Strategic Confusopoly:

Evidence from the UK mobile telecommunications market*

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Abstract

Can entire markets strategically confuse consumers to raise market prices? Using a detailed dataset covering virtually all mobile phone tariffs and their handsets in the UK between January 2010 and September 2012, we study the evolution of quality-adjusted prices and find that they increased until December 2010, even though the industry is mature, technologically homogeneous, and competitive. This price increase closely correlates with the rate at which operators introduced dominated tariffs (i.e., tariffs for which there is a cheaper alternative from the same operator), suggesting that firms use obfuscation strategies to reduce the transparency of their products, helping them increase the overall level of prices, even for efficient (i.e., non-dominated) tariffs. We explore alternative explanations, such as increased product differentiation, product proliferation, or collusion, and show that obfuscation is most likely the mechanism at play. Our exploratory study is one of the first to offer suggestive evidence of obfuscation as an industry-wide supply-side phenomenon.

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1 Introduction

Do firms strategically confuse their consumers to raise prices at the industry level, and if so, how? Strategic obfuscation can take several forms, such as bundling obscure product characteristics with well-known ones to shroud the prices of individual components (Gabaix and Laibson, 2006), issuing complex product descriptions (Ellison and Ellison, 2009), or simply introducing an excessive number of nonviable products (Miravete, 2013). In a world with perfectly informed consumers, this would seem ineffective at best, and harmful at worst. Even with imperfectly informed consumers, these strategies may not be profitable if firms face a non-negligible cost of launching these products or, more generally, of implementing these strategies.

If the product or service is such that the cost of introducing new variants is low, however, the number of products may increase rapidly and competitive imitation may be fast and complete (MacMillan et al., 1985; Piazzai and Wijnberg, 2019). If product features are new or hard to interpret, boundedly rational consumers may be unable to overcome their "comparison frictions", which may lead to suboptimal choices or simply consumer inertia ("choosing not to choose"; Iyengar and Lepper, 2000; Diehl and Poynor, 2010). Firms may use product proliferation as a way to obfuscate direct product comparisons (Blake et al., 2021), which may allow firms to raise prices unilaterally. However, can this be sustained as an industry equilibrium? Despite its theoretical appeal, few empirical studies look at obfuscation as an industry-wide strategy.

We explore the use of obfuscation strategies in an oligopolistic market and describe their implications for product prices and ultimately margins. We track prices of virtually all products offered in the UK mobile telecommunications industry over nearly three years and observe that quality-adjusted prices rise in the early part of our sample period and decline later. We get the same pattern for the share of "dominated tariffs", i.e. tariffs for which there exists a better alternative by the same firm for a given set of characteristics. This observation suggests that on the supply side, the level of prices and the level of obfuscation may be related firm choices. We argue that it is highly plausible that all firms in the industry participated in a "confusopoly" (an oligopoly of firms trying to confuse consumers), in which they jointly increased the number of dominated tariffs to create a "shroud" over the most efficient (i.e. non-dominated) tariffs

to raise average prices. In the latter part of the sample period, firms reduced the number of dominated tariffs, triggered by a move for transparency by the smallest operator and a push by the regulator to increase price and product transparency in the market. This period of "competition on transparency", where firms cleared their portfolio of dominated tariffs goes along with a steady decline in prices.

We focus an important, but understudied dimension of multiproduct strategy: the degree of transparency of product offerings when products are multi-dimensional and product introduction is low cost. While we cannot claim to identify the causal structure between two choice variables (price and the degree of transparency), we find strong suggestive evidence that firms indeed strategically choose the degree of transparency (or lack thereof) in their product portfolio as an obfuscation strategy to raise prices. This result is robust to a "forensic" search for alternative explanations such as product differentiation, product proliferation and competition on handsets. Obfuscation, i.e. firms' actions intended to increase the complexity of their products or prices, but more generally any action that increases consumers' search costs, is most common for tariffs bundled with a (typically subsidized) handset. While we do not have demand-side data, we focus on the supply side of an industry with an abundance of similar products and show that multiproduct firms compete by designing their product portfolio conditional on the degree of consumer sophistication. While obfuscation has been documented in several theoretical and empirical papers, we highlight its existence at the industry level in a market that is clearly defined, enabling us to comment on its co-occurrence with other strategies such as product proliferation, product differentiation and potential collusion on prices. We also connect to behavioral strategy by suggesting that consumers are boundedly rational in their use and valuation of new product characteristics and as such may fall victim to a "confusopoly" of firms offering a shroud of tariffs that makes understanding and comparison particularly difficult. Finally, we estimate that the total cost of obfuscation strategies for consumers was between 57m and 137m GBP in the least costly scenario or between 106m and 252m GBP in the worst case scenario.

In sum, we contribute to the study of obfuscation as a choice variable by multiproduct firms, the role of obfuscation in sustaining high industry-level prices, and more broadly for the analysis of firm strategies in markets with boundedly rational consumers.

2 Prior Work

The strategic use of obfuscation by firms, particularly in competitive and technologically homogeneous markets, has become increasingly relevant for understanding price dynamics. We explore the theoretical and empirical foundations of obfuscation strategies, examining how firms can manipulate product transparency to sustain higher prices and achieve market equilibrium, with a specific focus on mobile telecommunications markets. We will only give a snapshot of the vast literature on strategies in multiproduct markets and prior work in behavioral economics which sheds light on boundedly rational consumers (and how firms strategically interact with them) to provide a departure point for our theoretical and empirical exploration.

Strategic Decision Making in Multiproduct Markets. Multiproduct firms navigate various strategic decisions concerning product portfolios, pricing, and differentiation to maintain competitiveness. These decisions are shaped by costs, resource allocation, competitive dynamics, consumer demand heterogeneity, and budget constraints.

Product line length. A key decision for multiproduct firms is to determine how many products or product lines to offer. The size of the product portfolio plays a crucial role in competition and firm performance. Research indicates that expanding product lines can enhance consumer loyalty, allow firms to charge higher prices (Draganska and Jain, 2005), deter imitation by rivals (Piazzai and Wijnberg, 2019), or respond to competitor actions (Bayus and Putsis, 1999; Putsis and Bayus, 2001). Another strand of research focuses on resource allocation across product categories, where firms often group product line decisions based on resource reusability (Barroso and Giarratana, 2013). In telecommunication services, product lines are strategic complements, where one firm's expansion leads competitors to follow suit (Miravete, 2009). Offering many product variants, or brand proliferation, can create barriers to entry (Schmalensee, 1978). However, a large number of products does not always equate to high differentiation, as seen in the yogurt industry (Richards et al., 2013) and the smartphone industry (Fan and Yang, 2020).

Product differentiation. Firms differentiate their products through new attributes, technologies, or pricing schemes. Theory suggests that firms seek maximum differentiation from competitors to reduce price competition (D'Aspremont et al., 1979). Over time, product char-

acteristics may diverge as demand becomes less uncertain and more heterogeneous (Corrocher and Zirulia, 2010; Koski and Kretschmer, 2007). Introducing popular product attributes can also support firm survival, as discussed in the dominant design literature (Suarez and Utterback, 1995). Market concentration and mergers can affect variety in various ways, depending on the market conditions (Berry and Waldfogel, 2001; Götz and Gugler, 2006; Sweeting, 2010). If we shift the focus to consumers, other reasons could explain why firms tend to differentiate their products. Lancaster (1990) suggests that variety within a group of products would persist if each individual consumer seeks variety in his or her own consumption (i.e. if consumers have a *love for variety*) and if different consumers are willing to purchase different variants of a product because tastes vary (i.e if consumers are *heterogeneous* if their preferences.)

Prices. Another important product dimension that will determine its success is price. Firms positioned close to each other tend to compete intensively on price (minimal differentiation), while firms that differentiate themselves more through attributes or advertising (maximal differentiation) can charge higher prices. Hotelling's (1929) model suggests that firms choose minimal differentiation to stabilize prices, a finding supported by research indicating that firms may position their products near competitors when demand is spatially concentrated (Stahl, 1982), when there are demand spillovers (Gavazza, 2011), or when consumers face search costs (Dudey, 1990). Generally, there is a trade-off between a market area effect (the increase in demand from clustering) and a substitution effect (price competition due to ease of comparison).

In mobile telecommunications markets, multiproduct firms serve diverse consumers. In most industrialized economies, the industry is mature, with uniform technology and network coverage. As innovation primarily occurs at the hardware level, competition at the retail level focuses on setting tariffs: bundles of attributes and prices within contracts. The low cost of designing new products lets firms rapidly introduce and withdraw tariffs. Given heterogeneous consumer preferences and budget constraints, firms have to balance product variety. Despite the traditional principle of offering only the minimum number of variants to serve all profitable consumers, the low cost of launching products suggests that an increasing number of minimally differentiated tariffs could emerge, each targeting specific (micro-)segments of the market.

Imperfectly Rational Consumers and Strategic Firms. The interaction between (imperfectly rational) consumers and strategic firms shapes competitive dynamics in many markets. Firms often exploit consumer cognitive biases and decision-making limitations through complex product offerings and pricing schemes, impacting consumer welfare and market outcomes.

First, consumers face search costs, which increase as product variety grows (Diamond, 1971). Firms may deliberately increase these search costs by co-locating products in attribute space (Bernhardt et al., 2022) or using obfuscation strategies to increase the time needed to learn their prices (Ellison and Wolitzky, 2012). Higher search costs, for example, can help inferior products survive (Ellison and Wolitzky, 2012).

In addition to search costs, consumers also often exhibit bounded rationality, leading to suboptimal decision-making due to cognitive limitations and biases (DellaVigna, 2009; Spiegler, 2011). In markets where products (and prices) are complex or numerous, such as mobile telecommunications, these limitations are particularly pronounced. For example, prior literature documented the existence of loss aversion (Genakos et al., 2023) and overconfidence (Grubb, 2009; Grubb and Osborne, 2015) in these markets.

Firms aware of consumers' bounded rationality often design contracts which are sometimes referred to as *exploitative contracts*, taking advantage of biases like limited attention (Spiegler, 2006) or usage uncertainty (Lambrecht et al., 2007). Complex pricing schemes (Richards et al., 2010; Gu and Wenzel, 2012), complex product descriptions (Ellison and Ellison, 2009), and shrouded product attributes (Gabaix and Laibson, 2006) reduce transparency, increase search costs and make it harder for consumers to compared offering (Ellison and Wolitzky, 2012), which ultimately allow firms to extract higher profits (Menzio, 2023).

Firms in competitive markets tend to increase obfuscation rather than lower prices (Spiegler, 2016), especially for products with multiple attributes (Gabaix and Laibson, 2006). Competition may drive firms to increase pricing complexity, which decreases consumer welfare (Carlin, 2009). Price framing, which influences how consumers perceive prices (Chioveanu and Zhou, 2013), and complex price strategies may allow firms to sustain high profits in competitive settings. However, obfuscation does not always lead to higher prices. In some cases, it can help maintain a low-price strategy, depending on how consumers search and compare products (Wilson, 2010; Petrikaitė,

2018). Yet, it can backfire if consumers become distrustful of firms using these strategies, reducing their willingness to engage (Allender et al, 2021; Chiles, 2020; Seim et al., 2017).

In mobile telecommunications markets, where products are bundles of services and devices, firms easily observe competitors and imitate offerings. The low cost of introducing new tariffs enables firms to create complex menus, confusing consumers and raising search costs (Miravete, 2013). Mobile tariffs are difficult for consumers to evaluate due to hidden attributes like subsidies, further complicating the decision-making process (Gabaix and Laibson, 2006). With the introduction of cellular data and smartphones, the number of tariffs rose significantly, reducing transparency for consumers (as in the setting studied by Ellison and Ellison, 2009). Lastly, the bundled nature of mobile services and devices adds complexity, as (less easily observed) details like handset subsidies are often shrouded (like in the settings studied in Gabaix and Laibson, 2006 and Seim et al., 2017). Consumers are required to make difficult choices, complex calculations, which can result in suboptimal decisions and, ultimately, higher profits for operators.

Our setting combines various features that makes it particularly prone to obfuscation strategies: an oligopoly (Ellison and Wolitzky, 2012) of multiproduct firms (Spiegler, 2016) offering complex products with new and complex attributes (Gabaix and Laibson, 2006; Spiegler, 2006) facing boundedly rational consumers with search costs. This sentiment is shared by policymakers (European Commission, 2007 and 2017; Ofcom, 2018), who have repeatedly raised concerns about possible consumer harm in these markets arising from the lack of transparency of offers. We consider the industry as a whole - and shed light on how operators could have used obfuscation strategies in equilibrium, resulting in a "confusopoly".

3 Industry background

The UK mobile telecommunication market. There are four licensed Mobile Network Operators (MNOs) in the UK: Everything Everywhere (owned by British Telecom), O2 (owned by Téléfonica), Vodafone and Three (owned by Hutchison). The Office of Communications (Ofcom) regulates the industry by controlling licensing but otherwise the operators are free to market their products and set prices to consumers. At the end of 2011 (halfway through our

sample), there were 83 million mobile subscriptions (in a population of 63 million) and 53% of them were post-paid (i.e. monthly bill) contracts. Post-paid tariff plans are multi-dimensional. They include a monthly rental, a minimum contract term, voice, text and data allowances, and other add-ons, and they can be paired with a device and a variety of services. The industry is mature and highly competitive. Figure 1 shows the evolution of operators' market shares since 2005, with the shaded region representing our study period.

[Figure 1]

Two industry facts are worth noting. First, Orange and T-Mobile were allowed to merge in 2010, thus consolidating the UK market from 5 to 4 main operators. The merger was announced in September 2009 and cleared by the European Commission in March 2010, resulting in the creation of Everything Everywhere in May 2010. Although owned by the same company, Orange and T-Mobile continued operating under their own brands and kept their own shops and service centers as well as independent marketing campaigns until 2015. Thus, given our timeframe, we will look at the decisions of each of these firms separately.

Second, the introduction of 4G licenses meant that cellular data gradually became available in tariffs from late 2009 onwards.[1] However, to make full use of this option, consumers needed new mobile devices (smartphones). The evolution from two-dimensional (voice and texts) to three-dimensional tariffs (voice, texts and data) bundled with a whole set of new phones had a profound impact on the market as the number of available options for consumers surged from 2,118 varieties in January 2010 to 12,573 in just one year.

Given the complexity of the tariffs, consumers' capacity to make informed choices became a hot policy discussion topic. Although Ofcom never intervened directly in any price setting or restricted the types of tariffs that could be offered, they supported the idea that information should let consumers make better choices because consumers are more likely to shop around when information is available. Thus, the regulator has awarded accreditation to websites that allow

[1]This coincides with the release of Apple's iPhone 3G, basically the first smartphone able to connect to the cellular network.

consumers to compare phone companies to find the lowest tariffs. In 2009, Billmonitor.com (henceforth BM), the leading UK mobile phone price-comparison site, was the first firm to receive such an award for mobile phone services. We use BM as a base to construct the most comprehensive dataset of the supply side of available mobile tariffs in the UK.

4 Data

4.1 Data set construction

We construct a novel dataset that lets us analyze in great detail the evolution of mobile tariffs together with their handset characteristics and their prices in the UK between January 2010 and September 2012. To this end, we combine three data sources. First, we have the complete list of post-paid mobile tariffs offered by mobile operators from BM.[2] We define a tariff as a combination of a network (O2, Orange, Three, T-Mobile, or Vodafone), a contract length (between 1 and 36 months), allowances of sms, voice and data, on-net calls, mixed allowance (from zero to unlimited) and a handset (manufacturer and model), if any. For each tariff, we have the monthly price in GBP and the allowances of voice, text, data, mixed allowance (voice and sms combined), and on-net volume of calls. The original data set consists of 3,812,523 daily observations. Once aggregated monthly, we have 204,364 observations of 53,421 unique tariffs.

We obtained this unique, highly granular data thanks to our collaboration with BM, which gave us access to this specific time period. We did not select this time period and due to changes in company policy we cannot access an extended time frame (before or after). Still, our nearly three years of data give a comprehensive insight into what happened at the industry level, capturing market-level trends, the gradual introduction of mobile data, and the widespread diffusion of smartphones. Finally, given the scarce availability of such detailed data at the *industry level*, our data lets us conduct a detailed supply-side analyses.

The data includes two types of contracts serving different consumer segments:[3] traditional

[2]For data availability reasons, December 2011 and January, June, and July 2012 are missing, giving us 29 months in total.

[3]In 2010, Ofcom reported that sim-only contracts accounted "for more than one in five new pay-monthly connections". Nowadays, sim-only subscribers represent about 39% of the market in the UK (Ofcom, 2021).

ones, where mobile services are bundled with a handset usually subsidized by the operator, and tariffs which only include mobile services, known as *sim-only* tariffs. For the latter, consumers either use a handset they already own or purchase a new or used device of their choice. For tariffs bundled with handsets, we have information on the model and the upfront cost to consumers. Our data does not include information on the actual consumption or choices of subscribers (no demand-side information). Also, we observe no local discount or shop-level variation in prices of the contracts - we only observe national official prices advertised on the operators' websites.

We complement this data with information from GSMArena that provides detailed handset characteristics (dimensions, weight, camera quality, date of release, CPU, GPU, etc). When comparing the prices of different tariffs, this information lets us control for the quality evolution of handsets in detail. Finally, we merge this data with information from IDC on the list price (and sales) of each handset model. This information is necessary to calculate the implicit handset subsidy and to compare tariff (bundled with a handset) prices more accurately. Our final sample comprises 184,560 observations from 51,414 unique tariffs, of which 419 are sim-only.

Note that the tariff price we use in our analyses is the list price for a given mobile plan. This price corresponds to the minimum price that consumers will pay on a monthly basis. In reality, consumers may face a higher monthly bill due to extra costs related to the use of special numbers and international roaming, or due to usage beyond their allowances. The price of additional sms, minutes, or data (often called out-of-bundle rates) varies across operators. We do not observe these prices in our dataset, so the price we consider in our analyses is a lower bound or the most conservative estimate of the final tariff invoice for any given consumer.

4.2 Variables of interest

Tariff Prices. We define mobile tariff prices (in GBP) as a combination of monthly allowances of sms, data, on-net and off-net calls[4] and mixed allowances,[5] bundled with a handset (if the tariff is not a sim-only contract), offered by a given operator. All contracts are post-paid, so that consumers pay the tariff price at the end of the month. We observe the introduction and

[4]This corresponds to the voice allowance for calls on the operator's network (on-net) or on the other networks (off-net). Often, the allowance is not split between on-net and off-net.

[5]Mixed allowances combine texts and calls.

withdrawal of tariffs, as well as their price evolution over time.

Measuring dominated tariffs and obfuscation. Consumers selecting a tariff in this environment have to choose from a mobile operator a contract of a certain length that combines a number of texts, volume of data, minutes of call (both on-net and off-net), volume of mixed allowance, as well as the handset brand and model. The size of the choice set is potentially very large given all the possible combinations, so consumers have to perform a complex computation to find the cheapest option. Moreover, some tariff characteristics might be more salient depending on how they are positioned on the firm's website or catalogue, while others require sophisticated calculations. For example, computing the level of handset subsidy requires the consumer to find the list price of the phone,[6] so comparing subsidies across tariffs requires some serious research effort. While some consumers undoubtedly can perform such a complex choice selection, most consumers would restrict their attention to a limited number of the above characteristics to make their choice, which is how the obfuscation strategy of firms can unfold.

To uncover the existence and magnitude of obfuscation strategies in this market, we construct an aggregate measure, *dominated tariffs*. We define "dominated" tariffs using the following rules: (i) for a given combination of attributes, we identify the cheapest option by an operator (we call this the "efficient" tariff), and (ii) we code as "dominated" all other tariffs by the operator offering the same combination of attributes (plus potentially other characteristics that are not the focus) at a higher price. We analyze three consumer-focused definitions to proxy for different levels of attention.[7] First, *cost-conscious consumers* consider all tariffs from an operator with the same allowances for sms, voice, data, upfront handset cost, handset subsidy (in amount ranges), and contract length. Second, *brand-loving consumers* are, on top of the allowances of sms, voice, data and contract length, particularly sensitive to a specific handset brand and its cost ("it has to be Samsung"). Third, *handset-obsessed consumers* will, in addition to the allowances of sms, voice, data and contract length, only consider a specific brand-model of handset ("I need the new iPhone"). Tables A.1, A.2 and A.3 give one example each for each consumer type, using a

[6]The difference between the phone's list price and its upfront price for the consumer constitutes the subsidy.

[7]These definitions are derived from analyzing the way products were organized and presented on operators' websites in our sample period. Documentation that supports these definitions is discussed in Section 6.4.1.

slice of our data. All other tariffs by the same operator that month sold at a higher price with the same characteristics in focus, are considered dominated.[8]

Our measures of "dominated" tariffs broadly correspond to Miravete's (2013) "fogginess" measure for tariffs in the early cellular telephone industry in the US, but also deviates in important ways. Miravete (2013) covers three-part tariffs, where the allowance (priced $P_{\bar{q}}$) covers for a given volume of minutes $\bar{q}$, and the usage price corresponds to a unit price p for all minutes consumed beyond the allowance. A tariff then takes the form $Bill = P_{\bar{q}} + p(min\{0, q - \bar{q}\})$. We do not consider the unit price beyond the allowances in our computation, as we do not have information on actual consumption. However, the tariffs we use include a larger number of attributes, including data, handset cost, subsidy and contract length, which enter a consumer's utility but are not consumed in a linear fashion. While Miravete simulates usage patterns, we assume that the tariff price (the recurring charge) is the expected bill. The prices we analyze are a lower bound of the actual prices paid by consumers, and the obfuscation we measure takes place at the tariff selection stage prior to consumption.

Share of dominated tariffs at the industry level. By definition, a dominated tariff has a higher price. However, our aim is to examine how the share of dominated tariffs overall correlates with the prices charged for efficient tariffs. That is, we ask how the presence of *dominated* tariffs at the industry level serves as an indirect mechanism to create a "shroud" over the *efficient* tariffs and to raise prices paid by all consumers. To this end, we compute the share of dominated tariffs each month and include it as an explanatory variable in our main regression.

Number of products and differentiation of tariffs. Given the low cost of introducing a new tariff for mobile operators, we monitor the evolution of the number of products (typically a combination of handset and mobile services) available in the market. While this gives us some insights on the number of options faced by consumers and the potential proliferation strategies used by firms, it cannot properly capture the degree of differentiation of products available on the market. Indeed, a large number of products does not necessarily translate into a high

[8] We also consider alternative definitions of "dominated" with fewer or more elements entering the computation to reflect lower or higher levels of attention by consumers. We show in the Appendix that all measures evolve in a similar fashion over time (Figure A.1), which is what matters for our obfuscation index.

degree of differentiation. A first simple way to get an idea of the industry trend is to look at the location of products in the attribute space. As an illustration, Figure A.2 gives a 3D representation of product location at the beginning and the end of our study.[9] We observe that products offered by firms are positioned much closer to each other at the end of the focal time period. To learn more about the level of differentiation at the industry and operator-level, we compute the Euclidean distance between the characteristics of all pairs of tariffs available on the market, each month. Three key dimensions are considered: voice, SMS and data allowances.[10] In averaging the pairwise distances for every month, we get a first indication of the level of differentiation -the average distance between products- at the industry level at each point in time. We introduce both variables (number of products and distances) in our robustness tests to control for the influence of proliferation and variety of tariffs on their prices.

4.3 Descriptive statistics

Table 1 gives some descriptive statistics of the prices and characteristics of tariffs (combined with various handsets). On average, a tariff costs 33 GBP (monthly charge), and the handset 39 GBP (one-off charge). We observe two types of tariffs serving two segments of consumers: tariffs associated with a handset (about 99.8% of observations) and sim-only tariffs. Table 1 also gives information on our indicator for "Dominated tariff". We observe that, on average, over the period 15% of the tariffs are dominated.

[Table 1]

Table A.5, in the appendix, shows characteristics and prices of tariffs across operators. Three offers the cheapest tariffs on average (about 23 GBP), while Vodafone charges 39.5 GBP. Table A.6 shows that the modal contract length for sim-only tariffs is 1 month (57%), followed by 12 months (37%). With handsets, most contracts are 24 months (53%) or 18 months (45%).

A correlation matrix of our main variables is presented in the appendix in Table A.7.

[9] Points are not proportional to the number of products located at this position.

[10] We describe this computation in detail in the appendix on page A3. See also Table A.4 for summary statistics.

Figure A.3 simply shows the number of tariffs available each month over the period studied. We observe that the number of tariffs increases steadily, reaching a peak in January 2011 and then steadily declines. Figure A.4 shows the evolution of the average distance between tariffs and highlights that differentiation is steadily declining both at the between-operator level (i.e. different operators' portfolios become more similar over time) and the within-operator level (i.e. a single operator's portfolio contains fewer different products over time).

5 Econometric Analysis

Our measures of prices and dominated tariffs are affected by a host of factors, including product, firm, and market characteristics. We first construct price, obfuscation and differentiation indices by regressing our measures separately on a set of controls to retrieve the *residual variation over time* for our three choice variables. We then explore their interdependencies by regressing the price index on obfuscation and differentiation and a full set of controls including tariff and handset characteristics.

5.1 Price index

We first run a hedonic price regression, following a long literature starting with Griliches (1961) to extract quality-adjusted prices while controlling for various tariff characteristics:

$$Price_{it} = \alpha + \beta X_{it} + \sum_{t}^{T} \delta_t D_t + \varepsilon_{it}, \tag{1}$$

where $Price_{it}$ denotes the list price in GBP of tariff i available in year-month t. The vector of tariff characteristics X_{it} includes: (i) contract length (ii) unlimited voice dummy (iii) voice allowance (iv) unlimited sms dummy (v) sms allowance (vi) unlimited data dummy (vii) data allowance (viii) mixed allowance (voice and SMS), (ix) amount of subsidy associated with the handset and (x) mobile operator dummies. D_t are year-month dummies capturing industry-level shocks over the period. The normally distributed error term is denoted by ε_{it}. The estimated coefficients δ_t of the year-month dummies represent the quality-adjusted price index.

5.2 Obfuscation index

In a similar fashion, we calculate the obfuscation index by estimating the following regression:

$$Dominated_{it} = \mu + \sigma_1 Operator_i + \sigma_2 Simonly_i + \sum_t^T \theta_t D_t + \epsilon_{it}, \quad (2)$$

where $Dominated_{it}$ is a dummy variable with value 1 if tariff i is dominated in year-month t, $Operator_i$ captures mobile operators fixed effects, $Simonly_i$ is a dummy coded 1 if i is not associated with a handset, and D_t are year-month dummies. The coefficients $(\mu, \sigma_1, \sigma_2, \theta_t)$ are estimated using OLS and alternatively a logistic regression. The coefficients θ_t of the year-month dummies capture how the likelihood of observing a dominated tariff can be explained by the month it is observed in, controlling for time-invariant elements such as operator fixed effects, and constitute our time-varying obfuscation index. This index captures the monthly level of obfuscation of products available in the focal market.

5.3 Differentiation index

We measure the level of differentiation of tariffs in the market by computing the Euclidean distance between each tariff pair, i.e. between characteristics of tariff i and j, available on the market in a given month t.[11] Using these pairwise distances, as for price and obfuscation, we compute a differentiation index as follows:

$$Distance_{ijt} = a + X_{ijt} b + \sum_t^T \gamma_t D_t + \varepsilon_{ijt}. \quad (3)$$

In this dyad-level equation, $Distance_{ijt}$ denotes the Euclidean distance between tariff i and tariff j in month t. The coefficients (a,b,γ_t) are estimated using ordinary least squares (OLS). The vector of pairwise characteristics X_{ijt} includes a dummy for each combination of operators (within and across operator fixed effects) and for each combination of segments (within and across segments). The normally distributed error term is denoted by ε_{it}. The estimated coefficients γ_t of the year-month dummy variables d_T represent the product differentiation index, which captures the overall level of differentiation of products at the industry level in each month.

[11] We detail the computation in the appendix, on page A3.

5.4 Linking Price and Obfuscation

While the previous indices describe the evolution of firms' strategies, our aim is to also explore their potential interdependence. Specifically, we ask if and how the presence of dominated tariffs in the market impacts tariff pricing. To do so, we estimate the following model for all tariffs i observed in year-month t:

$$Price_{it} = \alpha + \beta ShareDominated_{st} + \gamma X_{it} + \varepsilon_{it}, \tag{4}$$

where $ShareDominated_{st}$ denotes the share of dominated tariffs in segment s at time t. This variable captures how industry-level obfuscation correlates with tariff prices. X_{it} is a vector of controls including handset and tariff characteristics.[12] In one of our specifications, we also include product proliferation and differentiation measures. ε_{it} denotes the error term, assumed normally distributed. We estimate this model using both the entire sample (efficient and dominated tariffs) and only the efficient tariffs to investigate if the presence of dominated tariffs can indirectly raise the prices of all or the efficient tariffs by functioning as a shroud.

6 Estimation results

6.1 Price, obfuscation and differentiation indices

Estimates of the price index regression (Equation 1) are reported in Table A.8. Using O2 tariffs as a base, we can see that tariffs offered by Three, for example, are 9.3 GBP cheaper ceteris paribus. We also see that compared to a "standard" 24-month contract, shorter commitment periods are associated with higher prices. This corresponds to the discounts offered by operators to consumers who agree to be locked-in. On average, unlimited voice costs 34.6 GBP per month, unlimited sms 0.34 GBP and unlimited data 3.12 GBP.[13] Further, different brands of phones are associated with different implicit prices. For example, a tariff bundled with an iPhone will be

[12] In our robustness tests, we also include a linear time trend, and alternatively, operator-specific time trends and operator-segment specific time trends. This lets us capture some unobservable elements which are potentially correlated with price. While multicollinearity with our variable of interest increases, our results remain stable.

[13] These values vary over time – but their average prices are pooled in the estimates for month dummies. These correspond to January 2010 values.

3.52 GBP more expensive compared to the same tariff bundled with a Samsung phone. Figure 2a shows the coefficients of the quality-adjusted price index (captured by year-month dummies).

Results from the obfuscation index regressions (Equation 2) are in Table A.9, where we use a linear probability model in Column 1 and a logit model in Column 2. Results indicate that compared to O2, tariffs by Orange are less likely to be dominated, while tariffs introduced by Three, T-Mobile and Vodafone are more likely to be dominated. Further, sim-only tariffs are less likely to be dominated, not surprisingly given the limited number of attributes they usually include. In particular, these tariffs do not include the handset subsidy dimension that often renders a tariff dominated. Hence, we expect tariffs with handsets to be dominated more often. Figure 2b plots the obfuscation index obtained in Column 2, i.e. the coefficients for the year-month indicators reported in Table A.9.

Finally, estimation results from the product differentiation index regression (Equation 3) are in Table A.10. This regression includes dyad fixed-effects that capture the distance within and between products offered by operators, with the base category being the distance between O2's products. We obtain positive and significant coefficients for T-mobile, meaning that compared to O2, T-mobile's products are more dissimilar to each other. Conversely, Vodafone's products tend to be more similar to each other. Further, operators are positioned in a specific way vis-à-vis each other, and this is stable over time, as suggested by the significant estimates for the "between-operator fixed effect" coefficients. Some operators position their products particularly distant from each other. For example, the average distance between products of O2 and T-mobile (0.51) or products from Orange and T-mobile (0.32) is clearly higher than the average distance within products in operators' portfolios. Hence, operators do not occupy exactly the same space and that is true over the period we observe. Figure 2c plots the product differentiation index over time obtained from our estimation.

[Insert Figure 2 here]

Co-evolution of indices. At first glance, we observe a steady decline in the product differentiation index over time that contradicts the evolution of prices: standard theory would

predict that as products get closer to each other in attribute space that should lead to a steady reduction in quality-adjusted prices. Conversely, the obfuscation index and the time series for the quality-adjusted price index in Figure 2 have very similar shapes and are highly correlated (Pearson's correlation coefficient is 0.48, significant at 1%): Both increase until the beginning of 2011 and then decline. We believe that this co-movement is not by chance and that prices and obfuscation may be part of the same process. The initial increase in dominated tariffs by all mobile operators could simply be the competitive equilibrium outcome at that time. As Gabaix and Laibson (2006) show, introducing "shrouded" attributes, or more generally making it difficult for consumers to pick their optimal product among a multitude of options can be optimal for competing oligopolists. The subsequent decrease in dominated tariffs from 2011 onward suggests that something triggered a breakdown of this equilibrium.

Anecdotal evidence corroborates this narrative. By 2010, evidence was mounting that consumers in the UK could save money by switching their utility (electricity, gas, or telephone) supplier. The main concern was that the complexity of tariffs and options available was inhibiting consumers' ability to make the right choices. The regulator for telecommunications (Ofcom), although never intervening directly in any price setting or restricting the types of tariffs that could be offered, strongly supported the idea of making tariff information available so that consumers could calculate savings and make switching easier.[14] The UK government also pushed the "midata" clause into law in 2013 (Halpern, 2015), which required companies to print a QR code on their bills that summarized subscriber details, usage patterns and their current tariff in a machine-readable form, essentially giving access to these data to switching sites and other intermediaries to act on consumers' behalf. Hence, there was growing suspicion from the regulator and the government that a "confusopoly" had been operating in that period and a belief that this phenomenon was inhibiting the efficient operation of the telecommunications market.

Around the same time, the market also started to respond to these growing concerns. Three, the last operator to enter, and consequently the smallest, introduced a new range of simplified tariffs and advertised heavily how transparent and simple they were. Specifically, the introduc-

[14]Genakos et al., (2023) study consumer switching behavior during the same period and show that personalized expert advice facilitates switching, but it is only part of the story and possibly a minor one as people respond to other behavioral incentives as well.

tion of the tariff named "The One Plan" by Three around December 2010 may have marked the end of the "confusopoly" period. As Figure 1 shows, the market share of Three steadily increased over time at the expense of Orange and T-Mobile — which, incidentally, were the operators using dominated tariffs most extensively. Hence, the last entrant, Three, behaves differently from the rest of the incumbent players, both in terms of pricing and in terms of tariff clarity, and may have triggered a breakdown of the confusopoly. Interestingly, Bourreau et al. (2021) show that the entry of a new operator (Free) in the French market caused a breakdown of tacit collusion via the introduction of fighting brands by incumbents, which *all* started offering new tariffs without handset at very low prices. In our setting, the maverick firm too seems responsible for the breakdown of strategic obfuscation strategies.

We now subject these conditional statistics to more rigorous econometric tests.

6.2 Full regression model

Table 2 shows the estimates from Equation 4 using all tariffs (columns 1-3) and only efficient tariffs (columns 4-6). In column 1, the coefficients of the share of dominated tariffs and the dominated indicator are positive and significant when we control for tariff characteristics and a time trend. This confirms that dominated tariffs were selling at a price premium, as expected, but also that the existence of a share of dominated tariffs was acting as a shroud and was raising the price of all tariffs. In column 2, both coefficients retain their sign and significance, even after controlling for handset quality through brand-model fixed effects. Column 3 presents the results obtained when we interact all variables with a post-January 2011 indicator, which was the peak of new product releases. Both coefficients are much weaker in the post-confusopoly period.

In columns 4-6, we estimate the same model using only the efficient (i.e. cheapest for a given bundle) tariffs at release. The specification in column 4 is similar to column 1. The dominated indicator is dropped now as there are only efficient tariffs in this sample. Yet, the coefficient of the share of dominated tariffs is positive and significant. In column 5, when we add the handset brand-model fixed effects, we find that a 1 percentage point increase of the share of dominated tariffs at the industry level is associated with an additional monthly cost of 0.0270 GBP of efficient tariffs, ceteris paribus. We show in Figure A.5 how price indices differ whether

we consider the full sample or a sample of efficient tariffs. We observe that the pattern observed over time remains, hinting that all products are affected.

[Insert Table 2 here]

As shown in Figure 2, both the price and the obfuscation indices reverse in January 2011. As seen in the last column of Table 2, the share of dominated tariffs at the industry level is positively associated with tariff price by 4.39 GBP before January 2011 and only about 1.84 GBP after, a 60% decrease in magnitude. These results confirm the patterns presented earlier and highlight that the confusopoly period was associated with softer competition and significantly higher price premia for both dominated and efficient tariffs, both of which dropped after January 2011.

6.3 Quantifying the cost of the Confusopoly

We combine our estimates with national-level statistics to approximate the confusopoly cost to consumers in the market under consideration. Given that the average share of dominated tariffs is 13% in our sample (ranges between 2.5-56%), the point estimate from Table 2, column 2 translates to an average price premium of 0.15 GBP over the period (ranging from 0.029 - 0.64.4 GBP). With a market of 82 million subscribers between 2010 and 2012 (Ofcom, 2013) of which 41 million are post-paid subscribers, an average churn rate of 13%[15] and an average switching rate within-operator estimated around 31%,[16] we can approximate the number of consumers changing a new tariff during this period to be between 5.33 and 12.71 million every year (or, between 16 to 38.1 million over the three years). Most of these consumers will sign up for a 24-month contract. Hence, even assuming that all these consumers are going to select an efficient and not a dominated tariff, the extra cost related to obfuscation in this market, paid by all consumers, is between 19.14m to 45.57m GBP per year or between 57.41m to 136.70m GBP over the period 2010-2012.[17] If some consumers select dominated tariffs, the total cost of confusopoly

[15]The churn rate corresponds to the share of consumers who change operators within a year.

[16]See Genakos et al (2023).

[17]Based on industry reports and operators' financial statements, industry-level total profit can be estimated at 12 billion over the period. 60.4 million, the lowest bound of our estimated Confusopoly cost, represents 0.50% of

naturally increases, ranging between 105.76 and 251.92m with only 10% of consumers selecting a dominated product. Table 3 summarizes these calculations.

[Insert Table 3 here]

6.4 Robustness of the results

We now discuss the robustness of our findings and explore various alternative explanations. We report the main conclusions below and refer the reader to the Appendix for supportive evidence.

Alternative definitions for dominated tariffs. Dominated products are defined based on assumptions about what is likely observed by consumers, using the way products were displayed and described on the operators' websites between 2010 and 2012. Our main results used the *cost-conscious* consumer definition. We also considered alternative definitions that used fewer or more criteria to reflect lower or higher levels of consumer attention. As shown in Figure A.1, all these measures evolve in a similar fashion over time. We conducted our main analysis with all the definitions and the results are presented in Figure A.6, showing the robustness of our main specification. In addition, Table 4 presents the results for our regression of efficient tariffs for "always efficient tariffs" (i.e. tariffs that were efficient throughout their lifetime) or alternative definitions of dominated tariffs. Column 1 corresponds to Model 6 in Table 2. Column 2 corresponds to results obtained with a sample of *always efficient* tariffs, i.e. tariffs that remained non-dominated over their whole life span. Columns 3 and 4 show the coefficients of interest if we consider the *brand-loving* or *model-obsessed* definitions respectively, presented in Figure A.6. These results highlight the robustness of our main specification, while the magnitude of the coefficient varies across models.

Introduction and withdrawal of dominated tariffs. Do dominated tariffs have a similar market lifespan as efficient tariffs? On the one hand, dominated tariffs are more profitable, so

this amount. 259.05 million, our highest estimation, gives 2.15% of the industry profit. This is comparable to the average increase in profit observed after the departure of a non-performing top manager (Denis and Denis, 1995). We detail our assumptions and computation in our section "Confusopoly and Profits" in the appendix, page A24.

that firms may want to keep them on the market for longer. On the other hand, dominated tariffs may be "hit and run" products introduced as part of an obfuscation strategy and then taken off the market more quickly than efficient tariffs. We conducted a survival analysis to see if dominated tariffs differ from efficient ones in their longevity and found that dominated tariffs are withdrawn faster from the market on average (Table A.11). Thus, dominated tariffs are indeed strategically different from efficient ones, but it also indicates that they are not introduced as "core" products of operators' portfolios, but rather as tools for obfuscation purposes. Dominated products were likely not created to serve some stable niche markets, satisfying heterogeneous consumers' tastes. If that were the case, we would expect them to be performant (and profitable) and therefore maintained by the operators. Our results hold whether we use a non-parametric approach (see the Kaplan Maier curves in Figure A.7), a semi-parametric approach (Columns 1-2, Table A.11),[18] and a parametric approach, using accelerated failure time models (Columns 3-4, Table A.11 and Table A.12).

Comparing tariffs with handsets and sim-only tariffs. Our sample includes a sample of sim-only tariffs (i.e. tariffs without handset associated) that we can exploit to explore the likely mechanism of obfuscation. By estimating price and obfuscation indices for these tariffs, we find a very different pattern for both quality-adjusted prices and obfuscation levels (Figures A.9 and A.10). The result is not unexpected as sim-only tariffs usually include a limited number of (easily observable) attributes, most notably no handset subsidy, which is often the dominated part of a tariff. Hence, the obfuscation we document in this paper is fully driven by traditional tariffs, the dominant market segment in our sample period (around 83% in the UK, Ofcom, 2011; OECD, 2013).

Heterogeneity across operators. Separating our indices by operator indicates that the trends observed at the aggregate level largely hold for all players in the industry (Figures A.11 and A.12). The quality-adjusted price index and the obfuscation index of each operator follow the industry-wide pattern of an increase and then decrease (albeit less precisely) - save for Three, which decreased its prices between the summers of 2010 and 2011. This corroborates that Three

[18] We report these results even though the proportional hazard assumption is violated. See Figure A.8.

was the "maverick" firm behaving differently from the rest of the firms.

[Insert Table 4 here]

6.5 Additional insights

We now discuss the alternative explanations for our findings, as well as the robustness of our empirical approaches. We recap the former in Table 6.

Product proliferation and price discrimination. What we call obfuscation might be the outcome of improved opportunities for price discrimination, which could have been triggered by changes in consumer preferences that called for increasingly fine-grained segmentation of the market. Given the introduction and diffusion of new tariff characteristics (data) and new mobile devices (smartphones), one may argue that the coefficient on obfuscation simply captures the general trend of product proliferation, which would be a rational firm's response to consumers' changing needs and tastes. We explore the co-existence of these two elements by adding measures of product proliferation measured as the total number of tariffs and its growth rate) as additional regressors to our preferred specification. In Columns 2 and 3 of Table 5, we see that the measures of product proliferation are positively correlated with tariff prices, but they do not wash out the role of obfuscation, which is still positive and significant during the "confusopoly" period. Thus, although obfuscation -the introduction of a shroud of dominated tariffs- naturally goes hand-in-hand with the proliferation of tariffs, the two phenomena play a separate role in explaining industry-level tariff prices. Relatedly, the abundance of tariffs may also reflect experimentation by operators - as they do not know consumer preferences precisely, they would introduce a multitude of tariffs that may, or may not, meet the preferences of diverse segments of consumers. However, even if tariffs were introduced without superior knowledge of consumer preferences, it seems unlikely that operators would introduce dominated tariffs, i.e. ones for which better options are available by the same operator, with virtually identical characteristics.

Demand side considerations: love for variety and differentiation of tariffs and handsets. One could argue that the price increase we document in this paper is simply explained by the increased variety and differentiation of products responding to consumer tastes. Put differently, the demand side, i.e., changes in preferences, could be the sole driver of our empirical observations rather than a deliberate strategy of firms aiming at confusing them. We believe that this is a plausible argument that is not borne out in our data however, for three reasons.

First, product differentiation in terms of the main tariff attributes (voice, text and data) is steadily declining over the period, as highlighted in Figure 2. Standard theory predicts that prices and product differentiation evolve in the same direction. Given that in the first half of the time period studied they move in opposite directions, tariff differentiation seems an unlikely driver. Moreover, in Table 5, in Column 4, we add this differentiation measure to our main specification. As we can see, the degree of differentiation is negatively related to prices, without qualitatively affecting the role of obfuscation.

Second, the dominated tariffs introduced by operators are suboptimal by definition: The *same operator* offers a tariff with the same (or better) characteristics at a lower price. The only way such a tariff could be chosen rationally by a set of consumers is that they value a product characteristic unobserved by the researcher but observable to the consumer. Given the high correlation between obfuscation indices for different levels of consumer attention - as we capture it empirically-, and the fact that the highest level of attention we consider accounts for every tariff feature a consumer can see on an operator's website, we cannot think of a feature observed and valued by a non-negligible group of consumers, but not by the researcher.

Third, differentiation (e.g. via exclusivity) in terms of different handsets bundled with the tariffs by mobile operators is equally unlikely to drive our results. Although operators themselves do not decide on the characteristics of the handsets, they choose which brands and handsets to feature and how heavily to subsidize them. Consequently, operators may have differentiated their products through exclusive offerings of specific handsets, which in turn would allow them to raise prices (Sinkinson, 2014). At the brand level, operators offered comparable variety in terms of brands, and the brands with the highest market shares (i.e., Apple, Samsung etc.) were offered by all operators (Figure A.13). This suggests that brand exclusivity did not play

a major role in our study period.[19] At the brand-model level (i.e. iPhone Apple 4 and 4S, Samsung S3 etc.), the pattern looks similar, with portfolio length (i.e. number of products) comparable across operators and covering similar ranges of list prices, which proxy for handset quality (Figure A.14). Again, assessing the product overlap, almost two-thirds of handsets were available from multiple operators, and especially more popular handsets tended to be offered by more than just a single operator (Figure A.15). Therefore, handset exclusivity does not seem to be a differentiation strategy widely used in this setting. However, it is still possible that operators can exploit consumers purchasing "rare" handsets by charging them higher prices. In a set of regressions based on our preferred specification and increasingly restrictive subsamples of tariffs, we find that even for tariffs with handsets available from all operators, the price premium for dominated tariffs and the role of the "shroud" of dominated tariffs persists in magnitude and significance (Table A.13). In sum, handset selection is not a credible alternative explanation for the link between obfuscation and prices we find.

[Insert Table 5 here]

Yet, despite our efforts and the inclusion of every observable characteristic both for the tariffs and the handsets, one could argue that there is still some unobserved component that leads to higher prices. One such plausible source of unobserved variation in our setting is advertising. As we do not observe product-specific advertising, the best we can do to address this concern is to introduce more restrictive time trends, at the operator, and operator-segment levels in our main regression models. Results from these regressions are presented graphically in Figure A.16. None of our previous results change in any fundamental way. Therefore, even though we acknowledge the possibility of some unobserved (to us) characteristics affecting preferences, we find it highly unlikely that consumers' love for variety would change so drastically over the period of these two years and a half to generate the observed phenomena.

[19] Most operators also had their own handset brand, but they always represented a small part of the market.

Collusion. Another potential interpretation of our results is the existence of a tacit collusive agreement among firms in this market. From a theoretical point of view, this market has a number of characteristics that makes it prone to collusion: it is a tight oligopoly with high barriers to entry and product offerings that are highly visible across competitors. Overt collusion on prices, though, would be unlikely given the industry's high visibility and tight regulatory oversight. However, firms could use product proliferation as a means to make it difficult for consumers to compare prices and quality, thus softening competition among them, which could lead to higher prices. Indeed, Hoernig (2002) uses a theoretical model to show how tariff proliferation creates confusion (when consumers have limited search capabilities) that, in turn, can be used for collusion in an imperfectly competitive setting. Although this mechanism seems plausible, we believe that it still cannot explain all the facts. First, product proliferation cannot explain the existence of dominated tariffs. Second, although positively correlated with prices, product proliferation plays only a minor role quantitatively, as we saw in Table 5. Third, the incentives to increase product proliferation do not square with the observed decrease in product differentiation both within and between operators.

Obfuscation, the introduction of a shroud of dominated tariffs, by all firms in the first part of our data could be the outcome of firms imitating each other or because firms acquire a mutual understanding that this strategy would be jointly more profitable (tacit collusion). Each firm obfuscating makes it more difficult for customers to compare and switch providers, which softens competition and leads to higher prices. Is the industry obfuscation equilibrium due to unilateral decisions or coordinated action? Answering this question would require much more detailed inside information of the kind that only competition authorities can collect. However, we use our price and obfuscation indices as time series to conduct vector autoregressions and test for Granger causality to explore this possibility to the extent possible with our data. Results are presented in Tables A.14 and A.15. The conclusions from these analyses are that price increase and obfuscation arise *simultaneously* and do not *cause* each other. In other words, it appears that there is no sequence at play, i.e. firms do not obfuscate and *then* raise their prices – or, conversely, raise their prices and then obfuscate. Our conclusion is that obfuscation and price increases are part of a joint strategic process.

Impact of the merger. A final alternative explanation is that the Orange/T-Mobile merger led to increased market concentration, which led to higher prices despite declining product differentiation. While appealing at first glance, this argument is incomplete. First, it is not clear why firms would use obfuscation strategies if competitive pressure was declining due to the merger. Second, it seems counter-intuitive that firms will become less differentiated in a market occupied by fewer players. Third, the likely merger effect cannot explain what triggered the second phase of falling prices. Fourth, existing evidence on this particular merger does not support the narrative of a price increase. Indeed, a report by the European Commission (2017) discusses the Orange/T-Mobile case and assesses the impact of the merger on prices and investments. Using mobile expenditures for different baskets and a difference in difference estimation framework with a group of control countries, the report finds that prices *fell* between 2 and 18% after the merger.

6.6 Is it really obfuscation? A summary of the forensic evidence

In the preceding two sections, we demonstrated the statistical robustness of our results. However, as with most observational data, conclusive proof that increased obfuscation and increased prices go hand in hand is lacking. We therefore identified a set of plausible alternative explanations for the pattern we observe and tried to rule them out (or in) subsequently. Specifically, we ruled out that a change in the competitive landscape, collusion on prices, product differentiation or proliferation, unobserved quality dimensions, love for variety, unilateral firm behavior explain the pattern we observe, or that it is just dominated tariffs driving it. A summary of all arguments and our respective tests is given in Table 6.

[Insert Table 6 here]

Most alternative explanations can explain at most part of the pattern, but not all of it. Moreover, the fact that obfuscation and prices move in such close synchronicity strongly suggests that they are chosen jointly by the firms. Moreover, the strong correlation between prices and obfuscation at the industry level suggests that these parallel movements may have been part of

an *industry-wide* process covering *both* strategic variables. To summarize, absent an exogenous shock that would facilitate a quasi-experimental research design and applying Occam's razor, we have ruled out a host of plausible alternative explanations, making us confident that obfuscation indeed plays the role we attribute to it, namely that it creates a shroud over the most efficient prices such that even the most competitive price in the industry can be raised.

7 Discussion and conclusion

We documented the evolution of prices and dominated tariffs in the UK mobile phone market between January 2010 and September 2012. We define the level of obfuscation in the industry as the share of dominated tariffs in the market and find close co-movement between the tariffs' prices and the level of obfuscation. Thus, it appears that firms introduce a shroud of products to make it harder for consumers to pick their best alternative and to relax competition that way. Employing a "forensic" approach, we look for alternative explanations and proceed to rule out changing tariff and handset characteristics as well as product proliferation or product differentiation as alternative channels, and find that strategic obfuscation was especially prevalent for tariffs with less salient attributes (those bundling a tariff with a subsidized handset) and that dominated tariffs tend to be short-lived compared to efficient tariffs, consistent with the intuition that their introduction follows different strategic considerations than for efficient ones. Prior work on the topic has highlighted that this is theoretically possible. We provide evidence that this can be a viable industry equilibrium.

Clearly, some caveats are in order. First, we do not observe consumer choices, just firm offerings. However, the existence and pattern of obfuscated tariffs suggest they did attract some consumers.[20] Second, our obfuscation measure may be imprecise. However, we see the same pattern for more and less stringent definitions. Third, and most importantly, we document the evolution of price and obfuscation over a limited time. Confounding factors or industry events could blur the link we posit or even account for the co-movement through an alternative channel. Most notably, the merger of two large players may have driven prices up initially. However,

[20] Moreover, BM's data is essentially user-generated, so some consumers must have subscribed and subsequently uploaded their bills to BM's website.

applying Occam's Razor, our candidate explanation needs just two assumptions (firms introduce tariffs to obfuscate, and the smallest firm had the least to gain from the obfuscation regime) to explain the evolution of prices. Statements by policymakers and industry participants support the view that obfuscation is indeed a deliberate strategy chosen by firms in this industry. Our data does not let us make a causal statement of the kind "obfuscation leads to higher prices": prices and the share of dominated tariffs are both choice variables by the firm, and the ease of launching and terminating tariffs makes it impossible to establish a temporary chain of events to establish causality. However, based on our descriptive and econometric evidence, we can confidently state that "obfuscation and higher prices go hand in hand".[21]

Our study offers suggestive evidence of strategic behavior that has largely gone unnoticed by scholars: Product choices in multiproduct firms have been studied from the perspective of firm resources (Barroso and Giarratana, 2013; Chatterjee and Wernerfelt, 1991) and from a market-based perspective (Sorenson, 2000), but the motivation of firms to create a shroud, or thicket, of products to reduce price pressures and to keep prices high is rarely discussed. Studying how firms identify their ability to obfuscate and how they implement it in practice in a causal setting, would be very promising. For example, the introduction of labeling or transparency requirements would allow for studying the causal effect of obfuscation and transparency on performance. The dearth of research on obfuscation strategies offers many avenues for future work.

Some recent regulatory statements underscore the continued relevance of obfuscation strategies. In September 2018, the UK national telecommunications regulator Ofcom published a proposal to promote "clear and fair handset charges for mobile users" suggesting that the lack of transparency for mobile consumers is still a concern. In their press release, they cite requiring the operators to "break down the cost of the different parts of the mobile package" as one way to increase transparency.[22] With the current deployment of 5G networks and the imminent commercial launch of new services, which will require consumers to equip themselves with new,

[21] This is in line with the findings by Dushnitzky et al. (2022), who identify "bundles" of strategic choices that are likely to be used jointly because they reinforce each others' effectiveness.

[22] Ofcom's statement reads: "We are also concerned that, when a mobile customer signs up for a bundled contract, providers are not transparent about the respective costs of the handset and the airtime. This means customers cannot tell how much they are paying for the different parts of their deal. We think this is unacceptable. Consumers should be able to clearly identify the goods and services they are paying for, so they can make an informed decision about what to buy."

compatible devices, operators may be drawn to similar strategies again.

Obfuscation strategies are feasible and profitable in markets with complex contracts (or products) and low cost of product introduction. Interestingly, the expectation that the internet and digital sales will trigger an increase in transparency through the reduction in search costs (Goldfarb and Tucker, 2019) may be offset by the ease of firms introducing variants of their products, creating confusion or fatigue among consumers. More generally, we document how firms in competitive markets with homogeneous and mature technology may still use innovative strategies to keep the market from becoming perfectly competitive. We also add to the literature analyzing firm strategies to exploit search costs and bounded rationality of consumers, even in highly populated product markets. To conclude, while we cannot claim to have answered all questions about obfuscation strategies and their impact, our "forensic" study is one of the first to identify, operationalize and analyze them in oligopolistic markets. We hope that documenting this phenomenon will inspire follow-up research on this frequently "hidden" part of firm strategy.

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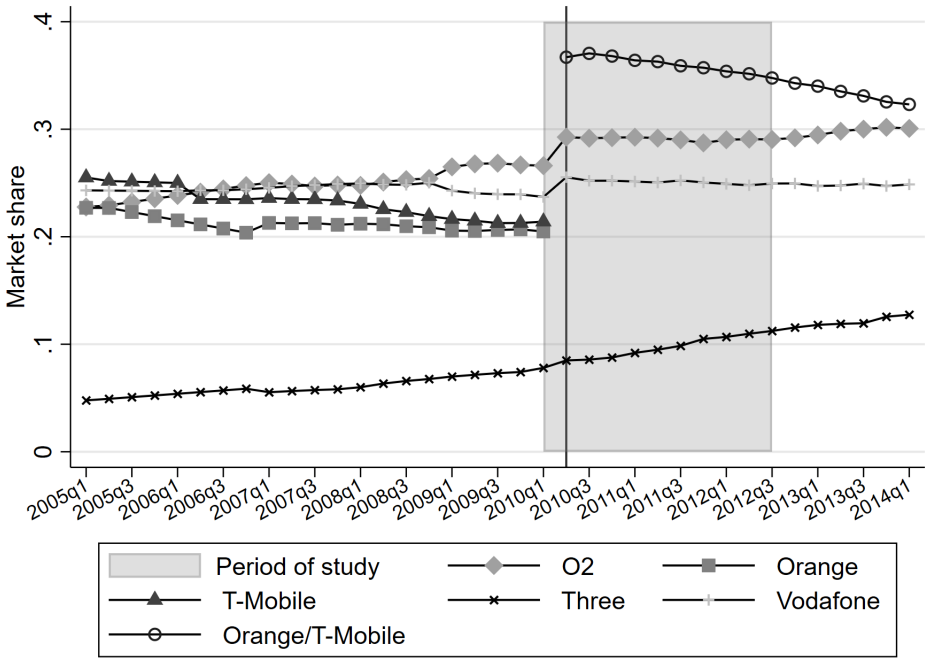
Figures and Tables

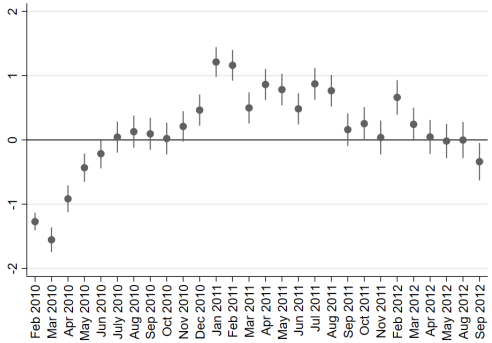
Figure 1: Mobile operators' market share of subscribers in the UK



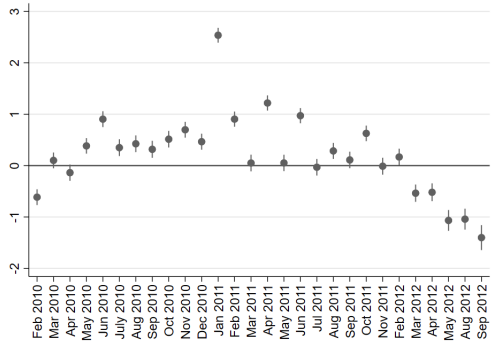
Note: Our period of study starts on January 2010 and ends on September 2012. The vertical line shows where the merger between Orange and T-Mobile took place.
Source: Operators' financial reports and Ofcom.

Figure 2: Evolution of indices

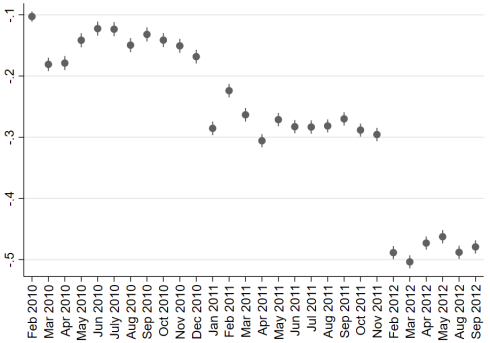
2a. Price index



2b. Obfuscation index



2c. Differentiation index



Notes: These figures present coefficients and standard errors obtained from Model I (Table A.8), Model II.b (Table A.9), and from the regression presented in Table A.10. The pairwise correlation between the first series (price index) and the second (obfuscation index) is 0.48, significant at 1%. The correlation between the first (price) and the third (differentiation) is -0.25 and is not significant.

Table 1: Descriptive statistics on combinations of tariff and handset

Variable	Mean	Std. Dev.	Min.	Max.
Tariff price	32.98	13.77	0	125
Handset cost	39.03	75.64	0	649.99
Amount of subsidy	191.7	100.76	0	650
Contract length	20.82	3.87	1	36
Sim-only tariff (0/1)	0.02	0.13	0	1
Voice allowance	651.45	624.51	0	3000
SMS allowance	291.84	823.89	0	5000
Data allowance	258.13	380.89	0	3072
On-net voice allowance	52.54	503.52	0	5000
Mixed allowance	7.85	94.15	0	3875
Unlimited voice (0/1)	0.04	0.2	0	1
Unlimited sms (0/1)	0.56	0.5	0	1
Unlimited data (0/1)	0.17	0.38	0	1
Unlimited on-net voice (0/1)	0.12	0.33	0	1
Dominated tariff (0/1)	0.15	0.36	0	1
N		184,560		

Notes: These statistics are computed for all tariffs. 71% of tariffs are associated with a zero handset cost, meaning that they are fully subsidized by the operator or that the tariff is a sim-only tariff. Indeed, sim-only tariffs are, by design, not associated with any handset - thus a zero handset cost. The definition for a dominated tariff presented in this table is our main definition (*cost-conscious*).

Table 2: Main price regressions

	(1)	(2)	(3)	(4)	(5)	(6)
		All tariffs			**Efficient tariffs**	
Estimation method	OLS	FE	FE	OLS	FE	FE
Dependent variable	$Price_{it}$	$Price_{it}$	$Price_{it}$	$Price_{it}$	$Price_{it}$	$Price_{it}$
Share of dominated tariffs	1.33***	1.15***		2.10***	2.70***	
	(0.16)	(0.14)		(0.21)	(0.19)	
Dominated dummy	1.63***	1.26***				
	(0.06)	(0.06)				
Post=0 × Share of dominated tariffs			4.00***			4.39***
			(0.64)			(0.65)
Post=1 × Share of dominated tariffs			0.58***			1.84***
			(0.17)			(0.27)
Post=0 × Dominated dummy			1.67***			
			(0.10)			
Post=1 × Dominated dummy			0.99***			
			(0.07)			
Observations	184,560	184,560	184,560	140,797	140,797	140,797
R2	0.86	0.88	0.88	0.86	0.88	0.88
SE Clusters	Tariff-level	Tariff-level	Tariff-level	Tariff-level	Tariff-level	Tariff-level
Tariff characteristics	Yes	Yes	Yes (× Post)	Yes	Yes	Yes (× Post)
Handset Fixed Effects	No	Yes	Yes (× Post)	No	Yes	Yes (× Post)
Time trend	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the list price in GBP of tariff i available in month t. We use a subsample of efficient tariffs (i.e. not dominated) at release in Columns 4, 5, and 6. Tariff characteristics include mobile operator dummies, contract length, sms, voice, data allowances or unlimited options, dummy for handset subsidy interacted with the amount of subsidy. The Least Square Dummy Variable (LSDV) approach is used in Columns 2, 3, 5 and 6. The full list of estimates is presented in Table A.18. Standard errors clustered at the tariff level are reported in parentheses below coefficients: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Source: Authors' calculations based on data from BillMonitor, GSMArena and IDC combined for the UK market between January 2010 and September 2012.

Table 3: Estimated confusopoly cost 2010-2012 (in millions GBP)

		Number of people switching tariff	
		Low (16m people)	High (38m people)
Share of consumers	0%	57	137
selecting a dominated	5%	82	194
tariff	10%	106	252

Notes: Estimations presented in this table are in millions of GBP. The computation relies on estimated coefficients presented in Table 2, Column 2. A contract length of 24 months is considered in all scenarios. The average number of dominated tariffs at the industry level over the period (January 2010 - September 2012) is considered, i.e. 13%. The two scenarios 'Low' and 'High' are based on estimations published by Ofcom. The number presented in the upper left corner can be read as follows: Between 2010 and 2012, the cost of the confusopoly, at the country level, is estimated at 57.41 M GBP in the scenario where 16M consumers select a tariff and no one of them select a dominated product, given that they are "locked in" for 24 months. The numbers presented in the main text correspond to 0.13*1.15*24*16=57.41m GBP and 0.13*1.15*24*38.1=136.7m GBP.

Table 4: Main price regressions with alternative sample and definitions

	(1)	(2)	(3)	(4)
	Efficient tariffs			
	Efficient Dominated Def. = *Cost-conscious*	Always efficient Dominated Def. = *Cost-conscious*	Efficient Dominated Def. = *Brand-loving*	Efficient Dominated Def. = *Model-obsessed*
Post=0 × Share of dom tariffs	4.39***	5.06***	6.37***	3.84***
	(0.65)	(0.47)	(0.80)	(0.52)
Post=1 × Share of dom tariffs	1.84***	1.54***	1.47***	1.70***
	(0.27)	(0.29)	(0.26)	(0.24)
Observations	140,797	128,896	136,637	153,034
R2	0.88	0.89	0.89	0.88
SE Clusters	Tariff-level	Tariff-level	Tariff-level	Tariff-level
Tariff characteristics	Yes (× Post)	Yes (× Post)	Yes (× Post)	Yes (× Post)
Handset Fixed Effects	Yes (× Post)	Yes (× Post)	Yes (× Post)	Yes (× Post)
Time trend	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Figure A.6 in the Appendix presents the coefficients obtained with all definitions. The full list of estimates is presented in Table A.19. The number of observations varies because the sample considered (efficient tariffs) depends on the definition of a dominated tariff considered. "Efficient" means efficient at release.

Table 5: Robustness tests

	(1)	(2)	(3)	(4)
Estimation method	FE	FE	FE	FE
Dependent variable	$Price_{it}$	$Price_{it}$	$Price_{it}$	$Price_{it}$
	Efficient tariffs Main model	Efficient tariffs Controlling for tariff proliferation	Efficient tariffs Controlling for tariff growth	Efficient tariffs Controlling for differentiation
Post=0 × Share of dominated tariffs	4.39***	2.33***	2.33***	4.36***
	(0.65)	(0.62)	(0.62)	(0.66)
Post=1 × Share of dominated tariffs	1.84***	0.57	0.57	2.18***
	(0.27)	(0.34)	(0.34)	(0.27)
Number of tariffs		0.10***		
		(0.01)		
Growth of number of tariffs			0.20***	
			(0.03)	
Distance with other tariffs				-4.01***
				(0.29)
Observations	140,797	140,797	140,797	140,797
R2	0.88	0.88	0.88	0.88
SE Clusters	Tariff-level	Tariff-level	Tariff-level	Tariff-level
Tariff characteristics	Yes (× Post)	Yes (× Post)	Yes (× Post)	Yes (× Post)
Handset Fixed Effects	Yes (× Post)	Yes (× Post)	Yes (× Post)	Yes (× Post)
Time trend	Yes	Yes	Yes	Yes

Notes: The dependent variable is the list price in GBP of tariff i available in month t. All tariffs are efficient at release (we exclude the dominated tariffs). Tariff characteristics include mobile operator dummies, contract length, sms, voice, data allowances or unlimited options, a dummy for handset subsidy interacted with the amount of subsidy. The full list of estimates is presented in Table A.20. Standard errors clustered at the tariff level are reported in parentheses below coefficients: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. **Source**: Authors' calculations based on data from BillMonitor, GSMArena and IDC combined for the UK market between January 2010 and September 2012.

Table 6: Summary of alternative explanations

|Alternative explanation	Possible relevance	Empirical evidence
Change in the competitive landscape: Reduced competitive pressure - for example, as a result of a merger (HHI increased)	It might explain the upward, but not the downward trend in quality-adjusted prices. The industry is mature and competitive. Evidence from policy reports that the overall level of prices actually went down.	In Figure 2a, we see that the time period between May 2010 and December 2010 would correspond to the merger narrative - but not to what is observed after January 2011. We discuss this point in detail in section 6.5.
Collusion between firms: Firms are colluding in prices or colluding in obfuscation. Such a strategy requires the coordination of all players operating in the industry	If firms agree on colluding on prices/obfuscation and they find a way to coordinate their actions, we should observe prices going up as long as no players deviate, which might have happened at the point in time we observe the quality-adjusted price decline.	See the discussion in Section 6.5. Also, Table A.14 and A.15 highlight that obfuscation and prices occur simultaneously - one does not trigger the other.
Product differentiation: Theoretically, we expect prices and differentiation to evolve in the same direction.	If products become more differentiated, we expect prices to go up. But this does not fit with the first period of observation: prices are going up while differentiation is going down.	Figure 2b shows the persistent decline of our differentiation index over the period. Figures A.2 and A.4 highlight that differentiation decreased overall (within and between operators' portfolio). Further, Table 5 (column 4) shows the robustness of our main coefficients after the introduction of a proxy for differentiation at the product level.
Proliferation of products: This strategy can drive prices up if consumers have search costs or are boundedly rational.	It cannot explain fully what we observe, in particular the introduction of inefficient (i.e. dominated) tariffs: indeed, obfuscation needs the proliferation of products: they work hand-in-hand.	Table 5, columns 2 and 3 show that our main coefficient remains significant after the introduction of proliferation proxies.

Table 6 (continued)

Unobserved dimensions of quality correlated with prices: Quality-adjusted price indices might have missed components that are valued by consumers but unobserved in our data.	The products we study are complex with a lot of dimensions. Several sources of quality might be unobserved: (i) advertising (ii) exclusivities of phones (iii) other tariff-specific elements.	We find, for (i) that including operator-specific time trends does not change our results. Figure A.16 in the paper shows that the introduction of operator-specific time trends does not change the magnitude and significance of our coefficients of interest. Regarding (ii), we find that exclusivities also cannot explain what we observe. We show in Figures A.13, A.15 and Table A.13 (by excluding tariffs with handsets exclusive to one or single operators) that they are not likely to drive the price evolution. Finally, using different definitions of a dominated tariff lets us test the robustness of our definitions. Table 4 (columns 3 and 4) and Figure A.6 (alternative definitions of dominated – also presented in the next column) highlight that the effect remains, whatever definition we take.
Love for variety: Consumers like variety and variety comes at a price.	This is plausible, but such a structural element would not translate into the dynamic pattern we observe. Rather, it would predict a higher price level in general. Consumer preferences (in particular preferences for variety) are not likely to change over a period of two years and a half.	Our survival analyses highlight that dominated products are more likely to be withdrawn by operators, suggesting that they are likely not to serve a stable niche segment of the demand (otherwise, these products would be maintained for at least as long as efficient tariffs, given their higher prices). See Table A.11 and Figure A.7.
Maybe 'just' one operator: If one operator uses an obfuscation strategy, this might fully drive our results	If one operator uses obfuscation strategies, it does not mean that the whole industry does it. Maybe the market power of this operator enables it to abuse its locked-in consumers.	Figures A.11 and A.12 show that the pattern observed at the industry level is also observed at the operator level. We also observe in Table A.17 a strong correlation between industry-level outcomes and operator-level outcomes (prices and obfuscation).

Table 6 (continued)

Dominated products are more expensive: The price of dominated tariffs might fully drive the price increase observed at the market level.	If there are dominated products introduced, they are more expensive by design. We conduct our analysis on efficient products (i.e. the share of dominated tariffs regressed on the price of efficient tariffs) and the effect holds. This strengthens the interpretation that dominated products act as a shroud.	Table 2, Columns 4 - 6 show that the price premium exists, even for efficient tariffs. Figure A.5 shows that the evolution of the quality-adjusted price index for efficient tariffs follows the same pattern as the main one that includes all tariffs.

Appendix

Definition of dominated tariffs: examples and evolution over time

Table A.1: Example of dominated tariff (main definition, i.e. *cost-conscious* consumers)

yearmo	tariff id	tariff cost	handset cost	network	sms	voice	data	onnet	mixed	contract length	brand model	handset model	list price	subsidy	group subsidy	min price	dominated (def5)
January 2010	23105	13.5	0	three	0	0	0	300	500	18	SONY ERICSSON	G502	46	46	1	13.5	0
January 2010	23107	13.5	0	three	0	0	0	300	500	18	INQ	INQ1	46	46	1	13.5	0
January 2010	23110	13.5	0	three	0	0	0	300	500	18	INQ	MINI 3G	57	57	1	13.5	0
January 2010	23118	13.5	0	three	0	0	0	300	500	18	HUAWEI	U7510	45	45	1	13.5	0
January 2010	23079	15	0	three	0	0	0	300	300	18	SONY ERICSSON	G502	46	46	1	13.5	1
January 2010	23081	15	0	three	0	0	0	300	300	18	INQ	INQ1	46	46	1	13.5	1
January 2010	23084	15	0	three	0	0	0	300	300	18	INQ	MINI 3G	57	57	1	13.5	1
January 2010	23092	15	0	three	0	0	0	300	300	18	HUAWEI	U7510	45	45	1	13.5	1
January 2010	23131	15.75	0	three	0	0	0	300	700	18	SONY ERICSSON	G502	46	46	1	13.5	1
January 2010	23133	15.75	0	three	0	0	0	300	700	18	INQ	INQ1	46	46	1	13.5	1
January 2010	23136	15.75	0	three	0	0	0	300	700	18	INQ	MINI 3G	57	57	1	13.5	1
January 2010	23144	15.75	0	three	0	0	0	300	700	18	HUAWEI	U7510	45	45	1	13.5	1
January 2010	23157	24	0	three	0	0	0	300	900	18	SONY ERICSSON	G502	46	46	1	13.5	1
January 2010	23159	24	0	three	0	0	0	300	900	18	INQ	INQ1	46	46	1	13.5	1
January 2010	23162	24	0	three	0	0	0	300	900	18	INQ	MINI 3G	57	57	1	13.5	1
January 2010	23170	24	0	three	0	0	0	300	900	18	HUAWEI	U7510	45	45	1	13.5	1
January 2010	23184	27	0	three	0	0	0	300	1100	18	SONY ERICSSON	G502	46	46	1	13.5	1
January 2010	23186	27	0	three	0	0	0	300	1100	18	INQ	INQ1	46	46	1	13.5	1
January 2010	23189	27	0	three	0	0	0	300	1100	18	INQ	MINI 3G	57	57	1	13.5	1
January 2010	23199	27	0	three	0	0	0	300	1100	18	HUAWEI	U7510	45	45	1	13.5	1

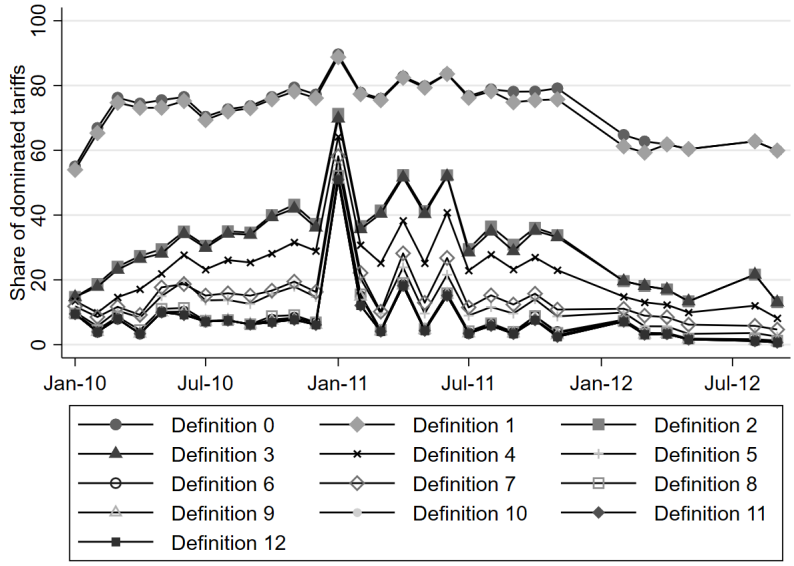
Table A.2: Example of dominated tariff (*brand-loving* consumers)

yearmo	tariff id	tariff cost	handset cost	network	sms allow	voice allow	data allow	onnet	mixed	contract length	brand model	handset model	list price	subsidy	group subsidy	min price	dominated (def7)
February 2010	26597	40	0	tmobile	0	0	unli	0	1150	18	SAMSUNG	GALAXY I7500	296	296	17	40	0
February 2010	26598	40	0	tmobile	0	0	unli	0	1150	18	SAMSUNG	GENIO TOUCH	110	110	5	40	0
February 2010	26606	40	0	tmobile	0	0	unli	0	1150	18	SAMSUNG	S3100	82	82	2	40	0
February 2010	26607	40	0	tmobile	0	0	unli	0	1150	18	SAMSUNG	S5230 TOCCO LI	114	114	5	40	0
February 2010	26622	50	0	tmobile	0	0	unli	0	1625	18	SAMSUNG	GALAXY I7500	296	296	17	40	1
February 2010	26623	50	0	tmobile	0	0	unli	0	1625	18	SAMSUNG	GENIO TOUCH	110	110	5	40	1
February 2010	26631	50	0	tmobile	0	0	unli	0	1625	18	SAMSUNG	S3100	82	82	2	40	1
February 2010	26632	50	0	tmobile	0	0	unli	0	1625	18	SAMSUNG	S5230 TOCCO LI	114	114	5	40	1
February 2010	26647	60	0	tmobile	0	0	unli	0	2125	18	SAMSUNG	GALAXY I7500	296	296	17	40	1
February 2010	26648	60	0	tmobile	0	0	unli	0	2125	18	SAMSUNG	GENIO TOUCH	110	110	5	40	1
February 2010	26656	60	0	tmobile	0	0	unli	0	2125	18	SAMSUNG	S3100	82	82	2	40	1
February 2010	26657	60	0	tmobile	0	0	unli	0	2125	18	SAMSUNG	S5230 TOCCO LI	114	114	5	40	1
February 2010	26672	75	0	tmobile	0	0	unli	0	2875	18	SAMSUNG	GALAXY I7500	296	296	17	40	1
February 2010	26673	75	0	tmobile	0	0	unli	0	2875	18	SAMSUNG	GENIO TOUCH	110	110	5	40	1
February 2010	26681	75	0	tmobile	0	0	unli	0	2875	18	SAMSUNG	S3100	82	82	2	40	1
February 2010	26682	75	0	tmobile	0	0	unli	0	2875	18	SAMSUNG	S5230 TOCCO LI	114	114	5	40	1
February 2010	26697	100	0	tmobile	0	0	unli	0	3875	18	SAMSUNG	GALAXY I7500	296	296	17	40	1
February 2010	26698	100	0	tmobile	0	0	unli	0	3875	18	SAMSUNG	GENIO TOUCH	110	110	5	40	1
February 2010	26706	100	0	tmobile	0	0	unli	0	3875	18	SAMSUNG	S3100	82	82	2	40	1
February 2010	26707	100	0	tmobile	0	0	unli	0	3875	18	SAMSUNG	S5230 TOCCO LI	114	114	5	40	1

Table A.3: Example of dominated tariff (*model-obsessed* consumers)

yearmo	tariff id	tariff cost	handset cost	network	sms allow	voice allow	data allow	onnet	mixed	contract length	brand model	handset model	list price	subsidy	group subsidy	min price	dominated (def10)
May 2010	23345	16	0	three	0	0	unli	0	100	24	NOKIA	2730	82	82	2	16	0
May 2010	23373	17	0	three	0	0	unli	0	100	24	NOKIA	2730	82	82	2	16	1
May 2010	23425	18	0	three	0	0	unli	0	300	24	NOKIA	2730	82	82	2	16	1
May 2010	23451	19	0	three	0	0	unli	0	300	24	NOKIA	2730	82	82	2	16	1
May 2010	23514	23	0	three	0	0	unli	0	500	24	NOKIA	2730	82	82	2	16	1
May 2010	23540	24	0	three	0	0	unli	0	500	24	NOKIA	2730	82	82	2	16	1
May 2010	23599	26	0	three	0	0	unli	0	900	24	NOKIA	2730	82	82	2	16	1
May 2010	23625	27	0	three	0	0	unli	0	900	24	NOKIA	2730	82	82	2	16	1

Figure A.1: Share of dominated tariffs according to various definitions



To create the obfuscation index, we define which tariffs are dominated. Because we are facing particularly complex combinations of attributes, we have considered several definitions for a dominated tariff, described below:

Handset is ignored

- Definition 0: Operator, allowances of sms, voice, and data are the same.
- Definition 1: Operator, allowances of sms, voice, data, and on net calls are the same.
- Definition 2: Operator, allowances of sms, voice, data, and contract length are the same.
- Definition 3: Operator, allowances of sms, voice, data, contract length and on net calls are the same.
- Definition 4: Operator, allowances of sms, voice, data, contract length, and handset cost are the same.
- **Definition 5**: Operator, allowances of sms, voice, data, contract length, handset cost, and level of handset subsidy are the same. Main definition for *Cost-conscious consumers*.
- Definition 6: Operator, allowances of sms, voice, data, contract length, handset cost, and exact amount of handset subsidy are the same.
- **Definition 7**: Operator, allowances of sms, voice, data, contract length, brand and handset cost are the same. Main definition for *Brand-loving consumers*.
- Definition 8: Operator, allowances of sms, voice, data, on-net calls, contract length, brand, handset cost, and level of handset subsidy are the same.
- Definition 9: Operator, allowances of sms, voice, data, on-net calls, contract length, brand, handset cost, and exact amount of handset subsidy are the same.
- **Definition 10**: Operator, allowances of sms, voice, data, on-net calls, contract length, handset model and handset cost are the same. Main definition for *Model-obsessed consumers*.
- Definition 11: Operator, allowances of sms, voice, data, on-net calls, contract length, handset model, handset cost and level of handset subsidy are the same.
- Definition 12: Operator, allowances of sms, voice, data, on-net calls, contract length, handset model, handset cost and exact amount of handset subsidy are the same.

Groups of handset subsidies are defined based on 20 quantiles of the subsidy distribution. Group 0 corresponds to no subsidy at all. Our preferred definition (used in the analysis) is Definition 5. We also use definitions 7 (*brand-loving)* and 10 (*model-obsessed*).

Differentiation of tariffs: Computation of pairwise distances

We measure the level of differentiation of tariffs in the market by computing the Euclidean distance between each tariff pair available on the market in a given month. Excluding different handset models and defining our tariffs as a combination of network, contract length and allowances, we have 10,477 observations with 1,306 unique tariffs. We use this dataset to compute the distance between tariffs — we do not account for handsets in this case. This eventually gives 1,978,742 pairs of tariffs.

Because the allowances have different measures (sms are counted in units, voice in minutes, and data in GB) and some tariffs include one or more flat-rates (i.e. unlimited units of sms, voice and/or data)[23], we normalize the allowances using the following formula:

$$z_i = \frac{x_i - min(x)}{max(x) - min(x)}$$

The normalized allowances take a value between 0 and 1, 0 corresponding to no allowance and 1 to unlimited allowance. Then, for each pair of tariffs i and j observed in month t and for an attribute $k \in \{data, voice, sms\}$, we compute the following:

$$distance_{kijt} = (k_{it} - k_{jt})^2$$

Finally, we obtain our product differentiation measure by computing the following:

$$distance_{ijt} = \sum_{k=1}^{K} (k_{it} - k_{jt})^2$$

This measure captures how tariffs are positioned relative to each other in the attribute space including the allowances of sms, voice, and data. Table A.4 shows descriptive statistics on the pairwise distance ranging between 0 and 3.[24] For example, a tariff with no allowance at all will have a pairwise distance of 3 with a tariff with unlimited voice, text and data – while the distance will be 2 for a tariff with unlimited voice and text and no data at all.

Table A.4: Descriptive statistics on the distances (pairwise observations)

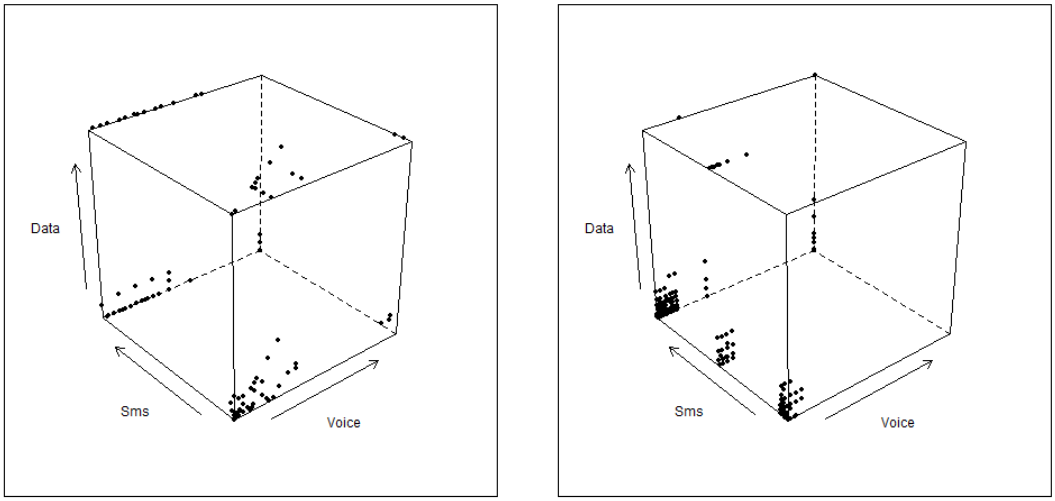
Variable	Mean	Std. Dev.	Min.	Max.
Distance (sms, voice, data)	0.70	0.64	0	3
Distance sms	0.41	0.44	0	1
Distance voice	0.09	0.25	0	1
Distance data	0.2	0.38	0	1
N		1,978,742		

[23]Flat rates are originally coded with an arbitrary value that is set at 10 000.

[24]The maximum distance between two tariffs in each of the dimensions (sms, voice, data) is 1, the maximum overall distance is 3.

Descriptive statistics

Figure A.2: Products in the attribute space



Note: Each dot represents the position of one (or several) tariff(s) in the attribute space. Each cube represents all the tariffs available at the focal month. Some tariffs overlap because they include exactly the same allowances of voice, SMS and data.

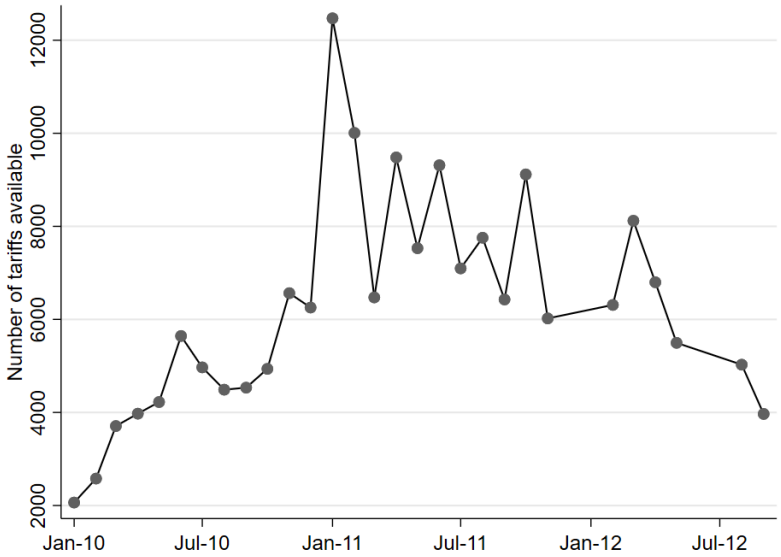
Table A.5: Descriptive statistics on tariffs (per operator)

	Tariff cost	Handset cost	Contract length	Sim-only	Voice	Sms	Data	On-net allowance	Mixed allowance	Unlimited voice	Unlimited sms	Unlimited data	Unlimited on-net
O2	37.92	24.64	20.58	0.02	508	65	338	1.57	0.00	0.14	0.85	0.07	0.10
Orange	32.58	33.68	21.04	0.02	664	79	309	0.00	0.00	0.00	0.74	0.09	0.00
Three	23.07	16.10	22.57	0.03	534	2912	347	1147	137.95	0.00	0.16	0.37	0.16
Tmobile	27.92	63.90	20.77	0.01	554	291	126	0.00	4.68	0.02	0.28	0.28	0.27
Vodafone	39.45	22.15	20.50	0.02	1106	180	323	0.00	0.00	0.00	0.57	0.16	0.00
Total	32.98	39.03	20.82	0.02	651	292	258	52.54	7.85	0.04	0.56	0.17	0.12

Table A.6: Contract length per tariff type

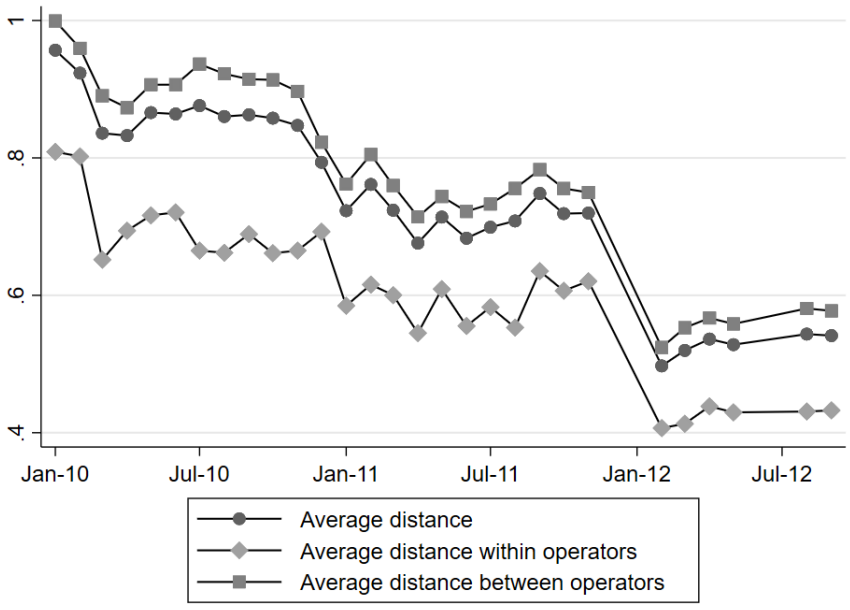
	Sim-only tariff	Tariffs with handsets
1	57.20	0
3	1.90	0
12	36.7	1.86
18	3.05	45.10
24	0.65	52.93
30	0.5	0.00
36	0	0.11
N	3,210	181,350

Figure A.3: Evolution of the number of tariffs



Note: All tariffs are represented on this figure (tariffs with handsets and sim-only contracts).

Figure A.4: Evolution of pairwise distance at the industry level



Correlation matrix

Table A.7: Correlation matrix with main variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
(1) Tariff price	1																
(2) Share of dominated tariffs	0.01***	1															
(3) Dominated dummy	0.09***	0.34***	1														
(4) Dummy for O2	0.21***	-0.06***	-0.04***	1													
(5) Dummy for Orange	-0.01***	-0.01***	-0.08***	-0.30***	1												
(6) Dummy for Three	-0.16***	-0.02***	0.10***	-0.13***	-0.11***	1											
(7) Dummy for Tmobile	-0.26***	0.00*	0.01***	-0.41***	-0.37***	-0.16***	1										
(8) Dummy for Vodafone	0.20***	0.09***	0.07***	-0.25***	-0.22***	-0.09***	-0.31***	1									
(9) Contract length	-0.11***	0.10***	0.07***	-0.04***	0.03***	0.10***	-0.01***	-0.04***	1								
(10) Unlimited voice	0.41***	-0.05***	0.02***	0.27***	-0.10***	-0.05***	-0.07***	-0.09***	0.03***	1							
(11) Voice allowance	0.63***	0.05***	0.05***	-0.13***	0.01***	-0.04***	-0.11***	0.31***	0.01**	-0.22***	1						
(12) Unlimited sms	0.25***	-0.02***	-0.01***	0.33***	0.19***	-0.18***	-0.40***	0.01***	-0.02***	0.15***	0.08***	1					
(13) SMS allowance	-0.13***	-0.02***	0.04***	-0.16***	-0.13***	0.69***	0	-0.06***	0.10***	-0.06***	0.04***	-0.40***	1				
(14)Unlimited data	0.07***	0.05***	0.08***	-0.15***	-0.11***	0.12***	0.20***	-0.02***	0.05***	0.03***	0.09***	-0.15***	0.10***	1			
(15) Data allowance	0.31***	-0.15***	-0.06***	0.12***	0.07***	0.05***	-0.25***	0.07***	0.04***	0.06***	0.15***	0.13***	0.06***	-0.31***	1		
(16) Mixed allowance	-0.01***	0	0.13***	-0.05***	-0.04***	0.30***	-0.02***	-0.04***	0.01***	-0.02***	-0.09***	-0.09***	-0.03***	0.05***	0	1	
(17) Subsidy	0.40***	0	0.10***	0.08***	-0.08***	-0.02***	-0.04***	0.06***	0.15***	0.12***	0.21***	0.07***	0.01***	0.07***	0.17***	-0.02***	1

**** p<0.01, ** p<0.05, * p<0.1*

Estimation results: Indices

Table A.8: Estimation results from the hedonic price regression

	Model 1	
Dep. Var.	Tariff price	
Estimation method	OLS	
Tariff characteristics		
O2	0.00	(.)
Orange	-2.19***	(0.07)
Three	-9.27***	(0.24)
T-Mobile	-5.70***	(0.08)
Vodafone	-3.26***	(0.08)
Contract length=1	14.13***	(0.45)
Contract length=3	12.16***	(0.67)
Contract length=12	10.20***	(0.15)
Contract length=18	5.71***	(0.05)
Contract length=24	0.00	(.)
Contract length=30	-3.89***	(0.72)
Unlimited voice=0	0.00	(.)
Unlimited voice=1	34.56***	(0.18)
Voice allowance	0.02***	(0.00)
Unlimited SMS=0	0.00	(.)
Unlimited SMS=1	0.34***	(0.06)
SMS allowance	-0.00***	(0.00)
Unlimited data=1	3.12***	(0.08)
Data allowance	0.01***	(0.00)
Mixed allowance	0.01***	(0.00)
Handset subsidy=0	0.00	(.)
Handset subsidy=1	16.63***	(0.39)
Handset subsidy=0 × Amount of subsidy	0.00	(.)
Handset subsidy=1 × Amount of subsidy	0.02***	(0.00)
Smartphone=1	0.10	(0.06)
Sim Only	0.00	(.)
Acer	2.79***	(0.39)
Apple	3.52***	(0.14)
Blackberry	1.18***	(0.09)
Dell	2.10***	(0.28)
Emporia	-2.33**	(0.85)
Htc	-0.11	(0.09)
Huawei	0.58	(0.81)
Inq	0.84	(0.57)
Lg	0.30**	(0.12)
Motorola	-0.34*	(0.16)
Nokia	0.10	(0.08)
Orange	1.66***	(0.20)
Palm	2.85***	(0.18)
Samsung	0.00	(.)
Sony	2.26***	(0.33)
Sony Ericsson	0.04	(0.09)
T-Mobile	0.86**	(0.30)
Vodafone	4.85***	(0.67)
Zte	-1.95	(1.48)
Year-Month Dummies	Yes	
Constant	-0.42	(0.41)
Observations	184,560	
R2	0.87	

Standard errors in parentheses, clustered at the tariff-level.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Coefficients estimated for Year-Month dummies are presented in Figure 2a. The base category for the variable "Manufacturer" is Samsung. 36 months contracts are grouped with 30 months contracts.

Table A.9: Estimation results from the dominated tariffs regressions

	Model 2.a		**Model 2.b**	
Dep. Var.	Dominated (0/1)		Dominated (0/1)	
Estimation method	OLS		Maximum Likelihood	
Model	Linear		Logit	
O2	0.00	(.)	0.00	(.)
Orange	-0.05***	(0.00)	-0.49***	(0.03)
Three	0.19***	(0.01)	1.29***	(0.05)
T-Mobile	0.01***	(0.00)	0.13***	(0.04)
Vodafone	0.05***	(0.00)	0.37***	(0.04)
Sim-only=1	-0.13***	(0.00)	-3.56***	(0.29)
Jan 2010	0.00	(.)	0.00	(.)
Feb 2010	-0.04***	(0.01)	-0.61***	(0.08)
Mar 2010	0.01	(0.01)	0.10	(0.08)
Apr 2010	-0.01	(0.01)	-0.14	(0.08)
May 2010	0.04***	(0.01)	0.38***	(0.08)
Jun 2010	0.10***	(0.01)	0.90***	(0.08)
July 2010	0.03***	(0.01)	0.35***	(0.08)
Aug 2010	0.04***	(0.01)	0.42***	(0.08)
Sep 2010	0.03***	(0.01)	0.32***	(0.08)
Oct 2010	0.05***	(0.01)	0.51***	(0.08)
Nov 2010	0.08***	(0.01)	0.70***	(0.08)
Dec 2010	0.04***	(0.01)	0.47***	(0.08)
Jan 2011	0.46***	(0.01)	2.54***	(0.07)
Feb 2011	0.10***	(0.01)	0.90***	(0.08)
Mar 2011	0.00	(0.01)	0.05	(0.08)
Apr 2011	0.15***	(0.01)	1.22***	(0.08)
May 2011	0.00	(0.01)	0.05	(0.08)
Jun 2011	0.12***	(0.01)	0.97***	(0.08)
Jul 2011	-0.01	(0.01)	-0.03	(0.08)
Aug 2011	0.02***	(0.01)	0.29***	(0.08)
Sep 2011	0.01	(0.01)	0.11	(0.08)
Oct 2011	0.06***	(0.01)	0.63***	(0.08)
Nov 2011	-0.00	(0.01)	-0.01	(0.08)
Feb 2012	0.01*	(0.01)	0.17*	(0.08)
Mar 2012	-0.04***	(0.01)	-0.54***	(0.09)
Apr 2012	-0.03***	(0.01)	-0.52***	(0.09)
May 2012	-0.06***	(0.01)	-1.07***	(0.10)
Aug 2012	-0.06***	(0.01)	-1.04***	(0.10)
Sep 2012	-0.07***	(0.01)	-1.40***	(0.12)
Constant	0.09***	(0.01)	-2.38***	(0.07)
Observations	184,560		184,560	
R2	0.13			
Log Likelihood			-684,31.68	

Standard errors in parentheses, clustered at the tariff-level
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Coefficients estimated for Year-Month dummies are presented in Figure 2b.

Table A.10: Estimation results from the regression of pairwise distances

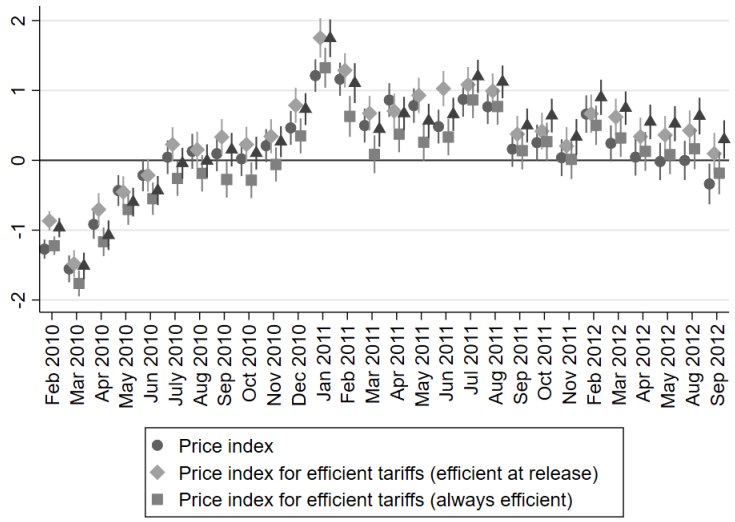
Dep var	$Distance_{ijt}$	
Model	OLS	
Within operators FEs		
O2 to O2	0.00	(.)
Orange to Orange	0.01	(0.01)
Three to Three	0.03	(0.02)
Tmobile to Tmobile	0.25***	(0.01)
Vodafone to Vodafone	-0.06***	(0.01)
Between operators FEs		
O2 to Orange	0.07***	(0.01)
O2 to Three	0.30***	(0.01)
O2 to Tmobile	0.51***	(0.01)
O2 to Vodafone	0.09***	(0.01)
Orange to Three	0.14***	(0.01)
Orange to Tmobile	0.32***	(0.01)
Orange to Vodafone	0.02***	(0.01)
Three to Tmobile	0.25***	(0.01)
Three to Vodafone	0.10***	(0.01)
Tmobile to Vodafone	0.31***	(0.01)
Between segments FEs		
Tariff with handset to tariff with handset	0.17***	(0.00)
Simonly to tariff with handset/t-handset to simonly	0.11***	(0.00)
Sim-only to Sim-only	0.00	(.)
Year-Month FEs		
Jan 2010	0.00	(.)
Feb 2010	-0.10***	(0.00)
Mar 2010	-0.18***	(0.01)
Apr 2010	-0.18***	(0.01)
May 2010	-0.14***	(0.01)
Jun 2010	-0.12***	(0.01)
July 2010	-0.12***	(0.01)
Aug 2010	-0.15***	(0.01)
Sep 2010	-0.13***	(0.01)
Oct 2010	-0.14***	(0.01)
Nov 2010	-0.15***	(0.01)
Dec 2010	-0.17***	(0.01)
Jan 2011	-0.29***	(0.01)
Feb 2011	-0.22***	(0.01)
Mar 2011	-0.26***	(0.01)
Apr 2011	-0.31***	(0.01)
May 2011	-0.27***	(0.01)
Jun 2011	-0.28***	(0.01)
Jul 2011	-0.28***	(0.01)
Aug 2011	-0.28***	(0.01)
Sep 2011	-0.27***	(0.01)
Oct 2011	-0.29***	(0.01)
Nov 2011	-0.30***	(0.01)
Feb 2012	-0.49***	(0.01)
Mar 2012	-0.50***	(0.01)
Apr 2012	-0.47***	(0.01)
May 2012	-0.46***	(0.01)
Aug 2012	-0.49***	(0.01)
Sep 2012	-0.48***	(0.01)
Constant	0.67***	(0.01)
Observations	1978742	
R2	0.11	

Standard errors in parentheses, clustered at the pair-level.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

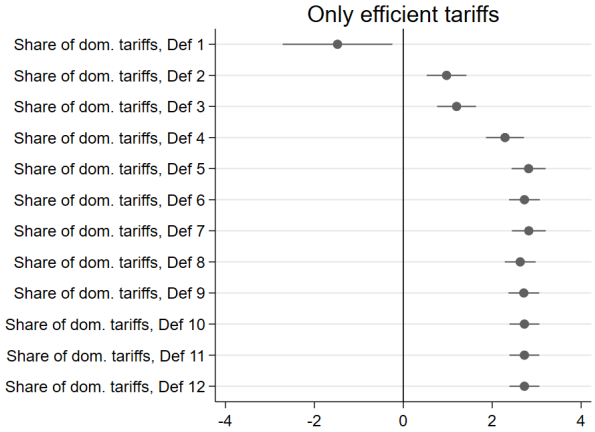
Notes: Coefficients estimated for Year-Month dummies are also presented in Figure 2c.

Figure A.5: Price indices for all vs. efficient tariffs



Note: Coefficients and their 95% confidence intervals are obtained from regressions including all tariffs or the sample of efficient tariffs.

Figure A.6: Coefficients on the share of dominated tariffs, with all definitions



Notes: The model estimated corresponds to our main model, presented in Column 5 of Table 2. Definitions are presented in Figure A.1.

Estimation results: Survival Analysis

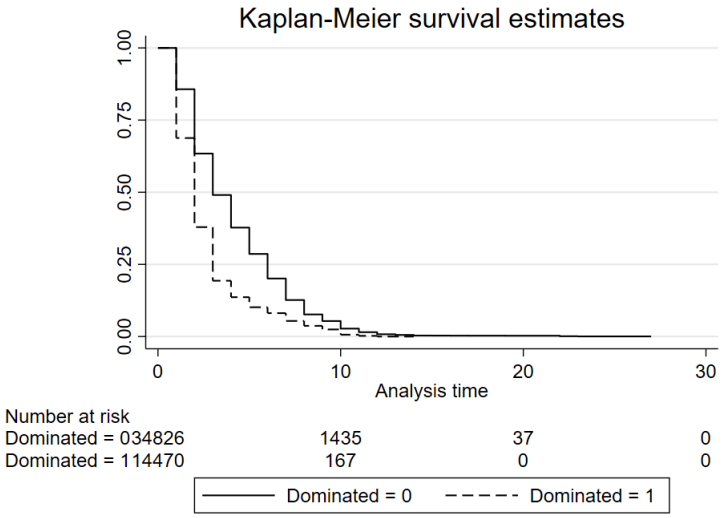
Table A.11: Survival Analysis

	Exit		**Survival**	
	Cox Proportional Hazard Models		Accelerated Failure-Time Models	
	Coef >1 → increased likelihood of exit		Coef >1 → increased likelihood of survival	
	(1)	(2)	(3)	(4)
Dominated tariff	1.34***		0.74***	
	(0.01)		(0.01)	
Dominated tariff (always)		2.21***		0.54***
		(0.03)		(0.00)
Number of tariffs in thousands	1.17***	1.17***	0.90***	0.90***
	(0.00)	(0.00)	(0.00)	(0.00)
Simonly tariff (0/1)	0.30***	0.31***	1.93***	1.88***
	(0.02)	(0.03)	(0.12)	(0.11)
O2	1.00	1.00	1.00	1.00
	(.)	(.)	(.)	(.)
Orange	1.17***	1.23***	0.90***	0.86***
	(0.01)	(0.01)	(0.01)	(0.01)
Three	1.61***	1.47***	0.69***	0.73***
	(0.03)	(0.03)	(0.01)	(0.01)
T-Mobile	0.90***	0.90***	1.09***	1.09***
	(0.01)	(0.01)	(0.01)	(0.01)
Vodafone	1.36***	1.30***	0.81***	0.83***
	(0.02)	(0.02)	(0.01)	(0.01)
ln sigma			0.63***	0.62***
			(0.00)	(0.00)
kappa			1.26***	1.25***
			(0.01)	(0.01)
Observations	178160	178160	178160	178160
Log Likelihood	-4.47e+05	-4.46e+05	-46724.38	-44901.25
AIC	893,535	891,088	93,469	89,822
BIC	893,606	891,160	93,570	89,923

Exponentiated coefficients; Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: All results are obtained with the Maximum Likelihood Estimator. An exit occurs for a given tariff if it is observed at t and not at $t+1$. We use our main definition of dominated to conduct this analysis. See Table A.12 for results with alternative parametrization of the AFT model.

Figure A.7: Survival of efficient and dominated tariff: Kaplan Maier Approach



Notes: Sample = 178,160 observations, 49,296 unique tariffs. An exit occurs for a given tariff if it is observed at t and not at $t+1$. We use our main definition of dominated to conduct this analysis.

Figure A.8: Graphical test for the proportional hazards assumption

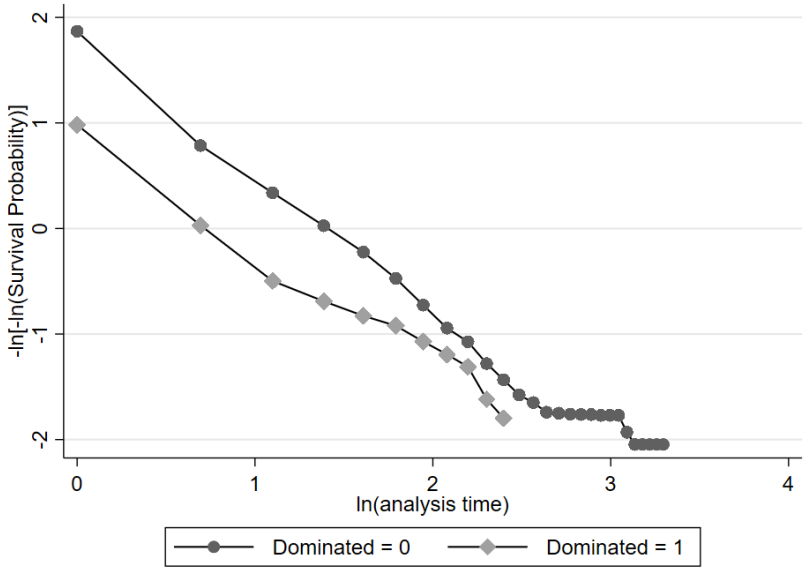


Table A.12: AFT Models: Parametrization

	(1) Gen Gamma	(2) LogLogistic	(3) LogNormal	(4) Weibull	(5) Exponential
Survival of tariffs					
Dominated tariff	0.74***	0.70***	0.74***	0.77***	0.91***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Number of tariffs in thousands	0.90***	0.90***	0.90***	0.90***	0.87***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Simonly tariff (0/1)	1.93***	1.87***	1.69***	2.56***	2.65***
	(0.12)	(0.11)	(0.11)	(0.13)	(0.16)
O2	1.00	1.00	1.00	1.00	1.00
	(.)	(.)	(.)	(.)	(.)
Orange	0.90***	0.91***	0.91***	0.87***	0.90***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Three	0.69***	0.68***	0.70***	0.70***	0.66***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
T-Mobile	1.09***	1.07***	1.10***	1.07***	1.09***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Vodafone	0.81***	0.81***	0.82***	0.78***	0.78***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
ln sigma	0.63***		0.64***		
	(0.00)		(0.00)		
kappa	1.26***				
	(0.01)				
ln gamma		0.37***			
		(0.00)			
ln p				1.66***	
				(0.01)	
Observations	178160	178160	178160	178160	178160
Statistics					
Log Likelihood	-46,724.38	-48,038.83	-46,883.27	-48,683.78	-57,148.53
AIC	93,468.76	96,095.66	93,784.55	97,385.57	11,4313.06
BIC	93,569.67	96,186.47	93,875.36	97,476.38	114,393.79

Exponentiated coefficients; Robust standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Indices for different segments/operators

Figure A.9: Price indices sim-only/tariffs with handsets

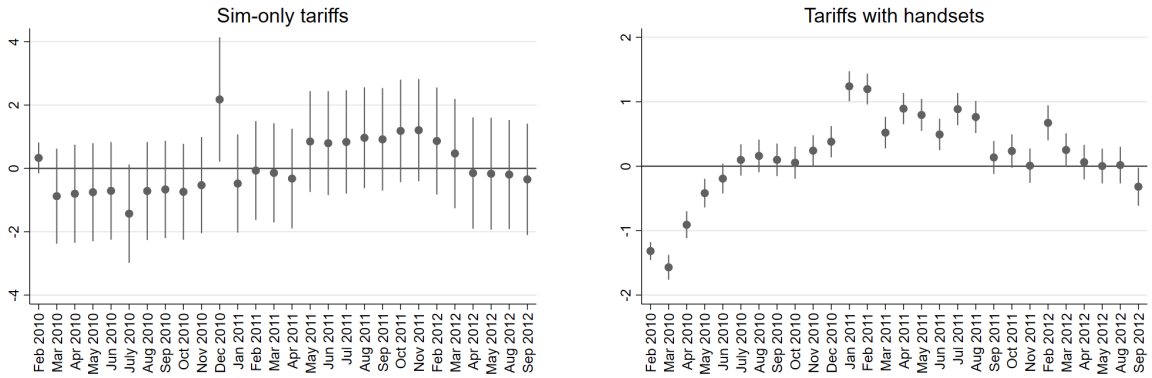
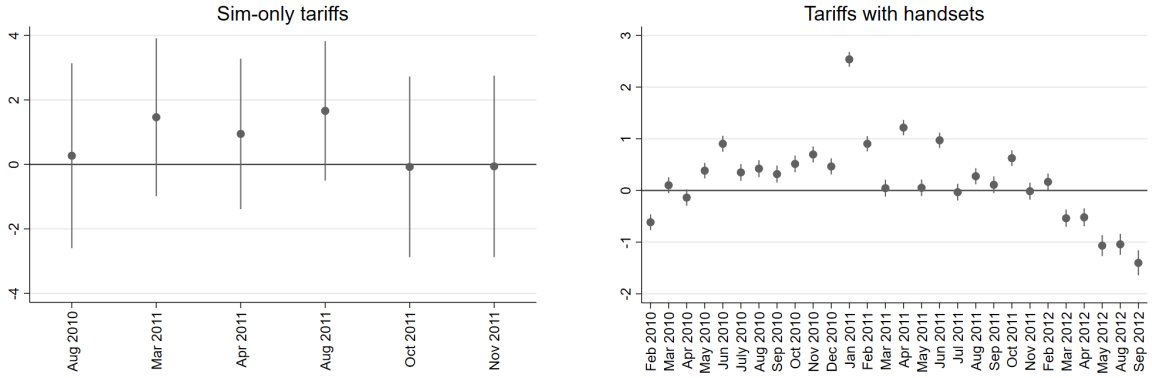
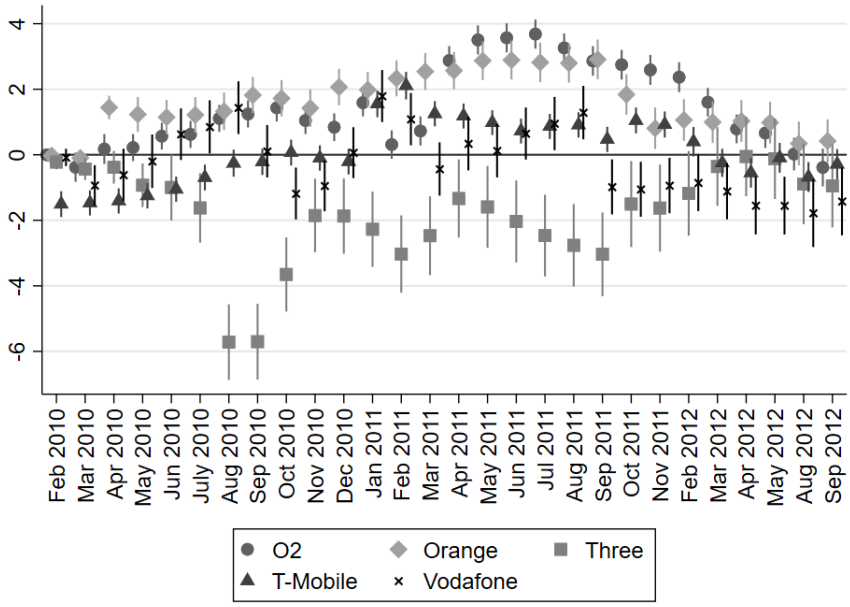


Figure A.10: Obfuscation indices sim-only/tariffs with handsets



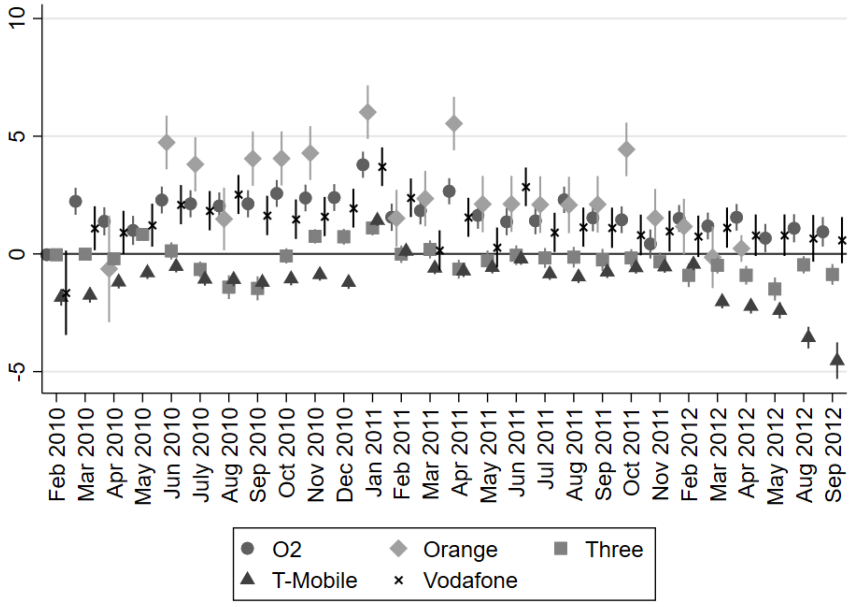
Indices obtained with regressions performed on subsamples.

Figure A.11: Price indices per operators



Indices obtained with regressions performed on subsamples.

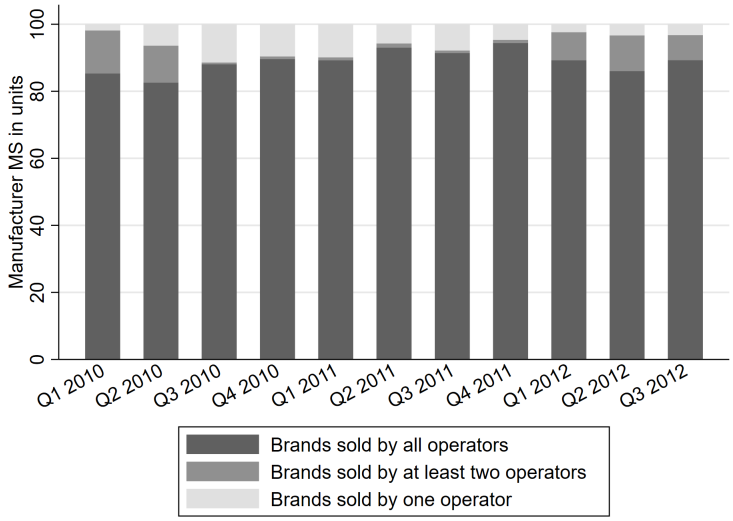
Figure A.12: Obfuscation indices per operators



Indices obtained with regressions performed on subsamples.

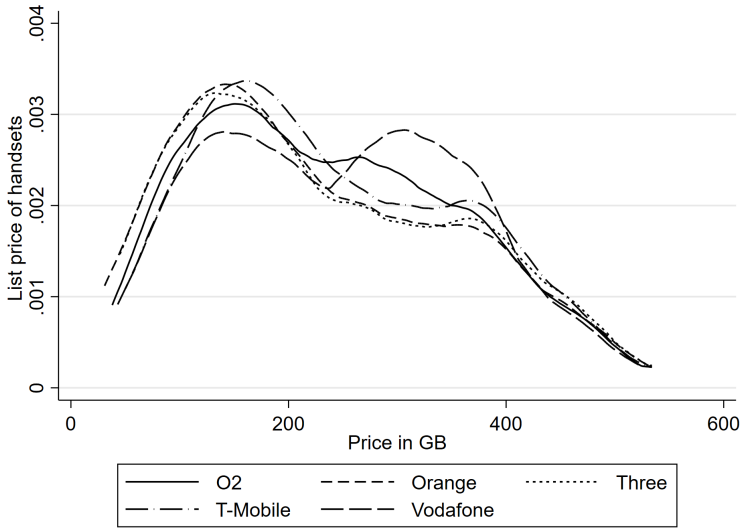
Differentiation of handsets

Figure A.13: Market share of brands offered by operators in the sample



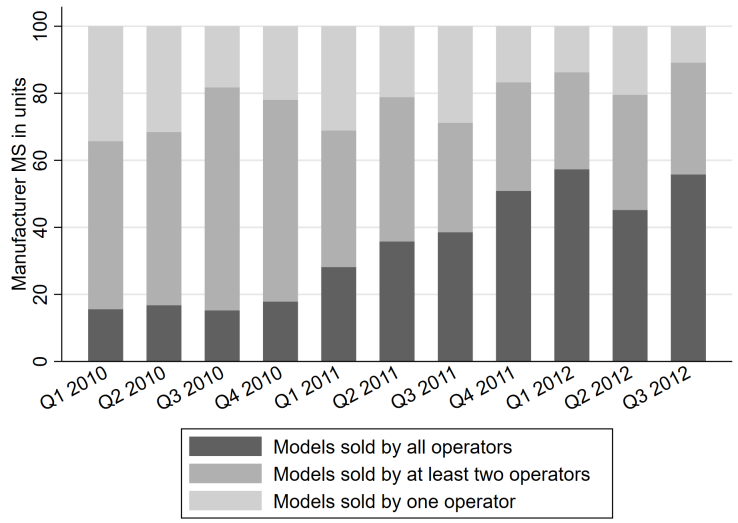
Note: The figure presents the market share in volume at the country level based on data from IDC. A few marginal brands that appear in IDC's data but are not sold by any operator at a given quarter are excluded from the computation.

Figure A.14: Distribution of handset list prices per operator, over years



Note: This figure highlights that all operators were offering very comparable ranges of products, from low to premium segments. Price is a reasonable proxy for the quality of products.

Figure A.15: Market share of models



Note: The figure presents the market share in volume at the country level, based on data from IDC. Models that appear in IDC's data but are not sold by any operator at a given quarter are excluded from the computation.

Table A.13: Estimation results with samples of tariffs

	(1)		(2)		(3)	
Estimation method	FE		FE		FE	
Dep. var	$Price_{it}$		$Price_{it}$		$Price_{it}$	
Sample	All tariffs		Tariffs with handsets sold by at least two op.		Tariffs with handsets sold by all op.	
Share of dominated tariffs	2.85***	(0.20)	2.99***	(0.21)	2.42***	(0.38)
O2	0.00	(.)	0.00	(.)	0.00	(.)
Orange	-2.12***	(0.09)	-2.14***	(0.09)	-1.68***	(0.14)
Three	-9.14***	(0.32)	-9.49***	(0.34)	-6.71***	(0.52)
T-Mobile	-4.89***	(0.10)	-4.91***	(0.10)	-3.52***	(0.14)
Vodafone	-2.17***	(0.12)	-2.15***	(0.12)	-1.14***	(0.16)
Contract length=12	10.62***	(0.17)	10.79***	(0.18)	10.82***	(0.25)
Contract length=18	5.91***	(0.05)	5.86***	(0.06)	5.85***	(0.08)
Contract length=24	0.00	(.)	0.00	(.)	0.00	(.)
Contract length=36	-6.05***	(0.60)	-6.14***	(0.70)	-3.57***	(0.35)
Unlimited voice=0	0.00	(.)	0.00	(.)	0.00	(.)
Unlimited voice=1	33.94***	(0.22)	33.70***	(0.25)	30.64***	(0.42)
Voice allowance	0.02***	(0.00)	0.02***	(0.00)	0.01***	(0.00)
Unlimited SMS=0	0.00	(.)	0.00	(.)	0.00	(.)
Unlimited SMS=1	0.45***	(0.07)	0.48***	(0.08)	0.69***	(0.12)
SMS allowance	-0.00**	(0.00)	-0.00	(0.00)	-0.00*	(0.00)
Unlimited data=1	2.78***	(0.09)	2.67***	(0.09)	1.95***	(0.14)
Data allowance	0.00***	(0.00)	0.00***	(0.00)	0.00***	(0.00)
Mixed allowance	0.01***	(0.00)	0.02***	(0.00)	0.01***	(0.00)
Handset subsidy=1 × Amount of subsidy	0.03***	(0.00)	0.03***	(0.00)	0.03***	(0.00)
Time trend	0.03***	(0.01)	0.04***	(0.01)	-0.02	(0.01)
Constant	-4.48	(4.18)	-12.45**	(4.50)	23.97***	(7.27)
Observations	137,654		122,563		52,323	
R2	0.88		0.87		0.87	
SE Clusters	Tariff-level		Tariff-level		Tariff-level	
Handsets Fixed Effects	Yes		Yes		Yes	

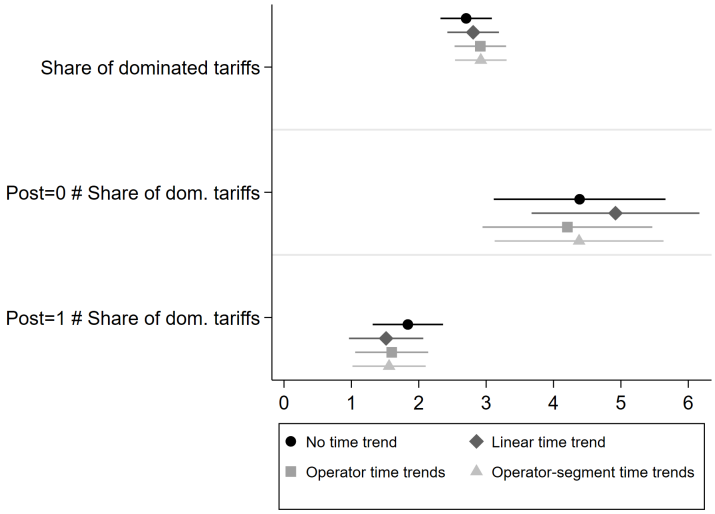
Standard errors in parentheses, clustered at the tariff-level.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: All tariffs are efficient tariffs at release. Column 1 corresponds to Model 2 presented in Table 2. Column 2 presents the results obtained with a similar model estimated on a sample of tariffs combined with a handset sold by at least two operators. Column 3 presents the results obtained with a similar model estimated on a sample of tariffs, which are combined with a handset sold by all operators.

Additional analyses

Figure A.16: Coefficients on the share of dominated tariffs, with various time trends.



Notes: Coefficients presented correspond to those presented in Columns 5 and 6 of Table 2. In our main specification, we do not use any time trends because of a multicollinearity issue occurring between the linear time trend and the variable "Share of dominated tariffs".

Vector Autoregressions and Granger Causality

Using the price and obfuscation indices obtained from the estimation of Equations 1 and 2, at the industry and operator level, we estimate the following models:

$$\begin{aligned} PriceIndex_t = \alpha + \beta_1 PriceIndex_{t-1} + \beta_2 PriceIndex_{t-2} + \beta_3 PriceIndex_{t-3} \\ + \beta_4 ObfuscationIndex_{t-1} + \beta_5 ObfuscationIndex_{t-2} + \beta_6 ObfuscationIndex_{t-3} + \varepsilon_t \end{aligned} \tag{5}$$

$$\begin{aligned} ObfuscationIndex_t = a + b_1 ObfuscationIndex_{t-1} + b_2 ObfuscationIndex_{t-2} \\ + b_3 ObfuscationIndex_{t-3} + b_4 PriceIndex_{t-1} + b_5 PriceIndex_{t-2} \\ + b_6 PriceIndex_{t-3} + \varepsilon_t \end{aligned} \tag{6}$$

This corresponds to simple vector autoregressions with three lags. $PriceIndex_t$ is the time series obtained with the coefficients δ_t from Equation 1. $ObfuscationIndex_t$ is the time series obtained with the coefficients θ_t from Equation 2. Given that we have some gaps in our time series, some observations are dropped from the estimation sample. Results are presented in Table A.14.

At the industry level, the price index is "persistent" with an AR(1) process. We also observe that the price time series is not dependent on the level of obfuscation observed in the past at the industry level. Our Granger causality test (presented in Table A.15) confirms that prices and obfuscation indices are not causally linked. We conducted additional analyses with price and obfuscation indices at the operator level to see if a causal effect can be identified for some firms. The tests are always negative. We therefore conclude that obfuscation and price increases arise at the same time, and that there are no dynamics at play (one does not cause the other – i.e. firms do not obfuscate and then raise their prices). This goes in the direction of obfuscation directly increasing prices, i.e. prices are increasing through obfuscation. This conclusion is reinforced by the fact that we see this very strong pairwise correlation occurring at the operator level presented in Table A.16. Indeed, we observe a significant coefficient for three out of five operators (correlation is not significant for the biggest and the smallest players). Are price indices more correlated than obfuscation indices? If yes, this might mean that there is collusion. As presented in Table A.17, obfuscation indices at the operator-level are more correlated to the industry-level index than the price indices at the operator level with the industry price index.

Table A.14: Estimation results from VAR

Equ. (4)	**Price Index**	
L.Price Index	0.72**	(0.24)
L2.Price Index	-0.28	(0.27)
L3.Price Index	0.10	(0.15)
L.Obfuscation Index	0.07	(0.12)
L2.Obfuscation Index	0.04	(0.12)
L3.Obfuscation Index	0.21	(0.12)
Constant	0.02	(0.09)
Observations	21	
R2	0.76	
Equ. (5)	**Obfuscation Index**	
L.Obfuscation Index	-0.00	(0.27)
L2.Obfuscation Index	0.28	(0.27)
L3.Obfuscation Index	0.37	(0.28)
L.Price Index	0.20	(0.55)
L2.Price Index	-0.10	(0.64)
L3.Price Index	-0.39	(0.34)
Constant	0.20	(0.22)
Observations	21	
R2	0.24	

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.15: Granger Causality

Y	X	$\chi 2$	$Prob > \chi 2$
Price Index	Obfuscation Index	4.56	0.207
Obfuscation Index	Price Index	3.24	0.356

Null hypothesis: Lagged values of X do not cause Y. If p value>0.05, we cannot reject the null hypothesis.

Table A.16: Correlation between price and obfuscation at the operator level

	O2	Orange	Three	T-Mobile	Vodafone
Correlation coefficient	0.19	0.47**	0.19	0.51***	0.51***
Market Share Jan 2010	26.6	20.5	7.8	21.4	23.7

Significance of the pairwise coefficient: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table A.17: Correlation of operator-level indices with industry-level indices

	Price_{Ind}	Obf_{Ind}
Price index O2	0.61***	0.32*
Price index Orange	0.71***	0.48***
Price index Three	-0.38**	-0.37**
Price index T-Mobile	0.87***	0.45**
Price index Vodafone	0.44**	0.67***
Obfuscation index O2	0.39**	0.71***
Obfuscation index Orange	0.47***	0.74***
Obfuscation index Three	0.08	0.51***
Obfuscation index T-Mobile	0.48***	0.85***
Obfuscation index Vodafone	0.46**	0.72***

Significance of the pairwise coefficient: *** $p<0.01$, ** $p<0.05$, * $p<0.1$. $Price_{Ind}$ is the price index at the industry level. Obf_{Ind} is the obfuscation index at the industry level.

Confusopoly and profits: Computation

Industry revenue: We collected publicly available data collected from reports published by OFCOM: Telecommunications Market Data Update 2010, 2011 and 2012. We obtain a total of 43.4 billion GBP for the focal market (UK, Retail, Post-Paid contracts). *Profitability* We can estimate the profitability of the main operators to be about 26%. This number is based on our own computation, which is based on reported revenue and operating income as presented in operators' financial reports for the year 2009. Vodafone and Telefonica (02) both have, for 2009, an estimated profit of 26%. Orange reported very low operating income, T-Mobile a negative result, and Hutchison (Three) did not report at all. *Profits over the period* Based on this estimation, we can quantify the industry-level total profits to be of 12 billion GPB. *Confusopoly cost as a share of profit* 60.4 million, the lowest bound of our estimated Confusopoly cost, represents 0.50%. 259.05 million, our highest estimation, gives 2.15% of the industry profit.

Full version of main tables

Table A.18: Main estimation results (with all controls)

	(1)		(2)		(3)		(4)		(5)		(6)	
	All tariffs						**Efficient tariffs**					
Estimation method	OLS		FE		FE		OLS		FE		FE	
Dependent variable	$Price_{it}$		$Price_{it}$		$Price_{it}$		$Price_{it}$		$Price_{it}$		$Price_{it}$	
Share of dom tariffs	1.33***	(0.16)	1.15***	(0.14)			2.10***	(0.21)	2.70***	(0.19)		
Dominated=0	0.00	(.)	0.00	(.)								
Dominated=1	1.63***	(0.06)	1.26***	(0.06)								
O2	0.00	(.)	0.00	(.)			0.00	(.)	0.00	(.)		
Orange	-2.07***	(0.08)	-2.05***	(0.08)			-2.20***	(0.08)	-2.04***	(0.09)		
Three	-9.80***	(0.26)	-9.01***	(0.26)			-9.87***	(0.28)	-9.01***	(0.31)		
T-Mobile	-5.67***	(0.08)	-5.12***	(0.08)			-5.46***	(0.08)	-4.77***	(0.10)		
Vodafone	-3.01***	(0.09)	-3.03***	(0.09)			-2.24***	(0.10)	-2.10***	(0.11)		
Contract length=1	-1.90***	(0.25)	14.31***	(0.44)			13.95***	(0.45)	14.02***	(0.44)		
Contract length=3	-4.17***	(0.53)	12.29***	(0.68)			11.05***	(0.65)	11.30***	(0.68)		
Contract length=12	6.14***	(0.39)	10.53***	(0.16)			9.99***	(0.16)	10.18***	(0.17)		
Contract length=18	5.65***	(0.05)	5.74***	(0.05)			5.82***	(0.06)	5.92***	(0.05)		
Contract length=24	0.00	(.)	0.00	(.)			0.00	(.)	0.00	(.)		
Contract length=30	-5.33***	(0.48)	-5.14***	(0.81)			-3.66***	(0.78)	-4.43***	(0.86)		
Unlimited voice=0	0.00	(.)	0.00	(.)			0.00	(.)	0.00	(.)		
Unlimited voice=1	34.24***	(0.20)	33.99***	(0.18)			34.37***	(0.22)	33.86***	(0.22)		
Voice allowance	0.02***	(0.00)	0.01***	(0.00)			0.02***	(0.00)	0.02***	(0.00)		
Unlimited SMS=0	0.00	(.)	0.00	(.)			0.00	(.)	0.00	(.)		
Unlimited SMS=1	0.18**	(0.07)	0.21***	(0.06)			0.46***	(0.07)	0.48***	(0.07)		
SMS allowance	-0.00***	(0.00)	-0.00***	(0.00)			-0.00	(0.00)	-0.00**	(0.00)		
Unlimited data=1	3.04***	(0.08)	2.89***	(0.07)			2.75***	(0.09)	2.76***	(0.09)		
Data allowance	0.01***	(0.00)	0.01***	(0.00)			0.01***	(0.00)	0.00***	(0.00)		
Mixed allowance	0.01***	(0.00)	0.01***	(0.00)			0.01***	(0.00)	0.01***	(0.00)		
Handset subsidy=1 × Amount of subsidy	0.02***	(0.00)	0.03***	(0.00)			0.02***	(0.00)	0.03***	(0.00)		
Post=0 × Share of dom tariffs					4.00***	(0.64)					4.39***	(0.65)
Post=1 × Share of dom tariffs					0.58***	(0.17)					1.84***	(0.27)
Dominated=0 × Post=0					0.00	(.)						
Dominated=0 × Post=1					0.00	(.)						
Dominated=1 × Post=0					1.67***	(0.10)						
Dominated=1 × Post=1					0.99***	(0.07)						
O2 × Post=0					0.00	(.)					0.00	(.)
O2 × Post=1					0.00	(.)					0.00	(.)
Orange × Post=0					-1.88***	(0.13)					-1.49***	(0.14)
Orange × Post=1					-1.79***	(0.09)					-2.01***	(0.11)
Three × Post=0					-9.10***	(0.29)					-8.99***	(0.35)
Three × Post=1					-6.24***	(0.44)					-5.46***	(0.49)
T-Mobile × Post=0					-6.56***	(0.13)					-6.20***	(0.14)
T-Mobile × Post=1					-4.11***	(0.10)					-3.58***	(0.12)
Vodafone × Post=0					-2.62***	(0.17)					-1.69***	(0.19)
Vodafone × Post=1					-2.99***	(0.11)					-2.05***	(0.13)
Contract length=1 × Post=0					9.63***	(0.70)					9.57***	(0.70)
Contract length=1 × Post=1					15.73***	(0.44)					15.33***	(0.44)
Contract length=3 × Post=0					0.00	(.)					0.00	(.)
Contract length=3 × Post=1					13.67***	(0.67)					12.52***	(0.68)
Contract length=12 × Post=0					6.88***	(0.34)					6.79***	(0.36)
Contract length=12 × Post=1					11.15***	(0.18)					10.69***	(0.20)
Contract length=18 × Post=0					5.13***	(0.07)					5.16***	(0.07)
Contract length=18 × Post=1					5.98***	(0.05)					6.30***	(0.07)
Contract length=24 × Post=0					0.00	(.)					0.00	(.)
Contract length=24 × Post=1					0.00	(.)					0.00	(.)
Contract length=30 × Post=0					-6.33***	(0.74)					-6.27***	(0.72)
Contract length=30 × Post=1					-4.56***	(1.39)					-2.53	(1.72)
Unlimited voice=0 × Post=0					0.00	(.)					0.00	(.)
Unlimited voice=0 × Post=1					0.00	(.)					0.00	(.)
Unlimited voice=1 × Post=0					35.00***	(0.17)					35.41***	(0.19)
Unlimited voice=1 × Post=1					33.63***	(0.22)					33.24***	(0.27)
Post=0 × Voice allowance					0.02***	(0.00)					0.02***	(0.00)
Post=1 × Voice allowance					0.01***	(0.00)					0.01***	(0.00)
Unlimited SMS=0 × Post=0					0.00	(.)					0.00	(.)
Unlimited SMS=0 × Post=1					0.00	(.)					0.00	(.)
Unlimited SMS=1 × Post=0					-0.09	(0.09)					-0.06	(0.10)
Unlimited SMS=1 × Post=1					0.23**	(0.08)					0.68***	(0.09)
Post=0 × SMS allowance					-0.00	(0.00)					-0.00	(0.00)
Post=1 × SMS allowance					-0.00***	(0.00)					-0.00***	(0.00)
Unlimited data=1 × Post=0					2.26***	(0.08)					2.09***	(0.09)
Unlimited data=1 × Post=1					2.38***	(0.11)					2.04***	(0.16)
Post=0 × Data allowance					-0.00	(0.00)					-0.00	(0.00)
Post=1 × Data allowance					0.01***	(0.00)					0.01***	(0.00)
Post=0 × Mixed allowance					0.01***	(0.00)					0.02***	(0.00)
Post=1 × Mixed allowance					0.00***	(0.00)					0.00*	(0.00)
Handset subsidy=1 × Post=0					0.00	(.)					0.00	(.)
Handset subsidy=1 × Post=1					0.00	(.)					0.00	(.)
Handset subsidy=1 × Post=0 × Amount of subsidy					0.03***	(0.00)					0.03***	(0.00)
Handset subsidy=1 × Post=1 × Amount of subsidy					0.03***	(0.00)					0.03***	(0.00)
Post=1					-5.56***	(0.71)					-5.25***	(0.73)
Handset subsidy=1							16.23***	(0.40)	0.00	(.)		
Constant	15.94***	(0.12)	14.71***	(0.12)	18.28***	(0.51)	-0.60	(0.41)	13.81***	(0.13)	17.07***	(0.50)
Handset Fixed Effects	No		Yes		Yes (× Post)		No		Yes		Yes (× Post)	
Observations	184,560		184,560		184,560		140,797		140,797		140,797	
R2	0.86		0.88		0.88		0.86		0.88		0.88	

Standard errors in parentheses, clustered at the tariff-level. Contracts with length = 36 grouped with length = 30.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.19: Main price regressions with alternative sample and definitions (with all controls)

	(1)		(2)		(3)		(4)	
	Efficient tariffs							
	At release Dominated Def. = *Cost-conscious*		Always efficient Dominated Def. = *Cost-conscious*		At release Dominated Def. = *Brand-loving*		At release Dominated Def. = *Model-obsessed*	
Post=0 × Share of dom tariffs (Def 5)	4.39***	(0.65)	5.06***	(0.47)				
Post=1 × Share of dom tariffs (Def 5)	1.84***	(0.27)	1.54***	(0.29)				
Post=0 × Share of dom tariffs (Def 7)					6.37***	(0.80)		
Post=1 × Share of dom tariffs (Def 7)					1.47***	(0.26)		
Post=0 × Share of dom tariffs (Def 10)							3.84***	(0.52)
Post=1 × Share of dom tariffs (Def 10)							1.70***	(0.24)
O2 × Post=0	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
O2 × Post=1	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Orange × Post=0	-1.49***	(0.14)	-1.60***	(0.13)	-1.49***	(0.14)	-1.95***	(0.13)
Orange × Post=1	-2.01***	(0.11)	-1.76***	(0.11)	-1.55***	(0.11)	-1.99***	(0.11)
Three × Post=0	-8.99***	(0.35)	-5.84***	(0.34)	-9.01***	(0.36)	-9.35***	(0.35)
Three × Post=1	-5.46***	(0.49)	-4.97***	(0.50)	-5.20***	(0.56)	-5.56***	(0.45)
T-Mobile × Post=0	-6.20***	(0.14)	-6.48***	(0.14)	-6.33***	(0.15)	-6.42***	(0.14)
T-Mobile × Post=1	-3.58***	(0.12)	-3.29***	(0.12)	-3.05***	(0.11)	-3.46***	(0.11)
Vodafone × Post=0	-1.69***	(0.19)	-1.36***	(0.20)	-1.61***	(0.19)	-2.24***	(0.18)
Vodafone × Post=1	-2.05***	(0.13)	-1.87***	(0.14)	-1.56***	(0.14)	-2.32***	(0.13)
Contract length=1 × Post=0	9.57***	(0.70)	9.45***	(0.73)	9.64***	(0.70)	9.47***	(0.69)
Contract length=1 × Post=1	15.33***	(0.44)	15.56***	(0.44)	15.85***	(0.44)	15.41***	(0.45)
Contract length=3 × Post=0	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Contract length=3 × Post=1	12.52***	(0.68)	12.75***	(0.68)	12.94***	(0.69)	12.90***	(0.69)
Contract length=12 × Post=0	6.79***	(0.36)	6.87***	(0.37)	6.86***	(0.36)	6.72***	(0.34)
Contract length=12 × Post=1	10.69***	(0.20)	10.94***	(0.20)	11.25***	(0.20)	10.82***	(0.19)
Contract length=18 × Post=0	5.16***	(0.07)	5.19***	(0.07)	5.16***	(0.07)	5.17***	(0.07)
Contract length=18 × Post=1	6.30***	(0.07)	6.55***	(0.07)	6.61***	(0.07)	6.17***	(0.06)
Contract length=24 × Post=0	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Contract length=24 × Post=1	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Contract length=30 × Post=0	-6.27***	(0.72)	-5.89***	(0.79)	-6.17***	(0.73)	-6.35***	(0.71)
Contract length=30 × Post=1	-2.53	(1.72)	-0.93	(2.02)	-2.63	(1.76)	-2.84	(1.78)
Unlimited voice=0 × Post=0	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Unlimited voice=0 × Post=1	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Unlimited voice=1 × Post=0	35.41***	(0.19)	35.81***	(0.18)	35.35***	(0.19)	35.06***	(0.18)
Unlimited voice=1 × Post=1	33.24***	(0.27)	33.02***	(0.30)	33.47***	(0.27)	33.25***	(0.25)
Post=0 × Voice allowance	0.02***	(0.00)	0.02***	(0.00)	0.02***	(0.00)	0.02***	(0.00)
Post=1 × Voice allowance	0.01***	(0.00)	0.01***	(0.00)	0.01***	(0.00)	0.01***	(0.00)
Unlimited SMS=0 × Post=0	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Unlimited SMS=0 × Post=1	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Unlimited SMS=1 × Post=0	-0.06	(0.10)	-0.63***	(0.10)	-0.11	(0.10)	-0.14	(0.10)
Unlimited SMS=1 × Post=1	0.68***	(0.09)	0.64***	(0.09)	0.49***	(0.09)	0.63***	(0.09)
Post=0 × SMS allowance	-0.00	(0.00)	-0.00***	(0.00)	-0.00	(0.00)	0.00	(0.00)
Post=1 × SMS allowance	-0.00***	(0.00)	-0.00***	(0.00)	-0.00***	(0.00)	-0.00***	(0.00)
Unlimited data=1 × Post=0	2.09***	(0.09)	1.78***	(0.09)	2.08***	(0.09)	2.10***	(0.09)
Unlimited data=1 × Post=1	2.04***	(0.16)	2.00***	(0.17)	2.21***	(0.17)	2.23***	(0.15)
Post=0 × Data allowance	-0.00	(0.00)	0.00	(0.00)	-0.00	(0.00)	-0.00	(0.00)
Post=1 × Data allowance	0.01***	(0.00)	0.01***	(0.00)	0.01***	(0.00)	0.01***	(0.00)
Post=0 × Mixed allowance	0.02***	(0.00)	0.01***	(0.00)	0.02***	(0.00)	0.02***	(0.00)
Post=1 × Mixed allowance	0.00*	(0.00)	0.00*	(0.00)	0.00*	(0.00)	0.00*	(0.00)
Handset subsidy=1 × Post=0	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Handset subsidy=1 × Post=1	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Handset subsidy=1 × Post=0 × Amount of subsidy	0.03***	(0.00)	0.02***	(0.00)	0.03***	(0.00)	0.03***	(0.00)
Handset subsidy=1 × Post=1 × Amount of subsidy	0.03***	(0.00)	0.03***	(0.00)	0.03***	(0.00)	0.03***	(0.00)
Post=1	-5.25***	(0.73)	-5.93***	(0.74)	-5.81***	(0.73)	-5.70***	(0.72)
Handset Fixed Effects	Yes (× Post)		Yes (× Post)		Yes (× Post)		Yes (× Post)	
Constant	25.44***	(4.60)	17.73***	(4.68)	23.62***	(4.64)	27.04***	(4.29)
Observations	140,797		128,896		136,637		153,034	
R2	0.88		0.89		0.89		0.88	

Standard errors in parentheses, clustered at the tariff-level.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: All regressions include handset fixed effects. Thus, the time-invariant characteristics of handsets are captured by the fixed effects.

Table A.20: Robustness tests (with all controls)

	(1)		(2)		(3)		(4)	
Estimation method	FE		FE		FE		FE	
Dependent variable	$Price_{it}$		$Price_{it}$		$Price_{it}$		$Price_{it}$	
	Efficient tariffs		Efficient tariffs		Efficient tariffs		Efficient tariffs	
	Main model		Controlling for tariff proliferation		Controlling for tariff growth		Controlling for differentiation	
Post=0 × Share of dom tariffs	4.39***	(0.65)	2.33***	(0.62)	2.33***	(0.62)	4.36***	(0.66)
Post=1 × Share of dom tariffs	1.84***	(0.27)	0.57	(0.34)	0.57	(0.34)	2.18***	(0.27)
O2 × Post=0	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
O2 × Post=1	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Orange × Post=0	-1.49***	(0.14)	-1.48***	(0.14)	-1.48***	(0.14)	-1.45***	(0.14)
Orange × Post=1	-2.01***	(0.11)	-2.01***	(0.11)	-2.01***	(0.11)	-1.98***	(0.11)
Three × Post=0	-8.99***	(0.35)	-8.98***	(0.35)	-8.98***	(0.35)	-8.86***	(0.36)
Three × Post=1	-5.46***	(0.49)	-5.50***	(0.49)	-5.50***	(0.49)	-5.13***	(0.48)
T-Mobile × Post=0	-6.20***	(0.14)	-6.21***	(0.14)	-6.21***	(0.14)	-6.13***	(0.14)
T-Mobile × Post=1	-3.58***	(0.12)	-3.57***	(0.12)	-3.57***	(0.12)	-3.58***	(0.12)
Vodafone × Post=0	-1.69***	(0.19)	-1.70***	(0.19)	-1.70***	(0.19)	-1.72***	(0.19)
Vodafone × Post=1	-2.05***	(0.13)	-2.07***	(0.13)	-2.07***	(0.13)	-2.05***	(0.13)
Contract length=1 × Post=0	9.57***	(0.70)	9.63***	(0.70)	9.63***	(0.70)	9.54***	(0.71)
Contract length=1 × Post=1	15.33***	(0.44)	15.31***	(0.44)	15.31***	(0.44)	15.44***	(0.46)
Contract length=3 × Post=0	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Contract length=3 × Post=1	12.52***	(0.68)	12.64***	(0.68)	12.64***	(0.68)	11.90***	(0.69)
Contract length=12 × Post=0	6.79***	(0.36)	6.83***	(0.36)	6.83***	(0.36)	6.59***	(0.35)
Contract length=12 × Post=1	10.69***	(0.20)	10.69***	(0.20)	10.69***	(0.20)	10.72***	(0.20)
Contract length=18 × Post=0	5.16***	(0.07)	5.16***	(0.07)	5.16***	(0.07)	5.15***	(0.07)
Contract length=18 × Post=1	6.30***	(0.07)	6.30***	(0.07)	6.30***	(0.07)	6.29***	(0.07)
Contract length=24 × Post=0	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Contract length=24 × Post=1	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Contract length=30 × Post=0	-6.27***	(0.72)	-6.27***	(0.72)	-6.27***	(0.72)	-6.25***	(0.71)
Contract length=30 × Post=1	-2.53	(1.72)	-2.60	(1.70)	-2.60	(1.70)	-2.62	(1.72)
Unlimited voice=0 × Post=0	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Unlimited voice=0 × Post=1	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Unlimited voice=1 × Post=0	35.41***	(0.19)	35.41***	(0.19)	35.41***	(0.19)	38.69***	(0.33)
Unlimited voice=1 × Post=1	33.24***	(0.27)	33.24***	(0.27)	33.24***	(0.27)	36.42***	(0.34)
Post=0 × Voice allowance	0.02***	(0.00)	0.02***	(0.00)	0.02***	(0.00)	0.02***	(0.00)
Post=1 × Voice allowance	0.01***	(0.00)	0.01***	(0.00)	0.01***	(0.00)	0.01***	(0.00)
Unlimited SMS=0 × Post=0	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Unlimited SMS=0 × Post=1	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Unlimited SMS=1 × Post=0	-0.06	(0.10)	-0.06	(0.10)	-0.06	(0.10)	-0.82***	(0.12)
Unlimited SMS=1 × Post=1	0.68***	(0.09)	0.69***	(0.09)	0.69***	(0.09)	0.09	(0.10)
Post=0 × SMS allowance	-0.00	(0.00)	-0.00	(0.00)	-0.00	(0.00)	-0.00***	(0.00)
Post=1 × SMS allowance	-0.00***	(0.00)	-0.00***	(0.00)	-0.00***	(0.00)	-0.00***	(0.00)
Unlimited data=1 × Post=0	2.09***	(0.09)	2.09***	(0.09)	2.09***	(0.09)	3.55***	(0.14)
Unlimited data=1 × Post=1	2.04***	(0.16)	2.04***	(0.16)	2.04***	(0.16)	4.82***	(0.25)
Post=0 × Data allowance	-0.00	(0.00)	-0.00	(0.00)	-0.00	(0.00)	-0.00*	(0.00)
Post=1 × Data allowance	0.01***	(0.00)	0.01***	(0.00)	0.01***	(0.00)	0.01***	(0.00)
Post=0 × Mixed allowance	0.02***	(0.00)	0.02***	(0.00)	0.02***	(0.00)	0.02***	(0.00)
Post=1 × Mixed allowance	0.00*	(0.00)	0.00*	(0.00)	0.00*	(0.00)	0.00	(0.00)
Handset subsidy=1 × Post=0	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Handset subsidy=1 × Post=1	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Handset subsidy=1 × Post=0 × Amount of subsidy	0.03***	(0.00)	0.03***	(0.00)	0.03***	(0.00)	0.03***	(0.00)
Handset subsidy=1 × Post=1 × Amount of subsidy	0.03***	(0.00)	0.03***	(0.00)	0.03***	(0.00)	0.03***	(0.00)
Post=1	-5.25***	(0.73)	-5.46***	(0.73)	-5.46***	(0.73)	-5.99***	(0.73)
Number of tariffs			0.10***	(0.01)				
Growth of number of tariffs					0.20***	(0.03)		
Distance with other tariffs							-4.01***	(0.29)
Handset Fixed Effects	Yes (× Post)		Yes (× Post)		Yes (× Post)		Yes (× Post)	
Constant	17.07***	(0.50)	16.78***	(0.49)	16.98***	(0.50)	20.56***	(0.55)
Observations	140,797		140,797		140,797		140,797	
R2	0.88		0.88		0.88		0.88	

Standard errors in parentheses, clustered at the tariff-level.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$