Three-part tariffs and consumer welfare of the local fixed telephone service: empirical evidence from Medellin

(**PRLIMINARY VERSION**)

By:

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Abstract: This paper provides evidence on the effects of three-part tariffs on consumers' welfare in the local fixed telephone service provided by the Telecommunications Company UNE in Medellin, which was authorized by the Telecommunications Regulatory Commission (CRT, for its Spanish name). Because of endogeneity problem coming from our specification models, the empirical strategy for studying month-to-month households' consumption is based on a panel data analysis by applying GMM estimators. Our results supports the hypothesis that consumers surpass expected consumption levels and therefore the total payment for the service is greater than planned.

Key word and phrases: three-part tariffs, consumers' welfare, endogeneity, GMM estimators.

JEL Classification: C14, C33, G38, D12, D60.

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Introduction

The use of nonlinear tariffs in public utility services is usually the norm. It is based on the assumption that welfare will improve (with reference to a tariff equal to the mean costs) by increasing the excess of the highest demands, increasing the provider revenue and ensuring the participation of the lowest demand in the market (Willig, 1978; Brown ad Sybley, 1986). About this belief Armstrong (2005) and Reiss and White (2006), among others, find that it depends on varied circumstances since, in a monopoly situation, provider revenue increases highly, but overall consumer surplus could be reduced, in favor of some (mainly high demands) and against low demands, and under competition, these results will be ambiguous. This will depend on consumers' response and the information on consumers that firms have.

A type of non-linear tariff that has been used recently, mainly in telecommunications, is the three-part tariff. It is composed of a fixed charge or access price, a "basic" consumption amount included in the fixed charge is and a marginal price for each unit of consumption in excess of the basic consumption. The fixed charge increases with the basic consumption chosen, and the variable charge decreases with each chosen plan, if the actual consumption is greater than the basic consumption. About the effects of this, which have not been sufficiently explored in the literature, Lambrecht, *et. al.* (2007) find that the consumer's choice is based on the fixed charge of the plan rather than on expected consumption, which will be later determined according to the chosen plan. Consumers' uncertainty potentially reduces their welfare and increases the firm's revenues, which are higher than those obtained with a two-part tariff. But the different actions consumers may take under a scheme designed for firms to maximize profits must be explored in the empirical field (Reiss and White, 2006)

This paper provides evidence on the effects of three-part tariffs on consumers' welfare in the local fixed telephone service provided by the Telecommunications Company UNE in Medellin since February 2006 until October 2007 when TELMEX entered in this market. This tariff was authorized by the Telecommunications Regulatory Commission (CRT, for its Spanish name), through Resolution 1250 of 2005, allowing companies to offer the consumers tariff plans according to their consumption needs, and replaced the traditional fixed-charge and variable charge per telephone impulse tariff.

An important consequence explored of three-part tariffs is that there can be winners as well as losers, which is not only a function of the type of demands, whether high or low, respectively. These can also motivate a persistent increase in consumption over time.

The empirical strategy for studying month-to-month households' consumption is based on a panel data analysis. A first approximation consists in specifying a linear relationship among the regressors (invariant across time), the non-observable heterogeneities and the households' monthly minute consumption. The possibility of endogeneity between minute consumption (and telephone expenditure) and expenditure on other public utility services (water, garbage disposal and energy) forces us to correct the problem through by the Generalized Method of Moments (GMM).

The second approximation, which is a dynamic one, consists in specifying a linear relationship between minute consumption and its lag. Again, latent endogeneity appears when estimating the interest parameter using a first-difference model, so that the GMM estimator offers an alternative for consumption adjustment, based on all possible lags as instruments. For the sake of comparison, we present estimations using OLS, Anderson-Shiao, intra-groups (WG), Two-Stage Least Squares (2SLS) and GMM.

This paper is divided in four parts: First, non-linear tariff mechanisms are defined and three-part tariff consequences on welfare are analytically foreseen. Next, a description of the information available is given and the different econometric estimations are presented. Finally, we present our conclusions.

I. Nonlinear and three-part tariffs

Two-part tariffs distinguish between the mean payment (according to the consumed amount) and the marginal payment (decreasing as the amount increases).[4] They are

[4] There are different forms of price discrimination, including: charging different consumers different prices for the same good (third-degree price discrimination); making the marginal price depend on the number of units purchased (nonlinear pricing) or on whether other products are also purchased from the same firm (bundling); whether this is the first time a consumer has purchased from the firm (introductory offers; customer "poaching") or whether the customer has previously purchased other similar goods from the firm. On the other hand, a firm's range of instruments to discriminate prices depends on the possibility of arbitrage and resale between consumers, on their ability to "anonymise" contact with firms and pretend to be a new customer, thus benefiting from introductory prices. Finally it will depend on whether the regulatory entity permits the firm to discriminate prices, keeping maximum prices or average costs constant and whether it is aware of the possibility of firms passing information to other firms about their customers' behavior in different markets (Armstrong, 2005).

determined by consumers' characteristics rather than by the company's cost structure. Thus they generate improved efficiency with respect to a tariff equal to the mean cost, provided that the marginal price is less than the mean cost, and the resulting deficit is compensated with a fixed charge (access charge) that results from distributing the fixed cost among all the demands. Its implementation will be socially plausible providing the fixed charge is such that the income effect is low and low-demand consumers are not excluded from the service (low income level or weak preferences).

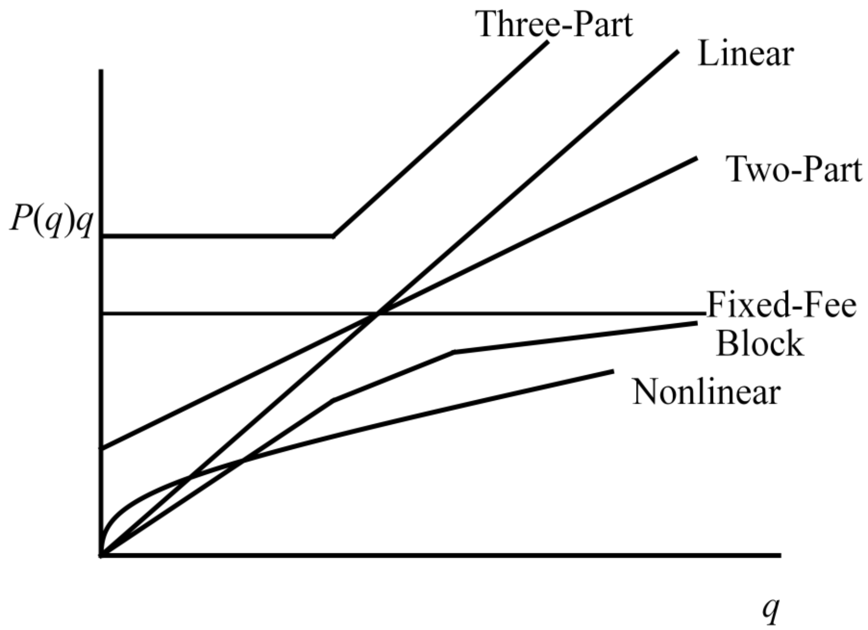
In Colombia, this type of tariff was applied in the local telephone service until 2005, where the mean reference cost (CMe_R) was charged through the monthly tariff $T(q) = F + p(q)$ where $T(q) = (CMe_R$ -CC)/12 and CC is the connection charge (access to the network). The mean reference cost CMe_R is a yearly-based component of the remunerated long term mean cost (15 years) with a rate of return of 13% and additional adjustment factors due to total costs dispersion and companies' demands in the different localities. Besides, a range for the charge of F was established, that is to say, $0{,}15T(q) \ll F \ll 0{,}50T(q)$, even knowing that F represented the basic costs of permanent availability of the service, in which that much variability should not exist (Resolution 087 of 1997 of the CRT). This led to the implementation of different two-part tariffs in each city, depending on the relationship between F and p(q) chosen by the local provider.

About applying the different two-part tariffs (the most common form of non-linear tariffs) the economics of regulation suggests it will be more convenient to offer as many different tariff plans as there are consumers. The highest fixed charge corresponds with lower variable payment so that consumers self-select the most convenient plan, depending on their preferences, income and expected consumption. Consequently, the lowest demand would pay a high variable charge and a fixed charge nearing zero whereas the highest demand would pay a high fixed charge and a marginal price going to zero, thus avoiding the exclusion of low demand consumers and reducing the mean payment of the highest demands (Brown and Sibley, 1986). These tariffs can be used in the same city or locality regardless of the cost of providing the service.

It has been believed that two-part tariffs will improve welfare, understood as the sum of the surplus of consumers and the benefits of the firm, in comparison with a tariff equal to the mean cost. We mean that any uniform price, other than the marginal costs, can be dominated in Pareto's sense by a non-linear tariff program and by increasing in at least the welfare of the highest demands, increasing company revenue, and holding the lowest demands at least constant (Willig, 1978; Brown and Sybley, 1986). This is what Armstrong (2005) and Reiss and White (2006), among others, pointed out, using dynamic models or revising the welfare issue in the supply-demand space instead of the typical formalization of the firm's budget restriction of welfare economy. This depends on varied circumstances, since under a monopoly situation, the firm's revenues are highly increased, but overall consumers' surplus is reduced, in favor of some (mainly high demands) and against the low demands, and the effects on welfare are ambiguous. When consumers are new or do not know the offers very well, the firm's revenues are further increased. These results are overflowed when the firm supplies several products and demands minimum-term contract from consumers. Under competition, results are not clear and depend on consumers' response and on the information on consumers that firms have.

In practice, a firm can design different non-linear tariffs, depending on the cost distribution it applies between the fixed and the variable part (graph 1). Across the tariffs, we find: 1) A two-part tariff with both a fixed part and a variable component constant, which can get rid of lower demands, 2) A two-part tariff where the highest fixed charges correspond with lower variable charges, as demands gets higher; 3) A fixed-fee block tariff, increasing this charge with an increase in the allowed consumption amount; 4) A variable-charge-only tariff, decreasing this charge with the increase in demand, 5) Fixed payment or variable charge can even change as demanded amounts change until reaching a tariff of the kind F(q), as in 3), or p(q) in the case of 4), both declining as consumption increases, 6) Finally, a tariff program T(q) = F(q) + p(q) could be sketched to group all the possibilities (Braeutigam, 1989).

Graph 1. ***Types of non-linear tariffs***



In 2005, the CRT issued Resolution 1250 justified by the following: "Consumers will be able to choose tariff plans according to their consumption needs and in correspondence with the current trends under which the Telecommunications industry is developed in Colombia and the world". This allowed those companies with a market share of over 60% to offer different plans as long as revenues were kept constant and with the restriction to offer the lower-income strata (I y II) a variable-cost-only tariff within the plans. The following is the tariff scheme applied by UNE[5] since February 2006:

$$T = \begin{cases} F_i(q_i) & q \leq q_i \\ F_i(q_i) + p_i(q - q_i) & q > q_i \end{cases} \forall i = 1, \dots, 4, \quad F_i < F_{i+1} \ y \ p_i > p_{i+1} \quad (1)$$

[5] This service was provided since 1917 by the municipality of Medellín. Since 1955 it was part of one of the services offered by the local autonomous public entity Empresas Públicas de Medellín (EPM). In 2006 this business was divided when the new EPM Telecomunicaciones Company was created, under the mixed-nature brand UNE. The company Telmex offered from the start a fixed charge with unlimited amount of minutes, to which UNE responded with the same option, but keeping the tariff plan offer studied in this paper. All these offers make part of packages including cable television, broad band and telephone service. A complete welfare analysis should consider the different goods offered by the companies. Armstrong and Vickers (2007) show that in a multiproduct monopoly case non linear tariffs increase firm's revenues and social welfare but not consumer's overall surplus (there will be winners and losers); when consumers may buy a certain product from each firm they can increase their surplus at the expense of the firm's revenues And when there are duopolies offering multiple services, the effects are ambiguous, depending on demand's heterogeneity and elasticity, choice and provider switching costs, and loyalty to a brand.

Minute amounts included on each F_i are 100, 300, 600 and 1000; no plans are offered for over 1000 minutes, but the variable charge decreases in the ranks 1000-1500, 1501-2000, 2001-3000 and over 3000 minutes (Bedoya and Ceballos, 2007).

Table 1. ***UNE's tariff scheme***

Plans	q_i	$F_i(q_i)$	$P_i(q-q_i)$	Indifference Consumption between plans i e i +1
1	100	12000	60	150
2	300	15000	54	504
3	600	26000	48	746
4	1000	33000	33	
	1501-2000	33000	30	
	2001-3000	33000	25	
	› 3000	33000	20	3308
Unlimited*		39155	0	

* It applies only since TELMEX got in to the market.
Source: UNE, Value added taxes not included in prices. Authors' calculations.

This scheme is a variety of non-linear tariff 5), called in the literature Three-Part Tariff, and defined by a fixed or access charge, a "basic" consumption amount included in the price and a marginal price for each unit of consumption in excess of the basic consumption. The fixed charge increases with the basic consumption chosen, and the variable charge decreases with each chosen plan. Therefore, a tariff's marginal price depends on consumption: it is zero if it remains within the basic consumption and positive if it exceeds it. Regarding the consequences on welfare, Lambrecht, *et. al.* (2007) have found that:

1. Access charge and basic consumption affect mainly the consumer´s plan choice more than the expected consumption; this consumption will be later determined according to the chosen plan. Therefore, there will be a temporary separation between tariff and consumption, unlike traditional two-part tariff, whose marginal payment is constant.
2. Consumer's expected expenditure increases with consumption variation steering the consumer to prefer high consumption tariff plans, mainly if uncertainty over consumption is high.

3. Basic charge and consumer's uncertainty potentially decreases consumer's welfare and increases company's revenues. These are greater than those obtained with a two-part tariff.
4. The firm will be motivated to focus on consumers with a high consumption variability to increase its income.

A first approximation to the consequences of UNE's tariff scheme on consumer welfare can be done descriptively (graph 2).[6] The dotted line represents the former tariff scheme, $T(q) = F + p(q)$, and the scale represents the four three-part tariff packages, where 150, 504 and 746 minutes are the points of indifference between paying $F_i(q_i) + p_i(q - q_i)\ and\ F_{i+1}(q_{i+1})\ \forall i$ .That means it will be more profitable for a consumer with a tariff plan of q_i minutes allowed to choose q_{i+1} when the minutes used in excess of the plan are the same of the indifference point.[7]

Note, for instance, that if a consumer surpasses the 150 minutes and does not choose the 300-minute plan, she will pay more, in fact, much more when compared with the former tariff. And if consumption is over 489 minutes, using the 300-minute plan, or over 705 on the 600-minute plan, she will pay more than on the former tariff. With regards to the 1000-minute tariff, there is a long stretch of consumption before both income lines cross, which goes from 746 to 2000 minutes. Here we find that any increase in consumption across this stretch will lead to a greater increase in billing than in consumption due to the curve slope, and it will be even greater on the two-part tariff. That shows there can be losses in some consumers´ welfare, depending on where their new consumption is located.

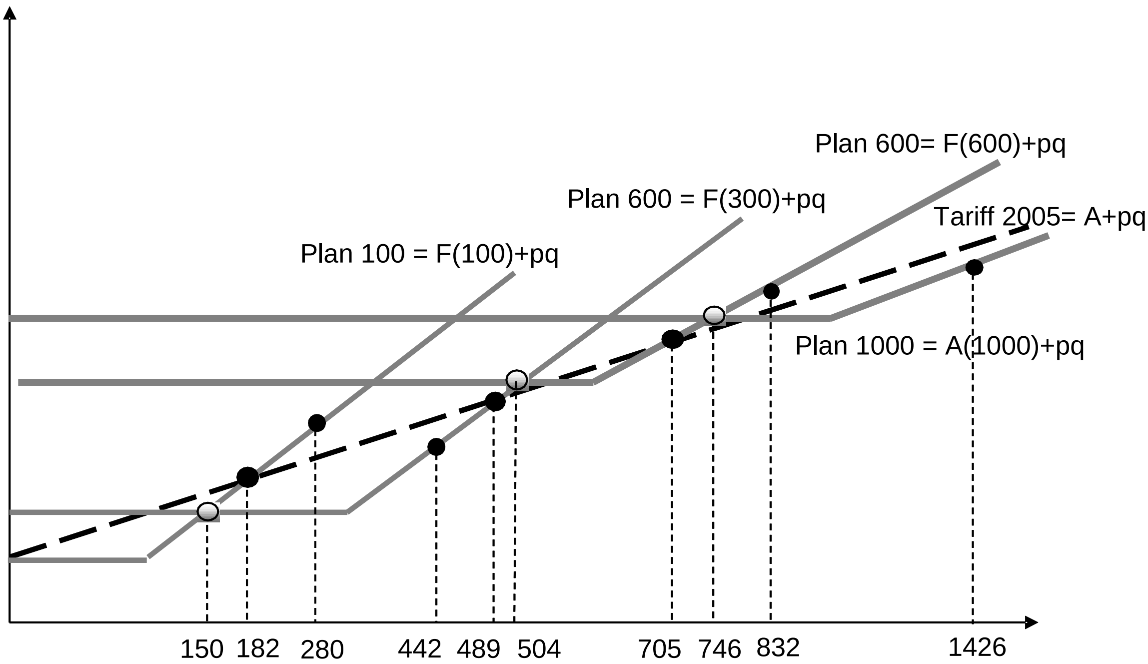
Evidence shows that consumers who signed up for the 100-minute plan in December 2006 had an average consumption of 280 minutes, which means an overbilling that

[6] This work focuses on consumers from stratum IV, who, by law, do not receive subsidies or have to pay tariff surcharges. Consumptions for plans correspond to those of December 2006 and the plans were effective since February 2006. Consumption for two-part tariff was measured in impulses for which there is no technical conversion factor because it depended on random factors asociated with the call, such as telephone answering time and call duration. The Graph 2 shows that for the conversion from impulse into minutes the domestic average calculated by the CRT (2000) was used, which is equivalent to 1.31 minutes per impulse, which results in a tariff per minute of 27 pesos on the former plan (See: Bedoya and Ceballos, 2008).

[7] UNE gives customers the chance to automatically adjust it between each plan by using the "Hable Tranquilo" option, at a monthly cost of 2500, additional to the tariff which is, for instance, equivalent to 21% of the monthly cost of the plan with the fewest minutes. It can be observed from table 4 that only the 12.44% of the user sample chose the "Hable Tranquilo" option.

could have been avoided if the 300-minute plan had been chosen, and is much higher than the amount that would have been billed on the former plan. Users who bought the 300-minute plan consumed 442 minutes on average, which places them below the payment line of the two-part tariff and therefore in a better situation. Users who signed up for the 600-minute plan used the service during 832 minutes on average, which places them above the former plan and, therefore, in a worse situation. Finally, consumers on the 1000-minute plan consumed 1,462 minutes on average, placing themselves below the dotted line and, therefore, in a better situation.[8]

Graph 2. ***UNE's two-part and three-part tariffs and consumers' demand, December, 2006***



* The fixed charge on the former tariff coincides with that of the 100-minute plan. Due to space restrictions, the scale for the 1000-minute plan variable charges is not included.
Source: UNE. Authors' calculations and design.

II. Description of the data

For this article, consumption of 410 households was observed between February and December 2006, as well as their billing and some demographic data such as house

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[8] In a previous work Bedoya and Ceballos (2008) find that users made mistakes when choosing their plan and that the adjustment process took all the year 2006, being more critical for low demand users, since high demands are tied to a single plan (1000 minutes), which negatively affects these users because they are the ones who value the service the most.

ownership, time living in same house, age of household head, his/her occupation, schooling, total number of people in the household, number of people by age range (younger than 19, between 20 and 29, between 30 and 39 and older than 40 years old) and their expenditure on public utilities.[9]

Table 2 shows the behavior of the variable consumption (minutes consumed in excess of the plan chosen by the consumer), the cost of consumption, the total consumption and the expenditure on household utilities.[10] On average, these variables increase throughout the year, together with their typical deviation, which means that users have significantly increased their consumption throughout the year and, therefore, payment for it has also increased. But the great variability of the data shows that this payment is not close from its average.

Tabla 2. ***Model's variable descriptive statistics***

	February to March		**April-June**		**July-September**		**October-December**	
	Mean	Typ. Dev.	Mean	Typ. Dev.	Mean	Typ. Dev.	Mean	Typ. Dev.
Variable consumption	268.0902	456.61197	277.2341	505.91064	307.0455	540.25079	338.9577	530.58524
Consumption cost	8,726.99	13,254.23	8,940.18	14,261.75	10,248.47	15,752.47	12,597.79	19,085.88
Total consumption	938.1256	684.38413	939.3285	724.46739	955.3951	752.98794	965.9325	723.60835
Expenditure on public utilities	227,300.06	184,182.41	227,300.06	184,139.73	227,300.06	184,139.73	227,300.06	184,139.73
N	820		1230		1230		1230	

Source: UNE. Authors' calculations.

It is worth noting that the differences between the variables increments: on average, the variable consumption grew by 8.18% during the year, whereas billing grew by 13.33% and total consumption grew only 0.98%. According to table 3, there is a significant decrease in the number of 100-minute plan users, whereas the other users increase with respect to February levels, mainly those on the 300 and 1000-minute plans.

[9] Bedoya and Ceballos (2008). Consumption and billing data provided by UNE.

[10] If a user has all the services, the bill will include local and long distance telephone service, electricity, gas, drinking water and basic garbage collection service (offered by the garbage collection company EVM but billed by EPM), cable television and Internet. UNE also offers packages that include cable television, internet and telephone service.

Table 3. ***Percentage of users on UNE´s plans by month, 2006***

Month	Plan/Minutes			
	100	300	600	1000
February	6.60%	24.40%	21.70%	47.30%
March	6.60%	23.40%	14.40%	55.60%
April	6.10%	25.90%	17.60%	50.50%
May	4.60%	30.70%	14.90%	49.80%
June	5.60%	25.90%	14.90%	53.70%
July	6.10%	24.60%	17.60%	51.70%
August	8.80%	25.90%	18.00%	47.30%
September	4.10%	26.80%	19.50%	49.50%
October	4.40%	25.90%	20.70%	49.00%
November	4.40%	25.60%	21.50%	48.50%
December	3.90%	25.90%	22.00%	48.30%

Source: UNE. Authors' calculations.

Table 4. ***Variable descriptive demographic statistics for UNE's IV stratum users, February-December, 2006***

House ownership			Do they have the "Hable tranquilo" plan?		
	Frequency	Percentage		Frequency	Percentage
Own	246	60.0%	**Yes**	51	12.4%
Rented	164	40.0%	**No**	359	87.6%
N	410		**N**	410	
Time lived in the house			**Age of household head**		
Less than one year	73	17.8%	**Under 19**	1	0.2%
One year	15	3.7%	**Between 20 and 29 years**	30	7.3%
More than one year	92	22.4%	**Between 30 and 39 years**	57	13.9%
Two or more years	230	56.1%	**Over 40 years**	322	78.5%
N	410		**N**	410	
Occupation of household head			**Schooling of household head**		
Looking for work	23	5.6%	**Elementary**	86	21.0%
Working	279	68.0%	**Secondary**	108	26.3%
Retired	108	26.3%	**Technical or Technological degree**	82	20.0%
N	410		**University degree**	114	27.8%
			Graduate degree	20	4.9%
			N	410	

Source: Bedoya and Ceballos (2008).

The rest of the variables that will be used represent user demographic categorizations, which are invariant over time or invariant over very short stretches. Most of the houses in which the telephone lines are registered are owned by the family who dwells in them (60%) and have lived in them for more than 2 years (56.1%). On average, the household head is a working person over 40 years old with a technical or technological degree. These families, on average, are composed of 3 members (25.6%). However, the 24.1% is composed of 2 people, the 23.4% of 4 people, the 9.5% of one person and the remaining 17.2% of more than 5 people. Likewise, in the 23.2% of these houses there are people under 19 years old; in the 23.6%, people between 20 and 29 years old; in the 16.6%, people between 30 and 39 years old, and in the 36.5% people over 40 years old.

III. Empirical strategy

A. Panel data model

A first approximation to study consumption and expenditure relationships could be a linear specification given by the following expression:

$$y_{it} = \alpha + \beta X_{it} + \gamma Z_{it} + \varepsilon_{it} \quad i = 1, \dots, N; \;\; t = 1, \dots, T \qquad (2)$$

Where X_{it} is a matrix of dimension (N×T) ×k, of time varying observables household characteristics, Z_{it} is a set of time invariant demographic characteristics and ε_{it} is the classical error term with conditional expected value equal to zero. Bedoya and Ceballos (2008) estimate this model with interesting results. However, these results do not take into account unobservable heterogeneities that characterize families or households.

Unlike the first model, we are considering unobservable effects models, which specification can be written as:

$$y_{it} = \alpha + \beta X_{it} + \gamma Z_i + \lambda_i + v_{it} \quad i = 1, \dots, N; \;\; t = 1, \dots, T \qquad (3)$$

Where λ_i is an time invariant individual effect, which could be random or fixed, X_{it} is the individual characteristics vector, Z_{it} is a set of time invariant demographic characteristics, β is the parameter to be estimated and v_{it} is the classical error term with the property of $E(v|X) = 0$. Note that different dependent variables generate different specifications. In this study, we could use three specifications where the dependent variable can be the variable consumption, the total consumption or the consumption's total cost.

It is worth noting that non observable heterogeneity, λ_i, can be correlated with observables. If we have strictly exogenous time varying and/or endogenous time invariant observables we could perform fixed effect estimator (within group); in doing so we get consistent estimator just for β. As a matter of fact, it is too difficult to motivate no-correlation between the time-invariant non-observable effect and the observables, especially with micro data. However, if we want to know the effect of time-invariant observables on the outcomes, a kind of instrumental variables estimator, via Hausman-Taylor procedure, is needed. Nevertheless, HT estimation procedure assumes that observables are not correlated with idiosyncratic error term, which some time is not satisfied.

Let us stress that marginal consumption is the **additional consumption** to the plan chosen by households, so we consider that this later is the most important outcome for our empirically exercises. The following table shows the percentage of households that exceeded their minute consumption with respect to what was originally signed up for throughout all the period of the analysis:

Table 5. ***Excess consumption distribution by type of plan***

Variable	Mean
Plan 100	.0250
Plan 300	.1605
Plan 600	.1073
Plan 1000	.3529

Authors' calculations

Precisely, the percentage of households which exceeded their minute consumption are those that signed up for the 300 and 10000 minute plans. In general, all of them exceeded their consumption, which mean additional revenue for the service provider, since these minutes are drastically more expensive.

An additional problem that going to arise upon including public utility expenditure into the regressors is that the former is jointly determined with telephone expenditure and therefore with consumption variable. This generates an endogeneity problem by simultaneity. As it is usually expressed in the Engel curve analysis literature (Deaton and Muellbauer (1980); Banks, Blundell and Lewbel (1997); Blundell and Pendakur

(1998) and Barrientos (2006, 2009), among others) this problem should be solved by using a Two Stages Least Square estimator combined with random effect estimations.

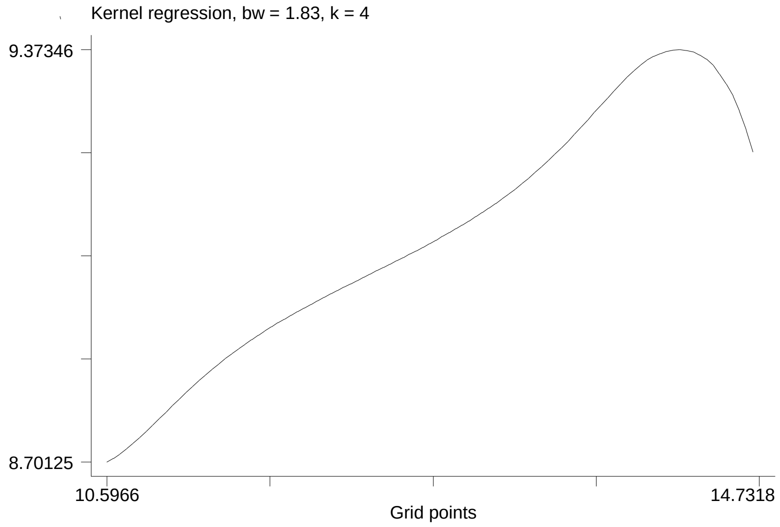
In this case, the endogenous variable is the (logarithm of) total expenditure and the instrumental variable par excellence is the family income. Additionally, we include as instruments all exogenous variables included in the original specification; this procedure improves the estimation results significantly.

According to the estimated parameters and results reported in tables 5-7, there seem to exist a curious effect. Namely, a substitution effect, possibly from fixed telephone service to mobile telephone service or an "out of home" effect. This does not depend on the functional form adopted. Graph 3 represents the non-parametric conditional mean of a regression problem given by:

$$y_{it} = m(\ln X_{it}) + \varepsilon_{it} \quad i = 1, \dots, N; t = 1, \dots, T \qquad (4)$$

Where y_{it} is the telephone service expenditure, X_{it} is the total household income of agent i, $m(\cdot)$ is an unknown function to be estimated and ε_{it} is the classical error term.

Graph 3. E*xpenditure on Public Utilities*



Source: UNE. Authors' calculations.

Graph 3 shows the estimation of the pure non-parametric Engel curve. *Caeteres paribus*, the estimated curve hints that the behavior of the average consumer within stratum 4 with regards to the fixed telephone minute consumption is very similar to the one of those basic goods such as food or public transportation, which can be considered inferior goods (see Barrientos, 2006 and 2009).

B. **A dynamic approaching**

The empirical specifications (2)-(3), can be considered static, in the sense that they do not take into account telephone consumption time adjustment with respect to the plan chosen in the past by each household. To take into account the effect of the adjustment on the time, we use an empirical model that can be written as:

$$y_{it} = \alpha y_{i(t-1)} + \lambda_i + v_{it} \quad i = 1, \dots, N; \;\; t = 1, \dots, T \qquad (5)$$

where $y_{i(t-1)}$ is the lagged dependent variable, λ_i is a non-observable and time invariant fixed effect and v_{it} is the error term with expected value equal to zero and constant variance, serially uncorrelated and independent between consumers. We are going to assume that λ_i is stochastic, and therefore it is necessarily correlated with the lag (unless it is a degenerated random variable, which is not the case).

An issue that must be dealt with is the inconsistency of the most common estimators in the literature, for instance OLS or Anderson-Hsiao estimators. If we apply minimum quadratic regression, we will obtain an estimator that is necessarily inconsistent. The source of the inconsistency could be eliminated by using first differences, in which case the term λ_i should disappear to obtain the within-group estimator. However, this triggers a correlation between the transformed independent variable and the transformed error. Increasing N does not make it disappear, so it is necessary to use an estimator that is consistent for fixed T (compared to N).

The empirical strategy should be different to avoid such inconsistency. It consists in finding a group of instruments to overcome the endogeneity produced by the lagged variable as regressor ($y_{i(t-1)}$). Since $T > 3$, we have the pair $y_{i(t-2)}, y_{i(t-3)}$ as instruments. However, for model (5) to work, it must be expressed in first differences:

$$\Delta y_{it} = \alpha \Delta y_{i(t-1)} + \Delta v_{it} \quad i = 1, \dots, N; \ \ t = 2, \dots, T \qquad (6)$$

Where $\Delta y_{it} = y_{it} - y_{i(t-1)}$, with $E(\Delta v_{it}) = 0$. Using OLS we will obtain an inconsistent estimator, but using Two-Stage Least Squares with instruments, which are correlated to $\Delta y_{i(t-1)}$ but orthogonal to Δv_{it}, we will obtain consistent estimators. However, by using all the possible instruments, or the generalized method of moment's estimator –GMM, it is possible to obtain a more efficient estimator than the one resulting from using T-2 instruments (see Arellano and Bond, 1991).

IV. Empirical results

Column 1 in table 7 shows the ordinary least square regression, column 2 shows the fixed effect estimator, column 3 shows the random effect estimator, and column 4 shows the random effect using instrumental variables procedure by performing Two-Stage Least Squares estimator, which is enough to guaranty consistency if the true model is linear. Column 5 shows us the HT estimator. By construction columns (1), (3), (4) and (5) show results concerning to a kind of Engel curve, which relates consumption variable and total expenditure in public utilities of household *i* at moment *t*.

Table 7. *Different specifications*

Variable Consumption										
	(1) Pooling Regression		(2) Fixed effect		(3) Random Effect		(4) Random effect IV		(5) Hausman Taylor	
Variables	**Coef**	**Z**	**Coef**	**z**	**Coef**	**z**	**Coef**	**z**	**Coef**	**Z**
# People Household	0.07	2.2	-----	-----	0.07	2.3	0.05	1.2	-0.05	0.7
Own House	-0.16	1.7	-----	-----	-0.16	1.8	-0.16	1.5	-0.91	2.7
Plan 300	**0.89**	**5.4**	**0.92**	**5.6**	**0.89**	**6.5**	**0.94**	**6.0**	**1.03**	**5.2**
Plan 600	**0.42**	**2.5**	**0.14**	**0.84**	**0.42**	**3.0**	**0.42**	**2.8**	**0.29**	**1.46**
Plan 1000	**1.51**	**8.8**	**0.68**	**3.8**	**1.5**	**10.0**	**1.41**	**9.0**	**0.95**	**4.53**
Ln(GSP)	2.8	1.48	-----	-----	2.8	1.5	-11.9	1.69	38.0	2.8
$(Ln(GSP))^2$	-0.10	1.3	-----	-----	-.10	1.3	0.51	1.79	-1.5	2.7
Time Liv_2	0.15	0.61	-----	-----	0.15	0.6	0.15	0.56	4.7	1.9
Time Liv _3	-0.14	-1.01	-----	-----	-0.14	1.0	-0.18	-1.23	6.3	3.7
Time Liv _4	0.03	0.24	-----	-----	0.03	0.25	-0.082	-0.56	2.7	2.5
ρ:	0.33		0.56		0.33		0.4		0.6	
Observations	2541		2541		2541		2541		2541	

All the regressions are controlled by time dummies, Age and Schooling of HH
IV Regression. ρ: Variance fraction due to λ

According to column 1 the Engel parametric specification does not seem to be the most appropriate in this case since the estimated coefficient of the logarithm of total expenditure on utilities is not statistically significant. Note that a simple linear specification such as this in column (1) does not seem quite suitable to draw clear conclusions especially if we don't take into account the possible correlation among observables and not observables.

It is clear too that fixed effect is not appropriated for estimating our Engel Curve, all time-invariant observables were eliminated from the model and just the information for different plans are still usable. Random effect models, even when these ones include instrumental variables, columns (3) and (4), do not allow curvature since estimated parameter for $(Ln(GSP))^2$ variable is non-statistically significant or has the opposite sign. Note that HT estimator reports the correct sign for estimated parameters for both total expenditure and its second power.

It is worth noting that estimated parameters for each plan (300, 600 and 1000) for all specification are positives (and highly significant), which is unexpected if agents were completely rational. In fact it means that plans lead to consumers to exceed his original consumption. Note that at the beginning the agents believe that the amount of minutes will be enough, do not update their expectations and, on average, end up with inconsistencies month after month. Price range segmentation or what is the same as nonlinearity in demand seems to confirm empirically what the theory predicts; the service provider ends up making additional profits from the typical consumer's irrationality and excess consumption.

Finally, upon estimating model (3), a sustained increase in additional consumption can be seen across months if we include time-dummies. This dynamic aspect, perhaps roughly expressed in the estimated parameters for these time-dummies, is captured in model estimations (5) and (6). Table 8 shows a dynamic approximation for the additional minute consumption and its adjustment over time.

Table 8. ***Dynamic approximation using OLS, WG, 2SLS and GMM***

	Estimation alternatives for AR(1) specification Dependent variable: variable consumption									
	OLS Levels (1)	**Within Groups (2)**	**2SLS (3)**	**2SLS (4)**	**GMM DIFOS (5)**	**GMM DIFOS (6)**	**GMM DIFOS (7)**	**GMM DIFOS (8)**	**GMM DIFTS (9)**	**GMM DIFTS (10)**
$y_{i(t-1)}$	0.67	0.11	0.22	0.25	0.174	0.175	0.154	0.132	0.135	0.138
	(30.7)	(3.43)	(2.4)	(2.1)	(4.0)	(4.1)	(3.7)	(3.2)	(3.4)	(4.2)
m1	----	-----	-----	------	0.0	0.0	0.0	0.0	0.0	0.0
m2	----	-----	-----	------	0.88	0.88	0.99	0.88	0.86	0.89
Sargan	-----	-----	-----	------	------	0.03	0.004	0.002	0.13	0.32
Instruments	------	------	$y_{i(t-2)}$	$y_{i(t-2)}$	$y_{i(t-2)}$	$y_{i(t-3)}$	$y_{i(t-3)}$	$y_{i(t-2)}$	$y_{i(t-3)}$	$y_{i(t-2)}$
				$y_{i(t-4)}$		$y_{i(t-4)}$	$y_{i(t-4)}$	$y_{i(t-3)}$	$y_{i(t-4)}$	$y_{i(t-3)}$
							$y_{i(t-5)}$	………………	$y_{i(t-5)}$	………… ……
								y_{i1}		y_{i1}

Notes: all estimations include monthly binary time variables
Asymptotic errors in parentheses
m1 and **m2** are hypothesis tests for first-and-second order serial correlation, asymptotically they are N(0,1).
Results for GMM are one step with heteroscedastically consistent standard errors.
Sargan a restriction over identification test for GMM estimators.

From all estimation cases it is possible to find that there is in general a significant gap in consumption given by the estimated α. Additionally, there is another gap in estimation when using OLS estimator and Within-Group and even if we use the Two-Stage Least Square estimator with only two instruments (AH estimator). For instance, we have $\hat{\alpha}_{OLS} = 0.67$, $\hat{\alpha}_{WG} = 0.11$ and $\hat{\alpha}_{AH} = 0.25$. However, when estimating by using three instruments, the adjustment in variable consumption of additional minutes is on average 16%. When using all possible instruments, the adjustment in consumption, *via* an increase in additional minutes, is just 13%. All of them are significant and independent from the variance and covariance matrix used to obtain the standard errors matrix.

Empirical results show that the adjustment in additional minute consumption in the fixed local telephone service has been on the rise across months. Minutes included in the chosen plans have not been enough, which has lead to additional consumption that was not in the consumption "plans" or "preferences" of the agents. In summary, not having robust evidence of an adjustment in additional consumption for the following months (not even under 5%), inconsistency in additional consumptions shows that neither consumption plans or preferences nor errors were corrected. This indicates a sort of irrationality of the agents at the time of signing up for these types of plans.

Conclusions

CRT regulatory commission granted the telecommunications companies liberty to offer tariff plans that allowed consumers of the fixed local telephone service a choice more consistent with their consumption plans. This made it possible for the company UNE of Medellin to offer a three-part tariff limited to a reduced number of plans. Theoretical and empirical evidence shows that, in general, these plans reduce consumers' welfare since they base their plan choice on the fixed charge and the minutes included, and not on their expected consumption. These plans can be designed so that consumers increase their consumption over time and even demand plans with more minutes included.

The present work supports the hypothesis that consumers surpass expected consumption levels and therefore the total payment for the service is greater than planned. Even more, the company would rightfully believe that there is a high probability in the future that many consumers decide to switch to a plan with more minutes, induced by successive deviations from the original plan. Dynamic model estimation shows that in fact there is a gap that is not corrected (or updated) over time.

Finally, one important limitation to draw more robust conclusions is the lack of more socio-demographic information both about the household and the household head.

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