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Complex Pricing and Consumer-Side Attention

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Complex pricing and consumer-side attention*

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Abstract

This paper analyzes a market in which two horizontally differentiated firms compete by setting menus of two-part tariffs, and in which some consumers are not informed about the linear per-unit price component. We consider two regulatory interventions that limit firms' ability to price discriminate: (i) diminishing the range of contracts via a reduction in the number of two-part tariffs offered (which prohibits inter-group price discrimination), and (ii) a reduction in tariff complexity via the abolishment of linear fees (which prohibits inter- and intra-group price discrimination). We characterize the effects of these interventions on firm profits and (informed and uninformed) consumer welfare, and identify conditions for the optimal policy. Our results provide insights for the evaluation of recent policy interventions (e.g., the regulation of roaming charges in the EU market).

JEL Classification: D43; L13; L42.
Keywords: Two-part tariffs; Consumer attention; Policy intervention.

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1 Introduction

Complex pricing structures and price menus are a typical phenomenon of today's business practices. Indeed, advances in information technology and its applications (internet, social media, etc.) enable firms to know more and more about their consumers, and speed up the trend toward more targeted offers and personalized pricing strategies. At the same time, however, consumers appear to find it increasingly difficult – even despite such services as price comparison websites on the internet – to compare all relevant information to make their purchase decisions. As a result, complex pricing practices have called the attention of authorities and consumer protection agencies that aim to ensure that consumers do not get lost in the wide array of offers.

In this paper, we study the regulation of complex pricing schemes (in particular, two-part tariffs) and its implications for consumer and social welfare. Building on the contributions by Gabaix and Laibson (2006) and Armstrong and Vickers (2012) and the literature that followed we develop a market model in which consumers do not take all relevant price components into account. In contrast to existing models, we focus on two-part tariffs where consumers are only imperfectly informed about the linear price component. Within this setting, we consider different regulatory interventions that limit firms' ability to set prices and/or their ability to price discriminate between consumers.

Examples for industries in which these tariffs are widespread, and in which consumers are only imperfectly informed are mobile telecommunications (flat rate, roaming charges), media markets (subscription price, per-view price), and gas and electricity contracts (fixed monthly/yearly price, price per usage). Yet, in many of these markets, some contract details are less salient than others, and not all price component are taken into account by consumers.

A prime example of the kind of the market we have in mind (and in which regulators have taken action) is that of roaming fees in telecommunication markets. An interesting aspect in this market is that consumers appear to be unaware of their contract details with regard to roaming. As Oxera point out, "[c]onsumers typically purchase roaming within a bundle that also contains domestic calls, texts and data usage. However, there is generally little awareness of roaming charges [...]."[1] In a similar vein, a study by the European Commission in 2014 ("E-Communications and Telecom Single Market Household Survey") revealed that to be on the safe side, a large share of users switched off their mobile phones when they traveled abroad, because they were unaware of the costs involved. In this market, the simplification of tariff structures was prominently featured in the European Commission's goal to reduce and abolish roaming tariffs in 2017.

[1] Oxera, Agenda, October 2014: "A Connected Continent? Eliminating excessive roaming charges in the EU", p. 1.

Our paper aims to contribute to understanding the effects of such interventions. This is particularly important, because economists worried about potential drawbacks via waterbed effects, such that lower roaming charges might lead to higher subscription prices (e.g., Duso, 2017; Sutherland, 2010). Oxera points out that revenue generated by roaming within the European Union accounted for an average of 4.2% of total mobile revenues across the European Union in 2009. Therefore, they conclude that "some attempt to protect revenue cannot be ruled out" (p. 4).[2]

The paper discusses under which circumstances such adverse waterbed effects might arise, and it analyzes their relationship to market transparency. Moreover, our results shed light on why the European Commission's and mobile operators' interests are misaligned with regard to the necessity of such a policy intervention.

To study markets with complex pricing schemes in which consumers are not taking all relevant information into account, we develop a duopoly model with firms competing for consumers in a differentiated product market. Each consumer has a downward-sloping demand function, and firms can potentially offer a menu of two-part tariffs. Motivated by the above example of roaming and building on the behavioral industrial organization literature (Gabaix and Laibson, 2006; Heidhues and Kőszegi, 2018), we incorporate the aspect of transparency in our model: When firms set two-part tariffs, a share of consumers (called uninformed consumers) are only aware of the fixed price component. As a consequence, these consumers neglect the linear price when they decide which firm to buy from. At a later consumption stage, however, these consumers have also learnt about the linear price, and they choose the consumption quantity accordingly. In contrast, informed consumers are fully aware of the firms' tariffs at all stages of the game.

Within this setting, we analyze various (potentially) complex pricing schemes. In our base version, firms offer a menu of two-part tariffs. These screening tariffs are designed so that informed and uninformed consumers self-select into different contracts. Informed consumers choose a contract with a high fixed fee and a low linear price, whereas uninformed consumers are attracted by a contract that offers a low fixed fee, but has a high linear fee (which is overlooked by uninformed consumers when choosing the contract). Interestingly, all contracts are inefficient, because the linear price exceeds marginal cost; informed consumers are better off than uninformed consumers.

As pointed out before, complex pricing schemes and consumer awareness have gained prominence in policy discussions. In the competition-policy debate, regulators and consumer protection agencies typically follow two approaches to increase the comparability of different offers: education and simplification. When consumers learn to find out about contract pitfalls, they may make more educated

[2]There are a couple of contributions investigating the previous regulation on wholesale and retail roaming fees from 2007 (see, for instance, Ambjørnsen et al., 2011). Moreover, Genakos and Valletti (2011, 2012) empirically identify waterbed effects in mobile telecommunication markets when interconnection charges are reduced.

purchase decisions. The same is true when firms are obliged to reduce the complexity of their pricing structures. Both policies can potentially result in an increased market transparency. We analyze two policy interventions that restrict firms' choice of pricing schemes: i) reducing the range of contracts so that firms compete in single two-part tariffs and ii) abolishing linear fees so that firms compete in fixed-fee contracts (as in the EU roaming regulation).

These interventions can also be understood in the extent to which firms are able to price discriminate. In our base version with a menu of two-part tariffs, firms can price discriminate intra-group (two-part tariff) but also inter-group (informed vs. uninformed consumers). The first intervention only bans inter-group price discrimination. The second intervention essentially bans both types of price discrimination, because with a single price instrument (the fixed price component), firms can no longer design self-selecting contracts.

The first intervention that only prohibits inter-group price discrimination is interesting in itself, because it can be viewed as an extension to the prominent framework developed in Gabaix and Laibson (2006). In contrast to their model and the literature that followed, add-on prices are only overlooked at the contracting stage, but are optimally accounted for in a subsequent consumption stage in our framework. We characterize the single equilibrium two-part tariff, and find that it depends on the shares of the two consumer types. Interestingly, whereas the linear price is strictly decreasing with the share of informed consumers, there exists a non-monotone relationship between the degree of transparency (as measured by the share of informed consumers) and both the fixed price component and profits. This is different from previous results with linear or fixed fees only (see the related literature below): In those cases, an increase in transparency, i.e., a larger share of consumers become informed about the prices set by the firms, always increases competition, and, hence, results in lower fixed fees and lower profits. In contrast, our results suggest that the extent of possible waterbed effects crucially depends on the degree of market transparency, and is only significant in situations with many informed consumers.

The fact that a change in the degree of transparency has ambiguous effects on profits under two-part tariffs is due to the relative strength of two opposing effects: On the one hand, more informed consumers imply that the linear price decreases so that firms focus more on the fixed fee to earn profits. This effect tends to increase the fixed fee with more transparency. On the other hand, informed consumer are more sensitive to changes in the fixed fee than uninformed consumers. This competition effect puts downward pressure on fixed fees. However, this effect becomes weaker as transparency increases. As a result, we find a u-shaped relationship so that fixed fees and profits first decrease, and then increase in the degree of transparency. Related to this, there is also a non-monotone relationship between the degree of transparency and consumer surplus under these tariffs, but in the opposite direction. In

particular, we show that for low and intermediate shares of informed consumers, simplifying the pricing structure increases consumer surplus. However, consumer surplus can decrease if a larger number of consumers is informed.

Consistent with the idea that regulation removes the opportunity to earn large profits from uninformed consumers, firm profit falls, and overall consumer surplus rises. Yet, there can be opposing effects on different consumer types. Whereas uninformed consumers always benefit from regulation, informed consumers can be worse off.

The second intervention prohibits linear fees (and, hence, any form of price discrimination) so that firms offer only a single contract at a fixed price. This contract does not depend on the shares of the consumer types. Compared to the base case with screening contracts, we find that consumers and firms are typically affected in opposite directions. When firms set fixed prices only, in models with only informed consumers, this necessarily increases firm profits, and hurts consumers (Gössl and Rasch, 2020). In our model with uninformed consumers, this may no longer hold, and firms may lose and consumers benefit if the market is sufficiently opaque (that is, the share of uninformed consumers is sufficiently large). Interestingly, however, uninformed consumers always benefit from the intervention, whereas informed consumer always lose out. Thus, the overall effects on firm profits and consumer welfare are driven by the group composition, and banning price discrimination can hurt firms, because it lowers their opportunities to exploit uninformed consumers.

Given that both interventions that we consider can be beneficial for consumers, it appears essential to identify which intervention fares better. We find that – depending on the parameterization of the model – both interventions can be the optimal choice of a regulator interested in promoting consumer surplus. The regulation toward a single two-part tariff is the better intervention for high levels of transparency, whereas a regime with fixed fees only provides a larger surplus to consumers if transparency is relatively low. If a regulator – apart from choosing the pricing regime – can influence consumer awareness (that is, via disclosure), a regulator intending to maximize (total) consumer surplus would opt for a single two-part tariff with an intermediate level of transparency.

Related literature

Our paper is related to two strands of literature. First, we contribute to the literature on behavioral industrial organization and add-on pricing. Second, we contribute to the literature on competitive price discrimination (in particular, two-part tariffs) in differentiated product markets.

We add to the growing literature on behavioral industrial organization that studies market outcomes in the presence of behaviorally biased consumers.[3] Within this

[3]For a survey, see, for instance, Grubb (2015b) and Heidhues and Kőszegi (2018).

literature, our paper is related to studies on add-on pricing where consumers do not take into account the prices of additional products or services (parking, minibar, luggage, etc.) when making a purchase decision (e.g., Gabaix and Laibson, 2006; Armstrong and Vickers, 2012; Grubb, 2015a; Heidhues et al., 2017). We extend this literature with regard to three aspects. First, this literature typically considers a binary purchase decision of the add-on, whereas in our setting, individual add-on demand depends on the price. Second, in our model, consumers are only unaware of one (linear) price component at the contract stage (when deciding where to buy), but are completely informed when making quantity choices about the add-on. This is consistent with the idea that, at some point, consumers become fully informed about the contract details, and can adjust their consumption behaviour. Third, our setting allows to explore different pricing scenarios (with intra- and inter-group price discrimination), and to analyze the welfare effects on market participants.

There is also an older literature on consumer-side market transparency assuming that an exogenously given share of consumers is uninformed about prices, and selects randomly among competing firms.[4] In contrast, consumers in our model can observe some, but not all price elements. The focus of these papers is also different, though. For example, these contributions analyze firms' ability to maintain collusion as the degree of transparency changes (Schultz, 2005, 2017; Rasch and Herre, 2013) and the scope of market entry for varying degrees of market transparency (Schultz, 2009; Gu and Wenzel, 2011).

We also contribute to the literature on competitive price discrimination in differentiated product markets (e.g., Armstrong and Vickers, 2001). Surveys are provided by Armstrong (2006) and Stole (2007). As in Yin (2004) and Gössl and Rasch (2020), we compare different pricing scenarios (two-part tariffs, only fixed prices). But, in contrast to the literature, we study a setting in which consumers are only partially informed about relevant price components. This makes it possible to study the effect of banning only inter-group price discrimination (firms can offer only a single two-part tariff) and situations in which both inter- and intra-group price discrimination are banned (firms can only offer a tariff with a fixed price, but no linear price component).

As in our study, a couple of recent papers investigate two-part prices or screening contracts with behaviorally biased consumers. For instance, Eliaz and Spiegler (2006) show how a monopolist can screen consumers who differ in their degree of naiveté. Heidhues and Kőszegi (2010) analyze a credit card market in which consumers differ in their beliefs about time-consistent behavior. Related to add-on pricing, Heidhues et al. (2017) consider a setting in which firms screen consumers by offering an inferior product (with a high add-on price) to naive consumers and a superior product to sophisticated consumers. Herweg and Mierendorff (2013)

[4] See, for instance, (Varian, 1980) for a setting with homogeneous products and Schultz (2005) for a model with differentiated products.

study a setting in which consumers are loss-averse, and derive conditions under which firms offer a flat-rate tariff (that is, a contract with a zero linear price). Heidhues and Kőszegi (2017) study the effects of price discrimination if firms have information about consumer naiveté.

The paper proceeds as follows. Section 2 presents the model setup. Section 3 derives the equilibrium when firms can offer multiple two-part contracts to consumers. Sections 4 and 5 analyze the outcomes when, due to policy interventions, firms are restricted in the type of contracts they can offer (either a single two-part contract or fixed-fee contracts). We compare the implications for firm profits, consumer surplus, and social welfare in Section 6. Section 7 concludes.

2 The model

We consider a model of horizontal product differentiation with two symmetric firms, $i \in \{1, 2\}$, located at opposite ends of a unit line (Hotelling, 1929). Fixed and marginal costs are normalized to zero. Depending on the pricing scenario considered (which will be explained later in more detail), firm i can offer a two-part contract with a fixed price f_i and a linear price p_i that must be paid for every unit purchased.

A unit mass of consumers is uniformly distributed along the unit line. There are two types of consumers, informed and uninformed. The share of informed consumers is ϕ, and the share of uninformed consumers is $1 - \phi$. These shares are the same for all locations $x \in [0, 1]$ on the unit line. The two groups differ in their information status j with regard to the firms' pricing policy. We denote informed consumers by $j = r$; uninformed consumers are denoted by $j = n$. (The details will be explained below.) Firms cannot distinguish between the different consumer types, i.e., firms cannot use third-degree price discrimination.

In contrast to a standard Hotelling model, we allow the quantity demanded by an individual consumer to depend on the price. A consumer who is located at x, and who purchases quantity $q \in [0, 1]$ units receives the following utility when buying from firm i:

$$u_i(x; q; f_i, p_i) = q - \frac{q^2}{2} - q\left(p_i + \tau|L_i - x|\right) - f_i, \tag{1}$$

where τ is the transport-cost parameter, p_i is the linear price, and f_i is the fixed price. The location of firm i is L_i.[5]

This formulation follows the approach in Yin (2004). We use a shipping model in which consumers incur (linear) transport costs per unit consumed.[6] This implies

[5]Note that we could add a fixed value for basic services (e.g., for domestic calls and internet services in the roaming example). For reasons of tractability, we normalize the valuation for such services to zero.

[6]Our linear demand specification is a simplified version of that in Section 3.2 of Yin (2004) which

that mismatch costs occur for each unit purchased, and $q\tau|L_i - x|$ represents the total disutility suffered by a consumer with preferred product characteristics x when consuming a product that is not ideal (and, hence, not located at x, but at L_i).

Consumer decision making proceeds in two stages. In a first step (the contracting stage), consumers decide where to buy. In a second step (the consumption stage), consumers decide about the quantity to be consumed at the chosen firm. At the consumption stage, a consumer chooses quantity q so as to maximize utility from consumption (equation (1)). This implies that the demand of a consumer located at x who buys at firm i takes the following linear form:

$$q_i(x; p_i) = 1 - p_i - \tau|L_i - x|. \tag{2}$$

At the contracting stage, the two consumer groups differ in the extent to which they take into account price information when deciding between the firms' contracts. An informed consumer ($j = r$) takes into account any price component charged by the two firms. In contrast, an uninformed consumer ($j = n$) is aware of the fixed fees charged by the firms, but neglects the linear prices, and expects both firms to set a linear price of zero when selecting a firm.[7] Hence, a consumer of type j (at location x) expects to consume the following quantities:

$$q_i^j(x; p_i) = 1 - \mathbb{1}_r p_i - \tau|L_i - x|, \tag{3}$$

where

$$\mathbb{1}_r(j) = \begin{cases} 1 & \text{if } j = r, \\ 0 & \text{if } j = n. \end{cases}$$

Note that for an informed consumer ($j = r$), the expected and actual consumed quantities coincide, that is, expressions (2) and (3) are identical. In contrast, for an uninformed consumer, expected and actual demand diverge. Indeed, by neglecting the linear price element, an uninformed consumer expects to consume a higher quantity than is optimally chosen later on.

Given expected demand levels, a consumer with information status j who is located at x, and who expects to purchase $q_i^j(x; p_i)$ anticipates the following utility when

is also used in Gössl and Rasch (2020). The shipping model allows us to derive tractable results, and fits to the market we have in mind. An alternative approach to introducing elastic demand in a Hotelling framework is to consider a setting in which the transport costs are incurred independently of the consumption volume. This approach is taken, for instance, in Armstrong and Vickers (2001) in the context of price discrimination and in Gu and Wenzel (2009) in the context of firm entry.

[7] We note that the results of our analysis do not depend on the assumption that uninformed expect both firms to have zero marginal prices. The same results would occur if consumers expect both firms to charge the same positive linear fee. What is important for our results is only that uninformed consumers are not responsive to linear fees at the contracting stage.

choosing firm i at the contracting stage:

$$u_i^j(x;q;f_i,p_i) = q_i^j(x;p_i) - \frac{(q_i^j(x;p_i))^2}{2} - q_i^j(x;p_i)\left(\mathbb{1}_r p_i + \tau|L_i - x|\right) - f_i.$$

Again, expected and actual utility levels coincide for an informed consumer, but an uninformed consumer expects a higher utility level from choosing a supplier. It should be noted that in this respect, our setup differs from existing models. In our setting, there is only a distortion in contract choice, but behavior is optimal in the consumption stage (once contracts have been chosen). This is different from existing contributions. For instance, in Gabaix and Laibson (2006), a share of consumers may opt for an overpriced add-on product even if there is a cheaper outside opportunity available. Similarly, in Heidhues et al. (2017), a consumer may purchase a product even if the price exceeds the valuation. In contrast, in our approach, all consumers eventually learn about all price components, and their actual purchase decisions are optimal ex-post.

Throughout the paper, we focus on situations in which the market is fully covered, i.e., each consumer buys at either firm 1 or firm 2, and in which firms would like to serve both types of consumers. This imposes restrictions on the admissible range of transport costs. On the one hand, transport costs must not be too large because otherwise some of the consumers prefer not to buy from any firm. On the other hand, when transport costs are very low, catering only to the uninformed or informed consumers may be optimal for the firms. The corresponding restrictions are summarized in Assumption 1 (and derived in the Appendix):[8]

Assumption 1.

$$0 \leq \underline{\tau}(\phi) \leq \tau \leq \bar{\tau} = \frac{4\left(23 - 2\sqrt{73}\right)}{79}$$

The timing of events is as follows:

Stage 1 (Pricing stage) Both firms simultaneously set their prices. Depending on the regime, firms may charge (i) a menu of two-part tariffs, (ii) a single two-part tariff, (iii) only a fixed fee.

Stage 2 (Contracting stage) Consumers observe firms' pricing decisions, and decide which contract to choose. Informed consumers consider all price elements, while uninformed consumers ignore linear price elements.

Stage 3 (Consumption stage) Uninformed consumers learn the linear price, and all consumers choose their consumption level. Firm profits and consumer surplus materialize.

[8] The assumption is written in terms of the transport-cost parameter τ. Of course, it could also be given in terms of the share of informed consumers ϕ (see the figures below).

Next, we solve for the subgame perfect equilibria of the various pricing scenarios.

3 Competition with screening contracts

We start by considering the case in which firms can offer two different two-part contracts aimed at screening informed and uninformed consumers. This scenario serves as our benchmark. We will later evaluate it against two policy measures: One intervention bans the linear price element, and requires firms to charge a fixed fee only. In a second intervention, a regulator bans multiple tariffs, and requires firms to offer a single contract (which can be a two-part tariff) to all consumers.

In the final stage (the consumption stage), all consumers (informed and uninformed) are fully aware of the pricing details of the chosen contract. As a result, the actual demand of every consumer is given by expression (2). However, when deciding from which firm to buy in the second stage, the uninformed agents are unaware of the linear component leading to a type-dependent location for the indifferent consumer. For consumer type j, the location of the indifferent consumer, $\tilde{x}^j$, is uniquely determined by:

$$u_1^j\left(\tilde{x}^j; q_1^j; p_1, f_1\right) = u_2^j\left(\tilde{x}^j; q_2^j; p_2, f_2\right). \tag{4}$$

Hence, the indifferent consumer of type j is located at

$$\tilde{x}^j = \frac{1}{2} - \frac{\mathbb{1}_r\left(p_1 - p_2\right)}{2\tau} - \frac{f_1 - f_2}{\tau(2 - \mathbb{1}_r\left(p_1 + p_2\right) - \tau)}. \tag{5}$$

Note from equation (5) that informed and uninformed consumers differ in their responsiveness to changes in the fixed component f_i: Demand by informed consumers is more sensitive to changes in the fixed fee than demand by uninformed consumers. Moreover, this responsiveness of informed consumers also increases with the linear price. This is due to the fact that informed consumers anticipate that their benefit from usage is low for relatively high linear prices. In this case, even small differences in the fixed fees translate into relatively large differences in utility from the two firms, increasing informed consumers' sensitivity to changes in the fixed fee.

Firms set their prices anticipating the type-dependent indifference levels and the fact that both types of consumers choose the same quantity after having learned p_i. Assume that $\tilde{x}^j \in [0,1]$. Then, firm i's maximization problem is given by

$$\max_{(p_{i,n},f_{i,n}),(p_{i,r},f_{i,r})} \pi_i((p_{i,n},f_{i,n}),(p_{i,r},f_{i,r})) =$$
$$\phi\left(p_{i,r}\int_{\min\{L_i,\tilde{x}^r\}}^{\max\{L_i,\tilde{x}^r\}}(1-p_{i,r}-\tau|L_i-x|)dx + f_{i,r}\tilde{x}^r\right)$$

$$+ (1-\phi)\left(p_{i,n}\int_{\min\{L_i,\tilde{x}^n\}}^{\max\{L_i,\tilde{x}^n\}}(1-p_{i,n}-\tau|L_i-x|)dx + f_{i,n}\tilde{x}^n\right)$$

subject to consumers choosing the intended contract:

$$u_i^r(x;q;f_{i,r},p_{i,r}) \geq u_i^r(x;q;f_{i,n},p_{i,n}),$$

$$u_i^n(x;q;f_{i,n},p_{i,n}) \geq u_i^n(x;q;f_{i,r},p_{i,r}).$$

The maximization problem allows firms to offer possibly different contracts to informed $(p_{i,r}, f_{i,r})$ and uninformed consumers $(p_{i,n}, f_{i,n})$. Because consumer types are not observable, firms have to ensure that each type chooses the intended contract. Proposition 1 describes the equilibrium contracts offered to the two consumer types (where the subscript S refers to screening contracts).

Proposition 1. When firms can offer multiple two-part tariffs, firms will design different contracts for informed and uninformed consumers. The contract designed for an informed consumer is

$$f_{S,r}^*(\tau) = \frac{3\tau(4-3\tau)}{16} \quad \text{and} \quad p_{S,r}^*(\tau) = \frac{\tau}{4}.$$

The contract designed for an uninformed consumer is

$$f_{S,n}^*(\tau) = -\frac{16-80\tau+35\tau^2}{64} \quad \text{and} \quad p_{S,n}^*(\tau) = \frac{4-\tau}{8}.$$

In equilibrium each firm earns profits of

$$\pi_S^*(\phi,\tau) = \frac{\tau(4(9-\phi)-\tau(17+5\phi))}{64}.$$

Consumer welfare and social welfare amount to

$$\Lambda_S^*(\phi,\tau) = 2\left(\phi\int_0^{\frac{1}{2}} u\left(x;q_1^r;p_{S,r}^*(\tau),f_{S,r}^*(\tau)\right)dx + (1-\phi)\int_0^{\frac{1}{2}} u\left(x;q_1^r;p_{S,n}^*(\tau),f_{S,n}^*(\tau)\right)dx\right)$$

$$\Psi_S^*(\phi,\tau) = \Lambda_S^*(\phi,\tau) + 2\pi_S^*(\phi,\tau).$$

The proposition shows that firms can successfully segment the market by offering different contracts to informed and uninformed consumers. The contract for the uninformed consumers has a lower fixed component and a higher linear price component than the contract for informed consumers. This price structure is attractive for an uninformed consumer, because he ignores the linear price, and only consid-

ers the fixed price element. In contrast, informed consumers are willing to pay a higher fixed fee to benefit from a lower linear price (and, hence, a higher consumption quantity).[9]

We note that the contracts offered to both types of consumers are inefficient, because the linear price exceed the marginal costs (normalized to zero). Given the higher linear price for uninformed consumers (and, hence, the larger distortion), it is clear that social welfare strictly increases as the share of uninformed consumers decreases.

It is interesting to look at the effect of the transportation costs on equilibrium prices. While for informed consumers, both price elements increase as transportation costs increase, this is not the case for uninformed consumers. Here, the fixed price increases, but the linear component decreases. The reason is that with a higher transportation cost, firms' revenues from linear sales are decreasing, which means that there is less incentive to attract uninformed consumers via a low fixed component.

The pricing structure toward uninformed consumers is reminiscent of other models in which consumers are unaware of add-on fees or other price elements, and in which this lack of awareness results in high prices for unobserved and low prices for observed price elements (e.g., Gabaix and Laibson, 2006; Armstrong and Vickers, 2012). We note that the firms may charge a negative fixed fee to uninformed consumers if transport costs are sufficiently small ($\tau < 8/7 - 4\sqrt{65}/35$). In such cases, firms find it worthwhile to subsidize so as to attract uninformed consumers via a give-away (negative fixed fee), and recoup the losses with a high linear price.

4 Reducing the range of contracts: Competition in single two-part tariffs

We now analyze the effects of a regulatory intervention that reduces the range of contracts so that firms can only offer one single contract. This contract can be a two-part tariff. As a result of this policy, firms can only exercise intra-group price discrimination, but cannot price discriminate between informed and uninformed consumers. Nevertheless, as we will show below, the presence of both consumer types shapes the design of the equilibrium contract.

Equilibrium behaviour

As in Section 3, firms set their prices anticipating the type-dependent indifference levels and the fact that both types of consumers choose the same quantity after hav-

[9] The contract for informed consumers corresponds to the benchmark cases (with only informed consumers) as analyzed in Yin (2004) and Gössl and Rasch (2020). We note that the same equilibrium contracts would emerge if firms could observe consumers' type, and could engage in third-degree price discrimination.

ing learned p_i, but are now restricted to offer the same contract to both consumer types. Offering a single contract (p_i, f_i), firm i's maximization problem now becomes

$$\max_{p_i,f_i} \pi_i(p_i, f_i; p_j, f_j) = \phi \left(p_i \int_{\min\{L_i,\tilde{x}^r\}}^{\max\{L_i,\tilde{x}^r\}} (1 - p_i - \tau|L_i - x|)dx + f_i\tilde{x}^r \right) + (1-\phi) \left(p_i \int_{\min\{L_i,\tilde{x}^n\}}^{\max\{L_i,\tilde{x}^n\}} (1 - p_i - \tau|L_i - x|)dx + f_i\tilde{x}^n \right),$$

where $\tilde{x}^r$ and $\tilde{x}^n$ are defined as in equation (5). Solving the maximization problem and defining

$$A := \sqrt{\tau^2 \left(-23\phi^2 + 18\phi + 9\right) + 8\tau \left(10\phi^2 - 9\phi - 3\right) - 64\phi^2 + 64\phi + 16}$$

gives the following equilibrium result (where the subscript T denotes the case with single two-part tariffs):

Proposition 2. When each firm sets a single two-part tariff, the symmetric equilibrium tariffs depend on the share ϕ of informed consumers, and are given by

$$p_T^*(\phi, \tau) = \frac{12 - \tau(5 - 3\phi) - A - 8\phi}{16(1-\phi)}$$

and

$$f_T^*(\phi,\tau) = \frac{(A + \tau(5\phi - 3) - 8\phi + 4)}{256(1-\phi)^2(A - 3\tau(\phi+1) + 8\phi + 4)} \left(A^2 + 2A(-3\tau\phi + \tau + 8\phi - 4) - 143\tau^2 + (8 - 3\tau)^2\phi^2 + 2(\tau(61\tau - 108) - 32)\phi + 312\tau - 48\right).$$

The equilibrium profit for each firm is

$$\pi_T^*(\phi,\tau) = \frac{\tau\left(\phi(A + 13\tau - 12) - 8(A + 3\tau - 4) + (8 - 3\tau)\phi^2\right)}{128(\phi - 1)\phi}.$$

Given symmetric equilibrium prices, consumer surplus is calculated as[10]

$$\Lambda_T^*(\phi,\tau) = 2\int_0^{\frac{1}{2}} u\left(x; q; p_T^*(\phi,\tau), f_T^*(\phi,\tau)\right) dx,$$

and social welfare is

$$\Psi_T^*(\phi,\tau) = \Lambda_T^*(\phi,\tau) + 2\pi_T^*(\phi,\tau).$$

Note that in this scenario in which firms have to offer the same contract to all consumers, both groups of consumers do not differ with respect to their surplus (as was

[10] We do not present formal expressions here due to readability, but illustrate our findings below. Details are available from the authors upon request.

the case with screening contracts), i.e., the share of partially informed consumers has no direct effect on total consumer surplus. It has, however, an indirect effect via firms' pricing decisions. This is different in existing approaches: For example, in Gabaix and Laibson (2006), the consumer types also make different decisions in equilibrium, whereas in our model, both types consume the same quantity in equilibrium. In our setting, the existence of the two groups only has an indirect effect via influencing the firms' pricing strategies (which then affect both consumer types in the same way).

Impact of transparency

Before comparing the equilibrium outcome with the one under screening, and before evaluating the policy effects, it is useful to closely inspect how the presence of the two consumer groups affects firms' pricing strategies and the equilibrium outcomes. The analysis is useful for understanding interventions that increase market transparency (for instance, via disclosure requirements and education initiatives).

The following proposition describes the effects of an increase of the share of informed consumers on equilibrium contracts:

Proposition 3. An increase in consumer transparency (as measured by the share of informed consumers) has the following effects on firms' equilibrium pricing strategies:

(i) It holds that $\partial p_T^*/\partial\phi < 0$.

(ii) There exists a $\phi_{f_T^*}(\tau)$ such that $\partial f_T^*/\partial\phi < 0$ for $\phi < \phi_{f_T^*}(\tau)$, and $\partial f_T^*/\partial\phi > 0$ for $\phi > \phi_{f_T^*}(\tau)$.

The existence of uninformed consumers in the market changes firms' equilibrium prices. Part (i) of the proposition shows that the linear price component decreases in the share of the informed consumers. In contrast, part (ii) shows that there is a non-monotonic effect on the fixed fee.

The effect on the linear price follows from a larger number of consumers considering this price component when choosing where to buy. Clearly, the more consumers are informed about the linear price at the contracting stage, the lower the price that firms have to set.

The non-monotonic effect of transparency on the fixed fee component is due to two opposing effects: a direct effect and an indirect effect. The direct effect is a composition effect, and the indirect effect works via the decrease of the linear price component as market transparency increases. The effects can be seen in the first-order

condition of firm profits with respect to the fixed fee f at the symmetric equilibrium:

$$\frac{\partial \Pi_1}{\partial f_1} = \frac{1}{2} + \underbrace{\left[\phi \frac{\partial \tilde{x}^r}{\partial f_1} + (1-\phi)\frac{\partial \tilde{x}^n}{\partial f_1}\right]}_{\text{direct effect: composition effect}} (f_1 + \underbrace{p_T^*(\phi)(1-p_T^*-\tau x)}_{\text{indirect effect: decreases with } \phi}) = 0.$$

The indirect effect follows from the decrease of the linear price component. With lower linear prices, informed consumers become less sensitive toward changes in the fixed fee. Hence, as the linear price decreases with more informed consumers, firms have larger incentives to increase the fixed fee. This effect is similar in spirit to an increase in the transportation-cost parameter in a standard Hotelling model. Because the linear price decreases with more informed consumers, consumption quantities increase (and, hence, consumption becomes more efficient). While consumers benefit from this effect, firm profits originating from the linear price component decrease. The lower profit reduces the intensity of competition among firms for new consumers via lower fixed fees, which enables them to charge higher fixed fees. This effect is similar to the cross-subsidization effects in the add-on literature (e.g., Gabaix and Laibson, 2006).

The direct effect is a composition effect. As noted earlier (see equation (5)), informed consumers are more sensitive to changes in the fixed fee than uninformed consumers. Hence, as the share of informed consumers increases, market demand becomes more elastic regarding the fixed fee forcing firms to reduce this fee. However, this effect becomes weaker as transparency increases. This effect can best be understood by looking at the cross-derivative of the marginal informed consumer (equation (5)) with respect to both price components:

$$\frac{\partial \tilde{x}^r}{\partial f_1 \partial p} = -\frac{2}{\tau(2-2p-\tau)^2} < 0.$$

Due to the two opposing effects, the overall effect of increased market transparency is u-shaped in the level of transparency. As part (ii) of Proposition 3 shows, the fixed fee first decreases for low values of the share of informed consumers and then increases for high values of the share of informed consumers. This is shown in Figure 1. The left panel illustrates the result for a given value of the transport-cost parameter, whereas the right panel shows the effects of changes in the transport-cost parameter. Moreover, the right panel also displays the parameter regions in which profits and consumer surplus increase or decrease if transparency is increased.

This non-monotonicity can also be illustrated by considering a regulation that lowers the linear price component directly (instead of indirectly via a larger number of informed consumers). In a version of our model in which firms set the linear fee at a regulated level of $\bar{p}$, and in which firms compete on the fixed fee, we can show the following result:

Corollary 1. Suppose that firms compete in a single two-part tariff and a regulator fixes the linear price at $\bar{p}$. Then, decreasing $\bar{p}$ leads to lower (higher) fixed fees for sufficiently high (low) values of $\bar{p}$.

This corollary relates our findings to the discussion of waterbed or see-saw effects, according to which the regulation of one price component may lead to the increase of other price components (e.g., Genakos and Valletti, 2011, 2012).[11] Our analysis brings a more nuanced picture forward, and suggests that the extent of such waterbed effects depends on consumer awareness. The corollary suggests that such adverse waterbed effects of regulation are non-monotonic. Starting from high levels of $\bar{p}$, a reduction in the linear fee also leads to a lower fixed fee. In contrast, if $\bar{p}$ is already at a low level, a further decrease of the linear fee may lead to a waterbed effect and, hence, a higher fixed fee.

The next proposition explores the welfare and profit implications of more transparency:

Proposition 4. An increase in consumer transparency (as measured by the share of informed consumers) has the following effects on welfare and firm profits:

(i) It holds that $\partial \Psi_T^*/\partial \phi > 0$.

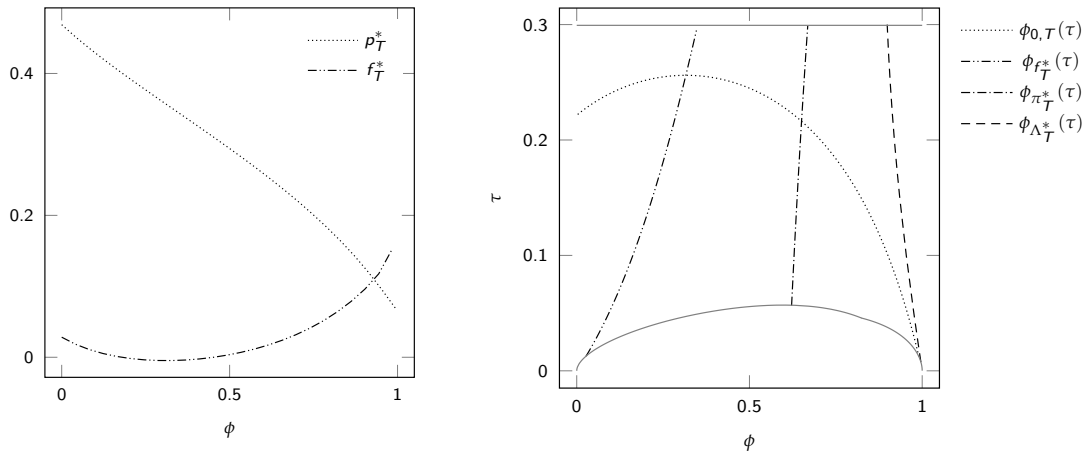
(ii) There exists a $\phi_{\pi_T^*}(\tau)$ such that $\partial \pi_T^*/\partial \phi < 0$ for $\phi < \phi_{\pi_T^*}(\tau)$, and $\partial \pi_T^*/\partial \phi > 0$ for $\phi > \phi_{\pi_T^*}(\tau)$.

(iii) There exists a $\phi_{\Lambda_T^*}(\tau)$ such that $\partial \Lambda_T^*/\partial \phi > 0$ for $\phi < \phi_{\Lambda_T^*}(\tau)$, and $\partial \Lambda_T^*/\partial \phi < 0$ for $\phi > \phi_{\Lambda_T^*}(\tau)$.

Because the only inefficiency in the market arises from a linear price which is set above the marginal cost of zero, we can immediately conclude that social welfare decreases as the share of informed consumers increases due to lower linear prices. Social welfare is maximized when all consumers are perfectly informed, because this means that the linear price is lowest.

Interestingly, as opposed to existing findings, the effects on firm profits and consumer surplus are non-monotonic. These effects are illustrated in the right panel of Figure 1. The u-shaped effect on firm profits follows the logic on firms' pricing strategies outlined in Proposition 3. When many consumers are initially uninformed, informing some of them leads to lower linear prices and lower fixed fees. As a consequence, profits decrease. The picture changes when few consumers are initially uninformed. In this case, the linear price decreases, but the increase in the fixed price compensates this negative effect so that overall profits increase. Lastly,

[11] For instance, Genakos and Valletti (2011) find that a decrease of interconnection charge in mobile telecommunication markets leads to an increase of subscription prices.



(a) Impact on prices ($\tau = 1/4$). (b) Impact on profits and welfare.

Figure 1: Impact of transparency, prices, profits, and welfare.

Note: The area between the solid gray lines in the right panel represents those combinations of the degree of transparency and transport costs considered in the analysis.

we also point out that profits are highest when all consumers are uninformed about linear prices, i.e., in particular, $\pi_T^*(1,\tau) < \pi_T^*(0,\tau)$.

With regard to consumer surplus, note that the previous literature suggests that consumers are affected most by the fixed fee (Gössl and Rasch, 2020). Because the fixed fee first decreases and then increases as the market becomes more and more transparent, this translates into the effect a change in transparency has on consumer surplus: It first increases, and decreases for (very) high levels of consumer-side transparency.

This last aspect also affects the optimal level of consumer transparency. From the observation that consumer surplus decreases in the degree of transparency when transparency is already high (see part (iii) of Proposition 4) and the fact that

$$\Lambda_T^*(0,\tau) = \frac{144 - 7\tau(72 - 31\tau)}{384} < \frac{67\tau^2}{69} - \frac{5\tau}{4} + \frac{1}{2} = \Lambda_T^*(1,\tau),$$

we can state the following result:

Corollary 2. Under a consumer standard, the optimal level of transparency is given by $\phi_{\Lambda_T^*}(\tau)$.

Implications of the policy intervention

We are now in a position to evaluate the effects of the policy intervention, that is, the effect of banning multiple two-part tariffs. We start by comparing the effects on prices.

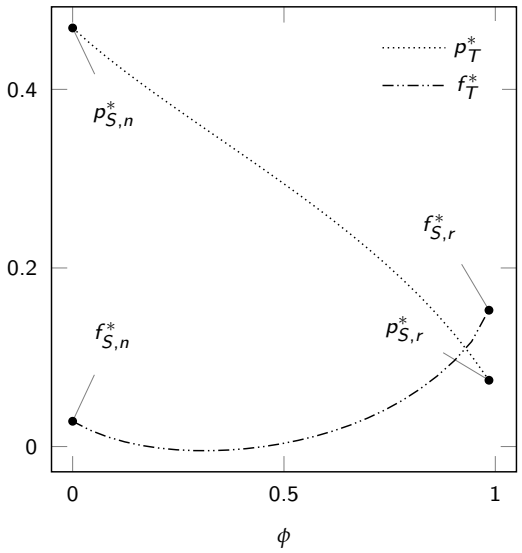


Figure 2: Impact of a policy that bans multiple two-part tariffs on prices.

Prices can be compared in Figure 2. The figure provides a comparison of prices under the screening contracts (for both informed and uninformed consumers) and the prices under a single two-part tariff. With regard to the linear price, the figure shows that due to the intervention, the linear price will decrease for uninformed consumers, but it will increase for informed consumers. More interestingly, because the fixed fee is u-shaped in transparency (see our previous discussion), this price component can decrease for both consumer segments.

Our next finding relates to firm profits:

Proposition 5. A reduction of the permissible number of two-part tariffs results in lower profits for firms, i.e., $\pi_T^* < \pi_S^*$.

The proposition shows that firm profits necessarily decrease when firms can no longer target uninformed consumers via a separate contract. Hence, losing the ability to price discriminate hurts firms.

Define the following critical level of transparency

$$\phi_{\Lambda_{ST,r}^*}(\tau) = \frac{(256 + 3232\tau^2 - 4000\tau^3 + 1101\tau^4 - (-4+3\tau)(-4+7\tau)^2\sqrt{16+8\tau+161\tau^2}}{2(256 - 256\tau + 2720\tau^2 - 3856\tau^3 + 1389\tau^4)}.$$

The following proposition evaluates the welfare effects of the intervention:

Proposition 6. (i) Informed consumers are made better (worse) off by the reduction of the permissible number of two-part tariffs when their share is small (large), i.e., $\Lambda_{T,r}^* > (<)\Lambda_{S,r}^*$ for $\phi < (>)\phi_{\Lambda_{ST,r}^*}$.

(ii) Uninformed consumers always benefit from the reduction, i.e., $\Lambda^*_{T,n} > \Lambda^*_{S,n}$.

(iii) Consumers as a whole always benefit from the reduction, i.e., $\Lambda^*_T > \Lambda^*_S$.

(iv) Requiring a reduction of the permissible number of two-part tariffs always increases social welfare, i.e., $\Psi^*_T > \Psi^*_S$.

The findings on firm profits and consumer welfare follow from the intuition that this intervention removes the ability of firms to earn relatively large amounts from targeting uninformed consumers via a separate contract. As a result, the market becomes more competitive so that firm profits fall, and consumer surplus can rise. Interestingly, however, while uninformed consumers always benefit, the effect is ambiguous for informed consumers.

5 Abolishing linear fees: Competition in fixed-fee contracts

In this section, we consider the case in which firms are restricted to fixed-fee pricing, and cannot make use of the linear price component. This means that both firms set a linear price of zero.[12] This intervention would correspond to the EU ban of roaming charges in mobile telecommunication.

Notice that this intervention – apart from eliminating the linear price component – reduces the range of possible contracts. With only a fixed fee, firms can no longer design different contracts to screen informed and uninformed consumers. Hence, this setting rules out any discrimination based on consumers' information status (inter-group price discrimination), but also bans intra-group price discrimination (via a two-part tariff).

Equilibrium behaviour

Because consumer information does not matter in this scenario, our model simplifies to the analysis in Gössl and Rasch (2020). From expression (2) it follows that the local demand of a consumer at firm i is $q_i(x) = 1 - \tau|L_i - x|$. Because there is no linear price, the actual demand level coincides with the expected demand for both consumer types at the contracting stage. Hence, the indifferent consumer $\tilde{x}_F$ in both segments is given by:

$$u_1(\tilde{x}; q_1; f_1) = u_2(\tilde{x}; q_2; f_2) \Leftrightarrow \tilde{x}_F = \frac{1}{2} - \frac{f_1 - f_2}{\tau(2-\tau)}.$$

[12] Note that we have normalized marginal costs to zero. Hence, this policy could be regarded as one that requires firms to price the linear component at cost.

Firms now simultaneously maximize:

$$\max_{f_i} \pi_{i,F}(f_i; f_j) = f_i \tilde{x}_F.$$

The following proposition describes equilibrium firm behaviour and the market outcome:

Proposition 7. When firms only compete in fixed fee, both firms set the same contract to both consumer types. The equilibrium fixed fee is

$$f_F^* = \tau - \frac{\tau^2}{2},$$

and firms earn

$$\pi_F^* = \frac{\tau}{2} - \frac{\tau^2}{4}.$$

Consumer surplus is given by

$$\Lambda_F^*(\tau) = \frac{13\tau^2}{24} - \frac{5\tau}{4} + \frac{1}{2},$$

and social welfare amounts to

$$\Psi_F^*(\tau) = \frac{\tau^2}{24} - \frac{\tau}{4} + \frac{1}{2}.$$

Implication of the policy intervention

We can now compare the outcome of this intervention with the market outcome when firms offer screening contracts to consumers (as described in Proposition 1). Define the following critical levels of consumer types:

$$\phi_{\pi_{SF}^*}(\tau) = \frac{4 - 9\tau}{4 + 5\tau} \qquad \phi_{\Lambda_{SF}^*}(\tau) = \frac{16 + 8\tau - 3\tau^2}{16 + 8\tau + 17\tau^2},$$

where $\phi_{\pi_{SF}^*} < \phi_{\Lambda_{SF}^*}$ for each τ.

The following two propositions describe the effects of the intervention on firms and consumers. The findings are also illustrated in the right panel of Figure 3.

Proposition 8. An abolishment of the linear price results in lower (higher) profits for firms as long as the share of informed consumers is sufficiently low (high), i.e., $\pi_F^* < (>)\pi_S^*$ for $\phi < (>)\phi_{\pi_{SF}^*}(\tau)$.

Proposition 8 says that, depending on the level of market transparency (as measured by the share of informed consumers) firms may lose or benefit from the inter-

vention. Indeed, this brings a more nuanced picture to the literature. The existing literature shows that in markets with full consumer information reducing the number of price elements over which firms can compete is beneficial for firm profits (Yin, 2004). In contrast, in our setting with informed and uninformed consumers this finding may not necessarily hold. Indeed, if the share of uninformed consumers is sufficiently large, profits fall due to the intervention. Hence, our model with imperfect consumer information is in line with mobile telecommunication firms' opposition to the recent EU ban of roaming charges.

The next proposition explores the welfare effects of the intervention:

Proposition 9. (i) Informed consumers never benefit from the abolishment of the linear price component, i.e., $\Lambda^*_{S,r} > \Lambda^*_{F,r}$.

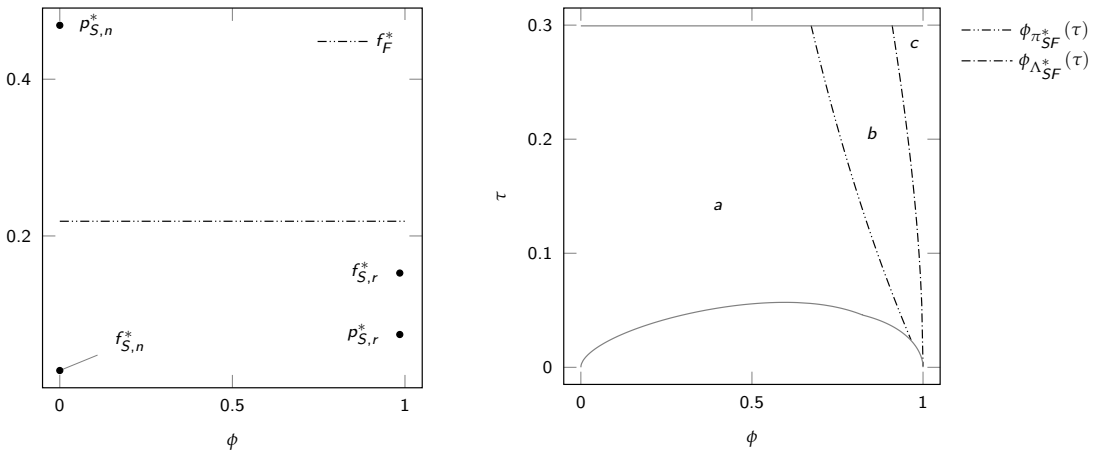
(ii) Uninformed consumers always benefit from the abolishment of the linear price component, i.e., $\Lambda^*_{S,n} < \Lambda^*_{F,n}$.

(iii) Consumers as a whole benefit from (are worse off after) the abolishment as long as the share of informed consumers is sufficiently small (large), i.e., $\Lambda^*_S < (>)\Lambda^*_F$ for $\phi > (<)\phi_{\Lambda^*_{SF}}$.

The main message behind Proposition 9 is that, while overall consumer welfare can go up or down, the effects on the two consumer groups are clear-cut. Uninformed consumers benefit from the intervention, and informed consumers lose out. Thus, the effects on overall consumer welfare largely depends on the distribution of types. With a large number of informed consumers ($\phi > \phi_{\pi^*_{SF}}(\tau)$), the effect is negative; for $\phi < \phi_{\pi^*_{SF}}(\tau)$, the effect is positive. Here, we also complement existing findings by showing that consumer information crucially matters to determine whether a reduction of pricing instruments hurts or benefits consumers.

The left panel of Figure 3 provides the intuition of these findings. While both consumer groups benefit from the reduction of the linear fee, all consumers are also negatively affected via higher fixed fees (waterbed effect). Note, however, that this waterbed effect appears stronger for uninformed consumers compared to informed consumers. Nevertheless, we find that uninformed consumers can overall benefit from the regulation when the decrease of the linear fee dominates. In contrast, informed consumers never benefit, because the reduction of the linear fee is, as can be seen in the figure, relatively small compared to the increase of the fixed fee.

Finally, note that the overall effects on social welfare are positive. As the intervention sets the linear price equal to zero, it implements the efficient consumption level and, hence, social welfare increases due to the intervention.



(a) Impact on prices ($\tau = 1/4$). (b) Impact on profits and consumer surplus.

Figure 3: Impact of a policy that bans linear prices.

Note: The area between the solid gray lines in the right panel represents those combinations of the degree of transparency and transport costs considered in the analysis. For combinations in section a, firms and consumers as a whole lose out due to the ban, whereas both parties benefit from it in section c. In section b, firms benefit, but consumers are made worse off.

6 Comparing policy interventions

In this section, we compare the two interventions, and identify conditions when each is the better solution for a regulator to implement. One potential aim of a regulator could be to maximize total consumer surplus. An alternative objective could be to maximize the surplus of uninformed consumers (if they are seen as vulnerable consumers). Interestingly, in both interventions, inter-group price discrimination is removed so that the two objectives are aligned. Yet, it will turn out that the preferences of the two consumer groups, informed and uninformed, are not generally aligned. A final aim of this section is to explore the effects of a further scenario in which a regulator – apart from affecting the price scheme – might also affect consumer awareness of the linear price component, for instance, via disclosure requirements.

Comparison of total consumer surplus and firm profits

We start by comparing preferences of firms and consumers as an aggregate group.

Proposition 10. Comparing the two scenarios of a policy intervention reveals that

(i) there exists a $\phi_{\pi^*}(\tau)$ such that $\pi^*_F(\tau) < \pi^*_T(\phi, \tau)$ for $\phi < \phi_{\pi^*}(\tau)$, and $\pi^*_T(\phi, \tau) < \pi^*_F(\tau)$ for $\phi > \phi_{\pi^*}(\tau)$;

(ii) there exists a $\phi_{\Lambda^*}(\tau)$ such that $\Lambda^*_T(\phi, \tau) < \Lambda^*_F(\tau)$ for $\phi < \phi_{\Lambda^*}(\tau)$, and $\Lambda^*_F(\tau) < \Lambda^*_T(\phi, \tau)$ for $\phi > \phi_{\Lambda^*}(\tau)$; and

(iii) it holds that $\Psi_T^*(\phi, \tau) < \Psi_F^*(\tau)$.

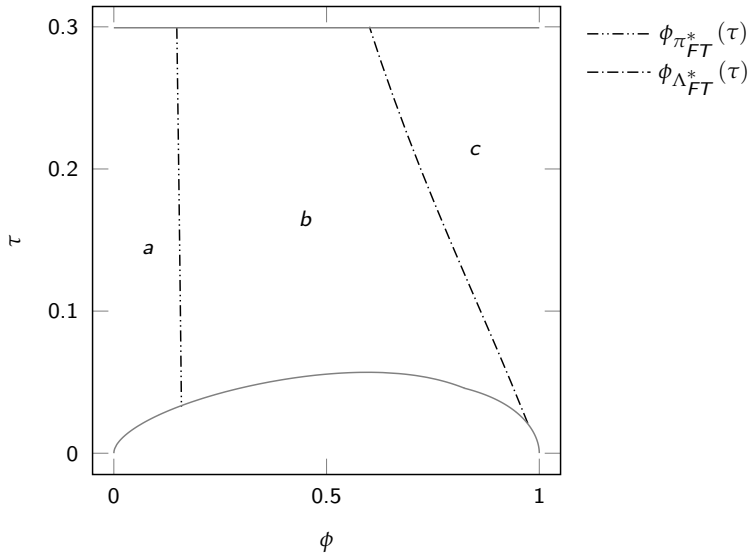


Figure 4: Optimal policy intervention for consumers.

Note: The area between the solid gray lines represents those combinations of the degree of transparency and transport costs considered in the analysis. For combinations in section a, firms prefer two-part tariffs, whereas the regulator with a consumer standard prefers fixed fees. In section b, firms and the regulator favor fixed fees. Firms prefer fixed fees, and the regulator favors two-part tariffs in section c.

Figure 4 illustrates the findings of the proposition (parts (i) and (ii)). The intuition behind these results can be related to our findings in Proposition 4. Consumers as a whole are better off when linear prices are abolished as long as the share of informed consumers is sufficiently low.[13] This is illustrated by the areas a and b in Figure 4. In this case, it is true that fixed fees would be lower under a single two-part tariff, but firms can exploit the fact that many consumers are not aware of the charged linear prices. As a result, a policy that bans this linear component maximizes total consumer surplus.

In the opposite case in which a larger number of consumers is informed, the optimal policy intervention would require firms to offer only a single two-part tariff (illustrated by area c in Figure 4). Because a larger number of consumers is informed, the negative effect of a high fixed fee when the linear fee is banned dominates so that consumers are better off with a (single) two-part tariff.

These findings for consumer welfare have important implications for firms: Firms' and consumers' preferences are generally not aligned, and we can conclude that, despite the fact that more pricing instruments tend to result in more intense com-

[13] While in our model, the effect of this policy intervention on consumer surplus crucially depends on the share of uninformed consumers in the population, this does not hold true for related models of add-on pricing. In Ellison (2005), "[...] such a policy would make all consumers better off. High types gain because they pay lower prices. Low types are better off despite paying more because they get a higher quality good."

petition, firms benefit from being able to exploit uninformed consumers when their share is large. In this situation, abolishing the linear fee boosts competition in fixed fees to an extent such that profits decrease.

Interestingly, however, there is also an intermediate region for the scope of transparency for which both, firms and consumers, benefit from the abolishment of the linear price (area b in Figure 4). Compared to the case with no or only very little market transparency, the linear price is lower, and, hence, social welfare is higher. In this intermediate range, firms cannot appropriate all of this gain but only parts of it due to competition. As a result, consumers also get a share of the gain.

Due to the positive linear price under two-part tariffs, social welfare is always higher in the fixed-fee scenario (which implies a linear price equal to the marginal cost of zero).

Differential effects on informed and uninformed consumers

As pointed out in the previous sections, we see that the interventions can have different effects on informed and uninformed consumers. While uninformed consumers benefit from both interventions, this is not the case for informed consumers. Therefore, in this subsection, we provide more detail on the groups' preferred pricing regimes (including no intervention at all).

The results of these comparisons are presented in Table 1. In addition to the effect on the two consumer types, the table, drawing on Proposition 10, shows the preferred pricing regimes for consumers as a whole and for firms. While the preferences of consumers and uninformed consumers are aligned, these can differ for informed consumers, in particular, in markets with a large number of uninformed consumers. The comparison shows that for sufficiently opaque markets, informed consumers prefer no intervention at all (that is, their surplus is maximized with screening contracts), whereas uninformed consumers prefer an intervention (typically, fixed fees only).

Interestingly, in contrast to uninformed consumers, informed consumers never prefer the ban of linear fees, because this makes it possible for firms to appropriate a large share of their surplus via a high fixed fee (Yin, 2004). In contrast, such fixed-fee-only contracts can be optimal for uninformed consumers, because uninformed consumers cannot be exploited via unexpected high linear prices.

Additional policy measure: Disclosure of linear prices

So far, the distribution of consumer types (informed vs. uninformed) was treated as an exogenous parameter. Here, we briefly discuss optimal policy decisions if a

Table 1: Optimal regimes.

	$\tau \lesssim 0.0798$			
	$0 \leq \phi < \phi_{\pi^*_{SF}}$	$\phi_{\pi^*_{SF}} \leq \phi < \phi_{\Lambda^*_{FT}}$	$\phi_{\Lambda^*_{FT}} \leq \phi < \phi_{\Lambda^*_{ST,r}}$	$\phi_{\Lambda^*_{ST,r}} \leq \phi \leq 1$
Firms	Screening	Fixed fees	Fixed fees	Fixed fees
Consumer surplus	Fixed fees	Fixed fees	Single TPT	Single TPT
Informed consumers	Screening	Screening	Screening	Single TPT
Uninformed consumers	Fixed fees	Fixed fees	Single TPT	Single TPT
Total welfare	Fixed fees	Fixed fees	Fixed fees	Fixed fees
	$\tau \gtrsim 0.0798$			
	$\phi < \phi_{\Lambda^*_{FT}}$	$\phi_{\Lambda^*_{FT}} \leq \phi < \phi_{\pi^*_{SF}}$	$\phi_{\pi^*_{SF}} \leq \phi < \phi_{\Lambda^*_{ST,r}}$	$\phi_{\Lambda^*_{ST,r}} \leq \phi \leq 1$
Firms	Screening	Screening	Fixed fees	Fixed fees
Consumer surplus	Fixed fees	Single TPT	Single TPT	Single TPT
Informed consumers	Screening	Screening	Screening	Single TPT
Uninformed consumers	Fixed fees	Single TPT	Single TPT	Single TPT
Total welfare	Fixed fees	Fixed fees	Fixed fees	Fixed fees

regulator not only restricts firms' pricing instruments, but can influence to what extent linear fees are salient, and can require firms to disclose and advertise the linear price component. In our setting, such a disclosure requirement could be interpreted as an increase in the share of informed consumers (and a corresponding decrease in uninformed consumers).

To fix ideas suppose that a regulator applies a consumer standard, and intends to maximize total consumer surplus. In addition to choosing the pricing regime, the regulator can determine the share of informed consumers at no cost. Then, we obtain the following result:

Proposition 11. A regulator that can choose the pricing regime and the level of transparency will impose a single-part tariff, and will never require full transparency.

The intuition for understanding this finding comes in two steps. First, note that with fixed fees only, the market outcome does not depend on the share of informed consumers, while it does in the case of a single two-part tariff. Hence, because the single-two part tariff is optimal for some level of transparency (see Proposition 10 and Table 1), fixed fees only can never be optimal if the regulator can also choose transparency. Second, from Corollary 2 it immediately follows that full transparency is never optimal. Thus, the regulator optimally prefers a regulation with a single two-part tariff, and requires an intermediate level of transparency.

This result suggests that, instead of banning roaming charges, a policy that requires firms to offer a single contract combined with an increased disclosure of roaming charges might have led to higher aggregate consumer surplus. In particular, one might argue that over time (in particular, due to increased use of data services) consumer attention of roaming services and charges would have increased automatically.

7 Conclusion

Regarding roaming, our analysis suggest that given the small share of consumers who are fully informed, the model can explain the divergence of interests in the political decision process: Telecommunication firms were against the abolishment of roaming fees, whereas the European Commission promoted it. Put differently, because the model predicts that given that mobile operators opposed this kind of policy intervention, this is evidence that only (very) few consumers were fully informed about all pricing components. In this case, however, a regulatory intervention is most warranted, because the difference in consumer surplus between the two-part-tariff and the fixed-fee scenarios is greatest. However, our analysis also suggests that the disclosure of roaming fees in combination with tariff simplification might have resulted in even higher levels of consumer welfare.

The welfare results of our model in a market with boundedly rational consumers not only provide a rationale for regulating the European telecommunications markets. They also allow to conjecture that a large fraction of consumers are severely challenged by the complex pricing schemes that many products inhibit. Consequently, following its consumer standard, it is consistent with our theory that the European Commission continues to make a noticeable effort to support consumers in making economically sound decisions.

In its most recent efforts to reduce pricing complexity, the European Commission has put into effect the Markets in Financial Instruments Directive (MIFID II). Applying from January 2018, this legislative framework is aimed at strengthening investor protection in Europe – among other aspects by educating consumers about the often complex pricing structures of financial products. Before consumers can buy or sell stocks or funds, the regulation requires banks to supply them with standardized information regarding the costs of transacting and holding these stocks.

Evidently, the pricing structures in the financial and telecommunications industries differ substantially and applying our results to other markets would require to take their peculiarities into account. As Faure and Luth (2011) argue, this quite generally applies to many findings of the behavioral literature in industrial organization that to a large extent are context-specific and applicable only to particular products, services, and consumer groups. This fact also suggests that there remains plenty of scope for further market studies shedding light on the economic consequences of consumers' behavioral biases.

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Appendix

Derivation of Assumption 1

In this appendix, we derive the transport costs thresholds which ensure that the pure-strategy equilibria characterized for all three scenarios discussed in the main text exist. The bounds on transport costs are necessary in the case of the upper bound due to our requirement of full market coverage, in the case of the lower bound to rule out deviations of firms to only serve one consumer group. We find that in both cases the constraints implied by the single TPT case are binding.

Market coverage condition: Competition with screening contracts

The market is covered when both consumer groups have non-negative utility from consumption. In the symmetric equilibrium the consumer with the lowest utility is located at $x = \frac{1}{2}$. It must hold that:

$$\begin{aligned} u_1^r\left(\frac{1}{2}, q^r, f_{S,r}^*, p_{S,r}^*\right) = \quad u_2^r\left(\tfrac{1}{2}, q^r, f_{S,r}^*, p_{S,r}^*\right) \quad \geq 0 \quad \Leftrightarrow \quad \tau \leq \frac{4}{9} \equiv \overline{\tau}^r, \\ u_1^n\left(\frac{1}{2}, q^r, f_{S,n}^*, p_{S,n}^*\right) = \quad u_2^n\left(\tfrac{1}{2}, q^r, f_{S,n}^*, p_{S,n}^*\right) \quad \geq 0 \quad \Leftrightarrow \quad \tau \leq \frac{4(27-4\sqrt{19})}{85} \equiv \overline{\tau}^n. \end{aligned}$$

Note that $\overline{\tau}^r < \overline{\tau}^n$.

Market coverage condition: Competition in single two-part tariffs

In this case the market is covered whenever:

$$u_1^r\left(\frac{1}{2}, q^r, f_T^*, p_T^*\right) = u_2^r\left(\frac{1}{2}, q^r, f_T^*, p_T^*\right) \geq 0$$

$$-\frac{(A+\tau(5\phi-3)-8\phi+4)\left(\tau\left(A(5-7\phi)-8\left(5\phi^2+32\phi-39\right)\right)+4\left(4(A-2)\phi-3(A+4)+16\phi^2\right)+\tau^2\left(5\phi^2+134\phi-143\right)\right)}{256(\phi-1)^2(A-3\tau(\phi+1)+8\phi+4)} \geq 0 \tag{6}$$

The point where (6) binds with equality implicitly determines $\overline{\tau}(\phi)$. Graphical inspection shows that $\min \overline{\tau}(\phi) = \overline{\tau}(\phi = 0) = 4/79(23 - 2\sqrt{73}) \equiv \overline{\tau}$. Note that $\overline{\tau} < \overline{\tau}^r$.

Market coverage condition: Competition in fixed fee contracts

In this case the market is covered whenever:

$$u_1^r\left(\frac{1}{2}, q^r, f_F^*, 0\right) = u_2^r\left(\frac{1}{2}, q^r, f_F^*, 0\right) \geq 0 \quad \Leftrightarrow \tau \leq \frac{2}{5} \equiv \overline{\tau}^f$$

Noting that $\overline{\tau}^f > \overline{\tau}$ we can conclude that for all $\tau \leq \overline{\tau}$ the market is covered in all our scenarios.

Firm non-deviation condition

Note that in the single two-part tariff scenario, firms may be able to profitably deviate and serve only one of the consumer groups. In the screening case such a deviation is never incentive-compatible for firms since offering two different contracts is costless and therefore profit-maximizing. Moreover, in the fixed-fees only case a deviation to one of the two groups of consumers is impossible since their information status coincides in this scenario.

In the following, we derive a lower bound on transport costs which ensures that serving both types of consumers is indeed optimal. If transport costs are too low, a firm can deviate by serving exclusively either informed or uninformed consumers. Upon deviating to only serve the uninformed consumers, firm 1 maximizes:

$$\max_{p_1,f_1} \pi_1^{D,n}(p_1,f_1;p_T^*,f_T^*) = (1-\phi)\left(p_1\int_0^{\hat{x}_T^n}(1-p_1-\tau x)dx + f_1\hat{x}_T^n\right),$$

where $\hat{x}_T^n = \frac{1}{2} - \frac{f_1-f_T^*}{\tau(2-\tau)}$ denotes the indifferent uninformed consumer with firm 1 deviating. Correspondingly, when deviating to only serve informed consumers the firm maximizes:

$$\max_{p_1,f_1} \pi_1^{D,r}(p_1,f_1;p_T^*,f_T^*) = \phi\left(p_1\int_0^{\hat{x}_T^r}(1-p_1-\tau x)dx + f_1\hat{x}_T^r\right),$$

where $\hat{x}_T^r = \frac{1}{2} - \frac{p_1-p_T^*}{2\tau} - \frac{f_1-f_T^*}{\tau(2-p_1-p_T^*-\tau)}$. We denote the prices under a deviation to consumer type $j \in \{n,r\}$ by $\{p_{D,j}^*, f_{D,j}^*\}$ and the corresponding payoffs of the firm by $\pi_1^{D,j}(p_{D,j}^*, f_{D,j}^*; p_T^*, f_T^*)$. Whenever deviating the firm will choose to deviate to that group of consumers that promises her larger profits and we denote the firm's deviation payoffs as $\pi_1^D \equiv \max\{\pi_1^{D,n}\pi_1^{D,r}\}$. Since we study the fully symmetric equilibrium we can drop the firm index in the following without any loss of generality and treat firms synonymously.

Since numerical simulations show that the deviator obtains zero profits from the group of consumers that is not targeted by the deviation, deviating by serving only one group of consumers will not be profitable for a firm if and only if $\pi^D \leq \pi_T^*$ holds. This condition can be reinterpreted as a lower bound on the transport cost parameter, $\underline{\tau}(\phi)$, such that for all $\tau \geq \underline{\tau}(\phi)$ the deviation of a firm to serve only one group of consumers is ruled out.

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