An assessment of the liberalization and the evolution of competition in the Moroccan Mobile market.

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Abstract

This paper analyses the liberalization process of the Moroccan mobile market since the beginning of the XXI century. Our database ranges from 2004 to the end of 2020. First, operators' market shares are presented and analyzed. Second, we build concentration indexes and other indicators of competitiveness. Finally, we conduct an econometric analysis to determine the extent to which regulatory measures, privatization, market structure and the population dimension determine market shares. Overall, we can argue that, although concentration remains high, the market has become more competitive since the liberalization process began. The statistical analysis and the econometric assessment show that the entrance of the third operator made the market more competitive. Indeed, there is evidence that operator companies competed to capture customers from each other during the period under study. These features suggest that mobile operators did not follow anticompetitive practices in order to restraint competition.

Keywords: Morocco mobile market, Liberalization, Privatization, Competitiveness, Market Shares.

JEL Classification: D21, D22, L13, L40

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1. **Introduction**

The development and deployment of telecommunication services are crucial for a sustained economic growth, especially for developing countries, where the liberalization of the telecom sector began in the first decade of the XXI century. In the context of African countries, telecommunication technologies have reached rural areas and the quality of the services has improved. In particular, the mobile segment has evolved considerably in comparison to fixed-line services (Gebreab, 2002). In the Middle East and sub-Saharan Africa regions, the use of mobile connections represents 51% and 39% of the population, respectively (Bahia and Suardi, 2019). This increase in the demand has favoured the liberalization processes in the region. Besides that, in the majority of cases, the former monopolist, the state-owned provider, has been partially or totally privatized.[4] However, after two decades of liberalization processes, an oligopolistic structure with few competitors is the common situation. Indeed, high entry barriers, due to the limited amount of available spectrum, and the huge fixed cost to develop the network are still present. Therefore, the main objectives of the regulatory authorities and antitrust agencies consist of controlling the market power of service providers and the prosecution of anticompetitive practices to protect consumers.

Traditionally, telecommunication markets in the developing countries are constrained by the lack of investments and by institutional foundations that make it difficult to achieve market efficiency. In this sense, the creation of national regulatory agencies and the transparency these institutions generate in the market helped to increase the attraction of foreign capital flows. Moreover, easy access to mobile phones enhanced the penetration rate, which led to increases in demand of mobile services. Hence, the study of the mobile market is of particular interest when aimed at measuring the extent to which the telecommunications sector can expand in developing countries.

There are some studies about the current situation of telecom markets in developing countries. Moshi and Mwakatumbula (2017) analysed how regulation and political conditions determine the evolution of investment in African countries. They argue that regulation and liberalization, together with market structure factors, determine the level of investments, whereas there is no statistical evidence on how political stability affects the evolution of the market. Concerning the role that governmental institutions and policies play in telecommunication markets, Singh (2000) concludes that in Asia, the liberalization and privatization would not necessarily lead to efficient property rights, which in turn promotes market expansion and efficiency. Mariscal (2020) studies the role of policy decision processes in Mexico's telecommunications market. After two reforms undergone in Mexico to increase market efficiency, overall results fell short of their own premises. In particular, the investment level remains low as well as digital exclusion. A recent study of African countries, carried out by Jahanbakht and Mostafa (2020), provides a descriptive analysis of how policy and company strategy interact and co-evolve in a path-dependent way within each stage of market development, such as introduction, growth, and maturity.

The mobile market in Morocco has been one of the most mature in the Africa region. According to the *Agence National de Réglementations del Télécommunication* (ANRT, hereinafter), the national regulatory authority of the Moroccan telecommunication market, the mobile penetration rate had increased to 137% at the end of 2020. The extensive use of smartphones has led to the growth of mobile data and voice traffic. The privatization process began with the liberalization of the telecommunication market that took place in the early XXI century, reaching 78% by 2020. Although the dominant position of the incumbent remains unaltered in the fixed-line market, the mobile market is getting more dynamics as new actors come into the mobile arena.[5] The former state-owned mobile operator Itisalat al-Maghrib (IAM, hereinafter) and two private operators are the main providers of mobile services that account for the majority of all internet connections.[6]

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[4] Further increases in demand have taken place due to increments in GDP per capita and the significant reduction of inequality.

[5] IAM has been accused of abuse of dominant position in the fixed-line market by competitors under the period under study (see for instance, Reuters, February 21st 2020 https://www.reuters.com/article/us-morocco-telecoms-idUSKBN20E31C).

[6] The incumbent company Maroc Telecom has also undergone strategic acquisitions (for instance, Etisalat Mobile Business in the United Arab Emirates) in 2019.

Since 2015, the three mobile network operators have benefited from new long-term evolution (LTE, hereinafter) licenses to exploit mobile data services.[7] These new LTE licenses ensured conditions to reach at least 65% of the population by 2020. Moreover, within the Maroc Digital 2020 strategy, a huge deployment of mobile broadband infrastructure is expected, that will further consolidate access to the mobile market by the urban and rural population in coming years.

In this vein, the assessment of market power is one of the major concerns of regulatory authorities in mobile telecommunication markets. Market power is the ability of firms to raise prices above the competitive level, which can lead to abuse of a dominant position by part of a number of firms. There are different ways to measure market power, which are indirectly related. The traditional approach is to consider the market share as a proxy for the market power. Moreover, market shares are used to calculate concentration indexes, which provide information of the degree of competitiveness in a given market. An alternative way that better reflects the definition of market power is the Lerner index, but is less often used due to lack of data. Elasticity of demand also determines market power, where a highly inelastic demand indicates the advantage that firms have to increase the price without losing customers. Similar to the Lerner index, elasticity of demand is difficult to estimate due to lack of information on prices and quantities. In this paper, we are interested in companies' market shares, as well as other economic variables, to investigate the extent to which the liberalization process in the Moroccan Mobile market is conducive to a competitive market. That is, we explore whether the small number of competitors explains the market power exerted by mobile service providers or instead, companies may follow anticompetitive practices, such as conscious parallelism or tacit collusion.

The huge development of mobile telecommunications all over the world has attracted academic attention since the last decade of the XX century. A number of studies investigate competition, policy measures, investments, consumers' attitude, and other aspects related to the market. Valaskova et al. (2019) analyze the competitive environment of the Slovak mobile market through traditional concentration indexes, Lorenz curve, Gini coefficient and information on firm´s revenue. They found that the market is highly concentrated and products are slightly differentiated, which could be a source of market power. Thi and Phu Hung (2017) explore the concentration and competitiveness of the Vietnamese mobile market by means of the Herfindahl-Hirschman index (HHI, hereinafter), and the estimation of demand elasticity. The results show that, whereas the HHI shows a highly concentrated market, demand elasticity is relatively elastic compared to other countries. Dewenter and Haucap (2004) study the Austrian market by using the elasticity of demand of each operator assuming that the market is divided into segments. They find that postpaid customers tend to have a higher demand elasticity than prepay customers. Moreover, they provide estimates for firm-specific demand elasticities. Concerning the African context, research covering the recent development of the mobile market that uses market shares and related market and policy variables is scarce. In particular, there is no paper that studies the Moroccan case.

In our study, we measure how the market benefits from the liberalization process of the Morocco's mobile sector and the entrance of new competitors. To the best of our knowledge, the only paper that studies the evolution of the liberalization process in Morocco is Achy (2008), although he did not perform statistical analysis nor an econometric study. He concludes that the improvements in the telecommunications market benefit other national communication-intensive industries, such as transport, distribution and finance. Our contribution is twofold. On the one hand, we provide a complete assessment of how the market has evolved as a result of the liberalization process. Our dataset comprises the third quarter of 2004 up to the last quarter of 2020. We include descriptive statistics of companies' market shares, build Hannah and Key concentration indexes (Hannah and Key, 1977), and other market indexes. On the other hand, an econometric analysis is conducted to highlight how factors such as the level of privatization of the incumbent company, the ANRT intervention through termination rates, the number of prepay customers and subscribers, the outgoing voice traffic, and the population dimension affect market shares; which in turn determines the competitiveness between companies.[8]

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[7] Moreover, these companies also offer fixed-line or fixed-wireless services.

[8] We refer to as prepay customers (also referred to as pay-as-you-go) when credit to use a mobile plan is purchased in advance. If there is no credit, then access is denied by the company who offer the mobile

We found that the Moroccan mobile market has become more competitive since the onset of liberalization. Although only three firms compose the market, the entrance of the third operator made the market more competitive. The HHI is above the level that regulatory authorities consider as a concentrated market, but it there was a sustained decrease throughout the period under study. Moreover, other market indexes show that the companies capture customers from each other. Overall, we have not found insights that companies may follow anticompetitive practices.

The rest of the paper is organized as follows. In section 2, we review the recent evolution of the liberalization process of the Moroccan telecoms market. Section 3 presents the regulatory framework and the overall situation of the mobile market. Section 4 describes data and methodology of our study. Section 5 presents the empirical analysis. Finally, Section 6 concludes. The usual disclaimers apply.

2. An overview of the liberalization process.

The Moroccan telecommunication market has undergone deep changes due to technological improvements, resulting in a downward trend in costs. At the same time, demand for telecommunication services, in particular mobile connections, has experienced an exponential increase since the late XX century. It put pressure on liberalization of the market, breaking the natural monopoly of the state-owned telecommunications provider. The first stone in the liberalization process was the Law 24/96, which came into force in 1997. On the one hand, two public companies were created from the dissolution of Morocco's National Post Office and Telecommunications Agency: the telecommunication operator IAM, and the postal operator BAM (Barid al Maghrib). On the other hand, the national regulatory authority of the Moroccan telecommunication market (ANRT) was established, aimed at operating as an independent supervisor. However, ANRT still depends on the Moroccan government: its supervision is under the Prime Minister and eight ministers from the board of directors take part in the regulatory decisions.

At the same time that the liberalization process was underway, the Moroccan authorities began a gradual privatization process of the state-owned firm IAM. The privatization started in 2001 by releasing an open tendering procedure to attract private capital, when the French media group, Vivendi Corporation, acquired 35% of the state´s equities. In 2005, Vivendi increased its participation up to 51%. Later on, in 2007, an additional 2% were transferred to Vivendi by Caisse des Dépôts et des Garanties (CDG), a financial state-owned company, while in 2013 the corporation transferred its 53% to Etisalat al-Maghrib. The last step of privatization was the offer of 8% to private investors in 2019. The Moroccan treasury, which represents the Moroccan state, still holds 22% and IAM´s staff (listed on Casablanca and Paris stock exchange) own the remaining 17%. It is worth mentioning that gradual privatization is not always a response to the requirements of the market liberalization, but can also be a response to governmental financial interest (World Bank, 2016).

Since the early XXI century, the government reduced entry barriers by granting new licences through tendering processes. It allowed new competitors to enter the mobile market. The second-largest operator is Orange Maroc (OM, hereinafter), the first private operator to enter the Moroccan market. OM was known as Médi Télécom or Méditel until December 2016. Initially, the state-owned financial firm CDG, the Moroccan financial group FinanceCom, the Spanish operator Telefonica, and Portugal Telecom, owned the operator. Since 2015, OM has been 49% owned by France's Orange Telecom, although the other 51% remains equally split between CDG and FinanceCom, which account for 25.5% each. The third operator, INWI (formerly known as WANA Corporate), is a subsidiary of Morocco's Société Nationale d'Investissement and the Kuwaiti group Zain. The former owns 31% of the shareholding structure and the latter the remaining 69% of equities (Lancaster and Lange 2020,).

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connection. We refer to as subscribers when customers pay the bill at the end of the month (also referred to as postpaid mobile service). Moreover, postpaid contracts usually involves long-term obligations (usually one year) for the customers. It means that migration to other company is not allowed or a penalty must be paid to get number portability.

OM began to operate in 1999 after getting a GSM (Global System for Mobile Communications) license.[9] It offered only mobile services, although it was also granted a next generation network (NGN, hereinafter) license in 2006. OM and INWI obtained the 3G license and the 4G license in 2006 and 2015, respectively. During the period under study, OM gave priority to investment in mobile infrastructure at the expense of the fixed infrastructure. Contrary to OM, INWI showed more interest in investing in fixed infrastructure when the company entered the market. However, it was unsuccessful despite making 1300 requests to access the local loop. INWI began operations in the mobile market in 2008. By acquiring a GSM license in 2009 and the aforementioned 4G license in 2015, the company's position in the market was reinforced.

3. Regulatory framework and the mobile market.

3.1. The regulatory authority ANRT.

It is the entity in charge of the control and regulation of the telecommunication sector (Law 24/96) beginning operations in 1998. It manages the market to ensure the dynamism of this strategic sector, providing the legal, technical, and economic conditions required to accomplish its mission. As we pointed out above, the agency is dependent on the Moroccan government, which in turn affects the efficiency of the regulation and deters foreign investors because of lack of transparency. The aforementioned Law 24/96 was amended and completed by the adoption of a set of laws in the following years. In particular, Law 55/01 (2004) has strengthened the Agency's prerogatives, including monitoring to ensure fair competition and resolving any disputes.

In the legal sphere, ANRT participates actively in preparing drafts of upcoming laws, decrees, and ministerial orders. It also implements tendering processes to allocate licenses and supervise bidding procedures, granting authorizations to establish independent networks. ANRT also establishes the interconnection terms, which include the termination rates a company has to pay when accessing a competitor's network. Moreover, ANRT determines the technical specifications and administrative approval to the terminal equipment radio, managing scarce resources and monitoring the operator´s performance in terms of the quality of services offered to the consumers. Regarding the market dimension, the main role of ANRT is to preserve fair competition by avoiding anticompetitive practices, such as predatory pricing or abuse of dominant position. It is also in charge of resolving disputes between operators.

3.2. Number portability

A crucial measure to enhance competition was the portability law. The implementation of number portability may strengthen the weight of marketing strategies for customer acquisition. Although the Moroccan regulatory authorities included portability in its regulation since enacting Law 24/96, this instrument did not come into force until 2015. The implementation of the portability law was delayed by technical difficulties, leading the ANRT to extend the deadline for operators to set up the necessary systems. Moreover, authorities argued that this instrument has to embody the learning from operators and consumers. Since October 4th 2006, a number of decisions were made to enable the portability law to become effective. After revisions on February 2011 and December 2012, portability was finally regulated by the decision ANRT/DG/N°04/15, issued in October 2015. The three operators are now legally required to allow a user to keep their mobile number and switch providers. In line with this regulation, the ANRT established a number portability database to further improve transparency and promote competition.

3.3. Termination rates.

The level of termination rates has experienced changes during the period under study. Until 2008II, ANRT applied the same termination rate to IAM and OM. When the newcomer INWI entered the market, ANRT began to apply an asymmetric policy: INWI's termination rate was higher than the others were. Since then, it has been the usual policy except for the period 2013III to 2016II, when symmetric termination rates were applied once more. Although termination rates have decreased in order to promote competition, regulatory authorities always applied to the former state-owned firm a lower (or equal, i.e. symmetric) termination rate than to the others. This measure has two effects on the market. On the one hand, it seems that IAM promoted loyalty

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[9] This second-generation norm allows only voice communications.

programs aimed at retaining customers by setting lower prices, avoiding the migration of customers to other companies. On the other hand, this measure may increase the income of those companies endowed with higher termination rates. It is observed that, as termination rates decrease and their absolute differences do so, market shares become similar among companies. It suggests that the asymmetry of termination rates favours those companies with low market shares.

The impact of termination rates on prices, welfare and companies' profits has already been studied. Genakos and Valletti (2014) show that the waterbed effect (when a decrease in the termination rate of mobile calls leads to an increase in prices) is insignificant and attribute this impact to the nature of the industry. In the case of the Moroccan mobile market, this effect does not occur, because the progressive decrease in the termination rates of the companies leads to a decrease in prices (Lancaster and Lange 2020, ANRT 2018). In Hurkens and López (2012) the effect of termination rates in companies' market shares is studied.[10] They conclude that asymmetric termination rates benefit the company that has the highest markup access, which in turn increases its market share. It could explain why INWI has significantly increased its market share during the period. In this sense, termination rates may somehow explain the evolution of market shares.

Moreover, it seems that termination rates and penetration rate might be interdependent in the Moroccan mobile market. As we mentioned above, the asymmetry of the termination rates yielded price decreases. Furthermore, higher penetration rates would intensify these price decreases because companies might intensify price competition in order to capture new customers: the higher the market share, the lower the costs related to the termination rate paid to access rival networks. Finally, those price decreases caused by termination rates reductions would contribute to a further increase of the penetration rate. Therefore, the role of these two variables is crucial to explain the companies' behavior in the market.

3.4. The mobile market.

The mobile market is the most important segment in the Moroccan telecommunication market. The expansion of the mobile market benefited from the huge penetration rate (see Figure 1), which rose from 34.23% in 2004 to 137.47% in 2020 (ANRT, 2020).


Figure 1. Mobile penetration rate
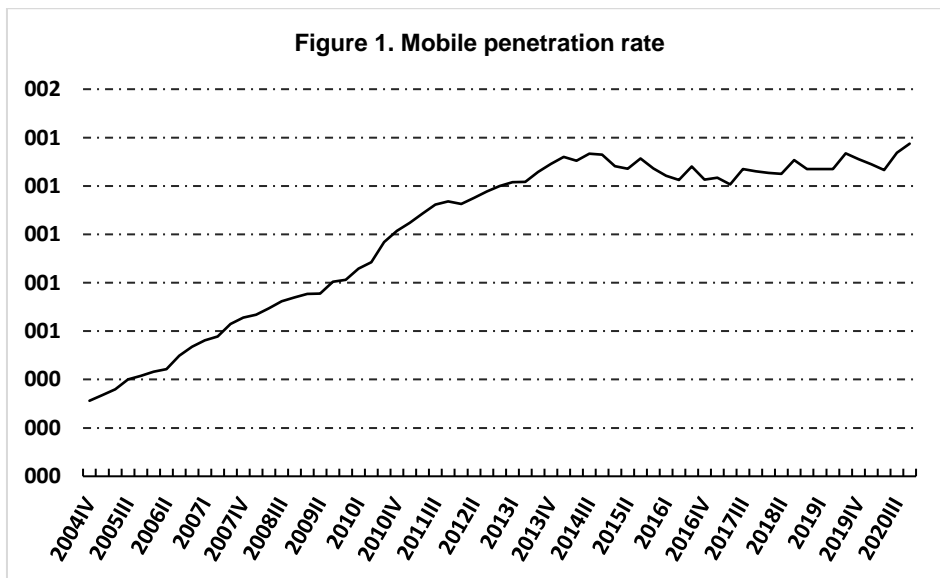
In contrast, the fixed-line and the broadband internet access (ADSL and fiber connections) are less developed. The broadband market, which is considered a strategic asset for economic growth, is still controlled by the incumbent provider IAM that held 99.93% of the market in 2019. The lack of investment in the broadband sector is due to the high costs involved in establishing

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[10] Mobile termination rates in the presence of network externalities is studied in Hurkens and López 2014.

and exploiting the physical infrastructure. The regulatory framework plays a crucial role in this aspect. In this respect, in 2005 the government created the telecommunication universal service fund (FSU). It is a public fund service (companies are obliged to contribute with 2% of yearly profits) aimed to compensate the lack of investment in non-profitable areas for the operators. As internet access is a complementary facility to the mobile market, the possibility of bundling data and voice facilities under the same service pushed forward the mobile business. The higher costs associated in getting access to rural areas also benefit the expansion of the mobile market, relegating the bundle of fixed telephony and broadband internet access to a marginal position.

Several studies have analyzed the determinant of mobile service diffusion. Gebreab (2002) found that competition and digitalization have a positive impact on mobile diffusion, while the presence of a state-owned provider has a negative impact. Thus, it seems that privatization is advised in order to enhance competitiveness. Gruber (2001) analyzed mobile service diffusion in central and Eastern Europe and found that the speed of mobile diffusion is positively linked to the number of firms in the market. In the Moroccan market, the wave of reforms undertaken to accomplish the liberalization of mobile services is reflected by the huge increase of the mobile penetration rate. This high penetration rate has allowed telecommunication services to reach customers in remote and rural areas. Competitiveness also benefitted from the entrance of the third operator – INWI in 2008. During the duopoly period, the incumbent attained more than 66% of the mobile market share. However, once INWI entered the market, it began to increase its market share significantly, while the incumbent gradually lost it, as we will see. The evolution of OM´s market share barely altered over that period, ranging from 33% to 34%. The passivity of OM to the presence of the third operator raises different hypothesis, such as a possible tacit agreement between OM and IAM aimed to reduce competition. Another possibility is that OM enhances customers' fidelity thorough loyalty programs. In this respect, Belabbes et al 2020 identify and analyse the drivers of customer experience in the Moroccan mobile market. Their results suggest that the most relevant determinants of customer experience in the Moroccan mobile market are the brand image, the pricing, the customer relation, the promotion and the usage tracking. In a study of the German mobile market, Gerpott et al. (2000) found that loyalty programs increased customers' satisfaction, reducing portability among companies. Thus, regulatory authorities might promote an efficient number portability procedure in order to enhance competitiveness.

The widespread contract to access mobile services is prepay, whereas a subscriber contract exhibits a flat evolution within the period studied (see Figure 2). Thus, prepay customers are the main driver of mobile diffusion. This is due to the fact that a significant percentage of the poor population are located in rural areas, where they may get access to mobile services at low prices. Indeed, prepay ARPM (average revenue per minute) is lower than subscribers ARPM (ANRT, 2020). It may indicate that companies compete in quantities attracting customers through programs of promotions, which in turn encourage competitiveness in the prepay segment.

Figure 2. Customers by type of contract
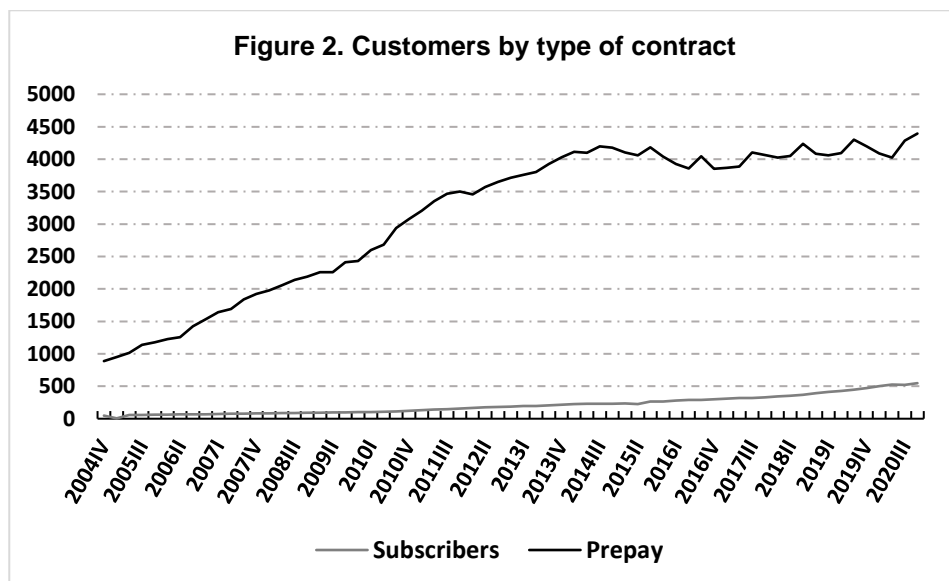
Institutional aspects also contribute to the spread of mobile services, namely the level of termination rates and the degree of privatization of the state-owned provider. Both of them are considered tools to boost market competitiveness. As we have pointed out, termination rates have experienced a considerable decline during the period under study. Moreover, the degree of privatization might contribute to enhance competitiveness among service providers. We will discuss these aspects in section 5.

The future expansion of the Moroccan telecommunication market depends on mobile services. However, the market is somewhat saturated, with practically a constant penetration rate over the last few years and a continuous reduction of final prices, which lead to narrow price-cost margins (Morocco Telecoms, Mobile and Broadband. Statistics and Analyses, 2020). The introduction of competition in the fixed voice and broadband internet access may expand company business. The efforts of the ANRT must be oriented towards introducing reforms to promote competition aimed to deter the monopoly power of the incumbent provider IAM. If the broadband market (ADSL and Fiber) were regulated, the operators would have offered bundled products (mobile+ ADSL or Fiber) to attract consumers who are reluctant to contract broadband services, which are considered unaffordable by a significant part of the Moroccan population.

4. Data collection and methodology

The procedure used to analyze telecommunications markets differs from one market to another. It depends on the available data and the market-specific characteristics. In the case of the Moroccan mobile market, data is limited. We collected data from the third quarter of 2004 to the last quarter of 2020. As primary source, we used the ANRT (annual reports and statistics) database, and the World Bank development indicators database. The regulatory agency reports companies' market shares based on subscriptions since 2004 on a quarterly basis. However, the tariffs of different services such as the subscriber segment and the prepay market are not available. We also used the reported data of penetration rate, termination rates that companies must pay to access competitors' networks, and the level of outgoing voice traffic. In addition, we used secondary sources, such as World Bank statistics and reports, and other market studies conducted by private agencies and practitioners (Oxford business group, Morocco Report 2018; Lancaster and Lange 2020, among others). From these secondary sources, we collected data on the degree of privatization of the state-owned firm, some financial information, and other market aspects. We assembled all these data in a comprehensive way to study the evolution of competition in the Moroccan mobile market.

We first present a detailed descriptive statistic of the evolution of market shares. Secondly, market shares are used to build concentration indexes. Moreover, we present the relative entropy and volatility indexes to better understand the evolution of the competitiveness of the Moroccan mobile market. Finally, we also run an econometric model in which we analyse the determinants of the market shares. Our set of explanatory variables includes the number of customers that join prepay and subscriber programs, along with other variables such as outgoing voice traffic, termination rates, the number of equities the government attain from the former state-owned provider, and urban population.

5. Empirical study

5.1 Descriptive analysis of market shares.

We start our analysis by presenting the evolution of companies' market shares during the period 2004III-2020IV. Mobile services comprise a number of facilities such as voice calls, internet access, and social networks. Although the type of access may vary across companies and the contracts a customer may subscribe are different (duration, capacity and quality, among other features), the final service is considered homogeneous. Because of that, and the low elasticity of demand (once the service is affordable, a given customer pays to get access) market shares become a good approach to measure the evolution of competitiveness. Table 1 presents the descriptive statistic of companies' market shares. Figures 3 and 4 present its graphical evolution.

Table 1. Operators' market shares. Descriptive statistics

	Mean	sd	CV	Min	Q1	Q2	Q3	Max	Obs
IAM	0.515	0.104	0.203	0.394	0.428	0.457	0.633	0.705	65
OM	0.329	0.021	0.064	0.280	0.317	0.331	0.341	0.376	65
INWI	0.202	0.084	0.414	0.012	0.202	0.229	0.255	0.282	50

The mean ($Mean$) and standard deviation (sd) indicate that, although IAM has the highest mean, its coefficient of variation (CV) presents an average value. The mean of the market share of INWI is minimum whereas for OM it is in the middle with the lowest coefficient of variation. These observations reveal that IAM and INWI contributed more than OM to the customers' mobility. Indeed, differences between the first ($Q1$) and the third ($Q3$) quartile are minimized for OM. Figure 3 shows the evolution of market shares of the three companies.

Figure 3. Market shares

Figure 4. Box plot market shares
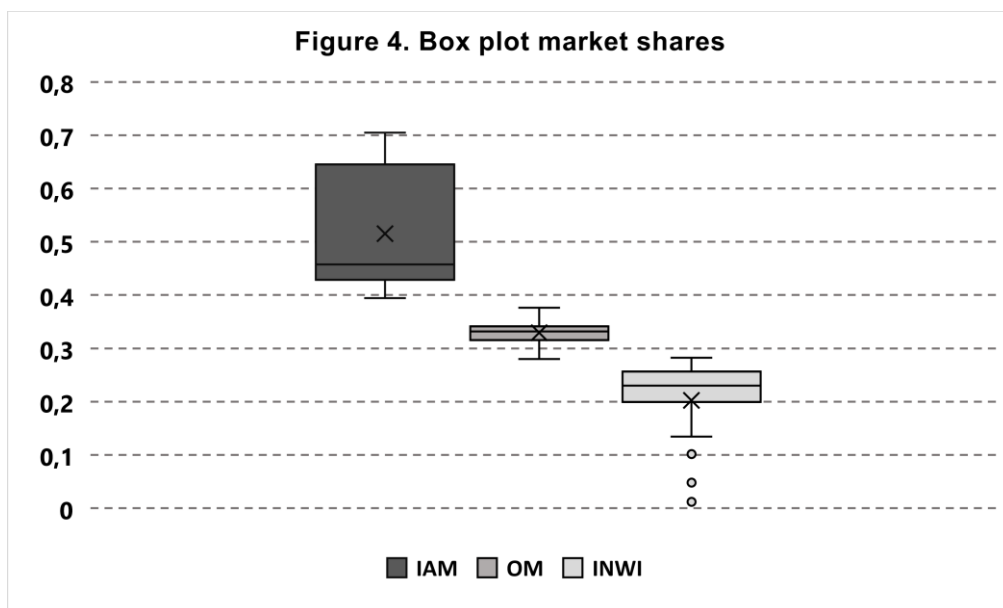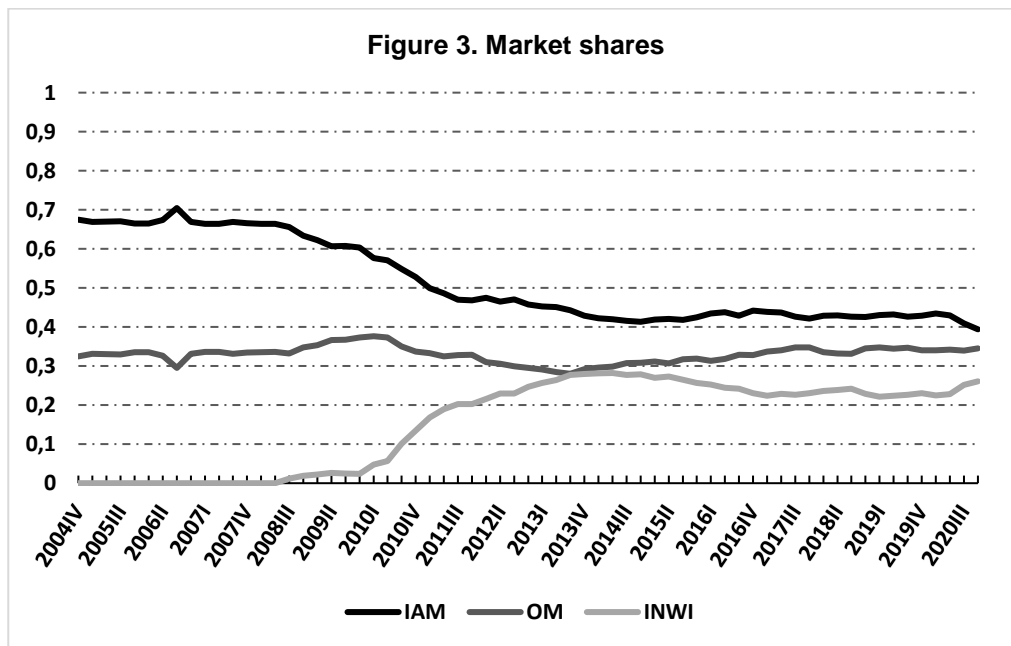
Overall, one can see that IAM's market share declines over the whole period. As the number of customers increases (see Figure 1), it seems that most of them were captured by INWI that continued such an active behavior during its first periods in the market. Figure 4 presents the box plot of the market shares. In the figure, IAM's box is the widest one with the mean close to the first

quartile, whereas OM's box is the narrowest and it is located in the middle. INWI's box is at the bottom but it is wider that OM's box with a low mean (the odd lower observations outside the box indicate a high growth of its market share). The location and features of the three boxes reveal that market shares have converged during the period, with the company INWI experiencing the highest (positive) variability. The narrow box of OM, located in the middle, with an almost zero coefficient of variation, suggests the hypotheses of the passive attitude to capture clients, focusing on customers who already have a mobile line with the company.

During the period, IAM, the incumbent provider, remains the leader, although the situation has changed since 2008III, when the third operator entered the market. Since then, the incumbent began to progressively lose its market share mostly to the benefit of the newcomer whereas OM, the first private provider to enter the market, had a more conservative behavior that led to a more stable market share. In particular, the arrival of INWI did not have a noticeable impact on market shares in the first periods (for instance, in the fourth quarter of 2009 the firm only captured 2.39% of the total market). INWI was lagging behind the others firms due to its deficient infrastructure. Managers decided to sell 31% of the equities to mobile operator Zain and Al Ajial Investment Fund Holding (Reuters, March 14th 2009), which improved the network infrastructure allowing INWI to increase its market share. Competition was fierce until in the third quarter of 2014, when the three operators almost stabilized their market shares. There may be two reasons that explain this situation. First, termination rates fixed by the regulatory authorities became symmetric across operators. Secondly, the penetration rate slowed down its increase (eventually, it was almost zero) and thus, the opportunity to capture new customers decreased.

5.2. Concentration indexes.

Concentration indexes are commonly used in industrial organization to study market power. Such indexes are a useful tool to assess the evolution of competition, the impact that new firms have in the market, and the approval of mergers when they take place. Hannah and Kay (1977) propose a set of desirable criteria (easy calculation, independence of the market size, and bounded) against which any of the numerous concentration measures may be judged. Although HHI and the concentration ratio are the most popular in the literature, we also use the Entropy index defined by Horowitz and Horowitz (1968) in our study. To complete the set of tools of market assessment, we present the Volatility index. Even though the above-mentioned concentration indexes are static, they can be used in a dynamic sense. Concentration indexes based on Hannah and Kay features have the following general form,

$$HK(\alpha) = \sum_{i=1}^{N} S_i^{\alpha}, \quad i = 1,2,\ldots N.$$

where N is the number of firms, S_i is firms' market share, and $\alpha \geq 1$. The HHI is a particular case of $HK(\alpha)$ when $\alpha = 2$. It stands for the percentage of the sum of squared market shares of all firms in the industry, giving more importance to those firms with the largest market share S_i,

$$HHI = \sum_{i=1}^{N} S_i^{2}, \quad 0 < HHI < 1.$$

The value of HHI ranges from near zero, as in the case of perfect competition, up to one, as in the case of dominant companies or pure monopoly. Otherwise, it is considered that the industry or market is non-concentrated if the index value is less than 0.15, while the market is moderately concentrated if the value of the index ranges between 0.15 and 0.25. The value of HHI above 0.25 represents a highly concentrated industry where firms exert a very high market power (US Horizontal Merger Guidelines, 2021).

Another index to measure industrial concentration is the concentration ratio CR_k. It provides information about the k firms $(k < N)$ with the larger market shares. In other words, it indicates the percentage of outcome these companies accumulate against the rest of competitors. In this case $\alpha = 1$. The value of the concentration ratio can range from nearly 0% to 100%. The explicit form of the index is the following,

$$CR_k = \sum_{i=1}^{k} S_i.$$

We calculate CR_2 for the companies IAM and OM in order to evaluate the impact of the newcomer since 2008III.[11]

The Entropy index, E, measures the uncertainty of maintaining a customer. In order to clearly assess the evolution of the degree of competitiveness we use the relative entropy (RE), which ranges from zero to one,

$$RE = \frac{E}{\ln(N)}, \ 0 < RE < 1, \text{ where } E = \sum_{i=1}^{N} S_i \cdot \ln\left(\frac{1}{S_i}\right), \quad 0 < E < \ln(N).$$

This index may highlight the interdependence between termination rates and penetration rate. Asymmetric termination rates and high penetration rate would increase competition among companies to capture and maintain customers. Indeed, losing customers implies a higher cost through the payment of terminations rates to the other competitors and less revenue related to the termination rate paid by the other competitors to that company. Table 2 presents the descriptive statistic of the concentration indexes, whereas Table 3.a and Table 3.b present the correlation matrix for the duopoly period and the triopoly period, respectively. Figure 5 presents the evolution HHI, CR_2, and RE over time.

Table 2. Concentration indexes. Descriptive statistics

	Mean	sd	CV	Min	Q1	Q2	Q3	Max
HHI	0.421	0.090	0.214	0.342	0.351	0.359	0.522	0.584
CR_2	0.844	0.112	0.133	0.718	0.755	0.776	0.980	1
RE	0.921	0.090	0.098	0.632	0.915	0.967	0.974	0.987

Table 3.a. Pearson correlations, 2004III-2020IV

	CR_2	RE	HHI
CR_2	1	-0.6612***	0.9847***
RE		1	-0.598***
HHI			1

P-value (p): *** $p < 0.01$

Table 3.b. Pearson correlations, 2008IV-2020IV

|	CR_2	RE	HHI
CR_2	1	-0.9721***	0.9790***
RE		1	-0.998***
HHI			1

P-value (p): *** $p < 0.01$

Table 2 shows that HHI, CR_2, and RE are somehow stable. Indeed, standard deviations and the coefficient of variation are closer to zero. HHI presents the highest variability with a negative evolution that reveals a less concentrated market as time goes on. The CR_2 index presents a lower variability than HHI due to market configuration: it had only two firms until 2008II. Moreover, RE is inversely correlated with HHI and CR_2; i.e., as concentration indexes decrease, the probability to lose a customer increases. Finally, relative RE is high, which implies significant movements of customers among companies during the period.

Figure 5 shows that the value of the HHI fell across the whole period, in particular when the third operator entered the market. At the end of the period, it approached 0.35. According to US antitrust authorities, we may argue that, although this value is still high enough (above 0.25), the market has evolved towards a more competitive environment. The concentration index CR_2 already reveals that IAM and OM have reduced their market shares since 2008III, which may already support the hypotheses that competitiveness took place in a fair sense.[12] The almost stabilization of the index since 2013III may be affected by the stabilization of the penetration rate as well as the termination rate, as we have explained previously. The value of the RE increased with the arrival of the third competitor. However, the increase was noticeable in the period where the termination rates were asymmetric. Indeed, since the first quarter of 2013, when the regulatory

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[11] Notice that CR_2 can be used in a dynamic sense because the position of the companies regarding the level of market shares remains unaltered during the whole period.

[12] Average prices of mobile telephone services decreased over this period by 50% according to ANRT reports (https://www.anrt.ma/en/publications/notes-dorientations-generales).

authority stablished a standard termination rate for the three firms, the index remained stable around the value 0.98.[13]

Figure 5. Concentration indexes
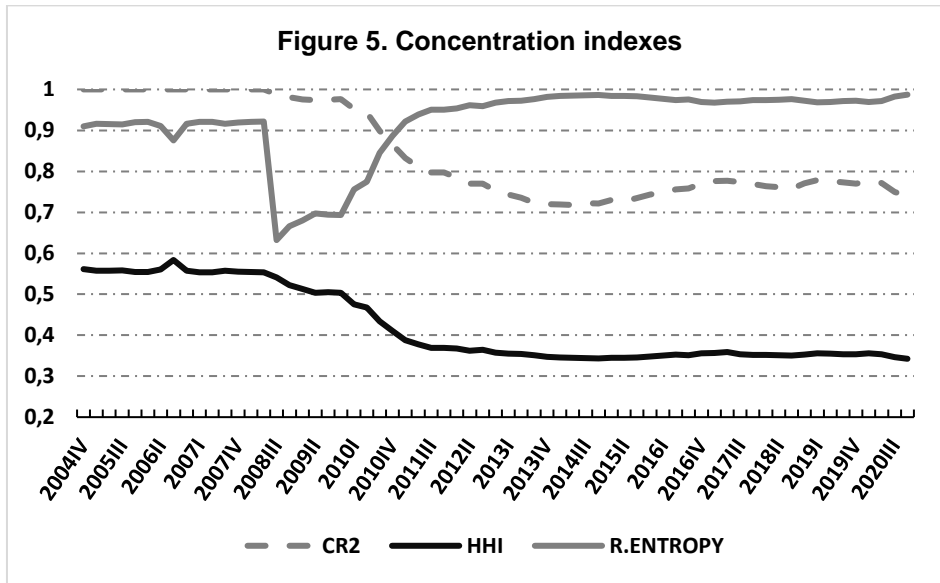
Finally, we present the volatility index to better assess the extent to which customers adhere different providers as the penetration rate increases. When the index takes value 0 it means that market shares are stable, which should imply a lower degree of competitiveness. The contrary occurs when it takes value 1. The Volatility index has the following general form,

$$V_t = \frac{1}{2}\sum_{i=1}^{N}\left|S_{i,t} - S_{i,t-1}\right|, \quad 0 < V_t < 1,$$

where $S_{i,t}$ and $S_{i,t-1}$ are the firms' market shares in two correlative periods. Figures 6.a and 6.b report the volatility index and trend, and its seasonality, respectively. Figure 6.a points out that market shares are more stable within the period 2013-2019. It coincides with the period when penetration rate was stabilized and termination rates were symmetric. Termination rates become asymmetric once more at the end of the period, while the volatility trend increases.

Figure 6.a. Volatility and trend

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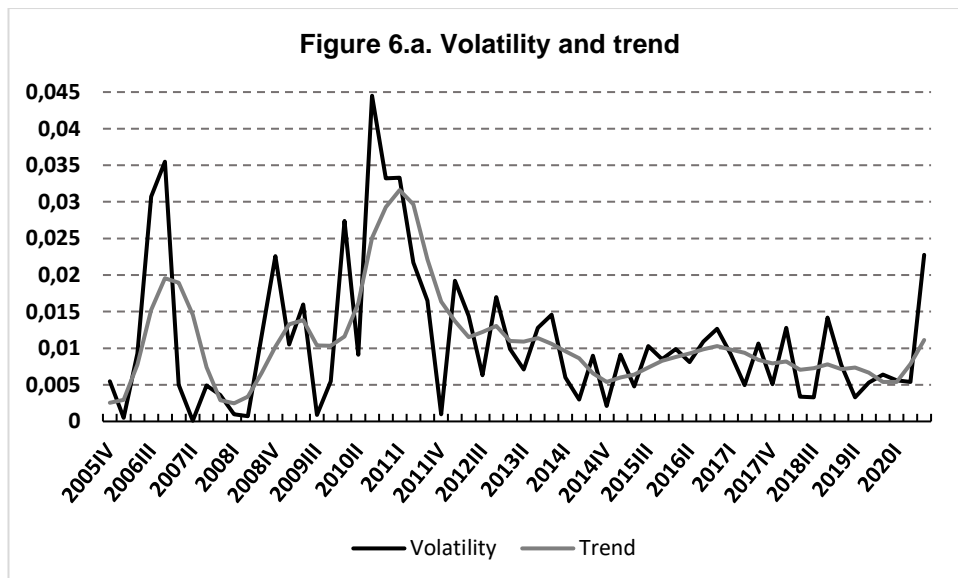
[13] The drop observed in 2008III was due to a technical reason: the denominator of the index jumped from $ln2$ to $ln3$.

Seasonality (Figure 6.b) occurs due to the influx of Moroccans who reside abroad. Most of the Moroccan emigrants come back for their summer holidays, mainly in the third quarter of the year. Almost all of them have prepay contracts, which they maintain during their holidays. When this population leaves the country, the competition becomes fierce again in order to capture those customers who live in Morocco the whole year and thus, volatility increases in the fourth and first quarters.

Figure 6.b. Seasonality
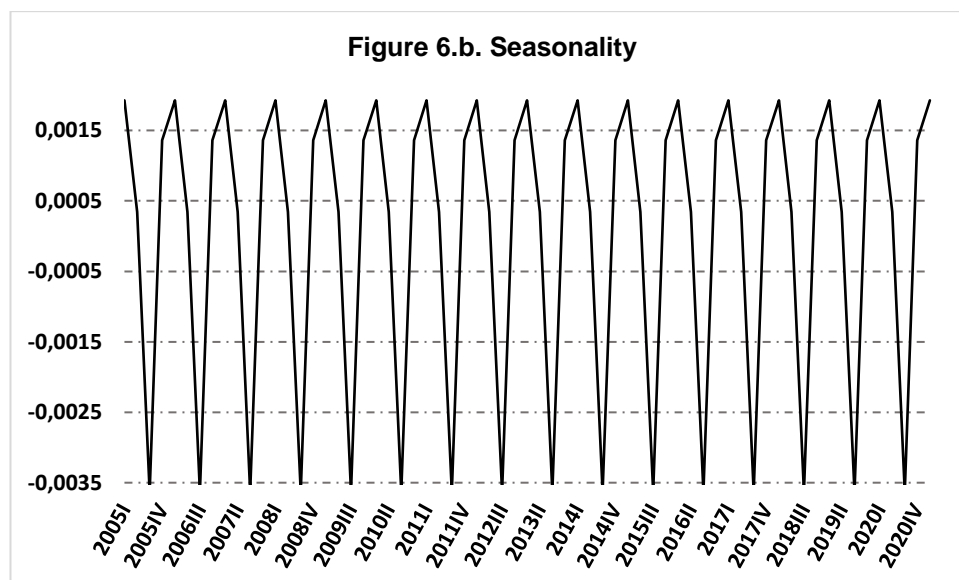
At this point we can conclude that, although the indexes denote a highly concentrated market, their evolution over time led to an increase in competition, mainly because the entry of the new operator INWI. In fact, over the period 2008-2013, the evolution of the indexes shows that the competition was intense, whereas over the period 2013-2019 the tendency was different. We assume that in these two periods the firms changed their strategies due to the stabilization of the termination rates and the penetration rate, which made the market more stable. It seems that the market may benefit in the near future from other incentives to make it more competitive. Indeed, it suggests that to boost competitiveness the entry of the fourth operator could be advised.

5.3. Econometric assessment

In this subsection, we study the determinants of market shares. To this end, we propose an econometric analysis with the set of variables listed in Table 4. According to the information available in our dataset, we divided explanatory variables into three groups. Within market variables, the number of prepay and subscriber customers are included as well as the amount of outgoing voice traffic minutes (in billions). The second group includes policy variables that depend on governmental decisions, such as the degree of privatization of the state-owned company IAM, and the level of the termination rates, which depends on the regulatory agency ANRT. Finally, the population dimension is represented by the level of urban citizens. Rural population is not included because its level remains almost unaltered throughout the whole period.

Table 4. Determinants of market shares in the Morocco mobile sector.

Category	Explanatory variables	Abbreviation	2004IV	2008III	2020IV
Market	**Prepay**	Pre	887,8	2141,0	4394,5
	Subscribers	$Subs$	45,9	88,3	547,6
	Outgoing voice traffic	OVT	10,16	24,85	14,16
Policy	**Degree of privatization**	DP	34%	70%	78%
	Termination rate IAM	TR_{IAM}	0,161	0,124	0,010
	Termination rate OM	TR_{OM}	0,161	0,124	0,011
	Termination rate INWI	TR_{INWI}	0,00	0,153	0,012
Population	**Urban population**	$Urban$	1645	1794	2299

Prepay, Subscribers and Urban population in tens of thousands. Outgoing voice traffic in billions of minutes. Termination rates in constant 2004 US$.

In what follows, we introduce the econometric model on the determinants of the market share for the period under study,

$$MS_{it} = \alpha + \beta_1 \cdot Pre_t + \beta_2 \cdot Subs_t + \beta_3 \cdot OVT_t + \beta_4 \cdot DP_t + \sum_{i=1,2,3.} \gamma_i \cdot TR_{it} + \theta \cdot Urban_t + \varepsilon_{it},$$

where subscript $i = 1,2,3$ indicates IAM, OM and $INWI$, respectively, and t represents time in quarters from 2004III to 2020IV, such that $t = \{1,2,..,65\}$. The estimated coefficients of the linear regression model are presented in Table 5. We run different specifications of the model to check for possible differences in the results obtained. In particular, model specification 1 only includes Market variables. Model specification 2 accounts for Market variables and Policy variables, whereas model specification 3 add the Population variable (and then, it comprises the three groups of variables). The coefficient of determination (R-squared) is reported at the bottom part of the table to track how the variability of the dependent variable MS_{it} is explained by the variability in the explanatory variables that we use across model specifications. Number of observations are also reported at the bottom part of the table, where we can see that it is equal to 50 for company INWI, since it entered the market in 2008III.

Table 5. Econometric analysis of the determinants of market shares.

VARIABLES	(1) IAM	(2) IAM	(3) IAM	(1) OM	(2) OM	(3) OM	(1) INWI	(2) INWI	(3) INWI
$Prepay$	-7.64e-05***	-7.61e-05***	-7.62e-05***	-1.60e-06	5.60e-06	4.78e-06	0.000169***	0.000103***	9.97e-05***
	(5.67e-06)	(1.13e-05)	(1.13e-05)	(5.43e-06)	(1.12e-05)	(8.98e-06)	(9.96e-06)	(1.31e-05)	(1.31e-05)
$Subs$	6.43e-05*	-2.65e-05	-6.27e-05	0.000175***	0.000133***	-0.000115**	-0.000216***	-0.000307***	-0.000176*
	(3.64e-05)	(2.55e-05)	(6.08e-05)	(3.49e-05)	(2.52e-05)	(4.81e-05)	(3.15e-05)	(5.65e-05)	(9.83e-05)
OVT	-0.00513***	0.000501	-0.0000415	-0.00471***	-0.00416***	0.000446	-0.00207	-0.00204	-0.000625
	(0.00151)	(0.00156)	(0.00178)	(0.00144)	(0.00155)	(0.00141)	(0.00168)	(0.00193)	(0.00209)
DP		0.245***	0.240***		-0.0241	-0.0575*		0.462***	0.369**
		(0.0393)	(0.0402)		(0.0390)	(0.0319)		(0.129)	(0.139)
TR_{IAM}		0.185***	0.188***		0.106**	0.121***		-0.176***	-0.183***
		(0.0524)	(0.0528)		(0.0519)	(0.0418)		(0.0556)	(0.0547)
TR_{OM}		-0.128***	-0.128***		-0.0201	-0.0239		-0.173	-0.322
		(0.0458)	(0.0461)		(0.0454)	(0.0365)		(0.415)	(0.418)
TR_{INWI}		-0.00417	-0.00547		0.0230***	0.0141***		0.178	0.297
		(0.00507)	(0.00547)		(0.00502)	(0.00433)		(0.310)	(0.313)
$Urban$			4.14e-05			0.000284***			-0.000129
			(6.31e-05)			(4.99e-05)			(7.94e-05)
$Constant$	0.784***	0.558***	0.490***	0.336***	0.206***	-0.255***	-0.339***	-0.353***	-0.0477
	(0.00991)	(0.0367)	(0.109)	(0.00950)	(0.0363)	(0.0863)	(0.0234)	(0.0892)	(0.208)
Observations	65	65	65	65	65	65	50	50	50
R-squared	0.970	0.989	0.989	0.332	0.734	0.831	0.965	0.985	0.986

Standard errors in parentheses. P-values (p): *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

First, it is interesting to note that the inclusion of Policy variables and the population characteristic helps to explain the regression model of the market shares, since R-squared values increase as we move from model specification 1 to 3. Looking at the market variables, Prepay has a statistically significant and negative effect on the dependent variable for IAM and a positive one for INWI, being robust to the inclusion of the policy variables and the population characteristic. It seems that, as the number of customers increases, those who prefer a prepay service are captured by the entrant firm INWI, whereas the incumbent loses its market share and the effect is not significant in the case of OM. Concerning the variable Subscribers, we observe that it has a statistically significant and negative effect on the market share of INWI. In the case of OM, it has positive effect, which becomes negative when controlling for the population characteristic. It may be due to a flatter evolution of the OM's market share compared to other companies (see Figure 3) and the explanation further below when analyzing the population characteristic.

Contrary to the above observations, there is no clear pattern of effects of Outgoing voice traffic on the market shares across specifications. Under model 1, the effect is negative and significant for IAM and OM. It can be argued that increases in the outgoing voice traffic comes from calls with origin in INWI mobile lines, although the estimated effect is not significant. It is worth mentioning that the increasing use of alternative communication channels, such as social networks, might dilute the effects of Outgoing voice traffic.

When focusing on the Policy variables and their effects on market shares, we observe differences in signs of the estimates for Degree of privatization across companies. We observe a robust positive and statistically significant effect of this variable on the market share of IAM and INWI, and a negative and significant effect in the case of OM. That is, when the state's intervention decreases, i.e. the degree of privatization increases, competition between companies is enhanced. In other words, we can observe that IAM and INWI benefit in terms of market share, whereas OM loses customers and thus, reduces its market share. A possible explanation of this effect is that as long as the former monopolist IAM is privatized, INWI and IAM become more aggressive in the market, stealing customers from OM.[14]

Now we highlight some results related to the termination rates. There are statistically significant effects on the market shares for the three competitors when the termination rate of IAM varies: a positive effect is observed for IAM and OM, whereas this is negative for INWI. It seems that INWI benefits from further reductions of IAM's termination rate, stealing customers not only from IAM but also from OM, making the market more competitive. The intuition is that when the termination rate of a given network decreases, it favors further reduction in prices of the rest of competitors, which in turn, attracts customers. Decreases in the termination rates of OM and INWI have significance for IAM and OM market shares, respectively. When the termination rate of OM decreases, it induces an increase in IAM's market share, whereas when the termination rate of INWI decreases, a decrease in OM's market share is observed. Since IAM is the company that holds the highest market share, a reduction in OM's termination rate may allow IAM to be price aggressive. However, further reductions in INWI's termination rate does not benefit OM. It may indicate that by decreasing the termination rate of INWI, OM is the company suffering most detriment due to its apparently more passive strategy in the market.

Finally, urban population has a positive and statistically significant effect on OM's market share. It is interesting to note that the inclusion of the population dimension into the model reverses the sign of the effect that the number of subscribers has on OM's market share. A possible explanation is the following. As long as population moves from rural to urban areas, affordability of mobile services in urban areas decreases since customers from rural areas have lower incomes. On the one hand, OM could concentrate on that population with higher income located in urban areas who prefer subscriber contracts (increasing the variable Subscribers), leaving prepay customers to IAM and INWI. On the other hand, OM might decrease the subscribers market share in rural areas, increasing the number of prepay lines. Thus, although the overall effect on the OM's market share can be positive, the number of OM subscribers may decrease whereas increases in the OM prepay lines offset the subscribers' negative effect.

6. Concluding remarks

In this paper, we investigate the extent to which the Moroccan mobile market is a competitive market and its evolution during the period 2004III-2020IV. Our findings suggest that, after almost 20 years of the liberalization process, the Moroccan mobile market exhibits an increasing degree of competitiveness, where three active companies operate. The former monopolist, the state-owned firm IAM, has been largely privatized. By 2020, 78% of the total equities were in private hands. Market shares of the three operators tend to be similar. It was mainly because of the continuous market share losses of IAM in favor of INWI, which seems to be more aggressive when capturing customers. Moreover, the evolution of concentration indexes, descriptive statistics and results of the econometric analysis have shed light on the degree of competitiveness.

The relative entropy reinforces these findings. Although companies' market shares still present significant differences, the probability of losing a given customer is high as market shares become closer to each other. In the same way, the volatility index has experienced a huge increase during some quarters since 2008III, when the company INWI entered the market. Although the index stabilized after a few quarters, it also shows a slight increase in its evolution by the end of the period of study, which coincides with the increase of INWI's market share.

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[14] It is remarkable that this company has a proportion of 8% of its equities owned by a financial governmental company, which in turn may yield to a more passive behavior aimed at maintaining prices and thus, losing competitiveness in the market.

The general picture of the evolution of the market is that IAM has lost customers as the market became more competitive. During the duopoly period, OM stole customers from IAM, whereas since 2008III, INWI has been more aggressive and OM has maintained a relatively flat evolution of its market share. A possible explanation to uphold these findings is as follows. Aimed at retaining customers, OM has been implementing a conservative strategy by using loyalty programs, which reduces competition by keeping a lower variance of the market share. Moreover, OM could have concentrated on urban areas, where operational costs are lower than in rural areas. Henceforth, OM might leave the rural market to INWI and focus on attracting customers in urban areas, where population increases considerably. Lastly, as a governmental financial company possesses 8% of the total equities of OM, it might avoid aggressive strategies to maintain the company's profitability by reducing the level of uncertainty.

As we pointed out before, although HHI and CR_2 present relatively high levels, they decrease over the period under study. We argue that the market exhibits an increasing level of competitiveness, where anticompetitive practices, such as tacit or explicit collusive agreements, may be difficult to sustain. Policy measures of privatization of the state-owned company, as well as market forces, such as the increase of the penetration rate that incentivizes companies to capture new customers, contribute to become the market procompetitive, especially with regard to prepaid programs.

In this vein, if entry barriers related to governmental restrictions and financial bottlenecks decrease, the Moroccan mobile market leaves room for new operators to come in to play, which in turn will make mobile services more affordable, enhancing the penetration rate. It is worth mentioning that, according to recent findings, the spread of telecommunication technologies is conducive to further increases of the GDP and inequality reductions (World Bank, 2016). Hence, the deployment of mobile services and its affordability may enhance the development of the Moroccan economy.

Acknowledgments

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