A MODEL OF OBFUSCATION WITH HETEROGENEOUS FIRMS

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PRELIMINARY DRAFT

Abstract

This paper analyses how the incentives for firms to obfuscate consumers vary with their brand awareness. I study a model under which consumers have limited time to search. Each firm chooses a price and an obfuscation level, which represents the amount of time a consumer has to spend in order to learn the firm’s price. Consumers search stores sequentially, and the search order is determined by the firms’ brand awareness. Consumers keep searching down the list until they run out of time. At that point, they purchase from the store with the lowest price, among the ones they visited. When a firm obfuscates, it prevents some consumers from learning its price. Those consumers will only learn prices from firms that are higher on the search order. This gives those firms some market power, which leads them to set higher prices. The obfuscating firm benefits from that, since it can also list a higher price. I find that, in equilibrium, the higher the ranking of the store, the more it will obfuscate and the higher its price.

Using a novel dataset on Internet Service providers from Canada, I find empirical support for the predictions of the model. I measure obfuscation using observable criteria on firms’ pricing schemes. I measure firms’ brand awareness by the number of Google searches in the recent past. I find positive correlation between the firms’ level of brand awareness and both their obfuscation level and price.

JEL Classification: D83, L13, L84

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1 Introduction

“Figuring out the monthly phone bill has become the consumer’s equivalent of deciphering hieroglyphics, with baffling new fees creating a thicket of items at the bottom of the bill. Some providers [...] have even started adding a ‘paper bill’ fee to pay for the bill itself”


Shopping for the lowest price has become a painful activity for consumers, with firms adopting convoluted price schemes that are difficult to compare. These confusing prices are observed in a variety of markets. In the US telecommunication industry, "the four major carriers offer a total of nearly 700 combinations of smartphone plans”\(^1\). In the banking industry, Citigroup was fined more than $700 million on July 2015, "partly for misleading customers when it came to fees and using confusing language to make it more likely that customers would buy services they didn’t need”\(^2\). In the Energy industry, "companies have admitted giving dire service and baffling customers with confusing bills designed to hide the true cost of heating and lighting out homes”\(^3\). Confusing prices are also observed in the supermarket industry. The U.K. Competition and Markets Authority reported that it has "discovered supermarket prices and promotions that have the potential to confuse or mislead consumers”\(^4\).

It has also been reported that less known firms tend to charge lower prices. As the Wall Street Journal reports, "you can pay $95 a month for a typical cellphone plan on AT&T Inc.’s network or you can pay about half that. The difference isn’t the number of minutes or text or data, or the level of service. It’s whether you write your monthly checks to AT&T or to Consumer Cellular, one of several companies that rent space on AT&T’s network and use it to offer their own plans, sometimes at far lower rates”\(^5\).

The literature provides some models that explain the incentives for firms to obfuscate (Carlin [2009]; Wilson [2010]; Ellison and Wolitzky [2012]). However, all models that study obfuscation assume homogeneous firms. I propose a model of obfuscation with heterogeneous firms. The results of the model are able to explain some empirical facts that were not yet accounted for. I assume that firms have different levels of brand awareness. My model closely follows that of Arbatskaya [2009], which considers an environment where consumers search stores following an exogenous order. However, while Arbatskaya [2009] analyses the relationship between the firms’ ranking in the search order and prices, I focus on the connection between firms’ brand awareness (that is reflected in how firms are ranked in the search order) and obfuscation.

Consumers start their search in the most well known store and keep going down the list until they run out of time. All consumers follow the same "brand awareness list". However, they differ

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\(^1\) The Wall Street Journal, July 31, 2013
\(^2\) Washington Post, July 22, 2015
\(^3\) Daily Mail, March 31, 2014
\(^4\) The Telegraph, July 16, 2015
\(^5\) The Wall Street Journal, December 3, 2013
in the time they have available to search. Firms choose prices and obfuscation, which captures the amount of time it takes for a consumer to learn its price. I model firms’ choice as a two-stage game. In the first stage, firms choose their obfuscation levels. In the second stage, firms’ obfuscation levels become common knowledge and firms choose prices. After firms have decided on their prices, consumers search as described above. The key difference between this model and Arbatskaya [2009] is that while in her model search costs are exogenous, here search costs are endogenous and determined by firms through their obfuscation levels.

I find that the more well known the firm is, the more it obfuscates and the higher its prices are. As the previous obfuscation models assumed homogeneous firms, this result was not accounted for in the literature.

I examine a novel dataset on Internet Service Providers in Ontario, Canada. I resort to Google Trends to obtain the relative number of Google searches of each provider, and I use that to construct a brand awareness score. I measure obfuscation using some observable criteria on firm’s pricing schemes. While some firms charge an activation fee, others do not. Moreover, some of the firms that charge an activation fee list it in the fine print. Another obfuscation device adopted by firms in this market is a lower rate for the first few months\(^6\). This makes it harder for the consumer to understand and compare the various pricing schemes from different companies. I find empirical support for the results of the model. Indeed, well known firms do obfuscate more and charge higher prices. The link between price and obfuscation level has already been found both in the theoretical (Carlin [2009]; Ellison and Wolitzky [2012]) and empirical literature (Muir et al. [2013]). I provide a new link between brand awareness and obfuscation.

I also find that increasing the number of firms leads to higher obfuscation levels, i.e., increasing competition leads to less transparency. This result is also found in Spiegler [2006], Carlin [2009] and Chioveanu and Zhou [2013]. Moreover, as the number of firms increase, prices also increase. Hence, increasing competition may have adverse welfare effects on consumers. However, I also find that competition has positive effects on consumers that allocate more time in their search for a lower price. When the number of firms increases, these consumers will search all stores and will pay a lower price. It is well documented in the literature (Marvel [1976]; Masson and Wu [1974]; Philips [1989]) that consumers that allocate more time to search (i.e., consumers with low search costs) tend to be the poorest. It follows that, even though competition has negative effects on consumers in general, it has positive effects on the welfare of poor consumers.

This paper also contributes to a recent body of the literature that aims to provide foundations for obfuscation to be individually rational. There are many reasons that would explain why increasing obfuscation is collectively rational. In fact, obfuscation increases consumers’ search costs and it has been established that firms’ profits are increasing in consumers’ search costs (Diamond [1971]; Wolinsky [1986]; Anderson and Renault [1999]). A more interesting question is why would

\(^6\)one firm in the sample, Acanac, listed a price of $9.95 for the first month and $35.95 for the months thereafter. The $9.95 price is advertised with a large font, while the $35.95 price, that will apply for all months except the first month, was included with a much smaller font
obfuscation be individually rational? It seems that if a firm deviated and offered transparent prices, it would be able to capture a larger share of consumers. Indeed, when firms use confusing pricing schemes, they risk losing a share of consumers that do not have enough time to understand it.

To address this issue, I model firms’ choice of obfuscation and price as a two-stage game. In the first stage, firms simultaneously choose their obfuscation levels. In the second stage, firms observe each others’ obfuscation levels and, after that, they simultaneously set prices. When a given firm, call it firm $i$, obfuscates, it prevents a fraction of consumers from learning its price, due to their time constraints. Those consumers will only learn prices from firms that are more well known than firm $i$. By obfuscating, firm $i$ on one hand loses consumers, but on the other hand it provides firms higher on the list with market power. This increased market power will lead those firms to charge higher prices. This in turn allows firm $i$ to also list higher prices. If firm $i$ decided not to obfuscate, then all consumers that were able to learn the price of firm $i - 1$ would also learn the price of firm $i$. Hence, firms $i - 1$ and $i$ would be competing over the same consumers. The result would be that of the Bertrand competition, under which both firms would charge marginal cost and make zero profits.

Notice that, after prices are set, each firm would want to deviate to zero obfuscation. By doing that, more consumers would become aware of its price. The key insight for obfuscation to be individually rational is that when firms set prices, they are already committed to their obfuscation level. If a firm deviates to zero obfuscation, the firm that is ranked above it on the list would respond by charging marginal cost. This assumption that firms are committed to their obfuscation level is connected to what we observe in reality, since prices tend to be much more flexible than obfuscation. In fact, choosing an obfuscation level implies designing a pricing scheme that is complex enough so that a consumer that wishes to understand it, will take the amount of time that the firm desires. On the other hand, firms can change prices merely by changing the numbers in the complex pricing scheme. Casual observation suggests that firms tend to keep their pricing schemes for long periods of time. However, they adjust they price more frequently.

Wilson [2010] also provides a model under which obfuscation is individually rational. He assumes that consumers observe firms’ obfuscation levels. Consumers with high search costs will only search firms that do not obfuscate. This provides an incentive for those firms to list higher prices. On the other hand, firms that do obfuscate charge lower prices and are visited by consumers with low search costs. The result that firms that obfuscate list lower prices is different from the majority of the models in the literature (eg. Carlin [2009]; Ellison and Wolitzky [2012]). Empirical evidence (Muir et al. [2013]) also suggests that firms that obfuscate tend to charge higher prices. Empirical findings in this paper also show a positive correlation between firms’ obfuscation and price.

In Ellison and Wolitzky [2012], obfuscation is also individually rational. However, their setting is much different than the setting considered here. They assume firms are homogeneous and set prices and obfuscation levels simultaneously. A key assumption in their model is that consumers have strictly convex search costs. By obfuscating, a firm increases consumers’ search costs. Hence, consumers will purchase from the first store they visit because they get too tired to search again.
This paper differs from theirs not only in the mechanism that makes obfuscation individually rational, but also on the focus. While Ellison and Wolitzky [2012] aim to develop a model in which obfuscation is individually rational, this paper focus on the link between brand awareness and obfuscation.

The rest of the paper is organized as follows. Section 2 presents the model and the main results. I assume, for simplicity, that consumers’ available time to search is distributed uniformly on the unit interval. In section 3 I show how the results change when I consider a general distribution for consumers’ search time. I also show how the results change when firms choose prices and obfuscation levels simultaneously. Section 4 describes the data and presents the empirical findings. Section 5 concludes.

2 Model

There are \( n \) firms in the market. Consumers search stores following an exogenous order. The interpretation is that the order reflects firms’ brand awareness. Firms have the same marginal cost, that I normalize to zero. Firms choose, simultaneously, their obfuscation level. The obfuscation is interpreted as the amount of time it takes for a consumer to understand the firm’s price. After observing all firms’ obfuscation levels, firms set their prices simultaneously. I consider a two-stage game under which firms choose obfuscation first because prices are much easier to modify than pricing schemes. When a firm chooses its obfuscation level, it is designing a new and complex pricing scheme. Prices are much more flexible, since changing them only involves changing the numbers in the pricing scheme.

All consumers have the same valuation, \( v \), for the good and follow the same search order. Each consumer has a limited amount of time to search. Consumers are heterogeneous and the available time they have to search is distributed uniformly on \([0, 1]\). As it’s standard in search models, consumers get the first price quote (from the first firm on the list) for free. When consumers run out of time, they purchase the good from the store that charges the lowest price, among the stores they have visited, as long as that price is lower than \( v \).

When a firm obfuscates, it determines the amount of consumers that will not have time to learn its price. So, by obfuscating, a firm is keeping consumers away and giving market power to firms that are ranked higher on the list. This may be desirable for a firm since the more market power those firms have, the higher the prices they will charge. Since consumers search sequentially and they visit stores in order, any consumer that learns a firm’s price, also knows all prices of firms that are ranked higher. So a firm will only sell to some consumers if its price is lower than all prices of the stores that are ranked higher on the list. By obfuscating, a firm gives market power to firms that are higher on the list, which leads to those firms charging higher prices, so the firm itself can charge a higher price.

Obfuscating presents a trade-off between keeping away consumers that will not have time to
learn the firm’s price and increasing the price that the competitors will charge. This trade-off is
detailed in the analysis of the two-firm equilibrium

**Two-firm equilibrium**

As it’s standard in search models, all consumers get the first price quote for free. So all consumers
know the price of firm 1. Hence, the obfuscation level of that firm has no meaning. I will analyze
the optimal obfuscation level for firm 2, denoted by $\alpha$.

When firm 2 obfuscates, there will be some consumers that will never learn its price. Those
consumers will purchase from firm 1. Since firm 1 will sell to those consumers regardless of the price
it charges (as long as it charges a price lower than $v$), it will have an incentive to charge a higher
price, to extract more revenue from those consumers. This, in turn, allows for firm 2 to also charge
a higher price and make profits. Proposition 1 characterizes the equilibrium price distributions
and profits, given that firm 2 chose to obfuscate $\alpha$ in the first stage. I denote by $F_i$ and $\pi_i$ the
equilibrium price distribution and profit of firm $i$.

**Proposition 1** Let $\alpha$ be the obfuscation of firm 2. In equilibrium,

$$F_1(x) = 1 - \alpha \frac{v}{x} \quad F_2(x) = 1 - \alpha \frac{v-x}{x}$$

$$\pi_1 = \alpha v \quad \pi_2 = \alpha (1 - \alpha) v$$

_Proof._ Since there are only two firms, the cdfs of both firms must have the same upper and lower
bound.

There can be no mass points at prices lower than $v$. If one firm, call it $i$, played price $x < v$
with positive probability, the other firm, call it $j$, would never play prices in the interval $(x, x + \epsilon)$
for $\epsilon$ small enough, since it would be better to play a price slightly lower than $x$. But then firm $i$
would prefer to play $x + \epsilon$ than $x$, which is a contradiction.

Since there are no mass points at prices lower than $v$, the upper bound of the cdfs must be $v$. If
the upper bound was $y < v$, firm 1 would prefer to play $v$ instead of $y$. Indeed, in both cases firm
1 would only sell to consumers that do not have time to learn the price of firm 2. But by charging
$v$, firm 1 can extract more surplus from those consumers.

Only one firm can play $v$ with positive probability. If both firms played $v$ with positive proba-
bility, each firm would prefer to play a slightly lower price.

Firm 1 makes profits in equilibrium, since it always sells to consumers that do not have time to
learn the price of firm 2. It follows that the lower bound on prices is higher than the marginal cost,
zero. This in turn implies that firm 2 also makes positive profits. Since firms must be indifferent
between all prices in the support of their cdf, and since $v$ is the upper bound of both cdfs, it follows
that firm 2 makes positive profits when it charges price $v$. Since firm 2 only sells when it has a price
lower than firm 1, it follows that firm 1 must play price \( v \) with positive probability. This in turn implies that the cdf of firm 2 has no mass points.

The mass of consumers that do not have time to learn the price of firm 2 is \( \alpha \). It than follows that the profit of firm 1, when charging price \( v \), is

\[
\pi_1(v) = \alpha v
\]

When firm 1 charges a price \( x < v \), its profits are

\[
\pi_1(x) = \alpha x + (1 - \alpha)[1 - F_2(x)]x
\]

Indifference of firm 1 yields

\[
F_2(x) = 1 - \frac{\alpha v - x}{x}
\]

It follows that the lower bound of \( F_2 \), which is the same as the lower bound of \( F_1 \) is \( \alpha v \)

Since there are no mass points at the lower bound, firm two will sell to all consumers that learn its price, when it charges the lower bound. Since the mass of consumers that have enough time to learn the price of firm 2 is \( (1 - \alpha) \), it follows that the profit of firm 2, when charging the lower bound, is

\[
\pi_2(\alpha v) = (1 - \alpha)\alpha v
\]

The profit of firm 2 when charging price \( x \) is

\[
\pi_2(x) = (1 - \alpha)[1 - F_1(x)]x
\]

Indifference of firm 2 yields

\[
F_1(x) = 1 - \alpha \frac{v}{x}
\]

Some consumers learn only the price of firm 1. However, any consumer that learns the price of firm 2 also knows the price of firm 1. Hence, firm 2 will only make sales if it offers a lower price than firm 1. The reverse is not true, i.e., firm 1 will make sales even if it has the highest price. This leads to firm 2 charging lower prices than firm 1. The result is described in Proposition 2.

**Proposition 2** \( F_1 \) first-order stochastically dominates \( \succ_{FOSD} F_2 \)

**Proof.**

\[
F_1(x) = 1 - \alpha \frac{v}{x}
\]

\[
= 1 - \frac{\alpha (1 - \alpha)v}{1 - \alpha x}
\]

\[
\leq 1 - \frac{\alpha v - x}{1 - \alpha x}
\]

\[
= F_2(x)
\]

where the inequality follows from the fact that the lower bound of \( F_1 \) and \( F_2 \) is \( \alpha v \)
If firm 2 obfuscates too little (\(\alpha = 0\)), all consumers will learn both firms’ prices. This will lead to the Bertrand equilibrium under which both firms charge marginal cost and make zero profits. If, on the other hand, firm 2 obfuscates too much (\(\alpha = 1\)), no consumer will learn its price and firm 2 will make zero profits. Proposition 3 characterizes the equilibrium obfuscation level for firm 2, denoted by \(\alpha^*\).

**Proposition 3** \(\alpha^* = \frac{1}{2}\)

**Proof.** Since firm 2 chooses \(\alpha\), we must have that
\[
\alpha^* = \arg \max_{\alpha} \pi_2
\]
where \(\pi_2\) is described in Proposition 1. The first order condition yields the result.

In equilibrium, half of the consumers will not have time to learn the price of firm 2. Those consumers will purchase from firm 1. The remaining half of consumers will learn both prices and will purchase from the firm with the lowest price. Firm 2 will have the lowest price with probability
\[
\int_0^v [1 - F_1(x)] f_2(x) dx = \frac{1+\alpha}{2}
\]

The 2 firm equilibrium has interesting properties. Firm 2 will obfuscate in such a way that only half of the consumers will learn its price. Firm 2 will also charge lower prices than firm 1. So the consumers that have more time to search pay a lower price, on average.

However, since the obfuscation of firm 1 is not relevant (since consumers learn its price for free), we cannot use the results from the two-firm equilibrium to find whether firms ranked higher on the search order obfuscate more. I will now analyze a three-firm equilibrium, and compare the obfuscation level of firm 2 with that of firm 3.

**Three-firm equilibrium**

I maintain the assumption that consumers get the first price quote, from firm 1, for free. Hence, the obfuscation level of that firm is not relevant. When firm 2 obfuscates, it gives market power to firm 1, since there will be some consumers that will not have time to learn any price other than the price of firm 1. When firm 3 obfuscates, it gives market power to firms 1 and 2, since some consumers will not have enough time to learn the price of firm 3, and will only learn the prices of firms 1 and 2. In this section, I analyze the obfuscation levels of firm 2, denoted by \(\alpha\), and firm 3, denoted by \(\beta\).

Proposition 4 characterizes the equilibrium profits, given the obfuscation that firms 2 and 3 chose in the first stage. All omitted proofs are in the appendix.

**Proposition 4** Let \(\alpha\) and \(\beta\) be the obfuscation levels of firms 2 and 3, respectively. In equilibrium,
\[ \pi_1 = \alpha v \]

\[ \pi_2 = \begin{cases} \frac{\beta \alpha (1-\alpha)}{\beta^2 + \alpha (1-\alpha)} v & \text{if } \alpha > \beta \\ (1-\alpha) \alpha v & \text{if } \alpha \leq \beta \end{cases} \]

\[ \pi_3 = \begin{cases} \frac{\beta (1-\alpha - \beta)}{\beta^2 + \alpha (1-\alpha)} v & \text{if } \alpha > \beta \\ (1-\alpha - \beta) \alpha v & \text{if } \alpha \leq \beta \end{cases} \]

Inspecting the profits of firm 3, we find that, in equilibrium, firm 3 will never obfuscate more than firm 2. In fact, when firm 3 obfuscates more than firm 2, i.e. \( \alpha < \beta \), its profits are decreasing in its obfuscation level, \( \beta \). Proposition 5 summarizes the obfuscation levels in equilibrium.

**Proposition 5** \( \alpha^* > \beta^* \)

**Proof.** Since firm 2 chooses \( \alpha \) and firm 3 chooses \( \beta \), it must be that

\[ \alpha^* = \text{arg max}_\alpha \pi_2 \quad \beta^* = \text{arg max}_\beta \pi_3 \]

If \( \alpha^* < \beta^* \), the profit of firm 3 would be \( (1-\alpha^* - \beta^*) \alpha^* v \), so firm 3 would want to decrease its obfuscation level. Hence, it must be that \( \alpha^* \geq \beta^* \). Moreover, in order for firm 3 to make sales, some consumers must have enough time to learn its price. We then have that \( \alpha^* + \beta^* < 1 \). These results combined imply that \( \beta^* < \frac{1}{2} \).

To see that we indeed have a strict inequality \( (\alpha^* > \beta^*) \), notice that

\[ \frac{\partial \pi_3}{\partial \beta} \bigg|_{\beta=\alpha} = \frac{\alpha[2\beta-1]}{[\beta^2 + \alpha (1-\alpha)]^2} < 0 \]

The result states that firms ranked higher on the search order obfuscate more. Proposition 6 characterizes the price distributions, in equilibrium.

**Proposition 6** Let \( \bar{P} \equiv \frac{\alpha \beta}{\beta^2 + \alpha (1-\alpha)} v \), \( \hat{P} \equiv \frac{\alpha (1-\alpha)}{\beta^2 + \alpha (1-\alpha)} v \) In equilibrium,

\[ F_1(x) = \begin{cases} 0 & \text{if } x \leq \hat{P} \\ 1 - \frac{(1-\alpha) \alpha}{\beta^2 + \alpha (1-\alpha)} \frac{v}{x} & \text{if } x \in (\hat{P}, \bar{P}) \end{cases} \]

\[ F_2(x) = \begin{cases} 1 - \frac{\alpha \beta}{\beta^2 + \alpha (1-\alpha)} \frac{v}{x} & \text{if } x \in (\bar{P}, \hat{P}) \\ 1 - \frac{\alpha}{\beta} \frac{v-x}{x} & \text{if } x \in (P, \hat{P}) \end{cases} \]

\[ F_3(x) = \begin{cases} 1 - \frac{(1-\alpha) \alpha \beta}{(1-\alpha-\beta)[\beta^2 + \alpha (1-\alpha)]} \frac{v}{x} & \text{if } x \in (\bar{P}, \hat{P}) \\ 1 & \text{if } x \in (\hat{P}, v) \end{cases} \]

The lower the ranking of a firm is, the more competition it faces. In fact, any consumer that has enough time to learn the price of firm 3, also knows the prices of firms 1 and 2. So, if firm 3 wants to make sales, it must have a lower price than both firm 1 and firm 2. On the opposite side we have firm 1. This firm will make sales even if it has the highest price, since some consumers do
not have time to search and only learn the price of firm 1. This leads to the result that firms ranked higher on the list charge higher prices. The result is summarized in Proposition 7.

**Proposition 7** \( F_1 \succ_{FOSD} F_2 \succ_{FOSD} F_3 \)

**Proof.** First let’s consider the region \((P, \hat{P})\)

\[
F_1(x) = 0
\leq 1 - \frac{\alpha \beta}{\beta^2 + \alpha (1 - \alpha)} \frac{v}{x}
= F_2(x)
\leq \frac{1 - \alpha}{1 - \alpha - \beta} \left[ 1 - \frac{\alpha \beta}{\beta^2 + \alpha (1 - \alpha)} \frac{v}{x} \right]
= F_3(x)
\]

For the region \((\hat{P}, v)\)

\[
F_3(x) = 1
\geq 1 - \frac{\alpha \beta}{\beta} \frac{v - x}{x}
= F_2(x)
\geq 1 - \frac{\alpha \beta}{\beta^2 + \alpha (1 - \alpha)} \frac{x}{v}
= 1 - \frac{\alpha \beta}{\beta^2 + \alpha (1 - \alpha)} \frac{v}{x}
\geq 1 - \frac{\alpha (1 - \alpha)}{\beta^2 + \alpha (1 - \alpha)} \frac{v}{x}
= F_1(x)
\]

where the last inequality follows from the fact that \(\alpha + \beta < 1\). This is true because if \(\alpha + \beta \geq 1\), firm 3 would make zero profits in equilibrium (since no consumer would learn its price), and hence would prefer a lower \(\beta\).

The equilibrium features many interesting properties. The higher the ranking of a firm, the more it obfuscates. Since firms at the bottom of the list face more competition, they also charge lower prices. Hence, consumers that have enough time to search those firms will pay lower prices. Figure 1 depicts the equilibrium.
Comparative statics

In this section I analyze how the equilibrium changes when another firm enters, by comparing the two-firm and three-firm equilibria. Proposition 8 compares the obfuscation level of firm 2.

**Proposition 8** Firm 2 will choose the same obfuscation level in both the two-firm and the three-firm equilibria

**Proof.** From Propositions 4 and 5, it follows that the profits of firm 2 in the three-firm equilibrium are

\[ \pi_2 = \frac{\beta \alpha (1-\alpha)}{\beta^2 + \alpha (1-\alpha)} v. \]

Since firm 2 chooses \( \alpha \), it must be that \( \alpha^* = \arg \max_\alpha \pi_2 \). The FOC yields that \( \alpha^* = \frac{1}{2} \), which is the same obfuscation level that firm 2 chooses in the two-firm equilibrium, as shown in Proposition 3.

Since the equilibrium obfuscation level of firm 2 is the same in the two-firm and three-firm
equilibria, I abuse notation and keep using \( \alpha^* \) to denote the obfuscation level of firm 2 in equilibrium. The main result of this section is presented in proposition 9.

**Proposition 9** When the market size increases from 2 to 3 firms, consumers spend more time searching and pay, on average, higher prices.

**Proof.** In the two-firm equilibrium, consumers either search only the first store (which they do without incurring any time), or search both stores and spend \( \alpha^* \) time. Consumers will only search both stores if they have enough time. Hence, the average time a consumer spends searching is 
\[(1 - \alpha^*)\alpha^* \]

In the three-firm equilibrium, consumers either search only one store, or they search the first two stores (spending \( \alpha^* \) time) or they search all stores and spend \( \alpha^* + \beta^* \) time. The average time a consumer spends searching is 
\[\beta^*\alpha^* + (1 - \alpha^* - \beta^*)(\alpha^* + \beta^*) = (1 - \alpha^*)\alpha^* + (1 - \alpha^* - \beta^*)\beta^* \]

It follows from Proposition 1 that the total firm profit in the two-firm equilibrium is 
\[(1 - \alpha^*\alpha^* + 2\beta^*)v\]

Since firm 3 chooses \( \beta^* \), it must be that \( \beta^* = \arg\max_\beta \pi_3 \). It then follows from Proposition 4 that the total firm profit in the three-firm equilibrium is 
\[\left(\frac{\beta^*}{\beta^* + \alpha^*(1 - \alpha^*)}\right) v\]

I find that increasing the number of firms increases obfuscation (measured by the time consumers spend searching). Firms reply to higher competition with less transparency. This result is in the same direction of (Spiegler [2006]; Carlin [2009]; Chioveanu and Zhou [2013]).

I also find that increasing the number of firms leads to higher prices that consumers pay, on average. Proposition 10 states how increasing the number of firms affects the different types of consumers.

**Proposition 10** When the market size increases from 2 to 3 firms, consumers that have search time lower than \( \alpha^* + \beta^* \) pay higher prices, while the remaining consumers pay lower prices.

**Proof.** Let’s start by analyzing the expected price for consumers that have search time lower than \( \alpha^* \). I denote by \( F^2_i \) and \( F^3_i \) the equilibrium cdf for firm \( i \) in the two-firm and three-firm equilibrium, respectively. Consumers that have search time lower than \( \alpha^* \) only learn the price of firm 1, so they will pay the expected price of firm 1.

**Two-firm equilibrium:** 
\[\int xdF^2_i(x) = \left[1 + \ln\left(\frac{1}{\alpha^*}\right)\right] \alpha^* v\]

**Three-firm equilibrium:** 
\[\int xdF^3_i(x) = \left[1 + \ln\left(\frac{(\beta^*)^2 + \alpha^*(1 - \alpha^*)}{\alpha^*(1 - \alpha^*)}\right)\right] \frac{\alpha^*(1 - \alpha^*)}{(\beta^*)^2 + \alpha^*(1 - \alpha^*)} v\]

The two expressions are equal when \( \beta^* = 1 - \alpha^* \). Moreover, the second expression is decreasing in \( \beta^* \). Since we know that \( \beta^* < 1 - \alpha^* \) (otherwise no consumer would learn the price of firm 3 and
firm 3 would rather choose a lower $\beta$), it follows that the average price for consumers with search time lower than $\alpha^*$ is greater under the three-firm equilibrium.

I will now analyze the average price for consumers that have search time in $(\alpha^*, \alpha^* + \beta^*)$

These consumers have enough time to learn the price of firms 1 and 2, but not to learn the price of firm 3. They will pay the expected value of the minimum price between firms 1 and 2.

**Two-firm equilibrium:** $\int \{f_1^2(x)\{1-F_2^2(x)\}+f_2^2(x)\{1-F_1^2(x)\}\}dx = 2\alpha^* v - \ln\left(\frac{1}{\alpha^*}\right)\frac{(\alpha^*)^2}{\beta^*(\beta^*+\alpha^*(1-\alpha^*))}$

**Three-firm equilibrium:** $\int \{f_1^3(x)\{1-F_3^3(x)\}+f_2^3(x)\{1-F_1^3(x)\}\}dx = \frac{\alpha^* \beta^*}{(\beta^*)^2+\alpha^*(1-\alpha^*)}\ln\left(\frac{1-\alpha^*}{\beta^*}\right) v + \frac{(\alpha^*)^2 (1-\alpha^*) v}{\beta^*(\beta^*+\alpha^*(1-\alpha^*))}$

The argument is the same as above. The expressions are equal when $\beta^* = 1 - \alpha^*$ and the second expression is decreasing in $\beta^*$. It follows that these consumers will pay higher prices under the three-firm equilibrium.

Lastly, I will analyze the average price for consumers that have search time higher than $\alpha^* + \beta^*$. These consumers have enough time to search all stores. For the two-firm equilibrium, this just means that they search the two existing stores, so they pay the same as consumers with search time in $(\alpha^*, \alpha^* + \beta^*)$, which was analyzed before. For the three-firm equilibrium, these consumers will search all three stores. Since the price of firm 3 is always lower than the price of firm 1 (from Proposition 6), it follows that the average price these consumers will pay is

$\int \{f_1^2(x)\{1-F_3^2(x)\}+f_3^2(x)\{1-F_1^2(x)\}\}dx = \frac{\alpha^* \beta^* v}{(\beta^*)^2+\alpha^*(1-\alpha^*)}\left[2 + \frac{\beta^*}{1-\alpha^* - \beta^*}\ln\left(\frac{\beta^*}{1-\alpha^*}\right)\right]$}

Plugging in the values of $\alpha^*$ and $\beta^*$ from the proof of Proposition 9, we find that these consumers pay lower prices under the three-firm equilibrium.

Even though increasing the number of firms leads to higher prices and higher obfuscation levels, it also leads to lower prices for consumers that have time to search. So, when another firm enters the market, consumers that do not have enough time to search will pay higher prices, but consumers that do have time will search all stores and pay a lower price. Higher search time is equivalent to lower search costs. It is established in the literature that poor consumers tend to have low search costs. We can conclude that when another firm enters the market, even though the average consumer will pay higher prices, poor consumers will pay lower prices.

## 3 Extensions

### 3.1 General distribution of search time

I have assumed that consumers’ search time follows the uniform distribution on $[0, 1]$. This assumption was mainly for the sake of the exposition of the results. Using that distribution for search time, when a firm chooses obfuscation level $\alpha$, it turns out that $\alpha$ is also the fraction of consumers that will not have time to learn the firm’s price. However, the results carry out to general forms of
the distribution of search times. In this section, I show how the main results change when using a general distribution of search time, that I denote by $G$.

Notice that when firms choose their obfuscation level, they are determining the fraction of consumers that will not have enough time to learn its price. This is what will determine firms equilibrium price distributions and profits. Firms are not concerned about the size of the obfuscation level. The only thing that matters is how the obfuscation level will determine consumer search.

Let $\alpha_U$ denote the obfuscation level of firm 2 when time search is distributed uniformly on $[0, 1]$ and $\alpha_G$ denote the obfuscation level of firm 2 when time search is distributed according to $G$. Let $\beta_U$ and $\beta_G$ be defined analogously for firm 3.

**Two-firm equilibrium**

In section 2, the obfuscation level that firm 2 chooses determines the fraction of consumers that will not have enough time to learn its price. Those consumers will purchase from firm 1. Since consumer’s search time was distributed uniformly on $[0, 1]$, the obfuscation level, $\alpha$, was also the proportion of consumers that would not have enough time to learn the price of firm 2. Notice that firm 2 was able to choose any $\alpha \in [0, 1]$. Hence, firm 2 was free to choose the proportion of consumers that would not learn its price, with no restrictions. It is important to notice that the magnitude of the obfuscation level is not important per se. It is only important to the extent that it determines consumers’ search. Hence, it must be that, when consumers’ search time is distributed according to $G$, firm 2 will choose an obfuscation level so that it keeps the same proportion of consumers not being able to learn its price. The proportion of consumers that do not have enough time to learn the price of firm 2 when it chooses obfuscation $\alpha_G$ is $G(\alpha_G)$. We then have that $\alpha_G = G^{-1}(\alpha_U)$.

In the second stage, when firms choose prices, nothing changes. This is because, in that stage, firms are not concerned about the magnitude of the obfuscation levels, they are only concerned about which consumers search which stores. Since the consumer search decision is the same, the equilibrium price distributions is also the same.

**Three-firm equilibrium**

The intuition is the same as in the two-firm equilibrium. Firms will choose their obfuscation level so that the consumers’ search decisions are the same as the equilibrium from section 2. This implies that $\alpha_G = G^{-1}(\alpha_U)$ and $\beta_G = G^{-1}(\alpha_U + \beta_U) - G^{-1}(\alpha_U)$.

Once again, the equilibrium price distributions are the same as described in 2. So the result that firms ranked higher in the search order will charge higher prices, described in Proposition 7, also follows through.

The only thing that is different in the equilibrium with a general distribution for consumers search time, is the magnitude of the obfuscation levels. The result from Proposition 5 that states that firms ranked higher in the search order exert higher obfuscation levels may be reversed. I
provide a sufficient condition for the result to hold when considering a general distribution for consumers’ search time.

**Proposition 11** If $G$ is convex then $\alpha^{G} > \beta^{G}$

**Proof.** Since $G$ is increasing and convex, it follows that $G^{-1}$ is concave.\footnote{see Binmore [1982]}

From Proposition 5, it follows that $\alpha^{U} > \beta^{U}$. It follows that

\[
\alpha^{G} - \beta^{G} = 2G^{-1}(\alpha^{U}) - G^{-1}(\alpha^{U} + \beta^{U})
\]
\[
> 2G^{-1}(\alpha^{U}) - G^{-1}(2\alpha^{U})
\]
\[
\geq 0
\]

where the strict inequality follows from $\alpha^{U} > \beta^{U}$ and the weak inequality follows from concavity of $G^{-1}$.

Since the equilibrium price distributions are the same as in section 2, all the comparative statics results follow through.

### 3.2 Simultaneous choice of price and obfuscation

In this section, I analyze the equilibrium in a setting under which firms choose prices and obfuscation levels simultaneously. I consider a general model with $n$ firms and denote by $\alpha_{i}$ the obfuscation level of firm $i$. Just like in section 2, consumers get the first price quote, i.e., the price quote of firm 1, for free. Hence, the obfuscation level of firm 1 is meaningless.

**Proposition 12** Zero obfuscation is a weakly dominant strategy for all firms

**Proof.** Fix a profile of prices $p \equiv (p_{1},...,p_{n})$ and obfuscation levels $\alpha \equiv (\alpha_{2},...,\alpha_{n})$. The profit of firm $i$ is

\[
\pi_{i}(p,\alpha) = \sum_{k=i}^{n-1} \alpha_{k+1} \mathbb{1}\{p_{i} = \min\{p_{1},...,p_{k}\}\} p_{i} + \left(1 - \sum_{j=2}^{n} \alpha_{j}\right) \mathbb{1}\{p_{i} = \min\{p_{1},...,p_{n}\}\} p_{i}
\]

It follows that

\[
\frac{\partial \pi_{i}(p,\alpha)}{\partial \alpha_{i}} = -\mathbb{1}\{p_{i} = \min\{p_{1},...,p_{n}\}\} p_{i} \leq 0 \quad \square
\]

This result is intuitive. When firms choose prices and obfuscation levels simultaneously, a firm’s obfuscation level has no impact on other firms’ prices. Hence, there is no longer an upside of obfuscating. When a firm obfuscates is simply prevents some consumers from learning its own price.
The result in Proposition 12 highlights that the reason why obfuscation is individually rational is that obfuscation is more rigid than prices. In fact, while changing obfuscation levels implies designing a new pricing schedule that has the complexity that the firm desires, changing prices only involves modifying the numbers in the existing price schedule. Casual observation of markets that are associated with high levels of obfuscation suggests that, indeed, firms change prices more often than they change pricing schemes.

Proposition 13 analyzes firms equilibrium profits.

**Proposition 13** In equilibrium, all firms make zero profits

*Proof.* I will start by showing that firm $i$ makes positive profits if and only if firm $i + 1$ makes positive profits. Let $F_i$ denote the cdf from which firm $i$ draws prices, in equilibrium. Suppose that firm $i$ makes positive profits. It follows that the lower bound of $F_i$ is higher than the marginal cost. Firm $i + 1$ can then make profits by choosing no obfuscation and a price slightly lower than the lower bound of $F_i$. Now suppose that firm $i + 1$ makes positive profits. It follows that the lower bound of $F_{i+1}$ is higher than the marginal cost. Firm $i$ can then make profits by choosing a price slightly lower than the lower bound of $F_{i+1}$.

It follows that, in equilibrium, either all firms make positive profits, or no firm does.

Suppose, by contradiction, that all firms make positive profits. In particular, firm $n$ makes positive profits. Since all consumers that learn the price of firm $n$ also learn the prices of all remaining firms, it follows that with some probability firm $n$ is the lowest-price firm in the market. This in turn implies that firm $n$ would strictly prefer to play zero obfuscation. Indeed, when firm $n$ obfuscates, it is only keeping some consumers from learning its price. Since there is a positive probability that firm $n$ has the lowest price in the market, it will want to maximize the number of consumers that learn its price. But if firm $n$ makes zero obfuscation, all consumers that learn the price of firm $n − 1$ also learn the price of firm $n$. Moreover, given the search order that consumers use, it is also true that all consumers that learn the price of firm $n$ also know the price of firm $n − 1$. Firms $n$ and $n − 1$ are competing over the same group of consumers that will purchase from the lowest-price firm, a la Bertrand. The equilibrium involves both firms charging marginal cost and making zero profits. This contradicts that firm $n$ makes profits.

4 Empirical Findings

In this section I analyze how obfuscation and prices are related to firms’ brand awareness.

4.1 Data

The dataset consists of obfuscation scores, brand awareness scores and prices for the 89 Internet Service Providers (ISPs) that offer Residential services in Ontario, Canada. I present a detailed
description on how each variable was computed.

**Obfuscation Scores**

A challenging task when studying obfuscation is to measure the complexity of firms’ pricing schemes. I follow the approach from Muir et al. [2013] and focus on observable criteria on pricing schedules. I find two major devices that firms use that increase the complexity of its prices: (i) firms may list a lower price for the first few months; (ii) firms may charge an activation/installation fee. Among firms that charge an activation fee, some of them list it near the price, while others list it in the fine print.

Charging a lower price for the first few months makes it harder to compare different pricing schedules. Consider a consumer that is faced with a firm that charges a flat rate for all months, and another that charges a lower price for the first few months and a higher price afterwards. In order for the consumer to make the correct decision, he has to know how long he plans to use the service. Even then, it still requires some calculation to figure out who has the lowest price. Even comparing prices from two firms that, both of them, charge different prices in the first few months is not straightforward. The calculations needed to do such comparison can also increase due to the fact that the length of the discount period may be different. In fact, while some firms offer a lower rate for the first 6 months, others only do it for 3 (or even only 1) months. I construct a score that reflects whether a firm engages in this obfuscation device. I let $O_D$ equal to 1 if a firm offers a different price in the first few months of the contract and equal to 0 otherwise.

The existence of an activation fee clearly makes it much harder for a consumer to compare prices. Indeed, when a consumer is faced with two firms that charge different prices and the firm that charges the lowest price also charges an activation fee, he needs to perform some calculations in order to understand what is best for him. Some firms make it even more time consuming by hiding those fees in the fine print. In those cases, consumers have to spend time reading through all the fine print even before starting to compare which firm has the lowest price. I let $O_F$ equal to 0 if a firm does not charge an activation/installation fee, equal to 1 if it charges a fee but lists it in the main table of prices and equal to 2 if it charges a fee and lists it in the fine print.

Besides the obfuscation scores already mentioned, $O_D$ and $O_F$, I construct another obfuscation score $O_T$ that captures the total obfuscation from the two devices. I define $O_T = O_D + O_F$.

There is significant dispersion in the complexity of pricing schemes. Figure 4 presents the distribution of firms across obfuscation scores. There are 4 possible levels of obfuscation. Only 2 firms present the highest possible level of obfuscation (which involves charging a lower price for the first few months and listing an activation fee in the small print). All the remaining obfuscation levels have significant share of firms adopting it.

The obfuscation range is very wide. While some firms adopt pricing schemes that are immediately understandable upon seeing them, other firms present such convoluted pricing schemes that one has to take some time to fully understand all conditions and fees. Figures 5, 6 and 7 present the
pricing schemes for two firms. Figure 5 details the available packages and prices for Bell Canada, the largest firm that operates in the market. It offers a wide range of packages. Each package has a regular price and a 3-month promo price. After selecting a particular package, the consumer is directed to the full offer details presented in Figure 6. It is only at this point, after already spending some time choosing which plan is best, that the consumer becomes aware of a nearly $50 activation fee. Footnote 5 then states that, even though the table suggests that Bell Install is included, conditions do apply. In order to find those conditions, the consumer must follow another hyperlink. Figure 7 details the available packages and prices for Coextro, a much smaller ISP. This firm only offers 2 packages and they do not charge activation or installation fees. Moreover, the monthly price is flat.

Brand Awareness Scores

Measuring firms’ brand awareness is a challenging task. Data on sales is not available for the majority of firms. Even if the availability of data was not an issue, firms’ revenue may not be a good indicator of their brand awareness. In fact, a firm could be very well known and, at the same time, charge a high price and sell only to a small fraction of consumers. I resort to Google trends to measure firms’ brand awareness. Google trends provides information on the number of Google searches for each firm. Even though data on the magnitude of Google searches is not available for each firm, it provides the ratio of the number of searches between different firms. The firm with the highest number of Google searches is attributed a score of 100. A firm that, for example, has half of that number of searches will get a score of 50. I construct a brand awareness score \( A \) by using the output from Google trends.

There are 89 ISPs that operate in Ontario, Canada. Most of them are relatively unknown. In fact, 65 of the firms are so rarely searched on Google, that their Google trends’ score is 0. The remaining 24 firms are more well known and have a positive score. For this reason, I construct another brand awareness score, \( A_B \), as a binary variable described as follows:

\[
A_B = \begin{cases} 
0 & \text{if } A = 0 \\
1 & \text{if } A > 0 
\end{cases}
\]

Prices

I measure the total price for two different time horizons: 12 and 36 months. I denote them by \( P_{12} \) and \( P_{36} \), respectively. I also measure variable prices for those time horizons, i.e., prices that do not include installation/activation fees. I denote those variables by \( VP_{12} \) and \( VP_{36} \). All prices are for an internet speed of 10 Mbps. I choose that speed because it is a very standard speed that most ISPs offer. For ISPs that do not offer that speed, I select the package with the speed closest to 10 Mbps. The standard deviation in ISPs speeds is only 2.33 Mbps.
Table 1 presents the summary statistics for the obfuscation, brand awareness and price variables.

<table>
<thead>
<tr>
<th></th>
<th>$O_D$</th>
<th>$O_F$</th>
<th>$O_T$</th>
<th>$A$</th>
<th>$A_B$</th>
<th>$P_{12}$</th>
<th>$VP_{12}$</th>
<th>$P_{36}$</th>
<th>$VP_{36}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>0.09</td>
<td>0.89</td>
<td>0.98</td>
<td>3.33</td>
<td>0.27</td>
<td>559.68</td>
<td>511.58</td>
<td>1597.53</td>
<td>1549.43</td>
</tr>
<tr>
<td>St. Dev.</td>
<td>0.29</td>
<td>0.76</td>
<td>0.82</td>
<td>11.86</td>
<td>0.44</td>
<td>131.75</td>
<td>112.79</td>
<td>350.98</td>
<td>338.58</td>
</tr>
<tr>
<td>Maximum</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>100</td>
<td>1</td>
<td>1274.87</td>
<td>1124.88</td>
<td>3524.63</td>
<td>3374.64</td>
</tr>
<tr>
<td>Minimum</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>347.40</td>
<td>347.4</td>
<td>1042.2</td>
<td>1042.2</td>
</tr>
</tbody>
</table>

Table 1: Summary statistics

### 4.2 Empirical Analysis

#### Relationship brand awareness - obfuscation

I start by running the most simple OLS regression to analyze the effect of firms’ brand awareness in their obfuscation level. I do this for each of the obfuscation and brand awareness variables defined in the previous section.

\[
\text{Obfuscation}_i = \alpha + \beta \text{BrandAwareness}_i + \epsilon_i
\]

where $\text{Obfuscation} \in \{O_D, O_F, O_T\}$ and $\text{BrandAwareness} \in \{A, A_B\}$

The results are presented in table 2. I find a positive relationship between firm brand awareness and obfuscation. This result is not only significant, it is also robust to the various measures of obfuscation and brand awareness presented in section 4.1. This result is consistent with the predictions of the model, under which firms that are ranked higher on the search order obfuscate more. Indeed, the interpretation of the search order is that consumers search in order of the firms that pop up first in their minds. Brand awareness is reflects the search order of consumer. This result constitutes a new empirical finding.

Figure 2 plots average obfuscation level by firm brand awareness. I split firms into 4 groups. The first group consists of all firms with a brand awareness score of zero. The remaining firms are evenly split among the remaining 3 groups, in increasing brand awareness.
I run the most simple OLS regression to analyze the effect of firms’ brand awareness in their prices. I do this for each of the brand awareness and price variables defined in the previous section.

\[
\text{Price}_i = \alpha + \beta \text{BrandAwareness}_i + \epsilon_i
\]

where \( \text{Price} \in \{P_{12}, VP_{12}, P_{36}, VP_{36}\} \) and \( \text{BrandAwareness} \in \{A, A_B\} \).

The results are presented in table 3.

I find that brand awareness scores are a significant predictor of firms’ prices. When I consider prices for a 12-month period, all results are significant at the 5% level. However, when I consider a longer horizon of 36 months, the results become even more significant. For prices for a 36-month


<table>
<thead>
<tr>
<th></th>
<th>$P_{12}$</th>
<th>$P_{12}$</th>
<th>$VP_{12}$</th>
<th>$VP_{12}$</th>
<th>$P_{36}$</th>
<th>$P_{36}$</th>
<th>$VP_{36}$</th>
<th>$VP_{36}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A$</td>
<td>2.3**</td>
<td>2.2**</td>
<td>8.4***</td>
<td>8.3***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.2)</td>
<td>(1.0)</td>
<td>(3.0)</td>
<td>(2.9)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$A_B$</td>
<td>69.7**</td>
<td>67.6**</td>
<td>239.5***</td>
<td>237.3***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(30.9)</td>
<td>(26.3)</td>
<td>(80.8)</td>
<td>(77.7)</td>
<td></td>
<td></td>
<td></td>
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<td>Observations</td>
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<td>89</td>
<td>89</td>
<td>89</td>
<td>89</td>
<td>89</td>
<td>89</td>
<td>89</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.044</td>
<td>0.055</td>
<td>0.055</td>
<td>0.071</td>
<td>0.080</td>
<td>0.092</td>
<td>0.084</td>
<td>0.097</td>
</tr>
</tbody>
</table>

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 3: The impact of Brand Awareness on Firms’ Price

period, all results are significant at the 1% level.

The results become more significant when we consider a longer horizon because, as detailed previously, more well-known firms tend to obfuscate more. One obfuscation device that firms use is to charge a lower price in the first months of the contract. Hence, when we consider a short horizon, firms that use that obfuscation device will have significantly lower prices.

Another obfuscation device that firms use is to charge an activation fee. It could be that more well-known firms’ prices are higher simply because they engage in such obfuscation device. To control for this possible issue, I also run the regression of variable prices on brand awareness. Variable prices consist only on monthly rates, and do not include activation fees. I find that brand awareness is also a significant predictor of variable prices. Hence, not only do more well-known firms have higher prices because they are more likely to charge an activation fee, they also have higher monthly rates.

Figure 3 plots prices by firms’ brand awareness. I consider only two brand awareness groups, using their $A_B$ score. As the figure shows, prices of more well-known firms are about 14% higher than prices of less known firms.

![Figure 3: Obfuscation by firm brand awareness](image-url)
5 Discussion

In many markets, firms are adopting confusing price schemes in order to increase consumers’ search costs. Empirical findings in this paper show that this practice is more frequently adopted by more well-known firms.

I propose a model under which consumers search stores in order of their brand awareness. The model predicts that more well-known firms will obfuscate more and list higher prices, just like the empirical findings suggest.

The model has important welfare implications. Indeed, by adopting convoluted price schedules, firms reduce consumers’ surplus. The reduction in consumers’ welfare comes from two sources. First, consumers have to incur higher search costs when searching for a product. Second, equilibrium prices are higher than they would be if firms were not adopting complex prices.

Competition alone is not enough to restore consumers’ welfare. In fact, firms respond to competition with less transparency, i.e., increasing the number of firms leads to even more complex prices. Not only that, when the number of firms increase, consumers end up paying, on average, higher prices.

In order to bring consumer surplus back to its original level (when firms were not obfuscating), it is necessary to stop firms from engaging in such practice. This is challenging to implement in practice. Regulation of some markets has taken steps to, at least, limit the amount of obfuscation that a firm can implement.

The European Parliament and the Council of the European Union have regulated the way that a creditor advertises credit agreements. In particular, Article 4 of Directive 2008/48/EC of 23 April 2008, specifies ”standard information to be included in advertising”. It states that ”the standard information shall specify in a clear, concise and prominent way by means of a representative example: a) the borrowing rate [...] b) the total amount of credit c) the annual percentage rate of charge d) the duration of the credit agreement”. As the European Commission explains, the Standard European Consumer Credit form ”is designed to give [consumers] the best overview of the terms and conditions of any credit contract [they] consider and includes key details such as: the main features, amount and costs of credit, the Annual Percentage Rate (APR), the number and frequency of payments requested from the credit provider, as well as a note on important legal aspects. This allows [consumers] to compare the offers of different credit providers and select the credit offer that works best for [them].”

In a similar attempt to reduce the level of obfuscation, the U.K. Competition and Markets Authority is enforcing supermarkets to display unit prices, for ease of comparison of ”the costs of different products, regardless of their respective sizes”.

In the model presented in this paper, firms that are higher on the search order make more profits. This could lead to competition for higher positions in the list. I interpret the search order as decreasing in firms’ brand awareness. Hence, competition for a higher ranking on the list is
simply an advertisement game.

**References**


Appendix A - Omitted Proofs

Proposition 4 Let $\alpha$ and $\beta$ be the obfuscation levels of firms 2 and 3, respectively. In equilibrium, $\pi_1 = \alpha v$

$\pi_2 = \begin{cases} \frac{\beta(1-\alpha)}{\beta^2 + \alpha(1-\alpha)} v & \text{if } \alpha > \beta \\ (1-\alpha)\alpha v & \text{if } \alpha \leq \beta \end{cases}$

$\pi_3 = \begin{cases} \frac{\beta(1-\alpha-\beta)}{\beta^2 + \alpha(1-\alpha)} v & \text{if } \alpha > \beta \\ (1-\alpha-\beta)\alpha v & \text{if } \alpha \leq \beta \end{cases}$

Proof. I start with the case $\alpha < \beta$. I will show that, in this scenario, all three cdfs will have the same lower bound. Notice that at least two firms must have the same lower bound (otherwise, the firm with the lowest lower bound would prefer to play higher prices, since by doing so it would sell to the same number of consumers at a higher price). I denote by $P_i$ the lower bound of the cdf of firm $i$ and $P$ the minimum of the three lower bounds. I will show, by contradiction, that no cdf can have a lower bound higher than $P$.

Case 1: $P_1 > P$

Notice that

$\pi_1(P_1) = \alpha P_1 + \beta[1 - F_2(P_1)]P_1 + (1 - \alpha - \beta)[1 - F_2(P_1)][1 - F_3(P_1)]P_1$

$\pi_1(P) = P$

$\pi_2(P_1) = \beta P_1 + (1 - \alpha - \beta)[1 - F_3(P_1)]P_1$

$\pi_2(P) = (1 - \alpha)P$

$\pi_1(P) - \pi_1(P_1) = P - \alpha P_1 - \beta[1 - F_2(P_1)]P_1 - (1 - \alpha - \beta)[1 - F_2(P_1)][1 - F_3(P_1)]P_1$

$> P - \alpha P - \beta P_1 - (1 - \alpha - \beta)[1 - F_3(P_1)]P_1$

$= \pi_2(P) - \pi_2(P_1)$

$= 0$

This contradicts that $P_1$ is the lower bound of the support of the cdf of firm 1.

Case 2: $P_2 > P$

$\pi_2(P_2) = \beta[1 - F_1(P_2)]P_2 + (1 - \alpha - \beta)[1 - F_1(P_2)][1 - F_3(P_2)]P_2$

$\pi_2(P) = (1 - \alpha)P$

$\pi_1(P_2) = \alpha P_2 + \beta P_2 + (1 - \alpha - \beta)[1 - F_3(P_2)]P_2$

$\pi_1(P) = P$
\[
\pi_2(P) - \pi_2(P_2) = (1 - \alpha)P - \beta[1 - F_1(P_2)]P_2 - (1 - \alpha - \beta)[1 - F_1(P_2)][1 - F_3(P_2)]P_2 \\
> P - \alpha P_2 - \beta P_2 - (1 - \alpha - \beta)[1 - F_3(P_2)]P_2 \\
= \pi_1(P) - \pi_1(P_2) \\
= 0
\]

This contradicts that \(P_2\) is the lower bound of the support of the cdf of firm 2.

**Case 3:** \(P_3 > P\)

\[
\pi_3(P_3) = (1 - \alpha - \beta)[1 - F_1(P_3)][1 - F_2(P_3)]P_3 \\
\pi_3(P) = (1 - \alpha - \beta)P \\
\pi_2(P_3) = (1 - \alpha)[1 - F_1(P_3)]P_3 \\
\pi_2(P) = (1 - \alpha)P \\
\]

\[
\pi_3(P) - \pi_3(P_3) = (1 - \alpha - \beta)P - (1 - \alpha - \beta)[1 - F_1(P_3)][1 - F_2(P_3)]P_3 \\
> (1 - \alpha - \beta)P - (1 - \alpha - \beta)[1 - F_1(P_3)]P_3 \]

\[
= \frac{1 - \alpha - \beta}{1 - \alpha}[(1 - \alpha)P - (1 - \alpha)[1 - F_1(P_3)]P_3] \\
= \frac{1 - \alpha - \beta}{1 - \alpha}[\pi_2(P) - \pi_2(P_3)] \\
= 0
\]

This contradicts that \(P_3\) is the lower bound of the support of the cdf of firm 3.

Since all the firms have the same lower bound, we can compute profits as

\[
\pi_1 = \pi_1(P) = P \\
\pi_2 = \pi_2(P) = (1 - \alpha)P \\
\pi_3 = \pi_3(P) = (1 - \alpha - \beta)P
\]

Moreover, it must be that the cdf of firm 1 has the highest upper bound. Indeed, if some firm charged a price higher than the upper bound of firm 1, it would not make sales, since all consumers know the price of firm 1. Furthermore, it must be that the upper bound of firm 1 is \(v\), since if it was lower than \(v\), firm 1 would prefer to increase its price, since that would imply selling to the same consumers at a higher price. Hence

\[
\pi_1 = \pi_1(v) = \alpha v
\]

We can conclude that \(\pi_1(P) = \pi_1(v) \iff P = \alpha v\)

Replacing in the profit function we get the result:

\[
\pi_1 = \alpha v
\]
\[ \pi_2 = (1 - \alpha)\alpha v \]
\[ \pi_3 = (1 - \alpha - \beta)\alpha v \]

I will now analyze the case \( \alpha \geq \beta \)

For this, I use the results in Proposition 6. Since the upper bound of the cdf of firm 1 is \( v \) and \( F_2(v) = F_3(v) = 1 \), it follows that \( \pi_1 = \alpha v \).

Since \( v \) is in the support of the cdf of firm 2,
\[ \pi_2(1 - F_1(v)) = \frac{\beta \alpha (1 - \alpha)}{\beta^2 + \alpha (1 - \alpha)} v \]

Since \( P = \frac{\alpha \beta}{\beta^2 + \alpha (1 - \alpha)} v \) is in the support of the cdf of firm 3, and since \( F_1(P) = F_2(P) = 0 \), it follows that
\[ \pi_3(P) = (1 - \alpha - \beta)P = \frac{\beta \alpha (1 - \alpha - \beta)}{\beta^2 + \alpha (1 - \alpha)} v \]

\[ \square \]

**Proposition 6**

Let \( P \equiv \frac{\alpha \beta}{\beta^2 + \alpha (1 - \alpha)} v \), \( \hat{P} \equiv \frac{\alpha (1 - \alpha)}{\beta^2 + \alpha (1 - \alpha)} v \) In equilibrium,

\[ F_1(x) = \begin{cases} 
0 & \text{if } x \leq \hat{P} \\
1 - \frac{(1 - \alpha)\alpha}{\beta^2 + \alpha (1 - \alpha)} v & \text{if } x \in (\hat{P}, v)
\end{cases} \]

\[ F_2(x) = \begin{cases} 
1 - \frac{\alpha \beta}{\beta^2 + \alpha (1 - \alpha)} v & \text{if } x \in (P, \hat{P}) \\
1 - \frac{\alpha (v - x)}{\beta} & \text{if } x \in (\hat{P}, v)
\end{cases} \]

\[ F_3(x) = \begin{cases} 
\frac{1 - \alpha}{1 - \alpha - \beta} - \frac{(1 - \alpha)\alpha \beta}{\beta^2 + \alpha (1 - \alpha)} v & \text{if } x \in (P, \hat{P}) \\
1 & \text{if } x \in (\hat{P}, v)
\end{cases} \]

**Proof.** I will show that the above constitutes an equilibrium. I will show that each firm is indifferent between all prices in the support of its cdf and it weakly prefers those prices than any price that is not on the support of its cdf.

**Firm 2** For \( x \in (\hat{P}, v) \)

\[ \pi_2(x) = \beta[1 - F_1(x)]v + (1 - \alpha - \beta)[1 - F_1(x)][1 - F_3(x)]v \]

\[ = \beta \frac{(1 - \alpha)\alpha}{\beta^2 + \alpha (1 - \alpha)} v \]

For \( x \in (P, \hat{P}) \)

\[ \square \]
\[ \pi_2(x) = \beta [1 - F_1(x)] x + (1 - \alpha - \beta) [1 - F_1(x)][1 - F_3(x)] x \\
= \beta x + (1 - \alpha - \beta) \left[ -\frac{\beta}{1 - \alpha - \beta} + \frac{1 - \alpha \alpha \beta}{\beta^2 + \alpha(1 - \alpha)(1 - \alpha - \beta)} \right] v x \\
= \frac{(1 - \alpha) \alpha \beta}{\beta^2 + \alpha(1 - \alpha)} v \]

**Firm 1**

For \( x \in (\hat{P}, v) \)

\[ \pi_1(x) = \alpha x + \beta [1 - F_2(x)] x + (1 - \alpha - \beta) [1 - F_2(x)][1 - F_3(x)] x \\
= \alpha x + \beta \frac{\alpha}{\beta} (v - x) \\
= \alpha v \]

For \( x \leq \hat{P} \)

\[ \pi_1(\hat{P}) - \pi_1(x) = \alpha (\hat{P} - x) + \beta \left[ [1 - F_2(\hat{P})] \hat{P} - [1 - F_2(x)] x \right] - (1 - \alpha - \beta) [1 - F_2(x)][1 - F_3(x)] x \\
= \alpha (\hat{P} - x) - [1 - F_2(x)] x - (1 - \alpha - \beta) [1 - F_2(x)][1 - F_3(x)] x \\
\geq \beta (\hat{P} - x) - [1 - F_2(x)] x - (1 - \alpha - \beta) [1 - F_3(x)] x \\
= \pi_2(\hat{P}) - \pi_2(x) \\
= 0 \]

**Firm 3**

For \( x \in (P, \hat{P}) \)

\[ \pi_3(x) = (1 - \alpha - \beta) [1 - F_1(x)][1 - F_2(x)] x \\
= \frac{(1 - \alpha - \beta) \alpha \beta}{\beta^2 + \alpha(1 - \alpha)} v \]

For \( x \geq \hat{P} \)
\[ \pi_3(\hat{P}) - \pi_3(x) = (1 - \alpha - \beta)[1 - F_2(\hat{P})]\hat{P} - (1 - \alpha - \beta)[1 - F_1(x)][1 - F_2(x)]x \]
\[ \geq (1 - \alpha - \beta)[1 - F_2(\hat{P})]\hat{P} - (1 - \alpha - \beta)[1 - F_2(x)]x \]
\[ = \frac{1 - \alpha - \beta}{\beta} \left[ [1 - F_2(\hat{P})]\hat{P} - [1 - F_2(x)]x \right] \]
\[ \geq \frac{1 - \alpha - \beta}{\beta} \left[ \beta \left[ [1 - F_2(\hat{P})]\hat{P} - [1 - F_2(x)]x \right] + \alpha(\hat{P} - x) \right] \]
\[ = \frac{1 - \alpha - \beta}{\beta} \left[ \pi_1(\hat{P}) - \pi_1(x) \right] \]
\[ = 0 \]
Appendix B - Additional Figures

Figure 4: Distribution of firms over obfuscation scores
Figure 5: Bell Canada pricing scheme - part 1
### Offer and Pricing Details

**Includes:**

<table>
<thead>
<tr>
<th>Service</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fibe 15</td>
<td>$55.95/mo.</td>
</tr>
<tr>
<td>$16 credit for months 1-3</td>
<td>-$18.00/mo.</td>
</tr>
<tr>
<td>Home Hub 1000</td>
<td>Included</td>
</tr>
<tr>
<td>One time modem rental fee discount</td>
<td>-$99.95</td>
</tr>
<tr>
<td>McAfee® Security from Bell - Good</td>
<td>Included</td>
</tr>
</tbody>
</table>

**3-month promo price:** $39.95/mo.

---

**Get a complete and customized installation:**

<table>
<thead>
<tr>
<th>Service</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell Install</td>
<td>Included</td>
</tr>
<tr>
<td>One time modem rental fee</td>
<td>$99.95</td>
</tr>
<tr>
<td>Activation Fee</td>
<td>$49.95</td>
</tr>
</tbody>
</table>

Available to residential customers in Ontario, where access and technology permit. For certain offers, the customer must select e-billing and create a MyBell profile. One-time activation fee ($49.95) extra. Modem rental required; one-time modem rental fee waived for new customers. Internet data usage 50 GB/mo.; $3.00/additional GB (max. $100/mo.). Subject to change without notice and cannot be combined with any other offer. Taxes extra. Other conditions apply, including minimum system requirements. Speeds on the Internet may vary with your configuration, Internet traffic, server, applicable network management or other factors.

1. Download access speed: 15 Mbps. Upload access speed will vary depending on the distance between the customer’s modem and switching equipment from Bell: min. 0.88 Mbps and max. 10 Mbps. Actual speeds experienced on the Internet may vary with customer’s configuration, Internet traffic, server, environmental conditions or other factors.

2. Available to new Internet customers and current dial-up customers with an account in good standing. $39.95 promotional monthly rate is a promotional credit against regular monthly pricing calculated as follows: regular monthly rate $55.95 (subject to change), less $16/mo. credit for 3 full billing periods.

3. Promotional price will apply to your first full 30-day billing period and for each full billing period after that, for the duration of your promotion. Your billing period may not start on the day you subscribe to our services. Regular price will apply for services delivered prior to your first full 30-day billing period.

4. Assuming optimal network conditions.

5. Conditions apply; see bell.ca/fullinstall.

---

Figure 6: Bell Canada pricing scheme - part 2
Enjoy life in the fast fibre-optic lane. Choose your speed.

Figure 7: Coextro pricing scheme

All Packages include:
- Free Installation
- $0 Activation Fee
- No Contracts
- No Modem Required
- 24/7 Technical Support