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COMPETITION IN THE TELECOMMUNICATION SECTOR: AN ECONOMETRIC APPROACH TO THE ENTRY OF *MASMOVIL* INTO THE SPANISH MOBILE COMMUNICATIONS MARKET

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Abstract

In the last thirty years, the Spanish telecommunication sector has experimented a liberalization process. We study the economic impact of the entry of a new firm, *MasMovil*, into this market. Based on a time series analysis, we develop an error correction model and a linear demand model in order to estimate the effects of *MasMovil*'s entry. We conclude that even though *MasMovil*'s entry had an impact on the market's performance, it was the merger of *MasMovil* and *PepePhone/Yoigo* that impacted the most economic efficiency as well as consumers' surplus.

Keywords: Telecommunication, competition, Spain, market power, horizontal mergers, time series.

JEL Codes: C32, C52, L13, L96.

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1 | Introduction and motivation

Telecommunications is an increasingly relevant sector of a modern economy. Broadly defined, it encompasses radio, television, and fixed and mobile telephony. More recently, news services such as cloud services, remote control of public infrastructures—like underground machines—have become part, or benefited from developments in the telecommunications sector. These, in turn, were essential for the emergence of globalization. In sum, telecommunications has been in recent years one of the most dynamic and innovative economic sectors.

In the last thirty years, the telecommunications sector has been increasingly liberalized. The underlying deregulation process aimed at increasing efficiency, investment and the creation of new technologies. In particular, it has given rise to significant price reductions and quality improvement of the services provided to consumers.

We analize the impact of the entry of a fourth operator, *MasMovil*, on prices, both in the short and long term. We aim at depicting the evolution of prices and economic efficiency over the period 2005 to 2018, and inferring the role of *MasMovil* in increasing increase competition in the mobile telecommunications market.

From the data, we develop two time series model using an ECM where we will study the macro effects and their respective forecast of prices and lines over the market concentration. Also it is analyze the welfare effects of *MasMovil*'s entry, the relation between concentration and efficiency loss in this market and the evolution of competition.

This paper progresses as follows. Firstly, we present the literature on competition and regulation of telecommunications markets and describe the Spanish market. Then, we develop the empirical framework. Finally, we conclude by pinpointing the limitations of our analysis and draw attention to future research lines. An annex contains ancillary material.

2 | Literature Review

2.1 | General Characteristics

In the previous century, national governments were in charge of “regulating” the telecommunications market, which they did by treating it a state-owned monopoly. However, in the ’80s and specially the ’90s, the sector was liberalized, non-state owned telecommunications were allowed to enter the market, and fixed costs experienced a reduction. This lead to the entry of new competitors and an increase in competition. Several economic characteristics of the sector should be highlighted:

- The sector requires effective price discrimination due to high fixed costs.
- Competition is affected (and restricted) by capacity constraints inbuilt into the available technology. Due to these capacity constraints, the standard competition model most adherent to this market is the Kreps and Scheinkman (1983) model, in which firms simultaneously and independently choose their capacity in the first stage to then compete in prices in the second stage.
- The sector is characterized by strong network externalities.Leff,N.H.(1984)
- The regulator can promote competition by either incentivizing entrants to invest in their own physical infrastructure, or alternatively allowing them to use the physical infrastructure of the incumbent. This gives rise to a so-called mobile virtual network operator (MVNO). For the most part, most countries opted for the latter regulatory approach. Calzada, J& Costas Comesaña, A.(2013)

- Scale economies are strongly present due to the large fixed costs associated with infrastructure. As a result, infrastructure duplication is in general not efficient.Doyle,C.(1997)

2.2 | Regulation.

Telecommunication regulation is currently focused on three main questions: (i) When should entry of new competitors be allowed? (ii) If the previous question is affirmatively answered, how should entry be effected? (iii) ¿When a Telecommunications Merger should be allowed.?

2.2.1 | Entry conditions.

Due to high cost of telecom sector the entrant firm have to use the telecom network of the incumbent, at least in the short term. Consequently, the regulator have to fixed the prices over the marginal cost in order to compensate the incumbent by the extra expenses derivative of the additional maintenance cost. As a result, in order to allow an efficient entry[1], we have to take into consideration at least tree symmetric aspects between the entry and the incumbent:

- If the entrant’s costs are lower than the incumbent’s, the incumbent may be forced to exit the market. In such case, the incumbent may be unable to catch up technologically to then be able to compete. This is undesirable from a social welfare viewpoint to the extent that it reduces competition. In some context this entry is denominated parasitism entry.

- Entry entails value creation insofar as it increases transactions. However, it also entails stealing business from incumbents, with no social welfare gain(except for cost differences between the incumbent and the entrant)if the entry is not produced in a competitive way in the retailed sector.

1 In this context we consider as efficient entry when the increase of global welfare derivate by the entry of competence will be higher than extra cost generated by the new entrants over the incumbent,

- Demand “symmetry” between the incumbent and the entrant might not be assured. If the demand face by one firm is quite different from the demand faced by another, the regulator needs to take such an asymmetry into account to effectively regulate.

2.2.2 | Price regulation

Price regulation must create incentives for quality improvement, issues raised by asymmetry of information (adverse selection ex ante, and moral hazard ex post), and rent seeking behavior on the incumbent’s part. In general, the regulator wants to apply Ramsey pricing in an environment characterized by large fixed costs and low marginal costs.

Several methods are often used to determine access prices:

- Efficient Component Pricing Rule(ECPR) .The access pricing is fixed based on the opportunity cost of the integrated access provided depending of the market conditions, product differentiation and substitution products. In the telecom market it depends of the increase of marginal cost of the incumbent occasioned by the entry of new competitors.

- Cross Subsidies, in this case the idea is to allow competition of price in the retailed sector that have a more elastic demand(local calls) and fixed prices in the another sectors(international calls) with an inelastic demand, that will allow to reduce the global inefficiency derivative by the higher taxes.

- Price Caps. In this case, the government fixed a maximum prices close to average cost of the main competitors used several index related to inflation, cost evolution and market behavior. However, due to the firms can not compete on prices, because prices is fixed, they will have strong incentives decreasing the overall quality, decreasing cost and increase their profits developing a moral hazard problem.

2.2.3 | Mergers in the telecommunication sector

In In the telecommunications sector there exist large efficiency gains arising from mergers (Neary, 2004). The merger of small firms usually can be effected by simply notifying the relevant competition authority.[2] In the case of the merger of large firms, several issues arise due to the relevant reduction in competition that the merger of large firms potentially entails.

Firstly, the merger of two firms is not the only way to avoid duplication of fixed cost. In the case of telecommunications firms, this can be accomplished by sharing the infrastructure or contracting a third party (such as Cellnex in Spain, or OMTEL in Portugal) that provides services to several firms.

Secondly, allowing the merger of operators who own infrastructure may reduce total network capacity to an a less than optimal level, decreasing the supply of services and leading to price increases (Levy and Retzes, 1992).

Thirdly, mergers participants argue a merger will allow them to increase investment and decrease the average cost. However, the European Union allows for joint ventures aimed at increasing the investment in R&D, in accordance with the R&D block exemption, or by requesting an individual exception to article 101 of Treaty of the Functioning of the European Union. Moreover, decreased competition as a result of the merger may reduce investment incentives (Aghion et al., 2005). In addition, a reduction in the number of firms in such a highly symmetric sector as the telecommunications industry may increase the likelihood that firms end up colluding (Compte, Jenny and Rey, 2002).

To sum up, a merger of large telecommunications firms may be socially deleterious and should not be waived through without consideration for its social welfare consequences.

2 Council Regulation (EC) No 139/2004 of 20 January 2004 on the control of concentrations between undertakings (the EC Merger Regulation).

2.3 | Competition

Starting in the nineties, when the liberalization of the telecommunications sector took off, several mechanisms were implement with aim of fostering entry while increasing economic efficiency and social welfare. We discuss three issues: collusion requirements, abuse of dominant position and spectrum auctions.

2.3.1 | Collusion

Collusion is a central issue hindering competition where the symmetry of the sector and restriction capacity using the network infrastructure possibility it[3]. However, in the telecommunications sector several factors make collusion hard to achieve:

- Unstable demand. In the last 20 years, the demand for telephone services has increased remarkably, making it difficult to forecast its evolution. This makes it harder for competing suppliers to effect collusion.

- Reduced concentration. Former monopolies have been replaced by oligopolies in which several main competitors operate.

- Entry costs. Technology improvements have decreased the entry cost.

- Cross ownership among competitors. Cross ownership among competitors can lead to reduced competition. In Spain, none of the foiur main competitors in the mobile telecommunications market owns more than 5% of the other mobile operators.

3 See CNMC(2017).

2.3.2 | Abuse of dominant position,

this is defined as the capacity of one firm with market power to obstruct the free competence between the rest of the firms, the most common are:

Predatory price practices. Predation through prices entails a dominant firm setting its price with the aim of preventing entry or forcing the exit of a competitor or competitors in the short run with the aim of benefiting from higher profits in subsequent periods. In these cases, there are two elements that allow us to distinguish between abuse of a dominant position, on the one hand, and price competition, on the other: the former strategy entails the observations of short-term losses for the incumbent (during the predation phase) and the existence of enough market power afterwards, in order to benefit from increased profits after predation has succeeded in competitors have been ejected from the market.

Predation is a phenomenon that can be explain only in a context of imperfect information. Players should be uncertain about the each other's cost conditions. Otherwise, the entrant can fully appraise market conditions and will not exit (or refrain from entering) unless it is *actually* incapable of competing.

Regulation with network effects. Regulating an industry with network effects, such as the telecommunications industry, requires that the installed base of end users of the incumbent be made accessible to entrants. Only then will the market be contestable. Otherwise, network effects will protect the incumbent—who typically benefits from a large installed base of consumers—from entrants with relatively minor installed bases. Compatibility of networks, interconnection requirements and number portability at low or zero charge are policies that regulators often promote to this end.

Denial of supply of essential inputs. The incumbent may deny access to a key input required for an entrant's successful entry.

2.3.3 | Spectrum auctions.

Auctions have become useful mechanisms for assigning the radio electric spectrum. They permit the assignment of licenses in an efficient and transparent manner. However, auction design is a complex problem. Design mistakes have strong effects in the final adjudication and the government's revenue collection. Some of these design variables that must be set are: the maximum amount of spectrum that each operator can acquire at auction, the number of auction rounds, ascending or descending nature of the auction, the minimum bid increase per round, and the information made available while the auction is progressing.

2.4 | Some comments about the telecom Spanish market(2004-2019)

Spain experimented changes from their liberalization of telecommunications in 1998 to the end of price regulation in 2004.From the end of regulatory period until today ,three periods emerged:

The transition from fixed to mobile communication phone calls together with an increase in market competition (2004–2012).

In this period, mobile communications began to supplant fixed telephony. This transition was enhanced by two measures: the introduction of portability in 2000, and the deregularization in 2007 of VNMOs, which required incumbent telecommunication operators with network infrastructure to offer access to VNMOs. Both measures allowed VNMOs market share to reach 15% of pre-paid calls. Other measures were the opening up of the local loop and the reduction in interconnection charges between operators that decreased them by 70% on average, although the reduction was not uniform across operators. *MasMovil* entered the market during the period (February '08), firstly as a VNMO and later, in 2011, with its own network obtained in the secondary market, i.e., after the 4G auction had taken place. *MasMovil* developed an infrastructure similar to those of *Movistar*, *Vodafone* and *Orange*.

Convergence between telephone operators (2012–2018).

ADSL reached 8.8 million lines at the end of 2012. It benefited from the enactment of local NEBA (New Ethernet of High Band), which allows for retail speeds of up to 30Mbps. This turned Spain into the EU country of with the highest level of FTTH (Fiber To The Home) and was instrumental in the entry of new internet firmas such as *Jazztel* and *Ono*. 4G technology became widespread during this period.

As a consequence of these developments, the phone operators started a fusion process in order to consolidate their position to the detriment of VNMO and independent internet providers. The acquisition of *Ono* by *Vodafone* (for EUR 7 200 M) in March ’14, the acquisition of *Jazztel* by *Orange* (EUR 4 055M) in June ’15 and the acquisition of *Yoigo/Pepephone* by *MasMovil* (EUR 612M plus EUR 158M) in April and June ’16, date from this period. At the end of this period, the business model adopted by operators evolved again by including data and audiovisual services, such as *Movistar+* and *Netflix*. These services, rather than the price of phone calls, became the focal point of competition.

Future perspectives (2019 onwards)

2019, the process leading to the auctioning of spectrum licenses for operating 5G services began. However, the cost of the frequencies acquired at auction together with the investment in new infrastructures required by the new 5G technology, will force telecommunications operators to share the network or sell the non- useful infrastructure to third firms, such as *Cellnex*. 5G will allow high-velocity data transmission and lower response times of the devices operating on the network (lower latency in the jargon of the sector). This technological improvement will allow operators offer new services that benefit particularly from lower latency, such as synchronous video game playing. These developments will determine how the shape of competition in the future.

3 | Empirical Analysis

3.1 | Methodology approach

The main objective of our work is to study the effects of *MasMovil*'s entry into the Spanish telecommunications market. To this end, we will estimate a time series model to analyze the macroeconomic effects of the entry over the prices and lines (both post-paid) as a result of entry, in a manner similar to Karacuka et al. (2011).

In this study, we will focus on the post-paid prices per minute as a main independent variable and post-paid mobile phone contracts, rather than using pre-paid prices per minute, the number of minutes by customer, or both.

The pre-paid price per minute does not depict well the Spanish market's characteristics and evolution. Firstly, the total number of pre-paid minutes has been constant between 2.3 and 3 billions minutes per year. In contrast, post-paid minutes have risen from 9.6 to 21.7 billions in fourteen years.

This increased in post-paid minutes over pre-paid minutes was incentivized by new contractual offerings that integrate mobile telephony with fixed telephony and Internet access. This has boosted the attractiveness of post-paid contracts *vis-à-vis* pre-paid ones, in particular from 2013 onwards, due to the increasing use of mobile data services. We thus believe that post-paid prices better reflect the evolution of the mobile telephony market as shaped by competition.

To analyze the effect of *MasMovil*'s entry over prices and lines, we estimate an error correction model (ECM) to create a contrafactual scenario in which *MasMovil*'s entry did not take place. In our ECM, the main variables are post-paid prices, post-paid telephone line contracts and a concentration index, the Herfindahl-Hirschman Index (HHI).

In addition, two linear models are also estimated involving prices and the number of mobile telephone lines based on two main assumptions: demand and supply linearity and constant demand independent of *MasMovil*'s entry. Based on these linear demand and supply models, we estimate the HHI in the contrafactual scenario in which *MasMovil* did not enter. In this case we use two comparative models, one in which we relate efficiency loss and market concentration, and the other were we relate efficiency loss and consumer surplus.

3.2 | Data and model specification

The data was obtained from *Comisión Nacional de Mercados y la Competencia*, even though most of it was collected by the extinct *Comisión Nacional de Telecomunicaciones*. The data are quarterly and include 57 periods between the first quarter of 2005 and the second quarter of 2019. The remaining data was obtained from the Bank of Spain, the *Instituto Nacional de Estadística* and an OECD database

STATA was used for the most part, with the exception of the graphs which were created on Calc.

3.2.1 | Error correction model

Based the assumption that market prices are strongly correlated with past prices, number of telephone lines by firm and the concentration of the sector, we develop two times series models, one involving HHI and post-paid prices and another using HHI and post-paid lines.

The HHI was computed as:

$$HHI_i = (Number of Lines_{Movistar}/Total\ Lines)^2 + \left(Number of\ Lines_{Vodafone}/Total\ Lines\right)^2$$
$$+\left(Number of\ Lines_{Orange}/Total\ Lines\right)^2 + (Number of Lines_{MasMovil}/Total\ Lines)^2$$
$$+\left(Number of\ Lines_{Resto of operators}/Total\ Lines\right)^2$$

where $Numberoflines$ represents the total number of post-paid mobile telephone lines of each firm and $Totalnumberoflines$ represents the total number of post-paid mobile telephone lines. Since we wish to measure marginal effects between periods, we apply logarithms to the main variables, namely, post-paid prices, post-paid lines and HHI.

Firstly, in order to obtain the best model, we apply the Box-Jenkins (1973) methodology and Akaike's (1974) and Schwarz's (1978) information criteria.[4] Subsequently, to compare the models' predictive capability, we used the Diebold-Mariano (1994) methodology, and choose the model with the smallest root-mean-square error term (RMSD). These results lead us to select an ARMA(1,4) for the prices/HHI model and an ARMA(2,2) for the lines/HHI model

Secondly, we graphically depicted the autocorrelations and partial autocorrelations, and observed that both series (prices/phone lines and concentration) are not stationary. As a result, we applied a first-difference model in order to obtain stationary. Next, we applied a Dickey-Fuller (1979) test in order to find out if both series have a unit root.[5] We confirmed that they do. We then applied the Engle-Granger (1987) co-integration test[6], confirming that both variables are co-integrated.

Thirdly, we use an error correction model (ECM) assuming one lag in the price variables and two lags in the case of line variables, from which we developed four prediction models, two based on the short term impact using the first difference—Models A)<lines> and C)<prices>—and two prediction models based on the long term impact, over lines and prices—Models B)<lines> and D)<prices>—respectively.

4 See Annex 1, A) Model selection: Box-Jenkins and information criteria.
5 See Annex 1, B) Unit root test.
6 See Annex 1, C) Engle-Granger co-integration test.

These results are presented in Table 1, and their mathematical specification is as follows:[7]

A)$\Delta ln\left(lines_{pospaid_{(t)}}\right) = \Delta\beta_0 + \beta_1 \Delta ln\left(lines_{pospaid_{(t-1)}}\right) + \beta_2 \Delta ln\left(lines_{postpaid_{(t-2)}}\right) +$

$\beta_3 \Delta ln\left(HHI_{(t)}\right) + \Delta u_i$

B) $ln\left(lines_{pospaid_{(t)}}\right) = \beta_0 + \beta_1 ln\left(lines_{pospaid_{(t-1)}}\right) + \beta_2 ln\left(lines_{postpaid_{(t-2)}}\right) +$

$\beta_3 ln\left(HHI_{(t)}\right) + u_i$

C) $\Delta ln\left(price_{postpaid_{(t)}}\right) = \Delta\beta_0 + \beta_1 \Delta ln\left(price_{postpaid_{(t-1)}}\right) + \beta_2 \Delta ln\left(HHI_{(t)}\right) + \Delta u_i$

D)$ln\left(price_{postpaid_{(t)}}\right) = \beta_0 + \beta_1 ln\left(price_{postpaid_{(t-1)}}\right) + \beta_2 ln\left(HHI_{(t)}\right) + u_i$

where $\Delta ln\left(lines_{pospaid_{(t)}}\right)$ and $\Delta ln\left(price_{pospaid_{(t)}}\right)$ measure the absolute increase of lines and prices between periods t and $t-1$, measured in percentage points. In addition, $ln\left(lines_{pospaid_{(t)}}\right)$ and $ln\left(price_{pospaid_{(t)}}\right)$ measure the number of lines and prices (measure in euros per minute) in the prediction model, where the interpretation of the dependent variable is the percentage increase between t and $t-1$.

On the one hand, the first-difference model allows us to eliminate the trend over all constant unobservable variables that have an impact on our model but were not included, such as inflation or growth perspectives. On the other hand, it does not allow us to gauge the evolution of prices and lines in absolute terms.

7 See Annex 2, Table 1.

Regarding independent variables, ($lines_{postpaid\ (t-2)}$, $lines_{postpaid\ (t-1)}$) measure the effect of the number of lines one and two lags on the number of lines in period t, $prices_{postpaid(t-1)}$ measure the effect of prices one lag on the dependent variable, and finally HHI_t measures the direct effect of concentration on the prices/lines and Ui and ΔUi measures the error term on the standard log model and first difference model.

However, it should be noted that lines models A) and B) are inconsistent with the data and theory. In the first difference model on lines, model A), that evaluates the proportional increase between periods, the concentration variable $\Delta\ln(levelofHHI_{(t)})$ is positive and statistically significant. This is not consistent with theory, that postulates that an increase in concentration should have a negative effect on the number of lines.

In addition, in the log standard model over lines, model B), two of the three independent variables $\ln(levelofHHI_{(t)})$ and ln(second lag o lines) are not statistically significant. We believe that $\Delta\ln(levelofHHI_{(t)})$ is not statistically significant in forecasting the number of post-paid mobile phone lines because there is no large change of concentration in the data series. Consequently, empirical inference based on these results cannot be made.

In what concerns Models C) and D), we can test whether coefficients are statistically significant and in accordance with theory, which requires that an increase in concentration should lead to increased prices. In models C) and D), two graphs reflect the results of the ECM. Three curves are presented, one depicting the original data results, another the prediction model based on the original prices/HHI with *MasMovil* present in the market, and the prediction model based on the prices in the absence of *MasMovil*'s entry, obtained from the linear demand model.

The adjustment coefficient (R^2) is considerably larger for the short-term prediction models A) and C) than for the long-term prediction models B) and D).

From the first-difference model over prices (model C), one notes that there is a large dependency and correlation of prices (86%) and concentration (93%) on the previous period. Evaluating the impact between periods, we observed that concentration comparatively has a less relevant effect than the first lag of prices.

From the standard log model over prices, one percentage point increase in prices gives rise to a decrease of 0.08% in prices, whereas one percentage point increase in concentration will give rise to a 4.6% price increase. In this case, the impact on the dependent variables of concentration is larger than the impact of the first lag of prices.

On the first difference, model C),the forecast results are not close to data(see Figure1)[8], because the predictive model is at variance with the actual values, especially from 2013 onwards. However, we observe that between the second quarter of 2016 and first quarter of 2017 there is a large increase in prices that is consistent with the several acquisitions performed by *MasMovil*. However, overall the model does not perform well. We believe this to be due to the difference in concentration not performing well in the short term, a period during which capacity restrictions do not change significantly.

The standard log model, model D), yields a good forecast regarding the global trend and the levels (see Figure 2)[9]. We observed that both forecast lines display a similar trend until the second quarter of 2016, when *MasMovil* merges with *PepePhone* and *Yoigo*, after which a remarkable change in the evolution of prices evolution becomes apparent.

8 See Annex 3, Figure 1

9 See Annex 3, Figure 2.

3.2.2 | Linear Demand Model

In order to complement models C) and D), we generate two additional models to evaluate the long-term impact over prices and phone lines, where we assume:

- Constant demand between periods, with the only change being the change in concentration, while assuming that all macroeconomic variables are the same. We assume that demand is the same in both scenarios, with and without *MasMovil*'s entry, and only the supply experiences change.
- Linearity in the supply and demand functions. By assuming a linear relationship and knowing the initial price/quantity and the initial HHI level and the HHI level of the counterfactual (i.e., the HHI level without *MasMovil*'s market share), we generate the prices/quantities of the counterfactual.
- Linear correlation between concentration/prices and concentration/number of phone lines. The ECM on prices demonstrates that there exists a positive correlation between concentration and prices. Now, we assume that this relation is linear.

With these assumptions we generate two graphs, one for lines [10] and another for prices[11]. We observed a similar trend in lines and prices, with no clear difference between prices/lines, with MasMovil and without, until the second quarter of 2016. At this time, a divergence of prices and lines becomes apparent, and becomes entrenched over time. Comparing the total results, we observe increments of 22 %, on prices and a reduction of 11% on lines at the end of the period.

10 Annex 3 , Figure 3
11 Annex 3 , Figure 4

3.2.3 | Estimation of the consumer surplus and efficiency losing

Taking into consideration the results over prices and lines obtained in the linear demand and supply model, we can estimate the efficiency loss and the impact on consumer of *MasMovil* no entering. We should note that we could not to obtain the supply curve. Consequently, our efficiency loss measurements are an estimate of the loss of consumer surplus. Figure 5 presents the correlation of the efficiency loss with the change in concentration.

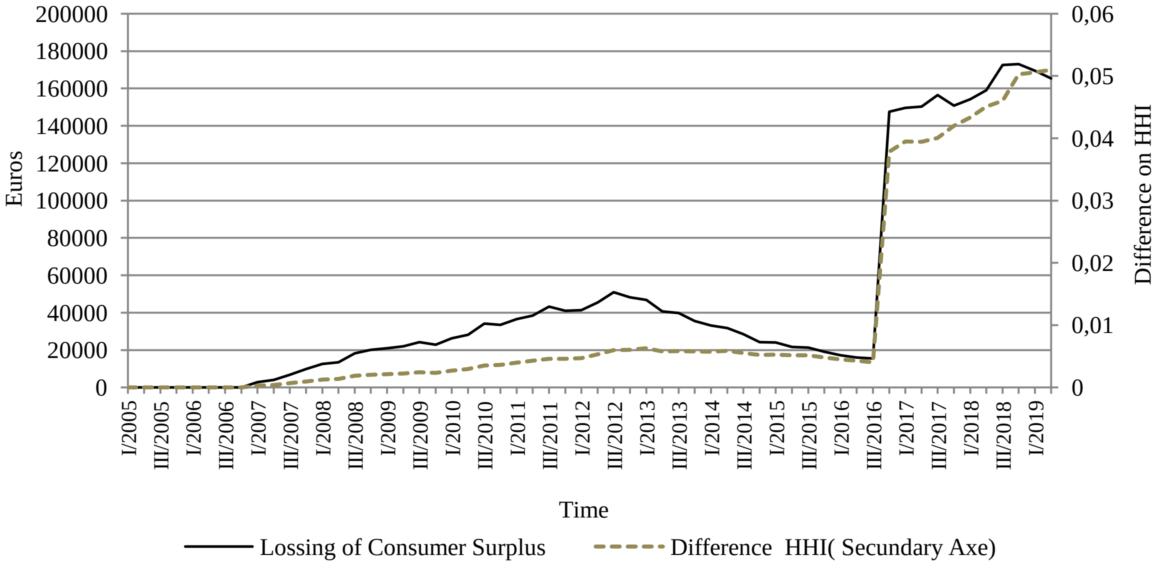

Figure5. Lose of efficence/HHI

We conclude that the entry of *MasMovil* prevented an efficiency loss of EUR 325 916, and a profits increase and a concomitant decrease of consumer welfare of EUR 2 808 994, approximately 2.3% and 2.35% of the total consumer surplus with and without *MasMovil* entry, respectively. Approximately 90% of the efficiency loss and 60% of the consumer surplus loss would have taken place after the second quarter of 2016. This leads to the conclusion that more relevant than *MasMovil*'s entry, it was the mergers that took place in the second semester of 2016 that increased the competition level in the Spanish post-paid calls' market.

3.3 | Evolution of the mobile phone operators competition

Regarding the effect of entry on the competitive level and the market shares of the main mobile phone operators, we should remark that though our data reflects *MasMovil*'s acquisition of *Yoigo* and *PepePhone* in the second quarter of 2016, the data does *not* reflect the effect of *Vodafone* and *Orange*'s acquisition of *Jazztell* and *Ono* in the following years because our data treats them as independent operators. Figure 6 shows the evolution of the market shares of the main mobile telephone operators in the post-paid contracts market.

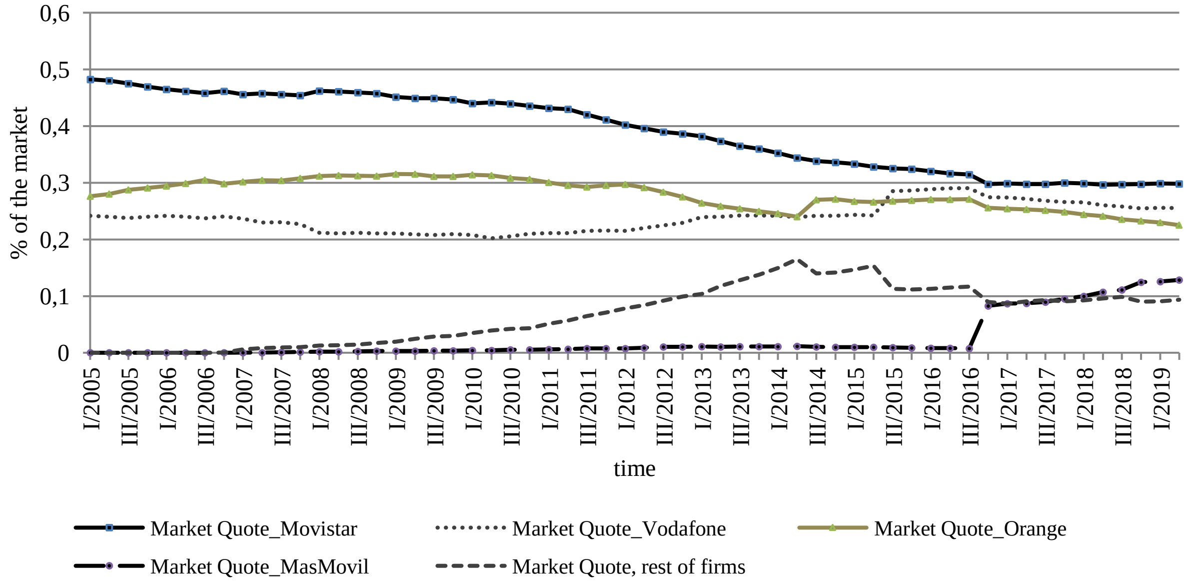

Figure6. Market Quote by firm

We observe a dynamic market where the effect of the entry on competition was not uniform. In the short term, entry did not have an effect on the competitors because the old clients of VMNOs became *MasMovil*'s clients. However, in the long term, we observe a slow fall in *Orange*'s market share, whereas *MasMovil* continued to see its market share increase. This was perhaps due to the fact that Orange was the smallest of the three main operators, measured by number of clients, and with the most competitive prices, compared to *Movistar* and *Vodafone*. Consequently, Orange was the least well positioned to retain clients when faced with *MasMovil*'s enhanced competition.

4 | Conclusions, limitations and main recommendations.

Our main conclusion is that the entry of *MasMovil per se* did not drastically change market concentration, because pre-entry concentration was not to high. However, *MasMovil* generated a relevant change in prices and the total lines of post-paid clients later, after it acquired *Yoigo* and *PepePhone* in the second quarter of 2016. This, in addition with the additional radio-electric frequencies acquired in the secondary market, allowed it to offer competitive prices from the following quarter onwards. At the same time, it is possible that *MasMovil*'s entry might have had a social-welfare enhancing impact on the probability of collusion among mobile operators.

We also conclude that *MasMovil* had not entered, an efficiency loss amounting to EUR 325 916 and a consumer surplus amounting EUR 2 808 994 would have been felt. We thus confirm, in line with economic theory, that there exists a strong correlation between efficiency and consumer surplus losses on the one hand, and concentration, on the other hand, in the short term.

Regarding the limitations of this work, we should remark that our models do not analyze the impact of *MasMovil*'s entry on *each* of its main competitors. The model based on instrumental variables controls for supply shocks in the first stage and thus yields the own-price elasticity of demand in the second stage, in line with the Kataruka et al. (2011) approximation, in order to reduce endogeneity of the model. This allows us to analyze the final effect over the main operators of *MasMovil's entry*.

Finally, it would be interesting to analyze the conditions under which horizontal mergers between telecommunication firms contribute to increase the competitively level of the sector.

Annex 1 | Test Results in of Error Correction Model Process

A) // Selection Model: Box-Jenkins and Information Criteria.

	Main Vaiable	AR(p)	MA(q)	AIC	BIC	Root Mean Square Error
Box-Jenkins Selection	$\Delta ln(price_{postpaid})$	2	4	-221,100	-204,897	0,2040555
	$\Delta ln(lines_{pospaid})$	2	2	-283,164	-271,011	0,12769
Information Criterial Selection	$\Delta ln(price_{postpaid})$	2	4	-221,100	-204,897	0,20406
		1	4	-227,468	-213,167	0,20406
	$\Delta ln(lines_{pospaid})$	1	1	-290,576	-282,404	0,13317
		1	2	-292,551	-282,336	0,12901

B) // Unit root test

Augmented Dickey-Fuller test for unit root, first difference — Number of observations = 56

	Interpolated Dickey-Fuller			
	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t) $\Delta ln(price_{postpaid})$, trend lags(1)	-3.459	-4.139	-3.495	-3.177
Z(t) $\Delta ln(lines_{pospaid})$, trend lags(1)	-3.787	-4.139	-3.495	-3.177

Augmented Dickey-Fuller test for unit root — Number of observations = 56

	Interpolated Dickey-Fuller			
	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t) $ln(price_{postpaid})$, trend lags(1)	-2.536	-4.137	-3.494	-3.176
Z(t) $ln(lines_{pospaid})$, trend lags(1)	-2.856	-4.137	-3.494	-3.176

C) // Engle-Granger Co-integration test

Engle-Granger test for cointegration, first difference — N(1st step)= 57, N(test)= 56

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t) $\Delta ln(price_{postpaid})$; $\Delta ln(HHI)$	-6.316	-4.099	-3.447	-3.121
Z(t) $\Delta ln(lines_{pospaid})$; $\Delta ln(HHI)$	-6.122	-4.099	-3.447	-3.121

Engle-Granger test for cointegration — N(1st step)= 58, N(test)= 57

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t) $ln(price_{postpaid})$; $ln(HHI)$	-1.478	-4.096	-3.445	-3.120
Z(t) $ln(lines_{pospaid})$; $ln(HHI)$	-2.721	-4.096	-3.445	-3.120

Annex 2 | ECM, formulation and table result

Mathematically our ECM models are:

A) $\Delta ln\left(lines_{pospaid_{(t)}}\right) = \Delta\beta_0 + \beta_1 \Delta ln\left(lines_{pospaid_{(t-1)}}\right) + \beta_2 \Delta ln\left(lines_{postpaid_{(t-2)}}\right) + \beta_3 \Delta ln(HHI_{(t)}) + \Delta u_i$

B) $ln\left(lines_{pospaid_{(t)}}\right) = \beta_0 + \beta_1 ln\left(lines_{pospaid_{(t-1)}}\right) + \beta_2 ln\left(lines_{postpaid_{(t-2)}}\right) + \beta_3 ln(HHI_{(t)}) + u_i$

C) $\Delta ln\left(price_{postpaid_{(t)}}\right) = \Delta\beta_0 + \beta_1 \Delta ln\left(price_{postpaid_{(t-1)}}\right) + \beta_2 \Delta ln(HHI_{(t)}) + \Delta u_i$

D) $ln\left(price_{postpaid_{(t)}}\right) = \beta_0 + \beta_1 ln\left(price_{postpaid_{(t-1)}}\right) + \beta_2 ln(HHI_{(t)}) + u_i$

Table 1
Estimation Result for ECM

	Lines postpaid		Price postpaid	
	First Difference	Standard log	First Difference	Standard log
Independent Variable	Model (A)	Model (B)	Model (C)	Model (D)
$\Delta ln(firstlagoflines)$	-0.564^{**} (0.164)			
$\Delta ln(secondlagoflines)$	-0.335^{**} (0.123)			
$ln(firstlagoflines)$		-0.108^{**} (0.0368)		
$ln(secondlagoflines)$		0.122 (0.127)		
$\Delta ln(firstlagofprices)$			-0.865^{***} (0.129)	
$ln(firstlagofprices)$				-0.0893^{***} (0.0252)
$\Delta ln(levelofHHI_{(t)})$	1.342^{*} (0.653)		0.931^{*} (0.388)	
$ln(levelofHHI_{(t)})$		-0.251 (0.150)		4.634^{***} (0.404)
$Constant$	-0.0111 (0.00721)	1.861^{**} (0.628)	-0.0195^{**} (0.00677)	0.266^{***} (0.0630)
N	55	56	56	57
R^2	0.580	0.178	0.517	0.300

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Annex 3 | Main figures of ECM and demand linear model.

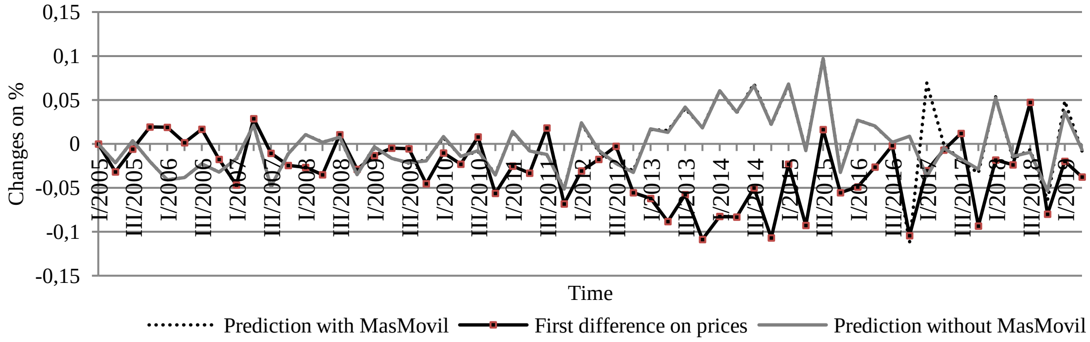

Figure1. First Difference Model over prices.Model C)

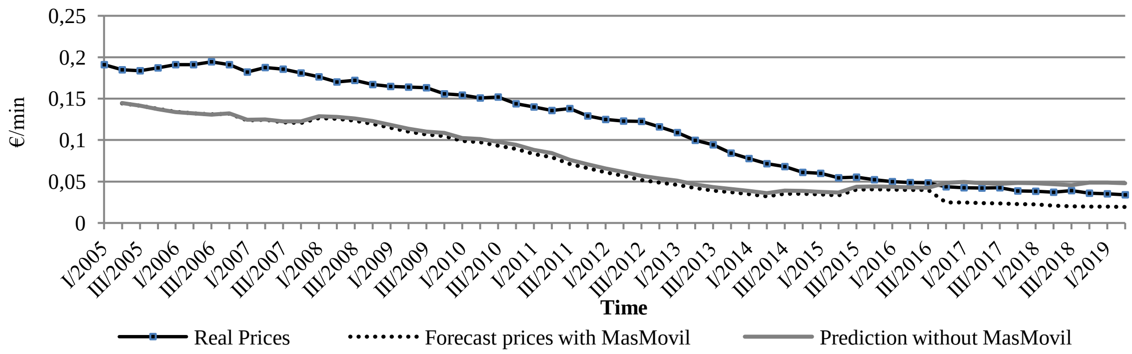

Figure2. Standard Log Model over prices.Model D)

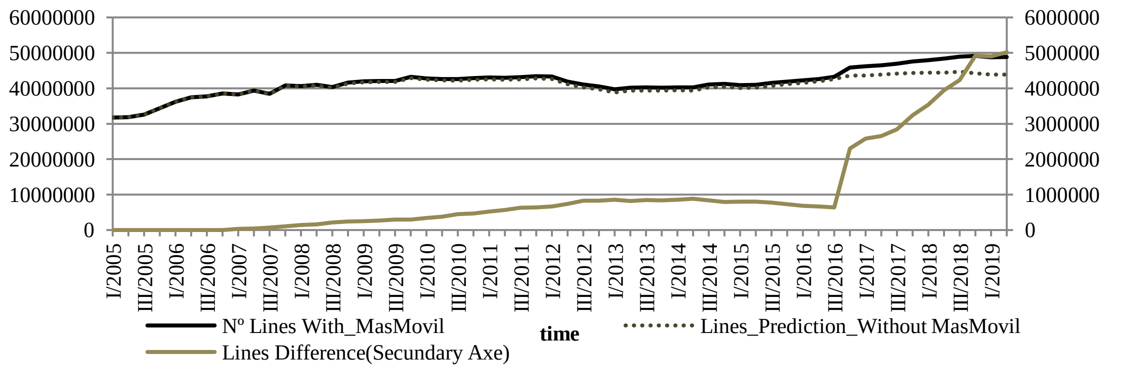

Figura3. Demand linear model-Lines

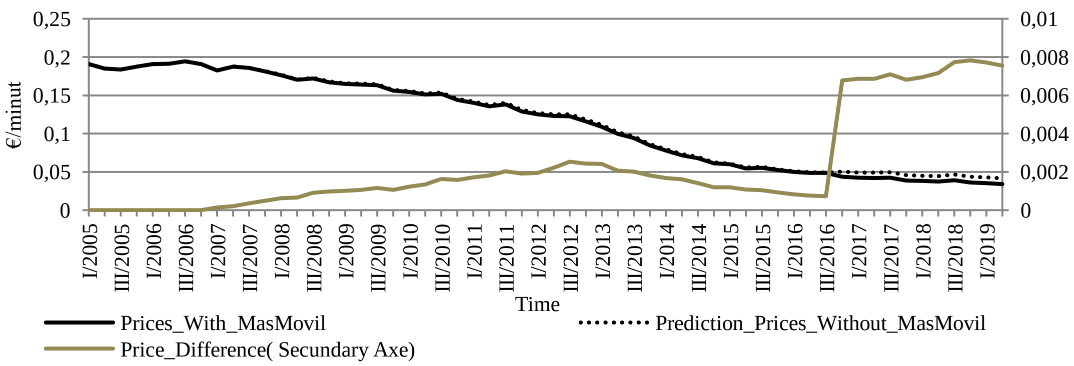

Figure 4,Demand linear model,prices

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