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 some consumers naively ignore shrouded additional fees. The key mechanism is that platforms shroud or unshroud sellers' fees to manage cross-group network externalities between buyers and sellers. First, we find that platforms have stronger incentives to shroud additional fees of sellers, than sellers themselves in the absence of platforms. This holds when platforms want to increase buyer surplus per interaction to encourage cross-group network externalities, like monopoly platforms and some settings with competing platforms. This suggests that the increasing prevalence of online marketplaces might have lead to more shrouding of additional fees and features. This also indicates that regulation can play a role in increasing transparency of these fees. In turn, regulators who worry about non-transparent pricing should pay special attention to platforms, and we discuss the effects of some transparency-inducing policies. Second, platforms might prefer to limit cross-group externalities to soften competition between platforms. In these cases platforms might regulate additional fees to the benefit of buyers. We discuss rational benchmarks without naive buyers, and connections to frequent practices like drip pricing, and platforms like Amazon or eBay regulating shipping fees.

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1 Introduction

Policymakers in many countries are increasingly concerned and start to actively regulate two-sided platforms who obfuscate fees that sellers charge on these marketplaces. The EU pressured AirBnB to include service fees and the hosts' cleaning charges in the displayed total prices.[1] UK authorities pushed the ticket marketplace Viagogo 'to make its exorbitant fees and delivery charges clear',[2] and the UKRN (2016) voiced concerns about unanticipated additional fees that sellers charge on price-comparison websites. In the USA, a report for the FTC (Sullivan, 2017) investigated hotels' resort fees, emphasizing that online travel agents do not warn consumers or disclose them. The US Department of Transport decided that online travel agents must display the total ticket price more prominently than the breakdown of its price components.[3] Despite these growing concerns, the economic literature did not yet study the incentives of two-sided platforms to obfuscate merchants' fees. In particular, as in many examples above, why do these platforms hide fees they do not even earn themselves? And when and how should regulators intervene?[4]

To investigate these questions we combine as of yet disjoint strands of the literature. Following Gabaix and Laibson (2006), the literature on deceptive products studies incentives of firms to disclose (a.k.a. unshroud) hidden product attributes that some naive consumers wrongly ignore. But this literature has not studied two-sided platforms. Similarly, the literature on two-sided platforms following Caillaud and Jullien (2003), Rochet and Tirole (2003), and Armstrong (2006) explores how platforms manage externalities between its users, but does not consider deceptive products or products with add-on features, and the incentives of platforms to disclose sellers' fees.

We model seller competition in a product category on a platform based on Gabaix and Laibson (2006). In each product category sellers charge a base price f and a possibly shrouded additional fee $a \leq \overline{a}$.[5] There are two types of buyers: the share α are naive and the remaining $1-\alpha$ sophisticated.

[1] See `https://www.euronews.com/2018/09/20/airbnb-complies-with-eu-consumer-regulation-demands`. Accessed 6. December 2019.

[2] Source: `https://www.theguardian.com/money/2018/aug/01/viagogo-ticket-prices-fees-delivery-costs`. Accessed 6. December 2019. Also, the OFT (2012) worries about intransparent payment surcharges of online retailers

[3] See `https://www.transportation.gov/individuals/aviation-consumer-protection/buying-ticket`. Accessed 6. December 2019. As another 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/`. Both accessed 15 August 2019.

[4] Also 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.

[5] The cap $\overline{a}$ captures, for example, an unanticipated willingness to pay for an add-on service like extra luggage or

When choosing a product, naifs wrongly ignore shrouded additional fees and end up paying more than anticipated. Sophisticates take shrouded fees into account and can avoid them at a cost $e < \overline{a}$. Since avoiding costs e without increasing product value, it is inefficient. This captures, for example flight-aggregator platforms where naifs might wrongly believe luggage is included in the ticket price. Sophisticates correctly anticipate large luggage fees and might reduce their luggage to avoid them.

A key novelty is that platforms shroud or unshroud additional fees of sellers on the platform. Unshrouding makes additional fees observable when consumers choose a product and turns some naifs into sophisticates. This captures the platforms' potential to create a more transparent marketplace. For example, flight-aggregator websites can disclose luggage fees, include them in list prices, or prioritize in the search algorithm airlines that transparently depict luggage fees.

In turn, many platforms display additional fees late in the purchase process to shroud them. Compelling evidence suggests that this practice—called 'drip pricing'—can boost revenue. Chetty et al. (2009) find that supermarket price tags without a sales tax of 7.375% increase sales by 8%. In Blake et al. (2018), an online ticket platform obfuscating a 15% fee increases revenue by 21%.[6]

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 to buy products from, and vice versa. We enrich the standard setting by modeling the buyer-seller interaction explicitly as outlined above. Platforms maximize profits, and can use two instruments to manage cross-group externalities. First, they charge prices for buyers and sellers who join the platform. Second, they shroud or unshroud sellers' additional fees on the platform.

Our framework applies to products with *avoidable* additional fees on platforms. Examples include flight-aggregators like Skyscanner, Google Flights, or Kayak with potentially shrouded luggage- or check-in fees, but also hotel-booking websites like booking.com or Expedia and additional service fees in hotels, or fees for express shipping. Our framework also applies to *unavoidable* additional fees that some consumers naively ignore when they are shrouded. Examples include sales taxes or fees for standard shipping on price-comparison websites (PCWs) and marketplaces.[7]

Our key mechanism is that platforms shroud or unshroud sellers' fees to manage cross-group

fast shipping. It can also stand for a regulatory cap on additional fees.

[6] In a lab experiment by Huck and Wallace (2015), drip pricing reduces consumer surplus by 22% relative to upfront prices.

[7] With unavoidable fees, e captures a participation distortion: sophisticates anticipate expensive additional fees and might not buy when it is efficient. $\overline{a}$ captures revenues from unavoidable fees that naifs wrongly ignore.

externalities. Shrouding induces the following tradeoff for the average perceived buyer surplus per interaction on the platform (henceforth 'buyer surplus').[8] Shrouding induces sellers to exploit naifs with large additional fees $\overline{a}$, which sophisticated consumers anticipate and avoid. The avoidance cost is inefficient and reduces buyer surplus. But since naifs ignore large additional fees, they wrongly believe that products are cheap, increasing perceived buyer surplus. In this way shrouding influences perceived buyer surplus, and therefore the number of buyers who join the platform. Because of cross-group externalities, the number of buyers impacts the number of sellers, which in turn affect the number of buyers and so on.

In the first group of market structures we investigate, platforms want to increase buyer surplus to create larger cross-group externalities. We start our analysis with monopoly platforms. Platforms (un)shroud to increase buyer surplus per interaction, launching a virtuous circle for the platform: a larger perceived surplus attracts more buyers to the platform. Because of positive cross-group externalities, more buyers attract more sellers and so on.

To increase buyer surplus, platforms might cater to naifs' mistakes. With sufficiently many naive buyers platforms shroud to appear cheap. This attracts more buyers and starts the aforementioned virtuous circle. With many sophisticates, however, platforms unshroud sellers' fees to prevent the avoidance effort. This tradeoff is in line with Einav et al. (2015) and Tran (2019) who find that eBay sellers should optimally offer either large shipping fees, or transparent and free shipping.

Our first main insight is the following: platforms have stronger incentives to shroud additional fees of sellers, than sellers themselves in the absence of platforms. This is true even though platforms do not earn the shrouded fees themselves, and holds when platforms' profits increase in buyer surplus. To show this, we compare unshrouding incentives of monopoly platforms with unshrouding incentives of sellers who interact without a platform as in Gabaix and Laibson (2006). Intuitively, without platform a shrouding equilibrium exists where all sellers shroud to earn large additional fees $\overline{a}$ from naive buyers. But a seller might unshroud to gain a competitive edge over their shrouding rivals: by unshrouding and reducing additional fees, a seller can show sophisticated buyers that she is cheaper. But platforms coordinate (un)shrouding for all sellers, eliminating the possibility for individual sellers to unshroud to gain a competitive edge. This reduces incentives to unshroud.

Our first main result has some important implications. First, it suggests that the increasing

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

prevalence of online marketplaces might have lead to more shrouding of additional fees and features. In line with this, 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.

Second, platforms having large incentives to shroud additional fees indicates that regulation can play a role in increasing transparency of these fees. In turn, regulators who want to induce transparent marketplaces should be especially concerned about platforms, even when they do not directly earn the fees they shroud.

Third, we discuss some policies in detail. Policymaker could insist that unavoidable additional fees like standard-shipping fees are included in base prices, or that buyers must opt-in to paying additional fees. Effects on total consumer surplus are ambiguous. These policies unshroud fees and reduce inefficient avoidance, increasing buyer surplus per interaction with a seller. But transparent products appear more expensive, reducing participation and the overall number of interactions.

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. Also these competing platforms want to increase buyer surplus to encourage cross-group externalities. Thus, platforms' incentives to shroud are unaffected by competition and our first main result carries over.

We then study 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* perceived buyer surplus and limit cross-group externalities. Everything else equal, a larger perceived buyer surplus attracts more buyers just like in previous scenarios. But with rigid unshrouding this induces a price response: the rival platform reduces prices to attract more buyers as well, leading to fiercer competition between platforms. To avoid price competition, platforms *reduce* perceived buyer surplus, reversing shrouding incentives. Platforms now unshroud when there are many naifs and shroud otherwise.

The reversed shrouding incentives imply our second main insight: platforms might regulate and cap sellers' additional fees. This holds in settings where platforms' profits decrease in buyer surplus.

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 caps reduce *perceived* buyer surplus, they never harm *actual* buyer surplus. Lower additional fees reduce inefficient avoidance of sophisticates and the share of the total price that naifs wrongly ignore. Caps induce a more transparent marketplace and can increase total consumer surplus.

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.

Our main results suggest that a key to understand platforms' incentives to design a transparent marketplace is whether they want to encourage or limit cross-group externalities. In the first case, platforms have rather large incentives to shroud and market regulators should be concerned about intransparent platforms. In the second case platforms may regulate sellers' additional fees.

We compare results to a rational benchmark without naifs, but sophisticates who demand an add-on. Monopoly platforms always unshroud their sellers' additional fees and induce a transparent marketplace, suggesting that naiveté plays a key role in explaining the prevalence of obfuscating platforms. 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 two-sided markets 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.

There are infinitely many sellers. Each seller offers a single product, and 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. In each product category, two sellers with marginal cost c are located at opposite ends of a Hotelling line of length one.[9] Each seller $s \in \{1, 2\}$ charges a base price f_s 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 a fee for extra luggage or seat selection.[10]

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 wrongly believe they are zero even when they are positive. The other group of buyers—sophisticates—also do not observe shrouded additional fees, but understand the firms' incentives. Sophisticates have correct Bayesian posteriors about shrouded a_s denoted Ea_s. When they anticipate large additional fees, sophisticated buyers can pay a precautionary avoidance cost 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 paying the avoidance cost e is inefficient. In the example of flight-ticket aggregators, some consumers might wrongly 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 key difference to previous articles with shrouded attributes is that not sellers but each platform shrouds or unshrouds additional fees, and it does so 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. Unshrouding only affects buyers on the unshrouding platform. This captures that a website adapting a more transparent price scheme mostly affects its own users. To simplify exposition, the main text assumes $\lambda = 1$, i.e. unshrouding eliminates buyer mistakes; but we prove all main results for $\lambda \in (0, 1]$. Appendix A.1 has the details.

The timing is as follows:

[9] Using a Hotelling model keeps results comparable to the literature on shrouded attributes. 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.

- **Period 1:** Platforms shroud or unshroud additional fees, and 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, all 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.
- **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.[11]

We look for perfect Bayesian equilibria.[12] Beliefs matter mostly for buyers and are quite 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 equals the share in the population 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. In period 3, a seller s with a rival r faces the following demand.

[11] In some settings like price-comparison websites, consumers who observe large additional fees or expensive upgrades on a merchants website could cancel the interaction and look for another seller. Ellison and Ellison (2009) find that consumers do not seem to do that. In equilibrium consumers choose their preferred product in period 4, suggesting that results are robust when in period 5 consumers can pay a small effort cost to buy from another seller.

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

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

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 the cost e to avoid it. Only naifs pay $\overline{a}$. Using these steps, the profits of seller $s \neq r$ simplify to

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

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

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

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 sophisticated ones.

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 wrongly ignore additional prices $\overline{a}$; sophisticates because they avoid $\overline{a}$. Avoiding $\overline{a}$ costs e to sophisticates and reduces average perceived buyer surplus by $(1-\alpha)e$.[13]

3.2 Seller Competition under Unshrouding

We now study subgames after the platform unshrouds additional fees. Unshrouding turns all buyers into sophisticated ones who observe additional fees when choosing a base product. Demand is

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

A seller s either charges large additional fees $a_s > e$ that sophisticates avoid, or small $a_s \leq e$ that sophisticates pay. The following Lemma characterizes optimal unshrouded additional fees.

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

Lemma 1. *With unshrouded additional fees, each seller s charges low fees $a_s \leq e$.*

Since unshrouding turns all buyers into sophisticates, sellers optimally charge additional fees below e. Otherwise, they could reduce a_s below e to increase margins without reducing demand.[14]

With unshrouding only total prices f_s+a_s matter for sellers' profits, resulting in classic Hotelling prices, profits, and buyer surplus per interaction. Using the superscript 'unshr' for 'unshrouding', seller s maximizes $(f_s + a_s - c)\left(\frac{1}{2} + \frac{(f_r+a_r)-(f_s+a_s)}{2t}\right)$, inducing $f^{unshr} + a^{unshr} = c + t$, where $a^{unshr} \leq e$. Profits are $\pi^{unshr} = t/2$, and buyer surplus per seller is

$$u^{unshr} = \frac{1}{2}\left[v - \frac{5}{4}t - c\right]. \tag{3}$$

The following Lemma summarizes buyer and seller surplus under the different scenarios.

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

1. $\pi^{unshr} = \pi^{shr} = t/2 \equiv \pi$.

2. $u^{shr} \geq u^{unshr}$ if and only if $\alpha \geq \underline{\alpha}$.

Mirroring classic results on deceptive products (e.g. Armstrong and Vickers (2012), Gabaix and Laibson (2006)), sellers earn the same expected profits per buyer, whether the platform shrouds or unshrouds. In equilibrium sellers compete away revenues from additional fees with a lower base price, and profits only depend on the product differentiation—t. Since seller profits are the same in both scenarios, the inefficiencies arising from inefficient avoidance e shows up in buyer surplus.

$u^{shr} \geq u^{unshr}$ if and only if $\alpha \geq \underline{\alpha}$ captures the tradeoff that shrouding makes products appear cheap, but induces avoidance costs to sophisticates.

4 Unshrouding Incentives of Platforms

This Section models three types of settings to explore incentives of platforms to unshroud sellers' 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.

[14] Note that $a_s \leq e$ is not pinned down only in the extreme case where $\lambda = 1$. For all λ close to one, it is strictly better to charge $a_s = e$ to maximize benefits from the remaining naifs.

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. We depart from this approach and model seller competition in a product category as in Section 3. For example, 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 surplus u^l per seller. The share of buyer-type l in the population is β_l with $\sum_{l=1}^{2} \beta_l = 1$.[17] The average surplus 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

$$v_B^l = n_S u^l + k - M_B \quad \text{and} \quad v_S = n_B \pi + k - M_S, \tag{4}$$

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 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. This drives the cross-group externalities and means that buyers benefit from more sellers and vice versa. Second, for any number of interactions, each additional interaction has the same expected marginal value.

[15] The main results are robust to differing costs, however, using the same costs shortens the exposition substantially.

[16] Results are qualitatively unaffected if monopoly platforms instead charge usage fees per interaction.

[17] We use two types to distinguish naive and sophisticated buyer types.

[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. Because the cost of serving a marginal agent on the platform C are likely small for online platforms, we do not consider $k > C$ a restrictive assumption.

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 sellers increases linearly in their valuation of the platform. Using this framework, we can derive the demand for the platform.[19]

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

$$n_B(M_B, M_S, u) = \frac{k(1+u) - M_B - uM_S}{1 - \pi u} \quad \textit{and} \quad n_S(M_B, M_S, u) = \frac{k(1+\pi) - M_S - \pi M_B}{1 - \pi u}. \quad (5)$$

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 reflects 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 equals its share in the population β_l. Thus, the share of naifs on the platform is always α. The reason is the linear valuation of buyers (4).[20] Third, by Lemma 2, $\pi = t/2$ both for shrouded and unshrouded additional fees. Thus, (un)shrouding directly impacts demand and profits only via u, and we can formulate the platform's problem as if it chooses u directly.

We can now state the monopoly platform's problem.

$$\max_{M_B, M_S, u} n_B(M_B, M_S, u) \cdot (M_B - C) + n_S(M_B, M_S, u) \cdot (M_S - C). \quad (6)$$

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

Lemma 4. *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 average buyer surplus from an interaction u.*

The key observation is that the monopoly platform wants increase buyer surplus u to benefit from cross-group exernalities. Thus, it (un)shrouds to maximize perceived buyer surplus u. A

[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.

larger u induces more buyers to join the platform. 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 $\alpha \geq \underline{\alpha}$, inducing sellers to charge large additional fees $\overline{a}$. Otherwise, the monopoly platform unshrouds additional fees, and sellers charge low additional fees weakly below e.*

With many naifs $\alpha \geq \underline{\alpha}$, the platform shrouds additional fees to appear cheap. But with few naifs, the platform unshrouds to simplify consumers' lives and prevent the inefficiency e of sophisticates. 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 wrongly ignore $\overline{a}$, and products are indeed cheap for sophisticates who avoid shrouded fees. Avoiding fees, however, induces the inefficiency e for sophisticates, which reduces buyer surplus by $(1-\alpha)e$.[22] Thus, if α is large, i.e. $\alpha \geq \underline{\alpha}$, the platform shrouds additional fees to make products appear cheap.[23] But if α is small, the platform puts a higher weight on the inefficiency e of sophisticates and unshrouds.

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 tickets, and upgrades to more expensive tickets.[24] This suggests that drip pricing made products appear cheaper.

Our results are also consistent with evidence by Einav et al. (2015) for sellers on eBay. Somewhat

[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.

[22] Under shrouding, sophisticates might suffer or benefit from the presence of naifs. Sophisticates cost for consumption are $f^{shr} + e$ with shrouding and $c + t$ otherwise. Thus, unshrouding reduces their costs for consumption with shrouding if $\alpha \geq \frac{e}{\overline{a}}$, but increases them if $\alpha \in (\underline{\alpha}, \frac{e}{\overline{a}})$

[23] Note that since $e \leq \overline{a}$, $\underline{\alpha} = e/(\overline{a} + e) \leq 1/2$.

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

surprisingly, sellers who charge shipping fees below 10$ can increase revenue by either increasing shipping fees, or by offering free shipping. Similarly, Tran (2019) finds an under-reaction to marginal changes in shipping fees, and a discontinuous positive effect of free shipping on demand on eBay Germany. 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 show sophisticates that they do not need to worry about large shipping fees.

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 two 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 at the same time when they set prices.[25] As in 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, 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*.*

Sellers without platforms 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* reducing additional fees to $a_s = e$ can increase profits. The deviating seller can show to sophisticated consumers that she is cheaper and *gain a competitive edge.* Sophisticated consumers no longer avoid additional fees, so the deviating sellers can earn smaller additional fees e from *all* customers. Thus, sellers deviate from shrouding if the share of naifs is small, i.e. $e > \alpha\overline{a}$.

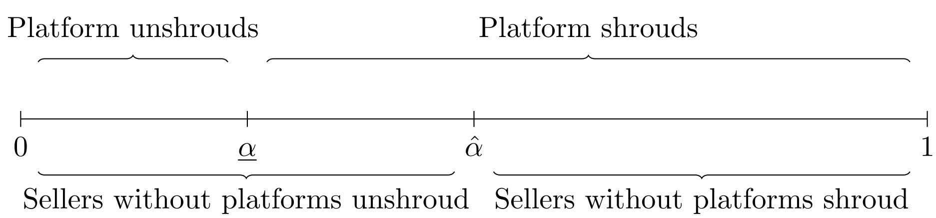
The following Proposition compares shrouding incentives of a monopoly platform and of sellers without platform. The result follows directly from comparing the respective cutoffs $\underline{\alpha}$ and $\hat{\alpha}$. Figure 1 illustrates this graphically. It is our first main result.

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

[25] More precisely, the game is the same as in Section 2 without platforms and without periods 1 and 2. In period 3, sellers set f_s and a_s and decide whether to shroud additional fees to consumers in the market or not.

Intuitively, sellers without platform unshroud to gain a competitive edge over their shrouding rivals, but platforms coordinate (un)shrouding and prevent that sellers compete with transparency. More precisely, by Lemma 5 sellers without platforms earn additional fees $\alpha\overline{a}$ from *naive* customers in a shrouding equilibrium. But a seller can unshroud to gain a competitive edge over the shrouding rival, earn e from *all* its customers and use these revenues to reduce base prices. Platforms, however, coordinate shrouding and unshrouding for all sellers, eliminating the possibility for an individual seller to gain a competitive edge. (Un)shrouding to maximize buyer surplus per interaction, the platform trades off benefits from shrouding—$\alpha\overline{a}$ from lower base prices to appear cheap—against the avoidance cost of sophisticates $(1-\alpha)e$. Because sellers' revenues from shrouded additional fees equal the fees that naifs wrongly ignore and make the platform look cheap, the benefits of shrouding are the same. But sellers can unshroud to gain a competitive edge, earning e from all its customers, while platforms only reduce the inefficiency of sophisticates $(1-\alpha)e$.

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



The result holds for all λ and $\hat{\lambda}$ and does not depend on whether the platform is better at unshrouding than sellers without platform.[26]

There is suggestive evidence that platforms have indeed strong incentives to shroud. First, Blake et al. (2018) show in their Table 9 that a wide range of two-sided online platforms like AirBnB, eBay, Hotels.com or TaskRabbit use some form of drip pricing. Second, we cite many articles throughout this paper who study the impact of arguably shrouded pricing schemes of two-sided 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

[26] Sellers without platforms deviate from shrouding to increase revenue from additional fees from $\alpha\overline{a}$ to e, none of which depend on $\hat{\lambda}$. 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 $\lambda > 0$. This implies that for $\lambda \in (0, 1]$, $\underline{\alpha}$ generalizes to $\underline{\alpha}_\lambda = \frac{e}{\overline{a}+\lambda e}$, which is below $\hat{\alpha}$ for all $\lambda > 0$.

Ellison, 2009, Einav et al., 2015, Greenleaf et al., 2016, Hossain and Morgan, 2006, Smith and Brynjolfsson, 2001, Tran, 2019), suggesting that these practices are quite common among online platforms.

4.1.2 Policies and Total Consumer Surplus

The previous Subsection suggests that policymakers who are concerned about shrouded prices should be particularly concerned about platforms.[27] We now discuss some transparency-inducing policies in the context of our model.

Upfront pricing: Policymakers can insist that prices include all unavoidable fees upfront. As an example consider the EU pushing AirBnB to include hosts' cleaning fees in prices upfront. In our model, this forces firms to unshroud additional fees.

Opt-in to add-ons: Policymakers could insist that sellers can only charge add-on fees if buyers gave explicit consent. This allows airlines to charge extra fees for check-in luggage, but only if buyers consent to these fees. By requiring consent, also this policy effectively unshrouds fees to buyers when they sign a contract. Additionally, it reduces ex-post surprises for naive buyers and allows them to avoid fees by default.

Implications on total consumer surplus are ambiguous. Both policies effectively force sellers to unshroud additional fees. Sellers respond with lower additional fees below e, leading to less avoidance behavior and therefore larger actual consumer surplus for a *given* interaction.[28] These policies, however, make the platform look more expensive to naive buyers, and unshrouding reduces the cross-subsidy from naive to sophisticated buyers. As a result, transparency can induce fewer buyers to participate on the platform and *reduce* the number of interactions on the platform.

4.1.3 Rational Benchmark: Monopoly

To further explore the role of naiveté, we study a classic benchmark model with only sophisticated buyers. The results are quite unambiguous: monopoly platforms want to unshroud additional fees.

[27] There are other reasons why policymakers who care about market transparency should focus on platforms. First, by designing a marketplace, platforms likely have a larger potential to induce transparency that sellers. Second, an increasing number of transactions takes place on platforms.

[28] When $\lambda \in (0, 1)$ and unshrouding does not affect all naifs, sellers might continue to charge large unshrouded additional fees. But nonetheless, the policies increases parameter ranges for which $a_s \leq e$ and buyers do not pay e.

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 results suggests that naiveté plays a key role in explaining why platforms obfuscate sellers' fees. It 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, preventing 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.8.

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 that raise awareness of exploitative features like pop-up windows on websites to remind consumers about airlines' luggage surcharges.

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. 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.[29] Membership fees also capture that some platforms do not monitor sales—e.g. some PCWs 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.

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

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:

$$n_B^{il} = \beta_l \left(\frac{1}{2} + \frac{v_B^{il} - v_B^{jl}}{2\tau_B} \right) \quad \text{and} \quad n_S^i = \frac{1}{2} + \frac{v_S^i - v_S^j}{2\tau_S}, \tag{7}$$

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

$$v_B^{il} = n_S^i u_{il} - M_B^i + k \quad \text{and} \quad v_S^i = n_B^i \pi - M_S^i + k. \tag{8}$$

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.[30] 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.[31] 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*

$$n_S^i = \frac{\tau_B \tau_S - \pi u_j + \tau_B (M_S^j - M_S^i)}{2\tau_B \tau_S - \pi(u_i + u_j)} \text{ and } n_B^i = \frac{1}{2} + \frac{(M_S^j - M_S^i)(u_i + u_j) + \tau_S (u_i - u_j)}{4\tau_B \tau_S - 2\pi(u_i + u_j)}. \tag{9}$$

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.

We can now analyze the problem of platform i

$$\max_{M_S^i, u_i} \left(M_S^i - C_S \right) n_S^i (M_S^i, M_S^j, u_i, u_j) - C_B n_B^i (M_S^i, M_S^j, u_i, u_j). \tag{10}$$

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

[31] 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.6. For similar reasons, Armstrong and Wright (2007), Nocke et al. (2007) and Eliaz and Spiegler (2011a) 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.

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.

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, the platforms' shrouding incentives coincide with the monopoly platform's shrouding incentives.*

Competition with flexible shrouding induces the same shrouding incentives as of monopoly platforms. In both cases, platforms maximize profits by maximizing buyers' perceived surplus per interaction. 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, the results from Proposition 2 extend and with flexible shrouding platforms have stronger incentive to shroud than sellers without platforms.[32]

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

4.3 Competition with Rigid Unshrouding

In all previous settings profits of platforms increase in buyer surplus, reflecting that platforms benefit from cross-group externalities. We now explore a scenario where platforms want to reduce perceived buyer surplus to soften competition between platforms, changing shrouding incentives.

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 that naive buyers who observe 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

[32] We do not discuss the rational benchmark explicitly, but also results from Section 4.1.3 carry over.

competition into account.[33] Thus, rigid unshrouding better describes platforms with frequently returning buyers, while flexible unshrouding captures platforms with more occasional buyers.

We change the timing of the game to study rigid unshrouding and split period 1 into two periods. In period 1a platforms choose whether to (un)shroud; in period 1b platforms observe the rival's shrouding choice from period 1a and set membership fees. The key difference to flexible unshrouding is that platforms observe if their rival shrouded when setting membership fees.

We solve the sequential game between platforms using backwards induction. By Lemma 1, shrouding of platform i changes perceived buyer surplus u_i. In the pricing subgame, platform i observes its rival's (un)shrouding decision, and maximizes profits by choosing membership fees for sellers. Using again Assumptions 1 and 2, and seller demand in (9), platform i's problem in period 1b becomes[34]

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

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*

$$\Pi^i = \frac{\left[3\tau_B \tau_S - \pi\left(u_i + 2u_j\right)\right]^2}{9\tau_B\left[2\tau_B\tau_S - \pi(u_i + u_j)\right]}. \tag{12}$$

Profits strictly decrease in u_i.

In contrast to the previous scenarios, 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

[33] This argument follows Dahremöller (2013).

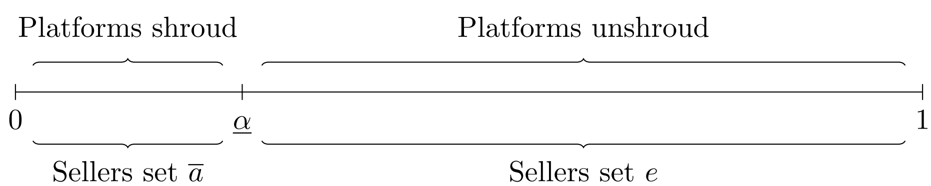
[34] Both Assumptions simplify the exposition of results. Without Assumption 1 the problem becomes highly intractable. We simulated solutions and found that our results also obtain without Assumption 1 for a wide range of parameters. Relaxing Assumption 2, $C_B < \frac{\left[6\tau_B\tau_S - 2\pi\left(u_i+2u_j\right)\right]^2}{18\left[2\tau_B\tau_S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

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. In sharp contrast to the previous settings, platforms (un)shroud to reduce perceived buyer surplus.[35]

Proposition 5. *With rigid shrouding, platforms shroud additional fees if and only if $\alpha < \underline{\alpha}$.*

The incentives of sellers are unaffected. As in Section 3, shrouding induces sellers to charge $\overline{a}$, and unshrouding induces additional fees below e. Rigid unshrouding, however, reverses the platforms' incentives to shroud, because offering a lower perceived buyer surplus softens competition between platforms.

Figure 2: Unshrouding incentives under competition with rigid unshrouding



In the first case ($\alpha < \underline{\alpha}$), there are only few naifs who ignore the large additional fees $\overline{a}$, but shrouding induces large avoidance costs $(1-\alpha)e$ for sophisticates. As a result, with few naifs the platforms shrouds to soften competition.

Platforms shroud but would prefer if sellers charge low additional fees just above e. They want to shroud fees but not appear too cheap. Lower additional fees would increase base prices and reduce perceived surplus of naifs without inducing sophisticates to avoid additional fees. Thus, perceived buyer surplus would decrease even more, and further soften competition between platforms.

[35] Note that platforms benefit from lower u_i, but this does not imply that platforms want to offer a bad service overall. Allowing for stand-alone benefits to differ between platforms, i.e. k_i for platform i, one can show that profits of platforms in period 1a increase in k_i, but continue to decrease in u_i. Platforms want to limit cross-group network effects, but they still benefit from offering a better stand-alone benefit.

A potential example for this scenario might be Mariott Hotels who were accused of adding 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 by charging commissions on resort fees. But as predicted by this scenario, they did not disclose them.[36]

In the second case ($\underline{\alpha} \leq \alpha$), platforms face many naive buyers. They unshroud to induce sellers to reduce additional fees below e. Unshrouding makes products on the platform appear more expensive; this reduces perceived buyer surplus and softens competition between platforms.

Remark on total consumer surplus: Because of Hotelling competition between platforms, in equilibrium platforms attract half the sellers and there is no participation distortion. Because shrouding still reduces actual buyer surplus per interaction, it reduces total consumer surplus.[37]

4.3.1 Platforms as Regulators.

The first scenario ($\alpha < \underline{\alpha}$) in the previous Subsection highlights a conflict between platforms and sellers on additional fees. Sellers charge large additional fees because they are shrouded, but platforms prefer smaller additional fees to induce larger base prices. With lower additional fees products on the platform appear more expensive, which softens competition between platforms. This conflict suggests that platforms would like to regulate additional fees of sellers.[38]

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

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 they shroud and the share of naifs is small.[39] As outlined above, for small α sellers charge large additional fees, but platforms prefer smaller ones to mitigate price competition with the rival

[36] 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.

[37] Clearly, participation distortions likely matter in practice, so we do not think that welfare implications of this model should be taken at face value.

[38] In practice the ability of platforms to impose caps on fees depends on the bargaining power of platforms. Especially towards large sellers, platforms might not be able to impose a cap.

[39] We show in Appendix A.1 that for general $\lambda \in (0, 1]$, platforms might also cap additional fees when they unshroud and the share of naifs is sufficiently close to 1.

platform. Platforms regulate additional fees to induce larger base prices. Products on the platforms appear more expensive, but this mitigates competition between platforms.[40]

Caps on additional fees reduce consumer mistakes, and can increase actual buyer surplus. 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 $\lambda < 1$, the cap might prevent the inefficient avoidance cost e of sophisticates and strictly increase actual buyer surplus.[41] Thus, platforms acting as regulators reduce consumer mistakes and can increase actual total consumer surplus.[42]

Our result 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.[43] 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.[44]

Our two main results together suggest that a key to understand platforms' incentives to design a transparent marketplace is whether they want to encourage or limit cross-group externalities. If they benefit, platforms have rather large incentives to shroud, and authorities should be concerned about intransparent platforms. On the contrary, when platforms prefer smaller cross-group externalities, they may act as regulators by capping sellers' additional fees.

[40] For $\alpha \geq \underline{\alpha}$, 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.

[41] For details, see Appendix A.1.

[42] Due to Hotelling competition between platforms the share of buyers and sellers is 1/2 in each equilibrium, and actual consumer surplus is proportional to the actual buyer surplus from an interaction. With a participation distortion, regulation could reduce the number of buyers on the platform.

[43] 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`.

[44] 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 compare results to a rational benchmark without naive buyers. Since platform i wants to reduce u_i to mitigate price competition, platforms 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 naive buyers competing platforms do not want cap additional fees. Without naifs, i.e. $\alpha = 0$, u^{unshr} is independent of $\overline{a}$, so caps on additional fees have no effect.

We study a more general benchmark in Appendix A.8. 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. These benchmarks without naifs cannot explain why platforms like Amazon or eBay might 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 **avoidable 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 choosing 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.[45]

[45] As an example of shrouding/unshrouding consider Alan et al. (2018) and Stango and Zinman (2014). They show that simply mentioning certain fees to consumers significantly reduces their probability to pay them.

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. use restaurants and sports facilities elsewhere, exercise less, or buy a local SIM card. The cost e captures this avoidance behavior. We can also 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, highlight which services are included in the room price, or adjust their search algorithm to favor hotels with transparent prices.

Standard shipping- and unavoidable fees. The basic model directly applies with avoidable additional fees. But following Heidhues and Koszegi (2018), we argue that it also captures scenarios with unavoidable additional fees, like fees for standard shipping or VATs. Naive buyers underestimate shrouded shipping fees, leading them to purchase more often than sophisticates. In this context, the additional fee $\overline{a}$ captures additional revenues from unanticipated shipping fees payed by naifs. The avoidance cost e captures a participation distortion: because sophisticates anticipate large shipping fees, they do not buy when their valuation is low, even though trade would be efficient.[46]

A common practice that platforms can use to shroud fees 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

[46] 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.

a product. Many researchers study shipping fees on eBay and other platforms. They find that drip pricing makes consumers less sensitive to shipping fees than to base prices.[47] 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. To avoid errors induced by drip pricing, platforms can unshroud by listing products with their total price, or by adapting their search algorithm to favor sellers with low additional fees.

6 Extensions and Robustness

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

Multihoming Sellers. The baseline model with competing platforms considers only singlehoming sellers. But results are robust with multihoming sellers. We introduce multihomers with zero opportunity cost of joining a platform, capturing 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, multihomers enter both platforms and mitigate platform competition for sellers. But as long as platforms compete intensely enough for singlehomers they still want to *reduce* buyer surplus per interaction to mitigate platform competition. This holds when the share of multihomers is not too large, and when platforms are close substitutes for singlehomers. With sufficiently many multihomers, however, platforms no longer compete for singlehomers and charge large membership fees: platform's profits increase in perceived buyer surplus and our first main result on large shrouding incentives of platforms also applies with competition and rigid unshrouding. See Appendix A.5 for details.

Imperfect Unshrouding. Our main results are robust with more general $\lambda \in (0, 1]$, i.e. when unshrouding is imperfect and leaves some naive buyers in the market. The key difference is that even with unshrouding, sellers might charge large additional fees $\overline{a}$ when the share of naifs is large

[47] See Blake et al. (2018), Brown et al. (2010), Einav et al. (2015), Hossain and Morgan (2006), Smith and Brynjolfsson (2001), Tran (2019). Dertwinkel-Kalt et al. (2019) study partitioned pricing on a website of a German cinema. With partitioned pricing, consumers initiate more purchases. They are the only paper we are aware of which finds that partitioned pricing does not increase finalized purchases. The authors argue that this results from a very transparent version of partitioned pricing where all additional fees and total prices are depicted in a very transparent way.

or unshrouding is ineffective (λ is 'small') after unshrouding, i.e. if $\alpha \geq \bar{\alpha} = \frac{e}{(1-\lambda)\overline{a}}$. Our first main result is qualitatively unaffected.[48] With competition and rigid unshrouding, the conflict between platforms and sellers about additional fees becomes more severe: for $\alpha \geq \bar{\alpha}$ platforms unshroud and prefer small additional fees, but sellers continue to charge large fees $\overline{a}$. Also in this case, platforms would prefer to cap additional fees—possibly even at zero. Intuitively, in this case unshrouding is quite ineffective, and regulating additional fees substitutes for more effective unshrouding.

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.2.

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.3.

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.4.

[48] One additional result with $\lambda < 1$ is that 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 (i.e. λ is 'small'), 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.

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 disclose sellers' additional fees, 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, Gomes and Tirole, 2018, 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 investigates the incentives of intermediaries like financial advisers to recommend deceptive products to consumers. Crucially, his setting does not feature cross-group network externalities and intermediaries are not two-sided.

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 three 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 settings where buyers and sellers exert the same cross-group externality on any platform. We instead allow the cross-group externality on buyers to differ between platforms. This allows us to explore asymmetric subgames where one platform shrouds and the other unshrouds.

Some recent articles investigate how heterogeneity among platform users influences migration between platforms. Carroni et al. (2019) study the incentive of superstar providers to make exclusive deals with a two-sided platform. Markovich and Yehezkel (2019) allow for a large user group and many small users and focuses on direct network effects. Similar in spirit to these papers, we relax the symmetry assumption about platform users. However, we focus on a different form of heterogeneity (naifs vs. sophisticates) and its impact on platform design.

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

Some other articles model competition between sellers on the platform explicitly (Belleflamme and Peitz, 2019a, Karle et al., 2019). They analyze how the platforms' membership fees impacts the number of sellers and thereby the degree of competition on the platform. Edelman and Wright (2015) study intermediaries restricting sellers from charging lower prices outside the platform. In contrast, we explore the platforms' non-price design choices like shrouding of sellers' additional fees.

Literature on platform design. Some recent articles emphasize the link between platform design and consumer search empirically (Chen and Yao, 2017, Dinerstein et al., 2018, Ghose et al., 2014). Among theoretical articles, Ronayne (2019) studies the role of PCWs for consumer search. Eliaz and Spiegler (2011b) build a model of search-engine pricing. Heresi (2018) finds that platforms might increase consumer search costs to raise sellers' profits. We approach the question of transparent platform design from another angle and study whether platforms (un)shroud sellers' fees.

8 Conclusion

We explore incentives of two-sided platforms to design a transparent marketplace and unshroud additional fees of sellers towards naive and sophisticated buyers. First, when platforms want to encourage cross-group externalities, they have stronger incentives to shroud than sellers without a platform. Second, with competition, platform might want to limit cross-group externalities and regulate additional fees to mitigate competition between platforms.

Platforms might be less effective in regulating fees when sellers can bypass the platform and sell directly to buyers. Caps on additional fees increase base prices on a platform and 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 for transparency.

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A Extensions and Robustness

Following Heidhues and Koszegi (2018), we argue in the main text that our baseline model in Section 2 captures scenarios where naive consumers overestimate the product value, e.g. because they ignore unavoidable shrouded fees like shipping fees, leading them to purchase more often. In this context, the additional fee $\overline{a}$ captures the revenues from unanticipated shipping fees payed by naifs. e captures a participation distortion of sophisticated consumers: anticipating large shipping fees, they do not buy when their value for the product is small, even though trade would be efficient. We now sketch a microfoundation for this interpretation.

We assume for simplicity that $\lambda = 1$. This captures that unshrouded shipping fees become part of the base price and are 'understandable' for all consumers.

The product involves a base price p and a shipping fee $s \leq \overline{s}$. With unshrouding, the shipping fee is included in the base price. The model is a classic Hotelling model as in the main text, except for three modifications. First, the outside option is only available at the end points. This modification follows Heidhues and Koszegi (2018).[49] With shrouding, in period 4 naifs ignore this shipping fee, but sophisticates correctly anticipate it. Second, to capture participation distortion, we assume that the consumption value is v_H with probability β, and v_L otherwise. We assume $v_H > v_L > c$, implying together with the previous modification that consumption is always efficient. Third, we assume that because of drip pricing, naifs are less sensitive to total prices in period 5, captured by $\gamma \in (0, 1]$. This is in line with the extensive evidence on drip pricing we discuss in the main text.

In contrast to the model in the main text with avoidable additional fees, this model features unavoidable additional fees. We show next that nonetheless, the model with unavoidable fees maps into the model with avoidable additional fees. To do so, we show that there exists a subgame equilibrium with shrouding where naifs always buy but sophisticates only do when their valuation is high. We will specify sufficient conditions below. This leads to profits for firm s with rival r equal to

$$(1-\alpha)\beta(\frac{1}{2} + \frac{p_r + s_r - p_s - s_s}{2t})\,[p_s + s_s - c] + \alpha(\frac{1}{2} + \frac{p_r - p_s}{2t})\,[p_s + s_s - c]\,.$$

As in the main text firms optimally set $s_r = s_s = \overline{s}$. Using this and rearranging terms, we get

$$((1-\alpha)\beta + \alpha)(\frac{1}{2} + \frac{p_r - p_s}{2t})\left[p_s + \frac{(1-\alpha)\beta}{(1-\alpha)\beta + \alpha}\overline{s} - c + \alpha\frac{1}{(1-\alpha)\beta + \alpha}\overline{s}\right].$$

We now redefine all anticipated fees as the transparent base price $p_s + \frac{(1-\alpha)\beta}{(1-\alpha)\beta+\alpha}\overline{s} \equiv f_s$, and all unanticipated fees as the shrouded additional fee $\overline{a} = \frac{1}{(1-\alpha)\beta+\alpha}\overline{s}$. Using this, the profits simplify to

$$((1-\alpha)\beta + \alpha)(\frac{1}{2} + \frac{f_r - f_s}{2t})\,[f_s + \alpha\overline{a} - c]\,.$$

[49] The main advantage of this modification is that the tradeoff between outside option and purchasing does not depend on t. This simplifies the model and implies there is either competition, or monopoly.

Clearly, these profits induce the same candidate equilibrium base prices as the equilibrium base prices in the main text, i.e. $f^{shr} = c - \alpha\overline{a} + t$, and candidate equilibrium profits $\pi^{shr} = (\beta + \alpha(1 - \beta))\frac{t}{2}$.

We now establish sufficient conditions under which firms do not want to deviate from this candidate equilibrium. More precisely, this candidate equilibrium exists if $v_L - c \in \big(\gamma(c+t) - c, \frac{1}{2}((1-\alpha)\beta + \alpha)t\big)$, that is if γ is sufficiently small and competition not too intense. First, we look for conditions under which in period 5 it is optimal to target only naifs with $s_s = \bar{s}$ and no sophisticates buy as a consequence. To ensure that only all naifs buy when values are low, we must have $p_s + \bar{s} \in (v_L, \frac{v_L}{\gamma})$. For the candidate equilibrium prices, this condition becomes

$$p_s + \bar{s} = f^{shr} + \alpha\overline{a} = c + t \in (v_L, \frac{v_L}{\gamma}).$$

The lower bound ensures that even a sophisticate with low valuation refrains from buying. The upper bound ensures that naifs with the low valuation are willing to buy. Setting $p_s + \bar{s}$ instead of selling to all consumers in period 5 at $v_L - c$ is optimal iff $((1-\alpha)\beta + \alpha)(f^{shr} + \alpha\overline{a} - c) = ((1-\alpha)\beta + \alpha)t \geq v_L - c$. Next, we need to check that in period 3, sellers do not want to deviate to setting $p_s + \overline{s} = v_L$ to sell to all consumers. A sufficient condition for this deviation to be unprofitable is $\frac{1}{2}((1-\alpha)\beta + \alpha)t \geq v_L - c$. It is easy to see that out of the four equilibrium conditions two imply two other, thus we conclude that the candidate equilibrium exists if $v_L - c \in \big(\gamma(c+t) - c, \frac{1}{2}((1-\alpha)\beta + \alpha)t\big)$, that is if γ is sufficiently small and competition not too intense.

Next, we characterize average perceived buyer surplus per interaction. Note that since the outside option is available at the end points, transportation costs do not directly impact average perceived buyer surplus per interaction

$$\begin{aligned}
u^{shr} &= \frac{1}{2}\Big[\alpha(\beta v_H + (1-\beta)v_L - f^{shr}) + (1-\alpha)\beta(v_H - f^{shr})\Big] \\
&= \frac{1}{2}\Big[\alpha(\beta v_H + (1-\beta)v_L) + (1-\alpha)\beta v_H - (\alpha + (1-\alpha)\beta)f^{shr} + (1-\alpha)(1-\beta)\left((v_L - c) - (v_L - c)\right)\Big] \\
&= \frac{1}{2}\left[\beta v_H + (1-\beta)v_L - c - (\alpha + (1-\alpha)\beta)t + (\alpha + (1-\alpha)\beta)\left(\alpha\overline{a} - (1-\alpha)\frac{1-\beta}{(\alpha + (1-\alpha)\beta)}(v_L - c)\right)\right] \\
&= \frac{1}{2}\left[v - c - (\alpha + (1-\alpha)\beta)t + (\alpha + (1-\alpha)\beta)\left(\alpha\overline{a} - (1-\alpha)e\right)\right],
\end{aligned} \tag{13}$$

where we define $v \equiv \beta v_H + (1-\beta)v_L$, and $e = \frac{1-\beta}{(\alpha+(1-\alpha)\beta)}(v_L - c)$. e captures a participation distortion, i.e. the inefficiency due to sophisticates not buying when they have a small valuation.

With unshrouding, we get results akin to the classic Hotelling competition with $f^{unshr} = c + t$, $\pi^{unshr} = \frac{t}{2}$, and $u^{unshr} = \frac{1}{2}[v - c - t]$. Thus, $u^{shr} + \pi^{shr} \geq u^{unshr} + \pi^{unshr}$ iff $\alpha > \underline{\alpha}$ as in the main text. Thus, the results for the monopoly platform are unaffected. The remaining results approximately hold if $(\alpha + (1-\alpha)\beta) \approx 1$, i.e. if β is close to 1 and the inefficiency due to the participation distortion is rather small.

One can show that the condition $\overline{a} > e$ translates into $\overline{s} > (1-\beta)(v_L - c)$, which is satisfied if the previous condition holds.

We do not think that $\pi^{shr} < \pi^{unshr}$ is a crucial implication in this setting. It only follows from the fact that with shrouding, sophisticates no longer buy with probability one. In practice, some naifs with valuation close to c likely start buying with shrouding, since shrouding reduces base prices. Adding such consumers would immediately induce $\pi^{shr} \geq \pi^{unshr}$. In this case, shrouding would be even more beneficial for monopoly platforms and competing platforms with flexible unshrouding.

A.1 Imperfect Unshrouding

A.1.1 Seller Competition under Unshrouding

This Subsection generalizes Section 3.2 to all $\lambda \in (0, 1]$.

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 7. *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 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 cost 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

$$u^{unshr;\overline{a}} = \frac{1}{2}\left[v - \frac{5}{4}t - c + (1-\lambda)\alpha\overline{a} - (1-(1-\lambda)\alpha)e\right]. \tag{14}$$

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

$$u^{unshr;e} = \frac{1}{2}\left[v - \frac{5}{4}t - c + (1-\lambda)\alpha e\right]. \tag{15}$$

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

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* $\alpha \geq \underline{\alpha}_\lambda$.
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 pay avoidance cost and fewer naifs wrongly believe to get a good deal.

A.1.2 Rigid Unshrouding with Imperfect Unshrouding

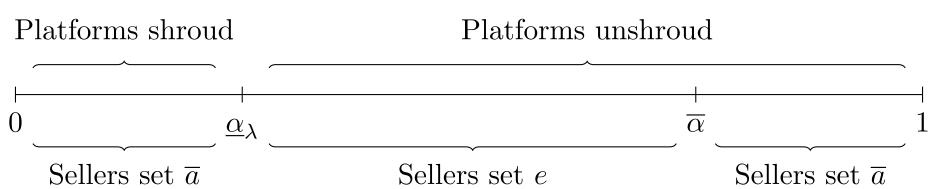
We now generalize results in Section 4.3 to the case with $\lambda \in (0, 1]$. Proposition 5 generalizes in the following way

Proposition 6. *With rigid shrouding, platforms shroud additional fees if and only if* $\alpha < \underline{\alpha}_\lambda$. *Sellers charge low additional fees* e *if and only if* $\underline{\alpha}_\lambda \leq \alpha \leq \bar{\alpha}$, *otherwise they charge high additional fees* $\overline{a}$.

Platforms shroud when there are only few naifs, $\alpha < \underline{\alpha}_\lambda$ just like in Section 4.3. In this case, shrouding reduces buyer surplus by inducing large avoidance costs $(1 - \alpha)e$ for sophisticates. For $\alpha \geq \underline{\alpha}_\lambda$, platforms unshroud to reduce the share of naifs who wrongly believe that products are cheap.

The incentives of sellers, however, are unaffected and now depend on λ. As in Section 3, shrouding induces sellers to charge $\overline{a}$. With unshrouding, as in Section A.1.1, 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 3.

Figure 3: Unshrouding incentives under competition with rigid unshrouding



First, with few naifs ($\alpha < \underline{\alpha}_\lambda$), the platforms shroud and sellers charge large additional fees

$\overline{a}$ as in Section 4.3. 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.

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 ($\underline{\alpha}_\lambda \leq \alpha \leq \bar{\alpha}$), 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 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.[50]

A.1.3 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

[50] 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`.

unshrouded. In both cases, platforms prefer smaller additional fees to induce larger base prices. This reduces the share of the total price that naifs wrongly 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 restrictions on sellers. We now investigate incentives of platforms to regulate additional fees. The following Corollary generalizes 2 and allows for all $\lambda \in (0, 1]$.

Corollary 4. *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* $\alpha < \underline{\alpha}_\lambda$.

The Corollary generalizes 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.[51]

A.2 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.

[51] 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.

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 $u^{unshr,\bar{a}}$ 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.3 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.4 Product Categories with $n \geq 2$ Sellers

We show in this Section that Lemmas 7, 8, and 5 are robust to competition between $n \geq 2$ sellers. This implies 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 7.

Lemma 9. *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 8 is also mostly unchanged in this model.

Lemma 10.

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

Lemmas 9, 10, and 11 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 9, 10, and 11 are unaffected by this extension.

A.5 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

$$(1+\gamma)\tau_B\tau_S - (1-\gamma^2)\pi u_j + (1-\gamma)\tau_B(M_S^j - 2M_S^i + C_S) = 0. \qquad (16)$$

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

$$\Pi_i = \frac{\left[3(1+\gamma)\tau_B\tau_S - (1-\gamma^2)\pi(u_i + 2u_j)\right]^2}{9\tau_B(1-\gamma)\left[2\tau_B\tau_S - (1-\gamma)\pi(u_i + u_j)\right]}. \qquad (17)$$

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 (16) 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.

When this condition is violated, there exists an exquilibrium where platforms no longer compete for sellers but instead extract all rents from them, charging $M_S^i = M_S^j = \pi/2$. It is straightforward to show that in this case profits of platform i increase in u_i, and the results of shrouding incentives of monopoly platforms apply in this case.

A.6 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.7 Monopoly platform taxing additional fees

In this extension we allow the monopoly platform to tax additional fees that sellers charge to end users. We show robustness of our baseline model by deriving a sufficient condition that ensures that the platform do not tax additional fees.

Let the setting be the same as in Section 4.1 with the additional simplifying assumption that access to platform is free to buyers ($M_B = 0$) and the costs are zero ($C = 0$). Let τ denote the percentage tax that the platform charges sellers for every unit of additional fee they collect.

Straightforward calculations show that in the subgame starting in Period 3, sellers will charge a higher base price due to the tax but the same total price. This leaves the cross-group externality of buyers exerted on sellers (π) unchanged, while decreasing the perceived buyer surplus per interaction. Let u denote this utility net of taxes, as before, then the utility inclusive of taxes is given by $u - \tau\alpha\bar{a}/2$. The demand functions can be derived analogously to (3), thus

$$n_B(M_S, \tau) = \frac{k(1 + u - \tau\alpha\bar{a}/2) - (u\tau\alpha\bar{a}/2)M_S}{1 - \pi u + \tau\alpha\bar{a}\pi/2} \quad \text{and} \quad n_S(M_S, \tau) = \frac{k(1 + \pi) - M_S}{1 - \pi u + \tau\alpha\bar{a}\pi/2}. \tag{18}$$

The platform's profit includes tax revenues $\frac{1}{2}n_S n_B \alpha\bar{a}\tau$, where $\frac{1}{2}n_S n_B$ is the total number of transactions that take place on the platform, and $\alpha\bar{a}$ is the average additional fee paid per transaction. The maximization problem of the platform is thus the following:

$$\max_{M_S,\tau} \; n_S(M_S, \tau) \cdot M_S + \frac{1}{2}n_S(M_S, \tau)n_B(M_S, \tau)\alpha\bar{a}\tau \quad \text{s.t.} \quad \tau \in [0, 1]. \tag{19}$$

In order to find sufficient conditions for a zero tax to be optimal for the platform, we proceed in two steps. First, we derive sufficient conditions for the determinant of the Hessian matrix to be always negative, in which case the unconstrained problem does not have any local extrema. This guarantees that the optimal value of the tax must be either 0 or 1. Second, in order to find the constrained optimum of the profit function, we derive the optimal prices M_S for both $\tau = 0$ and for $\tau = 1$, and compare the profit value at these two local optima. We find that the profit at zero tax is higher than the profit at full taxation if and only if

$$\frac{2}{\pi} < \pi + \alpha\bar{a}.$$

Intuitively, a larger $\alpha\bar{a}$ means that a tax $\tau = 1$ reduces the cross-group externality of buyers $u - \alpha\bar{a}\tau/2$ by more. Thus, platforms who want to benefit from larger cross-group externalities have a stronger incentive to set $\tau = 0$.

Moreover, the following is a set of sufficient conditions for the negativity of the Hessian matrix:

$$\frac{2}{\pi} < 2u^2\pi - 4(1 - u\pi) \quad \text{and} \quad 2(1 - \alpha\bar{a}\pi) + \pi^2[2 - 2u(u + \pi)] > 0.$$

Note that the three conditions above can be jointly satisfied if π is sufficiently large and u is sufficiently small. These are qualitatively the same conditions as the ones needed for zero membership fee $M_B = 0$, a strategy we observe in all of our motivating examples (see Section A.6).

A.8 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 $\bar{a}$. These consumers have a willingness to pay $\bar{a}$ 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 $a = \bar{a}$, avoiding consumers avoid additional fees, and the large additional fees extract the entire willingness to pay $\bar{a}$ 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 $u^{unshr;\bar{a}} = u^{shr} = v - \frac{t}{4} - c - t + \gamma\bar{a} - (1-\gamma)e$, with $f^{shr} = f^{unshr;\bar{a}} = c - \gamma\bar{a} + t$ and additional fees $\bar{a}$.

However, the implications change for lower unshrouded additional fees $a = e$. As before, we get

$f^{unshr;e} = c - e$ and $a = e$.[52] 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 12. *Sellers always charge additional fees below e when platforms unshroud fees. $u^{shr;e} = u^{unshr;e} > u^{shr}$.*

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.

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

B Proofs

Proof of Lemma 1. We proof the more general result of Lemma 7 that allows for all $\lambda \in (0,1]$. Lemma 1 obtains for the special case $\lambda = 1$.

Proof of Lemma 7. 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 $(1-\lambda)\alpha\overline{a} < e$. $\square$

Proof of Lemma 2. The Lemma follows immediately from comparing u^{shr}, and u^{unshr}. $\square$

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 (18). $\square$

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 (6) 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 (6) 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. $\square$

Proof of Proposition 1. We show the more general version for all $\lambda \in (0,1]$. Proposition 1 obtains for the special case $\lambda = 1$.

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 **??**.

First, Lemma 8 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 8 shows that $u^{shr} \geq u^{unshr;\overline{a}}$, 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 7 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. $\square$

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

Proof of Proposition 2. We show the more general version for all $\lambda \in (0, 1]$. Proposition 2 obtains for the special case $\lambda = 1$.

The Proposition follows immediately from the formulas in Lemma 8 and the assumption of $\lambda > 0$:

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

$\square$

Proof of Lemma 6. By plugging (8) into (7) 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:

$$n_S^i = \frac{1}{2} + \frac{M_S^j - M_S^i + n_B^i \pi - (1 - n_B^i)\pi}{2\tau_S} = \frac{1}{2} + \frac{M_S^j - M_S^i - \pi}{2\tau_S} + \frac{\pi}{\tau_S} n_B^i \tag{20}$$

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 (20), and rearranging terms reveals demand only as a function of membership fees and cross-group externalities, i.e.

$$n_S^i = \frac{2\tau_B\tau_S - 2u_j\pi + 2\pi(M_B^j - M_B^i) + 2\tau_B(M_S^j - M_S^i)}{4\tau_B\tau_S - 2\pi(u_i + u_j)}, \tag{21}$$

and similarly

$$n_B^i = \frac{2\tau_B\tau_S - \pi(u_i + u_j) + (M_S^j - M_S^i)(u_i + u_j) + 2\tau_S(M_B^j - M_B^i) + \tau_S(u_i - u_j)}{4\tau_B\tau_S - 2\pi(u_i + u_j)}. \tag{22}$$

Using Assumption 1 leads to (9). □

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 (10).

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 (9) 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. $\square$

Proof of Proposition 4. The first-order condition of (11) 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 (9), this is equivalent to

$$2\tau_B\tau_S - 2\pi u_j + \tau_B(M_S^j - M_S^i) - 2\tau_B(M_S^i - C_S) = 0. \tag{23}$$

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 (23) 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 (11) and simplifying leads to the equilibrium profits of platform i in (12). It is straightforward to show that Π^i is strictly decreasing in u_i under Assumption 3. This concludes the proof. $\square$

Proof of Proposition 5. We show the more general version Proposition 6 that allows for all $\lambda \in (0, 1]$. Proposition 5 obtains for the special case $\lambda = 1$.

First, for $\alpha < \underline{\alpha}$, i.e. for a small share of naifs, Lemma 8 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 8 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 7.

Third, for $\alpha > \bar{\alpha}$, i.e. for a large share of naifs, Lemma 8 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 7 that sellers charge a high additional fee $\overline{a}$ for $\alpha > \bar{\alpha}$. $\square$

Proof of Lemma 9. 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 the proof of 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 e. Thus, with unshrouded additional fees, sellers charge low additional fees if and only if $\alpha < \bar{\alpha}$. □

Proof of Lemma 10. 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 $u^{unshr;\overline{a}} = \frac{1}{2}\left[v - \frac{t}{4n} - c - \frac{t}{n} + (1-\lambda)\alpha\overline{a} - (1-(1-\lambda)\alpha)e\right]$ as average perceived buyer surplus per interaction.

Comparing these values shows that the cutoffs derived in Lemma 8 apply as well in the Salop model. □

Proof of Lemma 11. 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 $\alpha > \frac{e}{\overline{a}}$. □

Proof of Lemma 12. In the text before the Lemma. □