

Fischer, Christian; Rasch, Alexander

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Complex pricing and consumer-side transparency

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Complex pricing and consumer-side transparency

Christian Fischer¹
Alexander Rasch^{2,3,*}

¹University of Bayreuth

²Duesseldorf Institute for Competition Economics (DICE)

³European Center for Economic Research (ZEW)

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Preliminary Version

We analyze a situation in which two horizontally differentiated firms compete in two-part tariffs (i.e., a linear and fixed price), and some consumers are not informed about the linear per-unit price. We show that there is a non-monotone relationship between the degree of consumer-side transparency and firm profits. Moreover, different from a situation without uninformed consumers, firms may make higher profits under two-part tariffs than under fixed fees only. There is also a non-monotone relationship between transparency and consumer surplus. Our model can explain why firms are against the abolishment of roaming fees and why the European Commission (EC) promotes it.

Keywords: fixed fee; linear price; roaming; transparency; two-part tariff.

JEL classification: D43; L13; L42.

*Corresponding author. Email: rasch@dice.hhu.de. Address: Duesseldorf Institute for Competition Economics (DICE), University of Duesseldorf, Universitaetsstrasse 1, 40225 Duesseldorf, Germany. Phone: +49 (0)211 81-10234. Fax: +49 (0)211 81-15499.

1. Introduction

Complex pricing structures and price-discriminating menus are a typical phenomenon of today's business practices. Moreover, advances in information technology and its applications (Internet, social media, etc.) speed up the trend toward more and more differentiated as well as customized offers by firms. At the same time, consumers appear to find it more and more difficult—even despite such services as price comparison websites on the Internet—to compare all relevant information to make their purchase decisions. These pricing practices have called the attention of authorities and consumer protection agencies which aim to ensure that consumers do not get lost in the wide array of offers.

In this paper, we focus on the comparison of different pricing schemes and their implications for consumer and social welfare. We do so under the assumption that some consumers are uninformed with regard to particular price components. In particular, we analyze two different pricing policies: two-part tariffs (second-degree price discrimination) and fixed fees. Two-part tariffs, which are a form of nonlinear pricing, are a common business practice in many industries: Typically, they consist of a fixed (entry) fee and linear per-unit price. Examples for industries in which these tariffs are widespread are mobile telecommunications (flat rate, roaming charges), media markets (subscription price, per-view price), as well as gas and electricity contracts (fixed monthly/yearly [meter] price, price per usage).

In everyday business practice, some contract details are less salient than others. For example, firms may advertise a special low price but certain restrictions, which are reported in the small print, apply. In the competition-policy debate, regulators and consumer protection agencies typically follow two approaches to increase the comparability of different offers: education and simplification. If consumers learn to find out about contract pitfalls, they make more educated purchase decisions. The same is true if firms are obliged to reduce the complexity of their pricing structures. Both policies result in an increased market transparency. One recent example where the simplification of tariff structures is prominently featured is the European Commission's goal to reduce and abolish roaming tariffs. Our results shed light on why the European Commission's and mobile operators' interests are misaligned with regard to necessity of such a policy intervention.

We take these observations as a starting point to study the effects of market transparency on the consumer side and different pricing schemes for firm profits and consumer surplus. To this end, we use the approach by Yin (2004) who considers elastic demand in the Hotelling (1929) model. This setup allows to study both scenarios in which firms set (i) two-part tariffs (linear price and fixed fee) and (ii) fixed fees only. Motivated by the above example of roaming,

we incorporate the aspect of transparency in our model in the following way: When firms set two-part tariffs, we assume that a share of consumers are only aware of the fixed component. As a consequence, these consumers neglect the linear price when they decide which firm to buy from. Different from that, all consumers are always informed about the fixed fee charged by the two firms.

We find that there is a non-monotone relationship between the degree of transparency and profits under two-part tariffs. This is different from previous results with only linear or fixed fees (see the related literature below): In those cases, an increase in transparency, i.e., a larger share of consumers becomes informed about the prices set by the firms, always increases competition and hence results in lower profits. 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, a higher degree of transparency means that firms compete less in the fixed fee to attract uninformed consumers whose lower information status can be exploited through the fixed fee. On the other hand, more informed consumers means that the (average) number of pricing instruments in which firms compete increases.

Moreover, we show that for low shares of fully informed consumers, two-part tariffs result in higher profits than fixed fees. Hence, our model can explain why firms may find it profitable to charge two-part tariffs in reality, which is due to some consumers' lack of all relevant pricing information. Indeed, with fully informed consumers, setting fixed fees yields higher profits (Yin, 2004).

We also find a non-monotone relationship between the degree of transparency and consumer surplus under two-part tariffs. In particular, we show that for low and intermediate shares of fully informed consumers, simplifying the pricing structure increases consumer surplus. We therefore provide a rationale why it may make sense from the European Commission's point of view (consumer standard) to abolish roaming fees.

Our paper is related in particular to the industrial organization literature on consumer-side market transparency. The focus of the relevant papers is different, though. The contributions analyze firms' ability to maintain collusion as the degree of transparency changes (Schultz, 2005; Schultz, 2009a; Rasch and Herre, 2013) or the scope of market entry for varying degrees of market transparency (Schultz, 2009b; Gu and Wenzel, 2011). Our paper is also related to the literature on add-on pricing (Ellison, 2005; Gabaix and Laibson, 2006), which assumes that consumers do not take into account the prices of additional products or services (parking, minibar, luggage, etc.) when making a purchase decision. Our analysis differs from that literature in that we assume an exogenously given share of consumers, i.e., transparency is not a strategic variable firms determine. Moreover, the literature on add-on pricing typically considers a binary purchase decision, such that there are demand effects only

at the aggregated level. In addition, consumers may stay away from purchasing additional products or services, whereas we exclude this aspect. From a welfare perspective these papers consistently predict improvements in consumer welfare when add-on practices of firms are abolished. While this prediction is consistent with our model we augment it with a novel qualification: The positive effect on consumers exists only if the mass of uninformed consumers is sufficiently high.

The paper proceeds as follows. Section 2 presents the model. We derive the equilibrium and compare the outcomes in the two pricing scenarios in Section 3. Section 4 discusses a policy intervention where linear fees are abolished. Section 5 concludes.

2. Model

We consider a model of horizontal differentiation à la Hotelling (1929) with two symmetric firms $i \in \{1, 2\}$ located at the extremes of a line with unit length, i.e., $L_1 = 0$ and $L_2 = 1$. Fixed and marginal costs are equal to zero. Firms compete in prices. Depending on the pricing scenario considered, firm i (with $i \in \{1, 2\}$) sets a linear price p_i , which must be paid per unit purchased, and/or a fixed price f_i . It is assumed that firms cannot distinguish between the different consumer types we consider (see below), i.e., they cannot use third-degree price discrimination.

Consumers of mass one are uniformly distributed along the linear city. There are two types of consumers, and the two groups differ in their information status j with regard to the firms' pricing policy. A share ϕ of the consumers (with $\phi \in [0, 1]$) are rational and hence fully informed ($j = r$), i.e., take into account any price component charged by the two firms before making their purchasing decision. The remaining share $1 - \phi$ of consumers are naïve and partially uninformed ($j = n$): Whereas they are also aware of the fixed fees charged by the firms, they neglect the linear prices and expect both firms to set a linear price of zero. The share of fully informed consumers is the same for all locations $x \in [0, 1]$.

Building on Yin (2004), we allow individual demands to be elastic. A consumer with information status j who is located at x and who purchases $q \in [0, 1]$ expects to receive the following utility when buying from firm i :

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

where τ is the transport-cost parameter, and

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

Note that the quantity demanded depends on transport costs.¹ In the product differentiation interpretation of the model, this would mean that mismatch costs occur for each unit purchased. Then, $q\tau|L_i - x|$ represents the total disutility suffered by a consumer with preferred product characteristics of x when consuming a product that is not ideal (and thus not located at x but at L_i). Note that the larger are q and/or $|L_i - x|$, the greater the disutility.

A consumer chooses q in order to maximize their expected utility from consumption. This implies that the (expected) demand of a consumer of type j located at x who buys at firm i takes the following linear form:

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

Note that this expression for the local demand is relevant for the consumer's decision from which firm to buy (see below). However, once the partially informed consumers learn about the existence of p_i , they will account for it in their actual consumption decision, which in turn affects firms' profits. The actual demand level coincides with that of the informed consumers.

The timing of events is as follows:

Stage 1 Firms simultaneously set their prices.

Stage 2 Consumers (partially) observe firms' pricing decisions and decide which firm to buy from.

Stage 3 Uninformed consumers learn the linear price, and all consumers choose their demand. Firm profits and consumer surplus materialize.

Our focus here is 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

¹As such, we use the shipping model with linear demand from Section 3.2 in Yin (2004).

As Yin (2004) derives the results for general demand functions (in particular also for a shopping model [Section 3.1]), we conjecture that our results are not driven by our choice of model. The shipping model allows us to derive tractable results and fits better to the market we have in mind.

Gu and Wenzel (2009, 2012) propose a different approach to modeling elastic demand in this kind of setup: They consider a situation in which all customers have the same elastic demand, and the effects of varying degrees of demand elasticity can be analyzed.

range of transport costs. On the one hand, transport costs must not be too large, since 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 partially informed agents may be optimal for the firms. We thus assume the following:²

Assumption 1. *Transport costs are neither too low nor too high.*

Note that these bounds are always distinct from each other independent of the share of informed consumers. We will be more precise with regard to the actual values of these bounds when we give a complete graphical representation below.

Application: Roaming

We briefly argue how the above model can be applied to the mobile telecommunications market. This allows us to evaluate the European Commission’s decision to abolish roaming charges. First observe that assuming full market coverage for mobile services appears to be a realistic assumption.

Telecom operators in Europe used to differentiate between domestic and international use of their services. Nowadays a typical contract provides domestic consumption within a bundle of minutes, texts, and a data allowance each month,³ i.e., most consumers pay a flat rate for their domestic mobile services. In terms of the model, suppose that domestic mobile services are valued identically by all consumers. We normalize the valuation to zero. The service is priced at the fixed fee f_i .

Moreover, telecom operators imposed surcharges on consumers each time they crossed a border while using their mobile device on holiday or during business trips. Since 2007, roaming tariffs had seen great reductions, and there was an agreement on a new approach to end roaming by June 2017 (“roam like at home” [RLAH]). Under the EU’s Connected Continent package of reforms, RLAH is considered to help to achieve a single market for communications services in Europe, which enhances competition and drives growth.⁴ In contrast to domestic services, roaming services were mostly charged on a per-unit basis.

An interesting aspect in this market is that many consumers appeared to be unaware of their contract details with regard to roaming. As Oxera point

²For a derivation of these bounds, see the Appendix.

³See Oxera Agenda, October 2014: “A Connected Continent? Eliminating excessive roaming charges in the EU”.

⁴Another remedy for roaming services is ‘decoupling’, where end-users are allowed to choose an alternate provider for roaming services. See Oxera Agenda, October 2014: “A Connected Continent? Eliminating excessive roaming charges in the EU” for details.

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 [...]”⁵ In a similar vein, a recent 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. At the same time, however, mobile telecommunication operators informed their consumers via text messages of the costs involved for roaming once they crossed a border. Hence, consumers were aware of the fact that they can use their mobile while being abroad, but they were unaware of the charges for roaming services at the time of contract purchase. Once, they were in a situation in which they wished to use the service, they learned about the costs involved and could thus optimally choose their demand. In model terms, we assume that this part of mobile usage is subject to elastic demand. Moreover, consumers are heterogeneous with regard to roaming, and firms offer differentiated services, because consumers differ in travel destinations or business needs, and firms have different international cooperations which affect network coverage and quality. As such, it appears to be plausible to assume that ‘distance’ is related to quantity purchased. Firms charge a per-unit price equal to p_i .

3. Equilibrium analysis

In this section, we derive the unique symmetric pure-strategy equilibrium of the game for the case with two-part tariffs and partially uninformed consumers. It is assumed that firms are not restricted in their pricing behavior, i.e., firms are free to set prices below zero. We will later comment on the case with constrained pricing, i.e., prices must be non-negative. We solve the game using backward induction.

As mentioned before, in the last stage, all consumers have the same information with regard to firms’ pricing strategies. As a result, the actual demand of every single consumer is determined by the fully informed consumer’s version of expression (1). 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, who is located at \tilde{x}^j , is uniquely determined by:

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

⁵Oxera Agenda, October 2014: “A Connected Continent? Eliminating excessive roaming charges in the EU”, p. 1.

Hence, the indifferent consumer of type j is located at

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

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

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

Solving the maximization problem in the standard way and defining $A := \sqrt{\tau^2(-23\phi^2 + 18\phi + 9) + 8\tau(10\phi^2 - 9\phi - 3) - 64\phi^2 + 64\phi + 16}$ gives the following equilibrium result (where subscript T denotes the case with two-part tariffs):

Proposition 1. *When firms set unconstrained two-part tariffs, the symmetric equilibrium tariffs depend on the share ϕ of informed consumers and are given as*

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

and

$$\begin{aligned} f_T^*(\phi, \tau) &= \frac{-(4 + A - 8\phi + \tau(-3 + 5\phi))}{128(1 - \phi)^2(4 + A + 8\phi - 3\tau(1 + \phi))} \left(16 + \tau^2(67 - 7(10 - \phi)\phi) \right. \\ &\quad \left. - 16\tau(9 - (9 - \phi)\phi) + A(4 - 8\phi - \tau(1 - 3\phi)) \right). \end{aligned}$$

There exists a $\phi_0(\tau)$ such that $f_T^*(\phi, \tau) < 0$ for $\phi < \phi_0(\tau)$ and $f_T^*(\phi, \tau) > 0$ for $\phi > \phi_0(\tau)$.

The equilibrium profit for each firm is given by

$$\begin{aligned} \pi_T^*(\phi, \tau) &= \frac{\tau}{64(1 - \phi)(4 - 3\tau(1 + \phi) + A + 8\phi)} \left((4 + A - 3\tau)(36 - 17\tau) \right. \\ &\quad \left. - (8(32 + A) - (304 + 3A)\tau + 86\tau^2)\phi - \tau(16 - 7\tau)\phi^2 \right). \end{aligned}$$

Proof. See the Appendix. □

Let us briefly comment on the calculation of consumer surplus and social welfare denoted by Λ and Υ , respectively. Given symmetric equilibrium prices,

consumer surplus is calculated as

$$\Lambda_T^*(\phi, \tau) = 2 \int_0^{\frac{1}{2}} u(x; q; p_T^*(\phi, \tau), f_T^*(\phi, \tau)) dx.^6$$

Note that in the scenario with uninformed consumers, both groups of consumers do not differ with respect to their surplus, 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.

With regard to total welfare, we assume that equal weights are put on consumer surplus and firm profits. Thus, in the symmetric equilibrium, it is calculated as

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

Impact of transparency

We now analyze how changes in consumer transparency affect the equilibrium outcome. We will compare the insights to previous results in the literature. Our findings will be helpful to explain the changes resulting from a policy intervention which aims to abolish linear fees (see the next section).

The following proposition highlights the impact on profits and consumer surplus based on a straightforward comparative statics analysis with regard to the degree of transparency on the consumer side:

Proposition 2. *A change in consumer transparency implies the following changes:*

- (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 $\phi > \phi_{f_T^*}(\tau)$.*
- (iii) *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 $\phi > \phi_{\pi_T^*}(\tau)$.*
- (iv) *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 $\phi > \phi_{\Lambda_T^*}(\tau)$.*
- (v) *It holds that $\partial \Upsilon_T^*/\partial\phi > 0$.*

Before discussing these results in detail, let us start by briefly comparing our findings with the previous literature on the impact of consumer transparency

⁶We do not present formal expressions here due to readability but illustrate our findings below. Details are available from the authors upon request.

(see the Introduction). First, increasing transparency leads to a lower linear price, which is in line with previous findings. Interestingly, however, there is a non-monotone relationship between transparency and the fixed fee. Similarly, whereas previous findings suggest that profits always decrease as consumers are better informed, such a change can lead to an increase in profits in our case. A similar discrepancy arises with regard to consumer surplus: In contrast to previous results, consumers can be worse off when their information status improves. As we will argue below, these two observations are related to the relationship between fixed fees and transparency.

Note that we have assumed that firms are free to choose any prices here. Not surprisingly, the linear component, which is strictly decreasing in the scope of transparency, is never set below zero. This, however, is not true for the fixed fee. *Figure 1* below characterizes the fixed part for all permissible combinations of the transport-cost parameter and the degree of consumer-side transparency. As pointed out in *Proposition 1* and as can be seen from the figure, firms indeed choose a negative fixed fee when the level of differentiation is low to intermediate and/or when the share of uninformed consumers is relatively large. Moreover, we have that

$$f_T^*(0, \tau) = \frac{-16 + 5\tau(16 - 7\tau)}{64} < \frac{3\tau}{4} - \frac{9\tau^2}{16} = f_T^*(1, \tau),$$

i.e., the fixed fee is always highest when all consumers are informed about the linear prices, which is not immediate (see part (ii) of *Proposition 2*).

Let us now analyze how the above observations can be explained. We start by recalling an insight from the previous literature with only fully informed consumers (see Gössl and Rasch, 2017): Competing for consumers via the linear component is more fierce compared to competition in fixed fees: Cutting the linear price to steal market share is more attractive, because it comes with a silver lining of increased inframarginal demand. Clearly, previous and new demand (which is smaller than one here) is satisfied at a lower price now, but cutting a fixed fee by the same amount would leave demand (which is equal to one here) by all customers unchanged.⁷

The impact of consumer-side transparency on the fixed fee, profits, and consumer surplus is illustrated in *Figure 1* for all combinations of the level of transparency and transport costs considered.

The existence of uninformed consumers in the market changes firms' linear pricing. From part (i) of *Proposition 2* we know that the price increases as the share of uninformed consumers goes up, which means that firms no longer set the collusive linear price but a higher price. As firms can only partially

⁷As a result, profits are lower under linear prices only compared to the scenario with fixed fees only.

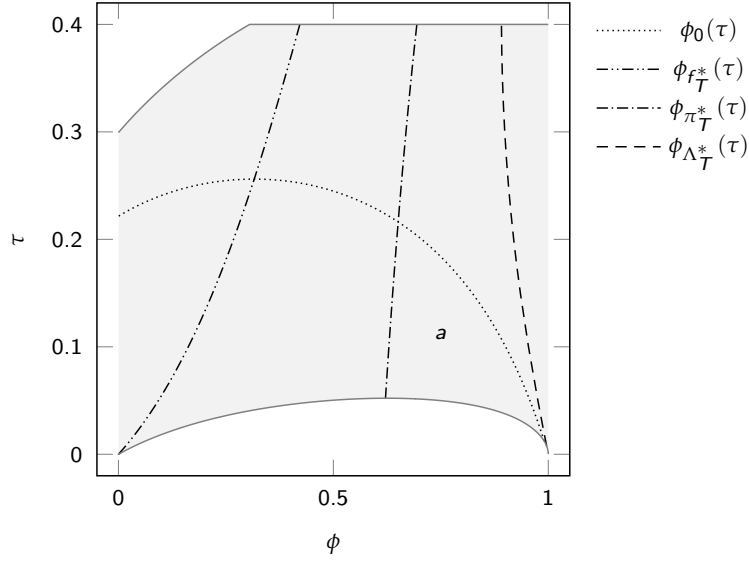


Figure 1: Impact of a change in consumer transparency.

Note: The shaded area represents those combinations of the degree of transparency and transport costs considered in the analysis.

extract consumer surplus under fully informed consumers through the fixed fee, firms try to exploit consumers' uninformedness by extracting some of the surplus left on the table through the linear price. Clearly, the less consumers are informed about the linear price at the moment they make their purchase decision, the higher firms can set this price. As 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 uninformed consumers increases.

Now consider the change of the fixed fee. We start with the case in which all consumers are initially uninformed about linear prices. In this situation, firms can charge the monopoly (collusive) linear price and they basically only compete in fixed fees. Now when the situation changes such that some consumers are no longer uninformed, firms no longer compete only in fixed fees but also in the linear price component. This increases competition, and fixed fees also decrease.⁸

Let us turn to the other extreme case in which all consumers are initially informed about linear prices. When the situation changes, and some consumers are no longer informed, this means that competition in the very competitive linear price component is relaxed. As a consequence, firms can make a higher

⁸We know from the previous literature that when firms only compete in fixed fees, they set higher fixed fees compared the those under two-part tariffs.

profit from local demand. As this is anticipated by the firms, they try to attract more consumers by setting a lower fixed fee.

We can thus conclude that increasing consumer-side transparency has opposing effects: (i) The (average) number of pricing instruments which firms can use to compete is increased, and (ii) it intensifies competition in the more competitive linear pricing component, which reduces competition in the fixed fee (as profits from local demand are reduced). These observations translate into profit changes as follows: When all 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 all consumers are initially informed, but transparency is reduced. In this case, price changes differ. As before, one may argue that the market becomes less competitive and hence more profitable, as the (average) number of pricing components in which firms compete reduces. However, in this case, competition in the very competitive linear pricing component is reduced. The resulting increase in competition via the fixed fee more than outweighs this benefit. As a consequence, profits go down.

Last, we 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, we point out that the previous literature suggests that consumers are affected most by the fixed fee. 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 (see part (iii) of *Proposition 2*) when transparency is already high 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:

Proposition 3. *Under a consumer standard, the optimal level of transparency is given by $\phi_{\Lambda_T^*}(\tau)$.*

In contrast, total welfare is maximized when all consumers are perfectly informed, as this means that the linear price is lowest.

Non-negative fixed fees

First note that the derivation of the equilibrium linear price reveals that firms set their linear prices independent of the fixed fee, which means that the linear price does not change compared to the previous scenario.⁹ Hence, we can state the following result (where the lower bar denotes the constrained pricing regime):

Proposition 4. *Equilibrium prices in the scenario in which firms are restricted to set non-negative fixed fees are given as*

$$\underline{p}_T^*(\phi, \tau) = \bar{p}_T^*(\phi, \tau)$$

and

$$\underline{f}_T^*(\phi, \tau) = \begin{cases} 0 & \text{if } \phi \leq \phi_0(\tau) \\ \bar{f}_T^*(\phi, \tau) & \text{else.} \end{cases}$$

Firm profits are given as

$$\underline{\pi}_T^*(\phi, \tau) = \begin{cases} \frac{(12-\tau(5-3\phi)-A-8\phi)(4+\tau(1+\phi)+A-8\phi)}{512(1-\phi)^2} & \text{if } \phi \leq \phi_0(\tau) \\ \bar{\pi}_T^*(\phi, \tau) & \text{else.} \end{cases}$$

With regard to the impact of a change in the level of transparency, we point out that the results from *Proposition 2* and *Figure 1* qualitatively continue to hold due to the fact that (positive) prices are unchanged. Apart from the fact that the fixed fee obviously no longer depends on the degree of transparency for $\phi \leq \phi_0(\tau)$, the only change is that firm profits decrease in transparency for more combinations of the transport costs and the degree of transparency. More precisely, when $\phi_{\pi_T^*}(\tau) \leq \phi \leq \phi_0(\tau)$ (see section *a* in *Figure 1*), profits no longer increase in the level of transparency but decrease. In this case, profits only depend on the linear price, because fixed fees are now set at zero. As the linear price always decreases in the degree of transparency, this is also true for firm profits.

4. Policy intervention: Abolishing linear fees

In this section, we analyze the effects of policy interventions which aim to improve transparency on the consumer side or abolish linear prices. In order to compare the cases with two-part tariffs and fixed fees only, let us briefly recall the results from previous contributions (Yin, 2004; Gössl and Rasch, 2017). Consider the case in which firms are restricted to fixed-fee pricing and

⁹See also Gössl and Rasch (2017).

cannot make use of the linear pricing component. This means, that both firms set a linear price of zero. This setup rules out any discrimination based on agents' not being informed. The local demand of a consumer at firm i will thus be: $q_i(x) = 1 - \tau|L_i - x|$. The indifferent consumer \tilde{x}_F is given by:

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

Firms now simultaneously maximize:

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

The resulting prices and payoffs are:

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

and

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

Consumer surplus is then given as follows:

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

Social welfare amounts to

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

The results from a straightforward comparison of the results from the scenarios with two-part tariffs and with fixed fees only are summarized in the following proposition:

Proposition 5. *Comparing the cases without and with a policy intervention reveals:*

- (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 $\phi > \phi_{\pi^*}(\tau)$, and*
- (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 $\phi > \phi_{\Lambda^*}(\tau)$.*
- (iii) *It holds that $\Upsilon_T^*(\phi, \tau) < \Upsilon_F^*(\tau)$.*

Figure 2 illustrates the findings of the proposition (parts (i) and (ii)).

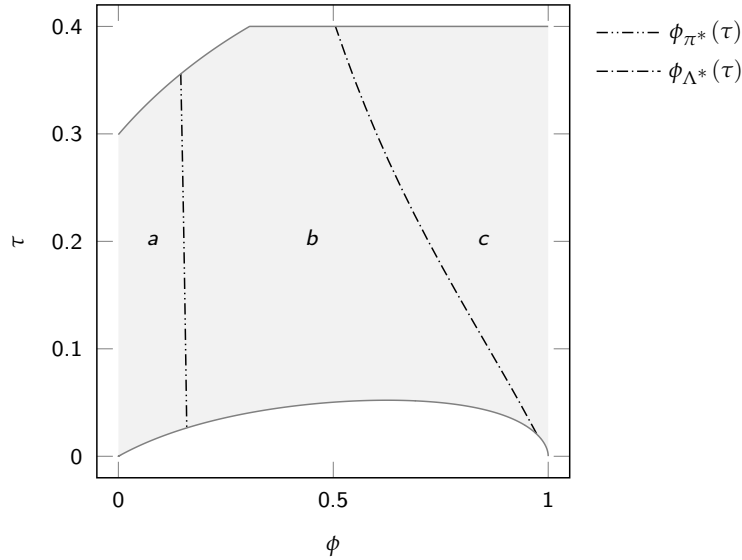


Figure 2: Impact of the policy intervention.

Note: The shaded area 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*.

We can thus conclude that despite the fact that more pricing instruments tend to result in more intense competition, 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 such an extent that profits decrease.

This has important implications for consumers: Consumers are better off when linear prices are abolished as long as the share of informed consumers is sufficiently low. In this case, it is true that fixed fees are lower under two-part tariffs, but firms can exploit that many consumers do not know anything about the linear prices charged.¹⁰

Interestingly, there is an intermediate region for the scope of transparency such that both firms and consumers benefit from the abolishment of the linear price. Compared to the case with no or only very little market transparency, the linear price is lower, and hence total welfare is higher. In this intermediate

¹⁰ While in our model the effect of such policy intervention on consumer surplus crucially depends on the share of uninformed consumers in the population this holds not 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.”

range, firms cannot appropriate all (or even more) 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 lower linear price under two-part tariffs, total welfare is always higher in the fixed-fee scenarios (which implies a linear price equal to the marginal cost of zero).

Non-negative fixed fees

Let us briefly comment on the case in which fixed fees cannot be negative. First note that this requirement has opposing implications for firms and the regulator: Whereas the two-part-tariff scenario is less attractive for the regulator in those regions in which the fixed fee increases, it becomes more attractive for the firms. As we will see now, this discrepancy may increase or decrease the above-mentioned (mis)alignment of interests.

Again, we provide a full comparison of the optimality of one pricing regime or the other for the two parties considered. Analogously to the critical values in *Proposition 5*, define $\phi_{\pi^*}(\tau)$ and $\phi_{\Delta^*}(\tau)$ as those values of the transparency level where profits and consumer surplus, respectively, are the same without and with a policy intervention. *Figure 3* illustrates the findings for the case with non-negative fixed fees.

On a general note, we point out that the insights from *Proposition 5* continue to hold qualitatively: The two parties disagree on the optimal pricing policy for some parameter combinations (see sections *a* and *c* in the figure) and they both favor the abolishment of linear fees for the remaining combinations (see section *b*). However, there are two subtle changes compared to the scenario with unrestricted pricing due to the above-mentioned effects. First, the section in which the regulator favors fixed fees, whereas firms would opt for two-part tariffs becomes larger (compare sections *a* in *Figures 2* and *3*). Indeed, we have that $\phi_{\pi^*}(\tau) \leq \phi_{\pi^*}(\tau)$. Second, the region in which the regulator does not opt for the abolishment of linear prices, but firms support such a policy becomes smaller (compare sections *c* in *Figures 2* and *3*). It holds that $\phi_{\Delta^*}(\tau) \leq \phi_{\Delta^*}(\tau)$.

Implications for roaming

As mentioned before, the European Commission ordered the abolishment of roaming surcharges by June 2017. From the comparison of the results without and with this policy intervention (independent of whether fixed fees are restricted or not), it becomes clear that under a consumer standard, this is indeed good news for consumers in the European market for mobile telecommunications where only (very) few of them choose their mobile operator taking into consideration roaming charges (see section *a* in *Figure 2*). Clearly, a policy which aims at ensuring that all consumers are fully informed at the time

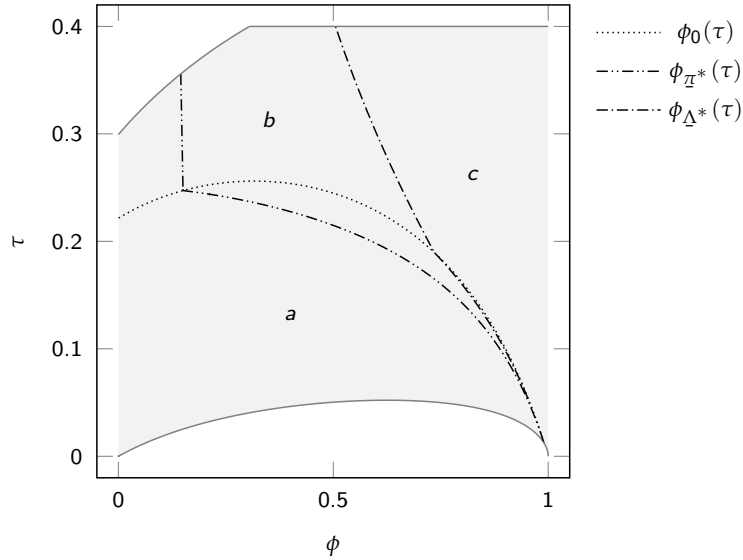


Figure 3: Impact of the policy intervention with non-negative fixed fees.

Note: The shaded area 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*.

of contract purchase would have been even better, as competition in two-part tariffs is tougher and makes consumers better off (see section *c* in *Figure 2*). However, such a policy is a lot harder to design and to monitor and it strongly depends on consumers' willingness to participate.

We also know from the analysis that in such a situation, firms find it optimal to set both a fixed and a linear price. Although more pricing instruments tend to increase competition, firms benefit from the fact that most consumers only take into account one of the price components when making their purchase decision. With regard to consumer education, we point out that firms do not have an incentive to better inform their consumers—to the degree that they become fully informed—in this situation either.

We can thus conclude that given the small share of consumers who are fully informed, the model can explain why we observed a divergence of interests in the political decision process: Firms were against the abolishment of roaming fees, whereas the European Commission promoted it. Put differently, 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, as the difference in consumer surplus between the two-part-tariff and the fixed-fee scenarios is greatest. This divergence of interests— independent of its feasibility—would not have not been solved by adopting consumer-education measures.

5. Conclusions

The welfare results of our model on 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 EC continues in making a noticeable effort to support consumers in making economically sound decisions.

In its most recent efforts to reduce pricing complexity the 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, it now requires banks to supply them with standardized information on 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 its 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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A. Existence of the symmetric equilibrium

In this appendix, we show that for any market share $\phi \in (0, 1)$ of informed consumers, there exists a range of transportation costs for which all consumers demand a positive quantity in the symmetric equilibrium.

Market coverage condition

The market is covered whenever all consumers (be they naive or informed) have a positive effective demand for one of the two products. Because of our Hotelling specification of the model, in the symmetric equilibrium the consumer with the lowest utility is located at $x = \frac{1}{2}$. For the market to be covered, at stage 3 consumers (which are all fully informed about prices) must have non-negative utility, i.e.:

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

The function $u_i^r \left(\frac{1}{2}, q^r, f_T^*, p_T^* \right)$ depends only on the parameters ϕ and τ . At the point where (2) binds with equality it gives an implicit solution for $\bar{\tau}(\phi)$. Plugging in, (2) can be written as:

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

Non-deviation condition

If transport costs are too low, the symmetric equilibrium will collapse since deviating by serving (and exploiting) only the uninformed consumers may be payoff-enhancing. Upon deviating, firm 1 maximizes:¹¹

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

where $\hat{x}_T^n = \frac{1}{2} - \frac{f_1 - f_T^*}{\tau(2 - \tau)}$ denotes the indifferent uninformed consumer, with the non-deviating firm 2 sticking to the equilibrium prices. We denote the resulting deviation prices by $\{p_D^*, f_D^*\}$. Upon deviating, the firm receives the payoffs $\pi_1^D(p_D^*, f_D^*; p_T^*, f_T^*)$. By symmetry, if firm 2 were the deviator it would receive the same payoff. In the following, we drop the firm index and denote

¹¹The argument works analogously when firm 2 is the deviator.

by π^D the deviator's payoff.¹²

Sticking to the pricing behavior of the symmetric equilibrium will then be incentive compatible whenever:

$$\pi^D \leq \pi_T^* \quad (3)$$

At the point where (3) binds with equality it gives an implicit solution for $\tau(\phi)$.

Equilibrium existence

For the existence of the fully covered symmetric equilibrium, both conditions (2) and (3) have to hold simultaneously. To be sure that it exists for all market structures, we show that for all ϕ there exists τ , s.t. $\tau(\phi) \leq \tau \leq \bar{\tau}(\phi)$.

Since both thresholds are given through highly non-linear implicit functions we will rely on a graphical proof. Figure 4 shows in $\{\tau, \phi\}$ -space for which parameter combinations the market is fully covered, and where deviation incentives exist. While in the yellow-shaded area deviations are profitable, this is not the case in the blue-shaded area. Here, the market is covered and the equilibrium will prevail. Clearly, for all values $0 < \phi < 1$ there is a whole range of τ for which the equilibrium exists.

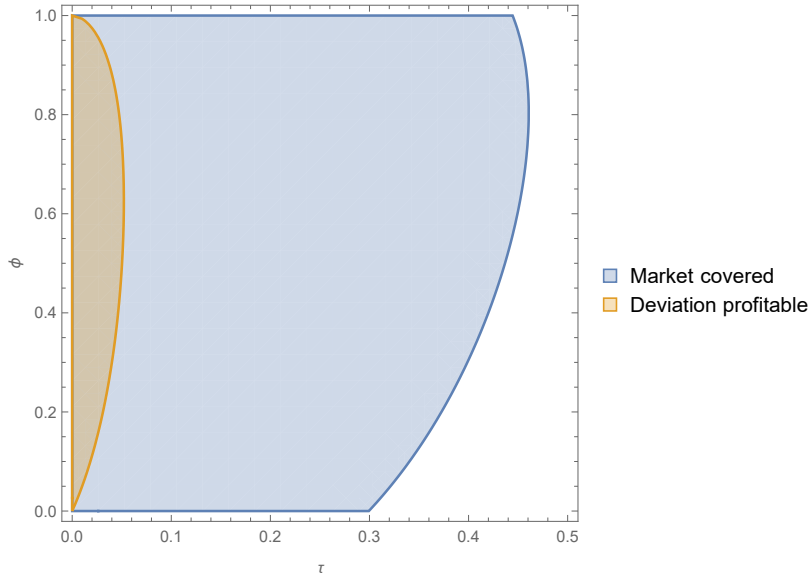


Figure 4: Admissible range of transport costs in the symmetric equilibrium

¹²Note that the deviating firm does not receive any revenue from the informed consumers – all of these will buy from the non-deviating firm.