# Curbing Obfuscation: Empower Consumers or Regulate Firms?*

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January 2020

**Abstract**

This paper develops a market model where consumers refrain from buying products that they are unable to understand and a firm can influence the probability of a consumer understanding its offer. In equilibrium, firms artificially increase product complexity, and firms that offer more transparent products choose on average higher prices. We study two sets of public policies. We show that consumer side policies may have the unintended consequence of encouraging obfuscation while firm side policies are always effective in curbing obfuscation. Interestingly, a consumer side policy can even harm consumers when it protects consumers so much that it greatly increases the marginal effectiveness of obfuscation. Policies on both sides can either increase or decrease social welfare depending on the marginal effectiveness and the marginal cost of obfuscation. Our main insights hold in both asymmetric and symmetric obfuscation equilibria.

*JEL Classification*: D18, D80, G28, L50

*Keywords*: Consumer Confusion; Obfuscation; Consumer Protection Policy; Regulation

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*We are grateful to Yongmin Chen, Ioanna Chioveanu, Dominique Demougin, Asen Kochov, Doug Miller, Andrew Rhodes, David Ronayne, Burkhard Schipper, Adriaan Soetevent, Greg Taylor, Chris Wilson and Jidong Zhou as well as two reviewers for their valuable discussions. We thank seminar audiences at Brunel, Fudan, Nottingham (Ningbo), Sheffield, Swansea, XJTLU and conference participants at IIOC, EEA, EARIE and the Econometric Society Asia and China Meetings for helpful comments. Yiquan wishes to thank the hospitality of Toulouse School of Economics and UC Davis where some parts of the paper were finalized during his research visits.

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# 1 Introduction

Consumers in modern retail financial markets are facing increasingly many complicated choices. Given the required levels of financial knowledge and product information for making good decisions, it is not surprising to see widespread mistakes in consumer decision making being documented in the recent literature. Campbell (2006) highlights a number of common mistakes including under-participation in the equity market, inadequate portfolio diversification, failure to re-mortgage, etc. Indeed, Agarwal et al. (2016) find that 59% of borrowers in their study refinance mortgages sub-optimally. Choi et al. (2010) and Duarte and Hastings (2012) find investors fail to minimize return adjusted fund management fees. Choi et al. (2011) find about 36% of the employees in their study of employer matched retirement plans under-contribute, leaving about 1.6% of their annual pay on the table. Other common mistakes, e.g., those observed in credit card and payday loan markets, were noted in Agarwal et al. (2009a,b). A natural question to ask here is: How could public policies help consumers make better decisions and achieve better outcomes?

A direct initiative is to empower consumers by improving their financial sophistication.[1] However, it should be noted that consumers are not making financial decisions in a static environment. Recently, Hastings et al. (2017) evaluated the effectiveness of a government intervention in Mexico's privatised social security system where providers' reaction to the public policy played an important role. Indeed, the supply side is often blamed for making consumer decisions more difficult than necessary. For instance, financial institutions might shroud certain elements of their pricing strategies (Gabaix and Laibson, 2006; Campbell, 2006) or highlight irrelevant information (Choi et al., 2010). It has also been well documented that 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; Hortaçsu and Syverson, 2004).

To better understand the effects of public policies, one needs to take an explicit account of supply side obfuscation. There are naturally two sets of public policies: one that focuses on preparing consumers for better decision making and the other that regulates the conduct of supply side providers. For example, recognizing that greater regulation of the financial market is needed in the wake of 2008 financial crisis, the Dodd-Frank Wall Street Reform and Consumer Protection Act was signed into law in 2010 in the US. In particular, under title X, the Bureau of Consumer Financial Protection (CFPB) was established to "help consumer finance markets work by making rules more effective, by consistently and fairly enforcing those rules, and by empowering consumers to take more control over their economic lives." This statement highlights the two sets of policies at the disposal of policy makers: firm side regulation and consumer empowering. The former may be interpreted

[1] That financially more literate consumers make better decisions has been documented in, e.g., Lusardi and Mitchell (2007); Lusardi et al. (2010); Stango and Zinman (2009); van Rooij et al. (2011), among others. As Hastings et al. (2013) note, however, the effectiveness of this policy calls for a causal relationship for which the evidence is much more limited.

as making it more difficult or more costly for firms to adopt obfuscation strategies while the latter as making consumers less easily confused by obfuscation strategies. With an annual budget of over $600 million in recent years, it is important to understand the commonalities and the differences of these two sets of policies.[2]

In this paper, we analyse and contrast these two sets of policies from a regulatory point of view. To this aim, we develop a simple duopoly game of strategic obfuscation where in the first stage firms independently select the level of price complexity at a cost and in the second stage they compete in prices. A strengthening of firm side regulation corresponds to an increase in the cost of obfuscation while a consumer empowering policy reduces the effectiveness of obfuscation. We then investigate how changes in these two types of policies affect firms' obfuscation choices and consumer welfare in equilibrium.

Our contribution is two-fold. First, we propose an alternative consumer decision rule within the standard obfuscation framework of Carlin (2009). Second, we provide a model that allows for comparing and contrasting the two sets of public polices and derive general results in this regard.

Specifically, differing from previous obfuscation models, a firm in the current paper can only confuse its own consumers.[3] Intuitively, when a firm obfuscates more, it reduces its own chances of being understood and patronised. We assume that this firm's obfuscation practice does not affect how consumers perceive competitors' offers. We take the view that consumers are averse to obscurity. In particular, our consumers would not buy from a firm whose offer they do not understand. If they understand neither, they will resort to a transparent outside option. If there's only one offer they understand, they buy it if the reservation price is not exceeded. They buy from the lower priced when they understand both offers. This mechanism is related to the one in the search model by Wilson (2010) which will be discussed in more detail in our literature survey.

Our consumer decision rule is primarily motivated by ambiguity/obscurity aversion and non-participation in the financial markets. Theoretically, Dow and Werlang (1992), Cao et al. (2005), and Easley and O'Hara (2009), among others, show that ambiguity aversion can explain under-participation in the equity market.[4] Recent empirical studies such as Bossaerts et al. (2010) and Dimmock et al. (2016) lend support to this explanation. Our consumers who are confused by both offers will abstain from this particular market. For example, confused retail investors would rather leave money in their savings account instead of investing in a mutual fund with fees as well as terms and conditions they do not understand. More broadly, other explanations for under-participation such as cognitive

[2]See CFPB budget information in CFPB (2016).

[3]In contrast, in e.g. Carlin (2009), Piccione and Spiegler (2012), and Gu and Wenzel (2014), a firm can unilaterally influence the share of "confused" consumers who then buy randomly from all available firms.

[4]Theories with standard expected utility, e.g. Arrow (1965) and Merton (1969), predict that all individuals should participate in the equity market. However, the US household stock market participation rate (either directly or indirectly through mutual funds and/or retirement accounts) is only about 50% in recent years. See, e.g, Guiso et al. (2008) and Bucks et al. (2009).

ability (Grinblatt et al., 2011) or financial knowledge (van Rooij et al., 2011) are also consistent with our modelling strategy. In these cases, obfuscation can be interpreted as making financial decisions mentally more demanding or as inventing new financial jargon with the aim to reduce consumers' ability in understanding their offers. A couple of recent papers (discussed in more detail in our literature survey) also adopt the idea that consumers prefer simple contracts (Papi, 2014; Bachi and Spiegler, 2018). Relatedly, consumers may prefer to visit firms with lower search costs as in Wilson (2010).

In this setup, obfuscation can only reduce demand. Then why do we still observe firms obfuscate? In a nutshell, given that the other firm is setting a low level of obfuscation, it is better off to obfuscate than not because the second stage price competition will be less fierce when the firm obfuscates. This is so because by obfuscation the firm makes more consumers understand only the other firm's price, and hence the other firms will have more captive consumers, find its demand less price elastic and ultimately compete less aggressively in the pricing stage.[5] As a result, the firm that offers a more transparent price usually has a higher price in equilibrium. This mechanism may explain the casual observation that simpler prices can be more costly for consumers than more complex ones such as all inclusive, no hidden charges, flat-rate contracts versus traditional ones in retail finance, holiday or telecom markets.[6]

There are two types of obfuscation equilibria in this model. In the asymmetric equilibria, exactly one firm obfuscates and the other selects no obfuscation. There exists also a unique symmetric equilibrium in which both firms obfuscate according to a cumulative distribution function. In our view, the asymmetric equilibria are better predictions of the longer run outcome where certain firms have the reputation of choosing simple and transparent prices while others usually have more complex prices. On the other hand, the symmetric equilibrium in mixed strategies captures the outcome in young markets where firms are not yet able to coordinate on an asymmetric equilibrium. Given its relevance, we are interested in characterizing this equilibrium although it is technically much more involved.

Policywise we show, as the main difference between the two sets of polices, that consumer

[5]It is true that obfuscation will raise the competitor's profits even more - as by obfuscation one "directs" consumers to the competitor - given that firm B already makes a transparent offer, firm A still makes more profits in absolute terms by obfuscation. The logic of this obfuscation mechanism, that is, benefiting the rival to soften competition is akin to those discussed in Gelman and Salop (1983), Chen (1997), Hendel and de Figueiredo (1997), and more recently in Esteves and Resende (2016), although all in different contexts.

[6]The empirical evidence whether transparent or intransparent firms charge higher prices appears to be mixed. For instance, Wilson (2010) provides anecdotal evidence from the car insurance market in the UK where a cheaper insurance company is less transparent via not listing on price comparison platforms. Other examples of such observations may include train tickets booked for a direct route are usually more expensive than those booked by splitting the same journey into shorter ones (Scott, 2016), and restaurants at prime locations in tourist destinations are usually dearer than those at the back of streets. More systematical evidence is provided by McDonald and Wren (2018) who argue that a firm with multiple brands can obfuscate the market, and find that (more obfuscated) multibrand firms post significantly lower prices relative to other firms. However, on the other hand, in the market for retail structured products Célérier and Vallée (2017) find that more complex products tend to have higher margins.

side policies may have the unintended consequence of encouraging obfuscation and even *reduce* consumer welfare while firm side policy is always effective in curbing obfuscation and promoting consumer surplus. On the other hand, both policies can either increase or decrease social welfare depending on the marginal effectiveness and the marginal cost of obfuscation. When the return on obfuscation is higher than the cost, stricter polices can decrease social welfare because of elevated total obfuscation costs - either through encouraged obfuscation in the case of consumer side protection or because obfuscation is more costly due to firm side regulation.

These main insights hold in both the asymmetric and symmetric obfuscation equilibria. However, consumption is less efficient in the symmetric obfuscation equilibrium because some consumers understand neither offer and opt for the low valued outside option. To obtain more concrete results, we investigate the situations where the marginal effects and marginal costs of obfuscation stay constant. We find consumer surplus is always higher in the asymmetric than in the symmetric equilibrium due to higher consumption efficiency. More interestingly, the scope for policy intervention is larger in the symmetric equilibrium case than in the asymmetric one. That is, a policy intervention is more likely to improve welfare in the symmetric equilibrium case than the asymmetric one.

Finally, in an extension to $n \geq 2$ firms, we demonstrate that insights derived in the duopoly setup carry over to the oligopoly case. Moreover, we show that a larger number of firms is beneficial for consumers (even if there are more obfuscating firms), and more interestingly, policy interventions tend to be more effective with a larger number of firms. The latter points to a complementarity between traditional competition policy (promoting firm entry) and consumer protection policies. Both policies are more effective in combination than alone.

### Related literature

The present paper complements the current research on government interventions and public policies that are designed to help consumers in the financial market. On the consumer side, Madrian and Shea (2001), Thaler and Benartzi (2004) and Beshears et al. (2008) find that improving the default choice for consumers can significantly increase their participation and contribution rates in the retirement savings plan. Duarte and Hastings (2012) investigate the Mexican government's initiative to increase fee transparency in their privatized social security system by publicising a single fee index that aggregates multiple fees into one measure. While consumer demand became more responsive to the easily understood fee index, firms start to game the system by setting higher fees on items that take less weight in the index. This is in line with our model prediction that the supply side would increase obfuscation to counter consumer side initiatives. In a related paper, Hastings et al. (2017) study two specific policy measures on each side of the market and obtain quantitative results through simulation. While we share the dichotomy of demand side and supply side policies, our aim is to provide a general theoretical account on these two sets of policies.

The closest paper to our approach is Wilson (2010) who employs a search framework and explicitly shows that an obfuscating firm can soften the competition for consumers with low time costs by inducing the remaining consumers to optimally first search its rival. In our framework, by introducing a more realistic consumer decision rule into the Carlin (2009) framework, we find a parallel mechanism. Firms employ similar asymmetric obfuscation strategies, and the more transparent firm charges, on average, a higher price. However, in contrast to Wilson (2010) our approach is more tractable for policy analyses and can be easily extended to oligopoly markets. In addition, our approach does not rely on the assumption that search costs are observable to consumers (prior to search) and we also characterise the symmetric (mixed-strategy) obfuscation equilibrium.

Recently, Ko and Williams (2017) and Kosfeld and Schüwer (2017) studied effects of policy initiatives in retail financial markets where firms may shroud add-on costs. Ko and Williams (2017) analyse the effects of two specific *supply side* regulatory measures: price controls and mandatory add-on disclosure. While when deployed alone either measure can harm welfare, the authors show such negative consequences shall not emerge if the two are used in combination. On the other hand, Kosfeld and Schüwer (2017) focus on *consumer side* education and show that education may lead to an equilibrium in which firms discriminate between consumer types and, to lower welfare. In a different but related framework, we identify conditions for policies on both sides that can delineate positive and negative welfare effects.

This paper is also related to the behavioural IO literature. For surveys, see Huck and Zhou (2011) or Grubb (2015a,b), and for a textbook treatment, see Spiegler (2011). One stream of this literature considers settings where firms can affect the comparability of offers across firms.[7]

Piccione and Spiegler (2012) offer a model where firms choose prices and a price frame. If firms choose different frames consumers are unable to make comparisons and select randomly one offer. This framework is suitable to analyse settings where firms can decide how to present and frame their offers (for instance, prices in terms of different measurement units.) The model proposed by Chioveanu and Zhou (2013) uses a similar mechanism and extends the analysis beyond duopoly. In Carlin (2009) a firm that increases the complexity level of their product also reduces the number of consumers who can make comparisons and increases randomly-selecting consumers. Gu and Wenzel (2014) is a version with asymmetric firms. *In contrast*, in the present paper obfuscation is interpreted as the complexity of a firm's offer, that is, how difficult a consumer finds it to understand the

[7]Other streams in behavioural IO on firm obfuscation consider approaches where consumers cannot correctly evaluate multi-dimensional products or price representations (e.g., Gabaix and Laibson, 2006; Spiegler, 2006; Heidues et al., 2017) or where firms strategically manipulate search costs (Wilson, 2010; Ellison and Wolitzky, 2012).

terms of a contract of the firm's own offer. Consumers who find a contract too complicated, will not consider purchasing such a product, and rather purchase from the competitor if it offers an understandable option, or resort to a transparent outside option.

Our assumption that consumers are averse to obscurity is also related to recent approaches with tradeoff-avoiding consumers. Bachi and Spiegler (2018) are the first to study the implications of trade-off averse consumers in a market model. They develop a model where two firms can offer products in a two-dimensional product space (two quality attributes). Consumers are averse to trade-offs and when faced with a "difficult choice" (that is, when each offers a preferred attribute along one dimension) they either turn to a default option or select according to one random attribute only.

Relatedly, Papi (2014) considers a market model where consumers are also averse to making trade-offs across attributes. He assumes that consumers are limited in the number of trade-offs they can perform. He finds that competition induces firms to offer products with extreme attributes, but become more balanced as consumers can handle an increasing number of trade-offs.

Policy and consumer protection interventions are a common theme in the behavioural IO literature. In particular, this literature argues that such interventions need not be successful and may indeed hurt consumers. For instance, Piccione and Spiegler (2012) argue that harmonising presentation formats, intended to simplify consumer choices, may lead more complicated price presentations and thus hurt consumers. Bachi and Spiegler (2018) examine the effects of default rules. Introducing an opt-out rule instead of an opt-in rule leads to higher participation but also to lower quality levels offered by the firms. In an asymmetric firm setting, Gu and Wenzel (2014, 2015) show that firms which initially offer transparent products may switch to more complicated products in response to policy interventions. The theme that interventions may hurt market outcomes is also present in this paper, but we offer a perspective on different types of policy interventions. We compare and contrast measures that act on the consumer side (e.g., education initiatives) and measures that act on the supply side (e.g, forbidding certain practices).

The rest of the paper is organised as follows. Section 2 outlines the model and Section 3 identifies both asymmetric and symmetric obfuscation equilibria. In Section 4 we analyse the effects of the two sets of policies. In Section 5 we extend the analysis to an oligopoly setting with more than two firms. Section 6 concludes.

## 2 The model

Consider a market with a measure one of consumers each demanding one unit of a homogeneous product with maximum willingness to pay $r > 0$. Without loss of generality, we normalise $r$ to one. On the supply side, there are two symmetric firms, $i = 1, 2$, competing to sell the product. For simplicity, firms produce at constant marginal cost which is normalised to zero.

### Consumer behaviour

Consumers may be confused by firms' pricing strategies. Let $x > 0$ be the measure of consumer side policy. When firm $i$ chooses an obfuscation level of $k_i \geq 0$, a fraction of $\phi(k_i, x) \in [0, 1)$ consumers becomes confused by $i$'s price. The remaining share of consumers, $1-\phi(k_i, x)$, is able to understand firm $i$'s pricing strategy. We assume: $\phi(0, x) = 0$, $\phi_k > 0$, $\phi_x < 0$, $\phi_{kk} \leq 0$, $\phi_{xx} \geq 0$ where subscripts denote corresponding partial derivatives.

Let us comment on these assumptions. Firstly, by obfuscation a firm increases the number of consumers who are unable to understand its price but with decreasing marginal effect. On the other hand, consumer side policy interventions (higher values of $x$) reduce the share of confused consumers at a decreasing marginal rate. If a firm chooses not to obfuscate at all ($k_i = 0$), all consumer understands its pricing strategy.[8]

Secondly, a priori, we place no restrictions on $\phi_{kx}$. When $\phi_{kx} = 0$, $x$ corresponds to a pure level effect of policy. When $\phi_{kx} < 0$, the policy not only has a level effect, but also decreases the effectiveness of further obfuscation. For instance, if the policy is an education initiative, consumers may have a better understanding of possible firm tactics making it harder for firms to use additional obfuscation. When $\phi_{kx} > 0$, the policy reduces the share of confused consumers for any given level of obfuscation, but increases the effectiveness of obfuscation efforts. Such cases may arise, for instance, if the policy induces consumers to take less care than prior to the policy.[9]

We envisage the following consumer decision rule. When a consumer understands both prices, she buys from the lower priced firm provided it does not exceed the reservation price $r = 1$; a tie is broken with equal probability. When she understands only firm $i$'s price, she buys from $i$ if its price is no higher than $r$. When the consumer understands neither, she refrains from buying this product and resorts to her outside option whose value is normalized at $0$.[10] A similar decision behaviour is considered in Bachi and Spiegler (2018) where a consumer that faces a "difficult choice" either turns to the default option

[8] Alternatively, one could also assume that even with firms choosing not to obfuscate a positive share of consumers would not be able to understand its price (that is, $\phi(0, x) > 0$). This might be a realistic description for complicated products such as insurance contracts. However, this modification would yield qualitatively similar results as the current version.

[9] That is, consumers may alter their behaviour in response to policy changes. See, for example, studies of offsetting behaviour in automobile safety (Peltzman, 1975; Peterson et al., 1995) as well as the comparable "rebound effect" in energy use (Greening et al., 2000; Gillingham et al., 2013).

[10] For instance, in the case of investment funds the outside option could be interpreted as investing in a savings account.

or selects according to one randomly chosen attribute.[11] Note also that a consumer in our model does not necessarily observe a firm's complexity level. It can be the case that she realises only whether or not she understands the offers without being able to rank them according to their complexity.

Assume additionally that a consumer's ability in understanding a firm's price is independent of her ability in understanding the other. Thus, for a combination of $(k_1, k_2)$, a fraction $\phi(k_1, x)\phi(k_2, x)$ of all consumers understands *neither* price, $[1 - \phi(k_1, x)]\phi(k_2, x)$ only firm 1's price, $[1 - \phi(k_2, x)]\phi(k_1, x)$ only firm 2's price, and finally $[1 - \phi(k_1, x)][1 - \phi(k_2, x)]$ both.[12]

### Firm behaviour

Obfuscation is costly, and the cost depends on the obfuscation level as well as on the supply side policy, $y > 0$. The cost of selecting a level of obfuscation is $c(k_i, y)$. We assume: $c(0, y) = 0$, $c_k > 0$, $c_y > 0$, $c_{kk} \geq 0$ and $c_{ky} \geq 0$, where subscripts denote corresponding partial derivatives. Costs are convex in obfuscation effort. For a given level of obfuscation, supply side policy $y$ increases the cost $(c_y > 0)$ and also increases the marginal cost of extending obfuscation $c_{ky} \geq 0$. For instance, a firm side policy might be a ban of a certain practice, so that firms are forced to employ more costly and less effective obfuscation tactics.[13] Further, $c_k(0, y) < \phi_k(0, x)$ so that obfuscation costs do not render it irrelevant.

There are two stages in the game. In stage one, each firm simultaneously and independently chooses a level of obfuscation. In stage two, after observing stage one choices $(k_1, k_2)$, the two firms simultaneously and independently set their prices $p_i \in [0, r]$.[14, 15] This time structure reflects the idea that pricing is a short-term decision and the obfuscation decision takes more time or is costly. For instance, if contracts or offers have to be redesigned, this time sequential structure is appropriate.[16]

[11] Alternative approaches where confused buyers purchase randomly from one supplier are Carlin (2009) or Piccione and Spiegler (2012), for instance.

[12] An alternative approach would be to assume that the ability to understand pricing strategies is correlated across products. For instance, one could assume that a consumer who understands a product with complexity $k_i$ is also able to understand the product of firm $j$ when $k_j \leq k_i$. However, as our main qualitative results are not affected by this alternative approach we present the simpler analysis with independent abilities.

[13] Policies that are easily circumvented by firms could also be captured by our model by considering $c_y = c_{ky} = 0$. However, as it will be clear later on that such policies have no effects on equilibrium outcomes (equation 7), we consider the more interesting cases as detailed above.

[14] We note that prices above the reservation price are weakly dominated even when allowed.

[15] We also note that by analysing a game where obfuscation decisions precede pricing decisions, we implicitly assume that pricing is more flexible while obfuscation tends to be more persistent. On the other hand, one could also consider that price and obfuscation are joint decisions. Which assumption is more appropriate depends largely on the context. Assuming a simultaneous move game would, however, lead to a qualitatively similar structure of equilibrium obfuscation as under sequential moves. A full characterisation is, however, beyond the scope of the present paper as such an analysis is complex, in particular, if outcomes are asymmetric. See, for instance, Chioveanu (2019) for such an analysis with two firms differing in their level of prominence.

[16] Note that, depending on the context, a simultaneous time structure might also be appropriate which would imply that both pricing and obfuscation can both be easily changed. In the current paper, we consider only the case where obfuscation is costly and takes time.

Stage two revenue $R_i$, given the above consumer decision rule, is thus

$$R_i(k_i, k_j, p_i, p_j, x)$$
$$= \begin{cases} p_i \{[1-\phi(k_i,x)]\phi(k_j,x) + [1-\phi(k_i,x)][1-\phi(k_j,x)]\} & \text{if } p_i < p_j \\ p_i \left\{[1-\phi(k_i,x)]\phi(k_j,x) + \frac{[1-\phi(k_i,x)][1-\phi(k_j,x)]}{2}\right\} & \text{if } p_i = p_j \\ p_i \{[1-\phi(k_i,x)]\phi(k_j,x)\} & \text{if } p_i > p_j \end{cases}.$$

Firms are risk-neutral profit maximisers. Their end payoffs in this game are

$$\pi_i = R_i(k_i, k_j, p_i, p_j, x) - c(k_i, y).$$

# 3 Analysis

We solve the game by backward induction starting with the second stage pricing decisions.

## 3.1 Pricing stage

In the second stage, with obfuscation choices having been made, firms compete in prices to maximise revenue. Because there are consumers who understand both prices and consumers who understand only one price, no pure strategy equilibrium exists in almost all pricing games.[17] Instead, applying Narasimhan (1988), the unique pricing equilibrium is in mixed strategies.

**Lemma 1** (Narasimhan, 1988)**.** Assume that $k_i \leq k_j$ where $i = 1, 2, j \neq i$. There exists a unique Nash equilibrium in the pricing stage, in which firm $i$ prices according to the cumulative distribution function

$$F_i(p) = \begin{cases} 0 & \text{if } p < p_0 \\ 1 - \frac{\phi(k_j,x) - \phi(k_i,x)p}{[1-\phi(k_i,x)]p} & \text{if } p_0 \leq p < 1 \\ 1 & \text{if } p \geq 1 \end{cases},$$

and firm $j$ prices according to the cumulative distribution function

$$F_j(p) = \begin{cases} 0 & \text{if } p < p_0 \\ 1 - \frac{\phi(k_j,x)(1-p)}{[1-\phi(k_j,x)]p} & \text{if } p_0 \leq p < 1 \\ 1 & \text{if } p \geq 1 \end{cases},$$

[17]The only exception is the case where both firms have chosen zero complexity in the first stage. Naturally, in this subgame Bertrand competition with marginal cost pricing would emerge.

where $p_0 = \phi(k_j, x)$ is the lower bound of both firms' prices.

Moreover, in this unique second stage pricing equilibrium the less obfuscated firm $i$ chooses on average a higher price than the more obfuscated firm $j$: $E(p_i) \geq E(p_j)$.

**Proof:** see Appendix A.1.

The pricing equilibrium has the following properties. $F_i$ stochastically dominates $F_j$, that is, $F_i(p) \leq F_j(p)$ for all $p \in (p_0, 1]$. This implies that the expected price of firm $i$ is higher than the one by firm $j$. Note also that the price distribution of firm $i$ has a mass point at the reservation price, 1. With a probability of ${}^{\phi(k_j,x)-\phi(k_i,x)}/_{1-\phi(k_i,x)}$ this firm chooses the reservation price.

Firm $i$ being the one that obfuscates less actually sets higher prices in terms of the usual stochastic order. Let a consumer who understands firm $i$'s price but not $j$'s be called firm $i$'s captive consumer. The reason for this pricing result is that the firm with a less complicated price now has more captive consumers than the other $(\phi(k_i, x) < \phi(k_j, x))$, and thus becomes more reluctant in engaging in price competition for those fully informed consumers. Hence, unlike models where confused consumers shop randomly, here the more transparent product comes at a higher price than the more complex option. This is in line with the search cost model of Wilson (2010) where the firm with lower search costs charges a higher price.

In stage two equilibrium, the expected revenues are:

$$E(R_i) = [1 - \phi(k_i, x)]\phi(k_j, x) \quad \text{and} \quad E(R_j) = [1 - \phi(k_j, x)]\phi(k_j, x).$$

As $\phi(k_i, x) \leq \phi(k_j, x)$, it follows straightforwardly that firm $i$ earns a higher expected revenue than $j$. The next result summarises.

**Proposition 1.** Assume that $k_i \leq k_j$ where $i = 1, 2, j \neq i$. In the unique second stage pricing equilibrium, the less obfuscated firm $i$ stands to earn a larger expected revenue than the more obfuscated firm $j$: $E(R_i) \geq E(R_j)$.

We point out that the result that the more transparent firms charges higher prices need not be robust. For instance, if one would consider a version where willingness to pay and the ability to understand complex products are positively correlated (possible, due to a positive correlation of education and income), the more transparent firm would largely focus on consumers with a low willingness to pay and the more obfuscated firm on consumers with a higher willingness to pay. This might reverse the order of the prices compared to our base version.

## 3.2 Obfuscation choice

Given the expected revenues in the pricing stage, firms' expected payoffs in the first stage are

$$\pi_i(k_i, k_j) = \begin{cases} [1-\phi(k_i,x)]\phi(k_j,x) - c(k_i,y) & \text{if } k_i \le k_j \\ [1-\phi(k_i,x)]\phi(k_i,x) - c(k_i,y) & \text{if } k_i > k_j \end{cases}.$$

We note that conditional on being the less obfuscated, a firm would like to choose as little obfuscation as possible. On the other hand, conditional on being the more obfuscated firm, there exists a positive level of obfuscation $k^*$ that maximises the firm's expected payoff. Let $k^*$ be implicitly defined by the first-order condition of payoff maximisation conditional on being the more obfuscated firm. That is,

$$[1-2\phi(k^*,x)]\phi_k(k^*,x) - c_k(k^*,y) = 0. \tag{1}$$

We further let the second order derivative be denoted by $S$. That is,

$$S := [1-2\phi]\phi_{kk} - 2\phi_k^2 - c_{kk}.$$

We assume $S < 0$. Thus, as $\phi_k(0,x) > c_k(0,y)$, there will be a unique $k^*$ implicitly determined by (1). Note also that as $c_k > 0$, $\phi(k^*,x) \in (0, 1/2)$. Denote $\pi^*$ the expected payoff when setting $k^*$ conditional on being the more obfuscated firm. That is,

$$\pi^* := [1-\phi(k^*,x)]\phi(k^*,x) - c(k^*,y).$$

We are now ready to discuss equilibrium obfuscation. We start from pure strategy equilibria which are asymmetric.

### Asymmetric equilibria

**Theorem 1.** There exist two pure strategy equilibria in the obfuscation stage where one of the firms chooses not to obfuscate and the other sets obfuscation at $k^*$. Namely, $(0, k^*)$ and $(k^*, 0)$. There exists no other equilibrium in pure strategies.

**Proof:** see Appendix A.2.

In these two pure strategy equilibria, one firm chooses no obfuscation and obtains an expected profit of $\phi(k^*,x)$ and the other firm chooses $k^*$ and obtains an expected profit of $\pi^*$ which is less than $\phi(k^*,x)$.

The intuition of this result is the following. Either firm would like to avoid obfuscation as long as the other firm obfuscates to a substantial extent. In this case, more consumers will consider buying from oneself when it obfuscates less *and* the second stage pricing game is not too competitive. If the other firm chooses a rather low price complexity, however, it is best to obfuscate to avoid fierce price competition even though this will turn some consumers to the competitor. We note that this intuition resembles that of the "Game of Chicken" where either player prefers to stay straight given that the other swerves, and prefers to swerves if the other stays straight.

In equilibrium, a share $\phi(k^*, x)$ of the consumers understands only the price of the non-obfuscating firm while the rest understands both prices. The non-obfuscating firm obtains the rent from those who only understand itself. The other firm gets part of the rent from the fully informed consumers. In these two equilibria, no consumer drops out of the market.

### Symmetric equilibrium

We now study the symmetric obfuscation equilibrium which is in mixed strategies.

**Theorem 2.** There exists a unique symmetric obfuscation equilibrium in which each firm chooses obfuscation according to the following cumulative distribution function

$$G(k) = \begin{cases} 0 & \text{if } k < 0 \\ \frac{\pi^* + c(k,y)}{[1-\phi(k,x)]^2} + \frac{c_k(k,y)}{[1-\phi(k,x)]\phi_k(k,x)} & \text{if } 0 \le k \le k^* \\ 1 & \text{if } k > k^* \end{cases} . \tag{2}$$

where the upper bound $k^*$ is implicitly defined by

$$[1 - 2\phi(k^*, x)]\phi_k(k^*, x) - c_k(k^*, y) = 0, \tag{3}$$

and $\pi^* := \phi(k^*, x)[1 - \phi(k^*, x)] - c(k^*, y)$.

**Proof:** see Appendix A.3.

We first note - as in the asymmetric pure strategy equilibrium case - that there exists a unique $k^*$ defined by (3). Indeed the upper bound of the support in the symmetric equilibrium is identical to the obfuscation level chosen by the obfuscating firm in the asymmetric equilibrium.

In the symmetric equilibrium both firms randomise their obfuscation choice over a continuous support. Note that as $G(0) > 0$, there is a mass point at $k = 0$ of probability $\pi^* + {c_k(0,y)}/{\phi_k(0,x)}$.

Since both firms obfuscate with a positive probability, in the symmetric equilibrium there is a positive expected number of consumers who understand neither offer and therefore drop out of the market. This is unlike the asymmetric equilibrium and adds an extra source of welfare loss besides obfuscation costs.

In this symmetric case, each firm expects to earn a profit of $\pi^*$ which is the same as the obfuscating firm's expected payoff in the asymmetric equilibrium. That is, total firm profits are lower in the symmetric equilibrium than in an asymmetric one.

#### Discussion of equilibria

Here we discuss the relevance of the two types of equilibria that exist in the obfuscation stage. In our view, either equilibrium has its relevance in some situations. However, as is discussed below, the asymmetric equilibrium probably is the more relevant outcome.

The asymmetric equilibrium offers higher total profits than the symmetric equilibrium. Indeed, no firm earns less than in a symmetric equilibrium, and one firm earns a strictly higher profit. Thus, firms have a strong incentive to behave according to this equilibrium. However, some coordination is needed as with two identical firms it is a priori not clear which firm takes which role. In particular, each firm prefers to be the non-obfuscating firm. Thus, we think that the asymmetric equilibrium is a plausible description of firm behaviour if the coordination problem can be solved. This might be, for instance, an accurate description for markets where the same firms have already been in competition with each other for some time and may have already gained a reputation of transparent or less transparent pricing strategies.

On the other hand, the symmetric equilibrium might be a plausible outcome if the coordination problem is severe. This can be relevant in young markets where firms have just entered. Over time, however, due to higher profits, firms have strong incentives to coordinate on one of the asymmetric equilibria. That said, one could possibly view the symmetric equilibrium as an "intermediate" outcome and the asymmetric equilibrium as the "long-run" outcome.

## 4 Policy effects

In this section, we explore the effects of consumer side and firm side policies that are designed to fight obfuscation. We start with *asymmetric* obfuscation equilibria.

Consider the asymmetric equilibrium in which, without loss of generality, $k_1 = 0$ and $k_2 = k^*$. In this case, there are two groups of consumers: $1 - \phi(k^*, x)$ of them understand both prices and $\phi(k^*, x)$ understand only firm 1. As all consumers understand at least one price, all buy. Hence, consumer surplus in this equilibrium, denoted by $CS_a$, is just their utility from consumption (normalised to 1) minus the transfer they make to the firms,

$$CS_a = 1 - E(R_1) - E(R_2) = 1 - \phi(k^*, x) - [1 - \phi(k^*, x)]\phi(k^*, x)$$
$$= [1 - \phi(k^*, x)]^2. \tag{4}$$

As the market is covered, consumers have unit demand and we have normalised production costs to zero, social welfare consists only of gains from consumption and the welfare loss due to obfuscation costs. Accordingly, it is $W_a = 1 - c(k^*, y)$.

### 4.1 Consumer side policies

Here we study the effects of consumer side policies on market outcomes. We start with how obfuscation incentives change when strengthening consumer protection policy, that is, increasing $x$, and how this changes the number of confused consumers.

Regarding the obfuscation incentives, the policy only affects the obfuscating firm with the other firm still employing the transparent pricing strategy. By totally differentiating (1), we have

$$\frac{dk^*}{dx} = \frac{2\phi_k\phi_x - (1 - 2\phi)\phi_{kx}}{S} = \frac{2\phi_k\phi_x - \frac{c_k}{\phi_k}\phi_{kx}}{S}, \tag{5}$$

where the last equality holds because $1 - 2\phi(k^*, x) = c_k(k^*,y)/\phi_k(k^*,x)$ in equilibrium.

The effect of $x$ on the share of consumers who understand only one price $\phi(k^*, x)$, consists of two parts. There is a direct effect $\phi_x$ and an indirect effect through the choice of obfuscation. Namely,

$$\frac{d\phi(k^*, x)}{dx} = \phi_x + \phi_k\frac{dk^*}{dx} = \frac{\frac{c_k}{\phi_k}\phi_x\phi_{kk} - c_k\phi_{kx} - c_{kk}\phi_x}{S}. \tag{6}$$

From equations (5) and (6), we find that whether or not consumer side policy is effective depends mainly on its impact on the marginal effectiveness of obfuscation, i.e., the cross derivative $\phi_{kx}$. Proposition 2 presents these findings as well as their welfare implications.

**Proposition 2.** In an asymmetric obfuscation equilibrium, an increase in the consumer side policy $x$ has the following effects.

i) If $\phi_{kx} < 2\phi_k^2\phi_x/c_k < 0$, both equilibrium obfuscation and the share of confused consumers decrease, i.e., $dk^*/dx < 0$ and $d\phi(k^*,x)/dx < 0$. Moreover, both social welfare and consumer surplus increase.

ii) If $\phi_{kx} > \phi_x\left(\phi_{kk}/\phi_k - c_{kk}/c_k\right) \geq 0$, both equilibrium obfuscation and share of confused consumers increase, i.e., $dk^*/dx > 0$ and $d\phi(k^*,x)/dx > 0$. Moreover, both social welfare and consumer surplus increase.

iii) If ${}^{2\phi_k^2\phi_x}/_{c_k} < \phi_{kx} < \phi_x\left({}^{\phi_{kk}}/_{\phi_k} - {}^{c_{kk}}/_{c_k}\right)$, equilibrium obfuscation increases but the share of confused consumers decreases, i.e., ${}^{dk^*}/_{dx} > 0$ and ${}^{d\phi(k^*,x)}/_{dx} < 0$. Moreover, social welfare decreases but consumer surplus increases.

**Proof:** see Appendix A.4.

Proposition 2.i) reveals that if a consumer side policy, besides having a level effect in reducing the number of confused consumers for any given obfuscation choice, can significantly impede the marginal effectiveness of obfuscation, then it not only decreases the share of confused consumers but also discourages the market from obfuscation. That is, when consumers side policy is really effective, it has both the level effect and the behavioural effect in combating obfuscation.

On the other hand, if unfortunately a consumer policy can strongly *increase* the marginal effectiveness of obfuscation, which may due to consumers taking less care, then it not only increases the obfuscation level in the market but also the share of confused consumers.[18] Thus, as Proposition 2.ii) highlights, the level effect of the policy is dominated by its behavioural effect. In other words, the increase in obfuscation is more than enough to offset the level effect of the consumer protection policy. This is a type of policy that we wish to avoid.

In the intermediate scenario, where the policy's level effect is not over turned by the compensating obfuscation choice, a consumer policy will be effective in reducing the share of confused consumers albeit the equilibrium obfuscation rises. This is the third case in Proposition 2 and contains the case $\phi_{kx} = 0$.

Moreover, regarding social welfare and consumer surplus, we have

$$\frac{dW_a}{dx} = -c_k(k^*, y)\frac{dk^*}{dx} \quad \text{and} \quad \frac{dCS_a}{dx} = -2[1 - \phi(k^*, x)]\frac{d\phi(k^*, x)}{dx}.$$

Thus, it follows straightforwardly that the effects of consumer side policy on social welfare and consumer surplus are in the opposite direction of the effects on equilibrium obfuscation and the share of confused consumers, respectively.

In this asymmetric obfuscation equilibrium, consumer surplus increases when the share of confused consumers decreases because of more intensive price competition in the second stage. On the other hand, social welfare in this equilibrium is affected only by the obfuscation costs, and hence, increases only when equilibrium obfuscation decreases.

[18]One particular example of this adverse effect of policy might be the introduction of a fee index in the Mexican privatized pension plan market to increase market transparency. As discussed in Duarte and Hastings (2012), while consumers trusted in the index and became very sensitive to it, the design of the index could be exploited by firms making it harder for consumers to identify the best offer. More generally, however, we are not aware of systematic evidence that analyses whether and to what extent policy interventions in retail financial markets can have such adverse effects. Nevertheless, as such effects seem to be present in other markets (see our discussion in footnote 9), it seems a fruitful avenue for further empirical research as such effects could have serious consequences on the effectiveness of policy interventions.

It follows that when the policy is strongly effective in reducing the marginal effectiveness of obfuscation, both consumer surplus and social welfare are positively affected. When it strongly *increases* the marginal effectiveness of the obfuscation, both consumer surplus and social welfare are negatively affected. Here we have the surprising result that consumer side protection policies can actually harm consumers. The reason is that in this case consumer protection policy significantly increases the marginal effectiveness of obfuscation which in turn encourages firms to obfuscate greatly more. This type of outcome emerges when consumers would take much less care themselves after the consumer protection policy. This is a strong case of Peltzman Effect: the benefit of a public policy is completely offset by changes in behaviour. Finally, in the intermediate case including $\phi_{kx} = 0$, consumer surplus increases while social welfare decreases because equilibrium obfuscation increases but not as much as to increase the number of confused consumers.

### 4.2 Firm side policies

Here we study the effects of firm side policies on market outcomes. From (1), we have

$$\frac{dk^*}{dy} = \frac{c_{ky}}{S} \quad \text{and} \quad \frac{d\phi(k^*, x)}{dy} = \phi_k \frac{dk^*}{dy} = \frac{\phi_k c_{ky}}{S}. \tag{7}$$

We note that, as with consumer side policies, the effect on consumer surplus is in the opposite direction of the effect on the share of confused consumers,

$$\frac{dCS_a}{dy} = -2[1 - \phi(k^*, x)] \frac{d\phi(k^*, x)}{dy}.$$

We can then summarise the effects of firm side policies as follows.

**Proposition 3.** In an asymmetric obfuscation equilibrium, an increase in firm side policy $y$ reduces equilibrium obfuscation and the share of confused consumers, and increases consumer surplus. These effects are strict when $c_{ky} > 0$.

**Proof**: Since $c_{ky} \geq 0$ and $S < 0$, by (7) it follows that ${dk^*}/{dy} \leq 0$, ${d\phi(k^*,x)}/{dy} \leq 0$ and ${dCS_a}/{dy} \geq 0$. When $c_{ky} > 0$, these inequalities hold strictly. *Q.E.D.*

In terms of social welfare, we observe

$$\frac{dW_a}{dy} = -\left[\frac{c_k c_{ky}}{S} + c_y\right].$$

That is,

**Proposition 4.** Social welfare increases (decreases) in $y$ if $c_{ky} > -{Sc_y}/{c_k}$ ($c_{ky} < -{Sc_y}/{c_k}$).

The intuition is as follows. For firm side policy to be effective in improving social welfare, its impact in reducing equilibrium obfuscation has to be sufficiently large; otherwise, the direct increase in obfuscation costs will dominate the reduction due to discouraged obfuscation and hence social welfare will decrease. To significantly reduce equilibrium obfuscation, a firm side regulatory policy not only has to make it more costly for firms to implement any given level of obfuscation, but also has to be powerful enough in increasing the "marginal" cost of obfuscation.

### 4.3 Consumer vs firm side policies

Comparing consumer and firm side policies, we note the following observations. First on the differences, if the objective of a public policy is to promote consumer welfare in the presence of strategic obfuscation, then firm side regulatory policies are generally more effective than consumer side policies. The reason is that firm side policies directly discourage obfuscation, while consumer side policies only work indirectly. Moreover, when consumer side policies are not powerful enough, it may indeed reduce consumer welfare due to strong compensating firm side obfuscation. Our analysis highlights this compensating effect of consumer side policies.

Second on the commonalities, for both sets of policies, the impact on the marginal effect relative to the level effect is of paramount importance. If consumer side policies not only make obfuscation less effective but also strongly reduce its marginal effectiveness or firm side policies not only make obfuscation more costly but also strongly increase the marginal cost of obfuscation, then it is clear consumers are better off and the market functions more efficiently as desired.

### 4.4 Constant marginal effects of obfuscation

To obtain more concrete results, in this section we consider scenarios where the marginal effectiveness of obfuscation as well as its marginal cost are independent of the obfuscation level. That is, $\phi(k, x) = \alpha(x)k$ and $c(k, y) = \beta(y)k$, where $\alpha(x) > 0$ and $\beta(y) > 0$ determine the marginal effects on consumer confusion and obfuscation cost, respectively. In other words, we restrict ourselves to the cases where $\phi_{kk} = c_{kk} = 0$. Adhering to previous assumptions, $\alpha_x < 0$, $\alpha_{xx} \geq 0$ and $\beta_y \geq 0$. The condition $\phi_k(0, x) > c_k(0, y)$ reduces to $\alpha(x) > \beta(y)$. The cross derivatives are $\phi_{kx} = \alpha_x$ and $c_{ky} = \beta_y$.

With these specifications, by Theorem 1 we can characterize $k^*$ and the obfuscating firm's expected profits as follows:

$$k^* = \frac{\alpha(x) - \beta(y)}{2\alpha^2(x)} \quad \text{and} \quad \pi^* = \frac{[\alpha(x) - \beta(y)]^2}{4\alpha^2(x)}.$$

The non-obfuscating firm's expected profits are

$$\phi(k^*, x) = \alpha(x)k^* = \frac{\alpha(x) - \beta(y)}{2\alpha(x)}.$$

Moreover, by (4), consumer surplus and social welfare are respectively

$$CS = \left[\frac{\alpha(x) + \beta(y)}{2\alpha(x)}\right]^2 \quad \text{and} \quad W = 1 - \frac{\beta(y)[\alpha(x) - \beta(y)]}{2\alpha^2(x)}. \tag{8}$$

In terms of consumer side policy, since $\phi_{kx} = \alpha_x < 0$, case ii) in proposition 2 does not apply. Hence, we note in this specification, consumer surplus increases. Also because $\phi_{kx} < {2\phi_k^2 \phi_x}/{c_k}$ reduces to $\alpha(x) < 2\beta(y)$, we have ${dk^*}/{dx} \lesseqgtr 0$ and $\frac{dW}{dx} \gtreqless 0$ when $\alpha(x) \lesseqgtr 2\beta(y)$. To summarise,

**Corollary 1.** Given constant marginal effects of obfuscation, an increase in consumer side policy increases consumer surplus. It decreases equilibrium obfuscation and increases social welfare when $\alpha(x) < 2\beta(y)$. The opposite holds when $\alpha(x) > 2\beta(y)$.

Corollary 1 highlights the situations where attention on the unintended effects of consumer side policy on firms' obfuscation choice is called for. When the marginal effects of obfuscation is independent of the obfuscation level, it is clear that when obfuscation is sufficiently effective relative to obfuscation cost ($\alpha(x) > 2\beta(y)$), firms will react to a stronger consumer side policy by increased obfuscation. This is socially wasteful.

By Proposition 3, we know that firm side policy will be effective in reducing obfuscation and increasing consumer surplus. For social welfare to be improving too, we need $c_{ky} > -S{c_y}/{c_k}$ which is $\alpha(x) < 2\beta(y)$ in this special case.

**Corollary 2.** Given constant marginal effects of obfuscation, an increase in firm side policy reduces equilibrium obfuscation and increases consumer surplus. It increases social welfare when $\alpha(x) < 2\beta(y)$. The opposite holds when $\alpha(x) > 2\beta(y)$.

Combining the above two corollaries, $\alpha(x) < 2\beta(y)$ emerges as the key condition in this specification for policies on either side to have intended beneficial effects.

Table 1 summarises the effects in the case of an asymmetric obfuscation equilibrium. We note that both policies are effective in improving consumer surplus. While firm side policies are always effective in curbing obfuscation, as noted in the general case, consumer side policies may instead increase obfuscation. From the social perspective, both policies are welfare improving when the marginal effectiveness of obfuscation is low compared to its marginal cost. When the marginal effectiveness of obfuscation is high, both policies reduce welfare because of higher obfuscation costs.

| | Consumer Side, $x$ | | | Firm Side, $y$ | | |
|---|---|---|---|---|---|---|
| | Obf. | CS | W | Obf. | CS | W |
| $\beta(y) < \alpha(x) < 2\beta(y)$ | $-$ | $+$ | $+$ | $-$ | $+$ | $+$ |
| $\alpha(x) > 2\beta(y)$ | $+$ | $+$ | $-$ | $-$ | $+$ | $-$ |

Table 1: The effects of an increase in consumer and firm side policies in an asymmetric obfuscation equilibrium

| | Consumer Side, $x$ | | | Firm Side, $y$ | | |
|---|---|---|---|---|---|---|
| | Obf. | CS | W | Obf. | CS | W |
| $\beta(y) < \alpha(x) < 3\beta(y)$ | $-$ | $+$ | $+$ | $-$ | $+$ | $+$ |
| $3\beta(y) < \alpha(x) < (2+\sqrt{5})\beta(y)$ | $+$ | $+$ | $+$ | $-$ | $+$ | $+$ |
| $\alpha(x) > (2+\sqrt{5})\beta(y)$ | $+$ | $+$ | $-$ | $-$ | $+$ | $-$ |

Table 2: The effects of an increase in consumer and firm side policies in the symmetric obfuscation equilibrium

### 4.5 Policies: Symmetric obfuscation

To save space, we present our policy analysis under symmetric obfuscation in an online supplementary note. Here we only summarise the main findings. As in the asymmetric case, we resort to the specification in Section 4.4 for concrete results regarding equilibrium obfuscation, consumer surplus and social welfare. As can be seen in Table 2, policies of either side boost consumer surplus. While firm side policy unequivocally curbs obfuscation, consumer side policy may have the unintended effects of encouraging obfuscation. When the marginal effectiveness of consumer protection policy is relatively large, policies at both sides can cause social welfare to decrease.

Comparing Table 1 and Table 2, we note that policy effects in these types of equilibria are qualitatively similar. However, we also note that in the asymmetric equilibrium case, a strengthening in either side policies will improve social welfare if $\beta(y) < \alpha(x) < 2\beta(y)$. On the other hand, this happens in the symmetric equilibrium case if $\beta(y) < \alpha(x) < (2+\sqrt{5})\beta(y)$. Thus, the scope for a welfare improving policy intervention is larger in the symmetric case: $[\beta(y), 2\beta(y)] \subset [\beta(y), (2+\sqrt{5})\beta(y)]$. Intuitively, compared to the asymmetric case, consumption is less efficient which leaves more room for improvement under a public policy.

## 5 An extension to $n$ firms

In this section, we extend the analysis to $n \geq 2$ firms while keeping all other assumptions intact. Namely, we now consider $n$ firms simultaneously and independently choose obfuscation levels in the first stage, and then compete in prices in the second stage. We restrict our attention to pure-strategy obfuscation equilibria.

Following a similar analysis as in Ireland (1993), in the second stage, the pricing equilibrium leads to the following expected revenue. Without loss of generality, let firm $i$ have the lowest obfuscation level. That is, $k_i \leq k_j$, $\forall j \neq i$.[19] Then, the firms' expected revenue are

$$E(R_i) = [1 - \phi(k_i, x)] \prod_{h=1, h\neq i}^{n} \phi(k_h, x) \quad \text{and} \quad E(R_j) = [1 - \phi(k_j, x)] \prod_{h=1, h\neq i}^{n} \phi(k_h, x).$$

We now demonstrate that in the first stage there exist $n$ pure strategy equilibria in which exactly one of the firms chooses zero obfuscation and the rest chooses the same level of obfuscation, $k^{**}$, implicitly defined by the below condition, (9).

$$[1 - 2\phi(k^{**}, x)]\phi^{n-2}(k^{**}, x)\phi_k(k^{**}, x) - c_k(k^{**}, y) = 0. \tag{9}$$

**Theorem 3.** There exist $n$ pure strategy equilibria in the obfuscation stage where exactly one of the firms chooses not to obfuscate and all other firms set obfuscation at $k^{**}$.

The proof is similar in spirit to that of Theorem 1 and hence, omitted here. Intuitively, conditional on being the lowest obfuscating firm, a firm wishes to reduce obfuscation as much as possible because in this way it not only increases its revenue but also reduces its obfuscation cost. On the other hand, when another firm selects zero obfuscation, other firms maximize the following profit function

$$\pi_j = [1 - \phi(k_j, x)]\phi(k_j, x) \prod_{h=1, h\neq i,j}^{n} \phi(k_h, x) - c(k_j, y),$$

where firm $i$ is the lowest obfuscating firm. Taking the first-order derivative and applying symmetry, we have (9).

Theorem 3 highlights that the asymmetric equilibrium structure of the duopoly case carries over to the oligopoly case with more than two firms. Moreover, besides these asymmetric equilibria, there also exists a symmetric equilibrium where all $n$ firms randomise their obfuscation choices over the same interval.[20]

### 5.1 Policy effects in oligopoly

We focus on the equilibria identified in Theorem 3. We note that in the oligopoly model *qualitatively* similar policy effects as in the duopoly case can be obtained. The derivations are relegated to Appendix A.6.

[19] More details of the mixed-strategy pricing equilibrium are outlined in Appendix A.5.

[20] A full characterisation of this symmetric mixed-strategy equilibrium is beyond the scope of the current paper.

Regarding the effects of a consumer side policy, it can be shown that Proposition 2 qualitatively holds. That is, also in the oligopoly case, depending on how the consumer side policy affects the marginal effectiveness of obfuscation ($\phi_{kx}$), equilibrium obfuscation and the equilibrium share of confused consumers may increase or decrease. Moreover, it follows that both consumer surplus and social welfare may decrease after the introduction of a consumer side policy intervention.

We also find Propositions 3 and 4 *qualitatively* carry over to the oligopoly case. Thus, independent of the number of firms, firm side policies tend to be beneficial for consumers, reducing obfuscation and the share of confused consumers. However, also in the oligopoly case, total welfare may decrease due to higher obfuscation investments by firms.

## 5.2 The effects of increased competition

An important question that can be answered only in this extension is the effects of competition. Namely, how does an increase in the number of firms affect obfuscation, consumer surplus and social welfare?

To this end, take the total differentiation of (9) regarding $n$ and we have

$$\frac{dk^{**}}{dn} = \frac{-(1-2\phi(k^{**},x))\phi_k\phi^{n-2}(k^{**},x)\ln\phi(k^{**},x)}{S_n},$$

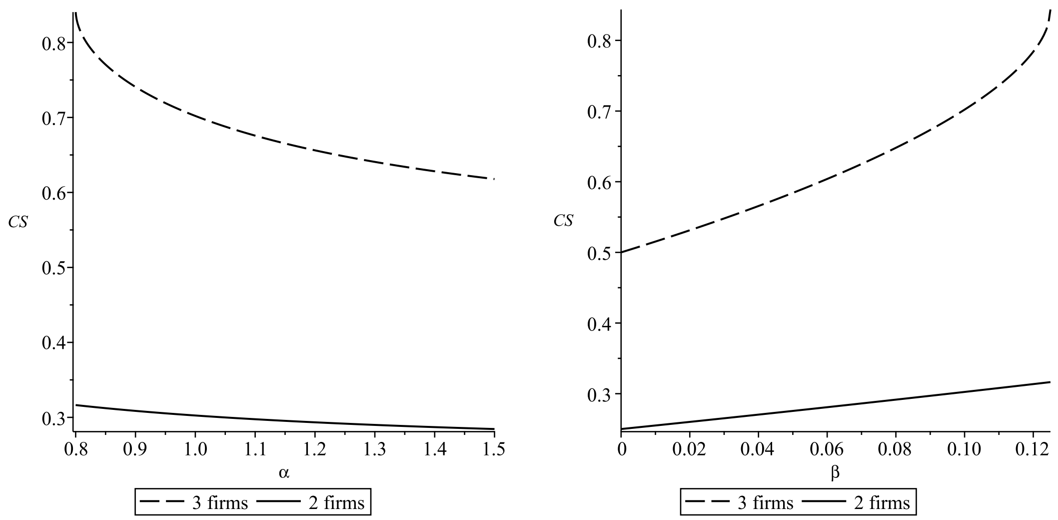
where $S_n < 0$ is the second-order condition, i.e., the derivative of the left hand side of (9) with respect to $k$. From (9), we have $1-2\phi(k^{**},x) > 0$, and hence, $\frac{dk^{**}}{dn} < 0$. It also follows that $\frac{d\phi(k^{**},x)}{dn} = \phi_k \frac{dk^{**}}{dn} < 0$.

**Proposition 5.** An increase in the number of firms, $n$, decreases firms' equilibrium obfuscation.

This proposition finds that increased competition is helpful in reducing obfuscation levels by obfuscating firms. That is, as the number of firms increases, each firm obfuscates less, but there is a larger number of obfuscating firms.

A relevant question then is whether consumer protection policies are more or less effective with a larger number of firms. As a general analysis has proven to be unattainable, we conduct this analysis using the specification from Section 4.4 with constant marginal effects. Figure 1 shows the results of our analysis comparing the effects with two and three firms. The left panel shows the effect of an intervention on the consumer side (reducing $\alpha$) and the right panel shows the effect on an intervention on the firm side (increasing $\beta$).

The figures have two messages. First, a larger number of firms is beneficial for consumers (even if there are more obfuscating firms), and policy can be an effective tool in improving




(a) Consumer side policy

(b) Firm side policy

Figure 1: The effects of policy interventions on consumer surplus with two and three firms

consumer surplus. Second, the figures also show that policy interventions tend to be more effective with a larger number of firms as consumer surplus increases more rapidly in the 3-firm case. This second finding points to a complementarity between traditional competition policy (promoting firm entry) and consumer protection policies. Both policies are more effective in combination than alone. This complementarity result is independent of whether consumer protection policies act on the firm or on the consumer side.

Regarding the effects of the number of firms on obfuscation our results differs from existing contributions. In their simultaneous move game Chioveanu and Zhou (2013) find that with a larger number of firms obfuscation increases as a way for firms to avoid increased competitive pressure and secure positive profits. If this effect is sufficiently strong consumers may be hurt by increased competition. A similar finding is obtained in Carlin (2009). In contrast, in our setting where consumers avoid confusing firms, obfuscation is reduced with more firms, and consumers benefit from firm entry.

# 6 Conclusion

This paper analyses firms' incentives to offer complicated contracts in a model where consumers differ in their abilities in understanding a contract and only consider a product whose terms they are able to understand. Within this framework we show that a firm that offers a more transparent pricing strategy chooses a higher price.

We are analysing the scope for regulatory intervention, contrasting interventions that act on the supply side of the market and those that act on the demand side. We show that consumer side policy may have the unintended consequence of increasing obfuscation while firm side policy is always effective in curbing obfuscation and promoting consumer surplus.

We have investigated the situations where the marginal effects and marginal costs of obfuscation stay constant. We find both polices are effective in increasing consumer surplus. However, consumer side policy may still have the unintended effects of inducing more obfuscation. Both sets of policies can either increase or decrease social welfare depending on the marginal effectiveness and the marginal cost of obfuscation. When the return on obfuscation is higher than the cost, stricter polices decrease social welfare because of higher obfuscation costs. We note that theses main insights hold in both asymmetric and symmetric obfuscation equilibria. However, the market is less efficient in symmetric obfuscation due to some consumers' abstinence from consumption.

# A Appendix

## A.1 Proof of Lemma 1

**Proof**: Fix a pair $(k_i, k_j)$. In Narasimhan's (1988) terminology, firm $i$ has a fraction $[1 - \phi(k_i, x)]\phi(k_j, x)$ of loyal consumers while firm $j$ has $[1 - \phi(k_j, x)]\phi(k_i, x)$. The share of switchers is $[1 - \phi(k_i, x)][1 - \phi(k_j, x)]$. Because $\phi(k_i, x) \leq \phi(k_j, x)$, firm $i$ has a larger share of loyal consumers than firm $j$ does. Proposition 1 can then be obtained by directly applying Narasimhan (1988). *Q.E.D.*

## A.2 Proof of Theorem 1

**Proof**: First, we show that $(0, k^*)$ and $(k^*, 0)$ are two Nash equilibria. We then show there exists no other equilibrium in pure strategies.

Suppose firm 1 chooses $k_1 = 0$. Then $k^*$ is the best response for firm 2 by the definition of $k^*$. Given firm 2 choosing $k^*$, firm 1 by setting $k_1 = 0$ obtains the highest expected payoff conditional on being the less obfuscated firm, $\phi(k^*, x)$. Choosing any $k_1$ above $k^*$ leads to

$$\pi_1(k_1, k^*) = [1 - \phi(k_1, x)]\phi(k_1, x) - c(k_1, y) < \pi^* < \phi(k^*, x).$$

Thus $k_1 = 0$ is the best response to $k_2 = k^*$. Similarly, $(k^*, 0)$ is a Nash equilibrium.

To see that there exists no other pure strategy equilibrium, note that in any such equilibrium at least one firm would set either $0$ or $k^*$. Otherwise, there will be profitable deviations. Given that at least one chooses either $0$ or $k^*$, the only possible equilibria are those established above. *Q.E.D.*

## A.3 Proof of Theorem 2

**Proof**: We first note that (2) satisfies the conditions of a cumulative distribution function: $G(k)$ is positive on the support, increases in $k$ and $G(k^*) = 1$. Secondly, the uniqueness can be shown following the standard arguments similar to Varian (1980).

We now show that given firm $j \neq i$ is choosing obfuscation according to (2), there exists no profitable deviation for $i$ from the mixed strategy of (2). Let $g(k)$ be the density function of $G(k)$ and let firm $j$ obfuscate according to (2). We have $\forall k \in [0, k^*]$,

$$\begin{aligned}
&E(\pi_i(k,x)) \qquad (10)\\
=&\underbrace{[1-\phi(k,x)]\phi(k,x)G(k)}_{\text{being more obfuscated}} + \underbrace{\int_k^{k^*}[1-\phi(k,x)]\phi(s,x)g(s)ds}_{\text{being less obfuscated}} - c(k,y)\\
=&[1-\phi(k,x)]\phi(k,x)G(k) + [1-\phi(k,x)]\int_k^{k^*}\phi(s,x)g(s)ds - c(k,y)\\
=&[1-\phi(k,x)]\cdot\left\{\phi(k,x)G(k) + \left\{\phi(s,x)G(s) - \frac{\pi^*+c(s,y)}{1-\phi(s,x)}\right\}\Bigg|_k^{k^*}\right\} - c(k,y)\\
=&\pi^*.
\end{aligned}$$

Therefore, for all $k_i \in [0, k^*]$, firm $i$ earns the same expected payoff of $\pi^*$.

When firm $i$ sets $k > k^*$, it expects a payoff of $[1-\phi(k,x)]\phi(k,x) - c(k,y)$. Since $k^*$ is defined by its FOC (3) and the SOC holds strictly, for all $k > k^*$ this payoff is less than $\pi^*$. *Q.E.D.*

## A.4 Proof of Proposition 2

**Proof**: We investigate the signs of $\frac{dk^*}{dx}$ and $\frac{d\phi(k^*,x)}{dx}$ in turn. Since $S < 0$, from (5) we have

$$\frac{dk^*}{dx} \lesseqgtr 0 \Leftrightarrow \phi_{kx} \lesseqgtr \frac{2\phi_k^2\phi_x}{c_k}.$$

Similarly, from (6), we have

$$\frac{d\phi(k^*,x)}{dx} \lesseqgtr 0 \Leftrightarrow \phi_{kx} \lesseqgtr \phi_x\left(\frac{\phi_{kk}}{\phi_k} - \frac{c_{kk}}{c_k}\right).$$

Finally, by (1) and $S < 0$, and noting that $\phi_x < 0$, $\phi_{kk} \leq 0$, we have

$$\frac{c_k}{\phi_k}\phi_{kk} - 2\phi_k^2 - c_{kk} < 0 \Rightarrow \frac{2\phi_k^2\phi_x}{c_k} < 0 < \phi_x\left(\frac{\phi_{kk}}{\phi_k} - \frac{c_{kk}}{c_k}\right).$$

The results are then obtained straightforwardly by considering different values of $\phi_{kx}$.

*Q.E.D.*

### A.5 Second-stage pricing equilibrium in the oligopoly model

Here we briefly outline the second-stage pricing equilibrium. The full details are available in Ireland (1993). Suppose firms are ordered such that $k_1 \geq k_2 \geq ... \geq k_n$ which implies $1-\phi(k_1) \leq 1-\phi(k_2) \leq ... \leq 1-\phi(k_n)$. There exists a mixed-strategy equilibrium in which all firms have the same minimum price. This lower bound is determined such that the most transparent firm prefers to charge the reservation value of 1 instead of undercutting this lower bound. Hence, the lower bound is $p_0 = \prod_{j=1}^{n-1} \phi(k_j)$. Price supports are nested such that the upper bound of the price distribution decreases with $k_i$. More specifically, the upper bound of firm $i \leq n-2$ is given by $p_i = \prod_{j \neq i} \phi(k_j)$ while the upper bound for the two most transparent firms $n-1$ and $n$ is equal to the reservation value 1. That is, more transparent firms (with many captive consumers) are charging prices over a larger interval while less transparent firms (with fewer captive consumers) focus on lower prices which generalises the findings of the duopoly pricing game. The detailed distribution functions are provided in Ireland (1993).

### A.6 Policy effects in the oligopoly model

To verify whether our main results in the duopoly case are still valid in an oligopoly, we repeat the analysis in Section 4. By totally differentiating (9), we have

$$\frac{dk^{**}}{dx} = \frac{[2(n-1)\phi - (n-2)]\phi^{n-3}\phi_k\phi_x - \frac{c_k}{\phi_k}\phi_{kx}}{S_n}, \tag{11}$$

where $S_n < 0$ is the second-order condition, i.e., the derivative of the left hand side of (9) with respect to $k$.

It follows that

$$\frac{d\phi(k^{**},x)}{dx} = \phi_x + \phi_k\frac{dk^{**}}{dx} = \frac{\frac{c_k}{\phi_k}\phi_x\phi_{kk} - c_k\phi_{kx} - c_{kk}\phi_x}{S_n}. \tag{12}$$

By comparing (11) and (12) with (5) and (6), we see that Proposition 2 indeed holds *qualitatively* in an oligopoly. That is, also in the oligopoly case, depending on how the consumer side policy affects the marginal effectiveness of obfuscation ($\phi_{kx}$), equilibrium obfuscation and the equilibrium share of confused consumers may increase or decrease.

Similarly, regarding consumer surplus and social welfare, it can be shown that

$$\frac{dW_n}{dx} = -(n-1)c_k(k^{**},y)\frac{dk^{**}}{dx}$$

and

$$\frac{dCS_n}{dx} = -n(n-1)\phi^{n-1}(k^{**},x)[1-\phi(k^{**},x)]\frac{d\phi(k^{**},x)}{dx}.$$

Thus a similar welfare result to that in Proposition 2 can be derived in this oligopoly case. It then follows that both consumer surplus and social welfare may decrease following the introduction of a consumer side policy intervention.

We now turn to firm side policies where we have

$$\begin{aligned}
\frac{dk^{**}}{dy} &= \frac{c_{ky}}{S_n},\\
\frac{d\phi(k^{**},x)}{dy} &= \phi_k\frac{dk^{**}}{dy} = \frac{\phi_k c_{ky}}{S_n},\\
\frac{dCS_n}{dy} &= -n(n-1)\phi^{n-2}(k^{**},x)[1-\phi(k^{**},x)]\frac{d\phi(k^{**},x)}{dy}, \text{ and}\\
\frac{dW_n}{dy} &= -(n-1)\left[\frac{c_k c_{ky}}{S_n} + c_y\right].
\end{aligned}$$

By comparing these results with those in section 4.2, we see immediately that Propositions 3 and 4 also *qualitatively* carry over to the oligopoly case.

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