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Deceptive Products on Platforms*

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Abstract

On many online platforms, sellers offer products with additional fees and features. Platforms often deliberately shroud these fees from consumers. Examples are shipping fees, luggage fees on flight-aggregator websites, or resort fees and upgrades on hotel booking platforms. We explore the incentives of two-sided platforms to disclose additional fees and design a transparent marketplace when consumers might naively ignore shrouded additional fees. First, we find that platforms have stronger incentives to shroud additional fees than sellers in the absence of platforms. This result holds for monopoly platforms and in some competitive settings. Second, competition might induce platforms to regulate additional fees, which benefits consumers. We discuss connections to frequent practices like drip pricing, and platforms like Amazon or eBay regulating shipping fees.

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1 Introduction

In many markets, consumers make costly mistakes. They underestimate total prices of products, or underestimate their future demand for add-on services. Examples include hotels, credit cards, bank accounts, printers and cartridges, and cell-phone contracts.[1] Many of these potentially deceptive products are sold online on two-sided platforms who intermediate between buyers and sellers. These platforms play a crucial role in designing a marketplace that is either transparent and mitigates consumers' mistakes, or facilitates their exploitation.

Two recent reports targeted at economic practitioners, i.e. Morton et al. (2019) and De Streel et al. (2018), stress the need to study non-transparent pricing and consumer biases as a source of harm on platform markets. Also policymakers argue that certain platforms should be more upfront about additional fees, e.g. for shipping or payment surcharges.[2] This article investigates the incentives of two-sided platforms to design a transparent marketplace. When do platforms act as a regulator, and when should they instead be regulated?

To answer this question we combine two different strands of the literature. Following Gabaix and Laibson (2006), the literature on deceptive products studies incentives of firms to unshroud hidden product attributes that some naive consumers falsely ignore. But this literature has not studied two-sided platforms. Today, two-sided online platforms play an increasing role in designing marketplaces and they have a great potential to induce transparent interactions. Similarly, the literature on two-sided platforms following Caillaud and Jullien (2003), Rochet and Tirole (2003), Armstrong (2006) does not consider deceptive products or products with add-on features and the incentives of platforms to disclose sellers' fees. We approach our question by combining models on deceptive products and two-sided platforms.

We model seller competition in a product category on a platform based on Gabaix and Laibson (2006). Sellers charge a base price f and an additional fee $a \leq \overline{a}$.[3] There are two types of buyers:

[1] For hotels, see Gabaix and Laibson (2006), for credit cards Ausubel (1991), Heidhues and Kőszegi (2010, 2017), Schoar and Ru (2016), Stango and Zinman (2009, 2015, 2014). For bank accounts see Alan et al. (2018), and for printers and cartridges Hall (1997). Grubb (2009), Grubb and Osborne (2014) study cell-phone contracts.

[2] For example, Canada's Competition Bureau puts pressure on Ticketmaster to be more upfront about additional fees. Ticket-buyers end up paying 20%, and sometimes up to 65%, above the initial price tag. Source: `https://www.digitalmusicnews.com/2018/01/26/canada-competition-bureau-ticketmaster/`. Accessed 15 August 2019. Similarly, the UK's OFT (2012) was concerned about intransparent payment surcharges, especially of online retailers.

[3] The cap $\overline{a}$ captures, for example, an unanticipated willingness to pay for an add-on service like extra luggage. It can also stand for a regulatory cap on additional fees.

the share α are naive, and the remaining $1-\alpha$ sophisticated. Naifs wrongly ignore shrouded additional fees and end up paying more than they anticipated. Sophisticates take shrouded fees into account and can make a costly effort $e < \overline{a}$ to avoid them. Since avoiding is costly without increasing product value, the effort e is inefficient. This captures, for example flight-aggregator websites, where naifs might falsely believe luggage is included in the ticket price. Sophisticates correctly anticipate large luggage fees and make an effort to reduce their luggage to avoid them.

Platforms shroud or unshroud sellers' additional fees. Naifs falsely ignore shrouded fees and sophisticates only observe them after choosing a product. Unshrouding turns some naifs into sophisticates, who can now observe additional fees when choosing a product. For example, flight-aggregator websites can disclose luggage fees, or include them in list prices.

We follow Armstrong (2006) to capture the two-sided nature of platforms. We assume positive cross-group externalities between buyers and sellers on a platform: buyers benefit from more sellers on the platform to buy products from, and vice versa. We enrich the standard setting by modeling the buyer-seller interaction explicitly as outlined above. Platforms can use two types of instruments. First, they charge prices for buyers and sellers who join the platform. Second, they can unshroud additional fees of sellers on their platform to design a transparent marketplace, or choose to shroud these fees. (Un)shrouding affects buyers' perceived utility from an interaction, and therefore the cross-group externalities between the two sides.

In addition to the aforementioned examples, i.e. online marketplaces with deceptive products and flight-aggregators with potentially shrouded fees like Skyscanner, Google Flights, or Kayak, our model applies to many other settings. Empirical evidence highlights the impact of (un)shrouded shipping fees that sellers charge on eBay and other platforms: listing products without shipping fees makes consumers less sensitive to shipping fees than the basic products' prices.[4] Similarly, many online platforms use drip pricing—the practice of displaying additional fees late in the booking process—which seems to induce consumers to underestimate total prices.[5]

We start our analysis with monopoly platforms. Platforms shroud or unshroud based on what maximizes average perceived buyer surplus from an interaction on the platform (henceforth 'buyer surplus').[6] This creates a virtuous circle for the platform: if buyers get a larger perceived surplus

[4] See Blake et al. (2018), Brown et al. (2010), Einav et al. (2015), Hossain and Morgan (2006), Smith and Brynjolfsson (2001).

[5] For surveys on drip pricing from the marketing literature, see Greenleaf et al. (2016), Ahmetoglu et al. (2014).

[6] To denote the overall welfare of buyers, we use the term 'total consumer surplus'.

from interacting with sellers, more buyers enter the platform. Because of the cross-group externalities, more buyers attract more sellers to the platform, who then attract even more buyers and so on. Thus, platforms maximize perceived average buyer surplus.

To maximize average perceived buyer surplus, platforms might cater to naifs' mistakes and shroud additional fees. Shrouding induces sellers to exploit naifs with large additional fees $\overline{a}$, which sophisticated consumers anticipate and avoid. The avoidance effort is inefficient, so it reduces perceived and actual buyer surplus by $(1-\alpha)e$. Since naifs ignore large additional fees, they wrongly believe that products are cheap. This increases perceived buyer surplus by $\alpha\overline{a}$. Unshrouding makes additional fees observable, inducing sellers to compete and to reduce additional fees. Products now look more expensive, but sophisticates no longer inefficiently avoid additional fees. Thus, with many sophisticates, platforms unshroud to prevent the avoidance hassle for sophisticates. But with many naifs platforms prefer to shroud additional fees to look cheap. These results are in line with evidence by Einav et al. (2015) who find that eBay sellers either optimally offer large shipping fees, or transparently offer free shipping.

A regulator who wants to induce transparent and low additional fees might have to force platforms to unshroud *and* cap additional fees. Intuitively, when there are many naifs and unshrouding is rather ineffective, sellers continue to charge large additional fees even when they are unshrouded. Thus, to induce lower additional fees, a regulator has to unshroud *and* cap them.

To better understand the unshrouding incentives of monopoly platforms, we compare them with unshrouding incentives of sellers who interact with buyers without a platform as in Gabaix and Laibson (2006). Intuitively, sellers without a platform shroud when there are many naifs from whom they can earn $\alpha\overline{a}$ with large additional fees. Unshrouding, however, allows sellers to earn lower additional fees e that sophisticates no longer avoid. Unshrouding sellers earn e from all customers. Thus, while monopoly platforms unshroud to reduce avoidance effort $(1-\alpha)e$ of *sophisticates*, sellers without a platform unshroud to cash in additional fees e from *both* customer types. This implies that monopoly platforms have a larger incentive to shroud than sellers without a platform.

Monopoly platforms having a stronger incentive to shroud than sellers without a platform is our first main result. It is robust when platforms are better or worse in unshrouding than sellers without a platform. In line with this result, Blake et al. (2018) show that a wide range of online platforms uses drip pricing to shroud additional charges like shipping fees, service fees, or VATs.

We then turn our attention to competition between platforms in the context of two-sided singlehoming, i.e. two platforms competing for buyers and sellers who choose to join one platform.

We establish that competition itself is not enough to induce platforms to unshroud more. We show this in a setting where platforms choose prices and whether to (un)shroud at the same time. This flexible unshrouding captures, for example, quick fixes to website design like pop-up windows that warn about likely luggage fees. In this setting, platforms' incentives to shroud are unaffected by competition and the monopoly results on shrouding incentives carry over.

We continue by studying more rigid unshrouding with competing platforms. This captures settings where unshrouding is more rigid than prices, e.g. major changes to a website like moving from upfront prices to drip pricing.

Rigid unshrouding reverses the platforms' shrouding incentives. Now platforms (un)shroud to *reduce* average perceived buyer surplus. Intuitively, a platform that increases perceived buyer surplus attracts buyers. But with rigid unshrouding, this induces a price response: the rival reduces prices to attract more buyers as well. This price response induces competition and makes the initial increase in buyer surplus unprofitable. To avoid price competition, platforms now *reduce* average perceived buyer surplus. Platforms now unshroud when there are many naifs and shroud otherwise.

Competition with rigid unshrouding induces a conflict of interest between sellers and platforms. Platforms now unshroud when there are many naifs, but sellers continue to charge large exploitative additional fees. This leads to our the second main result: platforms might want to regulate sellers by capping additional fees. Intuitively, caps on additional fees induce sellers to increase base prices: products on the platform appear more expensive, but this mitigates competition between platforms. Crucially, even though platforms reduce *perceived* buyer surplus, these caps never harm *actual* buyer surplus. Lower additional fees reduce inefficient avoidance of sophisticates and the share of the total price that naifs falsely ignore. In this way caps contribute to a more transparent marketplace.

This result offers a novel explanation for why platforms put restrictions on sellers. For example, Amazon and eBay restrict shipping fees that sellers can charge.

We compare results to a rational benchmark without naifs, but sophisticates who demand an add-on.[7] Monopoly platforms always unshroud their sellers' additional fees and induce a transpar-

[7] This benchmark is related to classic models of add-on pricing (Ellison, 2005, Verboven, 1999).

ent marketplace. Caps on additional fees increase average base prices by the same amount. Thus, caps do not affect average buyer surplus and have no effect.

Section 2 introduces a model of seller competition with deceptive products on platforms. Section 3 analyses this model. Section 4 explores its implications for the three aforementioned platform settings and contains our main results. Section 5 discusses applications and Section 6 extensions and robustness exercises. Section 7 draws connections to the literature and Section 8 concludes.

2 A Model of Seller Competition on Platforms

We study a two-sided market with three types of players: sellers, buyers, and platforms. Buyers and sellers interact exclusively on platforms. We introduce platforms' choices of membership fees and shrouding/ushrouding more explicitly below and start by modelling seller competition on a platform based on Gabaix and Laibson (2006). We discuss applications in more detail in Section 5.

Each seller offers a single product. There are infinitely many sellers, but each seller competes only within a product category on a platform. For example on flight-ticket aggregators all flights from Brussels to Budapest on a single day can be a product category. We assume for simplicity that all product categories are identical, independent, and consist of two sellers.[8] To keep results comparable to the literature on shrouded attributes, we model competition between sellers in a product category with a Hotelling model.[9] In each product category, two sellers with marginal cost c are located at opposite ends of a Hotelling line of length one. Each seller $s \in \{1, 2\}$ charges a base price f_s for the product and an additional fee $a_s \in [0, \overline{a}]$. In the flight-ticket aggregator example, f_s can be the ticket price, and a_s the fees for extra luggage or seat selection.[10] In contrast to most articles on shrouded attributes, not the sellers but the platforms decide whether to shroud or unshroud additional fees. We explain this in detail below.

There are two types of buyers. All buyers are aware of the base price f_s. A share α of buyers—the naifs—ignore shrouded additional fees a_s and falsely believe they are zero even when they

[8] We show in Section 6 that results are robust with more than two firms in each product category, and when product categories have ex-post different transportation costs and numbers of sellers.

[9] For similar approaches, see Gabaix and Laibson (2006), and the survey by Heidhues and Koszegi (2018).

[10] Gabaix and Laibson (2006) interpret $\overline{a}$ as an unanticipated willingness to pay of naive consumers for the add-on service when additional fees are shrouded. One can also interpret $\overline{a}$ as a regulatory price cap, or a price above which consumers would terminate the relationship, register a complaint, or start legal action against the firm. $\overline{a}$ could also stand for the cost of a last-minute intervention that allows the consumer to avoid purchasing an upgrade or add-on.

are positive. The other group of buyers—sophisticates—also do not observe shrouded additional fees, but understand the firms' incentives.[11] Sophisticates have correct Bayesian posteriors about a_s denoted Ea_s. When they anticipate large additional fees, sophisticated buyers can invest a precautionary effort e ($< \overline{a}$) to avoid paying the additional price. Charging the additional fee costs, for simplicity, zero, and avoiding this fee does not change product value, implying that the effort e is inefficient. In the example of flight-ticket aggregators, some consumers might falsely believe a checked-in suitcase is included, while others take precautions and only use hand luggage.

In each product category, the position of each buyer—sophisticated or naive—is uniformly distributed on the Hotelling line. Buyers have linear transportation costs t, and gross-value v for the product. We assume that v is sufficiently large such that the market is covered.

The platform shrouds or unshrouds additional fees for all transactions on the platform. We model the platforms' fees more explicitly below and focus on seller competition now. Unshrouding makes additional fees observable to buyers and turns the share $\lambda \in (0, 1)$ of naifs into sophisticates. The remaining $(1-\lambda)$ naifs continue to ignore additional fees. A larger λ captures that unshrouding is more effective in reducing naifs' mistakes. In the context of flight-ticket aggregators, unshrouding captures a more transparent price structure or website design, e.g. disclosing luggage fees upfront. For simplicity, unshrouding only affects buyers on the unshrouding platform. For example a website using a more transparent price scheme mostly affects its own users.[12]

The timing is as follows:

- **Period 1:** Platforms shroud or unshroud additional fees. Platforms charge membership fees to buyers and sellers.
- **Period 2:** Buyers and sellers decide whether to join a platform.
- **Period 3:** Sellers choose f_s and a_s.
- **Period 4:** Each buyer draws a position on the Hotelling line in each product category. They decide which seller to buy from in each category. With shrouded additional fees naive buyers consider only f_s; sophisticated buyers consider f_s and form Bayesian posteriors on a_s. With unshrouded additional fees, a share $(1-\lambda)\alpha$ remains naive and continues to consider only f_s; all other buyers are sophisticated and observe f_s and a_s. Buyers can initiate costly behavior e that allows them to substitute away from paying a_s.

[11] Naturally, we can also interpret α as the probability of a buyer to be naive.

[12] Section 6 discusses spillovers when unshrouding of one platform also affects consumers on a rival platform.

- **Period 5:** Buyers observe the additional fee (if they have not observed it already). Buyers who engaged in substitution in period 4 do not pay a_s. All others pay a_s.

We look for perfect Bayesian equilibria.[13] Beliefs matter mostly for consumers and are relatively straightforward, which is why we focus on sequential rationality. Sophisticated consumers have correct Bayesian posteriors about shrouded additional fees. Naifs wrongly believe shrouded additional fees are zero. In period 2, buyers know that their position on the Hotelling line in each category is uniformly distributed, and form expectations about their benefit from joining a platform.

3 Analysis of Seller Competition on Platforms

We now study seller competition in a product category, i.e. periods 3-5. We suppose for now that the share of naifs on the platform is α, and show in Section 4 that this is indeed the case. Note also that in period 3, platforms' membership fees are sunk, and only the platform's choice to (un)shroud influences demand. We therefore distinguish these two cases.

3.1 Seller Competition under Shrouding

First, we look for an equilibrium of seller competition in subgames where a platform shrouds additional fees. Then in period 3, a seller s with a rival r faces the following demand.

$$\begin{aligned} d_s(f_s, f_r; shrouding) &= \frac{1}{2} + \alpha \frac{f_r - f_s}{2t} + (1-\alpha)\frac{f_r + \min\{Ea_r, e\} - f_s - \min\{Ea_s, e\}}{2t} \\ &= \frac{1}{2} + \frac{f_r - f_s}{2t} + (1-\alpha)\frac{\min\{Ea_r, e\} - \min\{Ea_s, e\}}{2t}. \end{aligned} \tag{1}$$

Naifs only consider base prices and ignore shrouded additional fees. Sophisticates have Bayesian posteriors on additional prices and avoid them if they are above the avoidance cost e.

Buyers cannot condition their purchase decision on shrouded additional fees, and for any given Ea_s each seller s optimally charges $a_s = \overline{a}$. Sophisticated buyers anticipate $a_s = \overline{a}$ and pay effort e to avoid it. Only naifs pay $\overline{a}$. Using these steps, the profits of seller $s \neq r$ simplify to

$$(f_s + \alpha\overline{a} - c)\left(\frac{1}{2} + \frac{f_r - f_s}{2t}\right).$$

[13] Note that as in Eliaz and Spiegler (2006, 2008), naive consumers and firms agree to disagree on the underlying model. Alternatively, we could follow Heidhues and Kőszegi (2017) and study subgame-perfect Nash equilibria of the game between firms.

Using the superscript '*shr*' for 'shrouding', this leads to the following equilibrium of the subgame: $f^{shr} = c - \alpha\overline{a} + t$, profits per buyer $\pi^{shr} = t/2$, and *perceived* average buyer surplus per seller

$$u^{shr} = \frac{1}{2}\left[v - \frac{5}{4}t - c + \alpha\overline{a} - (1-\alpha)e\right]. \tag{2}$$

This resembles many earlier results in the literature on shrouded attributes. With shrouded fees, sellers earn additional fee $\alpha\overline{a}$ from naive buyers. Firms compete away this revenue by reducing base prices for all buyers. Effectively, naive buyers cross-subsidize sophisticates.

Average perceived buyer surplus u^{shr} increases in $\alpha\overline{a}$ because products seem cheap. All buyers perceive the discount on base prices of $\alpha\overline{a}$ as a good deal. Naifs because they falsely ignore additional prices $\overline{a}$; sophisticates because they avoid $\overline{a}$. Avoiding $\overline{a}$ costs effort e to sophisticates and reduces average perceived buyer surplus by $(1-\alpha)e$.[14]

3.2 Seller Competition under Unshrouding

We now consider subgames after the platform unshrouds additional fees. Only $(1-\lambda)\alpha$ of buyers remain naive. All others are sophisticated and observe additional fees. Demand is

$$d_s(f_s, f_r; unshrouding) = \frac{1}{2} + \frac{f_r - f_s}{2t} + (1-(1-\lambda)\alpha)\frac{\min\{a_r, e\} - \min\{a_s, e\}}{2t}.$$

The remaining $(1-\lambda)\alpha$ naifs continue to ignore additional fees. All other buyers are sophisticated and can now observe the unshrouded additional fees. Thus, a seller s can either charge large additional fees $a_s > e$ that sophisticates avoid, or small $a_s \leq e$ that sophisticates pay. The following Lemma characterizes the optimal choice of unshrouded additional fees.

Lemma 1. *Let $\bar{\alpha} \equiv \frac{e}{(1-\lambda)\overline{a}}$. With unshrouded additional fees, each seller s charges low fees $a_s = e$ if and only if $\alpha < \bar{\alpha}$, and large fees $a_s = \overline{a}$ otherwise.*

The intuition has two steps. First, both sellers set either e or $\overline{a}$. To see this, suppose a seller s charges (f_s, a_s) with $a_s < e$. Naifs and sophisticates who buy from s pay this price. Increasing a_s and reducing f_s by the same amount does not affect total prices, but the product appears cheaper for the remaining naifs and increases demand. Now consider fees $a_s \in (e, \overline{a})$. Only naifs pay these fees but ignore them, so increasing a_s to $\overline{a}$ increases profits. Second, for a given f_s the choice of

[14] The actual average surplus of buyers per seller—taking into account that naifs pay $\overline{a}$— is $u^{shr} - \alpha\overline{a}/2$. This is independent of $\overline{a}$.

additional fees $\overline{a}$ or e does not affect demand. Take again a seller s who charges e or $\overline{a}$. Naifs ignore additional fees and choose a seller only based on base prices. Sophisticates either pay effort e to avoid $\overline{a}$ or pay an additional fee e. In either case their costs of purchasing from s are $f_s + e$. Thus, sellers either charge $\overline{a}$ and earn $(1-\lambda)\alpha\overline{a}$ from their naive customers, or e from all their customers.

Using the superscript 'unshr' for 'unshrouding', if both sellers charge $a_s = \overline{a}$, they maximize $(f_s + (1-\lambda)\alpha e - c)\left(\frac{1}{2} + \frac{f_r - f_s}{2t}\right)$, inducing $f^{unshr;\overline{a}} = c - (1-\lambda)\alpha\overline{a} + t$, profits $\pi^{unshr;\overline{a}} = t/2$, and

$$u^{unshr;\overline{a}} = \frac{1}{2}\left[v - \frac{5}{4}t - c + (1-\lambda)\alpha\overline{a} - (1-(1-\lambda)\alpha)e\right]. \tag{3}$$

This expression follows the same intuition as u^{shr} with the only difference that unshrouding reduces the share of naifs to $(1-\lambda)\alpha$.

If both sellers charge $a_s = e$, seller s maximizes $(f_s + e - c)\left(\frac{1}{2} + \frac{f_r - f_s}{2t}\right)$, inducing $f^{unshr;e} = c - e + t$. Profits are $\pi^{unshr;e} = t/2$, and average perceived buyer surplus per seller

$$u^{unshr;e} = \frac{1}{2}\left[v - \frac{5}{4}t - c + (1-\lambda)\alpha e\right]. \tag{4}$$

Intuitively, no consumer pays e anymore, but the share $(1-\lambda)\alpha$ of naifs still ignores additional fees and believes the reduction in base prices e is a good deal.

The following Lemma summarizes the relation between buyer and seller surplus under the different scenarios and will be useful later.

Lemma 2. *Let* $\underline{\alpha} \equiv \frac{e}{\overline{a}+\lambda e}$.

1. $\pi^{unshr;\overline{a}} = \pi^{unshr;e} = \pi^{shr} = t/2 \equiv \pi$.
2. $u^{shr} \geq u^{unshr;e}$ *if and only if* $\alpha \geq \underline{\alpha}$.
3. $u^{unshr;\overline{a}} \geq u^{unshr;e}$ *if and only if* $\alpha \geq \bar{\alpha}$.
4. $u^{shr} \geq u^{unshr;\overline{a}}$.

Mirroring classic results on deceptive products (e.g. Armstrong and Vickers (2012), Gabaix and Laibson (2006)), sellers earn expected profits $\pi = t/2$ per buyer, whether the platform shrouds or unshrouds. In equilibrium, sellers compete away all profits from additional fees with a lower base price. Profits only depend on the substitutability of products—t. As seller profits are the same in both scenarios, the inefficiencies in the model — arising from inefficient avoidance e — will show up in buyer surplus.

Also note that $u^{shr} \geq u^{unshr;\overline{a}}$. Unshrouding without lower fees increases the share of sophisticates. More buyers exert avoidance effort and fewer naifs falsely believe to get a good deal.

4 Unshrouding Incentives of Platforms

This Section models three types of platforms to understand their incentives to unshroud additional fees. We start with a monopoly platform. The second and third settings investigate platform competition under two-sided single-homing with different timing structures.

Buyers and sellers interact exclusively through one or more platforms. Buyers benefit from an increased number of sellers, and vice versa. In other words, we assume positive cross-group externalities (a.k.a. cross-group network effects) among both sides of the platform.

We follow the literature on two-sided platforms based on Armstrong (2006). This literature usually assumes that sellers are monopolists in their product category or that buyer and seller surpluses from an interaction are exogenous. In contrast, we assume that sellers compete within a product category as in Section 3. For example, price-comparison websites (henceforth PCWs) or eBay and Amazon often display multiple substitutes. As a further novelty in these types of models, we allow for buyer heterogeneity to incorporate naive and sophisticated buyers.

4.1 Monopoly Platforms

This Subsection studies a monopoly platform intermediating trade between buyers and sellers. For simplicity we assume that the platform has the same per-capita cost of serving a buyer or a seller, C.[15] The platform sets membership fees M_B and M_S for buyers and sellers, respectively.[16]

To start, we derive demand of buyers and sellers for joining the platform in period 2. Each seller earns a profit π per user, and each buyer of type $l \in \{1, 2\}$ enjoys utility u^l per seller. The share of buyer-type l is β_l with $\sum_{l=1}^{2} \beta_l = 1$.[17] The average utility of buyers per seller is $u \equiv \sum_{l=1}^{2} \beta_l u^l$. Following the literature, we assume $\pi + u < 2$ to have a strictly concave problem. We solve for generic values of π and u and later apply the benefits per interaction derived in Section 3.

The value of buyers l and sellers from joining the platform are

$$v_B^l = n_S u^l + k - M_B \quad \text{and} \quad v_S = n_B \pi + k - M_S, \tag{5}$$

where $n_B \equiv \sum_{l=1}^{2} \beta_l n_B^l$ and n_S denote the number of buyers and sellers on the platform, respectively. Buyers and sellers get stand-alone utility k from joining a platform even when there is no one

[15] The main results are robust to differing costs, however, using the same costs shortens the exposition substantially.
[16] Results are qualitatively unaffected if platforms instead charge usage fees for each interaction on the platform.
[17] We use two types to distinguish naive and sophisticated buyer types.

on the other side. We assume $k > C$ to avoid the trivial case of an empty platform.[18] The valuations capture some common assumptions. First, each seller (buyer) interacts with all n_B^l buyers (n_S sellers) on the platform and enjoys the expected benefit π (u^l) per interaction. Second, independently of the number of interactions, each additional interaction has the same expected marginal value.

Buyers and sellers enter the platform based on a free entry condition. There is a mass m of potential buyers (sellers) whose outside utility is uniformly distributed on the interval $[0, m]$. Free entry leads to $n_B^l = v_B^l$ and $n_S = v_S$, i.e. the number of buyers and increases linearly in their valuation of the platform. Using this framework, we can now derive the demand for the platform.[19]

Lemma 3. *Buyers' and sellers' demand for a monopoly platform are*

$$n_B(M_B, M_S, u) = \frac{k(1+u) - M_B - uM_S}{1 - \pi u} \quad \text{and} \quad n_S(M_B, M_S, u) = \frac{k(1+\pi) - M_S - \pi M_B}{1 - \pi u}. \tag{6}$$

To illustrate, consider the demand of buyers. We emphasize three observations. First, buyers' demand decreases in M_B, but also in the price of sellers M_S. This captures the cross-group externality of sellers to buyers. A larger M_S reduces the number of sellers, which makes the platform less attractive for buyers. If buyers do not benefit from the presence of sellers (i.e. if $u = 0$), buyers' demand is independent of M_S. Second, individual buyer surplus u^l only enters demand via the average cross-group externality of buyers $u$implying that the share of buyer type l among the platform's buyers is always β_l. The reason is the linear valuation of buyers (5). This implies that the share of buyer type l among the platform's buyers is always β_l. [20] Third, by Lemma 2, $\pi = t/2$ both for shrouded and unshrouded additional fees. Thus, (un)shrouding impacts demand and profits only via u, so we can formulate the platform's problem as if it chooses u directly.

We can now state the monopoly platform's problem.

$$\max_{M_B, M_S, u} n_B(M_B, M_S, u) \cdot (M_B - C) + n_S(M_B, M_S, u) \cdot (M_S - C). \tag{7}$$

The monopoly maximizes profits by choosing membership fees and whether to shroud (captured by u). The following Lemma characterizes the solution.

[18] Stand-alone utilities can capture e.g. benefits from information: buyers learn non-price information about products whereas sellers value consumer data. k could also capture in a reduced form the value created from platforms' selling their own products, e.g. like Amazon's own products.

[19] This framework is common in the platform literature, a variant is used by e.g. Hagiu and Hałaburda (2014), Belleflamme and Peitz (2019a,b), Liu and Serfes (2013).

[20] This greatly simplifies our analysis: with non-linear valuation, the share of different consumer types would depend on the price levels M_B and M_S. We avoid the resulting fixed-point problem by assuming linear valuations.

Lemma 4. *Suppose $u + \pi < 2$. The monopoly platform charges $M_B = \frac{k(1-\pi)+C(1-u)}{2-u-\pi}$ and $M_S = \frac{k(1-u)+C(1-\pi)}{2-u-\pi}$. Profits are $\Pi^{Monopoly} = \frac{(k-C)^2}{2-u-\pi}$. The platform chooses shrouding or unshrouding to maximize perceived buyer surplus from an interaction u.*

The key observation is that the monopoly platform (un)shrouds to maximize perceived buyer surplus per interaction u. u captures the cross-group externality on buyers. A larger u induces more buyers to join the platform. But more buyers make the platform more attractive to sellers, and more sellers join as well. This creates a virtuous circle for the platform.[21] The monopoly extracts some of the surplus created by the virtuous circle by raising its prices.

We can now study more explicitly when the platform shrouds additional fees. To do so, we combine the results from Section 3 with Lemma 4, i.e. that platforms (un)shroud to maximize u.

Proposition 1. *The monopoly platform shrouds additional fees if and only if $\alpha \geq \underline{\alpha}$, which results in each seller charging high additional fees $\overline{a}$. Otherwise, the monopoly platform unshrouds additional fees, and sellers charge low additional fees e.*

First note that shrouding induces large fees $\overline{a}$, and unshrouding leads to small fees e. By Lemma 2 the platform prefers unshrouding with lower additional fees e over shrouding if and only if $\alpha < \underline{\alpha}$. By Lemma 1, sellers prefer small unshrouded additional fees e over large ones $\overline{a}$ if and only if $\alpha < \overline{\alpha}$. Since $\underline{\alpha} \leq \overline{\alpha}$, a platform that unshrouds indeed triggers small additional fees e. Thus, the platform chooses between shrouding with large $\overline{a}$, and unshrouding with small e.

With many naifs $\alpha \geq \underline{\alpha}$, the platform shrouds additional fees to appear cheap. But with few naifs, the platform unshrouds to prevent the hassle e of sophisticates. To illustrate, suppose $\lambda = 1$, i.e. unshrouding turns all naifs into sophisticates and eliminates buyer mistakes. To benefit from the virtuous circle, the platform shrouds or unshrouds to maximize u, facing the following tradeoff: with shrouding, sellers compete away revenues $\alpha\overline{a}$ from shrouded fees to reduce base prices. As a result, products on the platform appear cheap. They appear cheap to naifs who falsely ignore $\overline{a}$, and products are indeed cheap for sophisticates who avoid shrouded fees. Avoiding fees, however, induces inefficient hassle e for sophisticates, which reduces surplus u by $(1-\alpha)e$. Thus, if α is large, i.e. $\alpha \geq \underline{\alpha}$, the platform shrouds additional fees to make products appear cheap. But if α is small, the platform puts a higher weight on the inefficient hassle of sophisticates and unshrouds.

[21] This is a key mechanism in the platform literature at least since Armstrong (2006) and Rochet and Tirole (2003). Lemma 4 also reveals that $\pi + u < 2$ is necessary to avoid the virtuous circle leading to infinite profit for the platform.

Proposition 1 implies that the platform engages in shrouding when the share of naifs is large. Monopoly platforms have little incentives to induce transparency exactly when transparency would be most beneficial to mitigate consumer mistakes. This suggests that regulators who want to reduce exploitation of consumer mistakes should focus on markets with many naive consumers.

How can a regulator induce a transparent marketplace with low additional fees? For medium levels of naifs $\alpha \in (\underline{\alpha}, \overline{\alpha})$, a regulator has to force platforms to unshroud. Since $\alpha < \overline{\alpha}$, unshrouding suffices to induce sellers to reduce additional fees. But with many naifs $\alpha \geq \overline{\alpha}$, sellers charge $\overline{a}$ despite unshrouding. Intuitively, for $\alpha \geq \overline{\alpha}$ unshrouding is quite ineffective and there are many naifs left after unshrouding, so sellers continue to charge $\overline{a}$. What is worse, unshrouding *increases* the share of sophisticates and more buyers inefficiently avoid additional fees. Thus, for large α the regulator has to unshroud *and* cap sellers' additional fees.

Blake et al. (2018) study the second-hand ticket platform StubHub. StubHub moved from a price scheme with upfront prices that included all fees to drip pricing by displaying fees like shipping and handling later in the booking process. In line with our predictions, after moving to the more shrouded drip pricing consumers were more likely to buy expensive tickets.[22] Drip pricing also increased demand.[23] Both suggest that drip pricing made products appear cheaper.

Our results are also consistent with evidence by Einav et al. (2015) for sellers on eBay. Somewhat surprisingly, sellers who charge shipping fees below 10$ can increase revenue by either increasing shipping fees, or by offering free shipping. As in our model with naive buyers, consumers only partially internalize larger shipping fees. The benefit of free shipping is consistent with unshrouding shipping fees to avoid hassle for sophisticates, thereby increasing their willingness to pay.

4.1.1 Benchmark without Platforms

We ask in this Subsection if the presence of platforms intermediating buyers and sellers increases incentives to shroud. To do so we study a benchmark case where the sellers of one product category compete outside a platform. This setting closely follows Gabaix and Laibson (2006). Buyers and sellers interact directly and each seller can decide to shroud or unshroud additional fees. As in

[22] The authors use a randomized design with treatment and control groups. Since sellers could not charge different prices for these groups, the results do not reflect sellers' price responses to the policy change.

[23] Since the demand increase did not come from rivals but new customers, this case is best captured by our monopoly model.

Gabaix and Laibson (2006), if a seller unshrouds, a share $\hat{\lambda} \in (0,1)$ of naifs becomes sophisticated and all sophisticates can observe its additional fee.

Lemma 5. *(Benchmark: Proposition 1 of Gabaix and Laibson (2006)). In a market without platforms, if sellers decide whether to unshroud additional fees, an equilibrium with shrouded additional fees $\overline{a}$ exists if $\alpha \geq e/\overline{a} \equiv \hat{\alpha}$. Otherwise additional fees are unshrouded and set to e.*

While platforms maximize perceived buyer surplus, sellers without platforms shroud or unshroud to maximize their profits directly. They face the following tradeoff. If both sellers shroud they charge $a_s = \overline{a}$ and earn $\alpha\overline{a}$ from their naive customers. Deviating by unshrouding and keeping $a_s = \overline{a}$ is never optimal since unshrouding reduces the share of naifs who pay $\overline{a}$. But deviating by unshrouding and charging $a_s = e$ can increase profits. Sophisticated consumers no longer avoid additional fees, so sellers can earn smaller additional fees e from *all* customers. Thus, sellers deviate from shrouding if the share of naifs is small, i.e. $e > \alpha\overline{a}$.

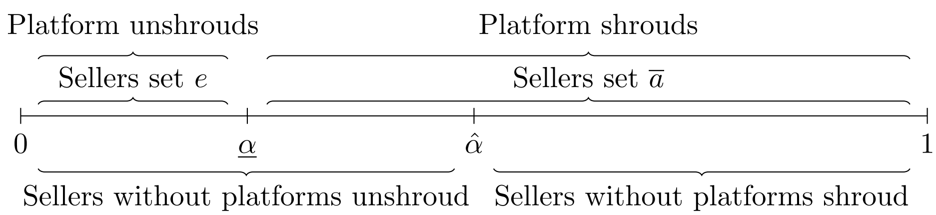
The following Proposition compares shrouding incentives of a monopoly platform and of sellers without platform. The result follows directly from comparing the respective cutoffs $\underline{\alpha}$ and $\hat{\alpha}$. Figure 1 illustrates this graphically. It is our first key result.

Proposition 2. $\underline{\alpha} < \hat{\alpha}$ *for all* $\lambda, \hat{\lambda} \in (0,1)$, *implying that monopoly platforms have stronger incentives to shroud than sellers without platforms.*

To illustrate, suppose unshrouding turns all naifs into sophisticates, i.e. $\lambda = 1$. By Lemma 5 sellers without platforms earn additional fees $\alpha\overline{a}$ from *naive* customers in a shrouding equilibrium, and they can unshroud to earn e from *all* customers. Platforms, however, shroud or unshroud to maximize perceived buyer surplus from an interaction on the platform. They trade off benefits from shrouding—$\alpha\overline{a}$ from lower base prices to appear cheap—against the cost of avoidance effort of sophisticates $(1-\alpha)e$. For $\lambda = 1$, unshrouding turns all naifs into sophisticates and reduces these perceived benefits and costs to zero. Thus, platforms and sellers without platforms enjoy the same benefits from shrouding—$\alpha\overline{a}$. But sellers without platforms benefit more from unshrouding. Intuitively, platforms unshroud to reduce the hassle of sophisticates—$(1-\alpha)e$—but sellers without platforms can cash in additional fees e from all (i.e. mass 1) of its customers.[24]

[24] For $\lambda < 1$, unshrouding platforms have a share $(1-\lambda)\alpha$ of naive customers who ignore paying e, raising perceived buyer surplus by $(1-\lambda)\alpha e$. This makes unshrouding more beneficial, but the above result still holds if $\lambda > 0$.

Figure 1: Unshrouding incentives of a monopoly platform, and sellers without platforms.



Note that since $\hat{\alpha}$ does not depend on $\hat{\lambda}$, the result does not depend on whether the platform is better at unshrouding than sellers without platform. Intuitively, sellers without platforms deviate from shrouding to increase revenue from additional fees from $\alpha\overline{a}$ to e, none of which depend on $\hat{\lambda}$.

There is suggestive evidence that platforms have indeed strong incentives to shroud. First, Blake et al. (2018) show in their Table 9 that different forms of drip pricing are standard practice in a wide range of two-sided online platforms like AirBnB, eBay, Hotels.com or TaskRabbit. Second, we cite many articles throughout this paper who study the impact of arguably shrouded pricing schemes of online platforms like drip pricing, or shrouded prices of additional fees (like shipping fees) or product upgrades (Ahmetoglu et al., 2014, Blake et al., 2018, Brown et al., 2010, Ellison and Ellison, 2009, Einav et al., 2015, Greenleaf et al., 2016, Hossain and Morgan, 2006, Smith and Brynjolfsson, 2001), suggesting that these practices are quite common among online platforms. Third, 'The Times' (Ahmed et al., December 26, 2009) gathers anecdotal evidence on online retailers, concluding 'that shoppers who buy online face paying up to 22 per cent more in hidden charges', even though base prices are often lower. They intuit that drip pricing plays a key role.

Remark on total consumer surplus: As outlined in Subsection 4.1, shrouding can make participating buyers worse off by inducing large fees to naifs and inefficient avoidance effort to sophisticates. But shrouding, by making the platform's products look cheap and exploiting network effects, can induce more buyers to participate. Thus, despite larger incentives to shroud, total consumer surplus can be larger with a platform than without.

4.1.2 Rational Benchmark: Monopoly

To better understand the role of naifs, we explore a classic benchmark model with only sophisticates. The results are quite unambiguous: monopoly platforms want to unshroud additional fees.

For a simple benchmark, consider the model of seller competition from Section 3 with only sophisticated buyers $\alpha = 0$. This captures a setting where the product has an add-on or an upgrade as in classic add-on pricing models (Ellison, 2005, Verboven, 1999).

Corollary 1. *If all consumers are sophisticated, platforms always unshroud additional fees.*

The result mirrors classic results on add-on pricing (Ellison, 2005, Gabaix and Laibson, 2006), where sellers always disclose add-on prices when doing so is cheap and all consumers are sophisticated. As outlined after Proposition 1, sophisticated buyers anticipate large shrouded fees and engage in inefficient avoidance behavior. Unshrouding induces lower additional fees e, which prevents inefficient avoidance behavior. Thus, platforms unshroud to benefit from the virtuous circle.

The same result holds in a more elaborate benchmark where some sophisticated buyers do not avoid additional fees even when they are expensive. We discuss this in detail in Appendix A.6.

4.2 Competition with Flexible Unshrouding

We now explore how competition affects the platforms' incentives to shroud. To start, this Subsection studies competition with flexible unshrouding and shows that the monopoly results hold.

We model flexible unshrouding in the following way. In period 1 platforms choose membership fees and (un)shrouding *simultaneously.* This captures quick fixes to raise awareness of exploitative features, like flight-ticket aggregators who use pop-up windows to remind consumers about luggage surcharges of airlines.

We study competition between platforms with two-sided single-homing. Two-sided single-homing refers to the fact that all buyers and sellers can join at most one of the platforms.[25] This setting is a reasonable first step to study, for example, competition between Amazon and eBay.[26] We follow the strand of the literature on two-sided markets that assumes platforms charge membership fees. The use of membership fees is realistic for example for sellers on eBay and Amazon.[27] Membership fees also capture that some platforms do not monitor sales—e.g. some PCWs

[25] We discuss robustness of this assumption below in Section 6.

[26] eBay has 25 million sellers, Amazon has only 6 million, suggesting that at least a large chunk of eBay sellers do not multihome on both platforms. Moreover, a sizable portion of Amazon sellers seems to not use eBay. All sources accessed on 15 August 2019: https://www.ebayinc.com/stories/news/ebay-celebrates-20-years-introduces-new-app-experience, https://www.marketplacepulse.com/amazon/number-of-sellers, https://www.statista.com/statistics/886926/amazon-sellers-other-marketplace-usage/.

[27] In fact, eBay and Amazon typically use a combination of membership fees and per-transaction fees. But as

like Kayak, Skyscanner or Tripadvisor—or that buyers and sellers can easily bypass platforms—e.g. by using the direct sales channels of hotels or airlines.

Following Armstrong (2006), we assume that the number of agents joining platform $i \in \{1,2\}$ in each group is given by the following Hotelling specification:

$$n_B^{il} = \beta_l \left(\frac{1}{2} + \frac{v_B^{il} - v_B^{jl}}{2\tau_B} \right) \quad \text{and} \quad n_S^i = \frac{1}{2} + \frac{v_S^i - v_S^j}{2\tau_S}, \tag{8}$$

where τ_B and τ_S are transportation costs incurred by buyers and sellers, respectively. Buyer and seller surpluses from joining platform i are akin to Section 4.1:

$$v_B^{il} = n_S^i u_{il} - M_B^i + k \quad \text{and} \quad v_S^i = n_B^i \pi - M_S^i + k. \tag{9}$$

As in Section 4.1, the share of consumer type l is β_l with $\sum_l \beta_l = 1$, $v_B^i = \sum_l \beta_l v_B^{il}$, and $n_B^i = \sum_l \beta_l n_B^{il}$. We assume that k is large enough to have both the buyers' and the sellers' market covered.[28] Average buyer surplus u^i can differ between platforms to allow for asymmetric scenarios where one platform shrouds and the other one unshrouds.

To simplify the demand system, we make the following assumption:

Assumption 1. $M_B^i = M_B^j = 0$.

This captures that in most of our leading examples, buyers have free access to platforms.[29] Using this assumption, we can derive the demand of buyers and sellers for platform i.

Lemma 6. *Suppose Assumption 1 holds. Then demand of sellers and buyers is*

$$n_S^i = \frac{\tau_B\tau_S - \pi u_j + \tau_B(M_S^j - M_S^i)}{2\tau_B\tau_S - \pi(u_i + u_j)} \text{ and } n_B^i = \frac{1}{2} + \frac{(M_S^j - M_S^i)(u_i + u_j) + \tau_S(u_i - u_j)}{4\tau_B\tau_S - 2\pi(u_i + u_j)}. \tag{10}$$

Buyer surplus u_i has a positive direct effect on the demand of sellers. Because of the virtuous circle, a larger u_i attracts more sellers, which in turn attracts more buyers etc.

highlighted by Armstrong (2006), allowing for both types of fees can induce multiple equilibria. This is why we follow much of the platform literature that focuses on membership fees (Armstrong and Wright, 2007, Belleflamme and Peitz, 2018, 2019a, Hagiu and Hałaburda, 2014, Karle et al., 2019, Liu and Serfes, 2013).

[28] In particular, $k > \max\{2\tau_B;\ 3\tau_S - \pi/2 + C_S - \pi u/\tau_B\}$ is a sufficient condition.

[29] This price-setting arises endogenously, for example, when platforms compete fiercely for buyers, i.e. when τ_B is small and π is large, but do not reduce M_B below zero to avoid attracting arbitrageurs. We discuss this formally and derive precise conditions under which $M_B^i = M_B^j = 0$ is optimal in Appendix A.5. For similar reasons, Armstrong and Wright (2007), Nocke et al. (2007) and Eliaz and Spiegler (2011) make the same assumption. Offering coupons would be a way for platforms to increase u_i at a cost without attracting arbitrageurs. However, as we show below, increasing u_i would not be profitable for platforms even if it were costless.

We can now analyze the problem of platform i

$$\max_{M_S^i, u_i} \left(M_S^i - C_S\right) n_S^i(M_S^i, M_S^j, u_i, u_j) - C_B n_B^i(M_S^i, M_S^j, u_i, u_j). \tag{11}$$

With flexible unshrouding, i chooses M_S^i, and whether to (un)shroud, i.e. u_i, simultaneously. We are mainly interested in whether platform i's profit increases as a result of shrouding. To simplify the presentation of results, we make another assumption, capturing that the cost of serving an additional consumer is vanishingly small for most digital platforms.[30]

Assumption 2. $C_B = 0$.

Proposition 3. *Suppose Assumptions 1 and 2 hold. Then the profits of platform i increase in* u_i*, for all* $i \in \{1, 2\}$ *and all* u_j *with* $j \neq i$*. Under platform competition with flexible shrouding, i.e. whenever pricing and shrouding decisions are simultaneous, the competing platforms' shrouding incentives coincide with the monopoly platform's shrouding incentives.*

Shrouding incentives of monopoly platforms are the same with competition and flexible shrouding. Again platforms maximize buyers' average perceived surplus from an interaction. Intuitively, because platforms set prices and (un)shroud simultaneously, they only consider the direct positive effect of (un)shrouding via u_i on sellers' demand: a larger perceived surplus attracts more buyers, which in turn attracts more sellers. Thus, the shrouding conditions in Proposition 1 apply to this competitive case as well. More importantly, also the results from Proposition 2 apply and with flexible shrouding platforms have stronger incentive to shroud than sellers without platforms.[31]

The main results of monopoly platforms carry over to competition with flexible shrouding. Thus, competition on its own is not enough to induce unshrouding and a more transparent marketplace.

4.3 Competition with Rigid Unshrouding

Flexible unshrouding is often not realistic. For example, changing an online platform from drip-pricing to list prices that include all unavoidable fees upfront may require major changes to the website's interface and takes more time than changing membership fees. We now study this more rigid (un)shrouding. Rigid shrouding also captures situations where naive buyers who observe

[30] The results clearly hold for strictly positive but sufficiently low cost levels as well.

[31] We do not discuss the rational benchmark explicitly, but also results from Section 4.1.2 carry over.

unshrouded attributes remain aware of these attributes for future purchases. When regular consumers stay sophisticated after unshrouding, platforms will take the effect of unshrouding on future price competition into account.[32] According to this argument, rigid unshrouding describes platforms with frequently returning buyers, while flexible unshrouding captures platforms with more occasional buyers.

We study rigid unshrouding by changing the timing of the game. We split period 1 into two periods. In period 1a platforms choose whether to (un)shroud the additional fee; in period 1b platforms observe the rival's shrouding choice from period 1a and set membership fees. Thus, in contrast to the previous Subsection, platforms who (un)shroud additional fees take the effect on future price competition with the rival platform into account.

We solve the sequential game between platforms using backwards induction. By Lemma 1, shrouding of platform i changes the cross-group externality u_i. In the pricing subgame, platform i observes its rival's (un)shrouding decision. Taking the resulting u_i and u_j as given, platform i maximizes its profits by choosing membership fees for sellers. Using again Assumptions 1 and 2, and seller demand in (10), platform i's problem in period 1b becomes[33]

$$\max_{M_S^i} \left(M_S^i - C_S\right) n_S^i(M_S^i, M_S^j, u_i, u_j). \tag{12}$$

We make the following technical assumption:

Assumption 3. $\tau_B \tau_S - \pi \max\{u_i, u_j\} > 0$.

Different versions of this assumption are standard in the literature. It implies that the platforms' problem is strictly concave and excludes situations where one platform corners the entire market of buyers or sellers. The following Proposition pins down equilibrium prices and profits.

Proposition 4. *Suppose Assumptions 1, 2 and 3 hold. With rigid (un)shrouding, in the equilibrium of the pricing stage platform $i \in \{1,2\}$ with $i \neq j$ charges $M_S^i = C_S + \tau_S - \frac{\pi(u_i+2u_j)}{3\tau_B}$, and earns*

$$\Pi^i = \frac{\left[3\tau_B\tau_S - \pi\left(u_i + 2u_j\right)\right]^2}{9\tau_B\left[2\tau_B\tau_S - \pi(u_i+u_j)\right]}. \tag{13}$$

Profits strictly decrease in u_i.

[32] This argument follows Dahremöller (2013).

[33] Both Assumptions simplify the exposition of results. Without Assumption 1 the problem becomes highly intractable. We simulated solutions and found that our results also obtain without Assumption 1 for a wide range of parameters. Relaxing Assumption 2, $C_B < \frac{\left[6\tau_B\tau_S - 2\pi\left(u_i+2u_j\right)\right]^2}{18\left[2\tau_B\tau_S-\pi(u_i+u_j)\right]\left(\tau_B-u_j\right)}$ is a sufficient condition for platforms to earn non-negative profits.

The key implication of rigid unshrouding is that platform i's profits now *decrease* in u_i. This is somewhat surprising, since as in Sections 4.1 and 4.2, u_i has a positive direct effect on platform i's demand from sellers. But in contrast to the previous cases, a larger u_i now triggers a competitive price response from the rival j in period 1b. As before, a larger u_i attracts more buyers to platform i, which in turn attracts more sellers. To respond, rival j sharply reduces membership fees M_S^j for sellers in period 1b. This price response makes platform j more attractive to sellers, and more sellers render platform j also more attractive to buyers. Additionally, membership fees are strategic complements, which further intensifies competition: after a reduction in M_S^j, firm i also reduces its membership fee M_S^i. Due to these competitive effects platform i's profits decrease in u_i.

Because a larger u_i triggers a price response that reduces profits, competing platforms with rigid shrouding maximize profits by *minimizing* average perceived buyer surplus from an interaction on the platform. This is in sharp contrast to monopoly platforms and competitive platforms with flexible shrouding, and has strong implications for the platforms' incentive to (un)shroud.

Proposition 5. *With rigid shrouding, platforms shroud additional fees if and only if $\alpha < \underline{\alpha}$. Sellers charge low additional fees e if and only if $\underline{\alpha} \leq \alpha \leq \bar{\alpha}$, otherwise they charge high additional fees $\overline{a}$.*

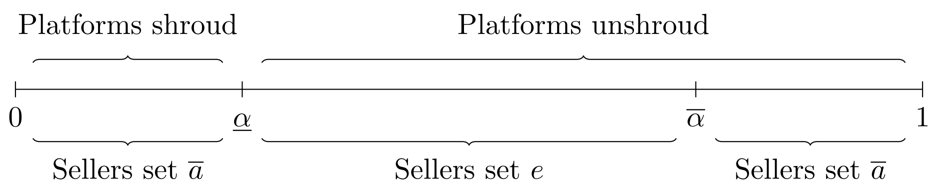
Platforms' incentives to shroud reverse because lower perceived surplus per interaction reduces price competition between platforms. Platforms now shroud when there are only few naifs, $\alpha < \underline{\alpha}$. In this case, shrouding reduces buyer surplus by inducing large avoidance costs $(1-\alpha)e$ for sophisticates. For $\alpha \geq \underline{\alpha}$, platforms unshroud to reduce the share of naifs who falsely believe that products are cheap.

The incentives of sellers, however, are unaffected. As in Section 3, shrouding induces sellers to charge $\overline{a}$. With unshrouding, sellers set large additional fees $\overline{a}$ if and only if $\alpha > \bar{\alpha}$. With many naifs, sellers choose large additional fees even when they are unshrouded. Thus, the reversal of platforms' shrouding incentives induces a conflict of interest between platforms and sellers. Combining the interests of platforms and sellers leads to three different scenarios, depicted in Figure 2.

First, with few naifs ($\alpha < \underline{\alpha}$), the platforms shroud and sellers charge large additional fees $\overline{a}$. If the platforms unshrouded, sellers would reduce additional fees. But this would increase perceived buyer surplus, increase platform competition and harm the platforms. As a result, the platforms prefer to shroud additional fees if the share of naifs is small.

A potential example for this scenario might be Mariott Hotels who were accused of adding

Figure 2: Unshrouding incentives under competition with rigid unshrouding



previously unadvertised ‘resort fees’ to their customers’ bills to appear cheaper on online travel platforms. These fees can be up to $95 per day. Online travel platforms like Booking.com, Priceline.com and Kayak tried to discourage these practices. For example, they charged commissions on resort fees. But as predicted by this scenario, they did not disclose them.[34]

Note that the platforms shroud but would prefer low additional fees just above e. They want to shroud fees but not appear too cheap. These lower additional fees would increase base prices and reduce perceived surplus of naifs without inducing sophisticates to avoid additional fees. Thus, buyer surplus would decrease even more, further mitigating price competition between platforms.

Second, for intermediate levels of naifs ($\underline{\alpha} \leq \alpha \leq \bar{\alpha}$), the platforms unshroud and sellers reduce additional fees to e.

Third, similarly to the first scenario, sellers and platforms disagree on additional fees when there are many naifs ($\alpha > \bar{\alpha}$). In this case, platforms unshroud. They would prefer low additional fees e, but since the share of naifs is large even after unshrouding, sellers set large additional fees $\overline{a}$ to exploit naive buyers.

The third case shows that while shrouding always induces large additional fees $\overline{a}$, unshrouding might not lead to lower fees. This is in sharp contrast to the previously studied market settings and the existing literature on deceptive products based on Gabaix and Laibson (2006), i.e. the benchmark we study in Lemma 5.

An example of the third scenario might be etsy.com, which offers a platform for sellers of handmade goods. Etsy announced in 2019 to prioritize sellers that offer free shipping on orders above $35, encouraging sellers to include shipping into the base price. But many sellers opposed this

[34] For details, see `https://www.cnbc.com/2019/07/09/marriott-accused-of-deceptive-drip-pricing-by-washington-dc.html` and `https://www.inc.com/chris-matyszczyk/the-biggest-nastiest-hotel-nickel-and-diming-fee-is-finally-coming-under-a-stunning-attack.html`. Both accessed on 15 August 2019.

move, arguing that reducing additional fees (in our model reducing $\overline{a}$) and increasing base prices would make them appear more expensive than other sellers who continue to charge separately for shipping.[35]

Remark on total consumer surplus: Analysing total consumer surplus is much simpler with competition and rigid unshrouding. First, because of Hotelling competition between platforms, in equilibrium each platform attracts half of the sellers and buyers under shrouding and unshrouding.[36] Second, in contrast to the monopoly platform discussed in Section 4.1, a regulator who forces the platforms to unshroud always induces sellers to reduce additional fees and increases total consumer surplus.[37]

Remark on unshrouding incentives: Compared to the settings in Sections 4.1 and 4.2, competition with rigid shrouding reverses the platforms' incentives to unshroud. But this does not imply that platforms now have stronger incentives to unshroud than sellers without platforms. The reason is that the benchmark results from Lemma 5 of sellers without platforms do not consider rigid unshrouding.

4.3.1 Platforms as Regulators.

The first and third scenarios outlined in the previous Subsection highlight the conflict between platforms and sellers on additional fees. For small α, sellers charge large additional fees because they are shrouded. For large α, sellers are not willing to reduce additional fees even when they are unshrouded. In both cases, platforms prefer smaller additional fees to induce larger base prices. This reduces the share of the total price that naifs falsely ignore and reduces perceived buyer surplus from an interaction. By reducing perceived buyer surplus, platforms mitigate price competition with other platforms. In other words, with lower additional fees products on the platform appear more expensive, which in turn mitigates competition between platforms.

This conflict between platforms and sellers suggests that platforms would like to put additional

[35] For more details, see 'The Verge' from July 9, 2019 at `https://www.theverge.com/2019/7/9/20687821/etsy-free-shipping-policy-seller-us-uk`, or 'Business Insider' from July 9, 2019 at `http://www.businessinsider.fr/us/etsy-unveils-new-plan-for-free-shipping-2019-7`.

[36] Clearly, this is not always realistic and (un)shrouding likely has an effect on the total number of buyers who are willing to join one of the platforms.

[37] The reason is that platforms shroud if there are few naifs, in which case sellers prefer to charge low additional fees when they are unshrouded. Formally, platforms shroud if $\alpha < \underline{\alpha}(< \overline{\alpha})$ and sellers charge low unshrouded additional fees if $\alpha < \overline{\alpha}$.

restrictions on sellers. We now investigate incentives of platforms to regulate additional fees.

Corollary 2. *Suppose platforms can impose a price cap on additional fees. Then the platforms impose a price cap at either* e *or zero if and only if* $\alpha > \bar{\alpha}$ *or* $\alpha < \underline{\alpha}$*.*

The Corollary summarizes the second main result of this article: platforms might regulate sellers to prevent them from charging large additional fees. Platforms regulate additional fees when the share of naifs is small or large. As outlined above, in both cases sellers charge large additional fees while platforms prefer smaller ones to mitigate price competition with the rival platform. Intuitively, platforms regulate additional fees to induce larger base prices. The platforms' products appear more expensive, but this mitigates competition between platforms.[38]

Such a regulation reduces consumer mistakes and increases actual buyer surplus. To see this, note that even though platforms aim to reduce perceived buyer surplus, regulation never reduces actual buyer surplus. Instead, lower additional fees increase base prices by the same amount and therefore reduce the share of the price that naifs mistakenly ignore. Additionally, with lower additional fees, sophisticated buyers might no longer incur the inefficient avoidance effort e, which can increase buyer surplus. Thus, platforms acting as regulators reduce consumer mistakes and increase actual consumer welfare.[39]

The conflict of interest between platforms and sellers offers an explanation for why some platforms actively regulate additional fees that sellers can charge. As an example, consider Amazon and eBay who both put caps on shipping fees.[40] Another example might be online travel platforms trying to prevent hotels' resort fees. These fees are often added later by the hotel and are not included in the advertised room price. To prevent hotels from charging these fees, Booking.com, Priceline.com, and Kayak started to charge commissions on these fees. Similarly, expedia.com assigns hotels who charge resort fees a lower priority in their search algorithm.[41]

[38] In the second scenario, sellers charge low additional fees but the platforms prefer large ones. Technically, our model would predict that platforms induce a minimum additional price in this case. We do not believe, however, that this would be a very likely course of action. Regulators would likely become very suspicious about minimum prices.

[39] Note that due to Hotelling competition between platforms the number of buyers and sellers is always 1/2 in each equilibrium, and actual consumer surplus is proportional to the actual buyer surplus from an interaction.

[40] Ebay has price caps for shipping rates. See shipping fee regulation (accessed on July 26, 2019) `https://www.ebay.com/help/selling/shipping-items/maximum-shipping-costs?id=4655`. Amazon regulates specific shipping rates. See their regulation (accessed on July 26, 2019) `https://www.amazon.com/gp/help/customer/display.html?nodeId=201910890`.

[41] See `https://www.cnbc.com/2019/07/09/marriott-accused-of-deceptive-drip-pricing-by-washington-dc.html` and `https://www.inc.com/chris-matyszczyk/the-biggest-nastiest-hotel-nickel-and-diming-fee-is-finally-coming-under-a-stunning-attack.html` for more details. Both accessed on 15. August 2019.

4.3.2 Rational Benchmark: Competition with Rigid Unshrouding.

As in Corollary 1 we can compare results to a rational benchmark without naive buyers. Again, predictions are extreme. Since platform i wants to reduce u_i to mitigate price competition, platforms will always shroud additional fees.

Corollary 3. *If all consumers are sophisticated, platforms shroud additional fees and sellers set high additional fees* $\overline{a}$.

Corollaries 1 and 3 imply that the rational benchmarks make extreme predictions. Either platforms always disclose additional fees, or they never do.

Crucially, without naifs competing platforms never use price caps on additional fees. In the present model with $\alpha = 0$, u^{unshr} is independent of $\overline{a}$, so caps on additional fees have no effect.

We study a more general benchmark in Appendix A.6. Instead of naifs, there is another type of sophisticates who have a willingness to pay $\overline{a}$ for an additional service. Again, caps are ineffective and platforms have no incentive to regulate additional fees. Intuitively, caps on additional fees increases base prices by the same amount, and capping additional fees does not increase the average surplus of buyers with correct expectations. We conclude that these models without naifs cannot explain why Amazon or eBay regulate shipping fees.

5 Applications

This Section discusses two types of applications of deceptive products on platforms.

First, classic examples of deceptive products are products with **add-on services or product upgrades**. Examples include hotels (Gabaix and Laibson, 2006), credit cards (Ausubel, 1991, Heidhues and Kőszegi, 2010, 2017, Schoar and Ru, 2016, Stango and Zinman, 2009, 2015, 2014), bank accounts (Alan et al., 2018), printers and cartridges (Hall, 1997), or cell-phone contracts (Grubb, 2009, Grubb and Osborne, 2014). In these settings, naive consumers underestimate their demand for or expenses of add-ons when buying the base product. The existing literature, however, has not studied the role of two-sided platforms like PCWs in these markets; yet these products are frequently intermediated by PCWs. By designing the marketplace, platforms face a strategic choice to shroud or unshroud deceptive features.[42]

[42] As an example of shrouding/unshrouding consider Alan et al. (2018) and Stango and Zinman (2014). They show

Ellison and Ellison (2009) investigate PCWs. They find that buyers often compare simple and cheap products on the PCW, but after being forwarded to the merchant's website, they purchase an expensive upgraded product. Consumers do not seem to go back to the PCW to compare the upgraded product, suggesting some degree of naiveté about demand for an upgrade.

We already discussed in Section 2 the example of flight-aggregator websites such as Skyscanner, Bravofly or Google Flights. A closely related example are *hotel booking platforms*. Platforms usually show basic room prices, but often do not disclose resort fees and additional prices for service upgrades and add-ons like room service, breakfast, or wifi. Naive consumers might wrongly believe they will not demand add-ons or underestimate prices. The additional fees capture these unanticipated expenses. Sophisticated consumers might correctly anticipate their demand for these add-ons and the hotels' pricing incentives. They can take precautions to avoid them, e.g. they use restaurants and sports facilities elsewhere, or buy a local SIM card. The effort e captures this avoidance behavior. We also like to think of e as hassle costs of consumers like calling the hotel or searching online to find out the actual price for additional services. Furthermore, hotel booking platforms can raise consumers' awareness of (unshrouded) additional fees: they can require that hotels list prices for additional services, or highlight which services are included in the room price.

Our second group of examples is **drip pricing**. Many PCWs and platforms like eBay or Amazon use drip pricing. They do not list products with their total price, but reveal some fees like shipping- or service fees, or the VAT later during the purchase process. Extensive evidence suggests that drip pricing induces consumers to underestimate the total costs of a product. Many researchers study shipping fees on eBay and other platforms.[43] They find that drip pricing makes consumers less sensitive to shipping fees than to base prices. Making shipping fees transparent by including them in listed prices reduces demand, or induces consumers to buy cheaper products. Chetty et al. (2009) provide evidence for price labels in a supermarket with- or without VAT. This evidence suggests that drip pricing induces at least some consumers to underestimate the total price, leading consumers to purchase too often, or to buy a more expensive alternative. The additional fee 'a_s' captures the associated additional revenues.[44] As in the previous applications, we can interpret e

that simply mentioning certain fees to consumers significantly reduces their probability to pay them.

[43] See Blake et al. (2018), Brown et al. (2010), Einav et al. (2015), Hossain and Morgan (2006), Smith and Brynjolfsson (2001)

[44] Heidhues and Koszegi (2018) already suggested this interpretation of a_s. They point out that the additional fee a_s can also result from additional sales when consumers overestimate their demand or underestimate total prices.

as a hassle cost that sophisticated consumers need to pay to understand the true total price when the platform shrouds. To avoid errors induced by drip pricing, platforms can unshroud by listing products with their total price.

6 Extensions and Robustness

In this Section we briefly summarize extensions and robustness checks of our baseline model.

Multihoming Sellers. For simplicity, the baseline models with competing platforms consider only singlehoming sellers. But results are robust with multihoming sellers. We introduce multihomers with zero opportunity cost of joining a platform. This captures multihomers as professional businesses who enter any platform if it is profitable. Results on flexible unshrouding are unaffected. We derive sufficient conditions under which the results with rigid unshrouding are robust. Intuitively, since multihomers enter both platforms, they mitigate platform competition. But as long as platforms compete intensely enough for singlehomers, they want to reduce buyer surplus from an interaction to mitigate platform competition. This is the case when the share of multihomers is not too large, and when platforms are close substitutes for singlehomers. See Appendix A.4 for details.

Unshrouding Spillovers. In the baseline model unshrouding only affects consumers on the unshrouding platform and we exclude the possibility of knowledge spillovers between platforms. To relax this assumption, this extension assumes unshrouding affects both platforms in the same way. First, when flexible unshrouding educates consumers on both platforms in the same way, platforms cannot use unshrouding to offer more buyer surplus than their rival. Thus, with perfect spillovers unshrouding has no effect on platforms' profits. Second, with rigid shrouding the main results are robust to spillovers. (Un)shrouding can still reduce buyer surplus, even when it affects surplus on both platforms equally. Details are in Appendix A.1.

Exogenous Additional Fees like VAT. In the baseline model sellers set additional fees. But this is not the case in some interesting applications. In particular, VATs are set by the authorities. Empirical evidence suggests that hiding VATs can benefit sellers through an increased volume of sales (Chetty et al., 2009). To capture these settings, this extension investigates exogenous additional fees $\overline{a}$. $\overline{a}$ represents sellers' gain from shrouding, e.g. because consumers underestimate total costs and purchase too often. Predictions for monopoly and competing platforms are qualitatively similar to the baseline model. Details are in Appendix A.2.

Product Categories with $n > 2$ Sellers. The main model assumes for simplicity that each product category consists of two sellers, and that all categories are identical. The main results on the incentives to shroud are unaffected if categories consist of $n \geq 2$ sellers. They also continue to hold if in period 2 sellers are uncertain about the degree of competition in their product category, i.e. the number of sellers in a product category or the degree of competition t. This way, the model can also incorporate ex-post heterogeneity in product categories after buyers and sellers decided which platform to enter. For details, see Appendix A.3.

Monopoly platform with rigid ushrouding. Lemma 4 considers a monopoly with flexible unshrouding. Clearly, $\Pi^{Monopoly}$ increases in u, so results are also robust with rigid unshrouding.

7 Related Literature

Our work connects most closely to the literatures on deceptive products and two-sided platforms. To our best knowledge we are the first to explore incentives of two-sided platforms to design a transparent marketplace, or to facilitate exploitation of consumer mistakes. We derive novel insights about what drives platforms to shroud fees, and on their incentive to regulate fees.

Literature on shrouded attributes. A growing literature studies incentives of firms to shroud fees to naive consumers who underestimate total expenses (Dahremöller, 2013, Gabaix and Laibson, 2006, Heidhues et al., 2016a,b, Johnen, 2019, Kosfeld and Schüwer, 2017, Murooka, 2015). Most of these papers study incentives of firms to unshroud their own fees towards naive consumers. Most closely related is Murooka (2015) who studies the incentives of intermediaries like financial advisers to recommend deceptive products to consumers. Crucially, intermediaries in his setting are not two-sided because of the lack of cross-group externalities.

We connect to the large *literature on two-sided platforms* based on the seminal articles by Caillaud and Jullien (2003), Rochet and Tirole (2003), and Armstrong (2006). Our approach is based on Armstrong (2006), but we develop his model in two important ways. First, and in contrast to much of the subsequent literature, we model buyer-seller interactions explicitly and allow platforms to have a direct impact on this interaction by (un)shrouding sellers' fees. To the best of our knowledge, we are the first to study two-sided platforms with sellers of deceptive products, or products with add-ons. Second, the classic model in Armstrong (2006) focuses on symmetric equilibria where buyers and sellers exert the same cross-group externality on any platform. We extend this setting and allow the cross-group externality on buyers to differ between platforms. This allows us to explore asymmetric equilibria where one platform shrouds and the other unshrouds.

Some articles model competition between sellers on the platform explicitly (Belleflamme and Peitz, 2019a, Karle et al., 2019). They investigate how the platforms' membership fees influence the number of sellers and thereby the degree of competition on the platform. In contrast, we explore how non-price design choices like shrouding of additional fees impacts competition and buyer surplus on the platform.

Another group of papers studies the incentives of two-sided platforms to disclose their membership fees (Hagiu and Hałaburda, 2014, Belleflamme and Peitz, 2019b). They study incentives of platforms to disclose membership fees of one side to the other side. In contrast, we study incentives of platforms to disclose fees that sellers charge on the platform.

Literature on platform design. Some recent articles emphasize how platform design influences consumer search. Several empirical papers establish the role of platform design on market outcomes (Chen and Yao, 2017, Dinerstein et al., 2018, Ghose et al., 2014). Ronayne (2019) investigates the role of PCWs for consumer search. Heresi (2018) finds that platforms might want to increase consumer search costs to raise sellers' profits, which platforms can extract. We do not study how platform design influences consumer search, but the transparency of additional price features.

8 Conclusion

We explore incentives of two-sided platforms to design a transparent marketplace that unshrouds additional fees of sellers towards naive and sophisticated buyers. First, we find that platforms have stronger incentives to shroud than sellers without a platform. Second, in competitive settings with rigid unshrouding, platforms might regulate additional fees, which benefits consumers.

The effectiveness of a platform regulating its sellers' fees might be undermined when sellers can bypass the platform and sell directly to buyers. Caps on additional fees increase base prices on a platform. Thus, caps make the platform appear more expensive than the bypassing option.

The bypassing problem, however, is not specific to our context and also applies to the fees that platforms charge to buyers and sellers.

We do not study the role of learning by consumers about their mistakes for two reasons. First, for consumers who use platforms infrequently, there is little scope for learning. Second, learning is unlikely to be complete. As pointed out by Agarwal et al. (2008) in the context of shrouded credit-card fees, consumers do learn after paying these fees, but also forget again.

In practice, reputation might induce sellers or platforms to offer more transparent prices. But in the context of platforms it seems often unclear whose reputation should suffer. For example, take a consumer who feels cheated by shrouded shipping fees. Who should she blame for not having seen these fees earlier? The platform for not forcing sellers to include shipping in the base price? Or the seller who did not mention shipping fees in the product description? Not knowing who to blame might at least partially undermine the effectiveness of reputation in the context of platforms.

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A Extensions and Robustness

A.1 Unshrouding Spillovers

In the main text we have made the simplifying assumption that a platform's decision to shroud/unshroud only affects consumers of the same platform. In this extension we relax this assumption and allow for spillovers of unshrouding, i.e. when a platform unshrouding its own prices also turns some consumers on the rival platform into sophisticates. Intuitively, with unshrouding spillovers the eventual gains from unshrouding are reduced for platforms compared to the baseline case because unshrouding creates less asymmetry.

To illustrate this, assume that platform i's unshrouding action turns a share λ of naive consumers sophisticates *on both platforms*. This assumption captures a scenario in which the same share of naifs are susceptible to being educated on both platforms, and they get informed about additional fees whenever either of the two platforms decides to unshroud.

For the **case of flexible shrouding**, i.e. when platforms decide simultaneously about shrouding and membership fees, unshrouding only affects the profit of platform i through its effect on the number of consumers attracted to the platforms. Clearly, platform i's unshrouding can only effect platform j's consumers if platform j shrouds. In the shrouding equilibrium as the two platforms are symmetric they get the same share of consumers: $n_i = n_j = 0.5$. This holds if both platforms unshroud as well because it also leads to the symmetric situation of having a share $(1 - \lambda)\alpha$ of remaining naifs on each platform. Therefore, unshrouding has no effect under flexible shrouding when the unshrouding action also affects the rival's consumers. In this view, unshrouding has an effect in the baseline model because it creates asymmetry in the share of naifs vs. sophisticates between the platforms, and this effect disappears when unshrouding also educates the rival's consumers.

For the **case of rigid shrouding**, i.e. when platforms decide first about unshrouding and later about membership fees, we next show that the baseline model's results are robust to educating the rival platform's consumers. We know from Proposition 4 that platforms earn a profit equal to

$$\Pi^i = \frac{\left[3\tau_B\tau_S - \pi\left(u_i + 2u_j\right)\right]^2}{9\tau_B\left[2\tau_B\tau_S - \pi(u_i + u_j)\right]}.$$

As before, unshrouding has a bite only if the rival shrouds as well, so as a first step we start from a symmetric situation of $u_i = u_j = u^{shr}$. We will next use the fact that as a result of unshrouding, the perceived buyer surplus *on both platforms* will be either $u^{unshr,\overline{a}}$ or $u^{unshr,e}$. In each case, unshrouding increases or decreases perceived buyer surplus by the same amount we call Δ. If platform i unshrouds, the new profit of platform i becomes

$$\Pi^i(\Delta) = \frac{\left[3\tau_B\tau_S - \pi\left(3u + 3\Delta\right)\right]^2}{9\tau_B\left[2\tau_B\tau_S - \pi(2u + 2\Delta)\right]} = \frac{\tau_B\tau_S - \pi\left(u + \Delta\right)}{2\tau_B},$$

where $u = u_i = u_j = u^{shr}$. Clearly, $\Pi^i(\Delta)$ is decreasing in Δ. As a direct consequence, unshrouding is profitable for platforms if and only if it reduces perceived buyer surplus. Thus we get the exact same condition for unshrouding being optimal as in the baseline model. The intuition is the same as well: a larger perceived buyer surplus leads to increased competition in the price setting phase, which in turn erodes profits.

A.2 VAT and Other Exogenous Additional Fees

If firms hide VATs, even sophisticated consumers cannot avoid them. But it is well-documented that if firms hide VATs, some consumers seem to underestimate the total price and purchase more often (Chetty et al., 2009). In this extension we investigate how such mistakes can be analyzed using our baseline model.

Recall that in the baseline model, we interpret $\overline{a}$ as additional revenues from fees that naifs do not anticipate. When naive consumers underestimate the total price, $\overline{a}$ represents increased revenues due to selling additional units that naifs would not buy if they anticipated the total price. Sophisticated consumers can avoid such mistakes by the costly action of finding out the relevant value of VAT. There are two crucial differences with respect to the baseline model. First, as opposed to other additional fees, the value of VAT cannot be freely chosen by the sellers, it is state-mandated. Thus, the additional revenue from consumers who underestimate the total price $\overline{a}$ is fixed. In particular, sellers cannot reduce VAT to a level at which sophisticates would prefer paying it to avoiding it (to e in the baseline model). As a direct consequence, sellers would always benefit from shrouding. Second, unshrouding may reduce the hassle cost of avoiding the consumer mistake, e. Let e' denote this reduced cost, and we allow for any $e' \in [0, e]$ as its value depends on the specific application studied. For instance, if the naifs buy an excessive amount due to drip pricing, then the platform showing them the total price inclusive of VAT reduces the hassle cost to zero. On the other hand, if the platform only warns consumers that additional charges may apply then sophisticates still have to go through the costly process of finding out the exact terms.

When the VAT is shrouded, it is straightforward to show that the optimal base price, the perceived buyer surplus and sellers' profit are unchanged compared to the baseline. When the VAT is unshrouded, then the situation is analogous to the case when the platform unshrouds and sellers set $\overline{a}$, with the exception that sophisticates have a lowered avoidance cost. Therefore the optimal base price is $f^{unshr;VAT} = c - (1 - \lambda)\alpha\overline{a} + t$, with profits $\pi^{unshr;VAT} = t/2$, and perceived buyer surplus

$$u^{unshr;VAT} = v - t/4 - c - t + (1 - \lambda)\alpha\overline{a} - (1 - (1 - \lambda)\alpha)e'.$$

Simple transformations reveal that

$$u^{shr} \geq u^{unshr;VAT} \iff \alpha \geq \frac{e - e'}{e - e' + \lambda(\overline{a} + e')} \equiv \widetilde{\alpha}.$$

Notice that $\widetilde{\alpha} = 0$ in the extreme case of $e' = e$, moreover, $\widetilde{\alpha}$ is strictly decreasing in e'. Therefore, for any $e' \in [0, e)$ there is a strictly positive threshold value for the share of naifs over which shrouding increases perceived buyer surplus.

As a direct consequence of Propositions 1 and 3, monopoly platforms and platforms under flexible shrouding decide to unshroud if and only if the share of naifs is smaller than the cut-off $\widetilde{\alpha}$. Conversely, Proposition 4 implies that under rigid shrouding, platforms unshroud if the share of naifs is larger than $\widetilde{\alpha}$.

Results are thus qualitatively similar but simpler then in the baseline model. Intuitively, the VAT model's results are less rich than the baseline model's because gains from a shrouded VAT are exogenously given to sellers whereas they can freely set other the types of additional fees.

A.3 Product Categories with $n \geq 2$ Sellers

We show in this Section that Lemmas 1, 2, and 5 in Section 3 are robust to competition between $n \geq 2$ sellers. To do so, we extend the model of seller competition to a Salop circle of length one with $n \geq 2$ equidistant firms. We assume again that the buyers' valuation v is sufficiently large such that the market is covered. We look for symmetric equilibria between sellers.

To start, suppose all firms shroud. Denote the symmetric equilibrium base price with shrouding f^{shr}. Again, because fees are shrouded, all firms optimally charge $a_s = \overline{a}$. Then the demand of firm s setting f_s becomes

$$x_s = \frac{1}{n} + \frac{f^{shr} - f_s}{t},$$

and profits of firm i are

$$\left(\frac{1}{n} + \frac{f^{shr} - f_s}{t}\right)(f_s + \alpha\overline{a} - c).$$

These profits are maximized at $f_s = f^{shr} = c - \alpha\overline{a} + \frac{t}{n}$, earning firm n profits $\pi_s = \pi = \frac{t}{n^2}$. Average perceived buyer surplus per seller is $u^{shr} = \frac{1}{2}\left[v - \frac{t}{4n} - c - \frac{t}{n} + \alpha\overline{a} - (1-\alpha)e\right]$.

We now consider the case when platforms unshroud additional prices. As before, sellers can either continue to charge large additional prices $\overline{a}$, or reduce them to $a_s \leq e$. We first establish robustness of Lemma 1.

Lemma 7. *With unshrouded additional fees, each seller s charges low fees $a_s = e$ if and only if $\alpha < \bar{\alpha}$. Otherwise, they prefer to charge large fees $a_s = \overline{a}$.*

It is now straightforward to show that Lemma 2 is also mostly unchanged in this model.

Lemma 8.

1. $\pi^{unshr;\overline{a}} = \pi^{unshr;e} = \pi^{shr} = \frac{t}{n^2}$.
2. $u^{shr} \geq u^{unshr;e}$ *if and only if* $\alpha \geq \underline{\alpha}$.
3. $u^{unshr;\overline{a}} \geq u^{unshr;e}$ *if and only if* $\alpha \geq \bar{\alpha}$.
4. $u^{shr} \geq u^{unshr;\overline{a}}$.

We now show that also Lemma 5 is robust in this setting.

Lemma 9. *If sellers decide whether to unshroud additional prices or not, an equilibrium with shrouding exists if* $\alpha > \hat{\alpha}$.

Lemmas 7, 8, and 9 allow us to generalize results even further. In each scenario, firms earn the same profits and average perceived buyer surplus is the same, net of any term involving $\overline{a}$ and e. Thus, the cutoffs derived in the previous Lemmas are also unaffected when sellers face uncertainty about the number of rivals they face on the platform n, and the degree of product substitutability t. To see this, suppose $(n, t) \in \{2, 3, ..., N\} \times \mathbb{R}_+$ are distributed according to the CDF $G(n, t)$. Each realization (n, t) is such that markets are covered, i.e. such that each firm always faces some competition. Suppose (n, t) realizes after sellers decide to enter the platform or not, but before competition on the platform takes place. It is straightforward to show that the cutoffs derived in Lemmas 7, 8, and 9 are unaffected by this extension.

A.4 Multihoming Sellers

This Section works out under which conditions the results in Section 4.3 on shrouding incentives with flexible and rigid unshrouding are robust to multihoming sellers. To do so, we extend the model from Section 4.3 and establish conditions under which the platform i's profit in period 1 decreases in u_i. We first focus on situations where platforms compete for singlehoming sellers, i.e. not exclusively for multihomers, and subsequently derive a sufficient condition for this to hold.

We model buyers as in Section 4.3. The share $\gamma \in (0, 1)$ of sellers multihome. They join a platform i if and only if $v_S^i = n_B^i \pi - M_s^i \geq 0$. Thus, we assume that mulihomers have zero opportunity cost of entering a platform, in contrast to singlehomers who have positive opportunity cost and only join a single platform. This captures the idea that multihomers are more likely to be professional businesses who enter a platform whenever it is profitable. $v_S^i \geq 0$ also implies that whenever singlehomers enter, multihomers do as well. The remaining $1 - \gamma$ sellers singlehome and are as in Section 4.3. We assume that competition on the platform is unaffected by multihomers. Thus, supposing singlehomers enter, the number of sellers is now given by

$$n_S^i = \gamma + (1 - \gamma) \left[\frac{1}{2} + \frac{v_S^i - v_S^j}{2\tau_S} \right].$$

Intuitively, multihomers enter whenever $v_S^i \geq 0$, and singlehomers choose between the two platforms as before in Section 4.3. As before, the number of buyers is $n_B^i = \frac{1}{2\tau_B} \left[\tau_B + v_B^i - v_B^j \right]$, and $v_B^i =$

$n_S^i u_i$, where we assume again Assumption 1. We can follow the same steps as in Lemma 6 to derive sellers' demand for platform i, taking into account that now $n_S^i + n_S^j = 1 + \gamma$:

$$n_S^i = \frac{(1+\gamma)\tau_B\tau_S - (1-\gamma^2)\pi u_j + (1-\gamma)\tau_B(M_S^j - M_S^i)}{2\tau_B\tau_S - (1-\gamma)\pi(u_i + u_j)}$$

and demand of buyers for platform i

$$n_B^i = \frac{\tau_B - (1+\gamma)u_j + n_S^i(u_i + u_j)}{2\tau_B}.$$

We see that both demand functions increase in u_i. This immediately implies that results from Propositions 3 are robust in this setting: with flexible unshrouding firms unshroud to maximize perceived buyer surplus and shrouding incentives coincide with the monopolies' incentives.

We now continue by looking at rigid unshrouding. Using again Assumption 2, platform i's profit are $\Pi_i(M_S^i, M_S^j) = (M_S^i - C_S)n_S^i$ and solves in period 2

$$\max_{\mathrm{M_S^i}} \Pi_i(M_S^i, M_S^j).$$

The FOC of platform i's problem simplifies to

$$(1+\gamma)\tau_B\tau_S - (1-\gamma^2)\pi u_j + (1-\gamma)\tau_B(M_S^j - 2M_S^i + C_S) = 0. \tag{14}$$

Subtracting the FOC of platform j and simplifying leads to

$$M_S^j - M_S^i = \frac{(1+\gamma)\pi(u_j - u_i)}{3\tau_B}.$$

Thus, we get the equilibrium price

$$M_S^i - C_S = \frac{\left[3(1+\gamma)\tau_B\tau_S - (1-\gamma^2)\pi(u_i + 2u_j)\right]}{3\tau_B(1-\gamma)},$$

and equilibrium profits in period 2 as

$$\Pi_i = \frac{\left[3(1+\gamma)\tau_B\tau_S - (1-\gamma^2)\pi(u_i + 2u_j)\right]^2}{9\tau_B(1-\gamma)\left[2\tau_B\tau_S - (1-\gamma)\pi(u_i + u_j)\right]}. \tag{15}$$

Π_i decreases in u_i if

$$(1-\gamma)\pi u_i < \tau_B\tau_S$$

which is guaranteed by Assumption 3 for any $\gamma \in (0,1)$. Therefore we conclude that the main results for rigid shrouding are robust to the presence of multihoming sellers whenever platforms compete for singlehomers.

Next, we derive a sufficient condition that ensures that platforms want to compete for singlehomers, i.e. they do not want to focus exclusively on extracting all surplus from multihomers. We do this by showing that the marginal profit in (14) is negative for $M_S^i = n_B^i \pi$ for any membership fee the rival would charge. As the marginal profit is increasing in M_S^j, we show this for $M_S^j = n_B^j \pi$. For simplicity, we also assume $C_S = 0$. The sufficient condition we derive is the following:

$$(1-\gamma)\tau_B \pi > (1-\gamma^2)\pi u_j + 2(1+\gamma)\tau_B \tau_S.$$

Intuitively, it is not worth extracting all the surplus of multihomers if their number is not very large (γ is sufficiently small) and if competition for sellers is fiercer than for buyers (τ_S is small relative to τ_B). We conclude that the results on rigid unshrouding from Propositions 4 and 5 are robust also with multihoming sellers.

A.5 Microfoundation of Assumption 1

We now derive conditions under which firms have no incentives to deviate from $M_B^i = M_B^j = 0$ in Proposition 4.

A reasonable microfoundation for $M_B^i \geq 0$ is consumer arbitrage. A platform that gives money to consumers to register on the platform will also attract consumers that never buy a product, and are therefore unprofitable. Thus, firms optimally set $M_B^i \geq 0$.

Next, we derive conditions under which $M_B^i = 0$ is optimal. Since $M_B^i \geq 0$, a sufficient condition is that $\frac{\partial \Pi^i}{\partial M_B^i}|_{M_B^i = M_B^j = 0} \leq 0$ for all i. To do so, we first need to derive demand as in Lemma 6. Following the same steps as in the Lemma without making Assumption 1 leads to

$$n_S^i = \frac{2\tau_B\tau_S - 2\pi u_j + 2\pi(M_B^j - M_B^i) + 2\tau_B(M_S^j - M_S^i)}{4\tau_B\tau_S - 2\pi(u_i + u_j)},$$

and similarly,

$$n_B^i = \frac{1}{2} + \frac{(M_S^j - M_S^i)(u_i + u_j) + 2\tau_S(M_B^j - M_B^i) + \tau_S(u_i - u_j)}{4\tau_B\tau_S - 2\pi(u_i + u_j)}.$$

We can now characterize $\Pi^i = (M_S^i - C_S)n_S^i + (M_B^i - C_B)n_B^i$ and derive $\frac{\partial \Pi^i}{\partial M_B^i}$. Taking the condition $\frac{\partial \Pi^i}{\partial M_B^i} \leq 0$, and simplifying by using $M_B^i = M_B^j = 0$ leads to

$$2\tau_B\tau_S - \pi(u_j + u_j) + (M_S^j - M_S^i)(u_i + u_j) + \tau_S(u_i - u_j) + 2\tau_S C_B - \pi(M_S^i - C_S) \leq 0.$$

Plugging in M_S^i and M_S^j from Proposition 4 and simplifying leads to

$$(u_i - u_j)[3\tau_B\tau_S - \pi(\pi + u_i + u_j)] + (C_B + \tau_B - \pi)[6\tau_B\tau_S - 3\pi(u_i + u_j)] \leq 0.$$

We know from Proposition 4 that profits Π_i decrease in u_i for all u_j. This implies that on the equilibrium path, both platforms will either shroud or unshroud and $u_i = u_j = u$, and the condition simplifies to

$$C_B + \tau_B - \pi \leq 0.$$

Thus, it is not optimal to increase M_B^i above zero if τ_B is small and π is large. When firms compete fiercely for buyers and sellers earn large profits from interacting with buyers, platforms compete fiercely for buyers and optimally charge them low membership fees. Because of arbitrageurs, these membership fees cannot be negative. Thus, firms optimally set $M_B^i = M_B^j = 0$.

A.6 Rational Benchmark with Heterogeneous Consumers

The rational benchmarks in the main text assume for simplicity that all sophisticated consumers are identical and avoid additional fees if they expect them to be large. We show now that the benchmark results also hold when some sophisticated consumers—just like naifs in the main text—pay additional fees also when they are expensive.

The share $1 - \gamma$ of consumers is sophisticated as in the main text. These consumers can avoid additional fees if they believe or observe that they are above e, their cost of avoiding additional fees. The remaining consumers γ do not avoid additional fees also when they are expensive and cost $\overline{a}$. These consumers have a willingness to pay $\overline{a}$ for an additional service. They are like naifs in the main text with the key difference that they correctly anticipate to pay additional fees, whether platforms shroud or unshroud them.

We proceed in two steps. First we investigate average buyer surplus u from interacting with sellers on the platform. Afterwards we can determine the optimal shrouding decisions of platforms.

When sellers charge large additional fees $a = \overline{a}$, avoiding consumers avoid additional fees, and the large additional fees extract the entire willingness to pay $\overline{a}$ of non-avoiding buyers. Thus, firms extract all surplus from non-avoiding buyers, and they have the same perceived utility than naive ones. This implies that $u^{unshr;\overline{a}} = u^{shr} = v - \frac{t}{4} - c - t + \gamma\overline{a} - (1-\gamma)e$, with $f^{shr} = f^{unshr;\overline{a}} = c - \gamma\overline{a} + t$ and additional fees $\overline{a}$.

However, the implications change for lower unshrouded additional fees $a = e$. As before, we get $f^{unshr;e} = c - e$ and $a = e$.[45] But buyer surplus now is

$$u^{unshr;e} = \gamma \left[v + \overline{a} - f^{unshr;e} - a\right] + (1-\gamma)\left[v - f^{unshr;e} - a\right] = c + \gamma\overline{a} - c - t - \frac{t}{4}.$$

In contrast to naive consumers in the main text, sophisticated consumer actually have a large willingness to pay $\overline{a}$ for the additional service. Thus, average buyer surplus is larger in this case than with naive consumers. Since consumers have correct expectations, this means that also when additional fees are regulated at e but shrouded, we have $u^{shr;e} = u^{unshr;e}$.

Do sellers have an incentive to charge a above e when additional fees are unshrouded? While this might be optimal with naive consumers, it is never optimal with sophisticated consumers. The reason is that sophisticated non-avoiding consumers respond to increases in unshrouded additional prices with decreased demand. More formally, suppose $f = c - e + t$ and $a = e$. An increase in a above e with unshrouded additional fees changes profits from non-avoiding sophisticates by

$$\gamma \left[\frac{1}{2} + \frac{e-a}{2t}\right] - \frac{\gamma}{2t}\left[c - e + t + a - c\right] = -\frac{\gamma}{t}(a-e) \leq 0.$$

Clearly, increasing a above e reduces profits from avoiding consumers, so the overall effect on profits is negative.

Similarly, reducing additional fees from $\overline{a}$ downwards such that $a > e$ increases profits by $\frac{\gamma}{t}(\overline{a} - a) \geq 0$. We conclude that firms never charge large additional fees $a = \overline{a}$ when additional fees are unshrouded.

The following Lemma summarizes these results.

Lemma 10. *Sellers always charge additional fees below e when platforms unshroud fees.* $u^{shr;e} = u^{unshr;e} > u^{shr}$.

[45] In fact any total price $f + a = c + t$ with $a \leq e$ is an equilibrium.

The Lemma implies immediately that the results from Corollaries 1 and 3 translate to this more general rational benchmark. Monopoly platforms always disclose additional fees and competing platforms with rigid unshrouding never do. Also competing platforms never want to induce caps on additional fees. Caps reduce additional prices by the same amount by which they increase base prices, and since sophisticated consumers have correct expectations about additonal fees, their utility is unaffected by regulation of additional fees. Thus, the rational model cannot explain why platforms would regulate additional fees.

B Proofs

Proof of Lemma 1. We first consider the case where $a_s \leq e$. Seller s has the following profits:

$$(1-\lambda)\alpha\left(\frac{1}{2}+\frac{f_r-f_s}{2t}\right)(f_s+a_s-c)+(1-(1-\lambda)\alpha))\left(\frac{1}{2}+\frac{f_r+\min\{a_r,e\}-f_s-a_s}{2t}\right)(f_s+a_s-c)\,.$$

Seller s chooses f_s and a_s. Clearly, profits from sophisticates only depend on the total price f_s+a_s, but demand from naifs is independent of a_s. Therefore, an increase in a_s is more profitable than an equal increase in f_s, and s optimally sets $a_s = e$. To see this, note that a combination (f_s, a_s) with $a_s < e$ cannot be optimal. Seller s can increase profits by charging (f'_s, e) such that $f'_s + e = f_s + a_s$. This keeps profits from sophisticates and margins from naifs unaffected while increasing demand from naifs.

Similarly, $a_s > e$ sophisticates avoid additional fees and naifs do not observe increases of a_s. Thus, each seller s chooses either $a_s = e$ or $a_s = \overline{a}$.

When s charges $a_s = e$, it earns

$$(f_s+e-c)\left(\frac{1}{2}+\frac{f_r+\min\{a_r,e\}-f_s-e}{2t}\right)=(f_s+e-c)\left(\frac{1}{2}+\frac{f_r-f_s}{2t}\right).$$

Since rival r either charges $a_r = e$ or $a_r = \overline{a}$, we know that $\min\{a_r, e\}$. Alternatively, s could charge $a_s = \overline{a}$ and earn

$$(f_s+(1-\lambda)\alpha\overline{a}-c)\left(\frac{1}{2}+\frac{f_r+e-f_s-\min\{\overline{a},e\}}{2t}\right)=(f_s+(1-\lambda)\alpha\overline{a}-c)\left(\frac{1}{2}+\frac{f_r-f_s}{2t}\right).$$

Notice that the larger additional fee does not reduce demand for firm s as sophisticates avoid it by paying e, and naifs do not take it into account. This is also why s's profits from $\overline{a}$ or e do not depend on whether r charges $\overline{a}$ or e. Thus, with unshrouded additional fees sellers prefer to charge low fees $a_s = e$ if and only if $(1-\lambda)\alpha\overline{a} < e$. □

Proof of Lemma 2. The Lemma follows immediately from comparing u^{shr}, $u^{unshr;e}$, and $u^{unshr;\overline{a}}$. □

Proof of Lemma 3. Combining $n_B^l = v_B^l + k$ with the buyers' surplus function and the definition of n_B leads to $n_B = \sum_{l=1}^{2} \beta_l v_B^l + k = n_S u - M_B + k$. Thus, for buyers' demand, the platform only considers the average utility of buyers per seller, u. Combining $n_S = v_S + k$ with the sellers' surplus function in a similar way leads to $n_S = n_B\pi - M_S + k$. Solving the resulting system of equations, we get (6). □

Proof of Lemma 4. It is straightforward to check that concavity of the profit function requires $\pi u < 1$, which is implied by $\pi + u < 2$. From the FOCs of the membership fees, we get

$$2M_B + (u+\pi)M_S = k(1+u) + C(1+\pi) \quad \text{and} \quad 2M_S + (u+\pi)M_B = k(1+\pi) + C(1+u).$$

Summing the two equations and dividing by $(2+u+\pi)$ leads to $M_S + M_B = C + k$, which we plug into the FOCs to get the optimal membership fees.

In order to have positive fees, we follow the platform literature and assume $u+\pi < 2$. Plugging these fees into $n_B(M_B, M_S, u)$ and simplifying, we can derive the equilibrium demand of buyers as a function of π and u as

$$n_B = \frac{k-C}{2-u-\pi}.$$

Similar calculations show that $n_S = n_B$. Plugging demand and membership fees back into (7) and simplifying leads to the monopoly profits.

It remains to show that the monopoly profits increase in u. To do so, treating u for simplicity as a continuous variable, we compute the derivative of (7) with respect to u

$$\frac{(k-M_S)(1-\pi u) + \pi[k(1+u) - M_B - uM_S]}{(1-\pi u)^2}(M_B - C) + \frac{\pi[k(1+\pi) - M_S - \pi M_B]}{(1-\pi u)^2}(M_S - C),$$

which simplifies to

$$\frac{(k-M_S)(M_B-C)}{1-\pi u} + \frac{\pi}{1-\pi u}\Pi^{Monopoly}.$$

Clearly $\Pi^{Monopoly} > 0$. Using equilibrium membership fees, it is straightforward to show that $\frac{(k-M_S)(M_B-C)}{1-\pi u} > 0$. We conclude that monopoly platforms choose between shrouding and unshrouding to maximize u. □

Proof of Proposition 1. By Lemma 4, the monopoly platform chooses between shrouding and unshrouding based on what maximizes the cross-group externality u, i.e. perceived surplus of buyers of each interaction on the platform. Thus, the Proposition follows directly from Lemma 2.

First, Lemma 2 states that sellers earn the same profits whether the platform shrouds or unshrouds. Thus, the platform chooses between shrouding and unshrouding based on what maximizes perceived buyer surplus.

Second, Lemma 2 shows that $u^{shr} \geq u^{unshr;\bar{a}}$, i.e. if sellers continue to charge large unshrouded additional fees, the platform prefers to shroud these fees. Additionally, $u^{shr} \geq u^{unshr;e}$ if and only if $\alpha \geq \underline{\alpha}$. Thus, if $\alpha \geq \underline{\alpha}$ the platform prefers to shroud additional fees.

Third, if $\alpha < \underline{\alpha}$, we also have $\alpha < \bar{\alpha}$ and Lemma 1 implies that sellers charge low additional fees e if the platform unshrouds. Since $u^{shr} < u^{unshr;e}$ if and only if $\alpha < \underline{\alpha}$, the platform unshrouds if and only if $\alpha < \underline{\alpha}$. This concludes the proof. □

Proof of Lemma 5.

A firm i that deviates from the shrouding equilibrium by unshrouding optimally sets $a_s = e$. With a larger a_s, unshrouding only reduces the share of profitable naive consumers and can never be optimal. With a smaller $a_s < e$, firm s could increase demand from consumers who remain naive by increasing a_s while keeping $f_s + a_s$ constant to keep demand from sophisticated consumers unaffected. Thus, deviating firms maximize

$$(1-\hat{\lambda})\alpha\left(\frac{1}{2}+\frac{f^{shr}-f_s}{2t}\right)(f_s+e-c)+\left(1-(1-\hat{\lambda})\alpha\right)\left(\frac{1}{2}+\frac{f^{shr}+e-f_s-e}{2t}\right)(f_s+e-c),$$

which simplifies to

$$\left(\frac{1}{2}+\frac{f^{shr}-f_s}{2t}\right)(f_s+e-c).$$

Using $f^{shr} = c - \alpha\bar{a} + t$ from above, $f_s = c + t - \frac{1}{2}(\alpha\bar{a} + e)$ maximizes s's deviation profits, earning s a profit of $\pi^{dev} = \frac{1}{2t}\left(t + \frac{e-\alpha\bar{a}}{2}\right)^2$. Thus, this deviation from the shrouding equilibrium is unprofitable if $\pi = t/2 > \pi^{dev}$, that is $\alpha > \frac{e}{\bar{a}}$. □

Proof of Proposition 2. The Proposition follows immediately from the formulas and the assumption of $\lambda > 0$:

$$\underline{\alpha} < \hat{\alpha} < \bar{\alpha} \Longleftrightarrow \frac{e}{\bar{a} + \lambda e} < \frac{e}{\bar{a}} < \frac{e}{\bar{a} - \lambda \bar{a}}.$$

□

Proof of Lemma 6. By plugging (9) into (8) and using $n_B^j = 1 - n_B^i$, one can express the number of agents joining the platforms as a function of the fees and n_B^i:

$$n_S^i = \frac{1}{2} + \frac{M_S^j - M_S^i + n_B^i \pi - (1 - n_B^i)\pi}{2\tau_S} = \frac{1}{2} + \frac{M_S^j - M_S^i - \pi}{2\tau_S} + \frac{\pi}{\tau_S} n_B^i \tag{16}$$

Using the same steps, we get the number of buyers on platform i:

$$n_B^i = \frac{1}{2} + \frac{v_B^i - v_B^j}{2\tau_B} = \frac{1}{2} + \frac{M_B^j - M_B^i - u_j}{2\tau_B} + \frac{u_i + u_j}{2\tau_B} n_S^i.$$

Plugging this expression back into equation (16), and rearranging terms reveals demand only as a function of membership fees and cross-group externalities, i.e.

$$n_S^i = \frac{2\tau_B \tau_S - 2u_j \pi + 2\pi(M_B^j - M_B^i) + 2\tau_B(M_S^j - M_S^i)}{4\tau_B \tau_S - 2\pi(u_i + u_j)}, \tag{17}$$

and similarly

$$n_B^i = \frac{2\tau_B \tau_S - \pi(u_i + u_j) + (M_S^j - M_S^i)(u_i + u_j) + 2\tau_S(M_B^j - M_B^i) + \tau_S(u_i - u_j)}{4\tau_B \tau_S - 2\pi(u_i + u_j)}. \tag{18}$$

Using Assumption 1 leads to (10). □

Proof of Proposition 3. In the following we show that platform i's profit increases in perceived buyer surplus u_i, for sufficiently low levels of C_B. This implies that as in Section 4.1 shrouding is beneficial for the platforms whenever it increases average perceived buyer surplus.

First note that since firms choose M_S^i and whether to shroud or not simultaneously, we only need to consider the direct effect of u_i on (11).

For given membership fees, the change in platform i's profit as a result of an increase in perceived buyer surplus is given by

$$\frac{\partial \Pi^i}{\partial u_i} = \left(M_S^i - C_S\right) \frac{\partial n_S^i}{\partial u_i} - C_B \frac{\partial n_B^i}{\partial u_i}.$$

It is straightforward to see from (10) that the number of sellers on the platform—n_S^i—increases in u_i.

Under Assumption (2), the profit Π^i is clearly increasing in u_i. Intuitively, an increased perceived utility attracts more buyers to the platform, which in turn attracts more sellers. As pricing and shrouding decisions are made simultaneously, the platform takes membership fees as given and does not worry about a potential price response of its opponent to unshrouding.

We conclude that with flexible unshrouding, competing platforms decide between shrouding and unshrouding by what increases average perceived buyer surplus. □

Proof of Proposition 4. The first-order condition of (12) is

$$n_S^i + \left(M_S^i - C_S\right) \frac{\partial n_S^i}{\partial M_S^i} = 0.$$

Using buyer and seller demand (10), this is equivalent to

$$2\tau_B\tau_S - 2\pi u_j + \tau_B(M_S^j - M_S^i) - 2\tau_B(M_S^i - C_S) = 0. \tag{19}$$

Note that the second-order condition is equivalent to $-4\tau_B/(4\tau_B\tau_S - 2\pi(u_i + u_j)) < 0$, which is always satisfied by Assumption 3. Similarly, for firm $j \neq i$ we get the first-order condition

$$2\tau_B\tau_S - 2\pi u_i + \tau_B(M_S^i - M_S^j) - 2\tau_B(M_S^j - C_S) = 0.$$

Summing both first-order conditions gives

$$M_S^i + M_S^j - 2C_S = \frac{4\tau_B\tau_S - 2\pi\left(u_i + u_j\right)}{2\tau_B}.$$

Reformulating this gives the best-response function

$$M_S^j(M_S^i) = 2C_S - M_S^j + \frac{4\tau_B\tau_S - 2\pi\left(u_i + u_j\right)}{2\tau_B}.$$

Plugging this into (19) and simplifying leads to

$$M_S^i = C_S + \frac{6\tau_B\tau_S - 2\pi(u_i + 2u_j)}{6\tau_B}.$$

We can now calculate

$$M_S^j - M_S^i = \frac{\pi(u_j - u_i)}{3\tau_B},$$

and calculate equilibrium demand of sellers on platform i

$$n_S^i = \frac{\left[6\tau_B\tau_S - 2\pi\left(u_i + 2u_j\right)\right]}{6\left[2\tau_B\tau_S - \pi(u_i + u_j)\right]},$$

and

$$n_B^i = \frac{\left(6\tau_B\tau_S - 3\pi(u_i + u_j)\right)\tau_B + (u_i - u_j)(3\tau_B\tau_S - \pi(u_i + u_j))}{6\tau_B\left[2\tau_B\tau_S - \pi(u_i + u_j)\right]}.$$

Plugging this into (12) and simplifying leads to the equilibrium profits of platform i in (13). It is straightforward to show that Π^i is strictly decreasing in u_i under Assumption 3. This concludes the proof. □

Proof of Proposition 5. First, for $\alpha < \underline{\alpha}$, i.e. for a small share of naifs, Lemma 2 implies that

$$u^{unshr;e} \geq u^{shr} \geq u^{unshr;\overline{a}}.$$

In this case unshrouding would induce sellers to charge the low additional fee e, which would be the worst outcome for platforms as that would lead to the highest perceived buyer surplus. Knowing this, platforms shroud their additional fees. As a reaction to shrouding, sellers set the high additional fee $\overline{a}$.

Second, for $\underline{\alpha} \leq \alpha \leq \bar{\alpha}$, i.e. for an intermediate share of naifs, Lemma 2 implies

$$u^{shr} \geq u^{unshr;e} \geq u^{unshr;\overline{a}}.$$

Again, unshrouding reduces consumers' perceived surplus which increases platforms' profits. However, sellers charge the low additional fee e since $\alpha \leq \bar{\alpha}$ under a medium share of naifs by Lemma 1.

Third, for $\alpha > \bar{\alpha}$, i.e. for a large share of naifs, Lemma 2 implies that

$$u^{shr} \geq u^{unshr;\overline{a}} \geq u^{unshr;e}.$$

Therefore unshrouding reduces consumers' perceived surplus which increases platforms' profits by Proposition 4. We also know from Lemma 1 that sellers charge a high additional fee $\overline{a}$ for $\alpha > \bar{\alpha}$. □

Proof of Lemma 7. Take a seller s and suppose she sets $a_s \leq e$. Consider the profit function of firm s, supposing all rivals play the same strategy (f_r, a_r).

$$(1-\lambda)\alpha\left(\frac{1}{n} + \frac{f_r - f_s}{t}\right)(f_s + a_s - c) + (1 - (1-\lambda)\alpha))\left(\frac{1}{n} + \frac{f_r + \min\{a_r, e\} - f_s - a_s}{t}\right)(f_s + a_s - c).$$

The same arguments as in Lemma 1 imply that s optimally sets $a_s = e$ whenever $a_s \leq e$. For a given sum $f_s + a_s$, $a_s = e$ maximizes profits from the remaining naive consumers, while keeping profits from sophisticated ones unaffected. When all firms charge $a_s = e$, this simplifies profits to

$$\left(\frac{1}{n} + \frac{f_r - f_s}{t}\right)(f_s + e - c).$$

It is optimal to set $a_s = e$ whenever an upward deviation to $\overline{a}$ is not profitable. This deviation induces

$$\left(\frac{1}{n} + \frac{f_r - f_s}{t}\right)(f_s + (1-\lambda)\alpha\overline{a} - c).$$

This upward deviation does not change demand of sophisticated consumers. Before the deviation they payed the additional fee e. After the deviation they avoid $a_s = \overline{a}$, which costs them the effort e. Thus, with unshrouded additional fees, sellers charge low additional fees if and only if $\alpha < \bar{\alpha}$. □

Proof of Lemma 8. With unshrouding and small additional fees e, prices are $f^{unshr;e} = c - e + \frac{t}{n}$, earning profits $\pi = \frac{t}{n^2}$. Average perceived buyer surplus is $u^{unshr;e} = \frac{1}{2}\left[v - \frac{t}{4n} - c - \frac{t}{n} + (1-\lambda)\alpha\overline{a}\right]$.

Similarly, under unshrouding with large additional fees $\overline{a}$, we get $f^{unshr;\overline{a}} = c - (1-\lambda)\alpha\overline{a} + \frac{t}{n}$, earning profits $\pi = \frac{t}{n^2}$, and average perceived buyer surplus $u^{unshr;\overline{a}} = \frac{1}{2}\left[v - \frac{t}{4n} - c - \frac{t}{n} + (1-\lambda)\alpha\overline{a} - (1-(1-\lambda\right.$

Comparing these values shows that the cutoffs derived in Lemma 2 apply as well in the Salop model. □

Proof of Lemma 9. Gabaix and Laibson (2006) do not establish this type of result for a Salop circle, which is why we present a proof in more detail.

A firm i that deviates from the shrouding equilibrium by unshrouding optimally sets $a_s = e$. With a larger a_s, unshrouding only reduces the share of profitable naive consumers and can never be optimal. With a smaller $a_s < e$, firm s could increase demand from consumers who remain naive by increasing a_s while keeping $f_s + a_s$ constant to keep demand from sophisticated consumers unaffected. Thus, deviating firms maximize

$$(1-\hat{\lambda})\alpha\left(\frac{1}{n} + \frac{f^{shr} - f_s}{t}\right)(f_s + e - c) + \left(1 - (1-\hat{\lambda})\alpha\right)\left(\frac{1}{n} + \frac{f^{shr} + e - f_s - e}{t}\right)(f_s + e - c),$$

which simplifies to

$$\left(\frac{1}{n} + \frac{f^{shr} - f_s}{t}\right)(f_s + e - c).$$

Using $f^{shr} = c - \alpha\overline{a} + \frac{t}{n}$ from above, $f_s = c + \frac{t}{n} - \frac{1}{2}(\alpha\overline{a} + e)$ maximizes s's deviation profits, earning s a profit of $\pi^{dev} = \frac{t}{n^2}\left(1 + n \cdot \frac{e - \alpha\overline{a}}{2}\right)^2$. Thus, this deviation from the shrouding equilibrium is unprofitable if $\pi > \pi^{dev}$, that is $\alpha > \frac{e}{\overline{a}}$. □