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Abstract

During 2014, the Comisión de Regulación de Comunicaciones in Colombia enacted a Resolution by which permanence clauses or fixed-length terms in mobile telecommunications contracts were prohibited for network operators offering bundled mobile terminals and voice plans. Prohibition was enacted under the argument permanence clauses create switching costs, reduce competition, and generate information asymmetries. In this study we measure the impact of the Resolution on consumer, firm, and social welfare by estimating the structural demand for mobile terminals and conducting two counterfactual scenarios. We show switching costs by means of permanence clauses reduce consumer utility and increase the variance of the utility distribution. We also show the Colombian market for mobile terminals has been better off without permanence clauses, with both consumers and firms experiencing gains from the prohibition. However, variation in firm surplus is explained mostly by the variation in profits of incumbent network operators than by the variation in profits of firms selling terminals at cash price. Our study contributes to the literature of bundled sales and switching costs and is crucial from the perspective of regulation and industrial policy in the telecommunications sector.

Keywords: switching costs; permanence clauses; structural demand; telecommunications; fixed-length contracts. JEL codes: L500, L130, L110

1 Introduction

On March 25th, 2014, the *Comisión de Regulación de Comunicaciones* (CRC)[1] enacted Resolution 4444 to ban fixed-length terms in mobile telecommunications contracts also known as *permanence clauses*. Until then, network operators sold bundles of mobile terminals and voice plans, enforcing consumers to buy network services during a minimum amount of time. According to the CRC, permanence clauses allowed operators to create switching costs, reduce competition in retail markets, skim the market of voice and data plans, and reduce incentives to invest in service quality. Therefore prohibiting permanence clauses could increase consumer welfare and allow consumers to compare individual prices of mobiles and voice plans from different network operators. However, the effects of the prohibition have not been addressed before. In this article we measure the impact of Resolution 4444 on consumer, firm, and social welfare by estimating a structural demand model for the market of mobile terminals.

Permanence clauses have been central to the discussion of competition policy in the telecommunications sector of different countries because of their contradictory effects on welfare. During 2010, a government agency in Peru (OSIPTEL) restricted the length of mobile telecommunications contracts to six months, which they considered was enough time for the network operator to cover the risk of non repayment of mobile terminals. The policy increased the imports of terminals, reduced the average mobile price, and increased consumer switching among network operators (OSIPTEL, 2016). In South Korea, the elimination of permanence clauses increased the variety of mobiles in the market and incentive the entrance of dual-SIM mobiles (Lee et al., 2006). But in Finland, for example, the prohibition increased search costs for consumers because of the lack of coordination between network operators and mobile retail sales firms (Tallberg et al., 2007). Belgium and Australia also enabled permanence clauses to incentive investment in new technologies and provision of new services that would not have been introduced otherwise (ACCC, 2016).

The economic literature also provides evidence both in favor and against the ban of permanence clauses. In favor, Crawford and Cullen (2007) and Burnett (2014) state that bundled sales reduce menu and search costs for consumers, and simplify consumer choice over terminals and plans because they artificially limit the variety of products in the market. Bakos and Brynjolsson (2000) find that bundled sales do not necessarily harm market efficiency because they impose homogeneity in consumer taste over terminals and plans and hence increase the price elasticity of demand. Even in the presence of an inelastic demand, bundled sales can increase consumer welfare if there exists low consumer heterogeneity and low correlation between the preference for different brands (Armstrong and Vickers, 2010). These are the hypotheses we want to test for the Colombian telecommunications market. Prohibiting bundled sales could also harm consumers if some products or services disappear following the prohibition (Crawford

[1]The Colombian Agency of Communications Regulations.

and Yurukoglu, 2012). However, the exit of products and services is a hypothesis that we cannot test empirically given our data. Other arguments in favor of permanence clauses state that they provide risk coverage for operators, incentive investment in new technologies, reduce overall transaction costs (search and menu costs), and compensate ex-post inefficiencies in the sense that benefits from aggressive competition in ex-ante markets to lock-in consumers outweighs losses of price skimming in ex-post markets.

On the other hand, bundled sales can reduce consumer surplus by forcing consumers to buy products that generate disutility. They also incentive the provision of products or services whose supply is inefficient (Crawford and Cullen, 2007) by cross-subsidizing them. These types of subsidies or discounts can be conceived as entry deterrence strategies in the sense that potential entrants would not be able to charge the discounted sales price without incurring in losses (Economides, 1999). Even if a firm enters the market and incurs in ex-ante losses, it will not be able to outweigh losses in ex-post markets because permanence clauses tie consumers to their initial choice and artificially reduce the size of ex-post markets. In terms of switching costs, permanence clauses induce less switching than socially optimal because consumers are not able to move freely among operators over possible inefficiencies without having to pay some penalty. Crawford and Shum (2006) also mention that low competition in ex-post markets disincentives operators from investing in service quality, therefore individuals with high preferences for quality may be excluded from the market. In that same line, Beggs and Klemperer (1992) show that with permanence clauses operators have higher incentives to skim existing consumers than invest in new ones. Other arguments against permanence clauses state that they increase costs of entry for firms, reinforce network effects since operators could invest in generating incompatibilities with other operators and induce higher switching costs, and exclude financial markets since the operators are the ones financing mobile terminals and not financial institutions who may be more efficient at it.

This study contributes to the understanding of permanence clauses and the trade-off mentioned above for the Colombian case. Other authors have studied the welfare effects of number portability (Lee et al., 2006) and more recent work by Mo et al. (2017) and Lee et al. (2017), provide surveys of approaches to study price discrimination through bundled handsets and services in return for subsidizing the handset. However, studies that measure the welfare effects of switching costs with a structural model are very few, and none of them focus on the switching costs implied by permanence clauses. Lee and Park (2015), for example, focus on the impact of handset subsidies on the demand for bundles of mobile telecommunications service and handsets. We consider this particular type of switching cost relevant to the literature on telecommunications policy, as the effect of permanence clauses on social welfare can be ambiguous. In presence of permanence clauses, consumers *a priori* may experience a decrease in their utility as a result of a switching cost. However, since permanence clauses decrease the risk of losing customers in the short term, this may result in lower market prices.

Our analysis provides quantitative evidence that is crucial for the policy agenda in

Colombia: nowadays network operators are pushing towards the abolition of Resolution 4444 claiming that they have experienced a significant decrease in profits and arguing that investment in the 4G technology is no longer profitable; while mobile retail sales companies claim to have benefit from it. Although we can measure variations in firms profits due to Resolution 4444, it is important to acknowledge that we cannot test the investment argument empirically. We also acknowledge that a more complete demand model would include bundling between handset and mobile telecommunications services, which we do not control for in this paper. We consider our study in contributing to the literature on telecommunications policy for Latin-American countries as an initial approach in giving empirical evidence on the welfare effects of permanence clauses associated with the purchase of mobile handsets.

The rest of this document is organized as follows: after this introduction, the second section describes the Colombian telecommunications sector, the third one presents our theoretical and empirical model of demand for mobile phones, then we describe our data, provide estimation results and an analysis of welfare variation due to Resolution 4444 assuming an exogenous market structure, and the last section outlines some conclusions.

2 The Colombian telecommunications sector

The Communications Regulation Commission (CRC) in Colombia is the government agency in charge of the competition policy and the establishment of enabling rules for operators in the telecommunications sector. During 2011, the Commission enacted Resolution 3066 by which all rules applicable to permanence clauses, penalties due to early termination of contracts, and extensions of contracts, were published. The Resolution stated that operators could set permanence clauses for no longer than a year with previous written acceptance by the user. Extensions to the one-year clause were allowed under three specific cases: i) when the operator supplied additional services to finance the connection fee, ii) when the operator subsidized mobile terminals through bundled sales and iii) when the operator offered special tariffs that implied a substantial discount on the services it provided.

Bundles consisted of a mobile terminal and a monthly postpay voice plan that consumers had to buy during the time span fixed by the contract's permanence clause in order to pay for the terminal. Even if the consumer already owned a cellphone, changing the voice plan to a postpay plan implied locking-in to an operator's network through the permanence clause. Operators also sold terminals at cash price with access only to prepay plans without permanence. In *postpay calling plans* individuals decide on consumption first and then pay for services according to the tariff plan, while in *prepay calling plans* tariff and usage decisions are simultaneous. In both cases number portability

was restricted to the operator's network and was in place for the whole period of study.[2]

After the enactment and until 2013, the CRC received more than 40 complaints from market agents regarding decreased competition and entry deterrence strategies, as well as complaints from users regarding inconveniences and nonconformities with the permanence clauses (CRC Resolucion 4444, 2014). Looking to address these complaints, the CRC conducted a comparative study of local mobile phone prices versus international prices and a review of the effects of permanence clauses on competition. In the first case the Commission found mobile phone prices in Colombia were significantly higher than in other countries, despite having similar market structure but differing in the regulation of permanence clauses (Resolution 4444 and 4506 of 2014). In the second case, some studies revealed permanence clauses reduced operators' incentives to make quality investments, lead to nonlinear price increases of voice and data services, and were a means for the operators' strategic behavior.

These studies lead to several political discussions about prohibiting permanence clauses and contractual instruments that implied a switching cost for the consumer and a possible rise in firms' market power. During May, 2013 the Colombian Parliament approved the law prohibiting permanence clauses in communication services, including mobile terminals. Then, an analysis of Resolution 3066 and market surveys also revealed operators did not offer additional plans to finance connection fees nor special tariffs on the services they provided. This eventually lead to the elimination of the first and third cases allowed by the law in the setting of permanence clauses. With regard to the second case, the CRC identified bundled sales generated high market concentration, information asymmetries, and switching costs. As a result, during July 2014, the CRC enacted Resolution 4444 prohibiting permanence clauses and extensions to contracts signed before the enactment. The Resolution forced operators to offer mobile terminals and plans in separate contracts, to publish individual prices of all the services they provided, and to give a detailed description of voice and data plan consumption. It also standardized the billing structure in order to avoid information asymmetries. However, only if users accepted it, operators could negotiate permanence clauses.

In this study we analyze a particular type of switching and competition barrier by means of permanence clauses and estimate the impact of Resolution 4444 on consumer and firm surplus by modeling two counterfactual scenarios: one in which we assume the Resolution was never enacted and another in which we assume permanence clauses were never allowed in the Colombian cellphone market.

[2]The effects of optional calling plans are studied further in Miravete (2002). The author concludes optional calling plans do not increase consumer surplus because they allow the monopolist operator to discriminate and skim consumers in ex-post markets.

3 The demand for mobile terminals

To measure the impact of permanence clauses on welfare we estimate the demand for mobile terminals using the Berry et al. (1995) methodology. Consumer i in market t makes discrete choices over mobile terminals based on the indirect utility level, u_{ijt}, she perceives from the permanence clause c_{jt}, a set of K observable characteristics, $\mathbf{x}_{jt}$, and an unobservable (to the econometrician) attribute, ξ_{jt}, associated to terminal j, as well as from her available income, determined by the difference between her gross income y_{it} and the price of the terminal p_{jt}, and a random shock to her utility ε_{ijt}:

$$u_{ijt} = \alpha_i(y_{it} - p_{jt}) + \mathbf{x}_{jt}\beta_i + \tau_i c_{jt} + \xi_{jt} + \varepsilon_{ijt}. \tag{1}$$

Consumer heterogeneity is captured both through differences in income and differences in a set of unobservable individual characteristics, v_i modeled as a standard normal shock. These individual shocks can represent, for example, the particular taste of a consumer who gives more weight to smartphones with special apps for video calls or special tariffs on long-distance phone calls. Hence, the consumer-specific parameters of the indirect utility function (1) can be defined as follows:

$$\begin{pmatrix} \alpha_i \\ \beta_i \\ \tau_i \end{pmatrix} = \begin{pmatrix} \overline{\alpha} \\ \overline{\beta} \\ \overline{\tau} \end{pmatrix} + (\Sigma v_i + \Pi y_{it}), \tag{2}$$

where Σ is a scaling matrix of coefficients, and Π is a vector of coefficients.

Letting δ_{jt} be the average utility and μ_{ijt} the consumer-specific deviations from the average utility,

$$\begin{aligned} \delta_{jt} &= \mathbf{x}_{jt}\overline{\beta} - \overline{\alpha}p_{jt} + \overline{\tau}c_{jt} + \xi_{jt}, \\ \mu_{ijt} &= [-p_{jt}, \mathbf{x}_{jt}, c_{jt}](\Sigma v_i + \Pi y_{it}). \end{aligned}$$

we can rewrite the indirect utility function of buying an inside alternative as:

$$u_{ijt} = \alpha_i y_{it} + \delta_{jt} + \mu_{ijt}, \tag{3}$$

Consumers are also able to choose an alternative out of what is offered in the market, denoted by $j = 0$ and usually called the *outside option*. A common interpretation for the outside option is to be the choice of not buying. The indirect utility level for the outside alternative is:

$$u_{i0t} = \alpha_i y_{it} + \xi_{0t} + \sigma_0 v_{i0} + \varepsilon_{i0t}. \tag{4}$$

The term $\sigma_0 v_{i0}$ captures the possibility of there being more unobserved variance in the outside than the inside alternatives, which might be the case for consumers who decide

not to buy because of differences in access to the operators' network or because of their geographic location.

A consumer chooses mobile j if it generates the highest utility level compared to all other available options, $u_{ijt} \geq u_{ikt}$. Assuming ties occur with zero probability and ε follows an extreme value type I distribution, choice probabilities have a closed-form expression as in (5):

$$s_{ijt}(p_{jt}, \mathbf{x}_{jt}, \delta_{jt}, P_{ns}; \theta) = \frac{e^{\delta_{jt}+\mu_{ijt}}}{1 + \sum_{k=1}^{J} e^{\delta_{kt}+\mu_{ikt}}}. \tag{5}$$

and this defines the following market shares for product j:

$$s_{jt}(p_{jt}, \mathbf{x}_{jt}, \delta_{jt}, P_{ns}; \theta) = \int_{A_{jt}} s_{ijt} dP_o(v) dP_o(y). \tag{6}$$

where $A_{jt} = \{(y_{it}, v_i, \varepsilon_{ijt}) | u_{ijt} > u_{ikt}, \forall k \neq j\}$, $dP_o(v)$ is the density of v_i, and $dP_o(y)$ is the density of y_{it}.

3.1 Markups and cost function

The unobserved product characteristic to the econometrician, ξ_{jt}, is likely to be known by producers since it can represent, for instance, a measure of quality. It can also be known by consumers since it can capture aspects of past experiences with mobiles, style, or family effects that are difficult to quantify. This suggests ξ_{jt} is likely to be correlated with prices both from the demand and from the supply side, which generates the standard endogeneity problem. Price and market share simultaneity in the highly nonlinear model described in the previous section can be accounted for, first, by making ξ_{jt} a linear function of product observable characteristics and, second, by choosing optimal price instruments such as cost shifters. The former strategy will be explained in subsection (3.2) and the latter implies deriving the cost or pricing moments for each producer. We turn to the explanation of the cost function next.

Assume there are F firms in the market, each producing a subset $\mathcal{F}_f$ of mobile terminals. Producers compete via prices, so that the Nash-Bertrand equilibrium is given by the set of equations that solve the problem of profit maximization simultaneously. The profits function is:

$$\pi_{ft} = \sum_{j \in \mathcal{F}_f} (p_{jt} - mc_{jt}) M s_{jt}, \tag{7}$$

where M is the size of the potential market and mc_{jt} is the marginal cost associated with product j in market t. The first order conditions for profit maximization with

respect to the price of terminal j is given by:

$$s_{jt} + \sum_{r \in \mathcal{F}_f} (p_{rt} - mc_{rt}) \frac{\partial s_{rt}}{\partial p_{jt}} = 0 \tag{8}$$

Rewriting the first order conditions in matrix form and rearranging terms, we obtain an expression for price markups, which depends only on demand parameters:

$$b = p - mc = \Omega^{-1} s. \tag{9}$$

where,

$$\Omega_{jr} = \left\{ \begin{array}{ll} -\frac{\partial s_{rt}}{\partial p_{jt}} & \text{if } f \text{ produces both } r \text{ and } j \\ 0 & \text{o.w} \end{array} \right\}. \tag{10}$$

After recovering markups we can then estimate a cost function for each producer as:

$$\log(p_{jt} - b_{jt}) = \mathbf{w}_{jt}\gamma + \omega_{jt}, \tag{11}$$

where $\mathbf{w}_{jt}$ is a vector of observed cost shifters and ω_{jt} represents the value of unobserved costs associated with selling terminal j at market t. There are two things worth highlighting from the equation above: *i*) it implies constant returns to scale; and *ii*) price endogeneity is still an issue because ω_{jt} is likely to be correlated with ξ_{jt}. Cost shifters that are not accounted for in $\mathbf{w_{jt}}$, such as marketing efforts or financial contracts over the exchange rate, generate variations in prices making $corr(\xi_{jt}, \omega_{jt}) > 0$. Not accounting for this potential endogeneity is likely to result in biased estimates of α_i, in the utility function.

A common approach to solve this sort of endogeneity is by the use of instrumental variables. In our case we take advantage from the panel structure of our data to control for all possible sources of endogeneity by including product fixed effects and market fixed effects in both the mean utility and the cost functions.

3.2 The estimation algorithm

To estimate the parameters of the model, $\theta_1 = (\overline{\alpha}, \overline{\beta}, \overline{\tau}, \gamma)$, $\theta_2 = (\Sigma, \Pi)$, ξ_{jt} and ω_{jt} we use the methodology introduced by Berry et al. (1995). We begin by making an initial guess for $\theta_2 = \theta_2'$ in the respective parameter space. Then, conditional on a fixed point in the space of θ_2, δ_{jt} can be solved numerically using a contraction mapping:

$$s_{jt}(p_{jt}, \mathbf{x}_{jt}, \delta_{jt}, P_{ns}; \theta) = s_{jt}, \tag{12}$$

which amounts to compute:

$$\delta_{jt}^{(n+1)} = \ln(s_{jt}) - \ln(s_{jt}(p_{jt}, \mathbf{x}_{jt}, \delta_{jt}, P_{ns}; \theta)) + \delta_{jt}^{(n)}, \tag{13}$$

for each $n = 1, 2, \ldots,$ iteration, until convergence.

After solving for $\delta_{jt}(\theta_2')$, we proceed to estimate θ_1 by regressing this mean utility vector on observed product characteristics and price instruments. The parameters in γ and the cost-side unobservable can be estimated after computing the implied demand derivatives and recovering the marginal costs according to equations (9) and (11).

Using the structural estimates of the unobservables, (ξ_{jt}, ω_{jt}), the non-linear parameters, θ_2, can be computed by the following GMM estimator:

$$\theta_2^* = \arg\min_{\theta_2} \left(Z' \begin{pmatrix} \xi(\theta_2) \\ \omega(\theta_2) \end{pmatrix} \right)' W \left(Z' \begin{pmatrix} \xi(\theta_2) \\ \omega(\theta_2) \end{pmatrix} \right), \tag{14}$$

where Z is the matrix of instruments and W is a weighting identity matrix. The estimator for the variance-covariance matrix is computed as suggested by Cameron and Trivedi (2005).

3.3 The effect of permanence clauses

Switching costs by means of permanence clauses are measured by the parameter τ in the model which interacts with an indicator variable of mobile terminals sold with the clause. This indicator variable takes the value of 1 for terminals with postpay calling plans sold during the months previous to July 2014. We expect its sign to be negative suggesting permanence clauses reduce consumer utility with respect to the utility generated by terminals sold after July 2014 under any tariff plan and with respect to terminals sold before July 2014 under prepay calling options. We expect a negative sign also because it reflects the Commission's findings in previous studies. Moreover, to rule-out the bias in τ since it may be capturing other effects on utility due to differences between tariff plans (for example, if the highest quality mobile terminals are only sold together with a postpay calling plan or if there are positive unobserved network effects on postpay calling options, then τ would be positively biased and correlated with ξ_{jt}) we include the tariff plan as a control in our regressions. Since we do not observe the length of the permanence clause, mobiles sold just before July 2014 may be also biasing downwards the estimate of (absolute value) changes in consumer welfare or biasing downwards the (absolute value) estimate of τ. However, a downward bias on the parameter we expect to have a negative impact on consumer welfare, only suggests our estimates of welfare variation would be a lower bound (in absolute value) of the real effect of the permanence clauses. We also allow this effect to be differential across consumers by interacting the indicator variable with the unobserved consumer characteristic, so that the presence of

bundled sales or permanence clauses may impact both the mean utility level and the variance of the utility.

In addition to the raw estimate of switching costs using τ, we model changes in overall consumer welfare and firm profits by estimating two counterfactual scenarios: one in which we assume Resolution 4444 was never enacted, hence permanence clauses would still be permitted and the indicator variable would take the value of 1 for all terminals sold with postpay calling plans during the entire time series; and another in which we assume permanence clauses did not exist from the beginning of our sample (January 2014), hence the indicator variable would be zero always.

Let the upper script C denote the counterfactual scenario and the upper script O denote the observed scenario, equilibrium prices in the counterfactual solve the following equation:

$$p^C = mc^O + \Omega(p^C)^{-1} s(p^C, x^C, \xi, P_{ns}; \theta) \tag{15}$$

Equation (15) relies in several important assumptions. Marginal costs are assumed to be the same between the observed and the counterfactual scenarios. Although banning permanence clauses could cause an increase in menu costs because network operators would have to report the terminal's price and the plan's price separately, we assume, first, marginal costs do not depend on the permanence clause and, second, operator-manufacturer relations do not change. In light of our data, these assumptions are reasonable given prices reflect only the mobile's price but not the plan's price and given the marginal cost of an operator is actually determined by the cost of importing cellphones, hence price variations between the observed scenario and the counterfactual are due to changes in markups.

After computation of the market equilibrium under each counterfactual scenario, changes in consumer welfare under the BLP methodology can be obtained from equation (16), where $V_{ijt} = \delta_{jt} + \mu_{ijt}$. On the supply side, changes in firm surplus can be computed from equation (17), and the sum of these two expressions gives us the variation in welfare from the societal perspective (equation (18)).

$$\Delta C = M \int \frac{log(\sum_{j=1}^{J} e^{V_{ijt}^O}) - log(\sum_{j=1}^{J} e^{V_{ijt}^C})}{\alpha_i} dP(v) \tag{16}$$

$$\Delta E = \sum_f \pi_f^O - \pi_f^C = \sum_f \left(\sum_{j \in \mathcal{F}_f} (p_{jt}^O - cmg_{jt}^O) M s_{jt}^O - \sum_{j \in \mathcal{F}_f} (p_{jt}^C - cmg_{jt}^C) M s_{jt}^C \right) \tag{17}$$

$$\Delta S = \Delta C + \Delta E \tag{18}$$

4 Data and descriptive evidence

To estimate the demand for mobile terminals in Colombia and the effect of permanence clauses we have monthly data of a sample of mobiles sold between January 2014 and June 2016. The data was collected by GfK, a market research company, and was given to us by Fenalco, an alliance of retail sales companies. The data includes sales by retailers who authorized GfK (with written acceptance) to share the information with Fenalco. An observation in our dataset is identified by the combination of mobile reference, tariff plan (postpay, prepay, SIM free), distribution channel (authorized distributors, AD, and department stores, DS) and month. For each mobile reference we observe units sold, price, screen size in inches, and memory size in GB. For a single mobile reference, price varies only over operators, distribution channels, and time. The price variable was build by GfK in collaboration with network operators. It corresponds to the individual price of each mobile after removing the over-pricing due to voice and data plans. We define a market as a month and use the distribution channel as a product observable characteristic since a mobile reference can compete with itself in a market if being sold through different channels. We identify 5 producers in each market: Claro, Movistar, Tigo, SIM free in authorized distributors and SIM free in department stores. Since we can not observe all the individual SIM free producers, we assume those selling through authorized distributors act as a single producer and those selling in department stores act as another single producer.[3] Claro, Movistar and Tigo are the only ones who can offer bundled sales of terminals and plans because they are also the only network operators in the market. SIM free producers, as their name suggests, only sells terminals at cash price without a calling plan. In terms of consumer characteristics, the mean and standard deviation of the income distribution are obtained from the GEIH survey of the National Administrative Department of Statistics. These parameters are allowed to vary each month. We define the potential market as the employed population.

Table 1 presents some descriptive statistics of the variables used in our model specification.

[3]Given how the data is constructed, there is natural concern about potential selection biases. The retailers that authorized GfK are usually those with the highest number of sales, a characteristic that is evidently correlated with the unobserved terms in our model. A proper Heckman selection model to avoid such biases would require to specify a model that describes the probability of authorizing GfK to use their sales data as a function of a set of observed characteristics of the retailers themselves or of the terminals they sell. However, in the Colombian market there is no other available source with this sort of data for such small retailers. Therefore, although we acknowledge the potential for selection bias, we believe this set of retailers to be small enough not to influence the results. Moreover, this belief is supported by the similar estimations results we obtain for the same model using a more recent set of data, which includes one more year of information. These results can be seen in an available online appendix http://www.alvaroriascos.com/

These variables include quantity (in units of 1000), price (in 1000 constant COP), screen size (in inches), memory size (in tens of GB), and tariff plan (Postpay, prepay and SIM free). Numbers reported in the last 6 columns correspond to weighted-sales means. Several things standout from the table. Prices have an overall increasing tendency, but evidence a slight decrease just after July 2014 when Resolution 4444 was in force going from 317,300 COP in June 2014 to 273,800 COP in August 2014. Units sold have a seasonal behavior: they are larger during December and smaller during the months from February to April. However, seasonality is not only due to larger sales in certain months but also to greater variety of mobiles during the same months. Note the number of mobile references more than doubles after the Resolution going from 57 in January 2014 to 135 in October 2015. There is additional evidence that observable characteristics have been changing lately. For example, mobiles sold during 2016 have larger memory size and screen size than the ones sold in 2014.

Table 2 shows the number of mobiles sold under each tariff plan in both distribution channels before and after Resolution 4444 and their market shares. Overall, the share of terminals with postpay calling plans fell after the enactment 9 percentage points in authorized distributors and 20 percentage points in department stores. In the case of terminals sold in cash price with prepay calling options, the table shows its share in authorized distributors increased after the Resolution and decreased in department stores. More interesting are the changes in the SIM free market share in department stores which increased nearly 55 percentage points after the enactment, revealing the entrance of competitors in the market of mobile retail sales. Also, the proportion of terminals with postpay calling plans to total sales for each producer in both distribution channels decreased after the enactment: from 25 to 17% for Claro, from 47 to 38% for Movistar, and from 36 to 22% for Tigo.

5 Results

In this section we report the estimation results of the full model with interactions on product observable characteristics (permanence clause, screen size, and memory size). We use the Nelder-Mead simplex routine to minimize the GMM function. The joint estimation of demand and cost equations is presented in table 3. Panel I shows the parameters of the utility function and panel II the parameters of the cost function. The first column reports mean marginal utilities ($\overline{\alpha}, \overline{\beta}, \overline{\tau}$), the second column deviations from the mean (Σ), and the third column income interactions terms (Π).

We begin with a discussion of the demand side. All the coefficients of the mean marginal utilities are significantly different from zero. Larger screen size is associated on average to higher utility as well as a larger memory size. The coefficient on the permanence clause indicator is negative, as we expected, and suggests consumers experience lower utility levels from terminals sold with postpay calling plans before July 2014 than from

the ones sold under any tariff plan after the enactment of Resolution 4444 and from those with prepay calling plans before the enactment. The negative sign on the coefficient also indicates the consumer faces a higher cost from being locked-in to her initial choice of mobile and network compared to the cost of buying the terminal and then having to search for the voice plan, separately. In other words, the coefficient measures the differential cost in utility due to the permanence clause. The presence of an outside option, captured by the model's constant, is also associated to higher utility levels.

The standard deviations from the average marginal utilities are estimated precisely enough to be different from zero. The coefficient for memory size and screen size imply these characteristics significantly increase the variance of the utility, or consumer taste for memory and screen size is highly volatile. In terms of the substitution patterns, significant standard deviations means consumers who substitute away from a mobile with large memory size (large screen size) when its price increases will tend to do so disproportionately for other mobiles with similar memory size (screen size). As for the permanence clause, we find consumer taste for terminals with postpay calling plans before the enactment of Resolution 4444 is also highly volatile. However, since the average marginal utility of this characteristic is negative, then consumers will substitute away disproportionately towards cash price mobiles (with or without calling plans) when the price of a terminal with permanence clause increases. Notice that, even if we add two standard deviations to the average marginal utility generated by the permanence clause, the effect of permanence clause is still negative.[4] This means that is very unlikely to find consumers who may derive higher utility from being locked-in than from having the option of buying the terminal and the plan separately. Failing to account for deviations from the average marginal utility would, therefore, derive in biased estimates of the switching costs generated by the clause. The standard deviation in the model's constant is also significant, which means there is more variance in the utility generated by the outside than the inside alternatives. Overall, the indicator of permanence clause is the product observable characteristic whose impact on the utility distribution variance is the largest.

To derive a measure of the switching cost in COP we divide the estimate of τ_i by the marginal utility of income α_i. Table (4) reports the measure. Since an observation in our database corresponds to a mobile reference, results in this table must be interpreted as the distribution of the switching cost per mobile terminal. The permanence clause is associated to a cost of 17,579 COP (6.15 USD, approximately) on average per mobile. The maximum cost faced by a consumer due the clause is 53,583 COP (18.74 USD, approximately) and, as shown in the estimates of the standard deviations from the average marginal utilities, in the lower tail of the cost distribution there are some consumers that derive higher utility from the permanence clause: a maximum of 28,720 COP (10.04 USD, approximately) compared to mobiles sold in cash price. The table also reports the consumers' willingness to pay for each of the mobile observable characteristics.

[4]This is implied by computing: $\hat{\bar{\tau}} + 2 \times (\hat{\Sigma}_\tau + \hat{\Pi}_\tau) \approx -6.68 + 2 \times (1.16 + 1.25) < 0$.

Numbers are obtained in the same fashion than with switching costs. For every inch in screen size consumers are willing to pay 132,319 COP (46.27 USD, approximately) on average, while for every ten additional GB in memory size willingness to pay is 100,301 COP (35.07 USD, approximately).

The term on price is of the expected sign and is significantly different from zero. Its magnitude is such that all individual demands are elastic to price, which is crucial for the counterfactual exercises we estimate in the next section. Elastic demands also suggest markups are not infinite (or marginal costs are not negative) in any case even if there are only 5 competitors in the market. Results from the second panel of table (3) show both memory size and screen size increase the marginal cost, but increases due to the former are lower than the ones due to the latter as expected. Increasing memory size only implies changing the memory card on the mobile, while increasing screen size implies redesigning most of the hardware.

In figure (1) we show the distribution of markups as percentage of prices before and after the enactment of Resolution 4444 and in table (5) we report some percentiles of the distribution by tariff plan. The figure shows that the distribution of markups after the enactment moved to the left, with both the average markup and the variance of the distribution reducing with respect to situation before the enactment.

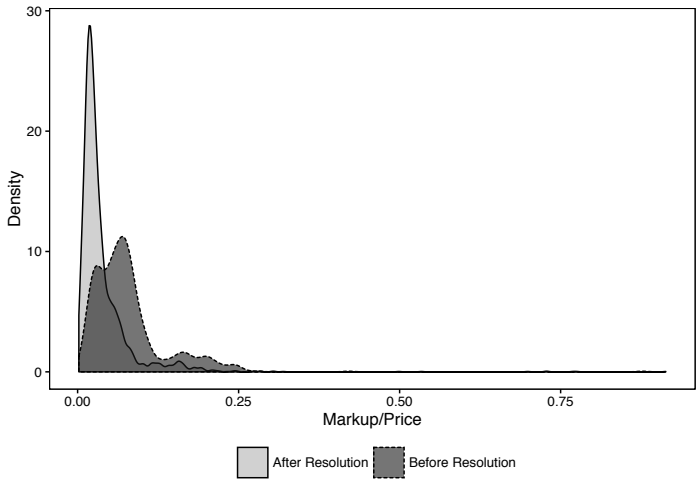

Figure 1: Empirical distribution of markups before and after Resolution

The table also shows, before July 2014, markups charged by producers on terminals with postpay calling plans were significantly higher than those after the enactment. Markups on this calling plan decreased on average 4 percentage points from one period to the other and the maximum markup went from 91% to 15% after the enactment. The same happens with markups charged on terminals with prepay calling plans which went from 7.6% on average to 4.1%. The variance of the distribution in both postpay

and prepay calling plans also decreases, suggesting markups fall and converge as a consequence of the elimination of permanence clauses. This evidence is consistent with the hypothesis that the elimination of permanence clauses induces the entrance of competitors and increases competition in the mobile retail sales market, forcing prices and markups downwards. Nonetheless, we can not empirically measure the effect on entry/exit decisions of retail mobile sales firms. The evidence is incomplete without analyzing markups for SIM free terminals that represent such independent retail sales companies. As reported in the table, the percentiles of the distribution of markups for terminals sold in cash price without voice nor data plans show slight reductions after the enactment of Resolution 4444, but variations are not significant. However, comparing the average markup between tariff plans, we find producers of SIM free terminals have a significantly lower markup than producers who act both as network operators and retail sellers, which might evidence price skimming strategies of the latter in ex-post markets.

All the above results are robust to changes in data and to small modifications in the estimation procedure. In an online appendix,[5] we show very similar estimation results for the same model estimating only the demand-side equations for efficiency purposes and using a more recent data provided by GfK that includes one more year of information. This robustness check also applies for the estimated price-elasticities of demand which, although estimated using another set of data and method of numerical optimization in the estimation process, are not substantially different from the ones shown in this paper.

6 Welfare analysis

To estimate the effect of permanence clauses on consumer, firm, and social welfare we compute two counterfactual scenarios. In the first scenario we assume permanence clauses were inexistent from the beginning of the sample period, hence the permanence clause indicator will take the value of zero. In the second scenario we assume Resolution 4444 was never enacted, thus permanence clauses would still be in force. In this case the permanence clause indicator variable will take the value of 1 for terminals with postpay calling plans before and after July 2014. In the latter, the permanence clause indicator is collinear with the postpay plan indicator. However we already separated the effect of permanence clauses from the aggregated effect of the tariff plan in our structural estimation.[6]

Substitution patterns among tariff plans in both counterfactual scenarios are reported in the first panel of table (6). The second panel reports substitution patterns between

[5]The online appendix can be checked in Alvaro Riascos' official website http://www.alvaroriascos.com/

[6]It is important to mention that in the observed equilibrium, although the elimination of permanence clauses starts in July 2014, the effect is not instantaneous as customers that already had already signed postpaid plans will have permanence clauses until the end of their respective contracts.

distribution channels and the third panel between producers. In the first counterfactual scenario, the elimination of permanence clauses during the months before July 2014 would have incentive consumers to substitute away from mobiles with prepay to mobiles with postpay calling plans. This effect is expected in the sense that under permanence clauses the consumer has to make an overpayment to its monthly tariff on the postpay plan to account for the interest rate on the terminal, therefore eliminating the clause has the consumer search for possibly cheaper ways of financing the terminal and being able to afford a postpay plan instead of a prepay plan. The table also shows that the sales of SIM free mobiles would have remained nearly unchanged under the first counterfactual. Although this result seems counterintuitive, the fact that the counterfactual is only in place for 7 months means we are not able to fully capture consumer switching among plans. The small variations in substitution patterns towards SIM free mobiles are also suggestive of the high entry costs, however the analysis of the effect of permanence clauses on firm entry decisions is left for further study. Overall, total sales would have increased 14,354 units under the elimination of permanence clauses before July 2014 and such increase would have occurred mostly in authorized distributors, whose share to total sales goes from 77% to 78% in the counterfactual. Sales would have also increased for the network operator Claro by almost 2 percentage points. This can be explained both by the fact that even after controlling for market share endogeneity, Claro is the largest network operator in Colombia which makes it more likely for a consumer to switch to this operator rather than to a smaller one or possibly a retail sales company. The second explanation is that because of the strong network incompatibilities between operators, Claro's costumers locked into its network through permanence clauses would have remained with this operator after eliminating the clause due to family effects and past experiences. Results also show consumers would have substitute away from Tigo and Movistar to Claro, suggesting potential network inefficiencies from the former. The fact that variations in the sales composition between the observed scenario and the first counterfactual among distribution channels and among producers are not as big in magnitude as among tariff plans, indicate that where mobiles are sold or who sells them is not as important for consumers as to what type of plan they can have access to.

We find prices decrease from the observed to the first counterfactual scenario but such variations are insignificant.[7] This means the substitution effect dominates the income effect although they both go in the same direction. Increases in the utility level due to the prohibition are greater than increases due to higher available income. The magnitude of these effects helps explain the substitution patterns among tariff plans (shown in table 6). If permanence clauses allow network operators to skim the market for voice and data plans, its prohibition would result in lower prices for plans and mobiles which, conditional on the characteristics of prepay and postpay plans, explains why consumers substitute away from terminals with prepay calling options to those with postpay calling options.

[7]These results are not reported but are available upon request.

In the second counterfactual scenario, the distribution of total sales among distribution channels shows more significant variations compared to the first counterfactual. We find that 7 percentage points of sales move from authorized distributors into department stores. This reflects how permanence clauses negatively impact profits of retail sales companies and potentially their entry decisions by decreasing the price in ex post markets and increasing the entry costs. Having a longer period of analysis in this counterfactual is also helpful for capturing this effect. In fact when we focus on the substitution patterns among producers we find that consumers would have substitute away from Claro mostly towards SIM free firms followed by Tigo and Movistar. This evidence shows that the variations in search costs associated to the terminal and the plan are not as important as the variations in the cost associated to the permanence clause. So overall, permanence clauses generate less consumer switching than is socially optimal. Claro's market share would have decreased 9 percentage points while that of Movistar and Tigo would have increased 3 percentage points each. Although these variations in the composition of sales between producers and distribution channels might not appear big in magnitude they do generate significant variations in consumer, firm, and social welfare as we will show later. In the case of tariff plans, consumers would have substitute away from terminals with prepay calling plans to cash price phones. Again giving evidence against an increase in search costs for consumers and in favor of higher utility due to higher variety of mobiles in the market. The share of SIM free terminals goes from 24% in the observed scenario to 28% in the counterfactual, while the share of terminals with prepay plans decrease 8 percentage points.

Table 7 presents the estimation of equations (16), (17), and (18) for each counterfactual scenario. All numbers are reported in COP of June 2016. For the estimation of ΔF we multiply variations in firm surplus by the inverse proportion of units reported in our data to units sold in the national market[8]. Figure (2) shows to what percentage of total market sales does our data accounts for.

[8]This information was also provided by GfK as mobile sales in Colombia per month.

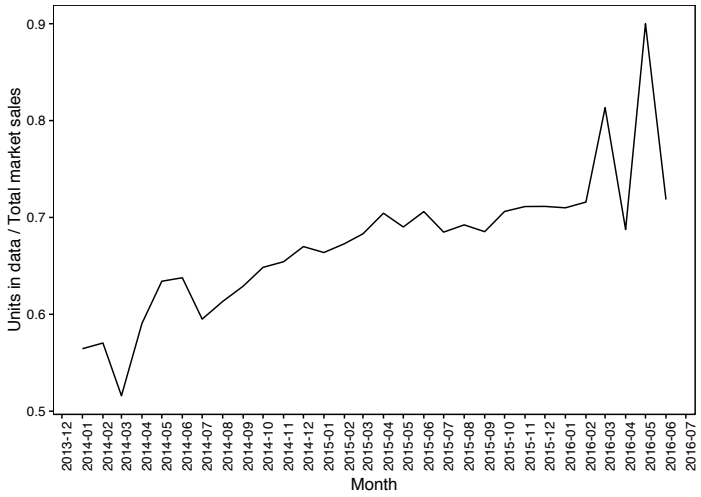

Figure 2: Representativeness of the data to total market sales

If η_t is the representativeness of our data during month t, then firm surplus is extrapolated to total market sales by multiplying units sold in the observed scenario and the counterfactual by $1/\eta_t$. Hence, we are assuming the unobserved portion of the market has the same sales composition as the one we observe. Given that variations are computed as the difference between the measure of welfare in the observed scenario and the measure of welfare in the counterfactual, a negative number suggests the counterfactual situation generates higher welfare, while a positive number means the observed scenario generates higher welfare.

In the first counterfactual, the elimination of permanence clauses from January 2014 would have increased overall welfare relative to the observed scenario by 56,537 million COP (19.77 million USD, approximately). This is explained both by an increase in consumer welfare of 50,069 million COP (17.51 million USD, approximately) and an increase in firm profits of 6,467 million COP (2.26 million USD, approximately). For producers, such gains are derived from more units sold compared to the observed scenario rather than from higher markups. However, increases in firm surplus would have been experienced more by network operators than by SIM free sellers but again this is partly explained by the short period of time in which this counterfactual takes place (see table 6).

In the second counterfactual, allowing permanence clauses would have decreased social welfare by 181,263 million COP (63.38 million USD, approximately) relative to the observed scenario during the 23 months from July 2014 to June 2016. Losses for consumers would have been 178,592 million COP (64.44 million USD, approximately) and for firms 2,671 million COP (0.93 million USD, approximately). The positive variations in producer surplus, which means lower profits from the counterfactual, are explained by the fact higher markups do not outweigh lower sales in the counterfactual.

In fact, sales in the counterfactual fall by approximately 143,639 units as shown in table (6).

Table (7) also shows the average variation in welfare per month, which allows us to compare results between the two counterfactual scenarios. Notice both exercises yield almost the same consumer loss per month, that is, 7,153 million COP (2.51 million USD, approximately) in the first counterfactual and 7,765 million COP in the second (2.72 million USD, approximately); while differences in the variations in firm profits are greater. The first counterfactual reports losses of 924 million COP (0.32 million USD, approximately) and the second of 116 million COP (40,560 USD, approximately) for firms. The aggregate measure of variation in welfare from the societal perspective is also similar between the two exercises, with the first yielding losses of 8,077 million COP (2.82 million USD, approximately) and the second of 7,881 million COP (2.76 million USD, approximately).

Table (8) decomposes the total effect on consumer, firm and social welfare by month. For the first counterfactual we find that during the months with less seasonality and less sales, consumers would have benefited from the permanence clauses. Since the size of the market in these months is relatively small we may be capturing the effect of aggressive competition in ex ante markets on consumer surplus. However from May to January, consumers experience losses that do not outweigh their gains in the previous months. This strong month effect that remains even after controlling for variables that are specific to the market helps us discriminate among types of consumers: we would expect individuals with less willingness to pay to buy mobiles during the months with high seasonality, which explains why variations in consumer surplus are negative in these months. But during any other month, consumers that buy mobiles and plans are more likely to have higher willingness to pay and therefore benefit from the permanence clause in terms of being able to finance their mobiles. From the firm's perspective, table (8) shows that their surplus would have been higher during the 7 months in which we eliminate the permanence clause. Although this result is very sensible to the assumption that marginal costs are the same between the observed scenario and the counterfactual our second exercise does not rely on this assumption and therefore provides better understanding about the variations in firm's profits. For the second counterfactual scenario, monthly variation in consumer surplus is mostly positive, with the greatest effects being perceived during August to December. Regarding variations in firm surplus, these are highly dependent on seasonality. We can clearly see that during months with relatively low sales, March to June, firm surplus is higher when permanence clauses are in place. Although this gives evidence in favor the argument that permanence clauses helps firms to finance their services and provide risk coverage, those gains do not offset the losses that firms experience during the months with high seasonality in which they would have been able to sell more units despite having a lower markup. Overall, both counterfactual analyses show that the variation in firm surplus is considerably lower than the variation in consumer surplus, so welfare losses experienced by consumers due to lower switching rates, less variety and lower service quality, have important policy

implications in the Colombian telecommunications sector.

Both counterfactual scenarios show the Colombian market for mobile terminals has been better off without permanence clauses. In the case of firms, we show network operators have been the ones experiencing greater benefits from the banning, despite their allegations of profit reduction and investment disincentives. In the case of consumers, we show that although there are some who derive higher utility from bundled sales with permanence clauses, their gains are significantly outweighed by the mass of consumers who experience lower utility levels from being locked-in.

As mentioned in the previous section, all the above results are robust to changes in data and to small modifications in the estimation procedure. This can be checked in an online appendix,[9] where we show results that support the same remarks about the welfare effects of permanence clauses for this model estimating only the demand-side equations for efficiency purposes and using a more recent data provided by GfK that includes one more year of information.

7 Conclusions

In this article we study the effect of permanence clauses in the Colombian market for mobile terminals. In particular we measure the impact of Resolution 4444 enacted by the Communications Regulation Commission, which eliminated permanence clauses after July 2014. To derive welfare variations after the enactment, we estimate the structural demand for mobile terminals in Colombia and compute two counterfactual scenarios using the random coefficients discrete choice methodology proposed by BLP. Switching costs due to permanence clauses are captured in the consumer's utility function using an indicator variable of the terminals with postpay calling plans before July 2014. These were the only mobiles sold in bundles with permanence clauses.

Results from the demand estimation show switching costs both reduce the consumer's average utility and increase the variance of the utility distribution. In our counterfactual scenarios we compute the aggregate variations in consumer, firm and social welfare assuming two things: first that permanence clauses were inexistent in the Colombian market throughout the time series, and second that permanence clauses were always in force. Results from the counterfactual scenarios also supported the hypothesis of permanence clauses being detrimental for consumer welfare, but in addition revealed they benefit firms basically because benefits experienced by network operators who sell bundled terminals and plans outweigh losses experienced by deterred competitors who would have sold terminals in cash price (with or without a calling option).

[9]The online appendix can be checked in Alvaro Riascos' official website http://www.alvaroriascos.com/

Our findings contribute to the discussions of the effects of switching costs and bundled sales on social welfare and provides empirical evidence of the effects of bundle sales for the Colombian case and for markets with similar structure. However, we do not address quantitatively all of the perspectives that might impact social welfare, such as investment incentives or entry/exit decision of retail mobile sales firms. Our findings are also relevant from the point of view of public policy since they provide quantitative evidence in favor of one of the most common policies in the telecommunications sector in different countries -the elimination of permanence clauses- and since it shows for the Colombian telecommunications market that allowing for permanence clauses as network operators support from recent discussions regarding Resolution 4444 would reduce welfare of both consumers and firms at least from the point of view of lower product variety and higher switching costs.

Table 1: Summary descriptive statistics

Month	No. of References	Units	Price	Postpay	Prepay	SIM free	Memory size	Screen size
Jan-14	57	344.3	267.0	0.255	0.734	0.011	0.335	2.969
Feb-14	57	351.3	250.5	0.247	0.749	0.004	0.322	2.998
Mar-14	55	330.2	273.4	0.237	0.758	0.005	0.365	2.963
Apr-14	78	305.3	277.8	0.247	0.746	0.007	0.365	3.185
May-14	71	417.3	292.6	0.280	0.704	0.015	0.415	3.388
Jun-14	74	377.6	317.3	0.330	0.666	0.004	0.447	3.454
Jul-14	85	374.3	267.5	0.241	0.700	0.058	0.457	3.452
Aug-14	89	346.5	273.8	0.240	0.694	0.067	0.445	3.509
Sep-14	96	371.2	278.0	0.255	0.659	0.086	0.426	3.502
Oct-14	83	415.7	265.2	0.159	0.754	0.087	0.418	3.606
Nov-14	89	458.6	287.5	0.188	0.649	0.162	0.470	3.657
Dic-14	99	736.2	289.8	0.186	0.667	0.147	0.481	3.794
Jan-15	105	466.0	293.1	0.121	0.753	0.125	0.482	3.643
Feb-15	119	344.5	333.3	0.162	0.647	0.191	0.549	3.773
Mar-15	133	282.8	385.1	0.191	0.590	0.219	0.618	4.025
Apr-15	136	306.4	371.9	0.122	0.639	0.240	0.600	3.961
May-15	135	373.4	390.8	0.122	0.611	0.266	0.615	4.003
Jun-15	116	338.9	394.1	0.099	0.631	0.270	0.641	4.089
Jul-15	105	353.4	373.4	0.094	0.655	0.251	0.603	4.063
Aug-15	133	351.7	399.5	0.080	0.695	0.224	0.619	4.127
Sep-15	153	363.9	412.2	0.093	0.667	0.241	0.630	4.101
Oct-15	135	362.3	465.6	0.118	0.580	0.302	0.701	4.216
Nov-15	109	374.8	394.5	0.124	0.604	0.272	0.645	4.092
Dic-15	109	631.7	400.6	0.109	0.555	0.336	0.658	4.195
Jan-16	114	359.9	423.3	0.137	0.544	0.319	0.726	4.202
Feb-16	128	310.0	455.1	0.124	0.498	0.378	0.799	4.302
Mar-16	121	321.3	452.8	0.134	0.549	0.317	0.787	4.316
Apr-16	119	344.5	462.4	0.126	0.562	0.312	0.811	4.326
May-16	106	395.1	408.3	0.122	0.543	0.335	0.776	4.296
Jun-16	94	342.0	458.8	0.150	0.490	0.360	0.851	4.440

Note: This table shows some summary descriptive statistics. The last 6 columns report the weighted-sales mean. Authors' calculations based on the data from GfK.

Table 2: Number of mobiles sold per channel and tariff plan

		Before Resolution		After Resolution	
		AD	DS	AD	DS
Postpay	Claro	450,858	92,147	854,001	108,873
	Movistar	28,982	32,453	21,746	84,291
	Tigo	4,728	51,043	17,354	190,227
		25.2%	**30.4%**	**16.4%**	**10.9%**
Prepay	Claro	1,344,965	287,752	3,968,297	705,191
	Movistar	31,084	38,280	17,165	153,945
	Tigo	53,876	45,467	390,578	338,986
		74.4%	**64.1%**	**80.5%**	**34.1%**
SIM free	SIM free	6,882	31,811	169,130	1,930,822
		0.4%	**5.5%**	**3.1%**	**55.0%**
Total		**1,921,375**	**578,953**	**5,438,271**	**3,512,335**

Note: This table shows the market share over the effective market ($\sum_j s_j = 1$) for each tariff plan before and after Resolution 4444 in authorized distributors(AD) and department stores (DS). Authors' calculations based on the data from GfK.

Table 3: Results from the full model

Variable	Estimate	Standard deviation	Interaction with income
Panel I: Demand			
Constant	-102.178^{***}	2.251^{***}	1.531^{***}
	(0.002)	(0.389)	(0.092)
Permanence clause	-6.676^{**}	1.155^{***}	1.251^{***}
	(0.002)	(0.415)	(0.032)
Price	-27.750^{***}	3.240^{***}	1.107^{***}
	(0.018)	(0.001)	(0.001)
Memory size	23.303^{***}	1.351^{***}	1.151^{***}
	(0.003)	(0.099)	(0.025)
Screen size	32.995^{***}	0.516^{***}	0.251^{***}
	(0.011)	(0.129)	(0.017)
Panel II: Cost			
log(Memory size)	0.031		
	(0.021)		
log(Screen size)	2.096^{***}		
	(0.004)		

Note: This table shows the joint estimation of demand (Panel I) and pricing equations (Panel II) in the full model with interactions. The first column shows the mean marginal utility, the second column shows the deviations from the mean, and the third the interactions with income. In both panels numbers in parenthesis are the standard errors. Authors' calculations from the data by GfK.

Table 4: Distribution of marginal utilities in COP

	Min	Pct(25)	Pct(50)	Pct(75)	Max	Mean	s.d
τ_i/α_i	−53,583	−24,014	−17,848	−11,504	28,720	− 17,579	9,812
$\beta_i^{Memory}/\alpha_i$	47,079	84,305	97,394	113,064	194,550	100,301	22,927
$\beta_i^{Screen}/\alpha_i$	81,282	116,818	129,267	144,870	228,845	132,319	22,422

Note: This table shows the distribution of marginal utilities associated to each observable characteristic. Numbers are reported in $COP_{June2016}$. The distribution is obtained by dividing each marginal utility by α_i. Authors' calculations from the data by GfK.

Table 5: Distribution of markups (%) by tariff plan before and after the Resolution

	Min	Pct(25)	Pct(50)	Pct(75)	Max	Mean	s.d
Before							
Postpay	0.42	2.45	3.85	7.04	91.33	6.14	7.92
Prepay	0.45	4.21	6.74	8.79	28.38	7.59	4.90
SIM free	0.19	1.39	1.85	2.43	7.94	1.97	0.97
After							
Postpay	0.32	1.23	1.76	2.47	14.96	2.20	2.15
Prepay	0.25	1.95	3.04	4.94	76.90	4.12	4.21
SIM free	0.23	1.17	1.77	2.33	7.55	1.89	1.16

Nota: This table shows the distribution of markups as a percentage of price by tariff plan, before and after the enactment of Resolution 4444. Markups are obtained from equation 9. Authors' calculations from the data by GfK.

Table 6: Substitution patterns in the counterfactual scenarios (%)

	Before Resolution		After Resolution	
	Observed	Counterfactual 1	Observed	Counterfactual 2
Tariff plans				
Postpay	26.40	31.09	14.26	18.08
Prepay	72.05	67.52	62.28	54.43
SIM free	1.55	1.39	23.46	27.49
Distribution channel				
AD	76.84	78.30	60.76	53.74
DS	23.16	21.70	39.24	46.26
Producers				
Claro	87.02	88.49	62.97	53.59
Movistar	5.23	4.67	3.10	5.51
Tigo	6.20	5.46	10.47	13.41
SIM free	1.55	1.39	23.46	27.49
Total Units	2,500,328 (100%)	2,514,682 (100%)	8,950,606 (100%)	8,806,967 (100%)

Note: This table reports the substitution patterns as changes in market share among tariff plans, distribution channels, and producers. In the first scenario we assume permanence clauses were inexistent from the beginning of the sample period. In the second scenario we assume Resolution 4444 was never enacted, thus permanence clauses would still be in force. The first two columns report market shares under the observed scenario and the first counterfactual from January 2014 to July 2014 (before the Resolution). The last two columns report market shares under the observed scenario and the second counterfactual from August 2014 to June 2016 (after the Resolution).

Table 7: Aggregate variation in consumer, firm, and social welfare due permanence clauses

Scenario		Δ C	Δ F	Δ S
Counterfactual 1	Total	−50,069	−6,467	−56,537
No Permanence Clauses	Mean	−7,153	− 924	−8,077
Counterfactual 2	Total	178,592	2,671	181,263
Permanence clauses always	Mean	7,765	116	7,881

Note: This table shows the aggregate variations in consumer, firm and social welfare implied by two counterfactual scenarios: one in which permanence clauses were inexistent (counterfactual 1), and another in which permanence clauses were always permitted (counterfactual 2). Results for Δ F are extrapolated to the Colombian market by multiplying the variations by the difference of GfK's representativeness to total market sales. We report the total variation over the months each counterfactual takes place and the monthly average variation. Numbers are reported in million $COP_{June2016}$. Authors' calculations from the data by GfK.

Table 8: Monthly variation in consumer, firm, and social welfare due to permanence clauses under national sales

	Counterfactual 1 No permanence clauses			Counterfactual 2 Permanence clauses always		
	Δ C	Δ E	Δ S	Δ C	Δ E	Δ S
Jan-14	−41,348	−102	−41,450			
Feb-14	4,673	−721	3,952			
Mar-14	2,186	223	2,408			
Apr-14	6,977	−633	6,344			
May-14	−7,677	−1,592	−9,269			
Jun-14	−8,775	−3,567	−12,342			
Jul-14	−6,105	−75	−6,180			
Aug-14				1,180	48	1,228
Sep-14				3,064	48	3,111
Oct-14				−1,666	8	−1,658
Nov-14				278	−151	127
Dic-14				3,543	−124	3,418
Jan-15				27,639	1,895	29,534
Feb-15				22,445	879	23,324
Mar-15				4,289	−173	4,116
Apr-15				7,744	−160	7,585
May-15				3,247	−179	3,068
Jun-15				13,821	−48	13,773
Jul-15				5,800	−166	5,635
Aug-15				11,721	238	11,959
Sep-15				26,546	747	27,293
Oct-15				15,615	328	15,943
Nov-15				12,775	286	13,061
Dic-15				3,300	484	3,784
Jan-16				−9,575	−256	−9,831
Feb-16				−5,955	−351	−6,306
Mar-16				9,205	−155	9,051
Apr-16				18,931	−201	18,730
May-16				6,350	−79	6,271
Jun-16				−1,705	−246	−1,951

Note: This table reports the monthly variations in consumer, firm, and social welfare under national sales implied by two counterfactual scenarios: (1) in which permanence clauses were always prohibited and (2) in which clauses were always in force. Numbers are reported in $COP_{June2016}$. Authors' calculations based on the data from GfK.

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