Are Consumers Myopic? Evidence from Handset and Mobile Services Choices *

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Abstract

In this paper, I estimate discrete choice models for handsets and mobile tariffs using a sample of 10,740 subscribers of a European mobile telecommunications operator, observed between April 2011 and December 2014. The estimates are used to measure consumer myopia, i.e. how they tradeoff current and future expenses when making their choices. I highlight differences across groups of consumers and, more importantly, over time. Indeed, I document a significant decrease in consumer myopia over the period I study, and show that this value seems to stabilize around a value close to what has been estimated in other markets. I argue that important changes in the market structure are the driving forces behind the decline of myopia, impacting prices and variety of tariffs available, as well as consumers' awareness. I also argue that this situation benefited all consumers, not only those who selected a SIM-only tariff. Finally, I estimate a series of counterfactuals to assess the gain in consumer welfare that resulted from the changes observed in this market. For example, I show that the introduction of SIM-only tariffs increased the average consumer's surplus by over 23€.

Key Words: Consumer myopia; Time preference; Mobile services; Heterogeneous preferences

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1 Introduction

Consumers facing a choice that involve an intertemporal dimension may undervalue or, conversely, overvalue future costs and benefits from a decision. Future discounting has been documented in choices of air conditioners (Hausman, 1979), heating systems (Dubin and Mc Fadden, 1984), cars (Dreyfus and Viscusi (1995), Busse et al (2013) Allcott and Wozny (2014), Grigolon et al (2018)) and more recently for photovoltaic systems (De Groote and Verboven (2019)). Exploring the existence of such implicit discount rates is crucial to understand better how consumer make consumption choices, but also to help decision-makers design policies which ensure consumer protection or design programs to promote the adoption of a new (durable) technology.

Although mobile tariffs typically tie consumers to a provider over an extended period and include a mobile handset at a one-off price, intertemporal choices in the mobile telecommunications market have been scarcely studied. The introduction in the recent years of SIM-only tariffs, i.e. mobile plans which are not bundled with handsets, expanded the choice set considered by individuals but, more importantly, gave consumers the opportunity to make a trade-off between current and future expenses, in choosing whether to buy a device at full price or select a subsidized one. In this paper, I aim at documenting this trade-off and highlight how it differs across individuals and over time. To do so, I develop a discrete choice model of demand for handset and mobile tariffs. I use a unique dataset of 10,740 subscribers to a European telecommunications operator who selected a handset and a tariff between April 2011 and December 2014. Consumers can either choose a contract with a subsidized handset which involve a low upfront price for the handset but higher monthly recurring charge in the future, or choose a SIM-only contract, which is typically cheaper and purchase their handset at full price. I use estimates from the demand model to compute an average measure of *attention weight* which captures the degree to which consumers are myopic or forward looking when making their decision. Estimation results suggest that consumers are myopic, but heterogeneously so. For example, I find that gender, age, intensity of usages and density of the city of residence have an influence on consumer myopia, while the median income and the unemployment rate do not. Estimation results also suggest that the level of myopia declined significantly over time, along with the adoption of SIM-only tariffs. Even though the natural interpretation of this result is that the increasing number of SIM-only subscribers mechanically drove the level of myopia down, I show that the decline is related to changes in prices which occurred after the entry of a new mobile network operator

(MNO). I argue that all consumers benefited from this entry, those who selected SIM-only tariffs as well as consumers who selected tariffs with handsets. I finally conduct several counterfactuals to comment on the welfare gains of changes observed in this market.

The remainder of the paper is organized as follows. Section 1 covers the related literature. Section 2 describes the industry and its recent evolution. Section 3 provides a description of the data. Section 4 specifies the model. Section 5 discusses the empirical results and Section 6 provides an overview of the robustness tests conducted. Finally, Section 7 concludes.

2 Related Literature

This paper aims at contributing to the literature on consumer intertemporal choices, i.e. choices which involve a trade-off between costs and benefits at different points in time. Such decisions are faced by firms which select, for example, which investments to make, or consumers who decide to save, lend or spend money. The theory of discounted utility is the most widely used framework for analysing intertemporal choices (Ericson and Laibson, 2019). It highlights the existence of a parameter (the *discount factor*) that impacts the utility derived from future expenses or earnings flows.

Evidence of future discounting has been documented in various markets, but predominantly in energy markets where consumers face a trade-off between capital cost and operating costs. Hausman (1979) computes an implicit discount rate for air conditioners purchase and finds an average rate of 20%, decreasing with household's income level. This suggests that consumers are biased towards present. Dubin and McFadden (1984) use a similar approach for the choice of heating and cooling systems and found similar values. More recent empirical work distinguishes the market interest rate from consumers' subjective valuation of the future, named in various papers *attention weight*, which is inversely proportional to consumers' myopia. Consumer myopia has also been documented in the car market, in the US (Busse et al (2013), Allcott and Wozny (2014)) and in Europe (Grigolon et al (2018)). These studies share a similar conclusion: consumer myopia estimated in these markets exists but is modest. Using a more dynamic approach, De Groote and Verboven (2019) measure consumers' valuations of the future in the adoption of photovoltaic systems. They find that households significantly discount the future and that this led the subsidization program implemented by the Government (based on future production subsidies) to be more expensive than what it could have been with an alternative policy based on upfront investment subsidy.

This last observation shows the role that myopia can play in the efficiency of policies. In the same fashion, Grigolon et al (2018) show that, for policies aimed at reducing gasoline consumption, fuel taxes are more effective than taxes on less fuel-efficient cars. In addition to its impact on the efficiency of policies, consumer myopia affects more generally the functioning of markets. It can play a role in competition between firms (Gabaix and Laibson (2006)) and was listed as one of the sources of consumer detriment by the European Commission (2007). This paper adds to the literature on consumer intertemporal choices in documenting consumer myopia in a market in which it has not been studied yet, i.e. the mobile market. This market has two interesting features. First, it involves a time horizon which is significantly shorter than the time horizon taken into account by consumers who choose a car or an investment in a photovoltaic panel. Second, the mobile market has been pointed out as particularly sensitive in terms of consumer detriment by the European Commission (2017).

Measuring myopia in the mobile telecommunications market also contributes to the understanding of consumer behavior in such markets. There is an extensive literature documenting tariff choices (Ben-Akiva et al. (1987)), price elasticities (Pereira and Ribeiro (2011)) and willingness to pay for service attributes (Rosston et al. (2010), Grzybowski and Liang (2015)). Dynamics of tariff choices have also been documented through empirical work on switching costs (Grzybowski (2008)) but also on consumers' learning in Miravete (2003). Literature on handset choices is less abundant, although it covers a wide range of issues, from documenting switching costs between phones (Park and Koo (2016) or between brands and OS (Grzybowski and Nicolle (2018), to estimating patent value (Hiller, Savage and Waldman (2018)). Papers relying on the simultaneous choice of mobile service and handset are scarce and focus on estimating switching costs between service providers (Culler and Scherbakov (2010)), measuring network effects between OS (Luo, 2018) or comment on the impact of exclusivities between smartphone manufacturers and mobile operators (Sinkinson, 2014)).

Finally, this paper relates to the large body of literature on the impact of competition on mobile services prices (Genakos, et al (2018), Nicolle et al (2018)) and variety. In particular, Bourreau et al (2018) suggest that the entry of a new operator in the French market benefited consumers though an increased variety of tariffs, itself related to the introduction of *fighting brands*. Although their data documents the demand for all operators (including MVNOs) and includes both post-paid and pre-paid tariffs, it is aggregated at the geographical-area level. Moreover, it includes no information on handsets selected by consumers. In contrast, the data I use in this paper is at the individual-level and contains

extensive information on tariffs and handsets, available and selected.

In this paper, I combine elements of the intertemporal choice literature with elements related to competition in mobile markets. Extending the approach by Allcott and Wozny (2014), I allow the attention weight to vary across individuals and over time. To investigate the driving forces behind the observed decline in myopia, I study prices and variety of alternatives offered to consumers and relate their evolution to changes which occurred in the market structure.

3 Industry Background

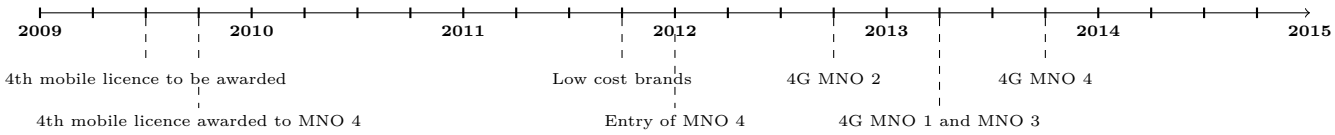
Mobile handsets have been, since the early stage of the industry, bundled with mobile tariffs involving a long-term commitment for the consumer, generally 24 months. This bundling strategy, which typically implies a *handset subsidy*, has been widely used by mobile operators to facilitate the take-up of mobile services (Barros (2006), Tallberg et al (2007)) but also as a competitive tool between firms (Choi et al, 2001).[1] SIM-only tariffs, i.e. mobile plans which do not involve any handset subsidies, were introduced by operators in response to competitive pressure from a new entrant (as in France and the UK), to cut down operational costs (as in Spain) or to serve niche segments such as commitment-averse or highly price sensitive consumers.[2] These tariffs also allow for a wider choice in terms of handsets. Indeed, consumers may be interested in low cost handset brands which were traditionally not included in the operators' catalogues or be willing to purchase a refurbished or second-hand phone. Moreover, handsets purchased directly from the manufacturers' shops such as Apple or Samsung stores come with additional services which can be highly valued by consumers. The emergence of SIM-only tariffs led to the development of alternative financing schemes for handset acquisition such as instalment plans, interest-free credit offered by operators and leasing deals. They also affected the replacement cycle of handsets. Indeed, while the handset replacement cycle of handset was following closely the commitment period associated with mobile tariffs in a large number of countries, it tended to lengthen since 2013, which coincides with the decline of mass handset subsidization.[3] Finally, regulation of mobile services also played a role in the changes observed in the market. Apart from bans on handset subsidies in Belgium (1991-2010), Finland (1996-2006) and Korea (2000-2006), policy-makers worked to reduce consumer lock-in in

[1] A good description of these practices across countries and over time is given in an OECD report (2013).

[2] See the report from the market research firm Wirelessprofit (2015)

[3] See "International Comparisons: the Handset Replacement Cycle" by Recon Analytics and http://reconanalytics.com/2015/02/2014-us-mobile-phone-sales-fall-by-15-and-handset-replacement-cycle-lengthens-to-historic-high/.

Figure 1: Timeline of entry and launch of 4G services



regulating early-contract fees or maximum contract length. Some national regulators also encouraged -or required- operators to unbundle services and handsets or to provide more transparent information in displaying separate payments for service and repayment of the handset (OECD, 2013).

Figure 2 gives an overview of the changes which occurred on the market I study, over the period 2009-2014. The major event is the entry of a new mobile operator in January 2012, what was expected since the firm was awarded the fourth 3G mobile license in 2010. In its application for the license, the entrant announced its will to exclusively offer sim-only tariffs at very attractive prices. This was anticipated by its competitors, which simultaneously launched their low-cost subsidiaries in October 2011. Even though a few sim-only tariffs were available before this date, it marked the beginning of their popularity. To finish, the period also witnesses the introduction of 4G services by the four operators.[4] I provide an additional description of the market in Appendix B.

4 Data

The data set consists of a sample of 10,740 new subscribers to a European operator, observed between April 2011 and December 2014. The original sample consists of a panel of 118,231 consumers with post-paid contracts from which 20,614 new subscribers are extracted. The data include information on the subscriber (age, gender, municipality of residence), the identifier of the tariff selected as well as the brand and model of handset used. Because this paper focuses on the first choice of these consumers, I keep only the first observation of each individuals so that the data set becomes a cross section. After restricting the sample to individuals aged between 18 and 75 years old, it consists in 19,701 observations. Also, I drop 29 subscribers for who I do not have information on the municipality of residence. Using the postcode of individuals, I complement the dataset with publicly-available information on median income, density of population and unemployment rate at the city-level. Next, I merge the tariff identifier available in the data with the list of tariffs characteristics provided by the operator. This catalogue includes information

[4] 4G licenses were attributed in December 2011 (for the 1800 Mhz spectrum band) and January 2012 (for the 2.6 Ghz spectrum band).

on voice and data allowance, as well as contract length and a dummy for the handset subsidy option. I have to drop some of them for which no information is available. After this operation, the sample consists of 18 709 individuals. Thereafter, I merge handsets observed in the data with a list of quarterly prices. About half were provided by the operator, other other half were collected via scraping[5] and some purchased from International Data Company. I was able to merge over 85% of the sample and keep 16,022 observations. To compute the exact amount of handset subsidy obtained by each consumer, I use an additional catalogue provided by the operator. The amount of subsidy may vary across models and over time, which is recorded in this catalog. Unsurprisingly, the more expensive the tariff, the bigger the subsidy.[6] I drop from the sample consumers who selected a tariff which include a handset subsidy but for which no list price is available and can therefore not compute a level of subsidy. I lose a significant number of individuals in the sample through this step but it is necessary to ensure that the prices introduced in the demand model are correct. The sample consists then of 10,766 observations. Finally, I merge the handsets selected with a list of characteristics scraped from GSMarena.com. It provides public information about the handset itself (dimensions, operating system, battery life, year of release, etc.). I have to drop 13 individuals for which handset characteristics are missing. The construction of the choice sets and further cleaning led to the loss of some additional individuals. The final sample consists in 10,740 individuals.[7]

Table A.1 provides an overview of the main variables included in the dataset. The average consumer is 42 years old. 51% of consumers are women. Monthly usage of voice is on average about 85 minutes and of data about 240 MB. The average price of a tariff is 35€ and the average list price of a handset about 364 €. A large majority of chosen tariffs are mobile plans with handset subsidy (84%), with an average amount of subsidy of 189€. The average commitment period is about 20.6 months, due to the high share of consumers choosing the standard 24 months contract. 22% of tariffs selected offer unlimited calls. The average data allowance is 910MB, ranging between 0 and 10 GB.

Table A.2 shows the evolution of tariffs selected by new consumers over time. The average price of a

[5]In particular, I collected the release price of handsets in this country from an independent website which aggregates characteristics and prices of handsets. I consider this price reasonable for the six months following the release date. After this period, I consider the price as missing.

[6]For example, in December 2014, the Apple's iPhone 4S was sold 492€ with a SIM-only contract, 370€ with a tariff above 20€ per month, 340€ with a tariff above 30€, 239€ with a tariff above 43€, 99€ with a tariff above 55€ and 49.9€ with a tariff above 90€.

[7]I have compared characteristics of consumers in final sample with consumers from the original sample, assumed unbiased, and found no significant difference. Nevertheless, despite particular attention paid to keep an unbiased sample, the original data itself consists of consumers from only one operator which offers high quality of services and potentially a larger share of premium tariffs with higher level of subsidy compared to its competitors. I comment on the representativeness of the data in Appendix B.

tariff declines by 10% between 2011 and 2014.[8]. The average list price of handsets declines with a similar magnitude, from 379€to 339€. The amount of subsidy granted to consumers with a handset subsidy tariff decreases almost 30%. This reduction may be surprising at first glance as one would expect subsidies to go up in a context of increasingly sophisticated handsets -and consequently increasingly expensive handsets-. Two opposite trends are reflected in this figure: on the one hand, in a context of increased competitive pressure, operators need to compete for premium consumers, namely those who are willing to pay for a high end tariff associated with high-end smartphone. This would steer for higher amount of subsidy. But, on the other hand, prices of tariff with handset subsidy also declined: since subsidies are computed on ranges of tariff prices, it mechanically declines too.[9]

A sharp take-up of SIM-only contracts is observed between 2011 and 2014. It goes from 3.5% in 2011 to 31.8% in 2014, peaking in 2013 with almost 35% of subscribers in the sample. Upfront price of handsets for these consumers decreased by almost 40% between 2011 and 2014, suggesting that they tend to choose cheaper devices when facing its full cost at purchase. Over the same time period, an increasing popularity of tariff with no commitment or short commitment period (12 months) is observed: the share of no-commitment contracts increases sixteen-fold, while short-term contracts more than doubled between 2011 and 2014. The increasing popularity of tariffs with no commitment is almost exclusively driven by the demand for tariffs offered by low-cost brands, introduced in October 2011.[10] Table A.2 also shows shares of observations by year. The significant drop observed between 2011 and 2014 is due to the extraction method used by the operator to construct the raw dataset. Indeed, individuals are selected among all customers of the firm based on their date of birth (day and month only). Over time, individuals churn but their phone numbers are potentially reallocated to other consumers so that new consumers are observed in the sample. The high share for 2012 corresponds to a period of net gain of consumers, mainly driven by the take-off of low-cost tariffs. Despite this surprising pattern, I believe there is no selection bias since the construction process of the raw data is random. Table A.3 presents shares of handset brands over the time. Four brands of handsets are the most widespread in our sample: Apple, Samsung, Nokia and BlackBerry. These shares are relatively stable in time, except for the brand Blackberry. Its share dropped

[8]National price index for mobile tariffs shows a decrease of 38% between April 2011 and December 2014

[9]In order to clarify how level of subsidies evolved, I have run several OLS regression with the amount of subsidy and included month dummies as regressors. Figure B.23 clearly highlights that the amount of subsidies has had the tendency to decline over the period, in particular since 2013.

[10]These brands offer a simplified range of SIM-only contracts with online subscription and online customer services. They represent 98% of free-of-commitment subscribers in the sample.

from 17.3% in 2011 to 1.3% in 2014. The share of other brands was multiplied by 6 between 2011 and 2014. Generally, the penetration of SIM-only tariffs enabled marginal brands -until then excluded from the mainstream retailing scheme- to gain market shares. Additional descriptive statistics are presented in the Appendix B.

Figure A.6 shows an histogram of the total cost of a mobile tariff and a handset over 24 months. The combinations with SIM-only tariffs cost on average 823€ over 24 months, ranging from 138€ to 2779€. The combinations which involve a handset subsidy cost tend to be more expensive, with an average cost of 1040€, ranging from 289€ to 4285€. Then, I attempt to measure the additional cost related to the choice of one option compared to the other (handset subsidy or SIM-only). To do so, I attempt to match each tariff with a 'twin' tariff which includes exactly the same allowances and options[11] but differs in the dimension of handset subsidy. This process is successful for 364 tariffs out of 518. Then, I merge the twin tariff in the original data and compute the total cost over 24 months with the tariff selected and its twin, based on the price of the handset that was truly selected by the consumer. This is possible for only 1,488 consumers out of 10,740.[12] I compute then the difference between the total cost with and without a handset subsidy and densities of these differences are show in Figure A.7. From this figure, which should be considered with caution because it relies only on a subsample of observations, one can see that SIM-only tariffs are not always the cheapest option. Indeed, the negative values here reveal that the SIM-only alternatives may be more expensive, up to 364€ over 24 months. Less surprisingly, we observe that the alternatives involving a subsidy can generate an additional cost for the subscriber up to 2815€ over 24 months. Overall, the differences computed on this subsample reveal that the average difference of total cost is about -74€, meaning that combinations which involve a handset subsidy have the tendency to be cheaper than their SIM-only counterparts. Although being counter-intuitive at first glance, this observation is in line with findings from the OECD report (2013).[13] This adds an interesting complexity in the analysis of choices in this framework as one type of tariff is not *per se* the best option for consumers.

[11] It also involves the same commitment period: 12 or 24 months.

[12] It is important to note that the matching process excludes the SIM-only contracts with no commitment period. Indeed, it is not possible to find a twin tariff for these tariffs as a handset subsidy is never granted by the operator if the consumer is not committed for at least 12 months.

[13] The report highlights that, even though tariffs with handsets generally represent a higher total cost for consumers, it also happens that the choice of tariffs with handset is "more economically rational than the independent acquisition of handsets". They argue that such situation can be observed in very competitive markets and that the coexistence of SIM-only tariffs and competitively-priced tariffs with handsets give the best options to consumers.

5 Econometric Model

The model developed in this paper relies on the assumption that individuals subscribe to a tariff and purchase a handset simultaneously. The price paid by the consumer for the handset equals the list price if the selected tariff is a SIM-only tariff. Alternatively, if the tariff is a traditional tariff with handset subsidy, the consumer pays the discounted price for the device.[14]

A discrete choice model framework is commonly used to analyze choices of telecommunication products. These models allow analyzing situations where an agent (a person, a firm) faces a choice or a series of choices over time, among a set of options. Each individual chooses with preferences depending on her characteristics (age, gender) and the product attributes (price, quality of services). A rational consumer chooses the alternative which maximizes her utility. Since the data set contains alternatives-specific variables, a conditional logit model is estimated. The first step of modeling is to define an exhaustive and mutually exclusive choice set. Consumers are assumed to choose a combination of tariff and handset among all the combinations available at current month. Each combination is constructed with a tariff from the list of available tariffs and a handset from the list of available handsets at current month.[15] Constructing an exhaustive choice set would be computationally impractical as each choice set would consist of about 40,000 alternatives[16] and the final data set of over 400 million of observations. The number of alternatives is limited by fixing a number of tariffs and handsets randomly chosen, which is a standard approach in the discrete choice literature (see Ben-Akiva et al (1987)). Robustness and implications of this assumption are discussed in the section 6.1

The majority of available tariffs since April 2011 are offered with several options in terms of commitment period and handset subsidy. Prices differ in each of these situations. The cheapest tariff is typically the tariff with no handset subsidy. These tariffs are offered free of commitment or with a 12-months

[14] I can observe which handset is used at subscription time thanks the device's International Mobile Equipment Identity (IMEI), registered in the operator's information system. I do not have information about when the handset was actually purchased and no information about the price actually paid by the consumer to acquire the handset. Nevertheless, for consumers who subscribed to a tariff with handset subsidy (84% of observations in our sample), timing and price are correct as, by design, the handset is obtained at the subscription, at a price which depends on the chosen tariff and advertised in the operator's catalog. For the SIM-only consumers, there is now way to be sure the handset was purchased at the time of subscription; consequently, I drop SIM-only consumers using handsets which are not available on the market anymore, obviously not purchased new at consumer's subscription.

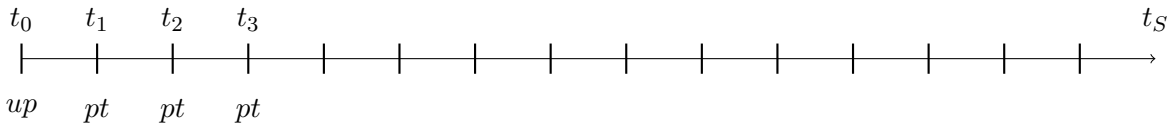
[15] Most of these handsets are listed in the operator's catalog. In this case, I use list price from this catalog. In reality, handsets may be purchased elsewhere but their prices are assumed equal to the operator's list price. For handsets outside of the operator's list, I use the official public price when released in the national market or data provided by IDC.

[16] Between 115 and 220 unique tariffs are observed, with an average of 164 tariffs per month. Between 203 and 355 unique handsets are observed, with an average of 242 handsets per month. If each handset is combined with each unique tariff, the choice set would consist in 164*242= 39,688 alternatives

commitment period, the latter being of about 5-10 euros cheaper compared to the no-commitment tariff. Tariffs with handset subsidy are associated with a commitment period of 12 or 24 months where the 24 months contracts are usually cheaper. In the choice set, in addition to the selected tariff, 10 randomly selected tariffs are added. Each tariff appears in all its available versions (handset subsidy, SIM-only, with or without commitment). Consequently, the number of unique tariffs in the choice set varies between 11 and 54. Similarly, 10 random handsets are added to the chosen handset. These handsets are combined with all tariffs selected as described previously. Handsets which are not listed in the carrier's catalog only appear in the choice set in combination with SIM-only tariffs. Each choice set consists in between 198 and 539 alternatives per individual.[17] This variation is related to the difference in number of options available for a same randomly selected tariff.

A consumer's decision affects her inter-temporal budget constraint in two ways: on the one hand, the consumer pays a capital cost at t_0, namely the upfront cost of the chosen handset up_{jk}, and on the other hand, the consumer pays the present discounted value of recurring charges for mobile services PT_j [18], from t_1 to t_S.

Figure 2: Time horizon of a consumer decision



A standard linear utility specification is used for individuals $i = 1, ..., N$ over different tariffs $j = 1, ..., J$ and handsets $k = 1, ..., K$. Utility depends on tariffs and handset characteristics and on the observable and unobservable individuals' characteristics. The indirect utility of individual i for tariff j and handset k is given by:

$$U_{ijk} = x'_{jk}\beta - \alpha(up_{jk} + \gamma PT_j) + \epsilon_{ijk} \tag{1}$$

where x'_{jk} is the vector which includes the following variables: a categorical variable for data allowance

[17] All combination of tariffs and handset in the choice set are theoretically possible: the carrier's catalog gives a level of subsidy, even for very cheap handset corresponding with expensive tariffs. Nevertheless, some of them may not be reasonably chosen such as a premium tariff with 10GB of data charged 120€per month coming with a low-end feature phone, which costs 30€ without subsidy. Moreover, some combination may be more advertised than others. Unfortunately, I do not have information on this.

[18] I assume here that the amount paid by the consumer every month, the bill, is equal to the tariff price.

(500 MB, 1, 2, 4, 6 or 10 GB); a dummy for unlimited calls; a continuous variable for call allowance for tariffs which do not include unlimited calls; a dummy variable for fixed broadband option; a categorical variable for tariff type (which combines handset subsidy option and commitment period); a dummy variable for each main brand of the sample; a dummy for smartphone; age of the handset model (in months); height, width, thickness (in mm), camera quality (in megapixels) and battery life (in hours) of the handset; a dummy variable for 4G handset when the tariff is compatible with 4G services. I interact the variables of interest (PT_j and up_{jk}) with quarters, age groups as well as various indicators related to the city of residence of the consumer: density of population, median annual income and unemployment rate. I also interact PT_j and up_{jk} with voice and data consumption. The dummy variable for unlimited calls is interacted with time. ϵ_{ijk} captures the unobserved variability generated, among others, from advertising, special discount or refund offers.

The upfront cost of handset is denoted up_{jk} and equals the full list price of the handset if a SIM-only tariff is chosen or the full price discounted by the subsidy granted by the operator if a classic tariff is chosen. PT_j is the present discounted value of expected future costs for mobile services. α is the marginal utility of income. γ is Allcott and Wozny (2014)'s attention weight which captures consumer's myopia. If γ equals zero, future costs do not have any weight in consumer's decision: she is fully myopic. If γ equals 1, consumer perfectly trade off the initial cost of the handset against present discounted value of future costs. If $\gamma > 1$, consumer overvalues future costs when making her decision. Net present value of future costs PT_j depends on tariff price pt_j, time horizon S and the market interest rate I denote r. I use the standard net present value formula to isolate the tariff price pt_j I observe in the data:

$$
\begin{aligned}
PT_j &= \frac{pt_j}{(1+r)^1} + \frac{pt_j}{(1+r)^2} + ... + \frac{pt_j}{(1+r)^S} && (2)\\
&= \sum_{s=1}^{S} (1+r)^{-s} pt_j && (3)\\
&= \frac{1}{r}[1-(1+r)^{-S}]pt_j && (4)\\
&= \rho pt_j && (5)
\end{aligned}
$$

I will refer to ρ as the capitalization coefficient. I now rewrite equation (1) in replacing PT_j by the

expression I developed above.

$$U_{ijk} = x'_{jk}\beta - \alpha(up_{jk} + \gamma\rho pt_j) + \epsilon_{ijk} \tag{6}$$

I can estimate the following model:

$$U_{ijk} = x'_{jk}\beta - \alpha_1(up_{jk}) + \alpha_2(pt_j) + \epsilon_{ijk} \tag{7}$$

with α_1 denoting the price coefficient for capital cost up_{jk} and α_2 the price coefficient for future expenses.

Parameters γ and ρ cannot be estimated separately from pt_j. I can isolate γ based on the equivalence of Equ. 6 and Equ. 7.

$$\alpha = \alpha_1 = \rho\gamma\alpha_2 \tag{8}$$

$$\gamma = \frac{\alpha_1}{\alpha_2} \times \frac{1}{\rho} \tag{9}$$

While α_1 and α_2 are estimated, ρ will be computed, based on assumptions on the market interest rate r and time horizon S. For r, I use the average consumption credit rate granted by banks, which range from 5 to 6.15% over the period, in the country concerned by the study. This value is very close to assumptions on r selected by Allcott and Wozny (2014) and Grigolon et al (2018) who both use $r = 6\%$ to compute the valuation of future payoffs in automobile market.[19] Alternative assumptions may be considered. Indeed r may take the value of the opportunity cost of funds, and, in this case, a national non-risky booklet interest rate may be considered. It varies from 1 to 2.25% . r may also takes value of consumption credit rate granted by specialized companies which offers revolving credit. This rate ranges between 12.8 and 15.2%. I compute myopia based on these two alternative assumptions and show its impact on γ is marginal and negligible in section 6.1. For S, which represents the time horizon consumers consider when trading-off present and future costs, I use the commitment period associated with the contract when it is different

[19] Allcott and Wozny (2014) and Grigolon et al (2018) use $r = 6\%$ as market interest rate to compute the valuation of future payoffs in automobile market. They use a weighted average of discount rate in the case of financed payment and cash payment. The value is calculated as follow:37% of the vehicles of the Allcott and Wozny's panel is financed at a real interest rate of 6.9% in average. 63% are purchased cash. In this case, the cost opportunity of funds is assumed to be equal to S&P 500 (Standard and Poors index) returns, i.e. at the time they did the study 5.8%. The weighted average is equal to 6.2. They use 6% for more convenience.

from zero. In the latter case, I assume S equals 19 months, which is the average time a non-committed consumer keeps her tariff in our data.[20] I compute myopia based on alternative assumptions on S and discuss its impact on γ in section 6.1. As r varies over time and S over consumers, depending on the length of chosen contract, ρ is time and individual specific.

Price endogeneity and unobserved product attributes

Price may be correlated to unobserved quality of handsets and tariffs and may be endogenous in the demand estimation. I use the control function approach as suggested by Petrin and Train (2010) which consists of a two-stage estimation. In the first stage, I regress the handset price on various products attributes, including some which are not introduced in the consumer utility function, in particular interactions of each attributes with a time trend. It is reasonable to assume that the attributes of handsets impact the manufacturing cost and consequently affect prices. Nevertheless, all these attribute may not be taken into account by consumers. Based on market research, only a few characteristics are considered: screen size, camera quality and phone reliability. Similarly, I regress the tariff price on various attributes. In particular, I interact the data allowance and the dummy for access to 4G services with the number of active 4G antennas deployed by this operator in each month.[21] These interactions capture the increasing cost borne by the operator that is likely unobserved by consumers. In a second step, I use the residuals from these regressions and introduce them as additional regressors in the main estimation. I show estimation results from first stage regressions in Tables A.7 and A.6.

Alternatively, I estimate a model with fixed effects for handsets (200 FE) as suggested in Berry, Levinson and Pakes (2004) and Goolsbee and Petrin (2004)). Due to the large number of products, I cannot interact all of them with time. Consequently, I interact brands or, alternatively, the 25 most popular models, with quarters. This way, I can account for the evolution of quality of brands over time. [To be computed and added to Appendix]

[20] Literature sets up this value as the durability of the good, its life time. Indeed, in the case of heating, cooling system or cars, goods may be sold at any moment; no contractual relationship bounds the consumer with the retailer who sold the good. In the framework of this study, the contrary is often the case. For instance, consumers willing to switch service supplier will be charged of a termination fee. Previously developed models in the field of energy took the average lifetime of the good as a reference for S. Ignoring the significant differences between configurations of bundles considered, one might take the average time period before handset is replaced. In this case, S would take a value close to 32 months which is the handset replacement cycle estimated by Recon Analytics in 2012. Nevertheless, this alternative does not make sense as the monthly recurring charge may vary over life time of the device.

[21] This data is publicly available and published by the National Frequency Agency. Figure B.18 shows the evolution of the number of active antennas for 2,3 and 4G technologies.

Choice Probabilities and Estimation

An individual i chooses a combination n of a tariff and a handset it this maximizes her utility among all the available alternatives in her choice set. A part of this utility (V_{in}) is observable to the researcher.

$$U_{in} = V_{in} + \epsilon_{in} \tag{10}$$

The probability that individual i chooses a combination n is given by:

$$P_{in} = Prob(V_{in} + \epsilon_{in}) > Prob(V_{im} + \epsilon_{im}) \quad \forall m \neq n \tag{11}$$

The closed form expression derived from the previous equation, which is the classic logit probability, is given by:

$$P_{in} = \frac{e^{V_{in}}}{\sum e^{V_{im}}} \tag{12}$$

under the assumption of the error term ϵ having a standard Type 1 extreme value distribution, with cumulative distribution function

$$F(\epsilon_{im})) = exp^{-exp^{-\epsilon_{im}}} \tag{13}$$

This translates into the log-likelihood function:

$$\mathcal{L}_i(\theta) = \sum_n z_{in} ln(P_{in}) \tag{14}$$

Given that our data set includes information on individuals (age, usages) as well as on alternatives (tariff prices, handset price and various quality measures), I use both regressors which are alternative-specific and others which are interactions between case-specific variables -age groups, time of subscription- and alternative-specific variables. Consequently, I estimate a conditional logit model using the *clogit* command in Stata. This model fits maximum likelihood for each group, i.e. at each consumer decision level.

Consumer Surplus

In the counterfactual simulations, I calculate consumer surplus for different scenarios. I follow the approach by Train (2009).

$$E(CS_i) = \frac{1}{\alpha} ln(\sum_{k=1}^{K} \sum_{j=1}^{J} e^{V_{ijk}}) + C \tag{15}$$

where $E(CS_i)$ denotes the expected consumer surplus, α the marginal utility of income, V_{ijk} is consumer i valuation of observable attributes of the alternative that combines a tariff i with a handset k and C is an unknown constant that represents the fact that absolute level of utility cannot be measured. Change in consumer surplus can be computed as follow:

$$\Delta E(CS_i) = \frac{1}{\alpha} [ln(\sum_{k=1}^{K^1} \sum_{j=1}^{J^1} e^{V^1_{ijk}}) - ln(\sum_{k=1}^{K^0} \sum_{j=1}^{J^0} e^{V^0_{ijk}})] \tag{16}$$

with superscripts referring to the period before (0) and after (1) the change.

6 Estimation Results

Demand Estimation and Computation of Myopia

In this section, I comment on the estimation results and then discuss computation of myopia. Table A.4 shows results from the main models. Model I shows the estimates obtained from a model which include no interaction and no residuals from first stage regressions. Model II includes the residuals from tariffs price and handset price regressions.[22] Model III includes interactions with time and Model IV includes interactions with time and consumers characteristics. I comment on the estimates obtained from Model IV as it is the most complete. I find highly significant and reasonable coefficients for all explanatory variables. In particular, I find, as expected, negative coefficients for tariff price (-0.10) and upfront cost of the handset (-0.01).

Categories of data allowance are positively valuated, with coefficients ranging from 1.31 for 500 MB to 5.17 for 10 GB, which converts into a willingness to pay[23] ranging from 26.2€ per GB for the smallest

[22] Estimates from the first stage regressions are shown in Table A.7 and A.6

[23] To compute the willingness to pay for tariff attributes, I divide the coefficient for the attribute by the tariff price coefficient. The willingness to pay obtained are valid for Q2 2011.

allowance to 5.17€ per GB in the biggest allowance. Tariffs are offered with an unlimited call option or a limited call allowance, which ranges from 30 minutes to 900 minutes. The unlimited option is highly valuated, with a willingness to pay of 14.2€. This valuation has a tendency to decline over time according to the interactions with quarters. The option for fixed broadband which provides access to the fixed internet and telephony at home (DSL or FTTH) is also positively valuated, with a willingness to pay of about 27.5€, consistent with the premium charged by the operator. I use as base outcome the most common tariff type, i.e. the 24-months contract with handset subsidy. Coefficients associated with other types of tariffs are negative and significant, suggesting that consumers value the possibility to bundle their mobile tariff and their handset in the framework of a long-term contract, once controlling for the financial aspects which are captured in the price coefficients.

Dummy variables for the main brands capture consumers' valuation for these brands compared to marginal ones, which constitute the base outcome. Apple's products are highly valued by consumers, with an average willingness to pay of 784€.[24] Blackberry is the second mostly valued brand with a willingness to pay of 368€. The coefficient for smartphone is also positive and significant, with an average willingness to pay of about 100€. Time since release which captures the age of the handset model is negative, meaning that on average, consumers prefer more recent models. On average, consumers' willingness to pay for a particular handset model would decrease by 1€ every month. Positive valuations for height and width show consumers' preference for large screens. The positive coefficient on thickness is surprising as one could expect that consumers would not appreciate thick handsets. Camera quality, which is measured in megapixels, and the battery life, measured by the stand-by time are both positively valued. Finally, the estimates suggest that the 4G compatibility, which captures consumers' valuation for this recent technological advance, is not significantly affecting utility.[25] To account for the endogeneity of tariff and handset price, I use the control function approach which involves a two-stage estimation. The coefficients estimated for residuals from the first-stage regressions are positive and significant (0.01 for handset price and 0.02 for tariff price). As suggested by the changes observed between Model I and Model II, the inclusion of residuals increases the price coefficient in absolute terms. Thus, as the theory suggests, without correcting for endogeneity the price coefficient is biased towards zero.

[24] To compute the willingness to pay for handset attributes, I divide the coefficient for the attribute by the upfront price coefficient. The willingness to pay obtained are valid for Q2 2011.

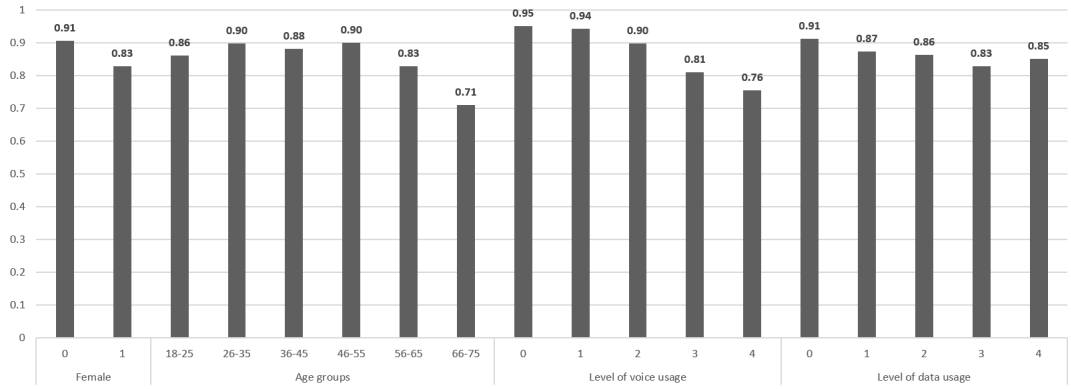
[25] The correlation that exists between handset characteristics probably explains the positive coefficient on thickness and the non-significance of 4G compatibility.

Figure A.8 shows how price coefficients evolve over time. All the interactions of tariff price with quarters are highly significant and suggest an increase in absolute term over time. On the contrary, interactions of the upfront cost with time are rarely significant and, when they are, their magnitude is relatively small. The model also allows the price coefficients to vary across consumers. The interactions with age groups, gender, density of the city and usages of voice and data are significant, while interactions with median income and unemployment rate of the city are not. For example, female consumers are more price sensitive in general, both regarding the present and future expenses. Estimates also highlight that individuals living in more dense areas are less price sensitive. Unsurprisingly, the intensity of usages are associated with lower price sensitivity. Fig.A.9 shows that price sensitivity to the upfront cost of the handset is heterogeneous across age groups, starting from -0.08 for consumers aged between 18 and 35 years old to -0.014 for consumers aged between 66 to 75 years old. This suggests that the willingness to spend for the handset decreases with the age of individuals, with those belonging to the youngest age group being almost half as price sensitive than those belonging to the oldest group. The heterogeneity in price sensitivity regarding the tariff price is of smaller magnitude, with the least price sensitive being the age group 25-26, with a price coefficient of -0.125. The youngest consumers are more sensitive to tariff price compared to this group (-0.136), but less than the other age groups with a price coefficient that ranges between -0.146 and -0.156.

Based on the estimates from Model IV, I compute two price coefficients for each individual: one for the tariff price (which is discounted in the utility function) and one for the upfront cost of the handset (which is not discounted and gives the marginal utility of income). These price coefficients vary with the quarter of initial subscription, the age and gender of the individual, density of the city of residence and usages. Then, I compute a capitalization coefficient ρ that varies over time and across individuals. To do so, I use the average national credit rate at the quarter of subscription to define the market interest rate r and the commitment period of the selected tariff to define the time horizon of choice S. For individuals without commitment, I define 19 months as the time horizon, as discussed in the econometric model description. Finally, I compute the attention weight, γ.[26] Average values for α_1 and α_2, ρ, r, S and γ per quarter are shown on Table A.5.

[26]Because some variables interacted with prices take extreme values and also because the computation of individual price coefficients involves a large number of them, the values I obtain may be unrealistic. Thus, I exclude from the subsequent analysis the consumers with extremely high or extremely low price coefficients, what represents 52 individuals out of the sample of 10 740 I use for the estimation. The values I obtain are very close to those obtained with Model III which include the 10,740 consumers from our sample.

Figure 3: Heterogeneity of attention weight across consumers



Average computed on 512 individuals observed in Q4 2014

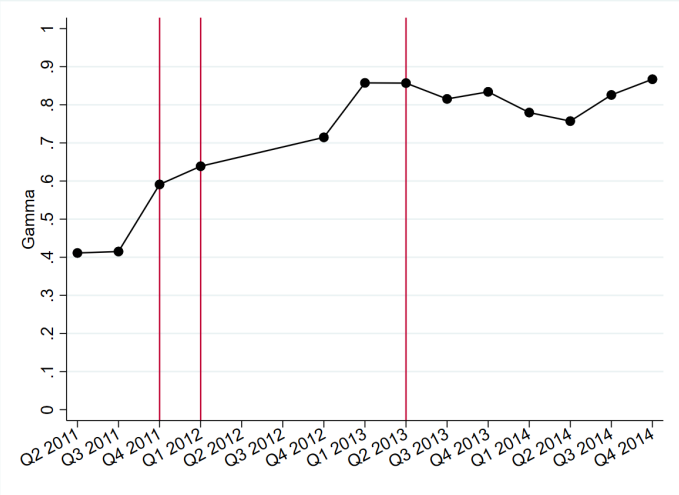
Figure 3 shows how γ varies across socio-demographics and level of usages, given that the quarter of subscription is Q4 2014. First, we see that the attention weight is, on average higher for male compared to female subscribers. Second, we observe that γ tends to decrease with age of individuals and their level of usages. This suggests that individuals who consume mobile services intensively are more myopic than others, this being driven by a lower sensitivity to the tariff price.

Figure 4 presents the main result of this paper and highlights the evolution of γ over time.[27] At the beginning of the time period studied, the attention weight is stable, with a value of 0.4 which indicates a significant level of future discounting. It sharply increases to 0.6 during the last quarter of 2011, what coincides with the introduction of low-cost tariffs. Subsequent to this, the attention weight keeps on increasing, to reach its peak in the first quarter of 2013, with a value of 0.86, that suggest a modest future discounting. It appears to decline after the launch of 4G services by the operator, but in a moderate magnitude (from 0.86 to 0.77) to increase again during the two last quarters of 2014. Even though some minor variation is still observed, it appears that the attention weight is stabilizing between 0.8 and 0.9 from the first quarter of 2013. These values can be compared with the attention weight estimated for other markets. For example, Allcott and Wozny (2014) find an average attention weight of 0.8 for consumers choosing cards in U.S and Grigolon et al (2014) an average of 0.88 for consumers choosing cars in Europe. This would indicate that the results I obtain here are reasonable and in line with the literature.

The significant evolution of attention weight I document can be analyzed in the light of the changes

[27] I do not show on this figure the results for the second and third quarter of 2012 because the number of observations for these quarters is not sufficient to be reliable. Indeed, I observe 63 and 16 individuals for each quarter respectively.

Figure 4: Estimation for γ



Average computed on 10,609 individuals.
Quarter 2 and 3 of 2012 are excluded because of their very small number of observations.

which occurred in the market over the period. First, the introduction of the low-cost brand in October 2011 coincides with the beginning of availability of SIM-only tariffs. Second, the entry of a new operator in January 2012 initiates a period of increased competitive pressure. Third, the launch of 4G services in April 2013 marks the beginning of a new technological era where consumers have to upgrade their devices to benefit from it. Disentangling the impact of each of these events is challenging, in particular because the first two are intrinsically correlated. One possible quantitative approach is to regress the value of attention weight γ with indicators which capture the evolution of the market. First, I calculate the share of SIM-only users, which I expect to be a major driver of the myopia's decline. Second, I collect information on the national index for mobile post-paid services, published by the national regulator. Third, I compute the a concentration measure, the Herfindahl-Hirschman Index, based quarterly market shares of operators published by the national regulator and Yankee Group. I show the evolution of these indicators in Figures A.11, A.12 and A.13. These three variables being highly correlated, I introduce them in three separate regressions. I add to the regressors the set of consumer characteristics I have used in the demand estimation (age, gender, population density, median income, unemployment rate and usage intensity). Additionally, I introduce a dummy variable that captures the availability of 4G services, the average price of handsets selected by consumers and the share of iPhone users in the sample, for each quarter.

Table 1: Regression of γ

	Model 1		Model 2		Model 3	
Consumer Characteristics						
Age group: 18-25	0.04***	(0.01)	0.03**	(0.01)	0.03**	(0.01)
Age group: 26-35	-0.02	(0.01)	-0.02*	(0.01)	-0.02	(0.01)
Age group: 36-45	-0.03***	(0.01)	-0.03***	(0.01)	-0.03***	(0.01)
Age group: 46-55	0.00	(.)	0.00	(.)	0.00	(.)
Age group: 56-65	-0.09***	(0.01)	-0.09***	(0.01)	-0.09***	(0.01)
Age group: 66-75	-0.18***	(0.02)	-0.17***	(0.02)	-0.17***	(0.02)
Female	-0.02*	(0.01)	-0.02*	(0.01)	-0.02*	(0.01)
Population density of the city of residence	0.00***	(0.00)	0.00***	(0.00)	0.00***	(0.00)
Average income in the city of residence	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
Unemployment rate	-0.13*	(0.05)	-0.10	(0.06)	-0.13*	(0.06)
Voice consumption in minutes	-0.00***	(0.00)	-0.00***	(0.00)	-0.00***	(0.00)
Data consumption in Gb	-0.01*	(0.00)	-0.01*	(0.00)	-0.01**	(0.00)
Market-level						
Availability 4G	-0.02	(0.04)	-0.32*	(0.13)	-0.14*	(0.06)
Average list price of handsets	-0.00*	(0.00)	-0.00	(0.00)	-0.00	(0.00)
Share of Apple users	1.30***	(0.31)	1.29	(0.67)	0.98*	(0.44)
Share of SIM-only subscribers	0.01***	(0.00)				
Post-Paid Services Price Index			-0.01**	(0.00)		
HHI					-0.00***	(0.00)
Constant	0.68**	(0.17)	2.21***	(0.50)	2.48***	(0.36)
Observations	10688		10688		10688	
R2	0.54		0.47		0.51	

Standard errors in parentheses

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

Results from these OLS regressions are shown in Table 1. Estimates from Model 1 confirm the intuition that the average value of attention weight is driven up by the share of SIM-only subscribers. Model 2 suggests that the level of prices at the national level is negatively correlated with γ, meaning that a decline in prices such as the one this market witnesses between 2011 and 2014 actually impacted positively the attention weight. Nevertheless, one can suspect the national price index to be heavily related to the intensity of competition on the market. This is confirmed by Model 3 which shows that the HHI, which measure the concentration of the market, is negatively and significantly correlated with γ. Estimates from Model 2 and Model 3 suggest that the availability of 4G would have negatively impacted γ, suggesting that operators may have changed their pricing strategies after the introduction of the technology. It can also be related to the average price of 4G handsets, although another variable in the model should have captured this effect. In Model 1, the average price of handset seems to have a negative impact on the attention weight, suggesting that consumers would be more myopic when choosing expensive phones. To finish, I find that the share of subscribers who select an iPhone drives the attention weight up. Although no determinant can be clearly isolated, the decline of consumer myopia appears to be very likely related

to changes in the market structure.

The channel through which the market structure impacted consumer choices and, ultimately myopia, is twofold. First, the increased competitive pressure led to a significant decline of tariffs prices, as shown in Figure A.14. Second, the strategy of the entrant, based on the supply of low-cost SIM-only tariffs, increased consumer's attention regarding the total cost incurred by the classic tariffs with subsidy. This was reinforced by the lawsuit initiated by the firm against one of its competitor and which pointed out the handset subsidization practice as detrimental for competition and consumers.[28] This dispute was only concluded in March 2018 with a decision of the court in favor of the entrant. In the data, this is translated by the growing number of SIM-only tariffs subscribers.

Interestingly, the events observed on this market seem to illustrate the setting developed in Gabaix and Laibson (2006). Indeed, in their paper, firms are competing in a market where a share of the consumers are myopic - the *naïve*, while others are not - the *sophisticated*. These firms are selling products which come with an add-on and have to decide if they shroud it or not -it is assumed to be high-priced-. One firm may decide to behave aggressively and inform the consumers about the shrouding behavior of its competitors. In this case, it renounces to the profit generated by the add-on in the hope of gaining market shares. Nevertheless this behavior is risky and a 'curse of debiasing' may arise if substitutes for the add-on exist. Indeed, sophisticated consumers may stay loyal to the incumbent firm and just avoid the add-on. In my setting, the entrant can be considered as the aggressive firm which intend to debias the myopic consumers. To do so, it draws consumers' attention on the extra cost incurred by the long-term contracts involving a handset subsidy. While some consumers switch to the entrant, some others stick to the incumbent firm which react in offering better deals, what would be captured in this paper in the increasing attention weight.

An alternative interpretation of my results is that consumers are budget-constrained and that the cohorts I observe at different points in time differ in this regard. While I cannot exclude that some individuals selected a tariff with a low upfront cost not because of myopia but because of their budget-constraint, I do not believe that they represent a large share of them. I also find not differences in socio-demographics across the different cohorts I consider, as shown in Table B.1. To finish, I have interacted the price coefficients with several variables that could have captured such effect (such as the

[28]The new entrant sued the second largest operator for unfair competition related to its handset subsidization practice. In a public announcement, the CEO of the firm declared that handset subsidies were 'disguised' consumption credit with extremely high rates, which can reach 300 or 400%.

median income and unemployment rate of the city), but they turned out to be insignificant in my demand estimation.

Counterfactual Simulations

I use the model to simulate consumer welfare for a series of scenarios. I follow the standard approach described in Train (2009) and detailed in section 5. First, I simulate a situation where all tariffs are available and only the sim-only segment witnesses a price decline. I adjust prices of tariffs with handsets to their pre-entry level. To do so, I estimate two quality-adjusted price indexes, one for sim-only tariffs and one for tariffs with handsets. These indexes are shown on Figure A.14. This scenario would correspond to the situation where the increased competitive pressure that follows the entry only affects the sim-only segment while the established operators maintain their prices on the classic tariffs segment. Second, I simulate a situation where all tariffs are available but their prices are at the pre-entry level. I adjust the prices using the price index from the first stage regressions.[29] This scenario would correspond to a situation where the new MNO would introduce the sim-only tariffs but without being aggressive in its pricing strategy. Third, I simulate a situation in which sim-only tariffs would not be available, with prices of tariffs and handsets remaining unchanged. This scenario would correspond to a situation of increased competition on the classic tariffs segment, for example related to the competition for 4G. Finally, I simulate a similar situation where the sim-only tariffs are not available and the prices are at the pre-entry level. Table 2 shows the results from the counterfactuals. The absence of the price decline observed on the segment of tariffs with handset would lead to a loss of 5.2€ in consumer welfare. Absent the price decline on all tariffs, this loss would be of 8.7€. More interestingly, without sim-only tariffs, consumer surplus would decline of 23.3€. If this unavailability of sim-only tariffs is combined with prices not declining in 2012, the loss in consumer surplus would be of 31.8€. These counterfactuals highlight that, even though the price decline observed in this market contributed to the gains in consumer welfare estimated, the introduction of sim-only is the major driving force behind it.

[29] The underlying assumption here is that the upfront cost of the handsets remains unchanged. Nevertheless, one could argue that this is not fully correct as subsidies are computed on ranges of tariff prices.

Table 2: Results from the counterfactual analysis

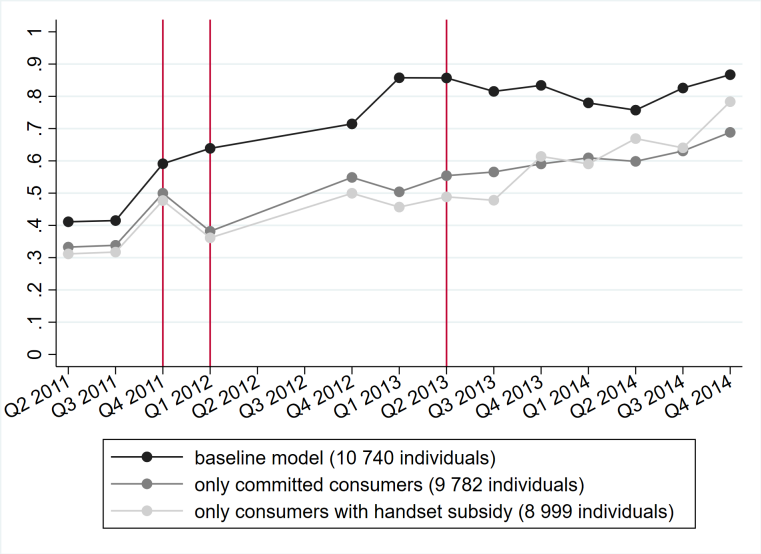
	Δ CS
Scenario 1: SIM-only (true prices) + tariffs with handsets (prices april 2011)	-5.22
Scenario 2: SIM-only (prices april 2011) + tariffs with handsets (prices april 2011)	-8.70
Scenario 3: Only tariffs with handset (true prices)	-23.28
Scenario 4: Only tariffs with handset (prices april 2011)	-31.77

Simulation computed on a sample of 10,609 individuals.
Quarter 2 and 3 of 2012 are excluded because of their very small number of observations.

6.1 Robustness Checks

Computation of consumer's myopia in this paper relies on several assumptions I attempt to soften in estimating alternative models or computing results with alternative assumptions. First, I use the estimates from the baseline model to compute alternative measures of myopia in changing parameters of the capitalization coefficient ρ, namely the market interest rate r and the time horizon of the trade-off, S. In the baseline computation, r equals the average rate of consumption credit granted by banks and is about 6% per year. I compute γ based on a lower rate $\approx 1.7\%$ which is the interest rate of a non-risky booklet regulated by the State, representing the opportunity cost of capital. I also compute γ based on a higher market rate $\approx 14.3\%$ which corresponds to the national average revolving credit rate. Fig. A.15 shows that alternative assumptions for r only slightly affect average values of gamma which now range from below 0.4 with the low r to 0.45 with high r in 2011 and from 0.84 to 0.91 in 2014. I also test how changes on time horizon S affect the results. In the baseline computation, it may take three different values, varying across individuals: S=19 for non-committed subscribers, S=12 for 12-month contract subscribers and S=24 for 24-months contract subscribers. In alternative calculations, I impose S to be equal to 12, 24 and 32 months for all consumers. Fig. A.16 allows to compare the evolution of γ under these different assumptions. First, we observe that the time horizon taken into account by individuals is, unsurprisingly, affecting the attention weight in a significant way. Under the assumption that $S = 12$, we see that it ranges from 0.75 in the beginning of 2011 to about 1.3 after 2013, meaning that consumers would actually overvalue the future when trading-off present and future expenses. This scenario is not plausible as it would imply that all individuals from the sample expect to stick to their contract for 12 months and then switch or churn. However, a large majority of consumers are committed 24 months to

Figure 5: Average γ computed with estimates from alternative models



Quarter 2 and 3 of 2012 are excluded because of their very small number of observations.

the operator and cannot easily switch tariff.[30] The results from the alternative computation considering all consumers are trading-off for 24 months is really close from our baseline estimation, in particular for 2011 because the majority of consumers were actually committed 24 months at this time. In this case, the attention weight would range between 0.4 and 0.7. The last assumption for S, 32 months, would correspond to the scenario where the time horizon of the trade-off corresponds to the expected life of the handset. In this case, values for γ are significantly reduced, from 0.3 in 2011 to 0.55 by the end of 2014.

Second, because the measure of myopia is significantly correlated with the share of SIM-only subscribers (correlation = 0.62), one could wonder if the decline I document is fully driven by the increasing number of consumers choosing SIM-only in the data. To shed light on this question, I estimate two alternative models on sub-samples of individuals. First, I restrict the sample to consumers who selected a contract involving a commitment commitment period of 12 or 24 months, which can be either a SIM-only or a classic tariff with handset subsidy. They represent 9,782 individuals out of the 10 740 individuals in the original sample. Computation of myopia for this sub-sample is of interest because it allows to consider a well-defined time horizon for the trade-off, and to slacken the assumption of S being 19 months for a part of consumers for which this information is not available, namely the non-committed consumers.

[30]The fee paid by consumers who churn before the end of their contract is regulated by a national law since 2008. Switching may be possible before the end of the commitment period but the "rules" are decided by each operator and are not transparent for the consumers.

Second, I restrict the sample to consumers who choose a contract with a handset subsidy. The sub-sample consists of 8 999 individuals who selected a handset in the operator's catalogue and are committed for 12 or 24 months. This analysis also allows to slacken the S-assumption for not-committed consumers but, more interestingly, to see how myopia of these consumers specifically evolved. Values for γ based on these alternative estimations are shown in Figure 5. First, one can observe is that the level of attention weight, is, in average, lower for consumer who are committed or who select a tariff with handset subsidy. Second, a significant increase of γ over time is also observed in the two alternative cases. While the results obtained on the main sample suggest that the attention weight was multiplied by two between 2011 and 2014, it was multiplied by 2.2 for consumers who selected a contract with commitment and by 2.6 for consumers who selected a tariff with handset subsidy. This suggests that the myopia decline I document in the main specification is not solely driven by the increasing number of SIM-only subscribers in the sample, as it is still observed once they are excluded from the analysis. It also supports the hypothesis of the market changes being responsible for the myopia decline of all consumers, with a particularly significant impact for consumers who selected tariffs associated with handset subsidies.

Additionally, I run separate regressions for each year. Results are shown in Figure A.17 and support the robustness of my results. I also run several models which include tariffs and handsets fixed effects and present the results in Table A.9. Comparing estimates from Model IV and model VIII, we see that the introduction of handset models fixed effects only marginally affect the price coefficients. In contrast, the introduction of tariffs fixed effects decreases significantly the tariff price coefficient in absolute terms (from -0.10 to -0.04). Introducing additional interactions of brands or models with quarters does not affect the price coefficients. Finally, I estimate the model using alternative choice sets. More precisely, I increase the number of random tariffs and random handsets which constitute each individual choice set. In order to keep the size of the data set reasonable, I have to downsize the sample proportionally to the growing size of choice sets. I also estimate a model with random coefficients on tariff price and upfront cost of the handset which allow to draw very similar conclusions.

7 Conclusion

In this paper, I studied the intertemporal decision of 10,740 consumers choosing a mobile tariff and a handset between 2011 and 2014. I developed various discrete choice models and used the estimates to

compute an average measure of *attention weight* which captures the degree to which consumers are myopic or forward looking when making their decision. Estimation results suggest that consumers are myopic, but heterogeneously so. For example, I find that gender, age, usage intensity and density of the city of residence have an influence on consumer myopia, while the median income and the unemployment rate do not. Estimation results also suggest that the level of myopia declined significantly over time, along with the adoption of SIM-only tariffs. Even though the natural interpretation of this result is that the increasing number of SIM-only subscribers mechanically drove the level of myopia down, I show that the decline is related to changes in prices after the entry of a new MNO. I argue that all consumers benefited from this entry, those who selected SIM-only tariffs as well as consumers who selected tariffs with handsets. I finally conduct several counterfactuals to comment on the welfare gains of changes observed in this market. For example, I show that the introduction of SIM-only tariffs increased the average consumer's surplus by over 23€. Exploring the existence of time preference is crucial to understand how consumer make consumption choices, but also to help decision-makers design policies which ensure consumer protection.

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Appendix A

Descriptive Statistics

Table A.1: Summary Statistics

Variable	Mean	Std. Dev.	Min.	Max.
Age of the customer	41.87	13.92	18	75
Female	0.51	0.5	0	1
Tariff price in €	34.59	20.64	4.9	169
List price of the handset in €	363.8	175.98	16	799.9
Option handset subsidy (0/1)	0.84	0.37	0	1
Amount of subsidy in €	188.44	124.01	0	588
Commitment period	20.55	7.43	0	24
Unlimited call (0/1)	0.22	0.42	0	1
Call allowance (in minutes)	80.05	70.76	0	360
Data Allowance (in GB)	0.91	1.36	0	10
Fixed broadband (0/1)	0.15	0.35	0	1
iPhone user (0/1)	0.25	0.43	0	1
Voice consumption (in minutes)	85.09	258.11	0	11691.07
Data consumption (in GB)	0.24	0.85	0	19.81
N		10740		

Table A.2: Statistics per year

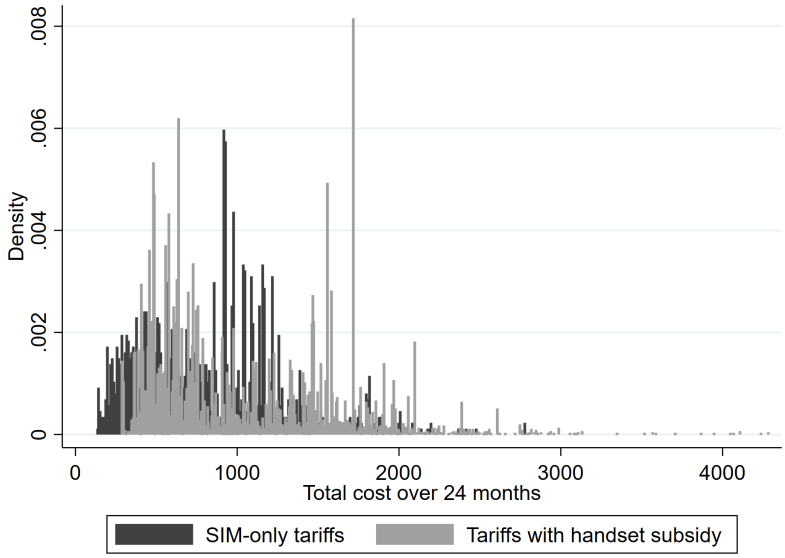
	2011	2012	2013	2014
Tariff price in €	37.1	31.8	29.8	33.8
List price of handset in €	378.6	362.1	335.0	339.2
Indiv. with handset subsidy	376.6	355.3	349.1	372.3
Indiv. with no handset subsidy	434.0	381.5	308.3	268.1
Amount of subsidy (if >0) in €	245.3	236.6	196.0	175.3
Upfront cost of handset in €	141.9	186.3	210.0	248.1
Indiv. with handset subsidy	131.3	119.0	158.0	238.7
Indiv. with no handset subsidy	434.0	381.5	308.3	268.1
Share of sim-only contracts (%)	3.5	25.6	34.6	31.8
Contract length				
No commitment	0.9	18.8	18.8	15.0
12 months	7.4	7.8	20.8	19.2
24 months	91.7	73.4	60.5	65.8
Share of observations	52.0	20.4	13.1	14.6
Individuals	5579	2189	1407	1565

Table A.3: Handset brands

	2011	2012	2013	2014
Apple	24.8	21.2	27.9	30.7
Blackberry	17.3	15.2	5.9	1.3
HTC	1.4	0.9	2.4	1.3
LG	3.2	2.2	3.8	3.5
Motorola	1.0	0.6	0.3	0.3
Nokia	16.0	17.7	15.9	11.3
Samsung	32.3	38.4	28.9	29.6
Sony	0.0	0.1	7.0	13.4
Sony-Ericsson	2.6	2.2	1.9	0.1
Others	1.4	1.6	6.1	8.8
	100.0	100.0	100.0	100.0

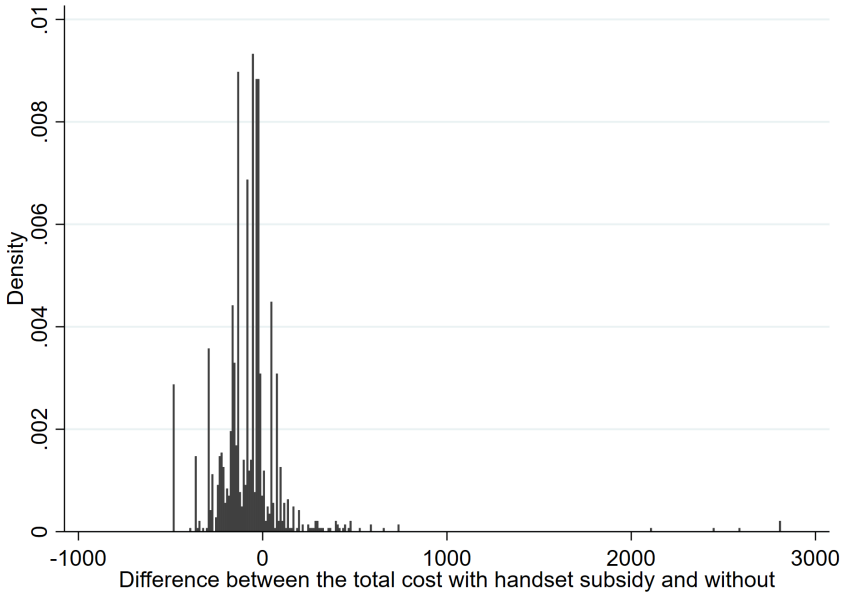
Total cost of the bundle over 24 months

Figure A.6: Histogram of the total cost of mobile tariff and handset, over 24 months



Computed for 10,740 individuals

Figure A.7: Differences in the total cost over 24 months



Computed for 1,488 individuals

Estimation Results

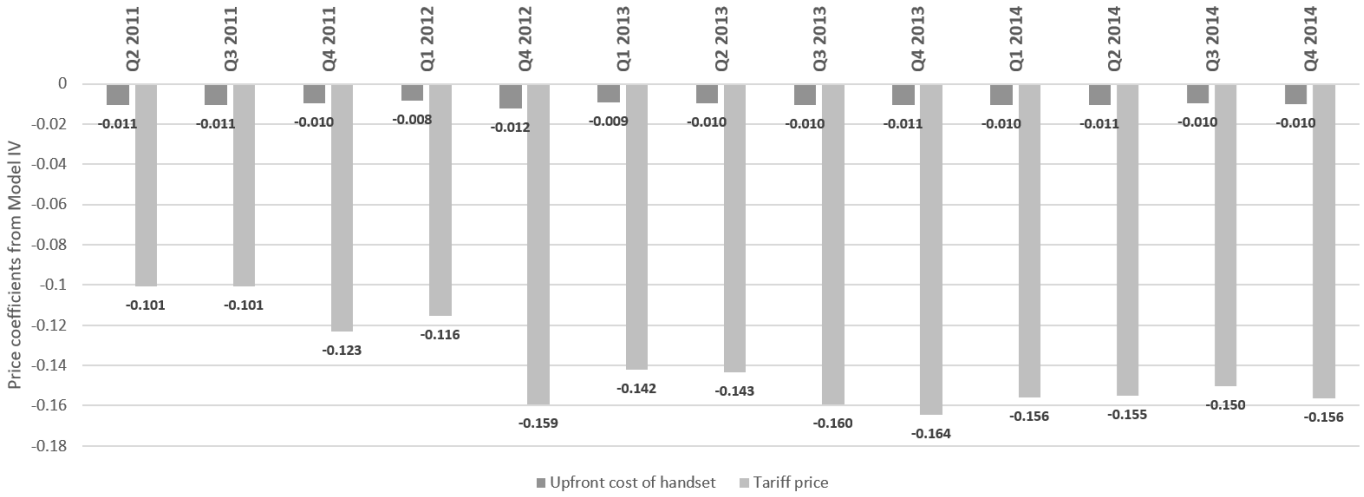
Table A.4: Main estimation results

	Model I		Model II		Model III		Model IV	
Prices								
Tariff price	-0.09***	(0.00)	-0.10***	(0.00)	-0.08***	(0.00)	-0.10***	(0.00)
Upfront cost of the handset	-0.01***	(0.00)	-0.01***	(0.00)	-0.01***	(0.00)	-0.01***	(0.00)
Tariff characteristics								
500 MB=1	1.25***	(0.03)	1.30***	(0.03)	1.29***	(0.03)	1.31***	(0.03)
1 GB=1	2.03***	(0.05)	2.16***	(0.05)	1.92***	(0.05)	1.96***	(0.05)
2 GB=1	2.21***	(0.05)	2.48***	(0.05)	2.54***	(0.05)	2.58***	(0.05)
4 GB=1	2.10***	(0.12)	2.28***	(0.12)	2.73***	(0.13)	2.81***	(0.13)
6 GB=1	3.74***	(0.10)	4.17***	(0.11)	5.13***	(0.13)	5.21***	(0.13)
10 GB=1	2.60*	(1.01)	3.63***	(1.02)	6.42***	(1.05)	5.17***	(1.15)
Unlimited calls=1	1.80***	(0.17)	1.87***	(0.17)	1.61***	(0.15)	1.42***	(0.15)
Call allowance (in minutes)	0.00***	(0.00)	0.00***	(0.00)	0.00***	(0.00)	0.00***	(0.00)
Fixed broadband=1	2.16***	(0.05)	2.40***	(0.06)	2.71***	(0.06)	2.75***	(0.06)
Handset sub, 24 months contract	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Handset sub, 12 months contract	-2.37***	(0.04)	-2.37***	(0.04)	-2.33***	(0.04)	-2.32***	(0.04)
Sim only, 12 months contract	-1.46***	(0.05)	-1.36***	(0.05)	-1.55***	(0.05)	-1.58***	(0.05)
Sim-only, 24 months contracts	-1.74***	(0.07)	-1.63***	(0.07)	-1.74***	(0.07)	-1.73***	(0.07)
Sim-only, no contract	-0.21***	(0.04)	-0.12**	(0.04)	-0.33***	(0.04)	-0.34***	(0.05)
Handset characteristics								
Dummy Apple	7.50***	(0.08)	7.95***	(0.09)	7.92***	(0.09)	7.84***	(0.09)
Dummy Blackberry	3.47***	(0.07)	3.87***	(0.07)	3.84***	(0.07)	3.86***	(0.07)
Dummy HTC	0.71***	(0.10)	0.93***	(0.10)	0.91***	(0.11)	0.93***	(0.11)
Dummy LG	0.63***	(0.08)	0.73***	(0.08)	0.71***	(0.08)	0.71***	(0.08)
Dummy Motorola	0.63***	(0.13)	0.70***	(0.13)	0.68***	(0.13)	0.71***	(0.13)
Dummy Nokia	2.03***	(0.07)	2.09***	(0.07)	2.07***	(0.07)	2.08***	(0.07)
Dummy Samsung	2.82***	(0.06)	2.90***	(0.06)	2.88***	(0.06)	2.89***	(0.06)
Dummy Sony	2.27***	(0.09)	2.33***	(0.09)	2.32***	(0.09)	2.33***	(0.09)
Dummy Sony Ericsson	0.78***	(0.09)	0.96***	(0.10)	0.95***	(0.10)	0.97***	(0.10)
Dummy smartphone	0.96***	(0.04)	1.02***	(0.04)	1.01***	(0.04)	1.03***	(0.04)
Time since handset release	0.01***	(0.00)	-0.01***	(0.00)	-0.01***	(0.00)	-0.01***	(0.00)
Heigth	0.02***	(0.00)	0.02***	(0.00)	0.02***	(0.00)	0.03***	(0.00)
Width	0.02***	(0.00)	0.01***	(0.00)	0.01***	(0.00)	0.01***	(0.00)
Thickness	0.02*	(0.01)	0.05***	(0.01)	0.05***	(0.01)	0.05***	(0.01)
Camera Quality	0.08***	(0.01)	0.09***	(0.01)	0.09***	(0.01)	0.09***	(0.01)
Standby autonomy in hour	0.00***	(0.00)	0.00***	(0.00)	0.00***	(0.00)	0.00***	(0.00)
4G access if handset is 4G compatible	-1.43	(1.01)	-1.60	(1.01)	-1.54	(1.01)	-1.54	(1.01)
Residuals from first stage regressions								
Residuals from handset price regression			0.01***	(0.00)	0.01***	(0.00)	0.01***	(0.00)
Residuals from tariff price regression			0.01***	(0.00)	0.02***	(0.00)	0.02***	(0.00)
Interactions with time								
Unlimited calls*Quarters					Yes		Yes	
Tariff price*Quarters					Yes		Yes	
Upfront*Quarters					Yes		Yes	
Interactions with consumer characteristics							Yes	
Tariff price*Age groups							Yes	
Upfront*Age groups							Yes	
Tariff price*Female							-0.01***	(0.00)
Upfront cost of handset*Female							-0.00***	(0.00)
Tariff price*Pop.density							0.00***	(0.00)
Upfront cost of handset*Pop. density							0.00***	(0.00)
Tariff price*Median income							-0.00	(0.00)
Upfront cost of handset*Median income							-0.00	(0.00)
Tariff price*Unemployment rate							0.03	(0.02)
Upfront cost of handset*Unemployment rate							0.00	(0.00)
Tariff price*Voice consumption							0.00***	(0.00)
Upfront cost of handset*Voice consumption							0.00	(0.00)
Tariff price*Data consumption							0.01***	(0.00)
Upfront cost of handset*Data consumption							0.00***	(0.00)
Observations	3,801,494		3,801,494		3,801,494		3,801,494	
Unique consumers	10 740		10 740		10 740		10 740	
Log Likelihood	-42,968.82		-42,432.20		-41,870.38		-41,185.32	

Standard errors in parentheses

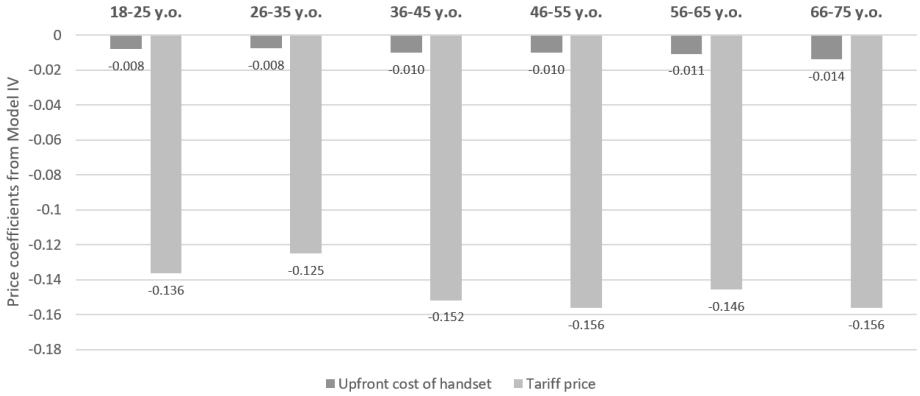
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure A.8: Evolution of price coefficients over time (Age group = 46-55)



Average computed on 2,602 individuals aged between 46 and 55.
Quarter 2 and 3 of 2012 are excluded because of their very small number of observations.

Figure A.9: Evolution of price coefficients across age groups (Quarter 4 2014)



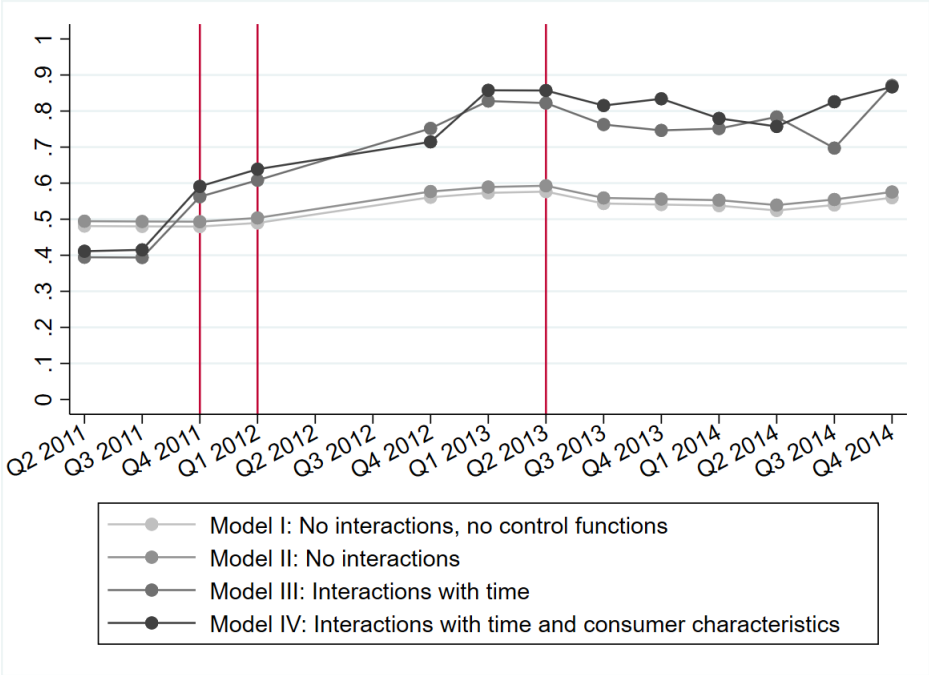
Average computed on 512 individuals observed in Q4 2014.

Table A.5: Average values per quarter

	α_1	α_2	$\rho\gamma$	r	S	ρ	γ
Q2 2011	-0.011	-0.085	8.14	6.28	23.07	21.77	0.39
Q3 2011	-0.011	-0.086	8.20	6.22	23.08	21.79	0.39
Q4 2011	-0.009	-0.111	12.03	6.15	23.05	21.78	0.57
Q1 2012	-0.008	-0.103	12.34	6.19	22.45	21.23	0.60
Q4 2012	-0.011	-0.137	12.77	5.84	20.58	19.58	0.70
Q1 2013	-0.009	-0.123	14.72	5.98	19.97	19.01	0.83
Q2 2013	-0.009	-0.127	14.09	5.79	19.96	19.02	0.80
Q3 2013	-0.010	-0.146	14.81	5.58	20.88	19.90	0.79
Q4 2013	-0.010	-0.146	15.08	5.66	20.95	19.95	0.80
Q1 2014	-0.010	-0.137	14.30	5.93	21.11	20.05	0.75
Q2 2014	-0.010	-0.141	14.80	5.63	21.48	20.44	0.76
Q3 2014	-0.009	-0.139	13.79	5.37	21.09	20.12	0.69
Q4 2014	-0.009	-0.140	15.13	5.23	20.49	19.60	0.83

Average computed on 10,609 individuals.
Quarter 2 and 3 of 2012 are excluded because of their very small number of observations.

Figure A.10: Evolution of attention weight over time



Average computed on 10,609 individuals.
Quarter 2 and 3 of 2012 are excluded because of their very small number of observations.

First stage regressions

Table A.6: Regression of handset price

	(1)	
Brand FE (43)	Yes	Yes
Smartphone	66.56***	(8.26)
Feature phone	0.00	(.)
OS: Android	-70.24***	(4.93)
OS: Bada	-40.19***	(9.44)
OS: Blackberry	0.00	(.)
OS: Flyme	0.00	(.)
OS: Nokia	-108.30***	(24.25)
OS: Sailfish	0.00	(.)
OS: Symbian	36.12***	(6.94)
OS: Windows	0.00	(.)
OS: iOS	0.00	(.)
No camera	0.00	(.)
Camera: 0.1 Mpx	185.14***	(43.67)
Camera: 0.3 Mpx	18.76***	(4.65)
Camera: 1.2 Mpx	0.00	(.)
Camera: 1.3 Mpx	9.35	(6.20)
Camera: 1.9 Mpx	-20.68	(43.56)
Camera: 2 Mpx	-13.47**	(4.72)
Camera: 3 Mpx	25.67***	(5.83)
Camera: 3.15 Mpx	21.82***	(5.87)
Camera: 3.2 Mpx	88.42***	(14.41)
Camera: 4 Mpx	285.10***	(16.62)
Camera: 5 Mpx	56.45***	(6.79)
Camera: 6.1 Mpx	138.89***	(36.33)
Camera: 6.7 Mpx	50.97	(44.29)
Camera: 8 Mpx	107.12***	(9.95)
Camera: 10 Mpx	174.52***	(30.82)
Camera: 12 Mpx	177.62***	(16.39)
Camera: 13 Mpx	168.89***	(17.55)
Camera: 16 Mpx	201.40***	(26.04)
Camera: 20 Mpx	177.40***	(30.45)
Camera: 20.7 Mpx	152.44***	(40.01)
Camera: 41 Mpx	112.37	(61.69)
LTE	91.76***	(16.27)
Screen size	31.11***	(5.17)
Height	0.20	(0.25)
Width	-1.27*	(0.54)
Thickness	1.35	(0.89)
Weight	2.71***	(0.13)
Brands FE*Month trend	Yes	
Smartphone*Month trend	-0.67**	(0.26)
Camera quality*Month trend	0.00***	(0.00)
LTE*Month trend	-1.35**	(0.42)
Screen size*Month trend	-1.00***	(0.18)
Heigth*Month trend	0.00	(0.01)
Width*Month trend	0.05**	(0.02)
Thickness*Month trend	-0.06	(0.04)
Weigth*Month trend	-0.05***	(0.00)
Constant	63.33	(41.88)
Observations	9577	
R^2	0.733	

Standard errors in parentheses

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

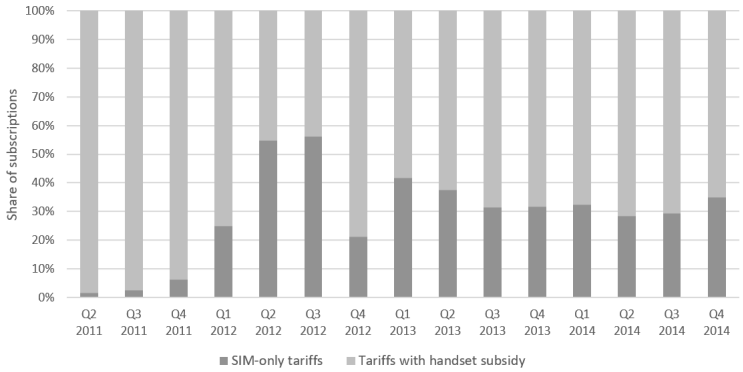
Table A.7: Regression of tariff price

	(1)		(2)		(3)	
Commitment period=0	0.00	(.)	0.00	(.)	0.00	(.)
Commitment period=12	-6.63***	(0.85)	-6.46***	(0.85)	-6.52***	(0.85)
Commitment period=24	-9.71***	(1.01)	-9.53***	(1.02)	-9.57***	(1.02)
Option Handset Subsidy=1	10.64***	(0.81)	10.60***	(0.81)	10.57***	(0.81)
Call allowance in minutes=0	0.00	(.)	0.00	(.)	0.00	(.)
Call allowance in minutes=1	-16.05***	(3.37)	-15.47***	(3.34)	-15.13***	(3.32)
Call allowance in minutes=30	-25.63***	(2.49)	-25.73***	(2.58)	-25.69***	(2.61)
Call allowance in minutes=40	-21.20***	(2.60)	-20.81***	(2.57)	-20.60***	(2.56)
Call allowance in minutes=45	-17.55***	(2.99)	-17.15***	(2.98)	-16.95***	(2.95)
Call allowance in minutes=60	-16.70***	(2.70)	-16.46***	(2.71)	-16.24***	(2.71)
Call allowance in minutes=80	-13.70***	(3.03)	-13.24***	(3.01)	-12.94***	(2.99)
Call allowance in minutes=90	-15.71***	(2.91)	-15.23***	(2.91)	-14.94***	(2.90)
Call allowance in minutes=100	-15.44	(10.77)	-15.41	(10.35)	-15.24	(10.34)
Call allowance in minutes=120	-14.02***	(2.41)	-13.66***	(2.40)	-13.43***	(2.38)
Call allowance in minutes=180	-5.52	(3.35)	-5.37	(3.42)	-5.31	(3.43)
Call allowance in minutes=240	-1.86	(4.03)	-1.51	(4.08)	-1.33	(4.11)
Call allowance in minutes=300	-0.83	(4.18)	-0.60	(4.30)	-0.52	(4.38)
Call allowance in minutes=360	20.05***	(5.25)	20.32***	(5.26)	20.40***	(5.33)
Call allowance in minutes=480	43.04***	(2.74)	43.70***	(2.74)	44.10***	(2.73)
Call allowance in minutes=600	51.99***	(4.86)	52.13***	(5.27)	52.11***	(5.62)
Unlimited call=1	24.75**	(7.94)	23.90**	(7.81)	23.48**	(7.74)
Data allowance=0	0.00	(.)	0.00	(.)	0.00	(.)
Data allowance=50	1.91	(1.66)	0.38	(1.66)	0.09	(1.66)
Data allowance=100	0.41	(1.18)	0.00	(1.20)	-0.15	(1.21)
Data allowance=200	3.83**	(1.16)	3.79**	(1.16)	3.71**	(1.16)
Data allowance=500	10.85***	(1.82)	10.85***	(1.85)	10.84***	(1.86)
Data allowance=1000	14.48***	(2.24)	15.12***	(2.25)	15.78***	(2.33)
Data allowance=2000	28.17***	(2.97)	29.32***	(2.96)	30.06***	(3.03)
Data allowance=3000	36.64***	(4.26)	39.01***	(4.63)	40.36***	(4.98)
Data allowance=4000	46.80***	(4.21)	50.92***	(4.66)	54.92***	(5.71)
Data allowance=5000	51.51***	(6.68)	57.57***	(6.80)	62.62***	(7.98)
Data allowance=6000	99.94***	(16.53)	106.33***	(16.42)	112.34***	(17.05)
Data allowance=7000	54.94***	(6.85)	74.31***	(11.09)	82.22***	(12.69)
Data allowance=10000	100.61***	(19.13)	130.85***	(22.45)	144.27***	(24.17)
Data allowance=14000	154.86***	(3.96)	200.66***	(19.63)	221.65***	(25.05)
Fixed broadband-DSL	22.28***	(1.74)	22.48***	(1.69)	22.62***	(1.66)
Fixed broadband-FTTH	24.59***	(2.28)	24.85***	(2.19)	24.70***	(2.18)
Fixed bill option=1	-5.99***	(0.94)	-5.83***	(0.94)	-5.72***	(0.94)
Low cost brand=1	-17.34***	(4.41)	-17.67***	(4.05)	-17.30***	(4.14)
Access to 4G network=1	-23.62***	(4.19)	-20.89***	(4.06)	-27.31***	(5.45)
Month Dummies	Yes	(.)	Yes	(.)	Yes	(.)
Data allowance × Number of 4G active antennas (thousands)			-0.04*	(0.02)	-0.07**	(0.02)
Access to 4G network=1 × Number of 4G active antennas					0.14*	(0.07)
Constant	44.44***	(2.77)	43.75***	(2.75)	43.46***	(2.75)
Observations	12857		12857		12857	
R^2	0.768		0.771		0.772	

Standard errors in parentheses

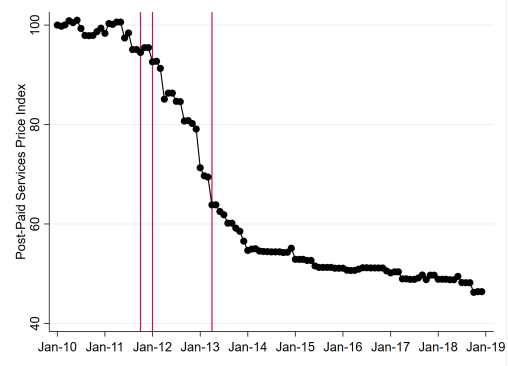
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure A.11: Type of selected contract, over time



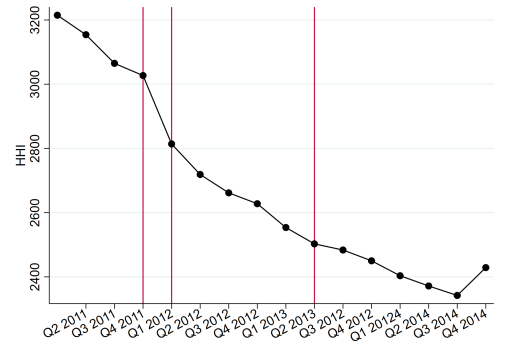
Computed on 10 740 individuals

Figure A.12: National price index for post-paid services (2010-2018)



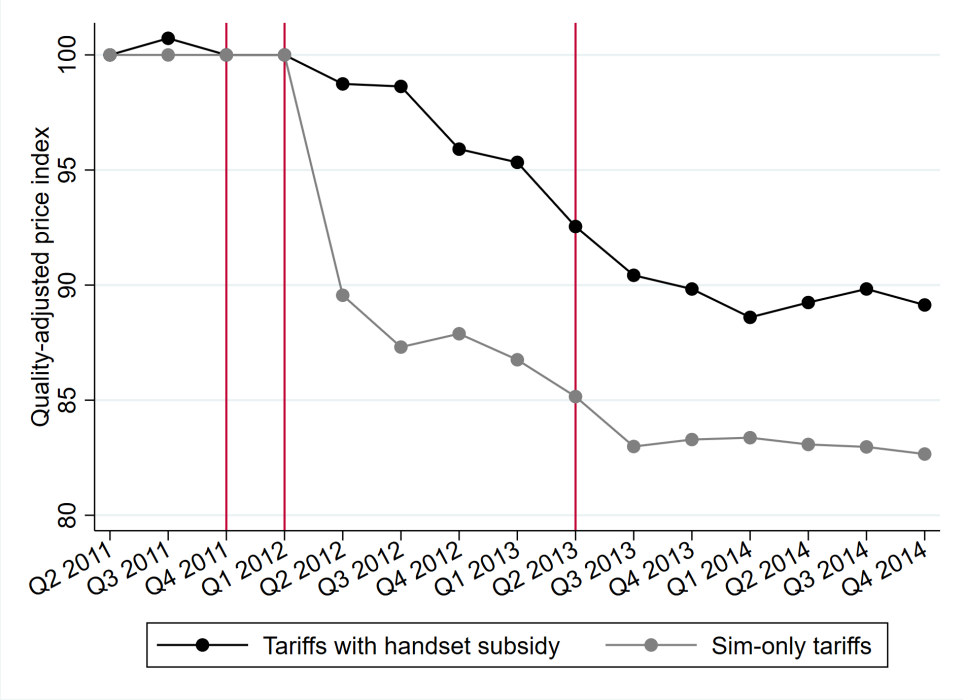
Source: National Regulator

Figure A.13: Herfindahl-Hirschman Index



Source: Own computation based on data from the National Regulator and Yankee Group

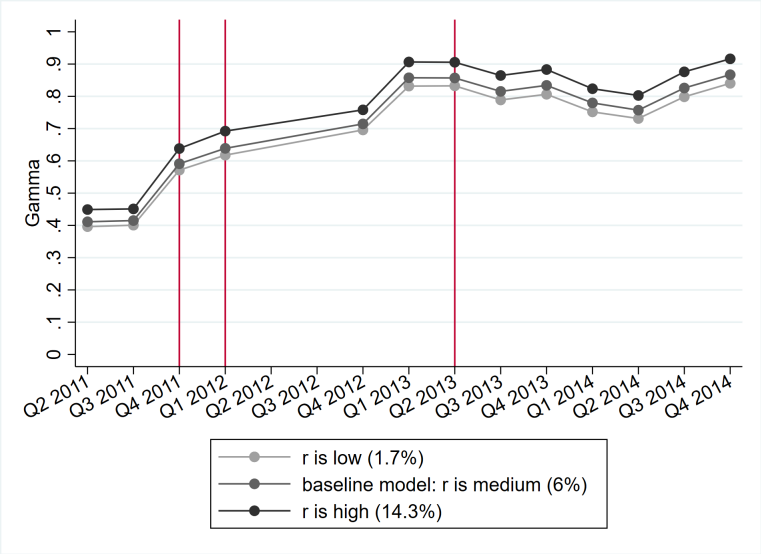
Figure A.14: Quality-adjusted price indexes



Computed with the estimates from the Model 3 estimated on two subsamples of tariffs: with and without handset subsidy. These indexes are obtained in adding the month dummy coefficient to 100. The base period is Q2 2011.

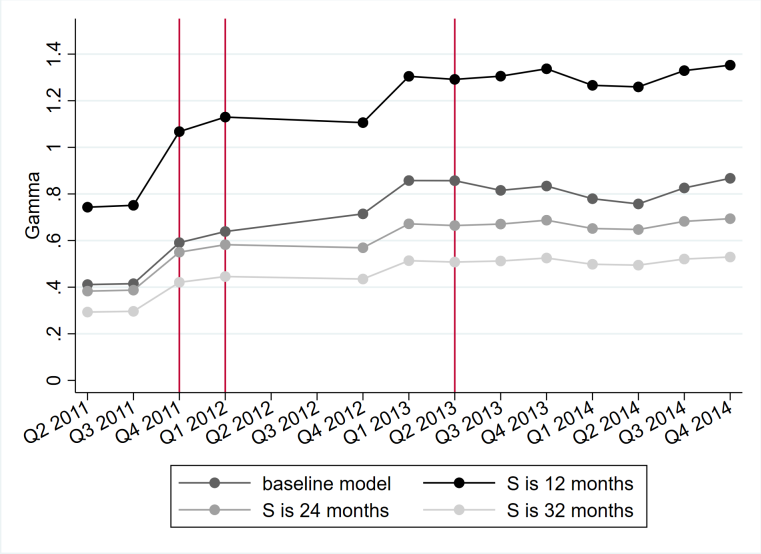
Robustness checks

Figure A.15: Average γ with alternative r



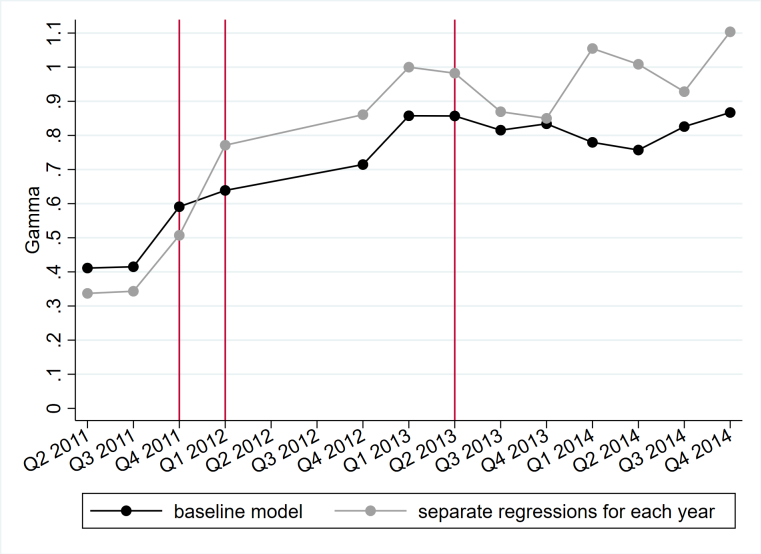
Average computed on 10,609 individuals.
Quarter 2 and 3 of 2012 are excluded because of their very small number of observations.

Figure A.16: Average γ with alternative S



Average computed on 10,609 individuals.
Quarter 2 and 3 of 2012 are excluded because of their very small number of observations.

Figure A.17: Average γ computed with estimates from separate regressions



Average computed on 10,609 individuals.
Quarter 2 and 3 of 2012 are excluded because of their very small number of observations.

Table A.8: Estimation results from regressions including alternative price coefficients

	Model IV		Model V		Model VI		Model VII	
Tariff price	-0.098***	(0.00)					-0.101***	(0.00)
Upfront cost of handset	-0.011***	(0.00)						
Total cost over 12 months			-0.009***	(0.00)				
Total cost over 24 months					-0.004***	(0.00)		
List price of the handset							-0.005***	(0.00)
Amount of subsidy							0.011***	(0.00)
500 MB=1	1.31***	(0.03)	1.33***	(0.03)	1.34***	(0.03)	1.32***	(0.03)
1 GB=1	1.96***	(0.05)	2.01***	(0.05)	2.06***	(0.05)	1.94***	(0.05)
2 GB=1	2.58***	(0.05)	2.66***	(0.05)	2.72***	(0.05)	2.57***	(0.05)
4 GB=1	2.81***	(0.13)	2.91***	(0.13)	3.00***	(0.13)	2.75***	(0.13)
6 GB=1	5.21***	(0.13)	5.37***	(0.13)	5.52***	(0.13)	5.13***	(0.14)
10 GB=1	5.17***	(1.15)	5.46***	(1.16)	5.66***	(1.17)	5.09***	(1.15)
Unlimited calls=1	1.42***	(0.15)	1.50***	(0.16)	1.50***	(0.16)	1.47***	(0.16)
Call allowance (in minutes)	0.00***	(0.00)	0.00***	(0.00)	0.00***	(0.00)	0.00***	(0.00)
Fixed broadband=1	2.75***	(0.06)	2.84***	(0.06)	2.89***	(0.06)	2.79***	(0.06)
Handset sub, 24 months contract	0.00	(.)	0.00	(.)	0.00	(.)	0.00	(.)
Handset sub, 12 months contract	-2.32***	(0.04)	-2.31***	(0.04)	-2.30***	(0.04)	-2.33***	(0.04)
Sim only, 12 months contract	-1.58***	(0.05)	-1.62***	(0.05)	-1.70***	(0.05)	-1.48***	(0.05)
Sim-only, 24 months contracts	-1.73***	(0.07)	-1.78***	(0.07)	-1.88***	(0.07)	-1.63***	(0.07)
Sim-only, no contract	-0.34***	(0.05)	-0.39***	(0.04)	-0.47***	(0.04)	-0.24***	(0.05)
Dummy Apple	7.84***	(0.09)	7.78***	(0.09)	7.63***	(0.09)	6.02***	(0.12)
Dummy Blackberry	3.86***	(0.07)	3.85***	(0.07)	3.80***	(0.07)	2.87***	(0.09)
Dummy HTC	0.93***	(0.11)	0.91***	(0.11)	0.87***	(0.11)	0.22	(0.11)
Dummy LG	0.71***	(0.08)	0.71***	(0.08)	0.71***	(0.08)	0.18*	(0.09)
Dummy Motorola	0.71***	(0.13)	0.71***	(0.13)	0.68***	(0.13)	0.30*	(0.14)
Dummy Nokia	2.08***	(0.07)	2.07***	(0.07)	2.06***	(0.07)	1.64***	(0.07)
Dummy Samsung	2.89***	(0.06)	2.89***	(0.06)	2.86***	(0.06)	2.40***	(0.07)
Dummy Sony	2.33***	(0.09)	2.33***	(0.09)	2.32***	(0.09)	1.93***	(0.09)
Dummy Sony Ericsson	0.97***	(0.10)	0.96***	(0.10)	0.91***	(0.10)	0.43***	(0.10)
Dummy smartphone	1.03***	(0.04)	1.02***	(0.04)	0.98***	(0.04)	0.72***	(0.04)
Age handset	-0.01***	(0.00)	-0.01***	(0.00)	-0.01***	(0.00)	-0.02***	(0.00)
Heigth	0.03***	(0.00)	0.03***	(0.00)	0.02***	(0.00)	0.02***	(0.00)
Width	0.01***	(0.00)	0.01***	(0.00)	0.01***	(0.00)	0.00	(0.00)
Thickness	0.05***	(0.01)	0.05***	(0.01)	0.05***	(0.01)	0.03***	(0.01)
Camera Quality	0.09***	(0.01)	0.09***	(0.01)	0.09***	(0.01)	-0.03**	(0.01)
Standby autonomy in hour	0.00***	(0.00)	0.00***	(0.00)	0.00***	(0.00)	0.00***	(0.00)
4G access if handset is 4G compatible	-1.54	(1.01)	-1.55	(1.01)	-1.54	(1.01)	-1.25	(1.01)
Residuals from handset price regression	0.01***	(0.00)	0.01***	(0.00)	0.01***	(0.00)	0.00*	(0.00)
Residuals from tariff price regression	0.02***	(0.00)	0.02***	(0.00)	0.02***	(0.00)	0.02***	(0.00)
Interactions with time	Yes		Yes		Yes		Yes	
Interactions with consumer characteristics	Yes		Yes		Yes		Yes	
Observations	3801494		3801494		3801494		3801494	
Log Likelihood	-41185.32		-41204.81		-41365.71		-40988.33	

Standard errors in parentheses

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

Table A.9: Estimation results from regressions including handsets and tariffs fixed effects

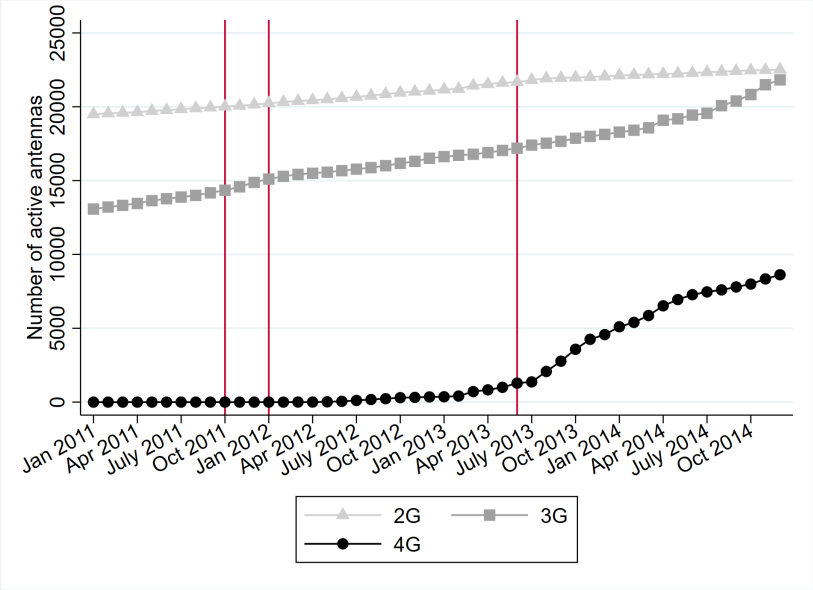
	Model IV		Model VIII		Model IX		Model X		Model XI		Model XII	
Tariff price	-0.10***	(0.00)	-0.09***	(0.00)	-0.04***	(0.00)	-0.04***	(0.00)	-0.04***	(0.00)	-0.05***	(0.00)
Upfront cost of handset	-0.01***	(0.00)	-0.01***	(0.00)	-0.01***	(0.00)	-0.01***	(0.00)	-0.01***	(0.00)	-0.01***	(0.00)
500 MB=1	1.31***	(0.03)	1.25***	(0.03)								
1 GB=1	1.96***	(0.05)	1.80***	(0.05)								
2 GB=1	2.58***	(0.05)	2.23***	(0.05)								
4 GB=1	2.81***	(0.13)	2.51***	(0.12)								
6 GB=1	5.21***	(0.13)	4.49***	(0.12)								
10 GB=1	5.17***	(1.15)	3.44**	(1.12)								
Unlimited calls=1	1.42***	(0.15)	1.35***	(0.15)								
Unlimited calls*time	Yes		Yes									
Call allowance (in minutes)	0.00***	(0.00)	0.00***	(0.00)								
Fixed broadband=1	2.75***	(0.06)	2.43***	(0.06)								
Handset sub, 24 months contract	0.00	(.)	0.00	(.)								
Handset sub, 12 months contract	-2.32***	(0.04)	-2.35***	(0.04)								
Sim only, 12 months contract	-1.58***	(0.05)	-1.45***	(0.05)								
Sim-only, 24 months contracts	-1.73***	(0.07)	-1.50***	(0.08)								
Sim-only, no contract	-0.34***	(0.05)	-0.15***	(0.05)								
Dummy Apple	7.84***	(0.09)			7.09***	(0.09)						
Dummy Blackberry	3.86***	(0.07)			3.35***	(0.07)						
Dummy HTC	0.93***	(0.11)			0.66***	(0.10)						
Dummy LG	0.71***	(0.08)			0.59***	(0.08)						
Dummy Motorola	0.71***	(0.13)			0.58***	(0.13)						
Dummy Nokia	2.08***	(0.07)			1.98***	(0.07)						
Dummy Samsung	2.89***	(0.06)			2.76***	(0.06)						
Dummy Sony	2.33***	(0.09)			2.24***	(0.09)						
Dummy Sony Ericsson	0.97***	(0.10)			0.73***	(0.09)						
Dummy smartphone	1.03***	(0.04)			1.01***	(0.04)						
Age handset	-0.01***	(0.00)			0.01***	(0.00)						
Heigth	0.03***	(0.00)			0.02***	(0.00)						
Width	0.01***	(0.00)			0.02***	(0.00)						
Thickness	0.05***	(0.01)			0.02**	(0.01)						
Camera Quality	0.09***	(0.01)			0.06***	(0.01)						
Standby autonomy in hour	0.00***	(0.00)			0.00***	(0.00)						
4G access if handset is 4G compatible	-1.54	(1.01)			-1.22	(1.01)						
Residuals from handset price regression	0.01***	(0.00)										
Residuals from tariff price regression	0.02***	(0.00)										
Interactions with time	Yes		Yes		Yes		Yes		Yes		Yes	
Interactions with consumer characteristics	Yes		Yes		Yes		Yes		Yes		Yes	
Handsets FE (200 most popular models)			Yes				Yes		Yes		Yes	
Tariffs FE (200 most popular tariffs)					Yes		Yes		Yes		Yes	
Main brands*Time									Yes			
25 most popular models*Time											Yes	
Observations	3801494		3801494		3801494		3801494		3801494		3801494	
Log Likelihood	-41185.32		-36998.22		-36810.94		-32173.32		-31733.65		-31523.34	

Standard errors in parentheses

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

Appendix B

Figure B.18: Number of active antennas (for MNO 1)



Source: National Frequency Agency

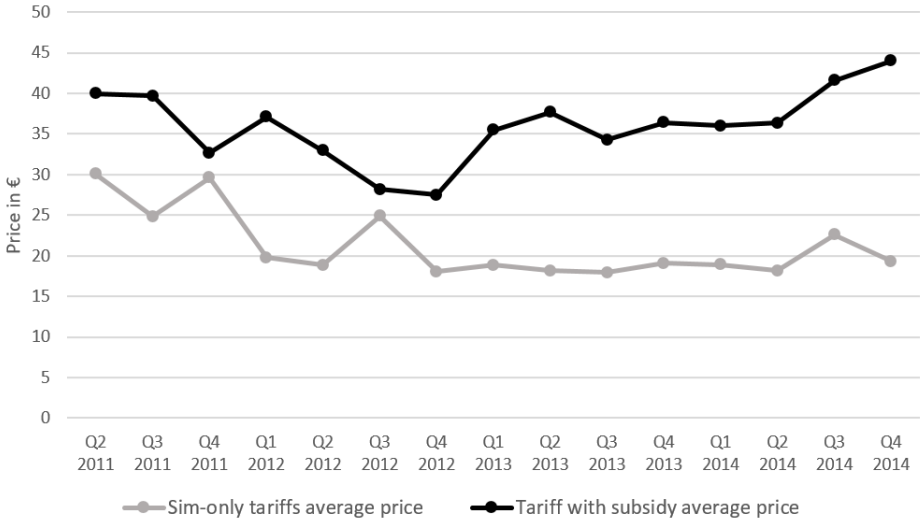
Table B.1: Evolution of subscribers

	Female	Age	Voice usage	Data usage	Smartphone	Apple	Samsung	Individuals
Q2 2011	0.50	43.22	71.72	0.09	0.64	0.22	0.33	1,583
Q3 2011	0.53	42.83	69.18	0.11	0.69	0.22	0.34	2,088
Q4 2011	0.51	42.83	59.03	0.10	0.75	0.30	0.30	1,908
Q1 2012	0.49	44.01	61.51	0.09	0.71	0.21	0.39	1,897
Q2 2012	0.61	46.05	82.48	0.14	0.50	0.22	0.25	64
Q3 2012	0.25	41.56	90.35	0.09	0.56	0.19	0.38	16
Q4 2012	0.51	35.30	152.94	0.11	0.50	0.20	0.38	212
Q1 2013	0.49	39.85	111.95	0.15	0.59	0.31	0.25	237
Q2 2013	0.51	39.53	136.81	0.27	0.67	0.34	0.25	298
Q3 2013	0.54	40.31	110.13	0.37	0.78	0.26	0.29	441
Q4 2013	0.52	37.64	160.73	0.48	0.81	0.24	0.34	431
Q1 2014	0.49	37.62	146.28	0.59	0.81	0.23	0.34	340
Q2 2014	0.52	38.93	125.29	0.60	0.85	0.27	0.31	267
Q3 2014	0.53	39.33	120.28	1.01	0.90	0.33	0.28	433
Q4 2014	0.50	38.19	127.70	1.03	0.93	0.35	0.27	525
SIM-only	0.46	41.98	86.23	0.25	0.69	0.30	0.30	1741
Handset with subsidy	0.52	41.84	84.87	0.24	0.73	0.24	0.33	8999

Table B.2: Evolution of tariffs

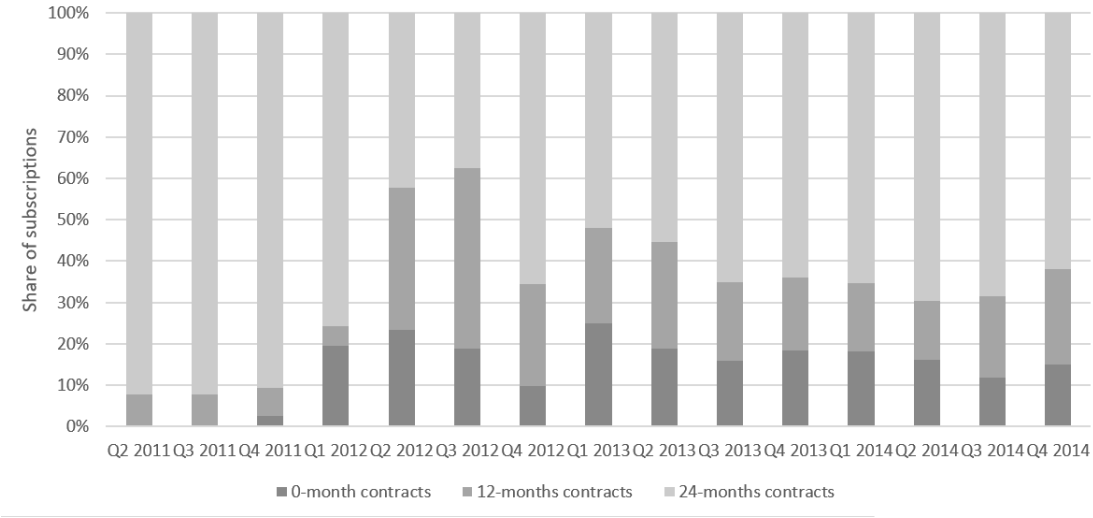
	Tariff price	Handset Subsidy (0/1)	No contract	Contract 12 Months	Contract 24 Months	Voice allow	Unlimited voice	Data allow	Fixed Broadband	Number of tariffs
Q2 2011	39.38	0.93	0.00	0.28	0.72	112.16	0.04	0.50	0.07	169
Q3 2011	44.33	0.88	0.00	0.35	0.65	107.22	0.09	0.62	0.09	178
Q4 2011	38.42	0.87	0.02	0.30	0.67	108.98	0.08	0.58	0.05	171
Q1 2012	38.01	0.77	0.05	0.32	0.63	88.52	0.15	0.61	0.10	128
Q2 2012	30.98	0.54	0.12	0.42	0.46	69.23	0.23	0.53	0.15	26
Q3 2012	30.98	0.50	0.17	0.42	0.42	65.00	0.25	0.61	0.25	12
Q4 2012	27.04	0.87	0.04	0.31	0.65	80.74	0.06	0.29	0.03	94
Q1 2013	29.81	0.75	0.06	0.36	0.59	81.49	0.14	0.46	0.06	87
Q2 2013	35.03	0.70	0.06	0.38	0.56	59.08	0.36	0.93	0.14	114
Q3 2013	30.96	0.69	0.05	0.39	0.56	55.71	0.44	1.05	0.13	105
Q4 2013	33.25	0.69	0.10	0.34	0.56	50.21	0.47	1.06	0.19	97
Q1 2014	31.02	0.64	0.08	0.34	0.58	43.03	0.38	1.29	0.12	76
Q2 2014	32.97	0.73	0.10	0.24	0.67	46.19	0.40	1.46	0.19	63
Q3 2014	33.30	0.67	0.07	0.36	0.57	44.40	0.36	1.59	0.19	75
Q4 2014	35.84	0.72	0.08	0.33	0.58	41.88	0.48	1.87	0.23	96

Figure B.19: Prices of selected tariffs



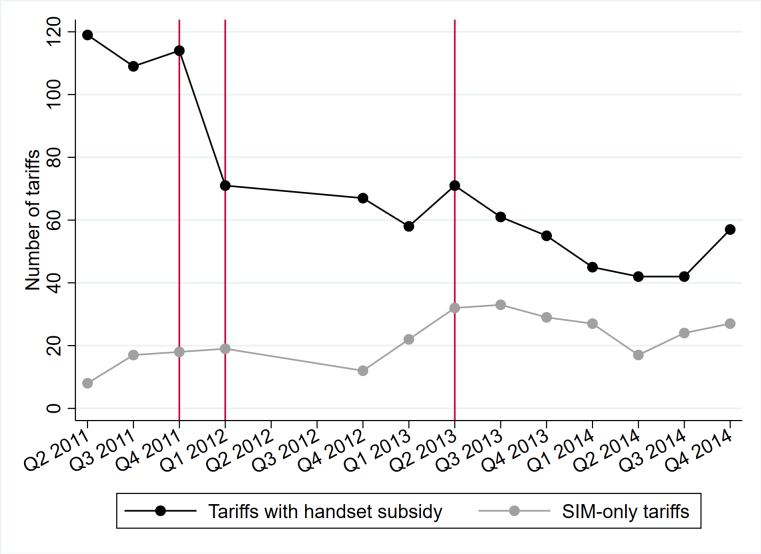
Computed on 10 740 individuals.

Figure B.20: Length of selected contracts



Computed on 10 740 individuals.

Figure B.21: Number of tariffs over time

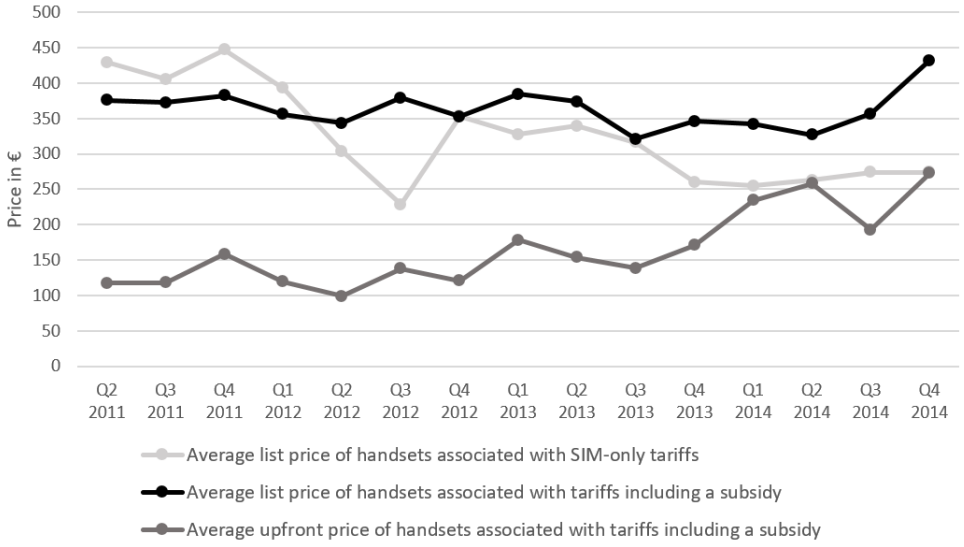


Q2 and Q3 2012 are excluded. Each tariff may be available with different commitment periods.

Table B.3: Evolution of handsets

	Handset list price	Smart-phone	LTE	Age	Height	Width	Thick-ness	Camera Quality	Apple	Samsung	And	Win	Black	Number of handsets
Q2 2011	282.87	0.31	0.00	27.49	105.29	51.81	15.07	2.57	0.01	0.20	0.16	0.05	0.02	357
Q3 2011	249.46	0.40	0.00	14.01	107.09	54.23	13.66	3.18	0.01	0.26	0.24	0.02	0.04	240
Q4 2011	252.77	0.44	0.00	15.06	107.83	54.81	13.59	3.34	0.01	0.23	0.26	0.03	0.04	265
Q1 2012	247.33	0.45	0.01	15.87	108.17	55.07	13.55	3.37	0.01	0.23	0.27	0.04	0.05	274
Q2 2012	248.04	0.49	0.01	18.76	108.78	55.47	13.36	3.48	0.01	0.21	0.29	0.04	0.05	239
Q3 2012	252.18	0.51	0.01	20.85	107.78	54.96	13.48	3.56	0.02	0.16	0.28	0.02	0.07	132
Q4 2012	260.29	0.52	0.05	21.16	110.79	56.40	12.93	3.94	0.02	0.24	0.31	0.06	0.05	262
Q1 2013	266.45	0.52	0.07	23.63	111.68	56.50	12.85	3.90	0.02	0.24	0.32	0.07	0.05	241
Q2 2013	257.71	0.58	0.09	23.87	113.95	57.91	12.46	4.23	0.01	0.24	0.39	0.07	0.05	309
Q3 2013	230.58	0.69	0.15	16.65	118.50	60.61	11.91	4.83	0.02	0.23	0.52	0.07	0.04	258
Q4 2013	230.76	0.71	0.17	17.57	119.01	60.84	11.84	4.96	0.02	0.24	0.53	0.06	0.05	266
Q1 2014	210.75	0.74	0.22	12.89	123.42	62.86	11.22	5.46	0.02	0.22	0.59	0.06	0.04	224
Q2 2014	211.35	0.78	0.29	13.60	124.69	63.62	10.96	5.97	0.02	0.20	0.62	0.07	0.04	234
Q3 2014	213.81	0.82	0.36	12.92	127.08	64.68	10.73	6.49	0.03	0.18	0.67	0.07	0.04	224
Q4 2014	218.56	0.82	0.41	14.96	127.67	64.75	10.77	6.66	0.03	0.18	0.66	0.07	0.04	217

Figure B.22: Prices of selected handsets



Computed on 10 740 individuals.

Table B.4: Regression of the amount of subsidy

	(1)		(2)		(3)		(4)	
	Amount of subsidy		Amount of subsidy		Amount of subsidy		Amount of subsidy	
Tariff price	1.44***	(0.00)	1.03***	(0.00)	1.01***	(0.00)	1.11***	(0.00)
List price of the handset	0.41***	(0.00)	0.37***	(0.00)	0.30***	(0.00)	0.24***	(0.00)
Quarter FE	Yes		Yes		Yes		Yes	
Brands FE			Yes		Yes			
Age handset					1.88***	(0.01)		
Dummy smartphone					-19.49***	(0.25)		
GSM					0.00	(.)		
UMTS					36.20***	(0.52)		
HSDPA					44.17***	(0.25)		
LTE					60.28***	(0.50)		
Models FE							Yes	
Observations	1099996		1099996		1097446		1099996	
Log Likelihood	-6.43e+06		-6.29e+06		-6.23e+06		-6.06e+06	

Standard errors in parentheses

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

Figure B.23: Evolution of subsidies over time

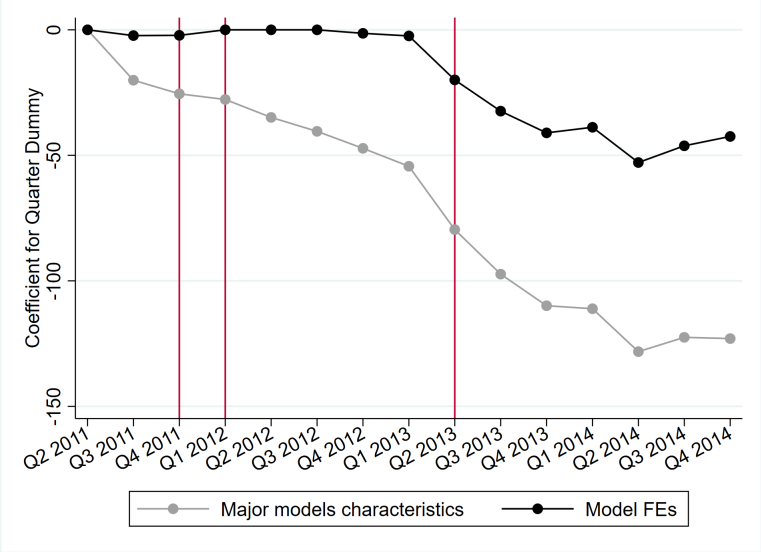
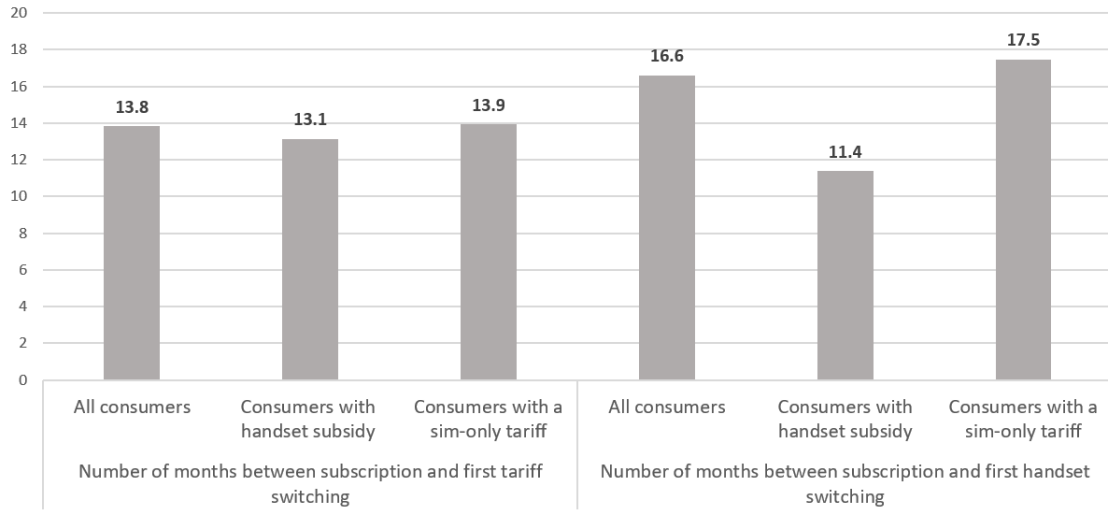


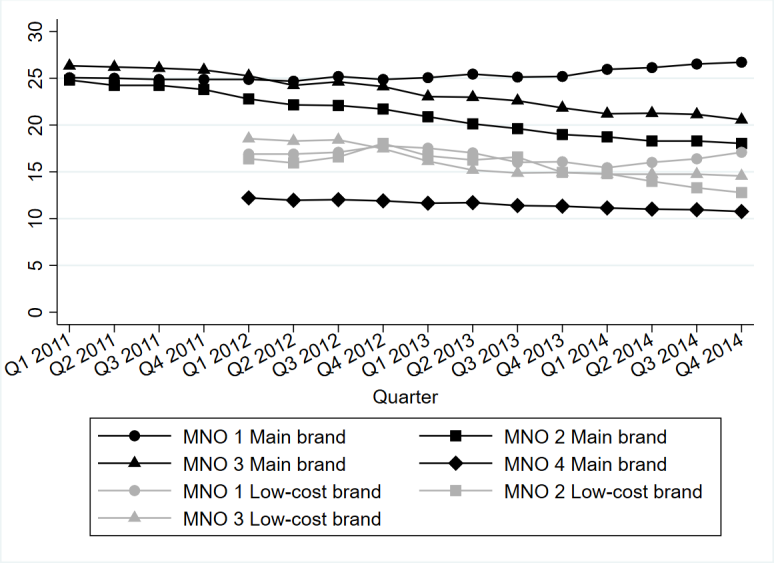
Figure B.24: Dynamics of handset and tariff switching



Computed on 10 740 individuals. The panel data I use to compute these values is right truncated.

Representativeness of the data

Figure B.25: Average prices observed at the national-level



Source: Bourreau et al (2018)

The data I use in this paper originates from the MNO 1 and covers subscribers to the main brand and the low-cost brand. The figure suggests that prices of established operators are relatively comparable, even though differences have tendency to grow since 2013. Nevertheless, at the end of the period (Q4 2014) if the average price of the MNO's 1 main brand is about 26€, while its competitors'prices are about 18 and 20€.

Table B.5: Characteristics of handsets

	IDC Sample					Our Sample				
	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
List price ()	188	217.10	154.04	17.7	737.5	340	263.21	168.78	16.5	799.9
Smartphone dummy	188	0.72	0.45	0.0	1.0	340	0.63	0.48	0.0	1.0
LTE dummy	188	0.24	0.43	0.0	1.0	340	0.19	0.39	0.0	1.0
Age handset (in months)	188	9.15	8.48	0.0	68.0	338	16.21	10.76	1.0	52.1
Heigth	188	119.94	15.73	87.0	179.0	340	115.92	15.62	67.0	172.0
Width	188	60.57	9.67	43.0	92.0	340	58.85	8.77	26.0	85.9
Thickness	188	11.60	2.68	6.2	20.7	340	12.19	3.28	6.7	40.0
Camera (in Mpixels)	188	5.83	5.16	0.0	41.0	340	4.88	4.34	0.0	41.0
Dummy Apple	188	0.03	0.18	0.0	1.0	340	0.02	0.15	0.0	1.0
Dummy Samsung	188	0.06	0.24	0.0	1.0	340	0.24	0.43	0.0	1.0
Dummy Android	188	0.40	0.49	0.0	1.0	340	0.45	0.50	0.0	1.0
Dummy iOS	188	0.03	0.18	0.0	1.0	340	0.02	0.15	0.0	1.0
Dummy Windows OS	188	0.13	0.33	0.0	1.0	340	0.06	0.24	0.0	1.0
Dummy Blackberry OS	188	0.05	0.23	0.0	1.0	340	0.04	0.21	0.0	1.0

In terms of price, we observe similar ranges in both samples: from about 17 to about 750€. The average price is lower in IDC sample, while handsets tends to be more recent (average age is 9 months, against 16 months is our sample).