The Effect of Shortening Lock-in Periods in Telecommunication Services

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Abstract

We study and measure the welfare implications of shortening the lock-in periods associated to triple play contracts using household level data for a period of 6 months from a large telecommunications provider. Using a multinomial logit model to explain consumer behavior we show that shortening the lock-in period decreases the profit of the firm more than it increases consumer surplus and, therefore, regulators need to be very careful when considering regulating these periods. If regulators shorten lock-in periods then firms are likely to respond by increasing prices to maintain their return on investment. We show that this behavior, however, will make consumers worse off compared to a world in which lock-in periods do not change. This result shows that regulators shortening lock-in periods may also need to regulate prices to avoid significant loss to consumers. Our paper effectively measures the effect of changing lock-in periods on consumer welfare, thus complementing the prior literature that looked at the effect of the former only on prices and churn rates, and shows the importance of using several regulatory policies in tandem to achieve the desired goals.

1 Introduction

In industries with significant investment in capex firms typically opt for subscription-based business models locking-in consumers into long-term contracts. These contracts, often termed lock-in periods in the industry, aim at ensuring that consumers stay with the firm enough time so that the cumulative of their monthly bills over their lifetime with the company covers not only the costs with maintenance and service provision but also the initial capital costs. In this type of markets,

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consumers can still terminate contracts before the lock-in period is over and leave to a competitor – an action called churn. However, in order to do so they need to pay significant financial penalties, which are again set in a way that allows the firm to cover its costs. Financial penalties may also be enforced when consumers change service within the same company. Lock-in periods are a particular case of switching costs, which, in essence, include any mechanism by which firms reduce the incentive of consumers to leave. Other examples besides lock-in periods include search costs, given that consumers have to search for a new service prior to switching, and learning costs, which may be significant when consumers have to acquire new skills to learn how to take advantage of new complex services (Klemperer, 1995).

For the most part, switching costs hurt consumers because they reduce the freedom to choose service provider (Klemperer, 1987). However, a number of complex effects may arise that render the effect of switching costs on consumer welfare ambiguous from a theoretical point of view (Dubé et al., 2009; Villas-Boas, 2015). For example, if firms cannot exploit existing consumers they are less likely to compete for them in the first place, which increases the average price. This complex dynamics suggest the need for empirical studies to find, in practice, the effect of switching costs on consumer behavior and welfare. Such empirical studies are much less abundant than the theoretical literature on the potential effects of switching costs. To this end, our study provides an empirical analysis of switching costs and focuses on the telecommunications industry, which is a good setting to study their effect. For example, in the European Union, the Telecommunications Law enforces that service contracts that lock-in consumers cannot exceed 24 months and operators must offer at least one alternative with a lock-in period shorter than 13 months (European-Union, 2009). Recent regulation by the FCC in the US (CTIA, 2014) requires mobile providers to allow consumers to unlock phones for free (and thus change provider and keep their device) once they stayed with the carrier for 24 months or paid the contracted financial penalty to leave. Likely, the policy debate will next focuses on how this law may extend beyond mobile services and whether 24 months is the appropriate duration for the lock-in period.

The contribution of our paper is therefore to study, and measure, the welfare implications of shortening the lock-in period to less than the current status quo of 24 months. Furthermore, we study the market for triple-play services, which is now dominant both in the US and in the EU (OVUM, 2015). We use data from a large provider between April and October 2013. For each household over time we have information on the service bundle they subscribe, the monthly price they pay, the lock-in period they face and the financial penalty they need to pay if they were to breach the contract. We also know when households change service within the company and when they churn. We also have information on similar bundles from competitors and on the prices they charge. We fit a multinomial logit model to this data to study the effect of switching costs, which are measured, in dollar terms, as reductions in consumer surplus. In our setting, and as expected, we find that switching costs within the company are, on average, slightly lower than the switching cost associated to churn. We also find, as expected, that switching costs reduce when lock-in periods are over.

More importantly, we find that shortening the lock-in period from the current status quo of 24 months decreases the profit of the firm more than it increases consumer surplus. This result shows that regulators need to be very careful when considering shortening lock-in periods because doing so may reduce welfare. Our study provides measurements for how regulators may trade off increases in consumer surplus with reductions in welfare if they were to focus solely on the former. A consequence of this result is that consumer surplus reduces if firms react to shorter lock-in periods by increasing prices to keep their profit levels. Therefore, our paper also shows that regulators enforcing shorter lock-in periods must also regulate prices to avoid significant loss to consumers. We also compute the maximum increase in prices that would render consumers indifferent between higher prices and longer lock-in periods. Our paper is the first to measure the switching costs associated to lock-in periods in the context of triple play services in telecommunications markets. Furthermore, we do so at the household level and we measure the effect of shortening the lock-in period on consumer surplus and firm profit, therefore going a step further relative to the prior literature that studied only the effect of switching costs on churn rates and, sometimes, on prices. We expect this work to provide novel insights to telecom regulators at a time when regulating the length of lock-in periods in being heavily debated in the industry, and in particular on the importance of using several policies in tandem to achieve the desired goals.

The remainder of our paper is organized as follows. Section 2 reviews the related work. Section 3 describes our empirical context and data. Section 4 introduces our model and empirical strategy. Section 5 presents our estimation results and policy simulation results. Section 6 summarizes our conclusions.

2 Literature Review

In subscription-based markets consumers generally bear substantial costs to change service or to switch provider. The presence of these costs has a critical impact on consumer behavior and firm strategy. According to (Chen and Hitt, 2006) these costs include search costs, transaction costs, learning costs, complementary costs and contractual switching costs. Search costs capture the effort that consumers may have to make in order to acquire information about alternative products. These costs are also sometimes also called pre-switching (Jones et al., 2002). High search costs can immediately lead to significant customer lock-in. Tools that allow for easily browsing information about the products available in the market, such as the Internet, may reduce them significantly. Transaction costs refer to expenditures during switching. The canonical example is the administrative costs associated to closing a bank account at one bank and setting up a new one at another bank (Colgate and Lang, 2001). Learning costs refer to the time and effort spent by consumers to learn how to use a new product, which increase with product complexity, sometimes to the point of requiring consumers to acquire new sets of skills (Klemperer, 1987; Burnham et al., 2003). Complementary investments refer to assets that only work with one product that consumers may need to invest in to take full advantage of the products they own. Examples include Apple's and Microsoft's ecosystems of software and applications. Lastly, contractual switching costs refer to contracts that offer discounts to consumers that make repeated purchases and/or require consumers to pay penalties for terminating them prior to expiry.

Regulatory authorities oversee switching costs and suggest legislation that Governments may enforce to limit them. This is a complex task because regulators have to deal with the trade-off between consumer surplus and market welfare, the latter defined as the sum of consumer surplus and firm profits. The regulator's role requires them to manage a double edge sword. According to the conventional wisdom, low switching costs are likely to increase consumer surplus (Klemperer, 1995). However, and at the same time, low switching costs provide little incentive for firms to provide service in the first place, which reduces both consumer surplus and welfare (Farrell and Klemperer, 2007). In addition, total welfare may also change depending on the allowed level of switching costs. Therefore, the regulator's task is not just one of fairly splitting welfare between consumers and firms but also one of looking for ways to maximize overall well-being (Gans, 2001). In general, regulators aim at limiting switching costs because when they are significant, market leaders are likely to enjoy a significant advantage that allows them to sustain a large market share (Lieberman and Montgomery, 1998; Bijwaard et al., 2008). With high switching costs entrants have a hard time to steal consumers that are locked-in to the market leader.

However, very low switching costs may also have an adverse effect for consumers (Cabral, 2009), which may seem counter-intuitive at first. One reason why switching costs hurt consumers is that firms can exploit consumers that are locked-in, a strategy called bargain-then-rip off (Klemperer, 1987, 1995). In fact, a number of empirical studies found that switching costs increase average prices (Sharpe, 1997; Shy, 2002; Stango, 2002; Viard, 2007) because firms charge higher prices to existing consumers (Chen, 1997). If firms cannot exploit these consumers then they have fewer incentives to attract them in the first place (Dubé et al., 2009; Shin and Sudhir, 2008; Doganoglu, 2010), which may result in higher prices. In addition, rational consumers foresight and realize that firms are likely to exploit them in the future and thus may be reluctant to accept low prices to begin with (Rhodes, 2014) in exchange for long lock-in periods, which creates attrition in the market and reduces consumer welfare. Furthermore, the higher the switching costs the less likely that consumers are myopic. An outlook of fewer consumers in the market is likely to increase risk and preclude the firm from investing enough capital at the outset (Laffont and Tirole, 2001; Gans, 2001; Chen and Hitt, 2006)

Regulators have been very active in monitoring switching costs and a number of papers use empirical data to measure them. For example, Borenstein (1991) measured the magnitude of switching cots in the US retail gasoline market, Knittel (1997) showed how the presence of significant switching costs led to little change in the prices of long distance phone calls in the US after the divestiture of AT&T in 1984, Viard (2007) studied the introduction of number portability for toll-free numbers in the US and found that switching costs had an ambiguous effect on prices for firms that could not discriminate between existing and new consumers, Epling (2002) studied competition in the long distance telephony in the US after the Telecom Act of 1996 and found that consumers subject to higher switching costs paid higher prices, Grzybowski (2008) found significant switching costs in the mobile sector in the UK after the turn of the century. Closer to our work, Shcherbakov (2016) studied switching costs in the TV industry in the US between 1997 and 2006. He found that these amounted to $109 and $186 for cable and satellite systems, respectively. These estimates are remarkably close to the ones we find in our paper.

In recent years, Governments around the world have been tightening regulations in the wireless industry. For example, in the US, President Obama signed the "Unlocking Consumer Choice and Wireless Freedom Act" into law in February 2014 (US.Congress, 2014), requiring US carriers to comply with requests from both prepaid and postpaid consumers to unlock their devices, which allows them to switch provider and keep the same handset, as long as certain parameters are met. Ofcom in the UK is currently triggering the exact same discussion (Ofcom, 2016). One such parameter is that the consumer remained with the carrier for the duration of the lock-in period or else paid a financial penalty to terminate it ahead of time. The questions that remain before us now are whether this line of regulatory policy will extend to other telecommunications services and what may happen if regulators change the minimum time that consumers have to stay with the carrier to become lock-in free. In this respect, our paper provides a timely analysis of how shortening lock-in periods may affect both consumers and firms in triple play markets. To the best of our knowledge, our paper is the first to develop such analysis. As customary in the field, we use Customer Lifetime Value (CLV) to measure how much consumers are worth to the firm (Gupta et al., 2004; Gupta and Lehmann, 2006; Gupta et al., 2006) and we use a multinomial logit model to measure consumer surplus as transformations of utility levels into dollar terms (Train, 2009).

3 Empirical Context

We use a transactional dataset from large telecommunications triple-play provider (hereafter referred as TELCO) covering the period between April and October 2013. Triple play service includes TV, Internet and fixed telephony. For each household and each month this dataset contains information on bundle subscriptions and prices charged. For each bundle offered by TELCO we have bundle-specific characteristics such as number of TV channels, the maximum Internet speed, premium features such access to Video-on-Demand and whether mobile service was included. We also have household level characteristics including the number of months that the household has been using each service from TELCO, that is, the households' tenure with each service, and the age of the head of the household that the firm records when service is initiated. Our data also has information on the monthly usage of these services, such as download and upload traffic with the Internet and the number of fixed-to-fixed phone calls. In this paper we analyze a random sample of 97,228 TELCO households. Our panel includes 6 months of data from April to October 2013. The subsections below describe in more detail the triple-play bundles available to consumers, the types of contracts that they can subscribe alongside with the associated switching conditions. We also describe the likelihood of changing bundle inside the carrier and that of churning.

3.1 Data on Triple Play Bundles

Our industrial partner is the leading provider of telecommunication services in the country we analyze and 70% of its customers subscribe triple-play service. Table 1 shows that these bundles offered different numbers of TV channels and different Internet speeds. Some bundles are marked premium and offer advanced features such as video-recording and video-on-demand. One bundle also offers mobile service. The 16 bundles in the this table make up for more than 95% of the triple-play market. This table reports the average price charged for each bundle and the standard deviation. The same bundle may be charged different prices to different households depending, for example, on when each household signs up and marketing campaigns. The price charged for any bundle to each household may change slightly around the list price. Prices depend, for example, on when households sign up, ongoing marketing campaigns and specific negotiations with TELCO. We also have information on the price of the best offer from a competitor for each bundle in the same local market. Specifically, for each household and each bundle, we have data that summarizes the lowest price available in the market in the local neighborhood for similar bundles offered by TELCO competitors.

Table 1: Summary statistics on Triple-Play packages offered by our industrial partner

No.	Share	N.channels	Internet	Telephony	Premium	Mobile	Avg. Price	Sd. Price	Best.Price
1	0.20	$\simeq$ 120	$\simeq$ 30mbps	Yes	No	No	57.62	13.42	52.59
2	0.13	$\geq$ 160	$\geq$100mbps	Yes	Yes	No	64.73	5.71	62.57
3	0.12	$\geq$ 160	$\geq$100mbps	Yes	Yes	No	71.65	12.36	67.75
4	0.11	$\geq$ 160	$\simeq$ 30mbps	Yes	Yes	No	57.57	5.77	53.63
5	0.07	$\geq$ 160	$\geq$100mbps	Yes	Yes	No	73.41	4.04	69.51
6	0.07	$\geq$ 160	$\geq$100mbps	Yes	Yes	No	76.78	10.67	71.65
7	0.05	$\simeq$ 120	$\simeq$ 10mbps	Yes	No	No	58.68	4.77	51.08
8	0.04	$\simeq$ 120	$\simeq$ 10mbps	Yes	No	No	54.31	2.54	53.36
9	0.04	$\simeq$ 150	$\simeq$ 10mbps	Yes	No	No	57.16	4.49	54.59
10	0.03	$\geq$ 160	$\geq$100mbps	Yes	Yes	No	73.01	12.10	70.50
11	0.03	$\simeq$ 150	$\geq$100mbps	Yes	No	No	54.98	11.46	52.92
12	0.02	$\simeq$ 30	$\simeq$ 10mbps	Yes	No	No	51.99	0.10	51.99
13	0.02	$\simeq$ 30	$\simeq$ 1mbps	Yes	No	No	45.93	1.23	45.48
14	0.02	$\geq$ 160	$\geq$100mbps	Yes	Yes	Yes	101.97	11.40	100.31
15	0.02	$\simeq$ 150	$\simeq$ 10mbps	Yes	No	No	55.82	6.78	53.36
16	0.02	$\simeq$ 120	$\simeq$ 30mbps	Yes	No	No	58.67	3.85	57.65

(a) All money values are in 2013 US Dollars. (b) *Premium* is a dummy variable indicating whether the product contains premium features. (c) *Best.Price* stands for the lowest price available in the local market for a bundle with similar features offered by other service providers.

3.2 Contract Types, Switching Conditions and Descriptive Statistics

A second dataset from our industrial partner includes detailed information on the contract signed by each household. Using anonymous identifiers we are able to match the contract information with the subscription level data such that for each bundle subscribed we know when was it was first subscribed as well as how many months to lock-in expiry are left in a certain month. During our period of analysis consumers can change bundle inside the same carrier or switch carriers. A consumer whose lock-in period is over needs to endure a lock-in period of 12 months when changing bundle inside the carrier. A consumer that is more than 12 months away from lock-in expiry experiences no change in the lock-in duration if she changes bundle inside the carrier. A consumer who is less than 12 months away from lock-in expiry gets her lock-in period reset to 12 months if she changes bundle inside the carrier. New consumers face always a lock-in period of 24 months so if a consumer switches providers then a lock-in period of 24 months is enforced by the new provider.

Between April and October 2013 two types of service changes can occur. Households can change bundle inside the carrier or churn. On average per month, 1% of the consumers churn, 4% of them change bundle inside the carrier and 2% of the consumers are new. Figure 1 shows the density of changes inside the carrier and churn as a function of time to lock-in expiry. The x-axis shoes the number of months to lock-in expiry and negative values indicate the number of months after the lock-in period expires. Rates of change in these figures are small within the first 12 months of a 24 month lock-in period. Otherwise, change happens when lock-in periods expire, in particular significant churn occurs around month 24. Sometimes, consumers churn when there is still 1 month to contract expiry because competitors cover this financial penalty to steal consumers. Changes inside the carrier happen within the second part of 24-month lock-in periods. These changes set back the lock-in period to 12 months. A peak of changes within the carrier occurs at around 10 months into the lock-in period, which may be related to the firm's proactive marketing strategies that are in part aimed at ensuring that lock-in periods remain far from expiry. During our period of analysis 54% of the households in our sample were within a lock-in period. Furthermore, during our period of analysis, all major service providers that compete with TELCO adopt similar contract policies.

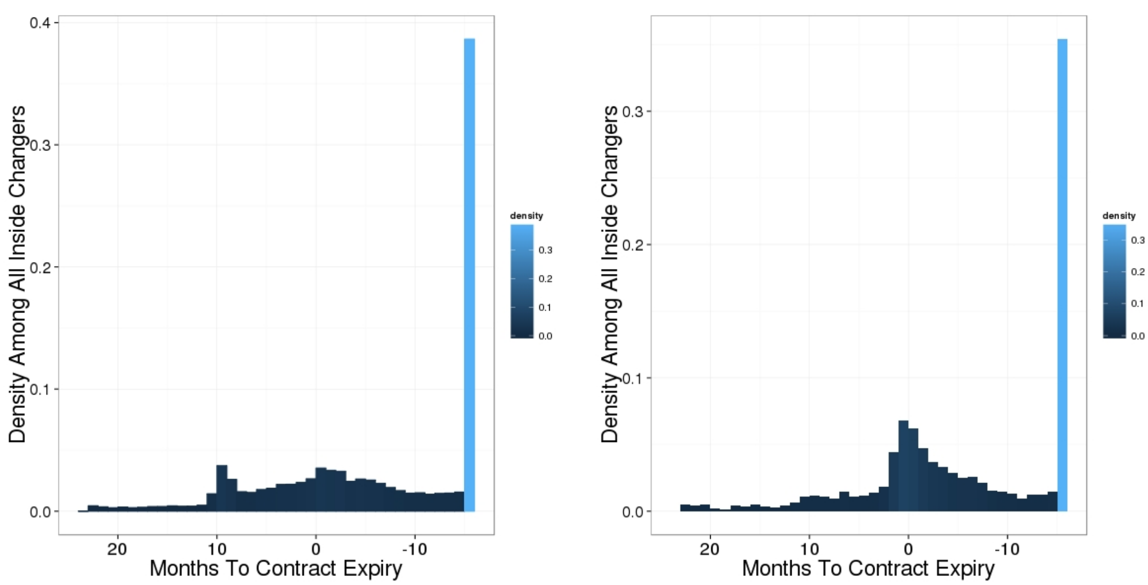

Figure 1: Density of changes inside the carrier and churn as a function of time to lock-in expiry

4 Model

4.1 Choice Model and Switching Costs

We model household behavior using a multinomial logit model. Households choose among J triple play bundles at TELCO or churn. If a household churns we assume it does so to subscribe a similar triple play bundle from a competitor. The prices offered by competitors are set as described in section 3.1. In this setting the utility of household h from choosing alternative j at time t, represented by u^t_{hj}, is given by:

$$u^t_{hj}(\mathbf{X_j}, p^t_{hj}, \mathbf{a_h^{t-1}}, \mathbf{z_h^t}, l^t_h, L^t_h) = V^t_{hj}(\mathbf{X_j}, p^t_{hj}, \mathbf{a_h^{t-1}}, \mathbf{z_h^t}, l^t_h, L^t_h) + \epsilon^t_{hj} \tag{1}$$

where $V(\cdot)$ represents the observable part of utility, which depends on a vector of bundle specific characteristics $\mathbf{X_j}$, the monthly bill p^t_{hj}, the household's choice of bundles up to the previous time period $\mathbf{a_h^{t-1}}$, a vector of demographic time-varying characteristics $\mathbf{z_h^t}$, the remaining lock-in period l^t_j and the original length of the last lock-in period (potentially the current one if still active), L^t_j. ϵ^t_{hj} represents the idiosyncratic error term, which we assume follows an i.i.d. Type I extreme value distribution. The probability that household h chooses alternative j at time t, which abusing slightly notation we represent by a^t_h, is given by:

$$P(a^t_h = j \mid \{\mathbf{X_j}, p^t_{hj}, \mathbf{a_h^{t-1}}, \mathbf{z_h^t}, l^t_j, L^t_j\}_{j=1}^{J+1}) = \frac{\exp u^t_{hj}(\mathbf{X_j}, p^t_{hj}, \mathbf{a_h^{t-1}}, \mathbf{z_h^t}, l^t_h, L^t_h)}{1 + \sum_{k=1}^{J+1} u^t_{hk}(\mathbf{X_h}, p^t_{hk}, \mathbf{a_h^{t-1}}, \mathbf{z_h^t}, l^t_h, L^t_h)} \tag{2}$$

We use a linear functional form for $V(\cdot)$ to estimate switching costs both to change bundle inside TELCO as well as to churn. We define:

$$
\begin{aligned}
V^t_{hj}(\mathbf{X_j}, p^t_{hj}, \mathbf{a^{t-1}_h}, \mathbf{z^t_h}, l^t_h, L^t_h) =& \mathbf{X_j}\alpha - \beta p^t_{hj} + \mathbf{z^t_h}\mu_j - \gamma_1 C^t_{hj} I_j \\
& + \gamma_2 C^t_{hj} O_j \mathbb{1}(l^t_h \leq 1) + \gamma_3 C^t_{hj} O_j \mathbb{1}(l^t_h > 1) + \gamma_4 C^t_{hj} O_j \mathbb{1}(l^t_h > 1) l^t_h \\
& + \gamma_5 C^t_{hj} O_j \mathbb{1}(l^t_h \leq 1) L^t_j + \gamma_6 C^t_{hj} O_j \mathbb{1}(l^t_h > 1) L^t_h \\
& + \gamma_7 C^t_{hj} O_j \mathbb{1}(l^t_h \leq 1) Tenure^t_h + \gamma_8 C^t_{hj} O_j \mathbb{1}(l^t_h > 1) Tenure^t_h
\end{aligned}
\tag{3}
$$

where $I_j = \mathbb{1}(j \neq J+1)$ and $O_j = \mathbb{1}(j = J+1)$ indicate whether alternative j is a bundle inside TELCO or churn, respectively. $C^t_{hj} = \mathbb{1}(a^{t-1}_h \neq j)$ indicates whether household h changes bundle at time t. $Tenure^t_h$ indicates the tenure of household h at time t with TELCO and $\mathbf{z^t_h}\mu_j$ represent interactions between household characteristics and dummies for each alternative. All coefficients in this expression have economic meaning and their ratio to β provide interpretations in dollar terms. γ_1 estimates the switching cost associated to changing bundle inside TELCO. γ_2 estimates the switching cost associated to churn when there is less than 1 month to the end of the current lock-in period (given that competitors typically cover the last monthly bill with the previous provider). γ_5 shows how this estimate changes with the original length of the current lock-in period and γ_7 shows how it changes with tenure. γ_3 estimates the switching cost associated to churn when there is more than 1 month to the end of the current lock-in period. γ_4 shows how an additional month within the lock-in period changes this estimate. Finally, γ_6 shows how this estimate changes with the original length of the current lock-in period and γ_8 shows how it changes with tenure. We expect the coefficients of switching cost terms (γ_1, γ_2 and γ_3) to be negative because they reduce product utility. γ_4 is expected to be negative because switching costs decrease with time to lock-in expiry. We expect γ_5 to be positive because consumers may get tired of a longer contract and be more likely to churn when the contract has expired. We also anticipate γ_7 and γ_8 to be negative because customers with longer relationships with the firm are less likely to churn.

4.2 Consumer Surplus and Firm Profit

With a multinomial logit model the surplus of the representative household is given by the utility of the best alternative, that is

$$CS_h^t(\{\mathbf{X_j}, p_{hj}^t, \mathbf{a_h^{t-1}}, \mathbf{z_h^t}, l_h^t, L_h^t\}_{j=1}^{J+1}) = \frac{1}{\beta} \max_{j=1,\dots J+1} \{u_{hj}^t(\mathbf{X_j}, p_{hj}^t, \mathbf{a_h^{t-1}}, \mathbf{z_h^t}, l_h^t, L_h^t)\} \tag{4}$$

$$E[CS_h^t(\{\mathbf{X_j}, p_{hj}^t, \mathbf{a_h^{t-1}}, \mathbf{z_h^t}, l_h^t, L_h^t\}_{j=1}^{J+1})] \approx \frac{1}{\beta} \ln(\sum_{j=1}^{J+1} \exp(V_{hj}^t(\mathbf{X_j}, p_{hj}^t, \mathbf{a_h^{t-1}}, \mathbf{z_h^t}, l_h^t, L_h^t))) + C \tag{5}$$

where the approximation for the expected value is obtained from integrating over the distribution of the error term and C is an unknown constant that is irrelevant for comparison purposes and therefore usually ignored for policy analysis (Train, 2009). The expected cumulative surplus of the representative household is therefore given by

$$E[CS_h] = \sum_{t=0}^{\infty} \frac{E[CS_h^t(\{\mathbf{X_j}, p_{hj}^t, \mathbf{a_h^{t-1}}, \mathbf{z_h^t}, l_h^t, L_h^t\}_{j=1}^{J+1})]}{(1+\delta)^t} A_h^t(\{\mathbf{X_j}, p_{hj}^t, \mathbf{a_h^{t-1}}, \mathbf{z_h^t}, l_h^t, L_h^t\}_{j=1}^{J+1}) \tag{6}$$

$$A_h^t(\{\mathbf{X_j}, p_{hj}^t, \mathbf{a_h^{t-1}}, \mathbf{z_h^t}, l_j^t, L_j^t\}_{j=1}^{J+1}) = \prod_{\tau=0}^{t-1} 1 - P(a_h^t = J+1 \mid \{\mathbf{X_j}, p_{hj}^t, \mathbf{a_h^{t-1}}, \mathbf{z_h^t}, l_h^t, L_h^t\}_{j=1}^{J+1}) \tag{7}$$

where $A_h^t(\cdot)$ represents the survival probability of household h at time t. δ represents the household monthly interest rate.

The profit of the firm is measured using household lifetime value, which is the sum of discounted net future earnings. The earnings include two parts, namely monthly payments and financial fees paid when contracts are terminated before expiry. Therefore, the profit of the firm, represented by

Π_h, is given by

$$\Pi_h^t = \sum_{k=1}^{J} s_k^t(p_{hk}^t - c_{hk}^t) A_h^t(\{\mathbf{X_j}, p_{hj}^t, \mathbf{a_h^{t-1}}, \mathbf{z_h^t}, l_h^t, L_h^t\}_{j=1}^{J+1})$$
$$+ B_h^t(\{\mathbf{X_j}, p_{hj}^t, \mathbf{a_h^{t-1}}, \mathbf{z_h^t}, l_h^t, L_h^t\}_{j=1}^{J+1}) \mathbb{1}(L_h^t - t \geq 1) p_{ha_h^{t-1}}^{t-1}(L_h^t - t) \quad (8)$$

$$\Pi_h = \sum_{t=0}^{\infty} \frac{\Pi_h^t}{(1+r)^t} - AC_h^t \quad (9)$$

$$B_h^t(\{\mathbf{X_j}, p_{hj}^t, \mathbf{a_h^{t-1}}, \mathbf{z_h^t}, l_h^t, L_h^t\}_{j=1}^{J+1}) = P(a_h^t = J+1 \mid \{\mathbf{X_j}, p_{hj}^t, \mathbf{a_h^{t-1}}, \mathbf{z_h^t}, l_h^t, L_h^t\}_{j=1}^{J+1})$$
$$\prod_{\tau=0}^{t-1} 1 - P(a_h^\tau = J+1 \mid \{\mathbf{X_j}, p_{hj}^\tau, \mathbf{a_h^{\tau-1}}, \mathbf{z_h^\tau}, l_h^\tau, L_h^\tau\}_{j=1}^{J+1}) \quad (10)$$

where $s_k^t(a_h^t) = P(a_h^t = k)$ represents the market share of alternative k and $B_h^t(\cdot)$ represents the churn probability of household h at time t. Finally, AC_h^t represents the household's acquisition cost, c_{hk}^t represents the marginal cost of servicing bundle k to household h at time t and r is the firm's monthly cost of capital.

5 Results

5.1 Effect of Switching Costs on Customer Utility

We estimate the multinomial logit model described in the previous section on a random sample of 97,228 households in our dataset. Table 2 shows the results obtained. Column (1) corresponds to equation 3.

The negative coefficients γ_1, γ_2 and γ_3 in both columns indicate inertia to switch with switching costs. The ratio of these coefficients to the coefficient on price allows us to interpret switching costs in dollar terms. The average switching cost to change bundle inside the carrier is \$156 (-6.2/-0.04).

Table 2: Multinomial logit results

	Discrete Choices	
	(1)	(2)
Price (α)	-0.040^{***}	-0.040^{***}
	(0.001)	(0.001)
Change Inside(γ_1)	-6.243^{***}	-6.260^{***}
	(0.020)	(0.020)
Change Outside × Contract Free(γ_2)	-7.911^{***}	-8.034^{***}
	(0.176)	(0.177)
Change Outside × Contract Active(γ_3)	-7.709^{***}	-7.861^{***}
	(0.229)	(0.231)
Change Outside × Contract Active × Month-to-contract-expiry(γ_4)	-0.077^{***}	-0.077^{***}
	(0.015)	(0.015)
Change Outside × Contract Free × Length-previous-contract(γ_5)	0.018^{**}	0.018^{**}
	(0.006)	(0.006)
Change Outside × Contract Active × Length-previous-contract(γ_6)	$0.011^{\cdot}$	$0.011^{\cdot}$
	(0.007)	(0.007)
Change Outside × Contract Free × Tenure(γ_7)	-0.006^{***}	-0.005^{***}
	(0.001)	(0.001)
Change Outside × Contract Active × Tenure(γ_8)	-0.008^{***}	-0.007^{***}
	(0.001)	(0.002)
Number of channels	0.002^{***}	0.003^{***}
	(0.000)	(0.000)
Internet speed	-0.004^{***}	-0.004^{***}
	(0.001)	(0.001)
Premium features	1.869^{***}	1.869^{***}
	(0.032)	(0.043)
Mobile	1.441^{***}	1.439^{***}
	(0.045)	(0.058)
$\mu_j \times HouseholdAge$	No	Yes
$\mu_j \times InternetUsage$	No	Yes
$\mu_j \times VoiceUsage$	No	Yes
Observations ($97,228$ *Households*)	$535,656$	$535,656$
Log-Likelihood	$-179,483$	$-178,175$
Mcfadden R^2	0.900	0.901

Note: ·p<0.1;*p<0.5; **p<0.01; ***p<0.001

Standard errors were robust clustered within households

This is more than twice the average monthly payment. The average switching cost to churn when the lock-in period is over is \$197 (-7.9/-0.04). We also observe that likelihood of churn reduces with the time left under the lock-in period. Each additional month in the lock-in period adds \$1.93 (-0.077/-0.040) to the switching cost associated to churn when lock-in is still active, i.e., \$193 (-7.7/-0.04). The interaction terms with tenure come in the expected direction. They show that older customers are less likely to churn. We also measure the effects associated to the initial length of the last lock-in period experienced by the customer (which may be the initial length of the current lock-in period when this is not yet over). This does not seem to change the likelihood of churn when customers are still within the lock-in period (γ_6 not statistically significant). However, the initial length of last lock-in period seems to increase the likelihood of churn after contract expires (γ_5 is positive and statistically significant).

As a robustness check, we interact household demographic characteristics with product dummies to control for potential specific demographic effects. The demographic variables we include are the (standardized) age of the household head when service accounts are opened, and the household's (standardized) intensity of usage for Internet and voice services respectively. Column (2) in Table 2 shows the estimation results corresponding to the model with additional control on alternative-specific demographic effect. The estimation results were consistent with the results shown in column (1).

5.2 Predicting Household Churn Hazard and Probability of Survival

Figure 2 shows the churn probability and the survival probability over time obtained using the models estimated in column (1) of Table 2. These probabilities are obtained by computing the market share of the churn alternative in our multinomial choice model. The top plot shows that the likelihood of churn increases over time while the lock-in period is active. This reflects the fact that the financial penalty that customers need to pay to churn reduces over time. After contract

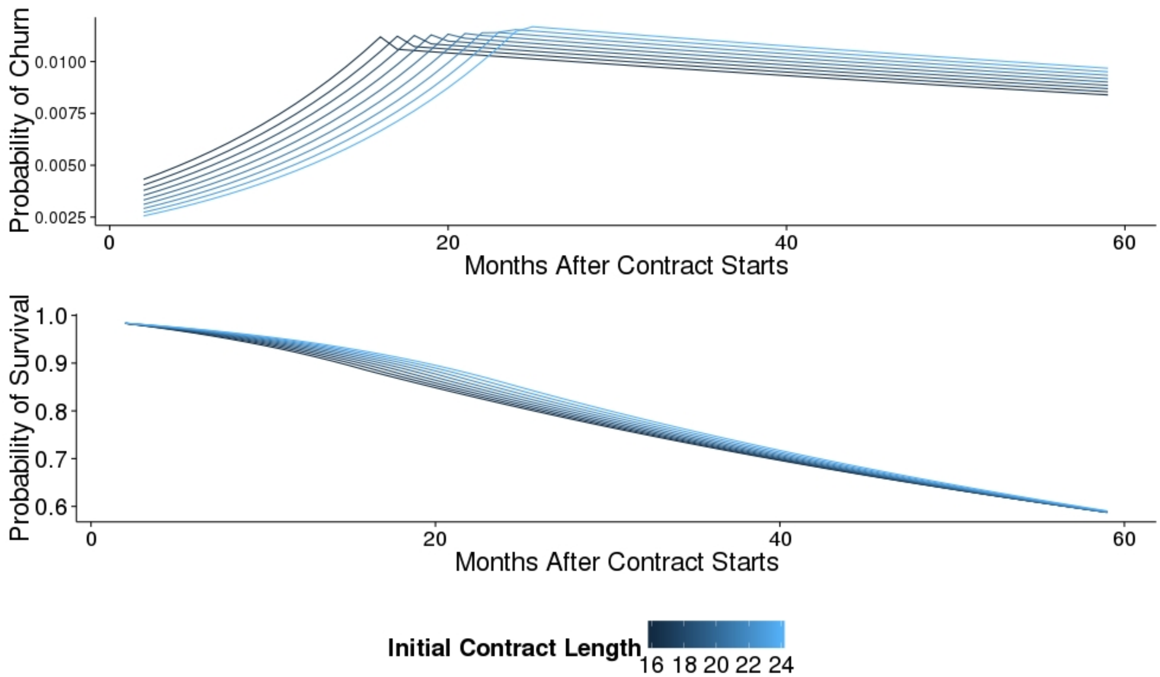

Figure 2: Probability of churn (*Top*) and probability of survival (*Bottom*) when the length of the lock-in period varies according to the estimation results in column (1) of Table 2.

expiry the likelihood of churn decreases smoothly over time as customers who choose to stay with the carrier become increasingly loyal over time. The bottom figure plots the probability of survival accordingly.

These figures also show the probability of churn and the probability of survival for different initial lengths of the lock-in period, which we obtain using simulation over the models estimated in column (1) of Table 2. We observe that when this length reduces, the monthly probability of churn increases in any given month when the contract is still active as a result of the reduced churn penalty. However, after the contract expires the probability of churn in any given month is slightly lower when the length of lock-in reduces (γ_5 being positive and statistically significant in Table 2). This may be due to the fact that consumers that were locked into longer contracts perceive differently the limitations associated to being in these contracts and become more willing to churn. Particularly in our empirical case, the survival probability converges after around five years.

5.3 Effect of Contract Length On Firms Profit And Consumer Surplus

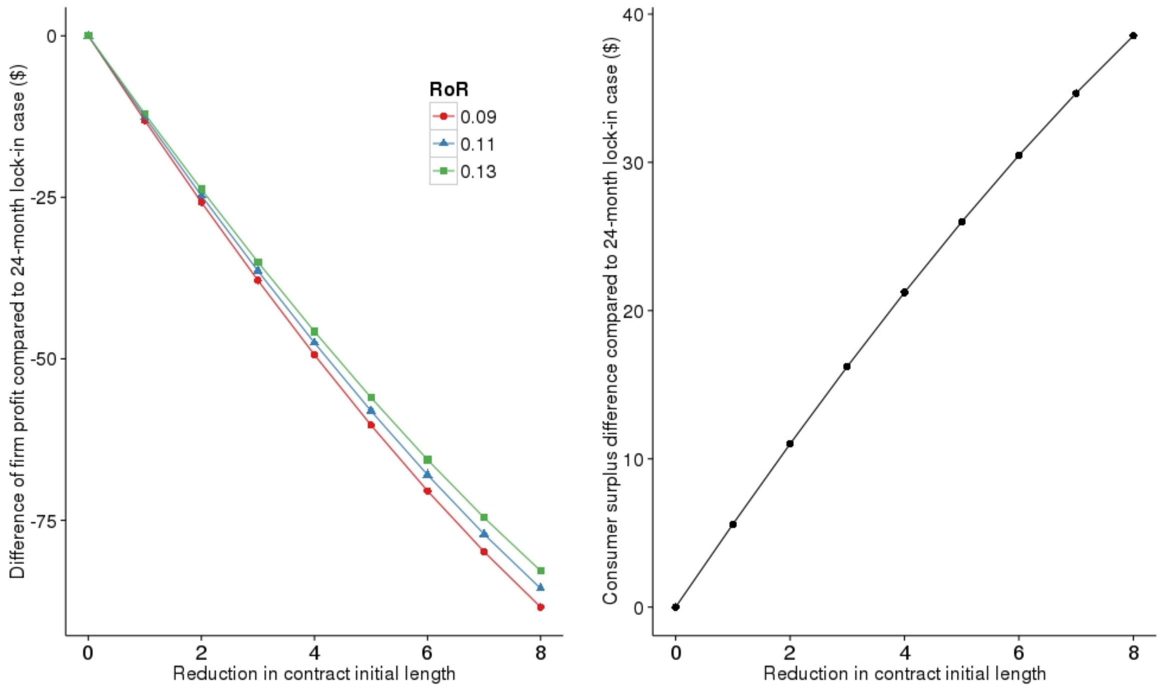

Figure 3: Difference in firm profits (*left*) and in consumer surplus (*right*) in dollars when the lock-in period reduces from 24 months. Plots are based on simulations using the estimation results in column (1) of Table 2.

Figure 3 shows how firm profit and consumer surplus change if the lock-in period reduces from the status quo of 24 months using the models estimated in columns (1) of Table 2. We simulate the market using a random sample of 10,000 households from our data. We assume that reductions in lock-in periods are policy enforced applied to all bundles and to every operator in the market alike. Therefore, there is no additional incentive for consumers to switch products or operators because these policy enforced differences apply similarly across the whole market. Furthermore, in every simulation the distribution of initial product subscription rates across all products offered by TELCO was set to be consistent with what we observe in our data. Consumer surplus and firm profit are simulated using equations 6 and 8, respectively. We simulate firm profit using 3 different levels of the yearly Rate of Return (RoR) set around the typical rates experienced in the telecommunication sector (9%, 11% and 13% according to Damodaran (2015)) and we assume them to be constant throughout our simulations. Finally, we note that consumer surplus is a function of the price of the bundles in the market, the length of the lock-in periods and their discount rate. Therefore, consumer surplus is not directly affected by firm RoRs but rather only through how the RoR affects price. The consumer monthly discount rate was set to 0.5%, which was the interest rate in 2013 in the country we analyze (World-Bank, 2013).

We observe that shortening the lock-in period leads to reductions in profits that supersede the gains in consumer surplus. For example, if lock-in periods reduce to 16 months, the lifetime consumer surplus increases less than $40, whereas the present value of the profits that the firm enjoys reduces more than $75. This consumer welfare gain corresponds to 1.5% of the expected present value of the profits the firm would get when the lock-in period is 24 months. Meanwhile, the firm would lose 3% of it. These results are qualitatively similar across the rates of return that we simulate and show that regulators need to be careful when they consider shortening lock-in periods. Doing so will certainly increase consumer surplus and reduce firm profits. Our work provides estimates for how much in our empirical case. However, the sum of consumer surplus and profits seems to reduce when lock-in periods shorten. This sum is not yet a measure of total welfare in the market because when consumers churn they are likely to join a competitor and thus generate revenue there. Yet, our results introduce a word of caution and show how regulating lock-in periods is a hard policy task that needs to judge competing welfare goals.

5.4 Effect of Contract Length When Firms React to Keep Profit Level

In this section we consider what happens when firms increase prices to compensate for the loss in profit due to reduced lock-in periods enforced by regulatory authorities. We assume that these changes in prices are similar, in percentage terms, for all products offered by TELCO. The left plot in Figure 4 shows how the firm increases price to counter a reduction in the lock-in period to keep

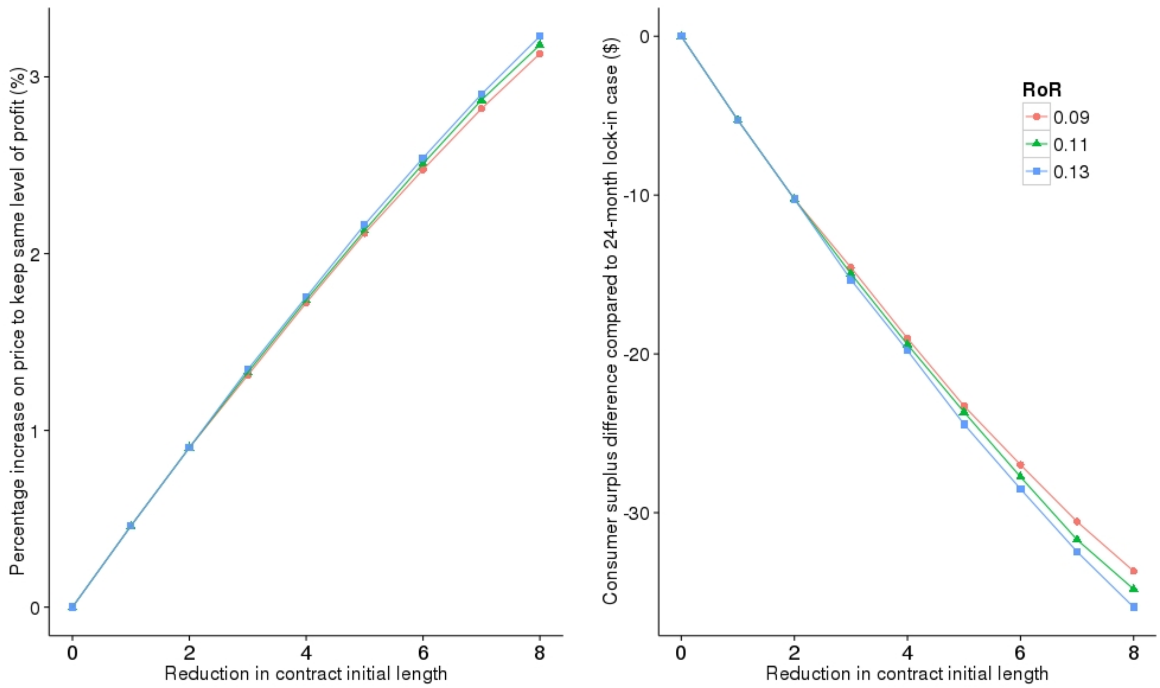

Figure 4: Percentage change in price ($left$) and in change consumer surplus ($right$) when the lock-in period reduces and the firm reacts to keep the same level of profit, comparing to the status quo of 24-month lock-in periods. Plots are based on simulations using estimation results in column (1) of Table 2.

the same level of profitability (RoR). For example, to keep the same profit the firm increases price by roughly 3% to counter a reduction in the lock-in period of 8 months. The right plot in Figure 4 shows what happens to consumers if the firm decides to increase prices when lock-in periods reduce to keep the same profit. As a result of the increased price, consumers lose around $35 in surplus and therefore they would have been better off if the regulatory authority did not reduce the lock-in period in the first place without preventing firms from increasing prices to counter the effect of the policy on their profits. These results are also qualitatively similar across the 3 levels of rates of return that we simulate and show how reductions in the lock-in period must be paired with price regulation, otherwise firms are likely to increase prices to counter the losses in profits arising from lock-in reductions leaving consumers even worse. How strong price regulation needs to be is likely to be determined by the level of competition in the market. Competitors may try to take advantage from reductions in the lock-in period to steal consumers from incumbents by offering shorter lock-in periods at prices that yield lower rates or return.

5.5 Effect of Contract Length When Firms React to Keep Consumer Surplus Level

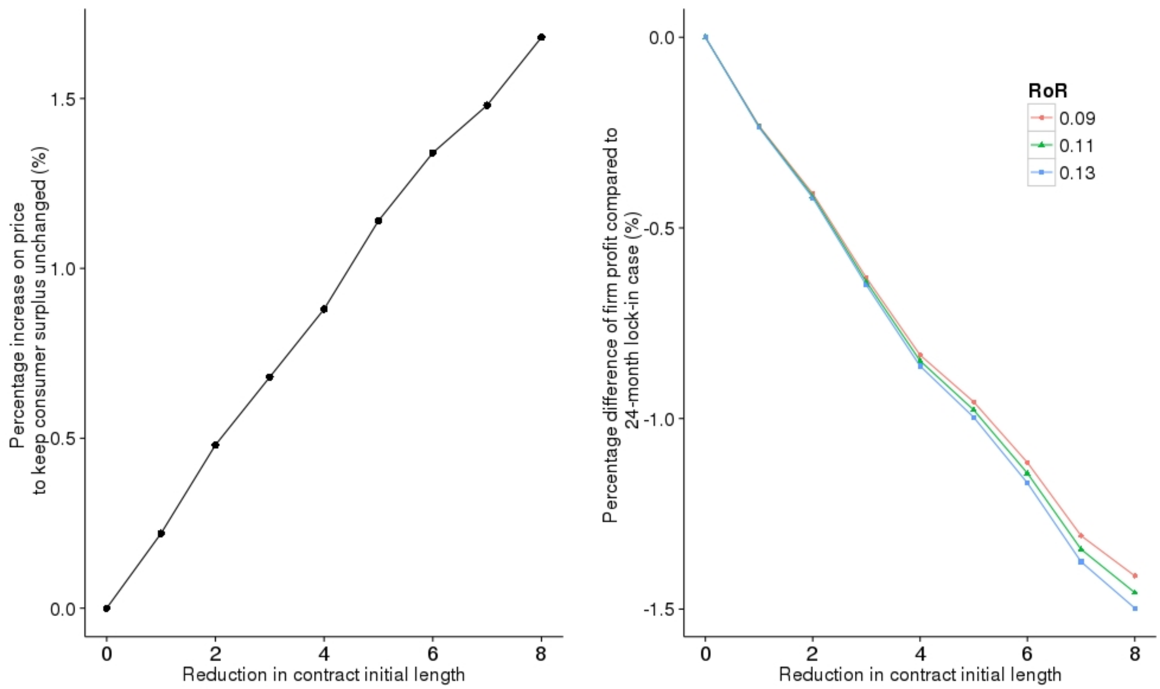

Figure 5: Percentage change in price (*left*) and percentage change in firm profit (*right*) when the lock-in period reduces and the firm reacts to increase price up to making consumers indifferent to the status quo of 24 months lock-in period. Plots are based on simulations using estimation results in column (1) of Table2.

We also study what increase in price would render consumers indifferent. Consider the case when the regulation allows firms to increase price in order to rescue part of their profit loss, but only to some extent so that consumer welfare is not reduced from the original level. The left plot in Figure 5 shows how the firm increases price to counter a reduction in the lock-in period to rescue part of profit loss while keeping consumer surplus constant. For instance, the firm increases price by roughly 1.7% to counter a reduction in the lock-in period of 8 months. This price increase is slightly more than half of the price increase when firms react to maintain profit if without price regulation.

The consumer surplus would not be directly affected by firm discount rates, but instead by product price, consumer discount rate and length of lock-in period. Therefore the price adjustment to counter any change in consumer surplus is not a function of firm RoRs. The right plot in Figure 5 shows what would happen to the firm's profit under such regulation. For example, if the lock-in period is reduced to 16 month, the firm would lose 1.5% of it's original profit if the lock-in period is 24 months. This, however, would still save the firm about half of the profit loss comparing to a case where no price increase is allowed (Figure 3). These results are also qualitatively similar across the rates of return that we simulate. Our analyses show how price regulation can pair with the lock-in period reduction to protect consumer welfare while to some extent protect the firm from losing much profit.

6 Conclusions

Lock-in periods in telecommunications services are a common practice employed by telecommunication providers to reduce the risk of failing to cover the significant capital costs needed to build the network in the first place and upgrade it over time. In short, operational revenues need to cover all operational costs and all investments in network upgrades as well as the initial cost with the network. The current practice is to lock-in consumers for periods of 24 months, which reduces the uncertainty for the firm. Consumers pay financial penalties if they breach contracts while lock-in periods are still active. Telecommunication firms have been operating with these type of contracts for a number of years now.

Telecommunication regulators have been studying the effect of lock-in periods on consumer welfare. Longer lock-in periods reduce the consumers' freedom to change telecommunications provider. This results in high monthly bills for consumers that are locked-in when compared to the market prices offered by competitors, which tend to decrease overtime due to technological progress and competition. However, a consumer that churns and moves to a competitor needs to endure a fresh

24-month lock-in period. Therefore, regulators are mostly interested in learning the impact of reducing the lock-in period on consumer welfare and, necessarily, on firm profit too, in order to anticipate how firms are likely to respond to potential changes in the current policy.

Our paper uses a dataset from a large triple-play telecommunications provider to study what happens to consumers and to the firm when the lock-in period reduces from the current status quo of 24 months. We use this dataset to fit a multinomial logit model in which households can choose to keep the same bundle, change service bundle inside the carrier or churn. This model allows us to measure the switching costs associated to changes of service inside the carrier and to churn in dollar terms. This model also allows us to simulate how changes in the length of the lock-in period affect both consumer surplus and profits. In our empirical context, we find that the average switching cost to change bundle inside the carrier is $156 whereas the average switching cost associated to churn is roughly $197 if lock-in free and more than 193$ when the contract is still active depending on how far away from lock-in expires.

We also find that the firm loses more profit than what consumers gain in surplus when the lock-in period reduces. For example, in our setting, consumer surplus increases less than $40 if the lock-in period reduces to 16 months. However, the firm profit decreases more than $75, 3% of its profit when the lock-in period is not reduced, showing that reductions in the lock-in period may reduce welfare. Consequently, our work shows that regulators need to be very careful when considering shortening the length of lock-in periods. Shortening the lock-in period increases consumer surplus, however, it also decreases the profit of the firm, and regulators need to ponder these two opposing forces in a way that provides consumers flexibility but also ensure that operators have sufficient incentive to be in business and maintain, or even upgrade, the quality of the services provided.

To shed more light on the above concern, we also simulate what happens to consumers if the firm increases the price of the services provided to consumers in order to keep its rate of return as an answer to a reduction in the lock-in period mandated by the regulator. In our empirical context, the firm increases prices by roughly 3% to keep the same profit, if the lock-in period reduces to 16 months. This increase in prices reduces the (lifetime) consumer surplus in roughly $35. We also compute the highest price increase that the firm can introduce in the market when the lock-in period reduces to leave consumers indifferent. In such case, firms would increase prices by about 1.7% to keep consumers indifferent. However, firms lose profit that corresponds to 1.4% of the profit it would get without lock-in period reduction.

In sum, our paper provides empirical estimates for how much switching costs are worth in a triple-play market and we simulate what may happen to firms and consumers if regulators decide to shorten lock-in periods. To the best of our knowledge, our paper is the first to provide these estimates and to use them to simulate the potential counterfactual worlds that would arise from changes in the current policy. We also show that shortening the lock-in period may not be enough to make consumers better off. In particular, we provide evidence that a policy that shortens the length of the lock-in period may need to be paired with a policy precluding operators from increasing prices too much, otherwise consumers may become worse off. How strong this price capping policy needs to be to ensure that consumers remain as well off as with longer lock-in periods is likely to depend on how fierce competition is. Consumers may be better off if some providers take advantage of the change in policy to steal consumers away from their competitors by offering the shorter lock-in periods at lower prices, which would render the additional regulation unnecessary.

Finally, our paper does not come without limitations. Chief among them is the fact that we do not model a fully competitive environment. We study how one firm reacts to the regulators change in policy but we do not take into account how this firm does so in a competitive environment in which several firms react simultaneously to the change in policy. In any case, our model is sufficient to allow us to reason about the potential outcomes that may arise and to show that shortening lock-in periods is a complex policy and managerial question that may deserve future research. Our study is the first to provide empirical evidence of the potential effects of shortening lock-in periods, which we believe will inform future studies and will call for more quantitative work in the field.

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