, the impact of obfuscation seems to have a particular strong impact on pricing by Firm 2. If only one firm obfuscates, the probability of a Firm 2 charging a price higher than 50 is extremely low (in less than 10% of all cases); the empirical distribution is rather flat for prices over 50. In contrast, if both firms obfuscate, this probability is six times higher and increases to 60%.[13]

Our experimental results are in line with those in Morgan et al. (2006a,b). They show in a symmetric setting where firms equally share naive buyers that prices are higher if the number of naive buyers is higher.[14] We extend their finding to an asymmetric setting where firms differ in the share of naive buyers they attract. We summarize our results:

Result 4. In more obfuscated markets, prices charged by both firms are on average higher.

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[13]Figure 5 in the Appendix shows the empirical price distributions for the treatment SYM. The figure shows that also in this treatment the price distribution with more naive buyers stochastically dominates the one with fewer naive buyers.

[14]Relatedly, Kalayci and Potters (2011) report evidence from a laboratory experiment where participants take both the roles of sellers and buyers. Sellers can make price comparisons harder by deciding on the number of attributes of a product. They find that prices increase with the average number of product attributes.
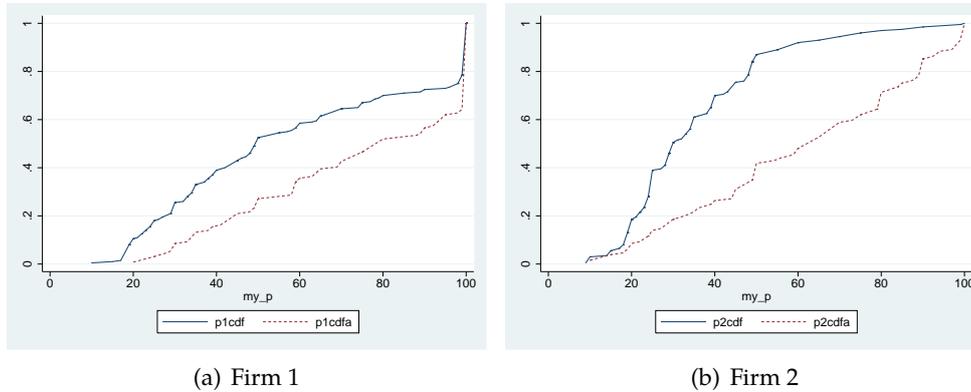
(a) Firm 1   (b) Firm 2

Figure 3: The impact of firms' pricing behaviour if obfuscation increases in treatment POL

The second implication of Firm 1 attracting a larger share of the naive buyers is that this firm should on average charge a higher price. The reason is that for this firm it is more costly to compete for sophisticated buyers as Firm 1 would have to give up more revenues from its large number of naive buyers. In contrast, Firm 2 has a lower number of naive buyers and hence the opportunity cost for competing tough for sophisticated buyers is lower. Table 6 shows that this is indeed confirmed. On average, Firm 1 charges a higher price than Firm 2. Tables 7 and 8 in the Appendix provide the relevant comparisons by session.[15] This is also confirmed if one compares the overall distribution of prices. Figure 4 shows the empirical price distribution in the treatment POL. In line with the model, the price distribution of Firm 1 stochastically dominates the one of Firm 2.[16] We summarize:

Result 5. Firm 1 charges on average a higher price than Firm 2.

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[15]For the treatment POL, Firm 1 charges a higher price than Firm 2 in all sessions. For treatment SYM, this is not confirmed for all sessions. In two session, both firm charge a relatively similar price. This, however, is not surprising as in this treatment each firms' share of naive buyers is similar and firms are not expected to differ much in pricing.

[16]In the appendix, Figure 6 plots the empirical price distribution in the treatment SYM. Overall, a similar result emerges. However, as the asymmetry is smaller firms the price distributions lie much closer to each other.
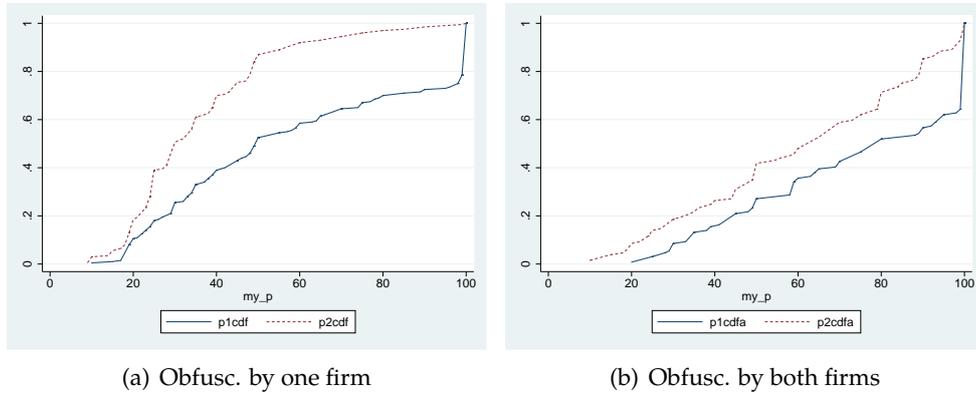
(a) Obfusc. by one firm (b) Obfusc. by both firms

Figure 4: Comparison of the price distributions of Firm 1 and Firm 2 in the treatment POL

4   Conclusion

In this paper we have studied obfuscation incentives in retail financial markets. Competing firms are heterogeneous in their level of prominence. While prominent always choose to obfuscate, the incentives to obfuscate for less prominent firms are more differentiated. We have identified several factors that determine the optimal level of obfuscation. A lower level of asymmetry and a stricter consumer protection policy increase the less prominent firms' incentives to obfuscate.

The key aim of the paper is to study the impact of regulation. We have shown that consumer protection policies designed to reduce the scope of obfuscation can have unintended consequence in asymmetric industries. While the effect on prominent firm is as expected, there is an unintended, adverse effect on less prominent firms. We have theoretically and experimentally shown that these firms may actually react by increasing their obfuscation level due to such a policy. Our experimental evidence suggests that consumer protection policies are much less effective than expected. When designing such policies, decision makers should be aware of that.

Though the main focus of this paper is on retail financial markets, the model itself and the implications that can be drawn from it are sufficiently general and can be readily applied to other markets as well. We have focused on financial markets as the problem of consumers' limited sophistication seems

to be particularly relevant in the area of financial decision making. However, it can be also be observed in other markets that consumers fail to make sophisticated decisions and that firms may devise obfuscation strategies to exploit this. For instance, our work may also be applied to telecommunications markets or insurance markets where the complexity of decision-making is high.

A Mathematical proofs

A.1 Proof of Proposition 1

Proof: We only show Firm 2's optimal obfuscation. Firm 2 wants to increase or decrease its own obfuscation level if

$$\frac{dE(\Pi_2)}{dk_2} \gtrless 0 \Leftrightarrow \phi(1-\phi)\mu^2 - 2\phi\mu + 1 \gtrless 0.$$

Let $\omega(\mu) := \phi(1-\phi)\mu^2 - 2\phi\mu + 1$. $\omega(\mu)$ is a parabola that opens upward with two roots being $\frac{\phi \pm \sqrt{\phi(2\phi-1)}}{\phi(1-\phi)}$. Since the larger root is above 1, $\tilde{\mu}(\phi)$ is the root of interest.

Bear in mind that $\mu(x, k_1, k_2)$ strictly increases in k_2. We differentiate three cases. First, if $\overline{\mu_x} < \tilde{\mu}(\phi)$, $\omega(\mu) > 0$ for all $\mu \in [\underline{\mu_x}, \overline{\mu_x})$ and therefore, Firm 2 wants to increase its obfuscation level to the upper bound, $\bar{k}$. Second, if $\underline{\mu_x} > \tilde{\mu}(\phi)$, $\omega(\mu) < 0$ for all $\mu \in [\underline{\mu_x}, \overline{\mu_x}]$ as $\overline{\mu_x} < 1 < \frac{\phi + \sqrt{\phi(2\phi-1)}}{\phi(1-\phi)}$. Consequently, Firm 2 wants to reduce its obfuscation level to the lower bound, $\underline{k}$. Finally, when $\underline{\mu_x} < \tilde{\mu}(\phi) < \overline{\mu_x}$, $\omega(\mu) > 0$ for all $\mu \in [\underline{\mu_x}, \tilde{\mu}(\phi))$ and $\omega(\mu) < 0$ for all $\mu \in (\tilde{\mu}(\phi), \overline{\mu_x}]$. The best choice for Firm 2 is then the unique level of obfuscation such that $\mu(x, k_1, k_2) = \tilde{\mu}(\phi) = (1-x)\theta(\bar{k}, k_2)$. The boundary cases are easily checked. *Q.E.D.*

A.2 Proof of Proposition 3

Proof: Following Propositions 1 and 2, we only have to show Part 2.

If $\underline{\mu_x} < \tilde{\mu}(\phi) < \overline{\mu_x}$, $\mu^* = \tilde{\mu}(\phi)$ and consequently, μ^* strictly decreases in ϕ. See Equation (13).

From Proposition 1, we know in this case $(1-x)\theta(\bar{k}, k_2^*) = \tilde{\mu}(\phi)$. Differentiating both sides w.r.t. ϕ we have

$$(1-x)\frac{d\theta}{dk_2}\frac{dk_2^*}{d\phi} = \frac{d\tilde{\mu}(\phi)}{d\phi} < 0.$$

Hence, whenever $\mu^* = \tilde{\mu}(\phi)$, $\frac{dk_2^*}{d\phi} < 0$, that is, Firm 2's equilibrium obfuscation strictly decreases in ϕ.

<div align="right">Q.E.D.</div>

A.3 Proof of Proposition 4

Proof: Note that $\overline{\mu_{x''}} < \overline{\mu_{x'}}$ and $\underline{\mu_{x''}} < \underline{\mu_{x'}}$. If $[\underline{\mu_{x''}}, \overline{\mu_{x''}}]$ and $[\underline{\mu_{x'}}, \overline{\mu_{x'}}]$ intersect, it can only be that $\overline{\mu_{x''}} \geq \underline{\mu_{x'}}$.

- Suppose $\overline{\mu_{x''}} \geq \underline{\mu_{x'}}$. Since $\tilde{\mu}(\phi) > \frac{1}{2}$, we need to differentiate two cases: there exists a ϕ such that $\tilde{\mu}(\phi) \in [\underline{\mu_{x'}}, \overline{\mu_{x''}}]$ and otherwise.

    - In the former case, $\tilde{\mu}(\phi)$ is attainable under both x' and x''. By Proposition 2, μ^* remains the same. As $(1-x')\theta(\bar{k}, k_2^{*'}) = (1-x'')\theta(\bar{k}, k_2^{*''})$, $x'' > x'$ and $\frac{d\theta}{dk_2} > 0$, $k_2^{*''} > k_2^{*'}$. This proves the first part of Proposition 4.

    - For the latter case to emerge, it must be that $\overline{\mu_{x''}} \leq \frac{1}{2} < \tilde{\mu}(\phi)$. By Proposition 1, the equilibrium share of naive consumers after the policy change is $\overline{\mu_{x''}}$ which is less than either $\overline{\mu_{x'}}$ (if $\overline{\mu_{x'}} \leq \tilde{\mu}(\phi)$) or any previously attainable $\tilde{\mu}(\phi)$ (if $\overline{\mu_{x'}} > \tilde{\mu}(\phi)$).

- If $\overline{\mu_{x''}} < \underline{\mu_{x'}}$. All possible shares of naive consumers under x'' is strictly less than those under x', hence its equilibrium level must decrease after the policy change. This concludes the proof.

<div align="right">Q.E.D.</div>

B Additional tables and figures

	session	1	2	3	4
Obfusc. by one firm	Firm 1	62.2	75.1	67.6	62.2
	Firm 2	48.9	61.1	61.3	58.3
	Δ	13.3	14.0	6.3	3.9
Obfusc. by both firms	Firm 1	84.6	88.4	87.8	79.2
	Firm 2	85.3	77.0	77.4	80.4
	Δ	-0.7	11.4	10.4	-1.2
Impact of obfusc.	Firm 1	22.4	13.3	20.2	17.0
	Firm 2	36.4	15.9	16.1	22.1

Table 7: Average prices in treatment SYM by firm type

	session	1	2	3	4
Obfusc. by one firm	Firm 1	62.0	52.7	55.0	51.9
	Firm 2	34.4	38.3	40.2	33.4
	Δ	27.6	14.4	21.8	18.5
Obfusc. by both firm	Firm 1	78.3	72.5	66.2	85.2
	Firm 2	62.5	53.6	58.1	73.4
	Δ	15.8	18.9	8.1	11. 8
Impact of obfusc.	Firm 1	16.3	19.8	11.2	33.3
	Firm 2	28.1	15.3	17.9	40

Table 8: Average prices in treatment POL by firm type
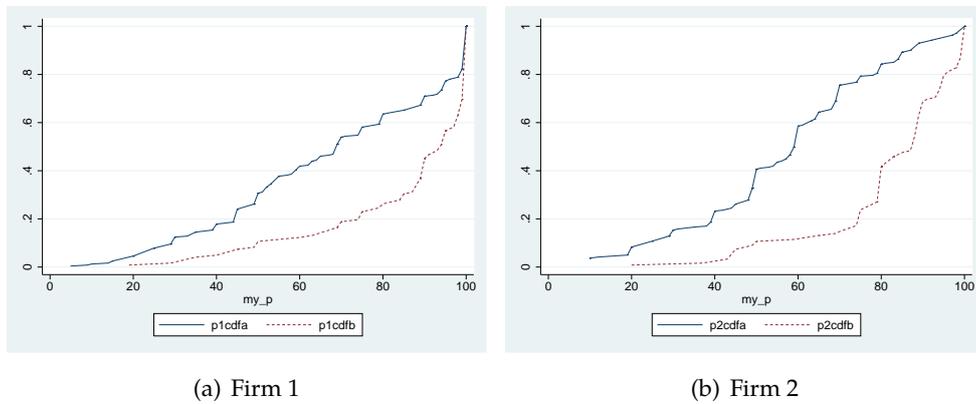
(a) Firm 1

(b) Firm 2

Figure 5: The impact of firms' pricing behavior if obfuscation increases (Treatment SYM)
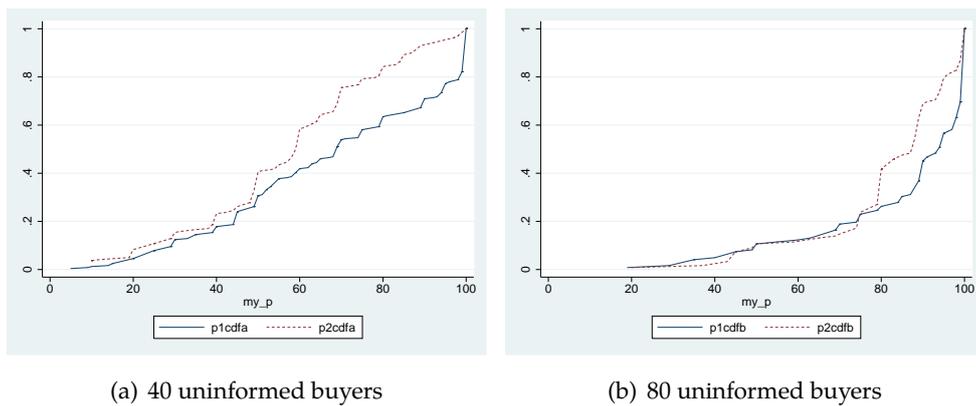

(a) 40 uninformed buyers

(b) 80 uninformed buyers

Figure 6: Comparison of the price distributions of Firm 1 and Firm 2 in the treatment SYM

C Instructions

Welcome to this experiment in decision making. Please read the instructions carefully.

During the experiment you can earn points depending on your own decisions and those of the other participants. At the end of the experiment this points are converted at a rate of 10.000 points = 1 EUR into Euro and paid to you.

You are starting with an amount of 40.000 points. This amount is increased by the earnings in each period.

The setup

In this experiment you are assigned the role of a seller. In each period of the experiment you are competing with another seller which is randomly determined among the other participants of the experiment. Your competitor is determined each round anew so that in each round you are competing with another participant.

There are two types of sellers: Type A and type B who interact with each other. Which role is assigned to you is determined at the start of each period and is communicated to you. If you are a seller of type A you are interacting with a seller of type B.

You and the other seller are selling a good to 100 buyers. Each buyer purchases exactly one unit of the good. The buyers are simulated by the computer. There are two types of buyers: "searching" and "non-searching" buyers. A "searching" buyer purchases the good from the seller that has chosen the lower price. "Non-searching" are programmed such that a share of 90% (60%) automatically purchases from the seller of type A and a share of 10% (40%) automatically purchases from the seller of type B.

In each period of the experiment you have to take two decisions which are described in the following.

The first stage

In the first stage of each period, both sellers simultaneously decide whether to increase the number of "non-searching" buyers. In the initial situation, there are 0 "non-searching" buyers and 100 "searching" buyers. For each seller deciding to increase the number of "non-searching" buyers , this number of "non-searching" buyers is increased by 40 (20). The number of "searching" buyers is decreased accordingly. The following table shows the number of "non-searching" and "searching" buyers depending on the decisions of both sellers:

Number of sellers deciding to increase the number of "non-searching" buyers	0	1	2
"Non-searching" buyers	0	40 (20)	80 (40)
"Searching" buyers	100	60 (80)	20 (60)

The second stage

In the second stage of each period, you receive information on the decisions taken in the first stage and thus you receive information on the number of "searching" and "non-searching" buyers. Subsequently, both sellers simultaneously decide on the price they charge. The chosen price must be an integer between 0 and 100.

End of each period

At the end of each period, the computer calculates how many units you and the other seller have sold. Note that each buyer buys exactly one unit of the good. The number of sold units is calculated as follows:

- your share of the non-searching buyers will buy from you

- searching buyers will only buy from you if you have chosen a lower price than the other seller.

Finally, you receive information about the points that you earned this period. The number of points earned is the number of sold units multiplied by the price you have chosen.

End of the experiment

The experiment is repeated for 25 rounds. Whether you take the role of seller A or B is randomly determined in each period. At the end of the experiment your earnings will be paid out to you. Your earnings comprises the show-up fee and the points you have earned during the experiment.

References

Agarwal, S., Driscoll, J. C., Gabaix, X., and Laibson, D. (2009). The age of reason: Financial decisions over the life cycle and implications for regulation. *Brooking Papers on Economic Activity*, 2:51–118.

Armstrong, M., Vickers, J., and Zhou, J. (2009). Prominence and consumer search. *Rand Journal of Economics*, 40(2):209–233.

Bolton, G. E. and Ockenfels, A. (2000). ERC: A theory of equity, reciprocity and competition. *American Economic Review*, 90(1):166–193.

Bolton, P., Freixas, X., and Shapiro, J. A. (2007). Conflicts of interest, information provision, and competition in banking. *Journal of Financial Economics*, 85(2):297–330.

Calvet, L. E., Campbell, J. Y., and Sodini, P. (2007). Down or out: Assessing the welfare costs of household investment mistakes. *Journal of Political Economy*, 115:707–747.

Calvet, L. E., Campbell, J. Y., and Sodini, P. (2009). Measuring the financial sophistication of households. *American Economic Review*, 99(2):393–398.

Campbell, J. Y. (2006). Household finance. *Journal of Finance*, 61(4):1553–1604.

Carlin, B. I. (2009). Strategic price complexity in retail financial markets. *Journal of Financial Economics*, 91(3):278–287.

Carlin, B. I. and Manso, G. (2011). Obfuscation, learning, and the evolution of investor sophistication. *Review of Financial Studies*, 24(3):754–785.

Choi, J. J., Laibson, D. I., and Madrian, B. C. (2010). Why does the law of one price fail? An experiment on index mutual funds. *Review of Financial Studies*, 23(4):1405–1432.

Christoffersen, S. E. K. and Musto, D. K. (2002). Demand curves and the pricing of money management. *Review of Financial Studies*, 15(5):1499–1524.

Ellison, G. and Ellison, S. F. (2009). Search, obfuscation, and price elasticities on the internet. *Econometrica*, 77(2):427–452.

Ellison, G. and Wolitzky, A. (2011). A search cost model of obfuscation. mimeo. MIT.

Fehr, E. and Schmidt, K. M. (1999). A theory of fairness, competition and cooperation. *Quarterly Journal of Economics*, 114(3):817–868.

Fischbacher, U. (2007). z-Tree: Zurich toolbox for ready-made economic experiments. *Experimental Economics*, 10(2):171 – 178.

Gabaix, X. and Laibson, D. I. (2005). Shrouded attributes, consumer myopia, and information suppression in competitive markets. *Quarterly Journal of Economics*, 121(2):505–540.

Henderson, B. J. and Pearson, N. D. (2011). The dark side of financial innovation: A case study of the pricing of a retail financial product. *Journal of Financial Economics*, 100:227–247.

Hortacsu, A. and Syverson, C. (2004). Product differentiation, search costs and competition in the mutual fund industry: A case study of S&P index funds. *Quarterly Journal of Economics*, 119(2):403–456.

Inderst, R. and Ottaviani, M. (2009). Misselling through agents. *American Economic Review*, 99(3):883–908.

Inderst, R. and Ottaviani, M. (2011). Competition through commissions and kickbacks. Forthcoming *American Economic Review*.

Kalayci, K. and Potters, J. (2011). Buyer confusion and market prices. *International Journal of Industrial Organization*, 29(1):14–22.

Lusardi, A. and Mitchell, O. (2007). Baby boomer retirement security: The roles of planning, financial literacy, and housing wealth. *Journal of Monetary Economics*, 54(1):205–224.

Lusardi, A., Mitchell, O., and Curto, V. (2010). Financial literacy among the young. *Journal of Consumer Affairs*, 44(2):358–380.

Morgan, J., Orzen, H., and Sefton, M. (2006a). An experimental study of price dispersion. *Games and Economic Behavior*, 54(1):134–158.

Morgan, J., Orzen, H., and Sefton, M. (2006b). A laboratory study of advertising and price competition. *European Economic Review*, 50(2):323–347.

Narasimhan, C. (1988). Competitive promotional strategies. *Journal of Business*, 61(4):427–449.

Stango, V. and Zinman, J. (2009). Exponential growth bias and household finance. *Journal of Finance*, 64(6):2807–2849.

Stango, V. and Zinman, J. (2011). Fuzzy math, disclosure regulation, and market outcomes: Evidence from truth-in-lending reform. *Review of Financial Studies*, 24(2):506–534.

van Rooij, M., Lusardi, A., and Alessie, R. (2011). Financial literacy and stock market participation. *Journal of Financial Economics*, 101(2):449–472.

Varian, H. R. (1980). A model of sales. *American Economic Review*, 70(4):651–659.