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**Conference Paper**

## The Nature and Magnitude of the Effects of Asymmetric Regulation of Mobile Termination Rates on the Mexican Retail Prices

22nd Biennial Conference of the International Telecommunications Society (ITS): "Beyond the Boundaries: Challenges for Business, Policy and Society", Seoul, Korea, 24th-27th June, 2018

**Provided in Cooperation with:**

International Telecommunications Society (ITS)

*Suggested Citation:* Robles-Rovalo, Arturo; Díaz-Goti, Emiliano; Guarneros-Gutiérrez, Rodrigo (2018) : The Nature and Magnitude of the Effects of Asymmetric Regulation of Mobile Termination Rates on the Mexican Retail Prices, 22nd Biennial Conference of the International Telecommunications Society (ITS): "Beyond the Boundaries: Challenges for Business, Policy and Society", Seoul, Korea, 24th-27th June, 2018, International Telecommunications Society (ITS), Calgary

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**The Nature and Magnitude of the Effects of Asymmetric Regulation of Mobile Termination Rates on the Mexican Retail Prices**

Arturo Robles-Rovalo  
Emiliano Díaz-Goti  
Rodrigo Guarneros-Gutiérrez

**Abstract**

*In theory, network profits are independent of the reciprocal termination rates when operators charge nondiscriminatory call prices (Laffont, Rey and Tirole, 1998). Additionally, termination rates can be used to subsidize subscriber acquisition cost. This issue is typically known as a “waterbed effect”, where a reduction (increase) in termination rates leads to corresponding increase (reduction) in subscription fees to consumers. We are using a practical case for testing the effects in the final prices for regulatory policy with several changes in mobile termination rates based on an asymmetric price access regulation.*

*In our example, the termination rates have been part of a vertical restriction strategy. The observed network-base price discrimination implemented by the major network (Telcel) resulted in deadweight efficiencies lost and created barriers to new entrance and blocked growth for the small networks OECD (2012). Historically, profits margins and mobile prices comes down whenever regulator have reduced termination rates; following the income effects in subscription (Tangeras, 2014). Having in mind this fact, regulators would diminish termination rates in order to pushdown mobile prices and stimulate competition, rest on a cost-based asymmetric price regulation.*

*The further research allows a statistical assessment of the asymmetric price regulation implemented by the Mexican regulatory authority during January 2013 to June 2017. This paper evaluates if asymmetric regulation brings a better impact in the Mexican consumer welfare, driving the retail prices of mobile services down, also the effectivity of this policy for the next years, taking in to account that there is not significant change in the market share among all mobile networks.*

**JEL Classification:** L38, L51, L59, L96 and O54.

**Keywords:** Mexico, Mobile Telecommunications, Termination Rates, Structural Change, Asymmetric Regulation, Convergence, Time Series Analysis.

## **Economic Framework**

Economic theory is required in order to support empirical work to be meaningful. The main rationale to regulate Mobile Termination Rates (MTRs) has been increase the social welfare. Nevertheless, there are enough economic literature which point out the two-sided nature of mobile interconnection markets, where is predominant (i) the role of externalities are playing in the analysis of competition; (ii) equilibrium pricing, and (iii) entry in the mobile markets. That is, in presence of dominance position in the market, high MTRs has an important effect in the price offer structure and incentive strategic movement for the dominant player in order to stablish a high difference between off-net/on-net tariffs, which concentrated mayor share of the market. The foregoing reality is that very few of the cost in the mobile network is traffic sensitive.

The high fixed costs and high economies of scale and scope entail that the marginal termination costs related to the mobile services are near zero and the existence of network externalities fundamentally changes the analysis of interconnection charges. The key issue is how the structure of prices should be set to recover mobile networks costs in case of internalizes network externalities.

In theory, high MTRs could incentive strategic pricing created by call externalities. In particular, on-net/off-net price differential triggers network externalities tariffs (Laffont, 1998), which becomes larger networks more attractive than smaller networks, generating a competitive disadvantage and reducing rivals profitability in order to limit entry (*i.e.* price squeezing), at the expense of a loss in their own profit even getting a negative profit temporary (*i. e.* predatory pricing).

Armstrong and Armstrong & Wright (2009) showed that high MTRs result in higher prices for off-net calls, which hurt smaller networks since most of their subscriber's calls must be off-net. If call externalities are partially or fully internalized, to the extent that a call to a subscriber on a rival network benefits the receiver, a network still has a strategic incentive to set inefficiently high off-net prices to reduce the number of calls received by rival networks subscribers.

In Mexico, before the Telecommunication and Broadcasting Reform (July 2014), we had a practical case where the major mobile operator (Telcel) applied a tariff structure on net/off-net in order to reduce the number of calls received by rival networks subscribers. After the reform, the new law points out the prohibition for on-net/off-net price differential and imposes asymmetric mobile termination rates among Telcel and the other competitors at the market<sup>1</sup>.

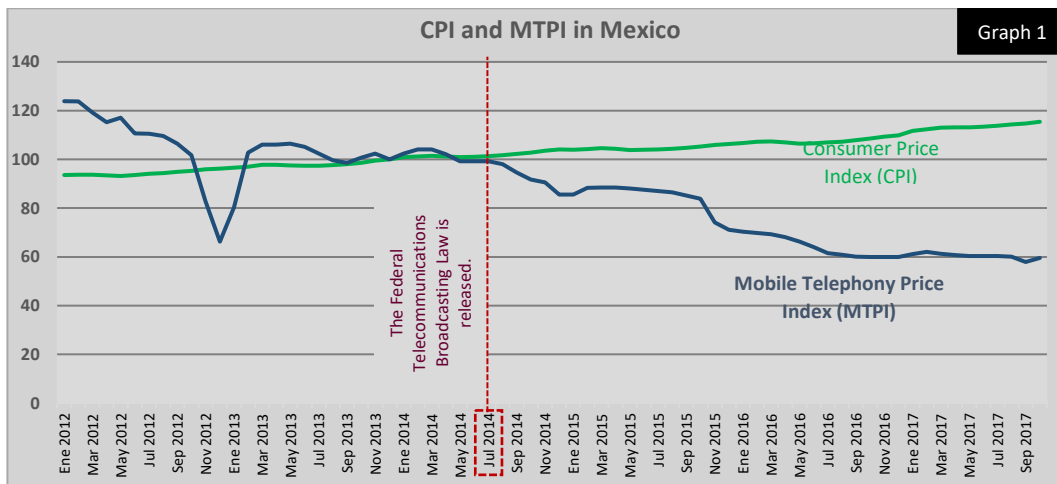
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<sup>1</sup> The Federal Telecommunications Broadcasting Law, Article 208, second paragraph, establishes that the preponderant economic agent or the agent with substantial market power shall not be able to applied differentiated charges to mobile users for calls they receive from his network or from other concessionaries (Page 80, available at: <http://www.ift.org.mx/sites/default/files/contentidogeneral/asuntos-internacionales//federaltelecommunicationsandbroadcastinglawmexico.pdf>).

Furthermore, the new law stresses the condition that once the mobile market will be in competition, the new model for interconnection will be “*bill-and-keep*”<sup>2</sup>. As Mexico has seen in his last four years of interconnection policy, a glide path for MTRs to zero effectively eliminates gradually the competitive advantage of larger networks, and this should promote growth by smaller networks. However, a transition to “*bill-and-keep*” should therefore give a more efficient wholesale and retail price structure in the short run, and help to eliminate barriers to entry, and thus increase competition and longer-run economic welfare.

### Motivation (Exploratory Analysis)

The Mexican Consumer Price Index (CPI) is growing mean while the Mobile Telephony Price Index (MTPI) is dropping down. As we can see in the Graph 1, the index of mobile voice service shows that the value of those services are less expensive (60%, less than the prices in 2013, just forty-six months before the telecommunications reform in Mexico).



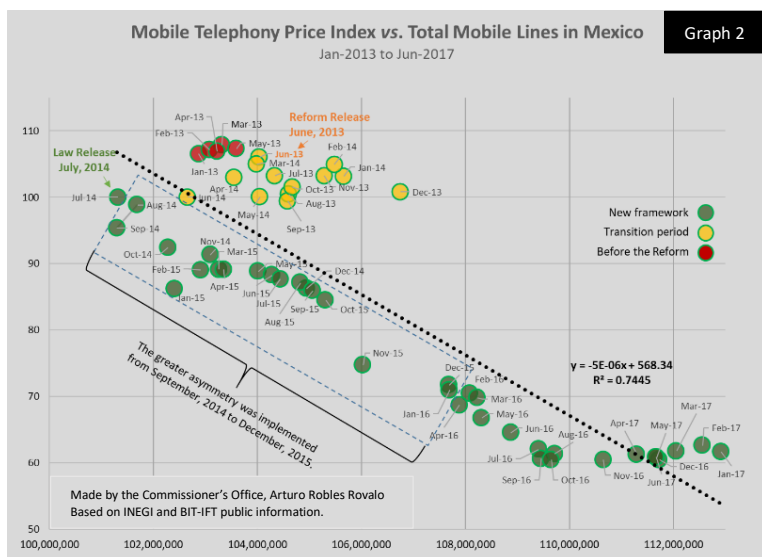
This figure shows an important reduction in prices for mobile services. The key point is consider that the rate of change in the offer of services is greater than the increase on demand of services, what could explain the reduction in prices and will be consistent with the theoretical framework that we are using.

In particular, if there is a market mechanism, we expect that the combined effect of entry of new firms and reduction of input prices at the market (*i.e.* MTRs) push the supply curve for mobile telecom services rightward by an amount that equaled or exceeded the rightward shift in demand, the expected result is a downward slopping supply function (LRS).

The following exploratory graph give us the idea of a downward slopping supply, at least after the Telecommunications Reform in Mexico. After that point, the relationship between Mobile Telephony Price Index (MTPI) and the Total Mobile Lines (TML) shows a completely different pattern than before

<sup>2</sup> Idem. Article 131, page 57, points out that when the Institute considers that there are conditions for effective competition in the Telecommunications sector, it shall determine the criteria the concessionaires of public telecommunications and fixed, and mobile networks must use to enter mandatory reciprocal traffic compensation arrangements without termination charges, including calls and short messages.

the telecommunications reform. We could say that data support the idea of having a strong market mechanism after the complete implementation of the telecommunications reform (green dots in the Graph 2).



Graph 2

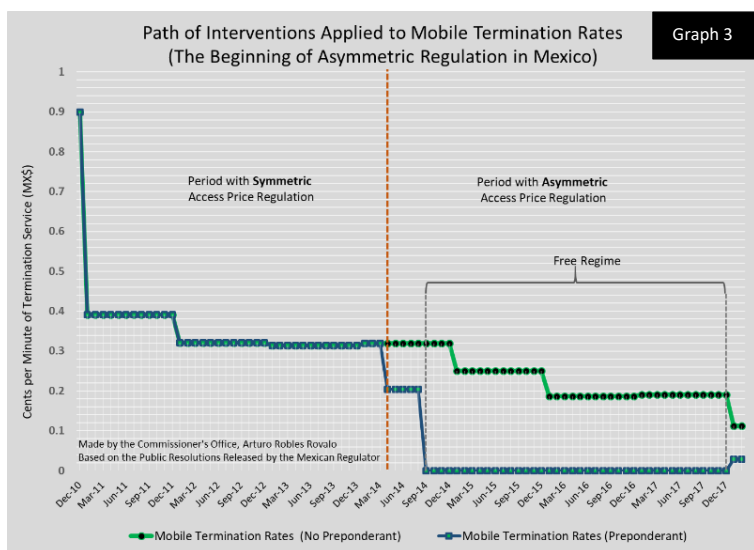
The same graph permit inferring a structural change in the data behavior. Before the telecom reform in Mexico (red and yellow dots), retail prices seem to be driven by Telcel’s price structure with high on-net/off-net price differential, where price index is apparently interdependent or poor sensitive to the total mobile lines.

A negative relationship between the price index and the total mobile lines

suggests the existence of a market mechanics, which could be explained by positive shifts on supply, related to more suppliers at the market, costs reductions, infrastructure sharing, and so on.

Backhaul costs, including interconnection, represent almost 6% in some cases of a wireless carrier total operating expenses (OPEX) and 30% of total network costs<sup>3</sup>. Having in mind this fact, the MTRs has represented an important cost for operators in Mexico.

In that regard, the asymmetric access price regulation with a cost-based access price for the incumbent and an access markup for the entrant stimulates competition in short and long term, based on Peitz (2005a), and the Mexican experience.



Graph 3

Following this visualization (Graph 3), we are able to see the path of interventions applied to MTRs in Mexico before and after the implementation of the Access Price Regulation. Data show us the pattern of every intervention made by the regulatory authority to reduce the termination rates in mobile-to-mobile services.

<sup>3</sup> Telecom Advisory Services, LLC (July, 2016), Assessment of the impact of the business data services market dynamics on innovation and competition in the U.S. wireless market, page 5 , available at: <http://cca-convention.org/wp-content/uploads/2016/08/Katz-Study-vFinal.pdf>.

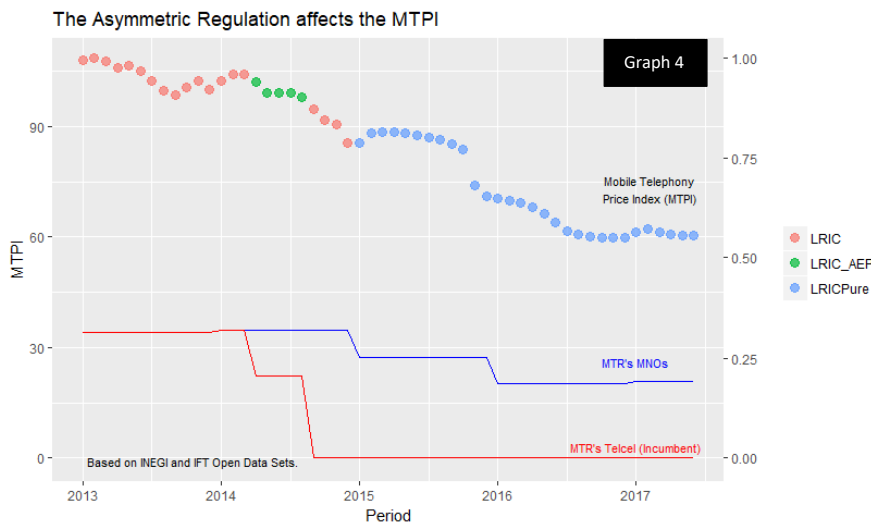
The Graph 3 show us the beginning of Asymmetric regulation since April 6<sup>th</sup>, 2014, Telcel was allowed to charge MX0.2045 (USD0.015) per minute for incoming calls, down from the existing rate of MX\$0.31 per minute, with the new charge set to remain in place until December 31<sup>st</sup>, 2014. While competitors interconnection fee was MX\$0.31 per minute (51.5% more than the Telcel’s MTR).

The second relevant stage at this asymmetric path began in September 2014, as you can see in the Graph 3, where the new Law established a **free regime** thus the maximum gap between MTRs was given from September 2014 to December 2017<sup>4</sup>. Every year after this point, the IFT defined the new MTR based on a Long Run Incremental Cost Pure Model (LRICPure).

However, in November 2017, the Mexican regulatory authority (IFT) had formally rolled back the ban imposed on the preponderant economic agent<sup>5</sup> —backed mobile giant Telcel to charge other carriers for termination services on his network— commonly referred to as the ‘**Zero Rate**’. The decision follows an injunction awarded by the Second Chamber of the Mexican Supreme Court of Justice on August last year.

Following the Second Chamber’s decision, the IFT release a price of MX\$0.029 per minute for calls terminating on the Telcel’s network, while this company will pay a rate of MX\$0.113 to terminate calls on the other networks. This new asymmetric regime started in January 2018, as is shown in Graph 3<sup>6</sup>.

A basic exploratory analysis of the MTPI and MTRs paths suggests that there is a relationship among those series. For instance, the Graph 4 shows evidence that let us make some conjectures:



(i) **There is a seeming correlation between MTPI and MTRs behavior.** You can even see there is a little increase in the MTR applied to Mobile Network Operators (MNOs) as per Jan 2017 (2% with respect to the later month) and this increase coincides with a

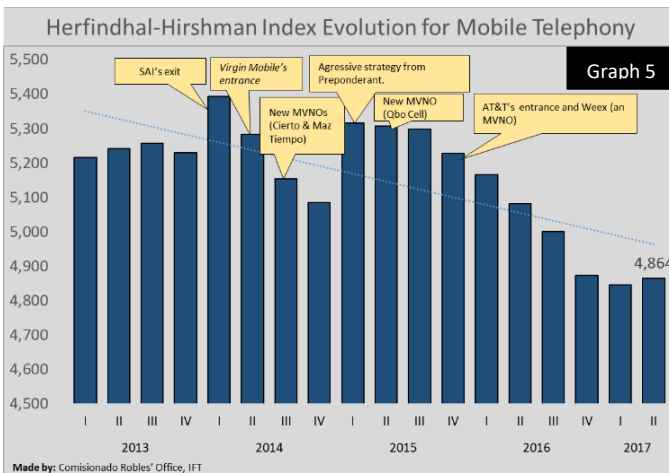
similar change at same time on the MTPI series with an apparent stabilization of the series;

<sup>4</sup> The Federal Telecommunications and Broadcasting Law, Article 131.

<sup>5</sup> For the purposes of the provisions established in this Executive Order, preponderant economic agents shall be deemed as such by virtue of their national participation in the provision of broadcasting and telecommunications services, when they directly or indirectly hold more than 50% of the domestic share. This percentage shall be measured either by the number of users, subscribers, audience, traffic on their networks or the capacity used by the same, according to the information held by the Federal Telecommunications Institute.

<sup>6</sup> The Federal Telecommunications Institute released the minimum technical conditions for efficient among concessionaries where the Institute determined the MTRs base on a cost model and international best practice and considering the participation of concessionaries at the market. Available at: [http://www.dof.gob.mx/nota\\_detalle.php?codigo=5504053&fecha=09/11/2017](http://www.dof.gob.mx/nota_detalle.php?codigo=5504053&fecha=09/11/2017).

- (ii) **Asymmetric price access regulation seems to be a key driver in the MTPI behavior.** In order to establish if this seeming correlation is relevant and consistent, must be needed a statistical analysis.
- (iii) **The asymmetric regulation encouraged the incentives for the entry of new companies in the Mexican mobile market.** For instance, AT&T in Mexico began operations at the end of 2015 following an aggressive price strategy (Graph 5 shows relevant entries in the market).



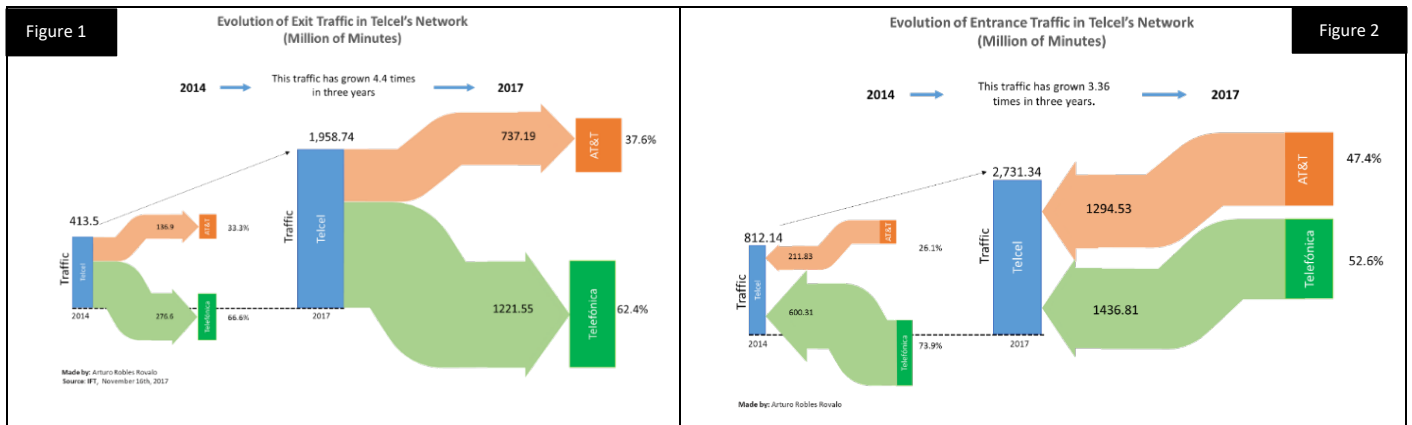
The reduction of marginal costs for MNOs, through an interconnection free regime based on Telcel's MTRs equal to zero, has permitted more aggressive price strategy from competitors, to take business from Telcel's network, and bring down the general level of prices.

As we can see in Annex 1, this strategic behavior from Telcel's competitors was observed in Mexico as an aggressive competition in calling plans. When Telcel was determined as a **preponderant economic agent** and were established termination fees for Telcel in zero.

In fact, regarding the main Latin American countries, there are markedly better offering in terms of prices, minutes offered (they were unlimited), SMSs and data for the Mexican consumer in the markets of prepaid and postpaid than the Argentinian, Chilean, Costa Rica, Uruguay and Colombian market (See Annex 1 to get specific information gathered by the authors).

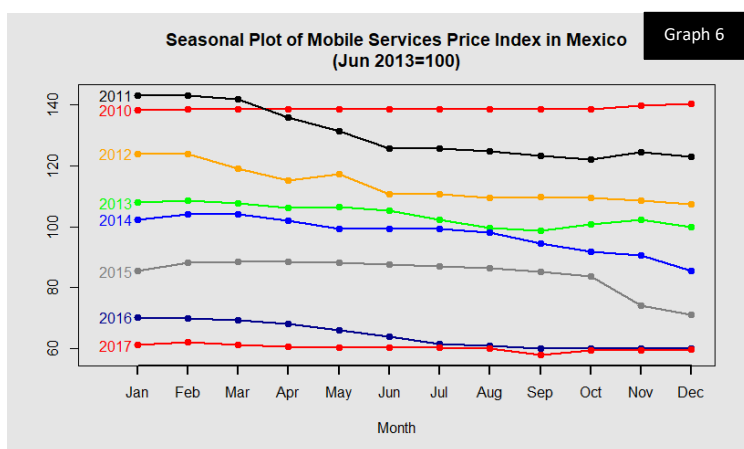
Notwithstanding the foregoing, the growth in traffic volume between networks as a proxy variable of the demand of interconnection is also a relevant driver to consider their movement in the model jointly with a reduction in the costs of interconnection leading from the intervention of the IFT.

The following *Sankey Diagrams* (Figures 1 and 2) show the traffic in the Telcel's network has grown considerably during the last four years (almost 5 times for exit traffic and 3.4 times for entrance).



Also, we can confirm in those figures that the traffic has been balanced. The entrance flow to the Telcel's network (Figure 2) was now practically equal in terms of percentage with a difference of only 5 percentage points between AT&T and Telefonica; while in 2014, the equivalent traffic for AT&T made up by the companies that now constitute this company was only 26% of the total entrance traffic.

A seasonal plot of MTPI also give us important facts (Graph 6). Controlling the seasonal behavior in the series, this plot confirms that MTPI presents a yearly seasonality (every twelve months). We can, also see the most relevant reductions in the general price index for these services were in the last four years (2013-2017). However, during the last two years (2016 and 2017) there is a more slowly movement in the downward path of prices.



What we can stand out here, also, prices seems to be higher in initial months. Secondly, 2010 presents a flat rate for all the day in contrast with the next years, and the price index has been at almost the same level from July 2016 to December 2017.

Every fact addressed in this exploratory analysis suggest evidence in regard to

the effectiveness of the asymmetric price access regulation implemented by the Federal Telecommunications Institute since April 2014 to January 2018, as well as a favorable scenario to expect lower final prices.

Having in mind every fact we found in the previous exploratory analysis, the proposal in this paper is demonstrate, based on the empirical Mexican markets information, that the competition among operators and, eventually, the reduction in retail mobile prices is a result of two key regulatory policies:

- (i) The asymmetry in the termination rates, and
- (ii) The policy to stablish that those termination rates goes down in a temporal path (glide path) based on a cost model.

## Looking for an Statistical Causality

Classical statistical techniques for a static analysis to compare before intervention and after are not applicable to time series, because it is a sequential data observations that are not independent; it means that a value in time  $t$  may be dependent of the past observations, such as  $t - 1$ ,  $t - 2$ , and so on.



The other limitation about the traditional statistical analysis is related to the impossibility of get a control group which is unaffected by the intervention (in this paper, asymmetric regulation of Mobile Termination Rates was general and affected every consumer and operator at the market).

The econometric relationship should be test initially using the Mobile Telephony Price Index (MTPI, jun. 2013=100) with several explanatory variables for the same phenomena given the facts found in the last section.

Level Metrics of Asymmetry		Gap Metrics of Asymmetry	
1.	Weighted Average of Mobile Termination Rates by Entrance Traffic (WP_Ent)	4.	Moving Average of Order 6 to Mobile Termination Rates Applied to Network Operators without Substantial Market Power (MA_MRT_NSP)
2.	Weighted Average of Mobile Termination Rates by Exit Traffic (WP_Exit)	5.	Moving Average of Order 6 to Asymmetry variable, as the difference between MRT_SP and MRT_NSP = Asymmetric
3.	Weighted Average of Mobile Termination Rates by Mobile Lines (WP_Lines)	6.	Moving Average Order 6 of another metrics for Asymmetry: $((MTR\_NSP-MTR\_SP) / \max(\text{Asymmetric})) * 100$

Having in mind every correlation, we can see that they have the expected sign. For instance, the weighted average mobile termination rates by total mobile or by exit traffic in minutes (*v.gr.* **WP\_Lines** and **WP\_Exit**) lines has a positive high correlation as a determinant of the Mobile Telephony Price Index (MTPI), and the metric established as asymmetric price access regulation is correlated negatively with the MTPI. That means that when the gap between the MTR’s Incumbent and the MTR’s MNOs increases the MTPI decreases.

Correlation Matrix (Raw Data)							
N= 54, t = (Jan. 2013 to Jun. 2017)							
Variables	MTPI	MTR_NSP	MTR_SP	WP_Exit	WP_Lines	Asimmetric	Asimmetric2
MTPI	1						
MTR_NSP	0.9366487	1					
MTR_SP	0.7730885	0.7560292	1				
WP_Exit	0.8349747	0.8281095	0.9919463	1			
WP_Lines	0.8034299	0.7948958	0.9979073	0.9969212	1		
Asimmetric	-0.5363918	-0.4797081	-0.9369833	-0.8877126	-0.9134321	1	
Asimmetric2	-0.5363918	-0.4797081	-0.9369833	-0.8877126	-0.9134321	1	1

Correlation does not imply causality. We must take in to account that the dependence or association we can see in this matrix is only a statistical relationship that only says how close two variables are near from a linear relationship with each other, but not represents a causal relationship.

In order to determine if there is a causal relationship we need a more formal econometric approach, which involve testing for “co-integration”. We commence with a standard model of co-integration with no structural change, based on the methodology’s Gregory and Hansen (1996).

$$y_t = \mu + \beta x_t + \varepsilon_t \quad t = 1, 2, \dots, n \quad (1.1)$$

where  $y_t$  is  $I(1)$  and  $\varepsilon_t$  is  $I(0)$ . The possible structural change would be reflected in changes in intercept  $\mu$  and/or changes to the slope  $\beta$ .

To model structural changes, we define the dummy variable:

$$P_{I,t} = \begin{cases} 1 & \text{if } t = I \\ 0 & \text{if } t \neq I \end{cases} \quad (1.2)$$

Structural change can take some forms.

- Level shift:

$$y_t = \mu_1 + \mu_2 P_{1,t} + \beta x_t + \varepsilon_t, \quad t = 1, 2, \dots, N \quad (1.3)$$

- Level shift with trend:

$$y_t = \mu_1 + \mu_2 P_{1,t} + \beta x_t + \omega t + \varepsilon_t, \quad t = 1, 2, \dots, N \quad (1.4)$$

- Regime shift model, which let the slope vector to shift as well:

$$y_t = \mu_1 + \mu_2 P_{1,t} + \beta_1 x_t + \beta_2 x_t P_{1,t} + \varepsilon_t, \quad t = 1, 2, \dots, N \quad (1.5)$$

For every case,  $\mu_1$  y  $\mu_2$  are levels of change in the model,  $\beta_1$  means the slope of co-integration and  $\beta_2$  is the change in the slope's coefficients.

We use the standard method to test the null hypothesis of no co-integration (in the context of the 1.1 equation). The estimation used to estimate the parameters is the ordinary least squares (OLS) and a unit root test is applied to the regression errors. Eventually, the same approach could be used for testing 1.3, 1.4 and 1.5 models, look at this equations require the identification of the change of regime or intervention.

These models of structural change under co-integration will be tested using the Mobile Telephony Price Index (MTPI, jun. 2013=100) with every explanatory variables for the same phenomena: asymmetric price access regulation.

Looking to confirm this criteria of transformation in our data, lead us to consider the coefficient of variation based on Guerrero (1993). This approach confirms that the original time series is less variable than a logarithmic transformation<sup>7</sup>, even this is the most frequent transformation for price indexes.

## Getting the structural change

Go back to the initial analysis, we must ask if there are identifiable breakpoints in the MTPI time series that we should consider during the model specification process. To answer this question we use the methodology created by Bai & Perron (2003). This algorithm is implemented for simultaneous estimation

<sup>7</sup> We looked for the best transformation of the time serie  $T(Z_t)$  so as to minimize the coefficient of variation:

$$T(Z_t) = \begin{cases} Z_t^\lambda & \forall \lambda \neq 0 \\ \log(Z_t) & \forall \lambda = 0 \end{cases}$$

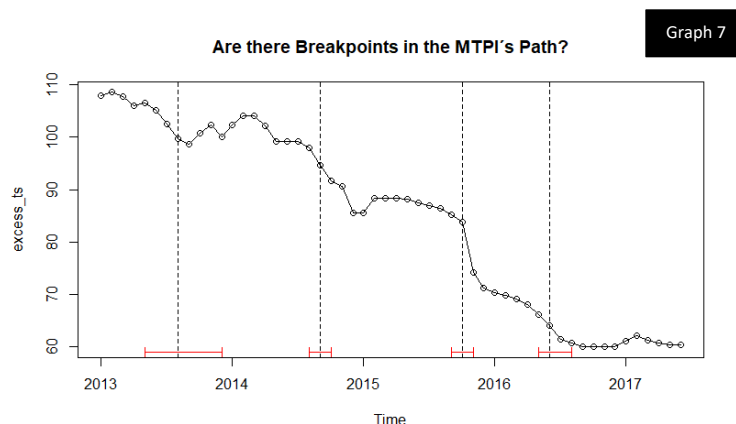
The coefficient of variation related to  $\lambda$  is:

$\lambda$	Coefficient of Variation
0	34.46740588
0.5	3.642507947
1	0.588046474
1.5	0.549192898
2	0.632469626

Having in mind that this methodology was created to pick up the best transformation, particularly between logarithm and other one, we avoid a transformation considering the coefficient of variation we get.

of multiple breakpoints. The distribution function used for the confidence intervals for the breakpoints is given in Bai (1997b). The ideas behind this implementation are described the original time series against its breakpoints and its confidence interval can be seen in the following the Graph 7:

Having in mind that every point was selected taking in to account the statistical behavior, based on mean and variance; we can talk about a structural change, which means an exogenous intervention (*i.e.* changes in the policy of access price regulation) to the natural pattern of the data (Graph 2).



This behavior is also consistent with

the breakpoints we found: August 2013, September 2014 and November 2015.

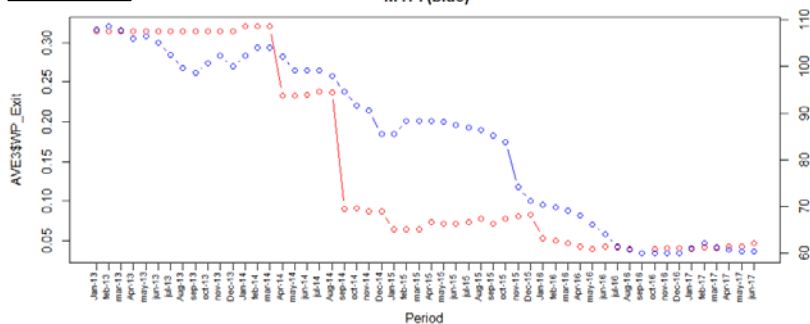
During those breakpoints, we are able to identify important regulatory changes (*v.gr.* Interventions):

- **August 2013.-** The structural regulatory change began with the constitutional reform in telecommunications matters published on 11 June 2013 (the Constitutional Reform). At this time, the regulation of mobile termination rates was on charge of the Mexican Federal Telecommunication Commission (COFETEL in Spanish). The model to determine the mobile interconnection rate was a Bottom-Up Long Run Incremental Cost and there is not asymmetry, although the constitution established that interconnection services are public services with general interest.
- **September 2014.-** The Federal Telecommunications and Broadcasting Law (the Law) was finally released on July 14<sup>th</sup>, 2014, and went into effect the next 13 August. Under the Law, Article 131, the Federal Telecommunications Institute begins a glide path in mobile termination rates with two characteristics: (i) A new cost model for the next year a Bottom-Up Long Run Incremental Costs Pure since December 2015, and (ii) Complete asymmetry since September 2014 where the preponderant carry did not allow establishing a tariff.
- **November 2015 and June 2016.-** At this period, the asymmetry among mobile termination rates achieve the maximum gap, particularly because that year was eliminated the national long distance charges based on the new law .

## Analyzing Data

We looked for the best-fitted model based on the raw data, taking in to account that MTR's MNOs gives the better lineal relationship, later the weighted average mobile termination rate by exit traffic and finally the asymmetric measure we suggest (See Graph 8).

Graph 8 Cointegration test, Weighted Average Rate by Exit Traffic (Red) MTPI (blue)



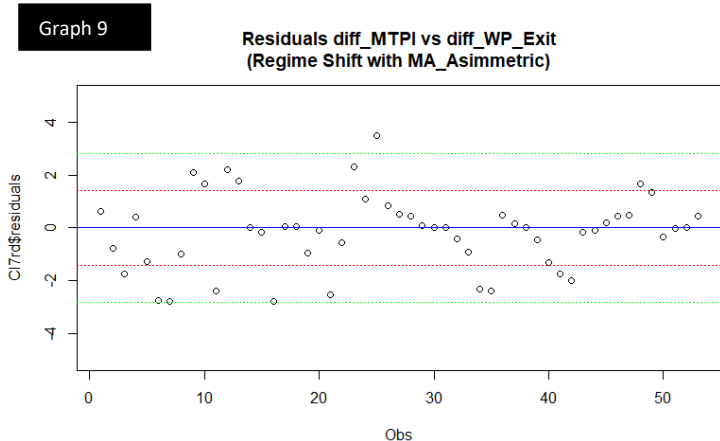
Just after a careful identification model process, the best-fitted model estimated with these data was made based on raw data in differences and simple moving average transformation for the variable Asymmetric<sup>8</sup>:

$$(MTPI_t - MTPI_{t-1}) = 16.77(WP\_Exit_t - WP\_Exit_{t-1}) - 2.55MA\_Asymmetric - 6.39P_{I,t} - 10.158P_{I,t} * WP\_Exit_t + \epsilon_t$$

(8.148) (1.11) (1.032) (4.29)

Where  $P_{I,t} = \begin{cases} 1 & \text{if } t = \text{August 2013, Sep 2014, Nov. 2015 or Jun. 2016} \\ 0 & \text{if } t \neq 1 \end{cases}$

For this model, the residual plot looks like this (Graph 9):



The Augmented Dickey Fuller Test shows that the residuals are not stationary, that means they are  $I(0)$ <sup>9</sup>, as well as their auto covariance<sup>10</sup>.

Concluding that this is the best-fitted model where we can confirm the effect of a reduction in the weighted

```
Call:
lm(formula = AVE3$diff_MTPi_out ~ AVE3$diff_WP_Exit + AVE3$MA_Asymmetric +
AVE3$Dummy + AVE3$PtWP_Exit + 0, na.action = na.omit)
```

Residuals:

Min	1Q	Median	3Q	Max
-2.8057	-0.8886	0.0309	0.4625	3.5057

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
AVE3\$diff_WP_Exit	16.779	8.148	2.059	0.0448 *
AVE3\$MA_Asymmetric	-2.555	1.117	-2.288	0.0265 **
AVE3\$Dummy	-6.390	1.032	-6.193	1.18e-07 ***
AVE3\$PtWP_Exit	-10.158	4.294	-2.365	0.0220 *

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.389 on 49 degrees of freedom  
(1 observation deleted due to missingness)

Multiple R-squared: 0.6073, Adjusted R-squared: 0.5753  
F-statistic: 18.95 on 4 and 49 DF, p-value: 1.796e-09

<sup>9</sup> Title:  
Augmented Dickey-Fuller Test

Test Results:  
PARAMETER:  
Lag Order: 1  
STATISTIC:  
Dickey-Fuller: -4.2961  
P VALUE:  
0.01

Description:  
Thu Mar 01 18:55:05 2018 by user: rodrigo.guarneros

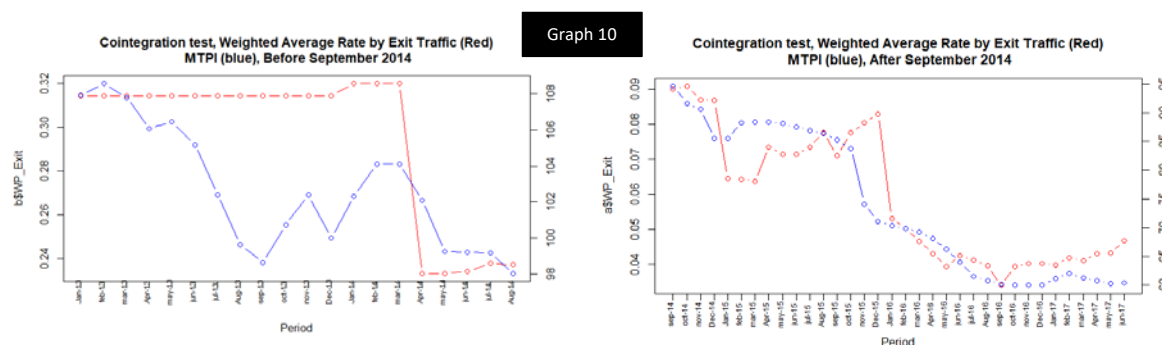
<sup>10</sup> Call:  
lm(formula = CI7rd\$residuals ~ lag(CI7rd\$residuals, difference = 1) + 0)

Residuals:

average mobile termination rates in Mexico and the effect of the increase in asymmetry price access.

In this regard, our model tell us that if we reduce the weighted average termination rate by exit traffic in the most relevant mobile networks in one cent, the Mobile Telephony Price Index decreases in 0.1677 points, *ceteris paribus*. At the same time, one cent of peso of increase in the gap between the MTR's MNOs and MTR's Telcel, drops down the MTPI in 0.0255 points, *ceteris paribus*. In addition, we can see that break points identified during the process of analysis are statistically significant. This last point mean that the break points we found are structural changes in the process of price behavior.

Particularly, September 2014 represents an important intervention momentum. If we use the same model to identify explanatory variables before and after this point, we find the following results (Graph 14):



This clear change in the data structure was confirmed when we find that the model fits better when we use only data related to September 2014 to June 2017 (N=34)<sup>11</sup>:

$$(MTPI_t - MTPI_{t-1}) = \frac{19.9590}{(8.66)}(WP\_Exit_t - WP\_Exit_{t-1}) - \frac{2.4902}{(1.06)}MA\_Asymmetric - \frac{6.81}{(0.96)}P_{It} - \frac{10.158}{(4.29)}P_{It} * WP\_Exit_t + \varepsilon_t$$

The next step is doing a residual analysis, where we need to confirm if  $\varepsilon_t$  is an I(0) series, applying the augmented Dickey-Fuller test so as to determine whether we can conclude from this time serie that it is

```

Min      1Q      Median      3Q      Max
-2.97752 -0.97183  0.00024  0.39724  3.11986

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
lag(CI7rdResiduals, difference = 1)  0.3539   0.1308   2.706  0.00925 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.341 on 51 degrees of freedom
(1 observation deleted due to missingness)
Multiple R-squared:  0.1255,    Adjusted R-squared:  0.1084
F-statistic: 7.321 on 1 and 51 DF, p-value: 0.009247

11 Call 1:
lm(formula = aSdff_MTPI_out ~ aSdff_WP_Exit + aSMA_Asymmetric +
  aSDummy + 0, na.action = na.omit)

Residuals:
    Min      1Q      Median      3Q      Max
-2.5343 -0.4685  0.0076  0.4455  3.4888

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
aSdff_WP_Exit  19.9590     8.6606   2.305  0.0281 *
aSMA_Asymmetric -2.4902     1.0616  -2.346  0.0256 *
aSDummy         -6.8178     0.9615  -7.091  5.76e-08 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.313 on 31 degrees of freedom
Multiple R-squared:  0.7091,    Adjusted R-squared:  0.681
F-statistic: 25.19 on 3 and 31 DF, p-value: 1.89e-08

```

stationary. In this sense, the Augmented Dickey Fuller Test tells that there is a 1% of probability of having an autoregressive behavior in the residuals.<sup>12</sup>

The Residual Standard Error is the average amount that the response will deviate from the true regression line. We can say that the percentage error in this model is **2.6%**. It's also worth noting that the Residual Standard Error was calculated with 31 degrees of freedom, and it's a better result than with the previous model considering all data.

In this case, the  $R^2$  is bigger than before, we get 0.681 instead of 0.57. Or roughly 70% of the variance found in the response variable `diff_ln_MTPI` can be explained by the predictor variable (`diff_WP_Ent`, `MA_Asymmetric`, and structural changes).

The F-statistic, that is larger than 1 (25.19), is already sufficient to reject the null hypothesis ( $H_0$ : There is no relationship between `diff_ln_MTPI`, `diff_ln_WP_Ent` and `MA_Asymmetric`).

These results have important policy consequences. The fact that mobile traffic is very high in Mexico, means that regulators should now be less worried about possible adverse or unintended short-run consequences of regulatory cuts to mobile termination charges. The absence of the waterbed effect may imply that further termination charges cuts will decrease the price of calls to mobile phones, which will benefit consumers. Nor there is any strong indication that these cuts have considerably weakened the mobile operators' position to survive or to compete by making new investments.

## Conclusions

- Every change in the price access regulation in Mexico is statistically significant, as well as the weighted average interconnection rate and the asymmetric policy. *Ceteris paribus*, a reduction in one cent in the weighted average interconnection rate by exit traffic implies a variation in the MTPI of roughly -0.20%.
- The asymmetric policy in Mexico has shown being relevant and inversely proportional to the variation in final prices for mobile services. Our model has shown that an increase of the asymmetry in one cent (gap between MTRs) means roughly 0.025% of reduction of MTPI, *ceteris paribus*.

---

<sup>12</sup> Title:  
Augmented Dickey-Fuller Test

Test Results:  
PARAMETER:  
Lag Order: 1  
STATISTIC:  
Dickey-Fuller: -3.1643  
P VALUE:  
0.01

Description:  
Fri Mar 02 15:04:21 2018 by user: rodrigo.guarneros

## Paper

### ITS South Korea (Confidential)

It is very remarkable that the model has shown that the categorical variable of intervention is relevant statistically, but it becomes more relevant if we consider jointly the level of the weighted average interconnection rate by exit traffic (*v. gr.*  $P_{I,t} * WP\_Exit_t$  in the model).

This variable explains the jointly effect of the intervention and the level of this intervention which means that one percent of change in the  $WP\_Exit$  in the identified breakpoint means an average reduction in the MTPI of 0.10 points, *ceteris paribus*.

- The asymmetric price access regulation in Mexico has experienced the maximum possible gap among Mobile Termination Rates for Incumbents and Mobile Network Operators in more than three years (September 2014 to December 2017). The court decision has reduce the asymmetry eliminating the free regime as of 2018. This means that the Asymmetric regulation price index based on costs is running out, even if the weighted average interconnection rates could be push down a little more.
- The challenge of regulator has changed. The Federal Telecommunications Institute, as other regulators abroad, should change the strategy, having in mind the state of the art in technology, the convergence in telecommunications services, and migrate to ***bill and keep*** interconnection model.

**Annex 1 (Prepaid and Postpaid services)**

**Table 1.-Prepaid (83% of the total mobile lines in Mexico<sup>13</sup>)**

Country	Operator	Minutes offered	SMS	Data	Validity	Price USD	Price USD PPP
Mexico	Telcel	Unlimited	unlimited	340 MB	3 days	1.5	3.4
	Movistar	unlimited	unlimited	400 MB	3 days	2.0	4.5
	AT&T	unlimited	unlimited	400 MB	7 days	2.6	5.6
Argentina	Claro	100 calls	300 calls	2 GB por \$100	7 days	5.1	8.5
	Movistar	unlimited por \$25	unlimited por \$25	300 MB por \$30	3 days	3.6	5.9
	Telecom Personal	75 por \$30	7000 por \$35	1 GB por \$60	7 days	5.6	9.2
Colombia	Claro	20	500	50 MB	2 days	1.0	2.3
	Movistar	35	10	120 MB	7 days	2.1	4.6
	Tigo	20	10	50 MB	2 days	1.0	2.3
Chile	Claro	80	-	500 MB	3 days	2.4	3.7
	Movistar	50	-	300 MB	3 days	1.6	2.5
	Entel	50	-	500 MB	7 days	4.7	7.4
Brazil	Claro	local calls unlimited and unlimited LD calls on-net	unlimited on-net, 100 free	2 GB	7 days	2.8	4.9
	Vivo	unlimited on-net	unlimited on-net	500 MB	7 days	2.2	3.9
	TIM	unlimited on-net 100 min off-net	unlimited	1 GB	7 days	2.8	4.9
Uruguay	Ancel	16	-	0.65 GB	30 days	4.0	5.3
	Movistar	unlimited on-net 25 min off-net	unlimited on-net 100 sms off-net	3 GB	7 days	6.5	8.5
	Claro	50 calls	300 calls	1 GB	3 days	2.5	3.3
Costa Rica	Claro	30	40	175 MB	2 days	3.2	4.6
	Kölbi	34	200	150 MB	7 days	4.4	6.4
	Movistar	15	15	650 MB	7 days	4.4	6.4

Source: Made with MNOs' information.

**Table 2.-Postpaid (17% of the total mobile lines in Mexico)**

Country	Enterprise	Minuts calls	SMS	MB	Validity	Price USD	Price USD PPP
Mexico	Telcel	unlimited	unlimited	1 GB	30 days	10.2	22.3
	Movistar	unlimited	unlimited	3 GB	30 days	12.7	27.9
	AT&T	unlimited	unlimited	1 GB	30 days	10.2	22.3
Argentina	Claro	unlimited on-net 200 min off-net	unlimited	1 GB	30 days	13.4	22.1
	Movistar	unlimited on-net 200 min off-net	unlimited	2 GB	30 days	15.1	25.1
	Telecom Personal	100	unlimited	1.5 GB	30 days	13.4	22.1
Colombia	Claro	unlimited	3000	5 GB	30 days	22.2	49.5
	Movistar	unlimited on-net 400 min off-net	3000	2.4 GB	30 days	17.4	38.7
	Tigo	unlimited on-net 400 min off-net	unlimited	2.5 GB	30 days	17.4	38.7
Chile	Claro	unlimited 100 calls	500	20 GB	30 days	23.7	36.9
	Movistar	unlimited 300 calls	unlimited a 300 números	25 GB	30 days	28.4	44.3

<sup>13</sup> This share is available at the Third Quarter Statistics Report 2017, Federal Telecommunications Institute, page 19: <http://www.ift.org.mx/sites/default/files/contenidogeneral/estadisticas/3ite2017.pdf>



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Country	Enterprise	Minuts calls	SMS	MB	Validity	Price USD	Price USD PPP
	Entel	unlimited 300 calls	1000	30 GB	30 days	37.0	57.6
Brazil	Claro	unlimited locals unlimited LD on-net	unlimited	6 GB free + 6 GB (From 00:00 to 6:00 am hrs)	30 days	27.7	48.8
	Vivo	unlimited locals unlimited LD on-net	unlimited	6 GB	30 days	30.5	53.6
	TIM	unlimited	unlimited	7 GB + 7GB for Netflix, Looke, Já! O Ei plus	30 days	27.7	48.8
Uruguay	Movistar	unlimited on-net 160 min off-net	unlimited	4 GB	30 days	23.2	30.6
	Claro	unlimited on-net 45 min off-net	100	2 GB	30 days	14.9	19.7
Costa Rica	Claro	unlimited (on-net), 75 (off-net)	-	2 GB	30 days	17.3	25.0
	Kölbi	35	30	2.5 GB	30 days	14.1	20.4
	Movistar	unlimited (on-net), 150 (off-net)	unlimited (on-net)	4 GB	30 days	26.3	37.9

Source: Made with MNOs' information.

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