Default Options and Social Welfare: Opt In Versus Opt Out

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Abstract

We offer a social welfare comparison of the two most prominent default options – *opt in* and *opt out* – using a two-period model of localized competition. We demonstrate that when consumers exhibit "stick-to-the-default-option" behavior, the prevailing default policy shapes firms' ability to collect and use customer information, and affects their pricing strategy and entry decision differently. The free-entry analysis reveals that fewer firms enter under opt out as competition is harsher, and opt out is the socially preferred default option.

Keywords: opt in, opt out, default options, free entry, welfare

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1 Introduction

Advances in information technology have introduced unprecedented possibilities for collecting, storing, transmitting, and analyzing personal information. Consumers' purchases provide firms with a wealth of internally collected personal information on disposable income, family size, age, and other information that is relevant for their purchasing behavior. Additionally, firms often rely on publicly available information such as marketed consumer data obtained from external sources and combine it with internally collected information. Many businesses use this internally and/or publicly obtained consumer information to segment their markets into specific customer categories.

The degree of available customer information highly depends on the two main default options current privacy regulation allows for. The first default option is an "opt-out" system requiring the consumer to make an explicit request not to be included in a program that could make her personal information publicly available to other firms. Firms share information with third parties only if the consumer does *not* object. In the US industries where the law currently requires that consumers be given a choice, opt out is the most prevalent default option. Examples include the 1999 Gramm-Leach-Bliley Act, the 2000 Fair Credit Reporting Act, and the 2000 Telephone Consumer Protection Act. Under these Acts, firms must provide the consumer with an opportunity to opt out whenever they intend to share personal information.

The second default option is an "opt-in" system requiring the consumer to opt in to any program that shares information with other firms. Under opt in, firms have "to obtain a consumer's explicit consent before sharing personal information about them" (Lacker (2002)). Opt in permits the use of personal information within the organization but requires the consumer's explicit consent before this information can be disclosed to third parties outside the organization.[1] Interestingly, many states in the US have already adopted or are considering regulatory actions regarding the Gramm-Leach-Bliley Act in favor of the opt-in default for sharing information with third parties. In the European Union, the opt-in system underlies the 1995 European Parliament and Council Directive 95/46/EC. The European Union Data Protection Directive of 1995 is also based on the opt-in rather than the opt-out model.

Default options have a highly significant impact on consumers' behavior and the implied availability of information. Defaults matter since consumers exhibit "sticking-to-the-default-

[1] Staten and Cate (2003) distinguish between "Third-Party Sharing Opt-In" and "Affiliate Sharing Opt-In." Both variants require opt-in consent before information can be disclosed to third parties. The distinction is that the second puts more restrictions on what can be disclosed to whom.

option" behavior. The opt-in default then leads to an information regime with only internal information. The opt-out default implies that customer information is publicly available and can be combined with internally collected information.

We illustrate the distinction between opt in and opt out with some real world examples. In the US, credit card companies can access a consumer's publicly available credit report to make them targeted offers even before serving them. In other countries, even though customer credit information sharing takes place through credit registries, such information typically cannot be tapped to initiate marketing campaigns and make tailored offers (see e.g., Jappelli and Pagano (2002)) for the effects on information sharing). The information can only be employed when the customer files a demand at a bank to obtain a loan or credit card. Internet providers like Google or companies like Facebook have a massive amount of information about their customers. An opt-out system allows these internet companies to provide information to firms in other markets which then can employ this information for their market segmentation strategies.

Consumers often stick to the default option for several reasons. First, consumers may believe that defaults are suggestions by the policymaker implying a recommended action. Second, choosing another alternative than the default involves effort and costs such as filling out a form whereas sticking to the default is effortless. Finally, defaults often represent the existing state and change usually involves a trade-off with losses being perceived larger than the gains. Therefore, a change in the default option, e.g. from opt in to opt out may result in a change of choice (see e.g. Johnson and Goldstein (2003) or Choi, Laibson, Madrian and Metrick (2003) for similar reasoning).

Empirically, there is overwhelming evidence that customers exhibit "sticking-to-the-default-option" behavior. Madrian and Shea (2001), for example, study participation in a US pension plan when the default option changes from opt in towards opt out (automatic enrollment). With automatic enrollment only a tiny fraction opts out whereas with opt in, less than half of the employees enroll (see also Choi, Laibson, Madrian and Metrick (2003) for the impacts of defaults on saving rates in pension plans). Johnson, Hershey, Meszaros and Kunreuther (1993) report that only 20% of car drivers buy additional coverage in an opt-in setting whereas 75% adopt the additional coverage in an opt-out setting. Johnson, Bellman and Lohse (2002) investigate how defaults determine the possibility for further contact through a website: twice as many people agree to be notified when they must opt out (96%) than when they need to opt in (48%). Finally, organ donations are severely determined by the opt-in or opt-out default. Johnson and Goldstein (2003), for example, report that the effective consent of individuals in countries where

opt out is the default is about 97.5% whereas it is only 15% in countries with opt in as the default. Summing up, empirical work shows that (i) the default option is an important driver of consumer's behavior, and (ii) there seems to be more opting in than opting out.

Our paper studies the social welfare implications of two default options — opt in and opt out — employing a two-period version of the Salop (1979) address model of localized competition. Our model allows to analyze social welfare in situations where public policy on default options determines (i) the quality of firms' access to customer information; (ii) firms' ability to practice different forms of price discrimination; and (iii) firms' entry decisions. In our model, the different default options shape the strategic decisions of firms since competitive interactions — prices and entry decisions — are determined by the flow of information. In particular, when opt in is the default, no public customer information is available. As a result, firms must rely only on internally stored consumer information based on past customers' purchasing habits, and learn about consumers' brand preferences only by first building up a customer base and by practicing behavior-based price discrimination as developed in Fudenberg and Tirole (2000). When opt out is the default, firms can rely on marketed data for potential customers, and can immediately segment consumers by practicing third-degree price discrimination, while further combining it with internal information. Finally, we can benchmark the two default options with respect to *anonymity*, where neither public nor internal information about customers is collected.[2] Firms then must resort to uniform pricing.

Our free-entry analysis reveals that the opt-out regime produces better social welfare results than the anonymity regime, which in turn outperforms the opt-in regime. Therefore, from a social welfare perspective, it matters whether opt out or opt in is adopted as the default option. Opt out performs better than anonymity due to the following trade-off. On the one hand, with opt out, and for a given number of firms, suppliers serve some consumers with a low preference for their brand. This results in higher "transportation costs" compared to anonymity, where there is no inefficient consumer allocation. On the other hand, opt out results in "all-out" competition, as public as well as internal information stimulates competition between a given number of firms. Consequently, fewer firms will enter under opt out than under anonymity. The overall effect is that social welfare increases more with opt out than with anonymity. Although some consumers are not served by their nearest supplier, increased competition sufficiently reduces excessive entry to enhance social welfare.

In contrast to anonymity, opt in reduces social welfare. This outcome stems from the com-

[2] This is often labelled as "*blanket opt-in*" (see Staten and Cate (2003)).

petitive interactions in the two periods. First, note that for a given number of firms, first-period competition with opt in results in higher first-period prices relative to a model with anonymity. The reasoning is that first-period competition with opt in is also determined by the firm's anticipated second-period pricing behavior, making first-period demand less elastic. The opt-in default option and anonymity result in consumers being served by their most preferred supplier in the first period. Thus, higher first-period profits with opt in augment excessive entry. Second, opt in implies that firms use internally collected information in the second period. This results in (i) all-out competition relative to the anonymity regime and (ii) inefficient allocation, as some consumers are served by a more distant supplier. The overall effect is that the lower first-period competition with ensuing additional entry and the inefficient second-period allocation dominate the impact of all-out second-period competition. The conclusion, then, is that opt in leads to lower social welfare than anonymity. Thus, the social welfare effects hinge crucially on the default options that determine the flow of information.

The free entry number of firms under opt in shows a lower degree of excessive entry as compared to anonymity. However, social welfare under free entry is lower with opt in. This counterintuitive result stems from inefficiencies owing to customer poaching which outweigh the excessive entry effect. An important result therefore is that social welfare under free entry does not necessarily increase when the degree of excessive entry diminishes.

Our model studies the interaction between privacy regulation and market structure under free entry. Campbell, Goldfarb and Tucker (2011) consider how privacy regulation affects entry of a specialist firm competing with a generalist firm. Stricter privacy regulation implies that consumers need to give costly opt-in consent to allow the firms to use their data. If the costs to consumers of giving consent is sufficiently large, privacy regulation hinders entry. While their paper studies the relationship between privacy regulation and incumbency advantages, we analyze the price and free-entry effects of two main default options of privacy regulation.

Our model also relates to the literature on behavior-based price discrimination. Taylor (2004) considers heterogeneous consumers with private valuations for one firm's good that are positively correlated with the good offered by another monopoly firm. A consumer's purchasing decision at one firm is therefore valuable to the other firm. Taylor examines an anonymity regime in which the sale of customer information is not possible, and a disclosure regime in which a firm may compile and sell its customer list to the other firm, which uses it to price discriminate. If consumers are myopic, a firm may from time to time charge high prices in order to elicit information about its customers' willingness to pay. If consumers anticipate the selling of their

purchasing behavior, they may strategically refuse to buy from one firm when it is charging high prices in order to obtain a lower price at the other firm. This strategic customer behavior reduces the value of a customer list and may force firms to price low. If consumers anticipate the selling of a customer list, a firm might choose to commit to not selling after all.[3] This could be interpreted as firms favoring "opt in."

Like Fudenberg and Tirole (2000), we study two-period competition where firms can price discriminate in the second period between their own previous customers and other customers.[4] Each firm charges a high price to its previous customers (i.e. its strong market) and a low price to rivals' first-period customers (i.e. its weak market). Since one firm's weak market is the other firm's strong market, the firms' best-responses are asymmetric and second-period competition drives prices down, as in Corts (1998). While these papers consider duopoly, we are interested primarily in the extent to which the different forms of price discrimination that result from the two default options affect social welfare under free entry. In their literature review, Armstrong (2006) and Stole (2007) remark that free entry typically results in too much entry from a social welfare perspective. If price discrimination increases profits, excessive entry is encouraged. By contrast, price discrimination lessens excessive entry if it reduces oligopoly profits.[5] Liu and Serfes (2005) consider a one-period free-entry analysis where the quality of marketed consumer information determines the degree of segmentation. They vary the degree of possible consumer segmentation, and find that moderate segmentation results in the most efficient free-entry outcome.

Our paper, in contrast, studies how default options (i) shape a firm's ability to collect and use customer information, (ii) bears on a firm's intertemporal behavior-based pricing strategy, and (iii) changes social welfare through firms' entry decisions. From a social welfare perspective, opt out is the preferred default option, while opt in underperforms in comparison to anonymity. We do not model other privacy concerns that consumers may care about. This is clearly a limitation of our analysis. Our paper highlights however that there may be a cost to privacy in that competition may be hampered.

Section 2 develops the analysis first for the anonymity benchmark and then for the two default options. Section 3 offers the main results of our paper by comparing the different settings. Section 4 discusses robustness of our results while Section 5 provides concluding remarks.

[3] See also Acquisti and Varian (2005), and Calzolari and Pavan (2005).

[4] Villas-Boas (1999) considers an overlapping generations model where firms recognize their own customers but cannot distinguish new entering consumers from others who previously bought from rivals.

[5] For another thorough review on price discrimination, see Fudenberg and Villas-Boas (2006).

2 Price competition, free entry and default options

A continuum of consumers with unit mass is uniformly distributed along a circle with circumference one. Consumers live for two periods, have constant preferences over time, and have a unit demand for non-durable goods in each period. Consumers' willingness to pay v is high enough so as to guarantee that all consumers buy in each period. A consumer located at distance x from firm i (with $i = 1, ..., N$) derives utility

$$v - tx - p_\tau^i$$

from consuming one unit of goods in period τ (with $\tau = 1, 2$) and purchased from firm i, where t denotes the linear transportation cost per unit of distance and p_τ^i the price paid at firm i.[6] With the exception of transportation costs, switching between sellers is cost-free, and there is no possibility of arbitrage between consumers.

Firms and consumers share a common discount factor $0 \leq \delta < 1$. Prior to first-period competition, N firms decide to enter the market for both periods and locate equidistantly along the circle. The cost of entry is $(1 + \delta) F$, sunk, and incurred at $\tau = 1$. This entry cost structure allows for a direct comparison with a one-period Salop model where the entry cost equals F. Thus, firms commit to enter for both periods before competition starts. Firms start to compete for consumers at $\tau = 1$. Depending on the default option in place, firms do or do not possess information about consumers prior to first-period competition. In period $\tau = 2$ firms compete again for consumers. The information available about their customer base or future clientele is again determined by the default option.

Firms compete in prices during each period and cannot commit to future prices; that is, we do not consider long-term contracts. Prices are set simultaneously in both periods. In contrast to Taylor (2004), our model is not designed to analyze the market for consumer information. Instead, our objective is to investigate the implications of two different default options regarding information collection on interfirm competition and the consequences in terms of social welfare. To study these effects in isolation, we assume that firms can access public information, when available, and gather internal information at zero cost.

[6] We assume that the available gross surplus v does not depend on the different privacy policies. Consumer surplus, however, may suffer from giving up privacy.

2.1 Anonymity

As a benchmark, we first present anonymity. Under anonimity, firms have neither internally collected nor public information to base their pricing on, and must charge a uniform price. Clearly, first- and second-period competition are not linked since first-period market shares do not affect second-period competition. We can therefore address first- and second-period competition independently of each other.

2.1.1 Oligopoly

Consider an oligopoly situation with N firms that are located symmetrically along the circle. The circle may be subdivided into N neighborhoods. Neighborhood "ij" is where firms i and j (with $i, j = 1, ..., N$ and $i \neq j$) compete with each other (so, effectively $j = i + 1$ for all $i = 1, ..., N - 1$, and $j = 1$ for $i = N$). We focus on a specific neighborhood ij. Each firm is active on two adjacent neighborhoods and its total profits stem from these two neighborhoods. As all competing firms are identical, we can derive the equilibrium by studying pricing on one neighborhood only. Of course, we obtain a firm's total profits by taking into account its activity on both neighborhoods. The distance between firms i and j equals $1/N$ for any neighborhood. As firms offer only one price, there is only one indifferent consumer located at a, with $0 \leq a \leq 1/N$, such that

$$p_\tau^i + ta = p_\tau^j + t(\frac{1}{N} - a),$$

where $p^i$and p^j are the prices charged by firms i and j in period τ, respectively.

Firms i and j maximize their profits

$$\Pi_\tau^i(p^i, p^j) \equiv p_\tau^i a \text{ and } \Pi_\tau^j(p^j, p^i) \equiv p_\tau^j(1 - a)$$

in the neighborhood ij during period τ. From the (necessary and sufficient) first-order conditions, the symmetric solution results in

$$p_\tau^i = p_\tau^j = \frac{t}{N}.$$

The variable profits during period τ on neighborhood ij become

$$\Pi_\tau^i = \Pi_\tau^j = \frac{t}{2N^2}.$$

2.1.2 Free Entry

The free-entry number of firms under anonymity is determined by the zero-profit condition

$$(1+\delta)\frac{t}{N^2} - (1+\delta)F = 0,$$

since each firm obtains profits from two neighborhoods and in two periods, and where $(1+\delta)F$ are the fixed entry costs. The free-entry equilibrium number of firms, N^f_{AN}, then becomes

$$N^f_{AN} = \sqrt{\frac{t}{F}}.$$

Social welfare losses with anonymity W^f_{AN} become

$$W^f_{AN} = (1+\delta)\frac{t}{4N^f_{AN}} + N^f_{AN}(1+\delta)F = \frac{5}{4}(1+\delta)\sqrt{tF}.$$

With anonymity, all consumers are served by their most preferred supplier. This is reflected in the first term of the social welfare losses as the average consumer travels $N^f_{AN}/4$. The second term represents the fixed entry costs.

2.1.3 Social Planner

How many firms will a *social planner* allow? And what are the associated social welfare losses? Let us assume that the social planner controls the (maximum) number of firms entering the market, but cannot control their oligopolistic behavior once they have entered.[7] With anonymity, a social planner minimizes the following social welfare losses

$$W_{AN} = (1+\delta)\frac{t}{4n} + n(1+\delta)F.$$

Minimization results in

$$n^*_{AN} = \sqrt{\frac{t}{4F}}$$

as the socially optimal number of firms. Plugging this n^*_{AN} into the social welfare losses yields

$$W^*_{AN} = (1+\delta)\sqrt{Ft}.$$

[7] Our analysis considers the second-best outcome as the social planner controls the (maximum) number of firms entering the market but not their oligopolistic pricing behavior once they have entered. The first-best outcome would be identical across default options since the social planner can then also control prices.

2.2 Opt in

With opt in, consumers must explicitly consent to third-party use of personal data. In line with empirical evidence already referred to in the Introduction, we make the simplifying assumption that all consumers incur such substantial transactional or behavorial costs that they do not opt in. As a result, the default determines their behavior and no consumer gives permission for personal information about their purchasing patterns in related industries to be made publicly available. The information structure is then that firms can only rely on internally collected information as no public information is available. Hence, they need to resort to uniform first-period pricing but can use internally collected information in their second-period pricing strategies**.** Firms are, in other words, able to apply purchase-history-based pricing in the second period. We assume that a firm can store information whenever a consumer patronized its shop in period one. As a result, firms may set different prices in the second period for its first-period customers and new consumers. This is optimal, as first-period consumers have revealed they have a "higher preference" for that firm, and are therefore willing to pay higher prices for its products. We first consider the oligopolistic setting based on Fudenberg and Tirole's (2000) analysis of behavior-based price discrimination. Then we turn our attention to the free-entry solution and social welfare, respectively.

2.2.1 Oligopoly

Consider an oligopoly situation with N firms that are located symmetrically along the circle. As before, neighborhood "ij" is where firms i and j compete with each other, and each firm is active on two adjacent neighborhoods. As our analysis concentrates on symmetric situations, let b denote the position of the indifferent consumer in the first period located in between i and j, with $0 \leq b \leq 1/N$. Denote by p_2^{ji} firm i's second-period price offered to customers of firm j's first-period market. Denote by x' the position of the consumer in the second period who is indifferent between switching from i to j or staying with i. Similarly, y' is the position of the consumer in the second period who is indifferent between switching from j to i or staying with j. It should be clear that $0 \leq x' \leq b \leq y' \leq 1/N$.

We start the analysis with second-period competition. Firm i has served the market segment $0 \leq b \leq 1/N$ in the first period, while firm j served $1/N - b$. The position of the second-period customer x', indifferent between switching from i to j, is such that

$$p_2^{ii} + tx' = p_2^{ij} + t(\frac{1}{N} - x').$$

Similarly, the position of the second-period customer y' indifferent between switching from j to i, equals

$$p_2^{jj} + t(\frac{1}{N} - y') = p_2^{ji} + ty'.$$

Firm i maximizes its second-period profits in neighborhood ij

$$\Pi_2^i(p_2^{ii}, p_2^{ji}) \equiv p_2^{ii}x' + p_2^{ji}(y' - b)$$

while firm j maximizes

$$\Pi_2^j(p_2^{jj}, p_2^{ij}) \equiv p_2^{jj}(\frac{1}{N} - y') + p_2^{ij}(b - x').$$

From the first-order conditions, the second-period prices equal

$$p_2^{ii} = t(2b + \frac{1}{N})/3 \ ; \ p_2^{ji} = t(\frac{3}{N} - 4b)/3 \ ; \ p_2^{jj} = t(\frac{3}{N} - 2b)/3 \text{ and } p_2^{ij} = t(4b - \frac{1}{N})/3.$$

Note that the first-period market share b shapes second-period competition. In particular, a greater b relaxes competition in i's first-period market but enhances competition in j's first-period market.

Let us now consider first-period competition, which determines the first-period market share.[8] In the first period, the indifferent, forward-looking consumer anticipates that, in the second period, the "poaching firm" will offer attractive prices. That is to say, the indifferent consumer anticipates that it will be beneficial in the second period to visit the rival shop. Given the discount rate δ, the indifferent first-period consumer located at b is characterized by

$$p_1^i + tb + \delta[p_2^{ij} + t(\frac{1}{N} - b)] = p_1^j + t(\frac{1}{N} - b) + \delta(p_2^{ji} + tb)$$

or

$$b = \frac{p_1^j - p_1^i + \delta(p_2^{ji} - p_2^{ij}) + \frac{t}{N}(1 - \delta)}{2t(1 - \delta)}.$$

In other words, the consumer in position b is indifferent between buying in the first period from firm i at price p_1^i and switching to j in the second period, or buying from j in the first period at price p_1^j and switching to firm i in period two.

The discounted total profits amount to

$$\Pi^i(p_{1,}^i \ p_1^j) \equiv p_1^i b + \delta[\Pi_2^i(p_2^{ii}, p_2^{ji})]$$

for firm i and to

$$\Pi^j(p_{1,}^i \ p_1^j) \equiv p_1^j(\frac{1}{N} - b) + \delta[\Pi_2^j(p_2^{jj}, p_2^{ij})]$$

[8] The analysis assumes that firms attract market share only from neighborhoods adjacent to their own locations. We return to this point at the end of the present subsection.

for firm j. In their first-period pricing decisions, firms take into account the effect of their choices on second-period profits. From the first-order conditions, the symmetric solution yields

$$p_1^i = p_1^j = \frac{t(\delta + 3)}{3N}.$$

The symmetric equilibrium then implies $b = 1/(2N)$, resulting in

$$p_2^{ii} = p_2^{jj} = \frac{2t}{3N} \text{ and } p_2^{ij} = p_2^{ji} = \frac{t}{3N}.$$

Comparison of prices reveals that

$$p_1^i = p_1^j > p_2^{ii} = p_2^{jj} > p_2^{ij} = p_2^{ji}.$$

Thus, first-period prices exceed second-period prices. Moreover, first-period prices are higher than in a standard Salop model with uniform pricing, where prices would equal t/N. The reasoning stems from the lower elasticity of first-period demand relative to the static Salop model. This lower elasticity relaxes first-period competition.

We also find that

$$x' = \frac{1}{3N} \text{ and } y' = \frac{2}{3N},$$

implying that one-third of all consumers are not served by their geographically most preferred supplier in the second period, whereas all consumers are served by the closest-by supplier in the first period.[9] Firm i and j's discounted total equilibrium profits in neighborhood ij amount to

$$\Pi^i = \Pi^j = \frac{t\,(9 + 8\delta)}{18N^2}. \tag{1}$$

This above analysis leads to similar results as in Fudenberg and Tirole (2000). Note, however, that our oligopoly framework allows for more than two firms. Our analysis concentrates on the competitive equilibrium resulting in Eq. (1) as this allows us to focus on free entry and compare our results with opt out and anonymity.[10]

[9] The condition that all consumers buy in the first period is guaranteed when $v \geq \max\left[t/2N + t(\delta + 3)/3N, 2t(2 + \delta)/3N\right]$. Otherwise, some consumers to the left of x' and to the right of y' would strategically refrain from purchasing in period 1. By doing so, they could benefit from the lowest second-period prices at the closest shop.

[10] We do not study in detail the possibility of firms to set "supercompetitive prices", i.e. prices whereby it captures all customers on both sides of the closest neigboring brand, as described in Salop (1979). While in Salop's model such deviations are unprofitable, they may be worthwhile in the two-period framework considered here. The reasoning is that although a deviation in the first period results in lower first-period profits, it may

2.2.2 Free Entry

We employ the results from the oligopoly case in order to study *free entry*. Recall that firms simultaneously decide whether to enter or not, and that entry costs amount to $(1+\delta)F$. After entry has occurred, the firms play the two-period game, as analyzed in the previous subsection. As prices with opt in decline from period 1 to period 2, additional entry in the second period of the game (at a cost F) is unprofitable. Our free-entry equilibrium of the two-period model is therefore entry-proof in the second period.

As firm i attracts consumers from its two nearby neighborhoods, profits double those of Eq. (1). For each firm, discounted total variable profits with opt in equal

$$\Pi_{IN}^{i} = \frac{t\,(9+8\delta)}{9N^2}.$$

Since the free-entry condition with opt in satisfies $\Pi_{IN}^{i} - (1+\delta)\,F = 0$, the equilibrium number of firms N_{IN}^{f} amounts to

$$N_{IN}^{f} = \sqrt{\frac{t(9+8\delta)}{9\,(1+\delta)\,F}}.$$

In comparison to a frictionless world without costs of entry and transportation, social welfare losses under free entry with opt in become

$$\begin{aligned} W_{IN}^{f} &= 2N_{IN}^{f}t[\int_{0}^{1/2N_{IN}^{f}} \mathbf{x}d\mathbf{x} + \delta(\int_{0}^{1/3N_{IN}^{f}} \mathbf{x}d\mathbf{x} + \int_{1/3N_{IN}^{f}}^{1/2N_{IN}^{f}} (1/N_{IN}^{f} - \mathbf{x})d\mathbf{x})] + N_{IN}^{f}\,(1+\delta)\,F \\ &= \frac{(45+43\delta)}{12}\sqrt{\frac{tF\,(1+\delta)}{(9+8\delta)}}. \end{aligned}$$

The first term between the square brackets reflects the first-period transportation costs, as consumers visit their most preferred supplier. The second term captures the discounted second-

substantially relax competition in the next period. Such a deviation becomes unprofitable (i) with sufficiently convex transportation costs, or (ii) when consumers only consider patronizing the two closest shops, for example because it is too costly to examine prices in non-neigboring firms, or (iii) when δ is sufficiently low (i.e. $\delta < 9/28$). To see the latter, start from the candidate equilibrium prices $p_1^i = p_1^j = t(\delta+3)/3N$. Given these prices, firm i can attract a first-period market share of $3/N$ by lowering its price with t/N and setting a first-period supercompetitive price equal to $\delta/3N$. As a result, its first-period profits will equal $\delta t/N^2$. Under the assumption that the nonadjacent firms do not adopt their pricing strategies, the second-period prices and market shares are t/N and $1/N$, respectively, as its adjacent firms will not have served any consumers in the first period. Its discounted profits, then, are $2\delta t/N^2$. This expression is larger then Eq. (1) whenever $\delta > 9/28$. Note that if the nonadjacent firms were also to adjust their prices, they would have an incentive to become more aggressive. Therefore the condition $\delta < 9/28$ is a sufficient condition but not a necessary condition.

period transportation costs. In the second period, some inefficient allocation takes place: consumers in the middle of each neighborhood visit a "more distant" firm in order to benefit from the more attractive second-period price. The third term reflects total entry costs.

2.2.3 Social Planner

What is the optimal number of firms from a *social welfare* point of view under the opt-in system? Firms will implement "purchase-history based price discrimination", since it is a dominant strategy for firms to price discriminate in period two. Entry still implies a social cost $(1+\delta)F$. The social welfare losses to be minimized by the social planner are

$$W_{IN} = 2n_{IN}t[\int_0^{1/2n_{IN}} \mathbf{x}d\mathbf{x} + \delta(\int_0^{1/3n_{IN}} \mathbf{x}d\mathbf{x} + \int_{1/3n_{IN}}^{1/2n_{IN}} (1/n - \mathbf{x})d\mathbf{x})] + n_{IN}(1+\delta)F,$$

where n_{IN} is the number of firms to be determined by the social planner. As with free entry, the first term between the square brackets reflects the first-period transportation costs, while the second term captures the discounted second-period transportation costs. Minimizing this expression yields the socially optimal number of firms with opt in n^*_{IN},

$$n^*_{IN} = \sqrt{\frac{t(9+11\delta)}{36(1+\delta)F}}.$$

This yields the following social welfare losses

$$W^*_{IN} = \sqrt{\frac{tF(11\delta+9)(1+\delta)}{9}}.$$

2.3 Opt out

The opt-out system offers consumers the option to prohibit firms from sharing their personal information. In line with the empirical evidence described in the Introduction, we assume that consumers stick to the default and therefore do not opt out. The consequence of such default behavior is that information about consumers' characteristics is publicly available. Consequently, each firm obtains marketed consumer information about consumers' brand preferences before first-period competition takes place. In our set-up, the marketed consumer information is that every firm is informed whether a consumer's location is "closer to its shop" or not, as in Bester

and Petrakis (1996).[11] This assumption maintains the essential characteristics of opt out, as entrants have access to customer information, and allows for an easier comparison with opt in. The publicly available information of customer location allows firms to practice third-degree price discrimination already in the first period. This public information segments the market into nearby consumers and others, since consumers located nearby have a "higher preference" for that firm while showing a lower preference for firms further away. Every firm has a dominant strategy to make use of this public information (see Thisse and Vives, 1988). In addition, all firms have an incentive to additionally compile information about consumers' purchasing behavior in period one and make use of it in period two. This additional information segments the market in period two into four segments, and further strengthens competition. Our analysis starts backwards from period 2, before analyzing period 1.

2.3.1 Oligopoly

Assume that N firms have entered the market. Firms are located symmetrically on the circle. As before, the distance between adjacent firms i and j in neigborhood ij equals $1/N$. The informational environment in period 1 is now such that firms i and j know whether or not a consumer is located in between 0 and $1/(2N)$ from its own brand. Firms i and j will then price discriminate in period 1 between consumers located in their hinterland and those located further away. Denote by $p_1^{i,i}$ firm i's price offered in period 1 to customers in its hinterland i (i.e. consumers located in the interval $[0, 1/(2N)]$), and by $p_1^{i,j}$ firm i's price offered to customers "located further away" in firm j's hinterland (i.e. consumers located in the interval $[1/(2N), 1/N]$).[12] Furthermore, denote by x_1 the position of the consumer in i's hinterland who is indifferent between proximate firm i and more distant firm j. Similarly, z_1 is the position of the consumer in j's hinterland who is indifferent between proximate firm j and the more distant firm i. It should be clear that $0 \leq x_1 \leq 1/(2N)$ and $1/(2N) \leq z_1 \leq 1/N$.

We start the analysis in period 2, where each firm now charges one price in each of the four segments between its own location and its neighbour's location. Firm i has served consumer segments $[0, x_1]$ in its own hinterland and $[1/(2N), z_1]$ in its neighbour's hinterland in period

[11] Note that this assumption implies that each firm's information set differs when the number of firms $N > 2$. In other words, the list of consumers known to firm i as living closest to its shop differ from j's list. An alternative assumption is that firms have identical information about every consumer's "brand ordering". In a localized model of competition, however, these two assumptions produce identical results. The reasoning is that, given our assumptions, serving consumers from non-adjacent neigborhoods turns out to be unprofitable (see footnote 9).

[12] To be precise, firm i sets an identical price $p_1^{i,j}$ for customers from any adjacent firm j.

1, while firm j has sold to customers located at $[x_1, 1/(2N)]$ and $[z_1, 1/N]$. The locations of the indifferent consumers in the four different segments in period two will be referred to as $\underline{x}_2$, $\overline{x}_2$, $\underline{z}_2$, and $\overline{z}_2$where the subscript refers to period 2 and $0 \leq \underline{x}_2 \leq x_1 \leq \overline{x}_2 \leq 1/(2N) \leq \underline{z}_2 \leq z_1 \leq \overline{z}_2 \leq 1/N$. As a result, the position of the four indifferent consumers in period 2 can be written as

$$\begin{aligned} p_2^{ii,i} + t\underline{x}_2 &= p_2^{ij,i} t(1/N - \underline{x}_2);\ p_2^{ji,i} + t\overline{x}_2 = p_2^{jj,i} t(1/N - \overline{x}_2); \\ p_2^{ii,j} + t\underline{z}_2 &= p_2^{ij,j} + t(1/N - \underline{z}_2);\ p_2^{ji,j} + t\overline{z}_2 = p_2^{jj,j} + t(1/N - \overline{z}_2) \end{aligned}$$

where the first part of the superscript (before the comma) refers to what firm the consumer purchased from in period one, and what firm the consumer buys from in period two, respectively. The second part of the superscript (after the comma) equals i when a consumer belongs to a firm i's hinterland, and j otherwise. The second-period profits can then be expressed as

$$\tilde{\Pi}_2^i(p_2^{ii,i}, p_2^{ji,i}, p_2^{ii,j}, p_2^{ji,j}) = p_2^{ii,i}\underline{x}_2 + p_2^{ji,i}(\overline{x}_2 - x_1) + p_2^{ii,j}(\underline{z}_2 - 0.5N) + p_2^{ji,j}(\overline{z}_2 - z_1)$$

and

$$\tilde{\Pi}_2^j(p_2^{ij,i}, p_2^{jj,i}, p_2^{ij,j}, p_2^{jj,j}) = p_2^{ij,i}(x_1 - \underline{x}_2) + p_2^{jj,i}(0.5N - \overline{x}_2) + p_2^{ij,j}(z_1 - \underline{z}_2) + p_2^{jj,j}(1/N - \overline{z}_2)$$

for firm i and j, respectively.

In period 1, the position of customer x_1 in i's hinterland, indifferent between firm i and j, is such that

$$p_1^{i,i} + tx_1 = p_1^{j,i} + t(\frac{1}{N} - x_1),$$

where $p_1^{i,i}$ is the price charged in period 1 by firm i to a customer located in its hinterland. Similarly $p_1^{j,i}$ is the price charged in period 1 by firm j to a customer in firm i's hinterland. In a similar fashion, the position of customer z_1 in j's hinterland, who is indifferent between j and i, equals

$$p_1^{i,j} + tz_1 = p_1^{j,j} + t(\frac{1}{N} - z_1).$$

The discounted total profits amount to

$$\tilde{\Pi}^i(p_1^{i,i}, p_1^{i,j}, p_1^{j,j}, p_1^{j,i}) \equiv p_1^{i,i}x_1 + p_1^{i,j}(z_1 - \frac{1}{2N}) + \delta[\tilde{\Pi}_2^i(p_2^{ii,i}, p_2^{ji,i}, p_2^{ii,j}p_2^{ji,j})]$$

for firm i and to

$$\tilde{\Pi}^j(p_1^{j,j}, p_1^{j,i}, p_1^{i,i}, p_1^{i,j}) \equiv p_1^{j,j}(\frac{1}{N} - z_1) + p_1^{i,j}(\frac{1}{2N} - x_1) + \delta[\tilde{\Pi}_2^j(p_2^{jj,j}, p_2^{ij,j}, p_2^{jj,i}p_2^{ij,i})]$$

for firm j. In their first-period pricing decisions, firms take into account the effect of their choices on second-period profits. From the first-order conditions, the symmetric solution yields the following first-period prices

$$p_1^{i,i} = p_1^{j,j} = \frac{2t\,(9-7\delta)}{N\,(27-20\delta)}; p_1^{j,i} = p_1^{i,j} = \frac{3t\,(3-2\delta)}{N\,(27-20\delta)}$$

and resulting second-period prices

$$\begin{aligned} p_2^{ii,i} &= p_2^{jj,j} = \frac{t\,(45-32\delta)}{3N\,(27-20\delta)}; p_2^{ij,i} = p_2^{ji,j} = \frac{t\,(9-4\delta)}{3N\,(27-20\delta)} \\ p_2^{ji,i} &= p_2^{ij,j} = \frac{2t\,(9-8\delta)}{3N\,(27-20\delta)}; p_2^{jj,i} = p_2^{ii,j} = \frac{t\,(9-8\delta)}{3N\,(27-20\delta)}. \end{aligned}$$

Total discounted profits per firm (net of fixed costs) in neighborhood ij become

$$\tilde{\Pi}^i = \tilde{\Pi}^j = \frac{t\left(3645-2835\delta-1728\delta^2+1360\delta^3\right)}{18N^2\,(27-20\delta)^2}.$$

2.3.2 Free Entry

Let us now consider what happens with *free entry*. Taking into account that firms realize profits in two adjacent neighborhoods and incur fixed entry costs, the per firm discounted profits become

$$\tilde{\Pi}^i = \frac{t\left(3645-2835\delta-1728\delta^2+1360\delta^3\right)}{9N^2\,(27-20\delta)^2} - (1+\delta)\,F.$$

The free-entry equilibrium number of firms with opt out, N_{OUT}^f, then equals

$$N_{OUT}^f = \frac{1}{3\,(27-20\delta)}\sqrt{\frac{t(3645-2835\delta-1728\delta^2+1360\delta^3)}{(1+\delta)\,F}}.$$

Discounted social welfare losses W_{OUT}^f can be computed as the sum of (i) current and discounted "transportation" costs, and (ii) entry costs. Social welfare losses then amount to

$$\begin{aligned} W_{OUT}^f &= 2N_{OUT}^f t \left[\begin{array}{c} \int_0^{x_1} \mathbf{x}d\mathbf{x} + \int_{x_1}^{1/2N_{OUT}^f} (1/N_{OUT}^f - \mathbf{x})d\mathbf{x} + \\ \delta\left(\int_0^{\underline{x}_2} \mathbf{x}d\mathbf{x} + \int_{\underline{x}_2}^{x_1} (1/N_{OUT}^f - \mathbf{x})d\mathbf{x} + \int_{x_1}^{\overline{x}_2} \mathbf{x}d\mathbf{x} + \int_{\overline{x}_2}^{1/2N_{OUT}^f} (1/N_{OUT}^f - \mathbf{x})d\mathbf{x}\right) \end{array} \right] \\ &\quad + N_{OUT}^f\,(1+\delta)\,F \\ &= \frac{t(8019-4455\delta-6696\delta^2+4144\delta^3)}{36N_{OUT}^f\,(27-20\delta)^2} + N_{OUT}^f\,(1+\delta)\,F. \end{aligned}$$

The two terms between the square brackets represent the customers' total travelling costs to the firms for customers living closer to i in neighbourhood ij. The first line refers to period 1 and the second line represents customers' visiting costs in period 2. We multiply times $2N_{OUT}^f$ to have total transportation costs. The last term represents the entry costs.

2.3.3 Social Planner

What is the optimal number of firms from a *social welfare* point of view under the opt-out system? Suppose that the social planner controls the (maximum) number of firms entering the market but cannot control their oligopolistic pricing behavior once they have entered. As it is a dominant strategy for firms to price discriminate between "close" and "distant" consumers, social welfare losses to be minimized are

$$W_{OUT} = 2n_{OUT}t \left[\begin{array}{c} \int_0^{x_1} \mathbf{x}d\mathbf{x} + \int_{x_1}^{1/2n_{OUT}} (1/n_{OUT} - \mathbf{x})d\mathbf{x} + \\ \delta \left(\int_0^{\underline{x}_2} \mathbf{x}d\mathbf{x} + \int_{\underline{x}_2}^{x_1} (1/n_{OUT} - \mathbf{x})d\mathbf{x} + \int_{x_1}^{\overline{x}_2} \mathbf{x}d\mathbf{x} + \int_{\overline{x}_2}^{1/2n_{OUT}} (1/N^f_{OUT} - \mathbf{x})d\mathbf{x} \right) \end{array} \right] + n_{OUT}(1+\delta)F$$

where n_{OUT} is the number of firms to be determined by the social planner. Solving the first-order condition yields the optimal number of firms, n^*_{OUT}, with

$$n^*_{OUT} = \frac{1}{6(27-20\delta)} \sqrt{\frac{t(8019 - 4455\delta - 6696\delta^2 + 4144\delta^3)}{(1+\delta)F}}.$$

Social welfare losses then become

$$W^*_{OUT} = n^*_{OUT}(1+\delta)F + \frac{t(8019 - 4455\delta - 6696\delta^2 + 4144\delta^3)}{36n^*_{OUT}(27-20\delta)^2}.$$

3 Social Welfare Comparison of Default Options

In this section we compare the social welfare implications of the two different default options and consider anonymity as a benchmark. We first consider the extent to which the different default options result in excessive entry. Next we discuss whether less excessive entry always leads to higher welfare on the basis of a social welfare comparison between free entry and the social planner. Finally, in order to further improve our understanding of the consequences of default options, we discuss consumers' behavior when consumers do not exhibit "sticking-to-the-default-option" behavior. In particular, we want to investigate whether consumers have an interest in adhering to the default when the costs of opting in or opting out are low. The proofs of the Propositions follow directly from a comparison of the findings in Section 2 and are therefore omitted. Our first proposition presents how the default options impact on the degree of excessive entry.

Proposition 1: *All default options result in excessive entry. Excessive entry is largest under anonymity, whereas opt out has the lowest degree of excessive entry. Formally, we find that*

$$N^f_{AN} > N^f_{IN} > N^f_{OUT} > n^*_{OUT} > n^*_{IN} > n^*_{AN}.$$

Not surprisingly, the anonymity benchmark yields excessive entry, as it coincides with Salop's (1979) findings; hence $N^f_{AN} > n^*_{AN}$. The opt-in and opt-out default option allow for price discrimination and lead to all-out competition (see Corts (1998)). Under both default options, firms make lower profits, which alleviates the excessive entry problem. More specifically, under the opt-out default, all-out competition occurs in both periods. With opt in, second-period prices are sufficiently low to result in general all-out competition, although first-period prices outweigh the prices of the anonymity regime. Consequently, the discounted price $\overline{P}^f$ an average consumer pays ranks ass

$$\overline{P}^f_{AN} > \overline{P}^f_{IN} > \overline{P}^f_{OUT},$$

and explains the free-entry ordering $N^f_{AN} > N^f_{IN} > N^f_{OUT}$.

The default option also determines the socially optimal number of firms. The opt-in default results in an inefficient allocation of consumers in the second period as some consumers choose a more distant supplier. The social planner corrects for this consumer behavior by increasing the number of firms as this reduces the cost of inefficient allocation. Under the opt-out default this inefficient allocation occurs in both periods, which explains $n^*_{OUT} > n^*_{IN} > n^*_{AN}$. Finally, note that imposing opt in or opt out as a default option mitigates the excessive entry problem, but does not resolve it entirely. This result further corroborates the findings of Norman and Thisse (1996) and Bhaskar and To (2004), who also study the effect of price discrimination on the free entry number of firms.[13]

Proposition 2 summarizes how default options determine social welfare.

Proposition 2: *Default options matter for social welfare. The free-entry analysis shows that opt out as default option generates greater social welfare than opt in. The social planner prefers anonymity and values opt in higher than opt out. Formally, we find that social welfare losses rank as*

$$W^f_{IN} > W^f_{AN} > W^f_{OUT} > W^*_{OUT} > W^*_{IN} > W^*_{AN}.$$

[13] In a somewhat different model where consumers can be sorted according to their willingness to pay, Borenstein (1985) predicts that the number of firms in a free-entry model increases with price discrimination. Similarly, Holmes (1989) finds that when firms' best-responses are symmetric, profits will increase with third-degree price discrimination.

The free-entry analysis reveals that opt out socially outperforms anonymity. This insight stems from the following trade-off. On the one hand, some consumers prefer to purchase from a more distant supplier. This inefficient allocation does not occur with anonymity, where all consumers patronize the closest shop, lowering social welfare. On the other hand, a significantly lower number of firms enter with opt out, as has been shown in Proposition 1, thereby improving social welfare. The analysis shows that the second effect dominates the first. So, although some consumers are not served by their closest-by supplier, opt out sufficiently mitigates excessive entry to enhance social welfare.

Proposition 3 summarizes how entry decisions further link to social welfare judgments.

Proposition 3: *The degree of excessive entry is not a sufficient statistic to make social welfare judgments.*

The default options influence social welfare differently as they determine the number of entrants and the degree of efficient consumer allocation. We find that the free entry number of firms under opt in results in a lower degree of excessive entry as compared to anonymity, i.e., $N^f_{AN} > N^f_{IN}$. Social welfare under free entry, in contrast, is lower with opt in, i.e., $W^f_{IN} > W^f_{AN}$. Two opposing effects explain this finding. On the one hand, opt in results in less excessive entry as opposed to anonymity. This is certainly to the benefit of social welfare. On the other hand, opt in results in inefficient allocation of consumers in the second period. The overall effect is that opt in reduces social welfare, which illustrates that, in contrast to the social planner, opt in is not a convex combination of the anonymity and opt-out regimes.[14] Proposition 3 therefore shows that social welfare under free entry does not necessarily increase when the degree of excessive entry diminishes.

4 Robustness and further discussion

We now discuss the robustness of our results regarding some of the assumptions underlying our analysis. We consider (i) the incentives to stick to the default, (ii) the amount of public information available, (iii) costly public information and incentives to collect information, (iv) opt-out without further collecting internal information, and (v) privacy concerns related to public information.

[14] Remark that social welfare with opt in is a convex combination of anonymity and opt out not only for the social planner but also for any given number of firms, i.e. oligopoly.

Stick-to-the-default-option: Our analysis thus far assumed that consumers behave according to the "stick-to-the-default-option". For example, this may happen when consumers experience high costs when deviating from the default standard. We now discuss what happens when a consumer experiences zero costs when deviating from the default option. In other words, we discuss whether consumers have an interest in exercising their option. We first consider the opt-out default option. By opting out, a consumer prevents the firm from employing his public information. Under the assumption that opting out does not reveal information about a consumer's location, the firm will charge him a uniform price t/N, as under anonimity, during both periods. Since t/N is higher than any price a customer can choose from under the opt-out system, no consumer has a unilateral incentive to opt out. We now turn to a consumer's incentives to exercise their opt-in option. Recall that exercising this option implies that a consumer's information becomes publicly available. The analysis for opt in is more involved as the willingness of a consumer to exercise his option is location dependent. To see this, suppose that firms cannot infer location-specific information when a consumer exercises his option. While each consumer then benefits from all-out competition in the first period, some consumers may incur a higher total expenditure in the second period since $p_2^{ji,i} > p_2^{ij}$.[15] Since firms anticipate that these consumers do not exercise their option, they will be able to infer some information about consumers' location. This observation shows that opting in may not be random across consumers further complicating the analysis. We do not further elaborate on such non-random behavior, also given the strong evidence on sticking-to-the-default behavior.

Available public information: Our opt-out analysis assumes that the marketed consumer information a firm has at its disposal in the first period consists of whether a consumer's location is "closer to its shop" or not. This public information in the first period makes market segmentation easier and drives the differences in results compared to opt in. How robust are our results to more or less public information being available? Consider first a situation where there would be no public information available in the first period. This could be the case when firms are operating in an industry where there is no relevant information that can be shared towards this industry. This would happen when this is a new industry where traditional consumer characteristics would be irrelevant, or when this public information is prohibitively expensive. The opt in and opt out system then simply coincide as the information structure is such that only internally generated information is employed. Next consider a situation where the public

[15] For example, this applies to consumers located in $[x', x_1]$. They buy from the poaching firm in period 2 when sticking to the default but buy from the nearby firm when exercising their option.

information would be better, i.e. where the consumers would be divided in more than just 2 groups (e.g., 4, 8, or more groups as in the one-period analysis of Liu and Serfes (2005)). We argue that our results on the ranking of the free entry number of firms and social welfare under free entry are robust to more detailed public information. One extreme case is when public information contains the consumer's address allowing for perfect price discrimination in both periods. In that event, competition becomes harsher and N^f_{OUT} decreases further confirming the free-entry ranking $N^f_{AN} > N^f_{IN} > N^f_{OUT}$. Similarly, the social welfare ranking under free entry $W^f_{IN} > W^f_{AN} > W^f_{OUT}$ holds as furthermore every customer now visits the nearby firm. The social planner's ranking when deciding on the number of firms is partially reversed with perfect price discrimination in both periods. In particular, we obtain that $n^*_{IN} > n^*_{OUT} = n^*_{AN}$ and $W^*_{IN} > W^*_{OUT} = W^*_{AN}$. Clearly, opt out with perfect price discrimination and anonymity are identical as every consumer visits the nearby firm so that there is no social welfare incentive to have more firms to reduce inefficient customer allocation. We refer to Liu and Serfes (2005) for an in depth analysis of the tradeoffs between entry and inefficient customer allocation in a model with different degrees of public consumer information.

Costly public information and incentives to collect information: We assumed that information is shared across markets such that a firm obtains it at no cost before ever dealing with consumers. However, firms gathering the information may not have incentives to release it to other firms. Consider, therefore, that public information has a price such that the collecting firms have incentives to release it. This would imply a divergence between the private cost of entry and the social welfare cost of entry as the fee paid by the entering firm is a revenue for another firm. This additional cost would reduce the free-entry number of firms and if not too large might bring it closer to the social welfare optimal.

Opt-out without internal information: We compared two information regimes, i.e., only internal information (opt in), and public information and internal information collection (opt out). We now discuss when firms would only rely on public information in the opt-out setting and not further collect internal information. Our main findings remain robust to this alteration. The opt-out system then becomes a replication in both periods of the second period of the opt in analysis.

Privacy: Our analysis assumes that consumers only care about expenditures. Consumers, however, could have other privacy concerns which our main analysis does not take into account. Suppose that consumers still exhibit sticking to the default behavior but associate a cost to their data being made public. In that event, the beneficial competitive effects of opt out may

be outweighed by the loss in privacy. This points out that the social welfare maximizing default option may hinge on whether the type of customer information being made public, is privacy sensitive or not.

5 Concluding Remarks

This paper identifies in a model of localized competition the social welfare effects of an opt-in versus an opt-out default option when consumers "stick-to-the-default-option." We find that these two commonly observed default options shape social welfare differently. In particular, the implemented default option affects the number of entrants and the degree of efficient consumer allocation. Our free-entry analysis shows that opt out is the socially preferred default option. Although the opt-out default leads to more inefficient consumer allocation, opt out leads to all-out competition, resulting in less excessive entry as compared to opt in. Policymakers should, therefore, realize that when consumers exhibit "sticking-to-the-default" behavior, the default option determines social welfare.

The free-entry analysis in our model of localized competition also yields two other results. First, the degree of excessive entry is not a sufficient statistic to draw social welfare conclusions. Social welfare is lower with opt in, although excessive entry is mitigated by comparison with anonymity. Second, social welfare results may differ substantially between oligopoly and free entry. To illustrate this point, we recall that, while it is clear that oligopoly results in inefficient consumer allocation in the case of opt out, our free-entry analysis reverses this result, as all-out competition substantially reduces excess entry.

We also discuss whether rational consumers have an interest in exercising their option when deviating from the default option carries a low cost. We show that it is then rational for consumers to never opt out and always opt in. The empirical evidence shows that only a tiny fraction of consumers opt out whereas a higher fraction opts in. A setup where some consumers show "stick-to-the-default-option" behavior and others having sufficiently low costs to exercise their option, concurs with this empirical evidence.

Our analysis in the main text assumes unit-demand consumers and markets that are covered in the three regimes. While these assumptions are standard in models of localized competition, as they considerably simplify calculations, they disregard the positive impact lower prices may have on social welfare stemming from reductions in deadweight loss. Dropping these assumptions, however, would reinforce the differences between opt in and opt out. The reasoning is that opt

out leads to lower prices, implying that consumers will increase their demand and markets will become "more covered" than with opt in, leading to more pronounced social welfare differences.

Finally, our analysis has limitations. For example, we did not consider how public information may harm consumer privacy. Often such information may impose a cost on privacy, costs which we did not take into account.

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