We analyze a situation in which two horizontally differentiated firms compete in two-part tariffs (fixed fee, linear price) and some consumers are not informed about the linear 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 promotes it.

**Keywords:** fixed fee; pricing; roaming; transparency; two-part tariff.

**JEL-class.:** D43; L13; L42.
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 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), and gas or 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 avenues 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 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. Telecom operators impose surcharges on customers each time they cross a border while using their mobile device on holiday or during business trips. Since 2007, roaming tariffs have seen great reductions, and there is an agreement on a new approach to end roaming by June 2017 “roam like at home”). 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 [...]. In a similar vein, a recent study by the European Commission in 2014 ("E-Communications and Telecom Single Market Household Survey") revealed that a large share of users—to be on the safe side—switch off their mobile phones when they travel abroad because they are unaware of the costs involved.

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 (fixed fee and linear price) and (ii) fixed fees only. 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.

\footnote{Oxera, Agenda, October 2014: “A Connected Continent? Eliminating excessive roaming charges in the EU”, p. 1.}
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 (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 this is not possible in the situation we analyze.

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.

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. The pricing of firm $i$ follows a two-part tariff structure and we denote fixed and linear component by $f_i$ and $p_i$, respectively. Firms cannot distinguish between the customers types outlined below when making the pricing decisions.

Customers are of mass one, uniformly distributed along the linear city and come in two types. The two groups differ in their information status $j$ on the firms’ pricing policy. With a probability of $\phi \in [0, 1]$ a customer is fully informed ($j = r$) and knows the linear price as well as the fixed fee charged by both firms before making the purchasing decision. The remaining share $1 - \phi$ of customers is partially uninformed ($j = n$). While they are also aware of the charged fixed fees, they expect both firms to set a linear price of zero. The probability of a customer being fully informed is the same for all possible locations $x \in [0, 1]$. Each customer buys at either firm 1 or firm 2 (but not from both) and the timing of events is as follows:

1. Firms simultaneously set two-part tariffs.
Consumers (partially) observe firms’ pricing decisions and decide which firm to buy from.

All consumers learn the linear price and choose their demand accordingly; firm profits and consumer surplus materialize.

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

\[
u_j^i(q, x, p_i, f_i) = q - \frac{q^2}{2} - q (\tau |L_i - x| + \mathbb{1}_r p_i) - f_i,
\]

where \( \tau \) 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 cost. 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 customer 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.

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

\[
q_j^i(x, p_i) = 1 - \tau |L_i - x| - \mathbb{1}_r p_i
\]

(1)

Note that this expression for the local demand is relevant for the customer’s decision from which firm to buy (Step 2 of the game). However, once the partially informed customers learn about the existence of \( p_i \) they will account for it in their actual consumption decision. Her actual demand level then coincides with that of the informed customer.

Our focus here is on situations where the market is fully covered and at the same time on situations where firms would like to serve both types of customers. This imposes restrictions on the admissible range of transport costs \( \tau \). On the one side, transport costs must not be too high since otherwise some of the customers prefer not to buy from any firm. On the other side, if transport costs are low catering only the partially informed agents may be optimal for the firms. It turns out that for every distribution of information types there exists a range of transport costs, \( \bar{\tau}(\phi) \leq \tau \leq \bar{\tau}(\phi) \), that has these
desired properties.

3 Analysis and results

3.1 Market equilibrium

In this section we derive the unique symmetric pure-strategy equilibrium of the game. Our results will illustrate how firms can exploit the information deficit of the partially uninformed customers under a complex, two-part tariff pricing structure.

We solve the game backwards. It is easy to see that in Step 3 all agents have the identical information about firms’ pricing strategies at hand. Hence, the actual demand of any customer is determined by the fully informed customer’s version of (1). However, when deciding about from which firm to buy the uninformed agents are unaware of the linear component leading to a type-dependent location for the indifferent customer, \( \tilde{x}^j_T \). For customer type \( j \) it is uniquely determined by:

\[
\begin{align*}
  u^1_j(q^1_j, \tilde{x}^j_T, p_1, f_1) &= u^2_j(q^2_j, \tilde{x}^j_T, p_2, f_2) \\
  \tilde{x}^j_T &= \frac{1}{2} - \frac{1}{2\tau} \left( \frac{f_1 - f_2}{p_1 - p_2} \right) \\
  \text{Consequently, the indifferent consumer of type } j \text{ is located at:}
\end{align*}
\]

The firm’s pricing decision takes place in anticipation of the type-dependent indifference levels and of the fact that both, informed and uninformed customers, choose \( q \) after having learned \( p_i \). Firm \( i \) therefore chooses the two-part tariff \( \{p_i, f_i\} \) to maximize:

\[
\begin{align*}
  \max_{p_i, f_i} \pi_{i,T}(p_i, f_i, p_j, f_j) = \\
  \phi \left( p_i \left| \int_{L_i}^{\tilde{x}^j_T} (1 - p_i - \tau |L_i - x|) dx \right| + f_i \tilde{x}^j_T \right) + (1 - \phi) \left( p_i \left| \int_{L_i}^{\tilde{x}^j_T} (1 - p_i - \tau |L_i - x|) dx \right| + f_i \tilde{x}^j_T \right)
\end{align*}
\]

Solving the maximization problem in the standard way gives the following equilibrium prices \( \{p^*_T, f^*_T\} \):

\[
\begin{align*}
  p^*_T &= \frac{\tau (5 - 3\phi) + \psi + 8\phi - 12}{16(\phi - 1)}, \\
  f^*_T &= \frac{\tau(5\phi - 3) + \psi - 8\phi + 4}{256(\phi - 1)^2 (-3\tau(\phi + 1) + \psi + 8\phi + 4)} 
\end{align*}
\]

\(^2\)For a derivation see the Appendix.
where \( \psi = \sqrt{\tau^2 (-23\phi^2 + 18\phi + 9) + 8\tau (10\phi^2 - 9\phi - 3) - 64\phi^2 + 64\phi + 16} \). The payoffs of firm \( i \) in equilibrium are then given as \( \pi_{i,T}(p^*_T, f^*_T) \), which we abbreviate because of symmetry as \( \pi^*_T \).

### 3.2 Benchmark scenarios

To allow a discussion of our model in the context of the regulatory debate sketched in the introduction, we now present two benchmark cases that have particular (practical) relevance for this case. First, we summarize the equilibrium of the above case when all consumers are fully informed and hence the case where no customer is uninformed about firms pricing strategies. Second, we present consumption and pricing strategies when firms are restricted in their pricing behavior and can only set fixed fees. This case can be seen as resulting from a regulatory intervention.

#### 3.2.1 Two-part tariffs under full information

This benchmark is the boundary case of the above model, where all agents are fully informed about the firms pricing strategies, i.e. \( \phi = 1 \). Respecting the market coverage and non-deviation constraints, i.e. \( \tau(\phi = 1) \leq \tau \leq \bar{\tau}(\phi = 1) \), the following equilibrium prices and payoffs can be obtained:

\[
\begin{align*}
p^*_T(\phi = 1) &= \frac{\tau}{4} \\
f^*_T(\phi = 1) &= \frac{3\tau}{4} - \frac{9\tau^2}{16} \\
\pi^*_T(\phi = 1) &= \frac{\tau}{2} - \frac{11\tau^2}{32}
\end{align*}
\]

We state this corner case as a benchmark because of its illustrative value for the comparative exercise in the following subsection.

#### 3.2.2 Fixed fees only

As a second benchmark we study the case where firms are restricted to fixed-fee pricing and 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 customer \( \tilde{x}_F \) is given by:

\[
\begin{align*}
u_1(q_1, \tilde{x}_F, f_1) = u_2(q_2, \tilde{x}_F, f_2) \iff \tilde{x}_F = \frac{1}{2} - \frac{f_1 - f_2}{\tau (2 - \tau)}
\end{align*}
\]
Firms now simultaneously maximize:

\[
\max_{f_i} \pi_{i,F}(f_i, f_j) = f_i x_F
\]

The resulting prices and payoffs are:

\[
f^*_F = \tau - \frac{\tau^2}{2}
\]

\[
\pi^*_F = \frac{\tau}{2} - \frac{\tau^2}{4}
\]

We will use the obtained benchmark results in the following discussion of the results of our model.

### 3.3 Comparisons

In this section, we study how the presence of uninformed consumers affects the outcomes of the two-part tariff pricing scenario. In particular, we analyze how the situation compares to the benchmark case in which uninformed consumers do not exist. As it turns out, the level of price transparency has ambiguous effects on firm payoffs and consumer welfare under two-part tariffs.

Our model features a non-monotone relationship between the level of price transparency, i.e., the share \( 1 - \phi \) of uninformed consumers in the population, and firm payoffs. To illustrate this result consider Figure 1. The dotted and dashed lines represent the benchmark payoffs under fixed fees and two-part without uninformed consumers, respectively. As has been shown by Yin (2004) and Gössl and Rasch (2016), firms in this scenario obtain higher payoffs under fixed fees for all levels of transport costs \( \tau \). The additional red lines in the plots represent situations in which a share of the consumers is uninformed and pricing follows a two-part tariff structure. The situation on the left-hand side shows the resulting payoffs when a large share (90%) of consumers are uninformed, while in the right-hand plot, it is a considerably smaller share (25%). Quite strikingly, with a lot of uninformed consumers, payoffs lie above the fixed fee case (Figure 1a), while for intermediate levels they lie even below the two-part tariff benchmark payoffs (Figure 1b) to which they finally revert when decreasing the share of uninformed consumers further to zero.

We suggest the following explanation of this effect which is driven by the existence of the uninformed consumers. In particular, we highlight that there are two opposing forces at work that lead to the non-monotone relationship.

In order to understand these, it is helpful to look at the equilibrium pricing under two-part tariffs illustrated in Figure 2. The blue and the orange line show the equilibrium prices under two-part tariffs as a function of market
transparency \( \phi \). A pattern that emerges for all values of \( \tau \) (and not only for the plotted version with \( \tau = 0.2 \)) is that the linear price \( p^*_T \) is always lowest and the fixed price component \( f^*_T \) is always highest with all consumers being informed (\( \phi = 1 \)). These observations are key for understanding the two opposing effects at work. On the one side, with consumers being uninformed about the linear price component \( p^*_T \), firms can increase it beyond the full information level and by this exploit the uninformed consumers’ information deficit. This has a positive impact on firm’s expected payoffs. On the other side, consider the fixed fee component \( f^*_T \) and observe that it is the only price component relevant for the uninformed agents’ decision from which firm to buy. This increases the competition that firms face and hence puts a downward pressure on \( f^*_T \) and also expected payoffs.

Figure 1: Comparison of payoffs.

Figure 2: Equilibrium pricing for \( \tau = 0.2 \).
These two countervailing effects can be used to explain the non-monotone relationship between price transparency and firm payoffs. First, consider the situation where the share of uninformed consumers is low, i.e., a high level of $\phi$. The observation that an increase in transparency increases firm payoffs in this parameter range suggests that the first-mentioned exploitation effect through the linear price component dominates. Conversely, consider the case in which the share of uninformed consumers is high at low values of $\phi$. Then an increase in price transparency tends to decrease firm payoffs suggesting that the second-mentioned competition effect through the fixed fees is dominant in this parameter range.

Overall, the above observations allow us to conclude that the effects on payoffs of changing the level of price transparency in a market with horizontally differentiated products highly depends on the status quo of how informed consumers are before an intervention. In the following, we will see that this non-monotonicity transfers directly into consumer surplus.

Consumer surplus in pricing scenario $k \in \{F, T\}$ is calculated as

$$\Xi_k = 2 \int_0^1 u_k(q_k^*, x, p_k^*, f_k^*) dx,$$

where $u_k$ is the utility resulting for a consumer located at $x$ under pricing scenario $k$, having effective demand $q_k^*$, and facing prices $\{p_k^*, f_k^*\}$. Note that $p_F^* = 0$ by definition.

Figure 3 gives a contrasted summary of the consumer surplus for two situations in which the share of uninformed consumers is high (Figure 3a) and low (Figure 3b), respectively. Again, the two benchmark cases are included with the same style as in Figure 1. For small and intermediate shares of fully informed consumers, a simplified pricing structure (in the sense of restricting firms to only charge fixed fees) increases consumer surplus, while for large shares the opposite is true. Observe from 3b that the consumer surplus under two-part tariffs increases above the full information benchmark when a large share of consumers but not all of them are fully informed (85% of them are in the case of the plot).
Figure 3: Comparison of consumer surplus.

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