Programa de Doctorado en Economía (DEcIDE)

Telecommunications Market in Morocco: development, liberalization, and competition.

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Que la Comisión Académica Interuniversitaria, en la reunión de 12 de septiembre de 2022, dentro del punto número 3 del orden del día "Autorización para la presentación de tesis doctorales" autorizó la presentación de la tesis de "Telecommunications market in Morocco: development, liberalization and competition" realizada por la estudiante Soumaya Amassaghrou y dirigida por el profesor Carlos Gutiérrez Hita.

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This thesis has been written to conclude my education in Economics science with specialization in Industrial Economics. The subject of the thesis is the study of competitiveness in the telecommunication market with special focus in the Moroccan one as case of study. The work examined how firm´s behaviour combined with regulatory framework impact the development of the market.

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Each one of us has his own path that begins with his birth and finishes with his death. Along this path there are several events that impact us. PhD is one of these events, at least in my case. An event that can be compared to the day when I went to school for the first time. In the first grade, I experimented to be scolded for doing some things, for example, for getting bad marks. This experience taught me how to overcome obstacles and recreate myself tricking my brain, and that was my strength. Another event came unexpectedly, OCD, that deprived me from this strength, since then my brain was tricking me for 16 years. PhD is a stage that comes to repair the profound scares left by OCD and depression appearance when I was left without either cognitive abilities or even the memory. To illustrate the damage left by my enemies, in the beginning of PhD, I was not able to read a page of an article and made a summary of it. The PhD was the only means to recreate new cognitive abilities and myself as well. It was a huge success, not only through

recovering what I lost 24 years ago, but I learned something new: discipline, respect, perseverance, patience and not losing the control against the hazards of life. Now I can affirm that I trick my brain.

PhD contributes to assimilating all the economic knowledge acquired in several years. From my point of view, being a real economist requires a PhD cursus, through it you develop what was acquired before and the most important thing you learn how to share it with others. Education is a luxury good that contributes most to the human welfare. Being a doctor in economy will afford me the opportunity to acquire and transfer knowledge constantly until the end of my life, and this is the most honourable duty of a human being.

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1. Resumen. El sector de las telecomunicaciones en Marruecos.

I.Introducción.

El desarrollo y la expansión de los servicios de telecomunicaciones son cruciales para el crecimiento económico sostenido, especialmente para los países en desarrollo como los africanos. En efecto, para mantener el ritmo de crecimiento de los países desarrollados, los países africanos deben aumentar la competencia en su mercado. Además, deben adoptar los nuevos avances tecnológicos en el sector industrial, así como en el sector de las telecomunicaciones a un ritmo más rápido para mejorar la calidad de los servicios ofrecidos y reducir los costes. En lo que respecta al sector de las telecomunicaciones, la privatización de la empresa estatal (el incumbente), junto con una liberalización eficiente del sector bajo normas reguladoras claras, son medidas necesarias para lograr un crecimiento económico sostenido.

El atractivo de los países en desarrollo para la inversión extranjera directa estaría estrechamente relacionado con el desarrollo de los servicios de telecomunicaciones en estos países. De hecho, el proceso de privatización se ha realizado mediante la atracción de inversores privados. Los países en desarrollo han sido activos en este sentido; han aplicado muchas estrategias para atraer inversiones extranjeras al mercado. Una de estas estrategias que ha destacado por su efecto controvertido es el periodo de exclusividad, que implica una concesión de poder de monopolio al titular recién privatizado, que le permite operar como monopolio durante unos años. Sin embargo, esta estrategia suscita un debate sobre su efecto real en el mercado. Wallsten (2000) muestra que el periodo de exclusividad tiene un impacto negativo en las inversiones en el mercado, reduciendo el número de infraestructuras desplegadas.

En general, la privatización tuvo lugar en el continente a principios de los años noventa, con el fin de superar los malos resultados de la empresa estatal, cumplir las normas de los organismos internacionales (por ejemplo, el Banco Mundial), fomentar la competencia y permitir que el mercado absorba eficientemente el progreso tecnológico. Sin embargo, a pesar de que el

proceso de privatización en el continente se ha llevado a cabo de forma progresiva, en 2008 sólo el 44% de las empresas estatales estaban totalmente privatizadas (UIT 2008). Aunque la privatización es un proceso en curso, la posición dominante de la empresa incumbente en el mercado de las líneas fijas (incluidas las instalaciones de voz y banda ancha) no ha sufrido ningún cambio significativo. En cambio, el mercado de la telefonía móvil es cada vez más competitivo. Gebreab (2002) analizó el impacto de la privatización, entre otros factores, en la difusión del mercado móvil y demostró que la privatización fomenta la competitividad en el mercado. Además, señaló que el segmento de las líneas fijas es un servicio complementario del mercado de los móviles, y atribuyó esta relación a las externalidades positivas, en las que el aumento de los abonados a las líneas fijas repercute en el aumento de las suscripciones a los móviles.

Los países africanos siguen casi las mismas pautas de desarrollo en los distintos segmentos del mercado de las telecomunicaciones. Gebreab (2002) señala que el segmento móvil ha evolucionado considerablemente en comparación con los servicios de línea fija. Por ejemplo, en el continente africano, en 2004 casi el 75% de los abonados al teléfono utilizaban el móvil. En cuanto a la infraestructura fija, se puede decir que, en general, el continente africano sigue sin estar conectado, sobre todo por la falta de inversión en la red de banda ancha. De hecho, las tecnologías de acceso de nueva generación (NGA, en adelante) se refieren al acceso 3G y 4G, mientras que las conexiones de fibra fija siguen siendo escasas no sólo en el sector rural, sino también en las ciudades medianas y grandes del continente. Además, aunque la difusión de las redes móviles es amplia, también dependen de la infraestructura de fibra óptica, lo que a su vez se convierte en una barrera de entrada para los nuevos competidores. Esta falta de inversión obstaculizaría la competitividad y el crecimiento económico del continente. Este panorama africano es el contexto en el que evoluciona el mercado de las telecomunicaciones de Marruecos.

II. El mercado marroquí de telecomunicaciones

El mercado de las telecomunicaciones ha experimentado profundos cambios debido a un profundo progreso tecnológico en los últimos veinte años. Este progreso es el resultado de una tendencia a la baja de los costes, que puso en duda la utilidad del monopolio natural de la empresa estatal. La liberalización del mercado fue también la respuesta al enorme aumento de

la demanda y a los nuevos retos de la sociedad de Internet. Las autoridades marroquíes fueron conscientes de la necesidad de la privatización, lanzando la Ley 24/96 de 1997, la primera piedra de este proceso. Los principales aspectos de la ley fueron la creación de dos empresas públicas: el operador de telecomunicaciones IAM (Itissalat Al-Maghrib), y el operador postal BAM (Barid al Maghrib), así como la creación de la Agence National de Réglementations des Télécommunication (ANRT) la autoridad nacional reguladora del mercado de las telecomunicaciones marroquí. La ANRT no es completamente independiente del gobierno marroquí. De hecho, la agencia funciona bajo la supervisión del primer ministro y otros 8 ministros a través del consejo de administración.

El siguiente paso del proceso de liberalización fue la privatización de IAM, el operador estatal: el gobierno vendió el 35% de las acciones del Estado al grupo Vivendi en 2001. El proceso de liberalización fue gradual durante dos décadas. En 2004, el gobierno ofrece el 14,9% de su capital en IAM mediante una oferta pública internacional. Fue la primera oferta internacional de acciones de una empresa marroquí. Posteriormente, en 2005 Vivendi aumentó su participación del 35% al 51%, mientras que el 2% restante fue transferido a Vivendi en 2007 por la empresa pública financiera Caisse de depot et de gestion (CDG, en adelante). En 2013 Vivendi anunció el cambio de la participación, transfiriendo su 53% a Etisalat. El último paso de la privatización fue la oferta del 8% a los inversores privados, realizada en 2019. Hay que mencionar que la liberalización gradual no siempre respondió a las exigencias de la liberalización y privatización del mercado. En la última operación de 2009, los analistas señalan que la venta del 8% de las acciones del Estado fue una medida para aumentar los gastos sin aumentar los impuestos. Fue una clara respuesta al descontento social. La otra vía para fomentar la competitividad en el mercado es la reducción de las barreras de entrada, lo que puede permitir que nuevos competidores ofrezcan servicios fijos y móviles.

i. Las empresas del mercado

Hay tres operadores en el mercado: Etisalat al Maghrib (IAM), Medi Telecom (MEDITEL), que recientemente ha adoptado la marca Orange, y WANA. Los accionistas de IAM son Etisalat, que posee el 53% del total de las acciones. El Tesoro marroquí, que representa al Estado marroquí, posee el 22%. El resto, un 17%, pertenece al personal de IAM y cotiza en las bolsas de

Casablanca y París. MEDI es propiedad del grupo ORANGE, que posee el 49% del capital. El resto del accionariado está en manos de CDG, y Finance Com, un inversor privado. Ambos poseen el 25,5%. Por último, WANA es una filial de Al Mada y del grupo kuwaití Zain. El primero posee el 31% del capital y el segundo el 69% restante.

MEDI llegó al mercado en 1999 tras obtener una licencia GSM. Compitió con IAM sólo en el segmento móvil, a pesar de que se le concedió una licencia NGN y una licencia 3G en 2006. De hecho, MEDI siempre ha favorecido la inversión en infraestructura móvil en detrimento de la infraestructura fija. Este sesgo también se manifestó cuando la ANRT ordenó la desagregación del bucle local en 2008. A pesar de esta medida, MEDI solo hizo 200 solicitudes para compartir la infraestructura de red del incumbente. En 2015 obtuvo la licencia 4G. WANA se incorporó al mercado en 2006, cuando se le concedió una licencia de 3G y NGN. A diferencia de MEDI, WANA mostró más interés en invertir en la infraestructura fija. Por ejemplo, invirtió en CDMA (movilidad restringida de línea fija), aunque no tuvo éxito. WANA también hizo 1300 solicitudes hasta 2016 para compartir la infraestructura de red del incumbente. Adquirió una licencia GSM en 2009, y una licencia 4G en 2015. IAM, la antigua empresa estatal, mantiene su posición dominante en el mercado de la banda ancha fija (principalmente conexiones ADSL) con una cuota de mercado del 99,93 % (ANRT 2020). Las decisiones de los competidores de no competir en el mercado fijo son principalmente el resultado de la escasa demanda y de los factores regulatorios que se analizan en las siguientes secciones.

ii. Impacto social del sector de las telecomunicaciones en Marruecos

El desarrollo de las tecnologías de la información y la comunicación (TIC, en adelante) ha experimentado un notable incremento debido al compromiso de los actores públicos y privados para alcanzar sus objetivos. De hecho, este sector se considera uno de los motores de otros sectores estratégicos del país. Siguiendo las directrices de la Comisión Europea, las TIC se consideran las tecnologías que sostienen la economía digital. Las TIC combinan los servicios y las industrias manufactureras cuyos productos cumplen y permiten la función de procesamiento de la información y la comunicación por medios electrónicos, incluyendo la transmisión y la visualización (OCDE). El desarrollo de este sector puede fomentar el crecimiento económico. Es bien sabido que el progreso tecnológico contribuye a la creación de riqueza. Algunos trabajos

han intentado evaluar este impacto. En Fernández et al. (2020) los resultados empíricos sugieren que el despliegue y desarrollo de las TIC tiene un impacto positivo en el crecimiento económico de los países que están bajo el paraguas de los países desarrollados europeos. Un estudio empírico similar fue realizado por Bahrini et al. (2019), donde encontraron que el desarrollo de las tecnologías de la información y la comunicación, excepto la telefonía fija, en Oriente Medio y Norte de África (MENA) y en el África Subsahariana (SSA) es el principal motor del crecimiento económico. En efecto, la difusión de los servicios móviles conlleva la reducción de la brecha digital al llegar a zonas remotas y, por tanto, contribuye a integrar a la población rural en el crecimiento económico, cumpliendo el objetivo de la economía inclusiva.

El impacto social del desarrollo del mercado de las telecomunicaciones se refleja en la consecuencia directa del desarrollo del sector de las TIC. El caso de Marruecos ilustra hasta qué punto las medidas políticas pueden apoyar al sector de las TIC, con el objetivo de crear empleo entre la población joven y estimular a las empresas para que estén a la vanguardia del progreso tecnológico. De hecho, el compromiso del gobierno de invertir en infraestructuras de red se vio favorecido por la cooperación con programas internacionales como el programa Digital Jobs Africa de la Fundación Rockefeller, cuyo objetivo es promover el empleo de los jóvenes en los países en desarrollo mediante el traslado de las actividades laborales a distancia de los países desarrollados a los países en desarrollo. La integración de la población juvenil en el sector de las TIC pretende también dotar a este segmento del mercado laboral de competencias digitales que contribuyan en el futuro a abrirles nuevos horizontes.

En general, se trata de un sector en auge que se beneficia de la proximidad geográfica a Europa, de los menores costes laborales y de la elevada tasa de penetración de las conexiones móviles (tanto de los servicios de voz como de banda ancha). Lo que ha consolidado la competitividad del mercado de las telecomunicaciones, en particular de los servicios móviles. Uno de los sectores basados y relacionados con las TIC es el offshoring, que es un sector importante que ha impulsado el desarrollo de la economía marroquí. Ha sido testigo de una gran cantidad de inversiones extranjeras. Además, crea alrededor de 120.000 nuevos empleos. La inversión en infraestructuras de telecomunicaciones atrae las actividades del offshoring . El compromiso de desarrollar la infraestructura de la red de telecomunicaciones se deriva del objetivo del gobierno de estimular el crecimiento económico a través de la atracción de la inversión extranjera mediante

la externalización. La externalización de procesos empresariales contribuye cada año en un 0,3% al crecimiento del PIB.

El desarrollo del mercado de las telecomunicaciones obstaculizaría la inmigración mediante la apertura de nuevos horizontes para la población joven y prepararía al país para construir la base de un nuevo tejido económico mediante la creación de un sector competitivo de las TIC capaz de mantener una alta tasa de crecimiento económico. En este caso se podría crear un círculo vicioso. La contribución del sector de las TIC al crecimiento del PIB puede aumentar de alguna manera la propensión de los consumidores a comprar servicios de telecomunicaciones de mayor calidad, lo que a su vez anima a las empresas a mejorar su red y, en consecuencia, a crear una infraestructura fiable que atraiga la inversión extranjera en el sector de las TIC. El gobierno marroquí debe redoblar los esfuerzos para desarrollar el sector de las TIC, con el fin de animar a la población a adquirir el servicio fijo de banda ancha y reducir el poder del mercado de la incumbente. El desarrollo de la red de acceso de nueva generación es fundamental para la competencia en el mercado.

iii. Análisis económico del mercado de las telecomunicaciones en Marruecos.

Como hemos mencionado anteriormente, los países en desarrollo experimentaron una enorme difusión de los servicios móviles en detrimento de los servicios fijos. En esta subsección examinaremos la relación que existe entre estos dos segmentos del mercado. A pesar del auge de los servicios móviles, la infraestructura fija nunca desaparecerá, porque la infraestructura móvil también depende de ella. Además, los nuevos avances tecnológicos, como las conexiones NGA por fibra, se proporcionan a través de la infraestructura fija. Esto plantea la cuestión de la relación que debe existir entre la infraestructura móvil y la fija para mejorar la competitividad y la innovación.

Al principio de la liberalización del mercado, debemos suponer que se produjo una interacción entre la evolución de la tecnología móvil y las medidas reguladoras. Así, la liberalización podría haber sentado las bases de una rápida difusión de la nueva tecnología y, viceversa, la aparición de los servicios móviles ha aumentado el compromiso de las autoridades reguladoras para alcanzar sus objetivos. Sin embargo, el impacto más interesante es cómo la red móvil impactó a la evolución de la red fija. La relación entre estas dos tecnologías se hace explícita en 2002,

cuando los abonados a la telefonía móvil superan a los de la fija (UIT 2003). Así, en una década las preferencias de los clientes se trasladaron a la red móvil desde la red de línea fija. Esta tendencia se debe al menor coste y al rápido despliegue de la infraestructura móvil, que a su vez estimula el interés de los nuevos operadores por invertir en ella. Además, en la mayoría de los países africanos, incluido Marruecos, la infraestructura de línea fija ha sido controlada por la antigua empresa estatal. En consecuencia, la competitividad era menor y a los operadores privados de líneas fijas les resultaba imposible competir bajando la tarifa. No obstante, algunos países en los que el índice de penetración de la infraestructura fija era mayor, intentaron integrar ambas tecnologías para ganar más cuota de mercado o mantener la fidelidad de sus clientes en un intento de frenar la migración a otros competidores móviles. En el informe de la OCDE de 2012, se destacan algunas formas de complementariedad de las redes fijas y móviles. En efecto, los operadores de telefonía fija intentan adoptar una modalidad dual para prestar un único servicio telefónico. Esta complementariedad de las redes fijas y móviles consiste en realizar llamadas de VoIP desde el móvil a través de Wi - Fi o acceso de banda ancha a una tarifa reducida (OCDE 2012). Así, el objetivo de esta herramienta de integración entre la infraestructura fija y móvil era animar a los clientes a utilizar su teléfono móvil a través del acceso a los servicios de infraestructura fija y, por lo tanto, impedir que los clientes vinculen el teléfono móvil sólo al servicio de infraestructura móvil. Esta estrategia se aplicó en la primera década del siglo XXI, pero fracasó en la mayoría de los países de la OCDE, excepto en Francia.

La infraestructura móvil es más barata que la fija, lo que atrae a más consumidores al mercado. Así, la tecnología móvil es menos sensible a las economías de densidad, lo que anima a los nuevos operadores a llegar a zonas remotas y a cumplir con los servicios universales. Este ahorro de costes influye en el interés de las autoridades reguladoras por la relación entre la infraestructura móvil y la fija. Por lo tanto, la tendencia observada es la sustitución de la infraestructura fija por la móvil. La relación entre ambos servicios viene determinada por varios factores. Desde el punto de vista de la demanda, si los costes de los servicios móviles son más bajos, puede animar a las comunidades de bajos ingresos a acceder al servicio móvil, que antes era inasequible. Por lo tanto, los servicios móviles podrían haber aumentado la tasa de penetración de los servicios de telecomunicaciones, ayudando a difundir el uso de esta tecnología en los países de bajos ingresos.

La OCDE, en uno de sus informes, destaca la importancia de una infraestructura móvil competitiva para mejorar la difusión de los servicios universales. Afirman que en aquellos mercados en los que la competencia tanto en redes fijas como móviles es elevada, hay más tendencia al crecimiento y la innovación. Sin embargo, este impacto en los países de renta relativamente alta es menor. En efecto, en estos países existe una mayor tasa de penetración del mercado fijo y, por tanto, se fomentaría el acceso a los servicios móviles al beneficiarse del valor añadido que ofrecen las conexiones de los servicios móviles. En este caso, ambas tecnologías podrían ser complementarias. En general, los servicios de línea fija están relacionados con la tecnología de banda ancha, mientras que los servicios móviles se relacionan con la tecnología de banda ancha móvil. Por lo tanto, la verdadera relación entre la infraestructura móvil y la fija podría reanudarse por la interacción entre las tecnologías de banda ancha fija y móvil, ya que los servicios de voz tradicionales se están quedando obsoletos. Esto plantea la siguiente pregunta: ¿la relación entre la infraestructura móvil y la fija determina la evolución del índice de penetración de la infraestructura de banda ancha? Si la respuesta es positiva, las autoridades reguladoras deberían tener en cuenta la sustitución fijo-móvil para establecer el marco óptimo para fomentar la expansión de la infraestructura de banda ancha.

A continuación, presento tres capítulos que recogen las principales cuestiones tratadas en este trabajo. Para ello, establezco un modelo que evalúa el despliegue de la NGA en el mercado. Además, utilizando diferentes fuentes de datos, he realizado dos estudios que evalúan la evolución de los mercados marroquíes de telefonía fija y móvil.

III. Descripción de los siguientes capítulos

En el capítulo 2, analizo la evolución global del mercado de las telecomunicaciones. He utilizado los índices de concentración para estudiar en qué medida el mercado evoluciona hacia un mercado competitivo. En primer lugar, me he centrado en el mercado de telefonía fija y móvil. En segundo lugar, he presentado un estudio econométrico en el que se utilizan indicadores socioeconómicos y variables microeconómicas como determinantes del índice Herfindhal-Hirshman. La principal conclusión de este capítulo es que el mercado móvil es el sector que ha introducido la competencia en el mercado de las telecomunicaciones. Sin embargo, el mercado fijo sigue casi monopolizado en manos de la antigua empresa estatal.

El estudio del mercado fijo motiva el capítulo 3, en el que he presentado un modelo de oligopolio para investigar el acceso al mercado de la banda ancha en el sector fijo. En efecto, el acceso al mercado de la banda ancha es crucial para introducir dinamismo en el sector porque la tasa de penetración es baja. A medida que nuevos clientes muestren interés por acceder a las conexiones de banda ancha fija, el mercado puede reducir la concentración. Una de las características que determina la evolución de este mercado son las tecnologías de nueva generación (NGA), principalmente las conexiones de fibra.

En el modelo, asumo que un nuevo operador puede ofrecer conexiones de banda ancha accediendo al bucle local desagregado o invirtiendo en NGA. Una característica importante del modelo es que estos dos tipos de conexiones pueden considerarse sustitutos perfectos cuando la asequibilidad del servicio es la principal preocupación de los consumidores. En general, he encontrado que al competidor entrante le puede resultar rentable invertir en NGA cuando la tarifa de acceso al bucle local es lo suficientemente alta y los costes fijos para desplegar la nueva tecnología pueden repartirse a lo largo de un periodo de tiempo suficiente. Además, el excedente del consumidor es mayor cuando el nuevo competidor invierte. Por último, estos resultados dependen en gran medida de la decisión de privatización de la empresa estatal.

El capítulo 4 es una evaluación de la evolución del mercado de la telefonía móvil, que es el sector más dinámico. En este capítulo, investigo hasta qué punto el mercado móvil marroquí es un mercado competitivo durante el periodo 2004III-2020IV. Nuestros resultados sugieren que, tras casi 20 años de proceso de liberalización, el mercado marroquí de la telefonía móvil presenta un grado creciente de competitividad, en el que operan tres empresas activas. El antiguo monopolio, la empresa estatal IAM, se ha privatizado en gran medida. En 2020, el 78% de las acciones totales estaban en manos privadas. Las cuotas de mercado de los tres operadores tienden a ser similares. Esto se debe principalmente a las continuas pérdidas de cuota de mercado de IAM en favor de INWI, que parece ser más agresiva a la hora de captar clientes. Además, la evolución de los índices de concentración, las estadísticas descriptivas y los resultados del análisis econométrico han arrojado luz sobre el grado de competitividad.

La evolución del comportamiento competitivo de los operadores durante el periodo estudiado parece estar determinada por el acceso a la tecnología, el cuerpo normativo, la evolución de la demanda y el nivel de privatización del operador estatal. Como la tecnología está muy extendida, la calidad de los servicios es similar independientemente de la empresa que proporcione la conexión a la red, y la demanda ha aumentado continuamente, la única forma de aumentar los beneficios es competir por la captación de clientes, lo que se traduce en precios más bajos. De hecho, a medida que aumenta la cuota de mercado, los precios fuera de la red disminuyen porque el pago de las tarifas de terminación también disminuye, lo que da lugar a precios más bajos en general. Mientras todas las empresas sigan este comportamiento, el poder de mercado no podrá ejercerse en gran medida, manteniendo la rentabilidad de los operadores en niveles relativamente normales y, por tanto, aumentando el excedente del consumidor. Además, las medidas políticas de privatización de la empresa estatal, así como las fuerzas del mercado, como el aumento del índice de penetración, han incentivado a las empresas a captar nuevos clientes contribuyendo a que el mercado sea más competitivo, especialmente en lo que respecta a los programas de prepago.

1'. Executive summary. An overview of the Moroccan Telecommunications Sector.

I. Introduction.

The development and expansion of telecommunication services is crucial for sustained economic growth, especially for developing countries such as African countries. Indeed, to keep up the pace of growth behind developed countries, African countries are supposed to increase the competition in their market. Moreover, they need to adopt the new technological progress in the industry sector

as well as in the telecommunications sector at a faster rate to improve the quality of the services offered and drive down the costs. Concerning the telecommunications sector, the privatization of the state-owned company (the incumbent), along with an efficient liberalization sector under clear regulatory rules, are necessary measures to achieve a sustained economic growth.

The attractiveness of the developing countries for foreign direct investment, would be closely connected to the development of the telecommunication services in these countries. Indeed, the process of privatization has been realized through the attraction of private investors. Developing countries have been active in this sense; they have applied many strategies to bring foreign

investments into the market. One of these strategies that has stood out for its controversial effect is the exclusivity period, which implies a concession of monopoly power to the newly privatized incumbent, that allows it to operate as a monopoly for few years. However, this strategy raises debate over its real effect on the market. Wallsten (2000) shows that the exclusivity period has a negative impact on the investments in the market, reducing the number of infrastructures deployed.

Generally, privatization took place in the continent in the early nineties, in order to overcome the poor performance of the state-owned company, to accomplish the rules of international organizations (for instance the World Bank), foster competition and allow the market to effectively absorb the technological progress. However, despite of the process of privatization in the continent has been carried out progressively, in 2008 only 44% of the state-owned companies were fully privatized (ITU 2008). Although privatization is an ongoing process, the dominant position of the incumbent company in the fixed line market (including voice and broadband facilities) has not undergone any significant change. In contrast, the mobile market is getting more competitive. Gebreab (2002) analysed the impact of privatization, among other factors, on the diffusion of the mobile market and showed that privatization fosters the competitiveness in the market. Furthermore, he outlined that the fixed lines segment is a complement service to the mobile market, and attributed this relationship to the positive externalities, where the increase of fixed lines subscribers has an impact on the upsurge of mobile subscriptions.

African countries follow almost the same patterns of development in the different segments of the telecommunications market. Gebreab (2002) points out that the mobile segment has evolved considerably in comparison to the fixed line services. For example, in the African continent in 2004 almost the 75% of the telephone subscribers used mobile. Regarding the fixed infrastructure, one can say that, overall, the African continent remains unwired, mainly because there is a lack of investment in the broadband network. Indeed, Next Generation Access (NGA, hereinafter) technologies relates to 3G and 4G access, whereas fixed fiber connections remain scarce not only in the rural sector but also in medium and big cities across the continent. Moreover, although the diffusion of mobile network is wide, they are also dependent of the fiber optic infrastructure, which in turns become an entry barrier to new competitors. This

underinvestment would hamper the competitiveness and economic growth in the continent. This African panorama is the context in which Morocco telecommunication market is evolving.

II.The Moroccan telecommunications market

The telecommunication market has undergone profound changes due to a deep technological progress in the last twenty years. These progress is the result of a downward trend of costs, which put in doubt the utility of the natural monopoly of the state-owned company. The liberalization of the market was also the response to huge demand increases and the new challenges of the *internet society*. Moroccan authorities were aware of the necessity of privatization, launching the Law 24/96 1997, the first stone in this process. The main aspects of the law were the creation of two public companies: the telecommunication operator IAM (Itissalat Al-Maghrib), and the postal operator BAM (Barid al Maghrib), as well as the creation of the *Agence National de Réglementations des Télécommunication* (ANRT) the national regulatory authority of the Moroccan telecommunications market. The ANRT is not completely independent of Moroccan government. Indeed, the agency is operating under the supervision of the prime minister and other 8 ministers through the board of directors.

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The next step of the liberalization process was the privatization of IAM, the state-owned operator: the government sold 35% of the state´s equities to Vivendi group in 2001. The process of liberalization was gradual over two decades. In 2004 the government offers 14,9% of its capital in IAM through an international public offering. It was the first international equity offer of a Moroccan company. Later on, in 2005 Vivendi increased its stake from 35% up to 51%, whereas other 2% were transferred to Vivendi in 2007 by the financial public company *Caisse de depot et de gestion* (CDG, hereinafter). In 2013 Vivendi announced the change of the ownership stake, transferring its 53% to Etisalat. The last step of privatization was the offer of 8% to private investors, undertaken in 2019. We must mention that the gradual liberalization was not always a response to the requirements of the liberalization and privatization of the market. In the last transaction in 2009, analysts point out that the sale of 8% of the state´s equities was a measure to increase the expenditures without increasing the taxes. It was a clear response to social

discontents. The other channel aiming at fostering competitiveness in the market is the reduction of entry barriers, which may allow that new competitors offer fixed and mobile services.

i. Players in the market

There are three operators in the market: Etisalat al Maghrib (IAM), Medi Telecom (MEDITEL), recently branded Orange, and WANA. IAM ´s shareholders are Etisalat which owns 53% of the total equities. Moroccan treasury, which represents the Moroccan state, holds 22%. The rest of 17% are owned by IAM´s staff and listed on Casablanca and Paris stock exchange. MEDI is owned by ORANGE group, which holds 49% of equity. The rest of the shareholders are hold by CDG, and Finance Com, a private investor. Both of them own 25,5%. Finally, WANA is a subsidiary of Al Mada and the Kuwaiti group Zain. The former owns 31% of equity and the latter the remaining 69%.

MEDI arrived on the market in 1999 after being granted a GSM license. It competed with IAM only in the mobile segment, despite it was granted an NGN license and 3G license in 2006. Indeed, MEDI has always favoured the investment in mobile infrastructure at the expense of the fixed infrastructure. This bias was also manifested when ANRT mandated the local loop unbundling in 2008. Despite this measure, MEDI only made 200 requests to share the incumbent´s network infrastructure. In 2015 it obtained 4G license. WANA joined the market in 2006, when a 3G and NGN license were granted. Unlike MEDI, WANA showed more interest in investing in the fixed infrastructure. For instance, it invested in CDMA (Fixed line restricted mobility), although it was unsuccessful. WANA also made 1300 request until 2016 to share the incumbent´s network infrastructure. It acquires a GSM license in 2009, and 4G license in 2015. IAM, the former state-owned company, maintains its dominant position in the fixed broadband market (mainly ADSL connections) with a market share of 99.93 % (ANRT 2020). The competitors´ choices regarding not to compete in the fixed market are mainly the results of the narrow demand and regulatory factors that are discussed in the following sections.

ii. Social impact of the telecommunication sector in Morocco.

The development of information and communication technologies (ICTs, hereinafter) has experimented a noticeable increase due to the commitment of public and private players to reach their objectives. Indeed, this sector is considered one of the drivers of other strategic sectors in the country. Following European commission guidelines, ICTs are considered the technologies underpinning the digital economy. ICTs combine services and manufacturing industries whose products fulfil and enable the function of information processing and communication by electronics means including transmission and display (OECD). The development of this sector may trigger the economic growth. It is well-known that technological progress contributes to the creation of wealth. Some works attempted to assess this impact. In Fernández et al. (2020) empirical results suggest that ICTs deployment and development has a positive impact on economic growth of countries that are within the umbrella of European developed countries. A similar empirical study was carried out by Bahrini et al. (2019), where they found that the development of information and communication technologies, except fixed telephony, in the Middle East and North Africa (MENA) and Sub -Saharan Africa (SSA) is the main driver of economic growth. Indeed, the diffusion of mobile services brings about the reduction of digital breach when reaching remote areas and thus, it contributes to integrate the rural population within the economic growth, fulfilling the aim of inclusive economy.

The social impact of the development of the telecommunications market is reflected in the direct consequence of the development of ICT sector. Morocco case illustrates the extent to which policy measures may support the ICTs sector, aiming at the creation of employment among the young population and stimulate firms to be in the forefront of technological progress. Indeed, the engagement of the government in investing in network infrastructure was fostered by the cooperation with international programmes such as The Rockefeller Foundation´s Digital Jobs Africa programme, which aims at promoting youth employment in developing countries through the removal of remote work activities from developed countries to developing countries. The integration of youth population into the ICTs sector aims also to provide this segment with digital skills that will contribute in the future to open new horizons for them.

Overall, it is an upsurge sector that benefits from the geographical proximity to Europe, lower labour costs, and high penetration rate of mobile connections (both voice and broadband services). It has consolidated the competitiveness of telecommunications market, particularly the

mobile services. One of the sectors that is based and related to ICTs is offshoring, which is an important sector that driven the development of Moroccan economy. It has witnessed a huge amount of foreign investment. Moreover, it creates around 120.000 of new employments. Invest in telecommunication infrastructure attracts offshoring outsourcing activities. The commitment to develop the telecommunications network infrastructure stems from the aim of the government to stimulate the economic growth through the attraction of foreign investment by offshoring outsourcing. Business process outsourcing contribute 0,3% each year to GDP growth.

The above mentioned consequence of the development of telecommunication market, would hamper the immigration through opening new horizons for youth population and prepare the country to build up the basis of new economic tissue by creating an ICTs competitive sector capable to maintain high rate of economic growth. A virtual circle could be created in this case. The contribution of ICTs sector to GDP growth may enhance in somehow the propensity of the consumers to purchase higher telecommunications service quality, which in turns encourage the companies to upgrade their network and, consequently, create a reliable infrastructure that attracts foreign investment into ICTs sector. Moroccan government must double the effort to develop ICT sector, in order to encourage the population to purchase the broadband fixed service and reduce the incumbent market power. The development of next generation access network is entrenched to the competitiveness in the market.

iii. Economic analysis of the Morocco telecommunications market.

As we have mentioned above, developing countries experimented a huge diffusion of mobile services in detriment of fixed services. In this subsection, we will examine the relationship that exist between these two segments of the market. Despite the upsurge of mobile services, fixed infrastructure would never disappear, because mobile infrastructure also depends on it. Furthermore, new technological progress such as NGA by fiber connections is provided through fixed infrastructure. This raises the question of the relationship that have to exist between mobile and fixed infrastructure in order to enhance competitiveness and innovation.

In the beginning of the liberalization of the market, we should assume that an interaction between the evolution of the mobile technology and regulatory measures took place. Thus, the liberalization could have laid out the foundation of a rapid spread of the new technology, and vice

versa, the emergence of mobile services has increased the regulatory authorities' commitment to achieve their goals. However, the most interesting impact is how the mobile network affected the evolution of the fixed network. The relationship between these two technologies becomes explicit in 2002, when the mobile subscribers overcame fixed line subscribers (ITU 2003). Thus, in a decade customers' preferences moved to the mobile network from the fixed line network. This trend stems from the lower cost and rapid deployment of mobile infrastructure, which in turns spur the interest of new entrants to invest in it. Furthermore, in most of the African countries, included Morocco, the fixed line infrastructure has been controlled by the former state-owned company. As a result, the competitiveness was lower and private fixed line operators found it impossible to compete by lowering the tariff. Nevertheless, some countries where the penetration rate of fixed infrastructure was higher, tried to integrate both technologies in order to gain more market share or maintain its customers' loyalty in an attempt to stop the migration to other mobile competitors. In the 2012 OECD report, it is highlighted some forms of fixed and mobile networks complementarity. Indeed, fixed operators tried to adopt a dual mode to provide a single telephone service. This fixed and mobile networks complementarity consists of making VoIP calls from mobile through Wi - Fi or broadband access at a reduced tariff (OECD 2012). Thus, the aim of this tool of integration between fixed and mobile infrastructure was to encourage customers to use their mobile handset through the access to fixed infrastructure services and, therefore, impede the customers to link the mobile handset only to mobile infrastructure service. This strategy was implemented in the first decade of the XXI century, but it failed in most OECD countries, except France.

Mobile infrastructure is cheaper than fixed infrastructure which attract more consumers to the market. Thus, mobile technology is less sensitive to economies of density which encourage the entrants to reach remote areas and accomplish with universal services. These savings in costs contribute to the interest of regulatory authorities towards the relationship between mobile and fixed infrastructure. Therefore, the observed tendency is the replacement of fixed infrastructure with mobile one. The relationship between the two services is determined by several factors. In the demand side, if the costs of mobile services are lower, it may encourage low-income communities to get access to the mobile service, which was previously unaffordable. Therefore,

mobile services could have increased the penetration rate of telecommunication services helping to spread the use of this technology in low-income countries.

The OECD in one of its reports highlights the importance of competitive mobile infrastructure to enhance the spread of universal services. They state that in those markets where competition in both fixed and mobile networks is high, there are more prone to growth and innovation. However, this impact in relative high-income country is lower. Indeed, in such countries there is a higher penetration rate of the fixed market and thus, the access to mobile services would be encouraged to benefit from the added value that offer the mobile services connections. In this case, both technologies could be complementary. In general, fixed line services are related to fixed broadband technology, while mobile services are bundled with mobile broadband technology. Therefore, the veritable relationship between mobile and fixed infrastructure might be resumed by the interplay between fixed and mobile broadband technologies, as traditional voice services are becoming obsolete. This is raises the following question, does the relationship between mobile and fixed infrastructure determine the evolution of the penetration rate of broadband infrastructure? If the answer is positive, regulatory authorities should take into account the fixed-mobile substitution in order to establish the optimal framework to encourage the expansion of broadband infrastructure.

In what follows, I present three chapters containing the main issues discussed in this work. For this aim, I set up a model that assess the deployment of the NGA in the market. In addition, by using different data sources, I have conducted to studies assessing the evolution of the fixed and mobile Moroccan markets.

III. Description of the following chapters

In chapter 2, I analyse the overall evolution of the telecommunications market. I use concentration indexes to study the extent to which the market evolves towards a somehow competitive market. First, I focus in the fixed and mobile market. Second, I present an econometric study where socioeconomic indicators and microeconomic variables are used as determinants of the Herfindhal-Hirshman index. The main conclusion of this chapter is that the mobile market is the sector that has introduced competition in the telecommunications market. However, the fixed market remains almost monopolized in hands of the former state-owned company.

The situation in the fixed market motivates chapter 3, where I present an oligopoly model to investigate the access to the broadband market in the fixed sector. Indeed, the access to the broadband market is crucial to introduce dynamism in the sector because penetration rate is low. As new customers show interest in accessing fixed broadband connections, the market may reduce the concentration. One of the features that determines the evolution of this market is the new generation technologies (NGA), mainly fiber connections.

In the model, I assume that a new entrant may offer broadband connections by accessing the unbundled local loop or investing in NGA. An important feature in the model is that these two types of connections can be viewed as perfect substitutes when the affordability of the service is the main concern of the consumers. Overall, I found that the entrant competitor may find profitable to invest in NGA when the access fee to the local loop is higher enough and the fixed costs to deploy the new technology can be spread over a sufficient period of time. Moreover, consumer surplus is larger when the new entrant invest. Finally, this results strongly depends on the privatization decision of the state-owned company.

Chapter 4 is an assessment of the evolution of the mobile market, which is the most dynamic sector. In this chapter, I 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 and results of the econometric analysis have shed light on the degree of competitiveness.

The evolution of operators' competitive behavior during the period under study seems to be determined by the technology access, the regulatory body of rules, the evolution of the demand, and the level of privatization of the state-owned operator. As the technology is widely spread and the demand is continuously increasing, the only way to increase profits is to compete for attracting customers, which yields to lower prices. Indeed, as the market share increases off-net prices

decrease because the termination rates payment also decreases, yielding to overall lower prices. As long as all the companies follow this behavior, market power cannot be exerted largely, keeping operators' profitability in relative normal levels and thus, enhancing consumer surplus. Moreover, policy measures of privatization of the state-owned company, as well as market forces, such as the increase of the penetration rate, have incentivized companies to capture new customers contributing to become the market more competitive, especially with regard to prepaid programs.

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2. Evaluating competitiveness in the Moroccan Telecommunications sector thorough market concentration.

Abstract

We present a study of the Moroccan telecommunications market, discussing the evolution of market concentration thorough the liberalization process in the last two decades. Following the concept of relevant market and its application to the telecommunications sector, our study focuses on describing the main features of the fixed market, the mobile market, and the posterior introduction of broadband and mobile internet niches. We first present a study of market concentration by using the Herfindahl-Hirschman index (HHI, hereinafter). Secondly, we use the econometric model to analyze how the HHI is explained by socio-economic and market variables. Overall, we found that the liberalization process has been successful in the Mobile market, where the monopolistic situation of the state-owned operator has changed towards a somehow competitive market in both voice and the internet access markets. Nevertheless, the fixed market (voice and broadband access) remains almost monopolized by the semi-privatized state-owned telecommunications company. Moreover, we found a positive correlation between the development of competitiveness in the telecommunications market measured by the HHI and some socioeconomic variables, which may favour a further expansion of the GDP.

Keywords: Moroccan telecommunications sector, relevant market, fixed market, mobile market, market concentration, competitiveness.

JEL classification: D21, D22, L13, L40.

1. Introduction.

In this work, we study the functioning of the Morocco's telecommunications market. We start discussing the main aspects of its development in the last two decades, which has led to a liberalization and increased competition in the market. In this context, we then investigate the features of the fixed market and the mobile market focusing on the internet access thorough fixed broadband connections and mobile internet access.

The telecommunications market is a complex market that evolves continually over time, mainly due to technological improvements, which in turn influences strategic sectors; e.g., health, education, energy, etc, and, in general, the industrial sector. Moreover, the spread of the telecommunications facilities is closely related not only to sociological aspects, such as consumer preferences and social habits, but also to institutional aspects like the privatization decision of the state-owned telecommunications companies that might be present in a country.

There is a wide literature on telecommunications markets that analyses the evolution of the sector in the context of developed countries. Our purpose is to contribute to the literature by studying the telecommunications market in developing country, in Morocco. As in other developing countries, in Morocco there is a huge diffusion of the mobile market compared to fixed voice telephony and broadband market. Contrary to other countries where the incumbent remains under public hands, in Morocco the incumbent operator has been almost privatized, which induces changes in the competitive structure of the market. Indeed, the state may accelerate the privatization if it considers that the sale of its shares would contribute to balance its budget. In contrast, it could also delay the full privatization if the balance of its budget can be achieved through the turnover of its participation into the incumbent.

The evolution and expansion of telecommunications services is crucial for a continuous economic growth, especially for developing countries. In particular, there is a reciprocal relationship between economic growth and the deployment of broadband infrastructures (Word Bank, 2016). Lam and Shiu (2010) study the relationships between economic growth and the development of the telecommunications sector in different countries and regions of the world. They found that there is a bidirectional relationship between real gross domestic product (GDP) and mobile telecommunications not only in high-income countries, but also in developing countries. They also found that countries in the upper-middle income group have achieved a higher average total factor

productivity growth than other countries. In an endogenous growth model, Jerbashian (2015) shows that the market structure of the telecommunications industry may contribute significantly to long-run growth, suggesting that policies that increase the number of operators and promote competition imply higher innovative effort in the telecommunications industry, which in turns, enhances economic growth.

The competition among operators can be achieved by means of the privatization of the state-owned company and regulatory improvements in the telecommunications market. However, some regulatory measures like the concession of an exclusivity period, where monopoly power is exerted, may delay investment decision of new entrants. This strategy raises debate over its real effect on the market. Wallsten (2000) shows that the exclusivity period has a negative impact on the investments in the market, reducing the number of infrastructures deployed. Despite privatization, the dominant position of the incumbent in the fixed market has not undergone any significant change, whereas the mobile market is getting more competitive. Gebreab (2002) analysed the impact of privatization, among other factors, on the diffusion of the mobile market in Africa countries. He has shown that privatization fosters the competitiveness in the market. Furthermore, he outlined that the fixed lines segment is a complement to the mobile, and attributed this relationship to the positive externalities, where the increase of fixed lines subscribers has an impact on the upsurge of mobile subscription. Breen et. Al. (2013) consider that the process of privatization has to be disaggregated into different stages, rather than considerate it as a single transaction.

A proper privatization process may increase the attractiveness of the country for foreign investment with a considerable impact on the development of the telecommunications sector. Hung Lin (2008) mentioned the importance of foreign direct investment in telecommunications in earlier stages of privatization. He found that one third of private investment into the incumbent resulting from privatization is from foreign origin. This relationship was also corroborated by the findings of Foudeh (2015). Through an econometric study he found that the process of privatization of different sectors of the economy in Middle East and North Africa (MENA) countries over the period (1990-2008) was accompanied by the growth of investment coming from outside.

Moreover, Rossotto et al. (2005) investigates the impact that opening up telecommunications to competition may has in MENA.

Population is other factor that has an important impact on the evolution of the market. A country with a high percentage of rural population and low population density would delay the full privatization of the incumbent (Michalakelis et al. (2010). The intuition behind is that the state would be reticent to completely delegate to a private operator the provision of basic communication services in order to preserve the economic and social cohesion and reduce the digital gap.

In this vein, taking into consideration the complexity of the market and its differences across countries, we investigate the telecommunications sector in Morocco looking at the evolution of the fixed and mobile market contemplating socioeconomic factors and economic indicators as its determinants.

The Moroccan case is interesting due to a number of facts. First, this country has experimented a huge and continuous economic growth during the last three decades. Second, there has been deep sociological and demographic changes that have reduced inequality as well as an increase of the urban population (Bounoua et al. 2020). Moreover, the Moroccan economic development has overcame many of its neighbouring countries. Thus, it is interesting to study the extent to which these facts affect the development of the telecommunications sector. One of the goals of the Moroccan government is to reach the category of upper-middle income countries. To achieve this goal, Morocco is attempting to diversify its economy, focusing on high value-adding industries such as the telecommunications sector and, in particular, by enhancing the development of internet access through fixed broadband deployment and mobile internet connections. Nevertheless, despite this economic progress, the Moroccan telecommunications market is still below the broadband penetration rate in the MENA region on average, as Malouche et al. (2019) pointed out. They remark that the lack of an efficient regulation of this market segment as well as the underinvestment in fixed infrastructure are behind this problem. Concerning the mobile segment, it has reached a relatively high level of competitiveness, in particular since the entrance of the third operator (Amassaghrou et al. 2021).

In our study, we investigate the evolution of the telecommunications market through the market concentration and carry out an econometric analysis on its determinants using a dataset from

National Telecommunications Regulatory Agency and World Bank from 2004 to 2020. Overall, our results suggest that the liberalization process has been successful in the mobile market, where the monopolistic situation of the state-owned operator has evolved towards a competitive market at both, the voice and the internet access markets. Nevertheless, the fixed market (voice and broadband access) remains almost monopolized by the semi privatized state-owned telecommunications company. Moreover, we found a direct relationship between the development of the telecommunications market and socioeconomic factors, which may contribute to a further expansion of the GDP.

The rest of the paper is organized as follows. Section 2 presents a description of the telecommunications market in Morocco. In Section 3, we evaluate market concentration in the Moroccan telecommunications sector. In Section 4 we run the econometric model to study the determinants of market concentration. Section 5 concludes and gives some policy implications. The usual disclaimers apply.

2. Moroccan Telecommunications market: regulation, fixed and mobile market.

The telecommunications market has undergone profound changes due to the technological progress, which has led to downward trend of costs. It put in doubt the social benefit of the natural monopoly and the necessity to set up a regulatory framework in order to enhance a liberalization process. Indeed, a crucial feature in the evolution of telecommunications markets is the regulation. Literature on regulation measures in the telecommunications market is mainly focused on the analysis of its impact on the investment in fixed broadband infrastructure and the deployment of the mobile sector (in both voice and internet connections). In particular, developing countries have experimented difficulties in fostering competition in these markets that needs considerable investment expenditures. Moreover, the economic and political uncertainty in many developing countries makes difficult the deployment of new telecommunications technologies.

2.1 Regulation.

Regulatory measures in telecommunications markets come from the bottlenecks at the wholesale level (the network infrastructure). By relaxing these upstream bottlenecks, regulatory measures facilitate the development of competition in downstream markets (where competition takes place among different operators). Moreover, regulatory intervention in telecommunications is typically

justified upon the existence of an upstream natural monopoly, network externalities and high and non-transitory barriers to entry. Therefore, an analysis of competitiveness in the upstream market depends on the competitive conditions in the related downstream markets.

The main objective of the regulation in the beginning of the market liberalization was to promote the competition on the market giving access to new operators to the legacy network, as well as fostering the entry of new operators. The aim of these measures is to minimize the existing obstacles of free entry in the market, by reducing the cost of investments and the uncertainties underlying the investment in network infrastructure such as demand fluctuations, technological progress, and financial market constraints. The ladder of investment approach, proposed by Cave, 2006, contributes to the reconciliation between service based-competition and facility-based competition, which are considered substitutes. The former, allows the entrant to have access to incumbent´s infrastructure depending on its capacity of investment: the little capacity of investment, the lower level in the ladder achieved. The other option to enter the market is facility-based competition, where the entrant deploys its own entire infrastructure to compete with the incumbent. Another issue that arises when considering the deployment of new infrastructures is the digital divide that exists between sparsely populated areas and densely ones. In the context of developing countries, this problem is notorious, given the lack of developed infrastructures. The implication of the municipalities in the deployment of fiber could be the flagship of these initiatives. Moreover, municipalities could reduce the cost of investments through cooperation with operators or third parties in deploying infrastructure or leaving room for fiber in different works of digging. In Moroccan market, the municipalities are considered an obstacle to the deployment of broadband infrastructure in general (World Bank 2016). In sum, if the aim of the government is to enhance competition in both, the fixed market and the mobile sector, a proper regulatory body is the first step to set up the liberalization process.

As a response to the new challenges in the liberalization process, Moroccan authorities issued the law 24/96 1997. The main aspects of the law were the creation of two public companies, the telecommunications operator IAM (Etisalat Al- Maghrib), and the postal operator BAM (Barid al Maghrib), as well as the creation of the *Agence National de Réglementations des Télécommunication* (ANRT, hereinafter) the national regulatory authority of the Moroccan telecommunications market. The next step of liberalization was the partial privatization of the

state-owned operator IAM, selling 35% of the state´s equities to Vivendi group in 2001. The process of liberalization was gradual over two decades. By 2021 the Royal of Morocco still attain 21% of the total equities. During the last two decades, the other channel aiming at fostering competitiveness in the market was reducing the barriers of entry and allowing the entry of two new competitors.

By 2022, there are three operators in the market: IAM, MEDI (Medi Telecom), recently branded Orange, and WANA. MEDI arrived to the market in 1999 after being granted a global system mobile communications (GSM) license. It competes with IAM only in the mobile segment despite it was granted next generation network (NGN) license and 3G license in 2006. Indeed, MEDI has always favoured the investment in the mobile infrastructure at the expense of the fixed infrastructure. This propensity was also manifested when ANRT mandated the local loop unbundling in 2008, MEDI only made 200 requests to share the incumbent´s infrastructure. In 2015 it obtained 4G license. WANA joined the market in 2006 when it obtained 3G and NGN license. Unlike MEDI, WANA showed more interest in investing in the fixed infrastructure. WANA made more than 1300 request until 2016 in order to share the incumbent´s infrastructure. It acquires GSM license in 2009, and 4G license in 2015. The incumbent IAM still maintains its dominant position in the fixed market, both in the voice and broadband facilities (largely dominated by ADSL connections). This dominant position is the result of the competitors' choice which depends on demand and regulatory factors, discussed in the following sections.

The expansion and the development of the telecommunications market is due principally to the diffusion of the mobile market thorough the deployment of voice and internet mobile facilities. It can be considered a somehow competitive market, though concentrated, as we will see. This situation contrasts with the broadband market, which is considered a strategic asset for the economic growth. The inefficiency of the regulatory framework is mainly related to the broadband market. In this vein, all the reforms required by the World Bank are oriented towards the expansion of broadband infrastructure (Word Bank, 2016). The well-known regulation tool of the broadband market is local loop unbundling, which was established in 2008. However, the ANRT failed to implement and enforce it, which causes the market to stay monopolized by the incumbent and create a future imbalance between the operators in terms of fiber optic infrastructure deployment. The regulation of the legacy network allows the entrant to build a wide customer base and

increases its profits in order to overcome the uncertainties related to the investment in new infrastructure.

The lack of investment in the broadband sector is due to the high cost required to deploy the infrastructure, and regulatory framework plays a crucial role in this aspect. On the one hand, the regulation on the access to public property, both state - owned property (managed by the ministry of equipment, transport, and logistics) and municipality property (managed by the ministry of interior) was not clearly designed and harmonized. In most of the cases, operators complain of the abusive fees established by the municipality. On the other hand, there is the absence of private infrastructure providers as well as internet access providers. These providers have more expertise deploying broadband infrastructure and offering services to the client, which allows them to set up infrastructure at lower costs. Due to a lack of a legal framework, that regulates their entry and monitoring their performance in the market, these types of players did not enter the market. Unlike Morocco, many emerging countries, such as eastern European countries and Turkey, have encouraged these operators to enter the market, and their broadband penetration has increased. Finally, the FSU (the telecommunications universal service fund) created in 2005 as a public´s fund service to encourage the deployment of telecommunications, rarely meets its annual objectives, especially concerning the roll out of broadband infrastructure. The main function of this fund was to compensate the lack of investment in underserved areas where the investment is not profitable for the operators.

2.2 Fixed market

The incumbent operator IAM dominated the entrant WANA, except during the period 2008-2012, when it transitory has higher market shares. Since then, MEDI possesses almost monopoly power in both, the voice and the broadband market. As the voice market is a mature market, the challenge is to enhance competition in the broadband sector. Overall, the internet market is divided into the broadband market (ADSL and fiber) and internet mobile (3G, 4G and 5G). In the Moroccan market, total internet penetration rate is below 100%, reaching 82.9% in 2020 (ANRT, 2020). When we focus on the fixed broadband market, this percentage is even lower with only 6.16% of the total internet market. The profound changes in the Moroccan telecommunications market have not enhanced the evolution of the fixed broadband market, which is still dominated

by the incumbent that holds 99.91% of the market share in 2019. However, the internet mobile market is more competitive: the incumbent holds 39% in 2020.

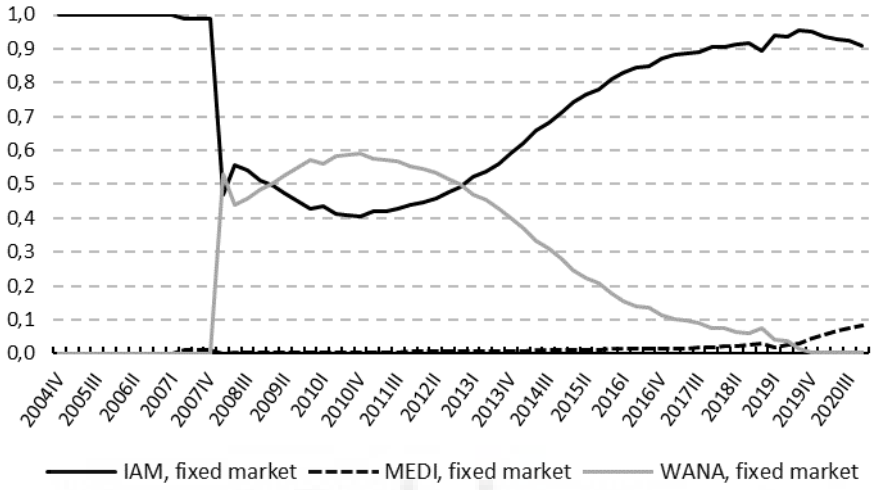
The low penetration rate of the fixed broadband market also featured a low-quality level. It is related to demand aspects, supply aspects and the regulation. Moreover, a weak regulation enforcement in fostering competition, discourage private and foreign investors to operate in the market and to deploy their own infrastructure (avoiding the necessity to rent the access to the incumbent radio spectrum licenses). Furthermore, the regulation authority could have encouraged other players to closely cooperate with the three active operators (a cross- sector synergy). However, the enforcement of the local loop unbundling, a necessary tool to improve the static efficiency, as well as a prerequisite for the dynamic efficiency, which is the long-term goal of the regulation (ladder of investment approach), has not been carried out successfully. The low demand constitutes an important factor of discouraging operators to invest. It already had a negative impact on the roll-out of the broadband infrastructure.

When it comes to the roll-out of the fixed infrastructure, operators prefer to deploy it in the urban areas where density of population is high, instead of rural areas. In 2019, 37% of the population live in dispersed and difficult access rural areas, which explains the low interest of the operators in investing in broadband connections (World Bank, 2020). Another aspect that has limited the expansion of fixed broadband infrastructure in rural areas is the low endowment of laptop and tablet devices. In fact, only 25.8% and 15.7% of rural population is equipped with laptop and tablet, respectively. Illiteracy rate, which is about 26.25%, is considered an important factor that hinders the diffusion of internet. It weakens the spread of the culture of digital skills being crucial for the deployment of broadband. The digitalization of the country enhances the diffusion of broadband infrastructure as well as the productivity of the industry. This procedure involves digitalization of public services, which strengthens the relationship between public administration and citizens, which can lead to a reduction in corruption.

Citizens and businesses being aware of the importance of digitalization would increase the demand for internet connections, in particular fixed broadband services. However, the business model of the three active operators focusses only on mobile services. The low demand for high-speed broadband slows down the investment and explains operators' preferences. Figure 1

reports the market shares of the three operators. One can see that the market is a duopoly where the market share of the third operator WANA is almost cero. Moreover, the partially privatized incumbent operator possesses a higher market share, which lead to the exertion of large market power.

Figure 1. Fixed market. Operators' market shares



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2.3 Mobile market

To some extent, Morocco reflects the patterns of telecommunications development in the African continent. The locomotive of the telecommunications development through the mobile diffusion is the increasing competition in the market. This is the result of the deep regulatory reforms aimed to enhance the liberalization process and huge demand increases over the last two decades. A number of studies have analysed the determinants of mobile services diffusion. Gebreab (2002) found that competition and digitalization have a positive impact on mobile diffusion, while the presence of a state-owned mobile operator has a negative impact. Gruber (2001) analysed the mobile diffusion in central and Eastern Europe. He found that the speed of mobile diffusion is positively linked to the number of operators in the market, the size of the deployment of fixed lines, and the length of waiting list. He concludes that the driving forces of mobile diffusion are competition, digitalization, institutional aspects, demand, and GDP per capita. Moreover, these factors do not have the same impact in different countries. Chavula (2013) investigates the impact of telecommunications penetration on per capita income growth, as peoples' living standards, in 49 countries of Africa. The overall results indicate that, according to the 2008 World Bank

classification criteria, fixed and mobile voice services and the Internet usage have a significant impact on growth in the upper-middle-income countries, whereas only the mobile penetration has a significant impact on growth in both the upper-low-income and the low-income countries in Africa.

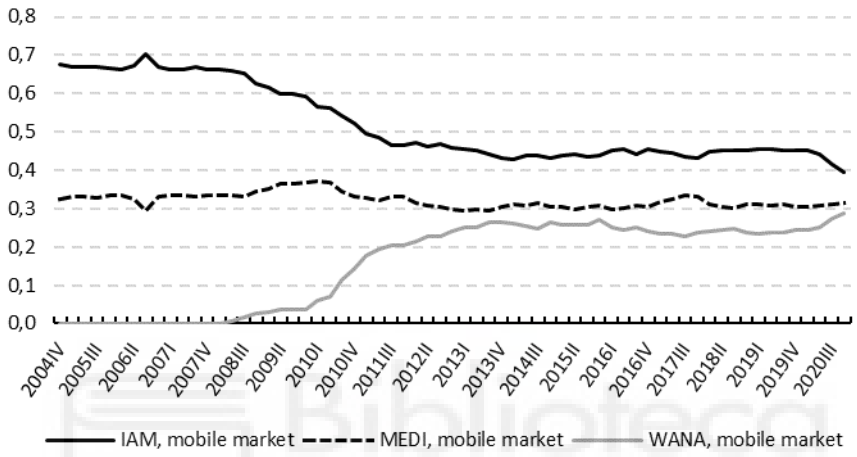
In the Moroccan market, the wave of undertaken reforms to accomplish the liberalization of the telecommunications sector has led to the expansion of the mobile services, which is illustrated by the huge increase of the mobile penetration rate going from 34.23% in 2004 to 137.47% in 2020 (ANRT 2020). This high penetration rate has allowed the telecommunications services to reach customers in remote areas, where fixed lines are difficult to expand due to the lack of infrastructures and the high fixed costs. Competition among operators has played a significant role in this expansion. Between 2004 and 2008 the mobile sector was a duopoly, were the incumbent operator held 66% of the mobile market share, while MEDI controlled only 33% (ANRT, First quarter 2008 release). Since 2008, when operator WANA has joined the market, it continuously increases its market share, while the incumbent has gradually lost it. By 2015, IAM held 42% of the market, WANA 25%, and MEDI 31%. In terms of market share, the passive behaviour by MEDI to the presence of the third operator raises different explanations. There could be a tacit agreement between MEDI and IAM or between MEDI and WANA. Instead, the management model of MEDI is such that it does not react to the increase of the penetration rate due to the arrival of new costumers. It also seems that MEDI gets behind its customers´ loyalty rather than seeking other ones.[1]

In the Moroccan market, the main driver of the mobile diffusion is the widespread modality of the prepaid subscriptions because of a large percentage of the low-income population found mobile services affordable. Indeed, prepaid average revenue per minute (ARPM) is lower than postpaid subscriptions revenue. Furthermore, in the Moroccan market there are sales promotions over 300 days per year that incentivize the consumption of this consumers' segment. Over the period 2004-2020 the percentage of prepaid costumers has slightly decreased reaching 89% in December 2020 (ANRT, Fourth quarter 2020 release). The institutional aspects also contribute to the spread of mobile services, namely the termination rate, which is a tool for regulatory agency to boost the

[1] For a detailed study of the evolution of operators' market shares in the mobile market see Amassaghrou et al. (2021).

competitiveness. The termination rate has experienced a considerable decline over the period 2010-2012. The drop of termination rate has led to the fall of prices increasing competitiveness among operators and, thus, benefiting consumers. Figure 2 stands for the market shares in the mobile sector. Contrary to the fixed sector, mobile operators have reached a high level of competitiveness, which contributes to the current expansion of the mobile connections in the country.

Figure 2. Mobile market. Operators' market shares



Source: own elaboration.

A further development of the Moroccan telecommunications market strongly depends on the mobile services. The business model of the two new operators is mostly based in this market. However, the mobile segment has been saturated: the penetration rate is no more growing, and the prices have decreased almost to marginal costs. An expansion opportunity may be linked to a further spread of the broadband connections (both ADSL, and next generation access technologies). Moreover, the operators would offer bundling products (voice and internet mobile connections plus fixed voice service) making consumers reticent to exclusively contract broadband services over the fixed line protocol, which are considered unaffordable by most consumers in the Moroccan market.

It is also well recognised in the literature related to bundling that offering bundle products to consumers lowers the price-sensitivity of consumers. It is worth saying that bundling products are prohibited, because the incumbent abuses of dominant position in the fixed market. Hence, a prerequisite to introduce fixed-mobile bundles would be to introduce competitiveness in the fixed

market. In other way, bundled commercial offers would harm the competitiveness in the whole market intensifying the incumbent´s market power.

3 Analysis of the market through market concentration

Market definition is one of the analytical tools that competition authorities use to examine and evaluate competition problems. The most used instrument to set market definition is the Small but Significant Non-Transitory Increase in Price (SSNIP) test. It was first set out in 1982 within the US Department of Justice Merger Guidelines. It seeks to identify the smallest market within which a hypothetical monopolist could impose a small but significant and non-transitory increase in the price of a good (usually a price increase of 5% for at least 12 months).[2] Once the relevant market is defined, competitors' market shares are used to calculate concentration measures in order to evaluate market power, merger processes, and abuse of dominant position.

The relevant market includes all those products that the consumer regards as sufficiently interchangeable or substitutable to prevent a price rise. Indeed, the ability of an operator to increase prices strongly depends on the demand substitution, supply substitution and potential competition. According to the European Commission *Notice on the Definition of the Relevant Market*, demand substitution is usually regarded as the most important competitive constraint affecting firms (EU-Lex, 1997). The second competitive constraint that operators face is supply side substitutability, which refers to the ability of other operators to switch production to become its products relevant in the short term. It could be carried out without incurring into significant additional costs or risks in response to small and permanent changes in relative prices. This implies that operators producing substitutes have the necessary production facilities and the technological expertise. Finally, potential competition refers to a threat of entry that either takes place in the long term or that involves substantial fixed (and sunk) costs. In the latter case, potential entrants may not respond to small but significant price increases because given the

[2] The SSNIP test defines the market as the smallest set of substitute products, such that a substantial (usually, five or ten percent) and non-transitory (usually, one year) price increase by a hypothetical monopolist would be profitable. Starting from a set of candidate products for the relevant market, the SSNIP test simulates a price increase above the competitive level by a hypothetical monopolist who owns only one product. As long as that leads to losses in profits, the test progressively increases the number of products owned by the monopolist. When the hypothetical monopolist does not estimate profits to decrease following an SSNIP, the set of products owned by the monopolist in the last simulation constitutes the relevant market.

irreversible investment incurred, they are committed to enter the market. Potential competition does not take place immediately, so that it is not taken into account when defining markets. It becomes important when competition authorities assign market shares to the companies present in the relevant market.

Network infrastructure usually is under the property of a reduced number of providers (eventually a state-owned operator), so that new entrants have to access the local loop. Accordingly, to give access to new competitors, the regulatory authorities oblige the incumbent(s) to unbundle the local loop. This is the case for ADSL connections. Local loop unbundling (LLU, hereinafter) can be partial or total. Usually, entrant operators request to access partial LLU because it is possible to offer fixed voice facilities by Voice under internet Protocol (VoiP). When an entrant operator requests to access total LLU, it is possible to offer voice facilities by using the traditional narrowband, whereas the broadband is occupied just to offer ADSL connections. The case of mobile connections by mobile cellular phones is different. It does not use a local loop. A customer may get access to internet by subscribing a contract, which includes voice calls and an amount of capacity (megabytes) to navigate in the internet network. Indeed, in telecommunications markets many services are consumed in bundles. Thus, the complementarity between retail products and services affects the market definition. Services in a bundle may be substitutes, such as internet mobile and fixed broadband services, complements (calls need to get access to the network in the fixed market), or can be consumed independently (as is the case with broadband and voice telephony). With respect to market definition, bundles of substitutes do not pose any particular problems. When dealing, however, with complements, which have exact opposite properties or products that can be consumed independently, competition and regulatory authorities need to consider whether the relevant product market should be defined at the aggregated level of the bundle or at the level of its individual elements.

In our approach, we begin from the most strictly market definition (independent services). Accordingly, we consider fixed voice facilities, broadband services, mobile calls and internet mobile. Secondly, when we introduce complementarity and substitutability, it is possible to define two bundles of services or clustered markets: the fixed network and the mobile network, giving access to fixed calls and broadband services, and mobile calls and internet mobile, respectively.

Markets, where consumers demand and producers supply a set of distinct products jointly, are known in the literature as cluster markets.[3] Cluster markets exist because the complementarities of individual components of a bundle, which arise when economies of scope in the production lead to lower transaction costs for the consumer. The fact that complementary products are demanded and provided in bundles does not therefore change the basic principles of market definition.[4] Finally, we broadly consider the whole telecommunications market, where the fixed network and the mobile networks are assumed to compete within the same market. These three approaches give us the opportunity to study the evolution of competition depending on the market definition approach. Moreover, from a policy perspective, regulatory authorities may be interested in studying separately the fixed and the mobile markets, figuring out a complete assessment of the evolution of the telecommunications market.

3.1 One-way substitution: from fixed to mobile services

The existence of one-way asymmetric substitution in the process of defining the relevant market is crucial in telecommunications markets. One-way substitution is defined when customers switch from low to high capacity networks and services, but not the other way around. Fixed to mobile substitution has important implications for regulatory authorities and antitrust agencies. Where fixed and mobile networks (voice and broadband) are likely to converge the authorities need to review the extent to which the two networks compete because it affects regulation and antitrust investigations in abuse of dominance and merger cases.[5]

Most of national regulatory authorities in Europe, after examined the extent to which fixed and mobile services can substitute each other, found that such services belong to separate retail markets. In particular, BEREC explains that such a conclusion is reached given: (i) "the existence

[3] The concept of 'cluster markets' was first used US by the US Supreme Court in United States v. Philadelphia National Bank.

[4] See European Commission (2002), Market Definition in the Media Sector – Economic Issues, Report by Europe Economics.

[5] For example, in December 2006, the Federal Communications Commission (FCC) approved a merger between two large US fixed-line operators (AT&T and BellSouth). The FCC found that the transaction was unlikely to have anti-competitive effects on the mass market for voice telephony because neither of the parties was at the time or was likely to become over time active in the market outside of its own region. However, the FCC also added that the rapid growth of intermodal competitors – from cable telephony, mobile wireless service providers as well as providers of certain VoIP services was likely continuing to provide end-users with viable alternatives (Federal Communications Commission, 2007).

of different characteristics between fixed and mobile offers (e.g., differences in price, bandwidth, mobility and usage limitations); and (ii) the existence of different preferences and different usage patterns between fixed and mobile services users" (BEREC, 2011).

In the fast evolution of the telecommunications sector, emerging services such as VoIP can effectively constraint behavior of the market players and thus affect the market definition concept. In cases when such services are considered by end-users as potential substitutes for traditional telecommunications services, they may have a considerable impact on the delineation of the precise boundaries of relevant markets. Given the progressive migration from the traditional telecommunications network to IP networks, regulatory and competition authorities, need to correctly assess the potential competitive constraints imposed by VoIP or other emerging services in order to properly delineate the relevant markets in IP environment.

3.2 Impact of bundled offers on wholesale markets

Determination of whether products are components of a single product or are in fact separate products in two different markets is by no means an easy task. The BEREC Report on impact of bundled offers in retail and wholesale market definition states that when a large portion of consumers purchases products in bundles, it may be appropriate to define a market as a bundle. However, consumers' behavior does not provide itself sufficient evidence on the suitability of market definition. As there are increased concerns about transparency and potentially anti-competitive impact of bundled offers, it is necessary that competent authorities have adequate information gathering powers.

If a regulatory authority concludes that a bundle, and not its individual elements, constitutes a relevant market, then there is a special need to analyze the impact it may have on the definition of the relevant upstream market, and in particular whether it may be appropriate to define a wholesale market for bundles. In order to secure a sufficient level of competition, it is essential that enough players have the ability to provide bundled offers to end-users. If alternative operators cannot access a relevant wholesale input, the owner of that input will be in a position to exert significant market power, and also to leverage market power into the adjacent markets. When

considering whether a wholesale market should also be defined as a bundle, competition and regulatory authorities may adopt the same analysis that is used during the delineation of retail markets.

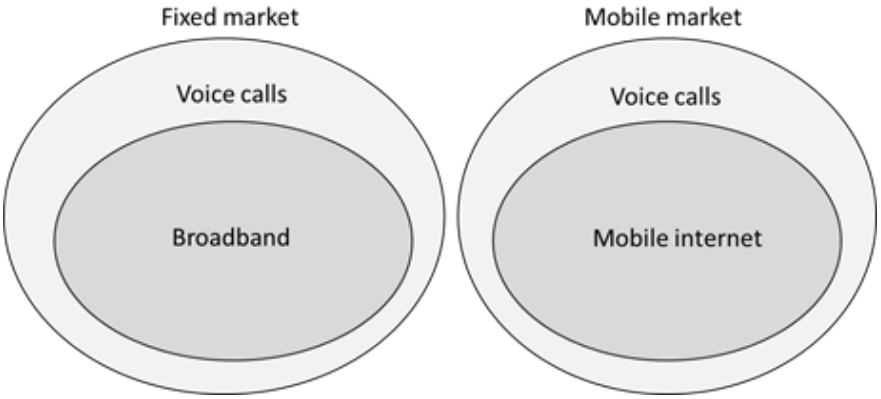
3.3 Analysis of market concentration

In this subsection, we present the analysis of the telecommunications market in Morocco by using market concentration. We want to study the extent to which the market can be considered competitive after the liberalization process started two decades ago. We collected data from the third quarter of 2004 to the last quarter of 2020. To do so, we first divide the market in order to determine how competitiveness in these markets may determine the overall competition in the general market. Based in the above discussion about market definition we have identified the market architecture presented in Figure 3. Accordingly, there are two differentiated markets within the telecommunications market, namely the fixed and the mobile market. Moreover, there are two types of submarkets in each of them. The fixed market already contents the fixed voice calls and the broadband access. As operator companies require an active fixed line to offer broadband services, this market can be considered as a submarket of the former ones. Regarding the mobile market, it can be distinguished the voice calls market and the internet mobile market. The latter already needs a mobile connection to offer the service, so this is a submarket of the voice calls market.[6] Taking these four markets separately, we first report market concentration according to the Herfindahl-Hirschman Index (HHI, hereinafter). It is important to note that, no matter consumers have access to both markets, these networks are considered independent infrastructures. Indeed, a household that usually is formed by more than one member has a fixed line connection and, in addition, each of its members already maintain a mobile subscription. Moreover, the subscription of both services are not substitutes because both services have different uses, as we claim in the discussion above. Finally, inside each market (either fixed or mobile), the voice service is independent from the internet access, and the connection to voice services may or may not include broadband and internet access, respectively. Once again, they are in fact different markets although voice connection is needed to get access to internet

[6] Although it is possible to subscribe to a different operator to get internet mobile access, in practice consumers prefer to subscribe the same mobile operator for voice and internet facilities.

services. Accordingly, the number of consumers in the voice market is always larger than that in the internet market (both, in the fixed and the mobile market).

Figure 3. The telecommunications market.



3.3.1 Evolution of competition of voice and internet services in the fixed and mobile markets

We use the well-known Herfindahl-Hirschman index, HHI, commonly used in industrial organization to study market power.[7] The HHI stands for the percentage of the sum of squared market shares of all operators in the industry, giving more importance to those operators with the largest market share MS_i. In our setting, we define,

$$HHI_t^{hk} = \sum_{i=1}^{N} (MS_{it}^{hk})^2, \quad 0 < HHI_t^{hk} < 1.$$

where MS_{it}^{hk} stands for the market share of each operator i at period t in each market h and submarket k, being $i = \{IAM, MEDI, WANA\}$, t indicates each quarterly observation since 2004 to 2020, $h = \{fixed, mobile\}$, and $k = \{voice, internet\}$. The value of HHI_t^{hk} ranges from 1/3, when the three operators capture the same market share, up to one, as in the case of a dominant company or pure monopoly. Figures 4 and 5 report the evolution of the HHI_t^{hk} over the period under study for each submarket within the fixed and mobile markets.

[7] 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. Concentration indexes based on Hannah and Kay features the general form $HK(\alpha) = \sum_{i=1}^{N} MS_i^{\alpha}$, $i = 1,2,..N$, where *N* is the number of operators, MS_i is operators' market share, and $\alpha \geq 1$.

Figure 4. *HHI* Fixed market: Voice calls and broadband

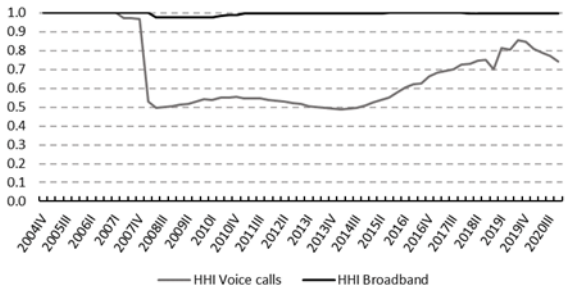
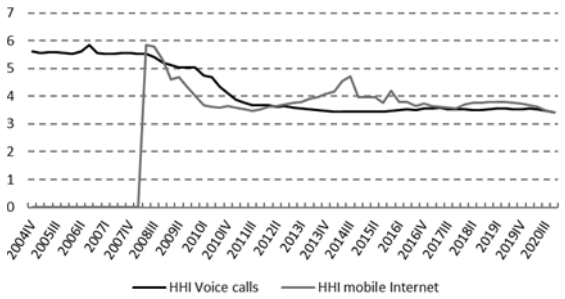


Figure 5. HHI Mobile market: Voice calls and mobile internet



Source: own elaboration.

Overall, one can see that the fixed market is more concentrated than the mobile market. Moreover, in the mobile market, both voice calls and internet mobile follow a similar evolution. This is because the implementation of the internet access favors bundling services subscriptions of voice calls and internet mobile. Moreover, as the market has three operators, the lower bound threshold is 0.33, so we can say that in the mobile market the dynamic of competition achieves less concentration, benefiting consumers.[8] Contrary to this, in the fixed market the long-run trend of the HHI index seems to be positive, which suggests that the regulatory measures and other market determinants do not favors competitiveness. In particular, the broadband access is almost monopolized by the incumbent operator IAM, whereas voice calls also present a higher concentration (see Figure 1).

3.3.2. Evolution of competition in the fixed and mobile markets

In order to conduct the study of market concentration in each market we need to construct a HHI_t^h for each market and the aggregate ones HHI_t^A, which we will use in subsection 3.3.3.

Definition 1. $HHI_t^h = \sum_i (MSh_t^k \cdot MS_{it}^{hk})^2$.

Definition 2. $HHI_t^A = \sum_h \sum_k \sum_i [MSh_t (MSh_t^k \cdot MS_{it}^{hk})]^2$.

The variable MSh_t^k is the market share of each submarket k in each market h for each quarterly observation (subscriptions in submarket k over total subscriptions in market h). Finally, MSh_t is the aggregate market share of each market h at each quarterly observation (subscriptions in market h over total subscriptions by adding both markets). Notice that, although a given customer

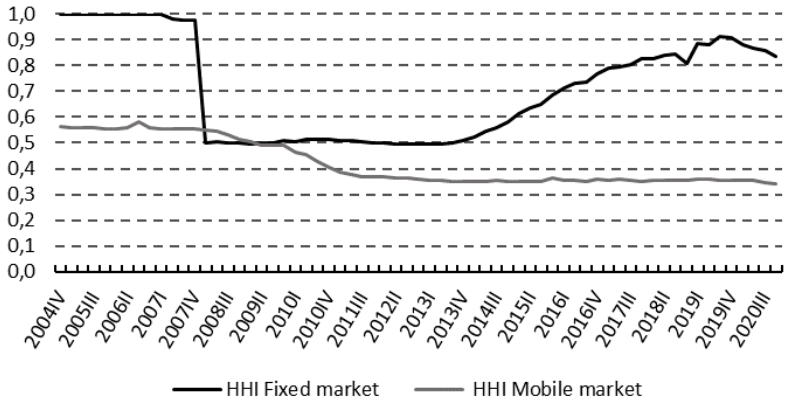
[8] A detailed study of the mobile market can be found in Amassaghrou et al. 2021.

may have both fixed and mobile connection, these markets can be studied separately because they satisfy different consumers' preferences. Moreover, a customer having a fixed connection share it with the rest of household members. Thus, our aggregations implicitly assume that each submarket captures a proportion of the total subscriptions of the telecommunications sector and their weight must be pondered accordingly. The metric of our HHI measures accomplish the following properties:

1) $\sum_k (MSh_t^k) = 1$, for each market h.
2) $\sum_h MSh_t = 1$.
3) $\sum_k \sum_i (MSh_t^k \cdot MS_{it}^{hk}) = 1$, for each market h.
4) $\sum_h \sum_k \sum_i [MSh_t (MSh_t^k \cdot MS_{it}^{hk})] = 1$.
5) If the three operators have $1/3$ of the market each (i.e., they have equal market shares), no matter the weight each market has in the telecommunications sector, HHI_t^k, and HHI_t^A get the lower bound value 0.333.
6) If there is a monopolist in the telecommunications sector, HHI_t^k, and HHI_t^A get an upper bound value of 1.

Figure 6 stands for the evolution of HHI_t^k. One can see that the mobile sector is largely procompetitive compared to the fixed sector. Accordingly, during most of the periods we observe $HHI_t^F > HHI_t^M$. It may come from the aggressive behavior of the operators in the internet mobile sector, where there are opportunities to expand the market as the deployment of networks reaches remote areas and the income of population increases. However, the lack of competition and the closer substitution between fixed and mobile connections made less attractive fixed broadband connections. The decrease of HHI_t^F in the last periods coincides with a higher competition to capture customers demanding fixed voice calls, but the broadband sector remains uncompetitive. The increase in customers in the fixed market already comes from the increase of urban population. Finally, except some quarters during the years 2007 and 2008 (where the release of the broadband service favored welcome packages at lower rates), the broadband market has been highly anticompetitive. On the other hand, in the mobile sector, HHI_t^M almost approaches 0.33, denoting that the sector is competitive. Further expansions of this sector should include a fourth operator, but it depends on the evolution of the demand and the entry barriers, which in turns depend on the regulatory body.

Figure 6. HHI Fixed and Mobile markets

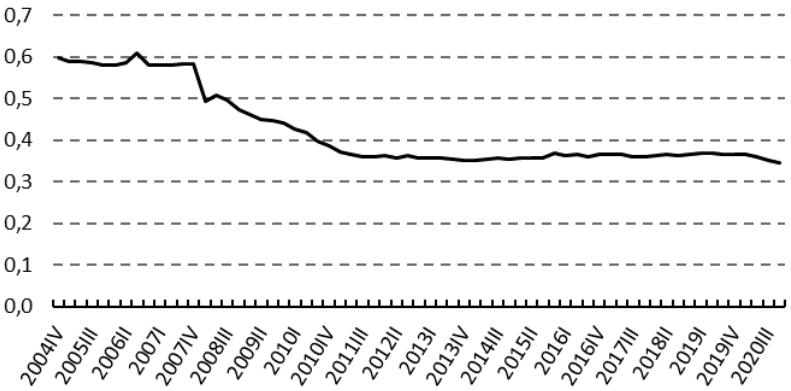


Source: own elaboration.

3.3.3 Evolution of the aggregate market.

When we consider the aggregate telecommunications market, it is notorious that the mobile sector introduces a dynamic trend towards a competitive situation. Indeed, as one can see in Figure 7, the HHI^A is somehow flat at levels approaching $1/3$, no matter the high concentration of the fixed market. The amount of mobile subscribers make that the market share of the fixed market is low enough and, accordingly, the influence in the overall evolution of the ratio is not so important. It means that the incentives to invest for the operators active in the market is biased towards the mobile market and, in particular, to the internet mobile segment. As we already pointed out in the previous section, further improvements in the competitiveness of the telecommunications market have to include a regulatory reform that incentivize active operators to invest in the fixed market.

Figure 7. Aggregate HHI



Source: own elaboration.

Incentives to invest are crucial to enlarge the market. In this sense, the next subsection is devoted to investigate how the profitability of the mobile market can influence the decision to invest and to enter the market.

3.4 Incentives to invest and enter the market

Here we focus on the extent to which an operator has the incentive to invest in the fixed or mobile market and the extent to which a new operator is willing to strategically enter the telecommunications sector. An interesting approach is to consider which market is more attractive in order to invest. As we have seen, the mobile market is the most dynamic market. In particular, within the mobile market, the access to internet from cellular devices is in continuous growth (ANRT, 2020). Indeed, the penetration rate in growing and accordingly operators attempt to capture new customers, whereas the penetration rate of voice calls is stabilized around 120%. Contrary to this, the fixed market is almost a monopoly and thus, the former state-owned operator IAM, now partially privatized, dominates the internet access thorough broadband. In this environment, incentives to invest prevail in the mobile internet market. In this vein, we want to know the likelihood that a given consumer has an internet connection (either by broadband or by internet mobile). Moreover, knowing that a consumer has internet connection, it is useful to know for actual and potential operators the likelihood that this connection comes from a mobile device (the posterior probability).[9] This, as the probability of having internet connection increases, the incentive to invest in this facility increases. Moreover, as the likelihood of that internet facility comes from the mobile market, the incentives to invest (or enter the market) in the mobile sector increases. The likelihood of have internet access ($internet$) is,

$$Prob_t(internet) = \sum_h Prob_t\left(internet/_h\right) \cdot Prob_t(h),$$

where $Prob_t\left(internet/_h\right) = MSh_t^{internet}$, and $Prob_t(h) = MSh_t$. The likelihood of that internet connection comes from a mobile device (the posterior probability) is,

[9] The posterior probability is the likelihood that an event will take place after a set of background information has been considered.

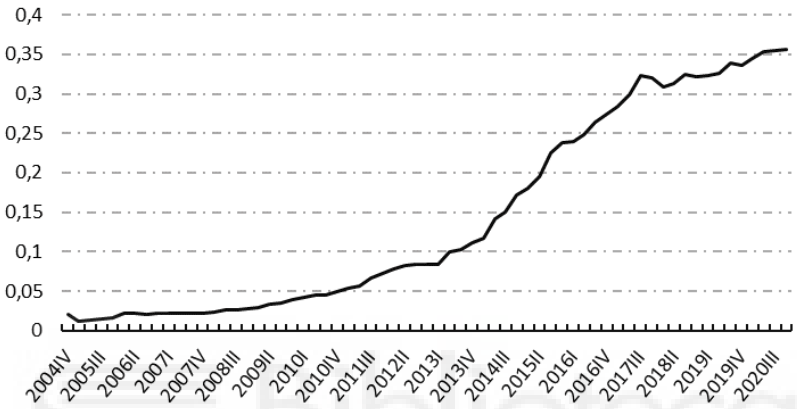
$$Prob_t\left(mobile/_{internet}\right) = \frac{Prob_t\left(internet/_{mobile}\right) \cdot Prob_t(mobile)}{Prob_t(internet)},$$

whereas the likelihood that this connection comes from a fixed line (broadband access) is

$$Prob_t\left(fixed/_{internet}\right) = 1 - Prob_t\left(mobile/_{internet}\right)$$

Figure 8 reports the evolution of the likelihood of having internet access, $pr_t(internet)$ for the period under study.

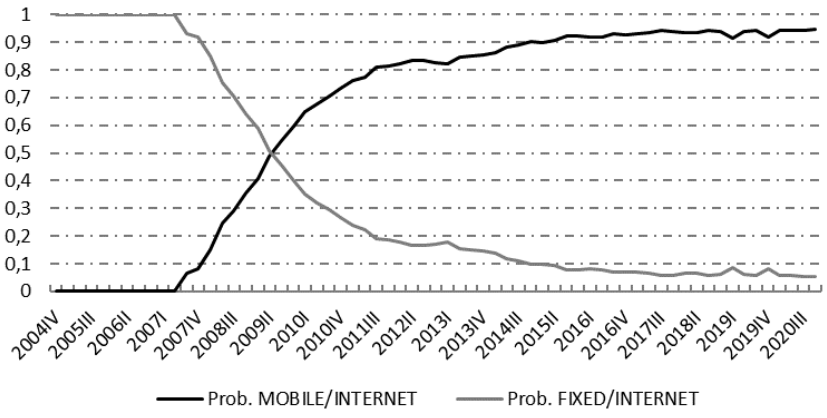
Figure 8. Probability of having internet access



Source: own elaboration.

One can see that the probability of having internet connection increases during the period. However, in last observations the slope of the trend becomes flatter, which may indicate that it is needed further investment in this technology in order to increase the penetration rate. Moreover, when we focus in the posterior likelihood (Figure 9), one can see that the positive evolution of the mobile access contrasts with the negative trend of fixed broadband.

Figure 9. Prob. of mobile and fixed connection, taking internet access



Source: own elaboration.

It means that there is a strong incentive to enter in into the mobile market and, in particular, to invest in the deployment of mobile internet connections, where the probability to attract customers is very high. Another implication is that the monopoly situation in the fixed market does not contribute to a further increase of competitiveness in the broadband submarket. Thus, it calls for attention to the regulatory authorities to enhance legal measures aimed to decrease entry barriers. The next section goes further in the analysis of the determinants of the HHI in the fixed and mobile markets as well as in the aggregate telecommunications sector in Morocco.

4 Data and methodology

In this section, we empirically study the extent to which the market concentration is affected by a number of socioeconomic factors as well as microeconomics features of the market. The analysis of the telecommunications market is subject to the data availability and the market-specific characteristics. In the case of the Moroccan mobile market, data is limited. As primary source, we use the database from the annual reports and statistics of the National Telecommunications Regulatory Agency and development indicators database from World Bank, as a secondary source. We first report the descriptive statistics of all the variables we gathered, such that our data on quarterly basis cover from the third quarter of 2004 to the last quarter of 2020. Then, we run the econometric model to analyze the market concentration at its aggregate level and disentangling it by fixed and mobile submarkets.

4.1 Descriptive statistics

The descriptive statistics of the variables provided in this section are number of observations, mean, median, standard deviation, minimum and maximum values, and coefficient of variation, The variables listed in Table A are split into panels. Panel A, called *Micro,* includes socio-demographic and macroeconomic indicators, whereas Panel B, called *Macro,* provides variables related to microeconomic indicators that characterize the market from the regulatory authorities and those which come from market competition as well as the probabilities of occurrence of an event. The variables marked in bold are used in the next section of the econometric analysis.

4.2 Econometric analysis

In this subsection, we present an econometric analysis to study the determinants of the market concentration according to the Herfindahl-Hirschman Index, HHI, at aggregated and

disaggregated levels as defined in Section 3.3. To this aim, we run multiple linear regression models using variables in bold listed in Table A. To avoid multicollinearity problems in the estimation process, the selection of the explanatory variables from the Table A has been carried out considering the linear relationship among these variables, which arise from their definition and construction.

Table A. Summary statistics.

	N	Min	Mean	CV	Max	Std. Dev.
PANEL A (Macro)						
Socio-demographic and macroeconomic indicators						
Population	65	30115196	33506238	.062	36910558	2073842.8
Population ages, 0-14.	65	9206301	9485579.4	.025	9880215	237710.14
Population ages 15-64.	**65**	**18996139**	**21874678**	**.072**	**24222688**	**1569020.7**
Rural population	**65**	**13460542**	**13575751**	**.003**	**13659048**	**47072.629**
Education	**65**	**.857**	**.931**	**.042**	**.992**	**.039**
Labor force	65	10499891	11507471	.038	12084530	438887.11
Unemployment rate	**65**	**.089**	**.095**	**.058**	**.11**	**.005**
GDP per capita (constant US$)	**65**	**1952.903**	**2465.691**	**.082**	**2694.079**	**201.757**
GDP per capita, PPP (constant US$)	65	5120.826	6550.785	.108	7537.485	704.691
Access to electricity	**65**	**.782**	**.928**	**.075**	**1**	**.069**
Final consumption expenditure (constant US$)	65	4.814e+10	7.021e+10	.172	8.734e+10	1.207e+10
Households and NPISHs Final consumption*	65	3.679e+10	5.347e+10	.17	6.680e+10	9.069e+09
PANEL B (Micro)						
Microeconomic indicators						
Tariff LLU, total	65	0	5.849	.565	10.223	3.305
Tariff LLU, partial	**65**	**0**	**2.552**	**.553**	**5.301**	**1.41**
Degree of privatization	65	.34	.682	.106	.78	.072
Pen. Rate fixed market (households)	**65**	**.148**	**.271**	**.39**	**.466**	**.105**
Pen. Rate mobile market	65	.312	1.012	.327	1.375	.331
Fixed lines**	65	283186	412944.26	.17	525752	70112.277
MS fixed market	65	.045	.085	.371	.141	.032
WANA fixed voice calls	65	0	.303	.873	.667	.265
MEDI fixed voice calls	65	0	.021	1.457	.141	.03
IAM fixed voice calls	65	.328	.676	.374	1	.253
WANA Broadband connections	65	0	.002	1.597	.008	.002
IAM Broadband connections	65	.988	.998	.004	1	.004
MS mobile market	**65**	**.859**	**.915**	**.034**	**.955**	**.032**
WANA mobile voice calls	65	0	.155	.726	.282	.113
MEDI mobile voice calls	65	.28	.329	.065	.376	.021
IAM mobile voice calls	65	.394	.515	.203	.705	.105
WANA mobile internet	65	0	.238	.809	.74	.193
MEDI mobile internet	65	0	.214	.599	.437	.128
IAM mobile internet	65	0	.333	.62	.587	.207
Concentration indexes						
HHI, aggregate	65	.345	.422	.216	.608	.091
HHI fixed market	65	.493	.712	.28	1	.199
HHI mobile market	65	.34	.422	.208	.584	.088
Probability of occurrence of an event						
Prob. of having internet connection	65	.012	.143	.876	.356	.126
Prob. of internet connection having mobile int.	**65**	**0**	**.642**	**.568**	**.945**	**.365**

*NPISH: Non Profit Institutions Serving Households. **We use the number of fixed lines, excluded households, as a proxy of the number of firms active in the market.

4.2.1 Aggregate telecommunications market

We specify the econometric model on the determinants of the aggregate HHI_t^A for the period under study as follows,

$$HHI_t^A = \alpha + Macro_t \cdot \beta_1' + Micro_t \cdot \beta_2' + \varepsilon_t. \qquad (eq.1)$$

The subscript $t = \{1,2,..,65\}$ stands for the time dimension in quarters of the year from 2004IV to 2020IV. The parameter α captures the constant part of the model, while vectors $\beta_1{}'$ and $\beta_2{}'$ are the parameters that represent the relationship between the independent variables grouped into *Macro* and *Micro* variables, respectively, with the dependent variable HHI_t^A. The vector *Macro* includes variables as Population ages 15-64, Rural population, Education, Unemployment, GDP per capita, and Access to electricity. While variables Tariff LLU, partial, Pen. Rate fixed market (households), MS mobile market, and Prob. of internet connection having mobile int. are regressors included in the vector *Micro*.

The Ordinary Least Squares estimated coefficients of the multiple linear regression model are presented in Table B. We run the model $(eq.1)$ to analyze the estimates of different sets of regressors, which are *Macro*, *Micro* and all regressors in the specifications, 1, 2, and 3 respectively. Adjusted R-squared is reported at the bottom part of the table to track how the variability of our dependent variable is explained by the variability in the explanatory variables that we use across different specifications of the model.

The estimated coefficients of *Macro* variables from the Table B in specification 1 show statistically significant and robust negative association of unemployment rate, GDP per capita, and population ages 15-64 with the aggregate concentration index. These results suggest that as population being from 15 to 64 years old and GDP per capita increase, the aggregate market concentration decreases and induces greater competition where the operators behave more aggressive in capturing customers. Moreover, the indirect relationship between these variables and concentration index, that seems counterintuitive, can be explained by a business stealing effect as follows. When the population loses the income or it decreases, people adjust their budget migrating from their fixed subscription to the mobile market where subscription prices are low because of a high competition in this market. While the positive relationship between the aggregate concentration index and education suggests that as the education increases, the quality and the low prices of telecommunications subscriptions are more demanded by well-

informed people. Regarding *Micro* variables in specification 2, we observe that all variables except the Tariff LLU partial, show statistically significant and robust negative association with the aggregate concentration index. The increment in Tariff LLU partial leads to the crowding out effect towards mobile market because fixed tariffs increase for the private companies and the partially privatized state-owned operator has no incentive to cut the prices. The negative impacts of the penetration rate and the market share of the mobile market on the market concentration is straightforward, as when the number of customers increases, the competitiveness also increases leading to further decreases in market concentration. Finally, when the probability of mobile connection having internet access increases, the incentives to invest in the mobile market and, in particular, in the deployment of internet technology increases. Since the three operators find it profitable to invest, the network improves and the competition to capture customers increases, which results on the decrease in the market concentration.

Table B

	HHI Aggregate		
VARIABLES	Spec.(1)	Spec.(2)	Spec .(3)
Education	1.170**		0.310**
	(0.497)		(0.149)
Unemployment rate	-2.507**		-1.409***
	(1.090)		(0.346)
GDP per capita (constant US$)	-2.373***		-0.696***
	(0.297)		(0.137)
Access to electricity	-0.318***		-0.0164
	(0.103)		(0.0454)
Population ages 15-64. Total	-0.000648***		-0.000217**
	(0.000101)		(9.24e-05)
Rural population	-0.00353*		-0.00183
	(0.00208)		(0.00113)
Tariff LLU partial		0.00189	0.00608***
		(0.00147)	(0.00194)
Pen. Rate fixed market (households)		-0.217***	-0.257***
		(0.0461)	(0.0701)
MS mobile market		-0.585***	-0.530**
		(0.210)	(0.230)
Prob. of internet connection having mobile int.		-0.203***	-0.152***
		(0.0152)	(0.0300)
Constant	6.656**	1.142***	4.048**
	(3.112)	(0.192)	(1.726)
Observations	65	65	65
Adjusted R-squared	0.902	0.986	0.992

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

4.2.2 Fixed and mobile telecommunications market

In Section 3 we distinguish theoretically the aggregate concentration index from the fixed and mobile market concentration indexes. Having this in mind, in this section we first check for the

differences in these markets empirically and, if so, we investigate the determinants of the concentration rates in each market independently. Although visual inspection of the graphical representation of HHI_t^{fixed} and HHI_t^{mobile} in Figure 6 suggests inequalities in the distribution, we test it statistically. We run skewness and kurtosis tests, which indicate that none of the concentration indexes are normally distributed ($p - value \leq 0.007$). Then, we use a Wilcoxon non-parametric test to check for the differences in the concentration indexes. Taking into account the lack of symmetry in the distributions, the tests on the differences in medians among concentration indexes show that there are statistically significant differences among all combinations of pairs of indexes: aggregate and fixed markets, aggregate and mobile markets, and fixed and mobile markets ($p - value \leq 0.001$).

In view of these differences, we investigate each market to see the degree of concentration separately and to perform a general assessment on how the aggregate index is affected by the sectorial concentration. To this aim, we run the multiple linear regression model focusing on explaining the market concentration in the fixed and mobile markets separately,

$$HHI_t^h = \alpha + Macro_t \cdot \beta_1' + Micro_t \cdot \beta_2' + \varepsilon_t, \qquad (eq.2)$$

This model (eq.2) is equal to the model defined before (eq. 1) except the superscript h, where $h = \{fixed, mobile\}$ indicates the market at stake. The estimation of the regression model for fixed and mobile concentration indexes is shown in Table C separately.

In terms of the signs of the estimates, the relationship between *Macro* variables in the fixed market is similar to the aggregate HHI results, although we would like to point out the following aspects. The effect of Access to electricity on HHI of the fixed market is negative and statistically significant in the first specification, whereas it vanishes in the third one once we additionally control for *Micro* variables. It might occur because, as the electricity access has been almost generalized across country, the inclusion of *Micro* variables absorbs its significance when determining fixed market concentration. Regarding the Rural population, comparing to the first specification, its estimated coefficient in the third specification becomes statistically significant exerting a negative effect on the market concentration. The intuition behind is that, due to the almost monopolized situation of IAM in this market, when the urban population increases (rural population decreases) the ability to exert market power increases. This effect is not significant when we analyse the aggregate

market, and it gains importance when we focus on the fixed sector. Turning to the set of variables grouped into *Micro*, we found robust and statistically significant negative association of Pen. Rate fixed market (households) with the HHI, and positive and statistically significant effect on HHI of Tariff LLU partial in the complete model as it happened in the aggregate market case.

Table C

	HHI fixed market			HHI mobile market		
	Spec.(1)	Spec.(2)	Spec.(3)	Spec.(1)	Spec.(2)	Spec.(3)
Education	8.519***		5.453***	0.250		-0.381*
	(1.560)		(0.686)	(0.455)		(0.208)
Unemployment rate	-6.750*		-5.769***	-3.623***		-2.507***
	(3.424)		(1.586)	(0.999)		(0.481)
GDP per capita (constant US$)	-10.86***		-5.881***	-1.693***		-0.146
	(0.933)		(0.627)	(0.272)		(0.190)
Access to electricity	-0.911***		-0.253	-0.342***		-0.0920
	(0.324)		(0.209)	(0.0946)		(0.0632)
Population ages 15-64. Total	-0.00108***		-0.00250***	-0.000613***		0.000255*
	(0.000317)		(0.000424)	(9.26e-05)		(0.000128)
Rural population	0.00652		-0.0183***	-0.00857***		-0.00169
	(0.00655)		(0.00517)	(0.00191)		(0.00157)
Tariff LLU, partial		0.0104	0.0480***		0.00192	-0.00595**
		(0.0116)	(0.00892)		(0.00215)	(0.00270)
Pen. Rate fixed market (households)		-1.648***	-1.791***		-0.197***	-0.0117
		(0.362)	(0.322)		(0.0672)	(0.0975)
MS Mobile market		-0.0813	0.943		-1.370***	-1.020***
		(1.650)	(1.056)		(0.306)	(0.320)
Prob. of internet connection having mobile int.		-0.191	0.235*		-0.140***	-0.246***
		(0.120)	(0.138)		(0.0222)	(0.0417)
Constant	-9.547	1.328	27.54***		1.813***	3.984
	(9.775)	(1.514)	(7.921)		(0.281)	(2.400)
Observations	65	65	65	65	65	65
Adjusted R-squared	0.798	0.824	0.966	0.911	0.969	0.984

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

In the case of the mobile concentration index, HHI^{mobile}, we found that within the *Macro* variables the effects of unemployment and population ages are statistically significantly negative and positive, respectively, and robust as it occurs in the aggregate analysis. The relationship between the unemployment rate and the concentration that we observe in fixed and mobile market can be explained by the nature of the use of internet services. These can be considered as a leisure for Moroccan consumers, who dedicate more time to internet services when unemployed. On the one hand, voice calls and their duration increase as leisure time increases. On the other hand,

use of the internet services can be a leisure for consumers using social networks and other activities such as online games. Moreover, as firms' recruitment processes use online platforms, one can expect an increase of the use of internet facilities. In case of *Micro* variables, we observe that estimated coefficients of the variables related to mobile market like MS Mobile market and Prob. of internet connection having mobile int. are robust and statistically significant.

5 Concluding remarks.

In this paper, we analyze the evolution of competitiveness in the Moroccan telecommunications market through market concentration. We present a description of the market emphasizing the evolution of the retail market in the fixed and mobile sector and conduct an analysis of market concentration to see how competition has evolved since the liberalization took place. We also carry out an econometric analysis on the determinants of the market concentration both at aggregate level and within each market, fixed and mobile contemplating sociodemographic and sectorial microeconomic indicators as its determinants.

Overall, we found that the market is competitive at aggregate level. However, a further inspection by markets reveals that the fixed sector remains concentrated, mainly because the broadband access is scarce. In contrast, the mobile market is procompetitive mainly because the access to mobile devices is cheaper compared to fixed connections. Moreover, the expansion of internet mobile has increased the number of subscribers, which favors operators to invest in the mobile network.

From the econometric analysis, we can extract interesting results. The telecommunications market is complex and the determination of the relevant factors that stimulate the investment is a useful information for regulatory authorities to adopt an optimal policy framework. Our findings suggest the existence of two different markets, although the competitiveness in each market can be determined by similar factors. We find some robust effects of variables that explain the evolution of the HHI. Sector attractiveness for investment plays a crucial role in fostering competitiveness in the market considering the negative and significant relationship between probability of internet connection having mobile internet and HHI for mobile market. Furthermore, regarding the impact of GDP per capita on the market competitiveness, we find that it has a

negative impact in the HHI, both at aggregate level and by markets: as GDP increases the level of HHI decreases, which positively affects competitiveness.

Finally, we want to point out that our study gives a general picture of the telecommunications market. Admittedly, although our results are relevant in the framework of a microeconometric analysis and it may highlight some insight for competition policy authorities, to understand the Moroccan telecommunications market further research is desirable. In this vein, future investigations may include the role that different players have in the market, such as industrial firms, municipalities and other governmental authorities. Moreover, a deep inspection of bundled services may enhance the understanding of the market.

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3. From copper to Next Generation Access technologies: product substitutability and investment in emerging telecommunications markets.

Abstract

In this paper, we present a duopoly model where a state-owned telecommunications operator and an entrant company offer ADSL broadband access supported by copper infrastructure and next generation access (NGA) connections, which are substitutes. The entrant operator may get access to the network by using the unbundled local loop or invest in infrastructure. We assume that the state-owned operator can be privatized. In an infinitely repeated game, we characterize different equilibria depending on the market configuration. Overall, we found that consumer surplus is enhanced when the state-owned operator remains under public hands and the level of substitutability is high. Moreover, as NGA operators' costs decrease firms' profits and consumer surplus increases. As substitutability decreases, welfare also decreases. Thus, there is a trade-off between substitutability and welfare: as consumers identify NGA connections as a superior technology, operators may exert higher market power, only mitigated as costs decrease.

Keywords: Telecommunications market, Unbundling, Copper network, Next generation access (NGA), product substitutability.

JEL classification: D21, D22, L13, L40.

1. Introduction.

Competition in telecommunications markets has taken place in different countries as liberalization processes became effective. Fixed voice calls and broadband access have improved because of technology deployment, mainly from the adoption of fiber connections as well as further improvements of the traditional copper infrastructure architecture. Traditionally, a state-owned monopolist provided the service until liberalization began. Since then, in many cases governments decided to privatize the state-owned company (SOC, hereinafter). In other cases, the SOC remains under public hands. In many cases, the strategy of some SOCs are ambiguous, seeking simultaneously governmental protection but also independency (Rentsch and Finger, 2015). It may obstacle the evolution of competition in the liberalization of a network industry. Concerning the strategy of entrant operators, in most of the cases they got network access through the unbundled local loop, whereas in others the entrant operator decided to invest and deploy its own network infrastructure in order to offer fixed voice calls and broadband access. When an entrant operator decides to invest in network infrastructure, it is crucial to decide the level of Next Generation Access (NGA, hereinafter) connection installed. Indeed, the bandwidth reached by fiber is higher than that offered by copper connections.[10] Differences come from the underlying technologies between fiber and copper, which cause the bandwidth gap. Other factors such that speed, performance, and reliability are equally important to business satisfaction.[11] Thus, different network architectures provide different levels of quality, speed and services. Moreover, consumers may prefer different type of connections at least for two reasons. First, some consumers may find the price of NGA connections too expensive and thus, they reach broadband access through ADSL technology supported by copper infrastructure. Second, some internet facilities benefit from the traditional copper architecture as they provide a better quality purposes. For instance, the development of Power over Ethernet (PoE) makes the copper

[10] Bandwidth is the maximum data transfer rate of data (usually Internet connectivity), or a network's capacity which is generally expressed in gigabits per second (Gbps) or megabits per second (Mbps). The more bandwidth offered, the more data you can transmit at one time (Collins, 2019).

[11] For instance, data signals degrade over a range, whereas fiber only loses 3% of the signal over distances greater than 100 meters, copper's losses are up to 94%. Durability is also superior in the case of fiber installations.

technology essential in applications like IP camera or in-building networks. The main reason is that they can deliver data and supply power at the same time (Zhang, 2019).

Consumers´ characteristic in the telecommunication market differs from country to country. In this paper, we analyse how competitiveness is affected by product substitutability, cost differences between traditional broadband services and NGA, and the threat of investment by entrant operators. In developing countries, competition the broadband market is barely inexistent. In most of the cases, the incumbent operator (usually a state-owned company) mainly offers ADSL connections, whereas NGA access is scarce. However, the potential development of NGA technologies (e.g., fiber to home FTTH) could afford for both the incumbent operator and potential entrants, the opportunity to deploy the fiber across the country, enhancing competitiveness in this market sector.

With the upgrading of copper access networks to NGA networks, new issues have emerged with respect to market definition. This is the case when consumers may choose between two extremely different broadband services in terms of speed, namely traditional ADSL connections based on copper technologies or NGA (fiber) connections. The former, implies a basic asymmetrical digital service with higher downloading speeds (usually around 2Mbit/s) than uploading speeds (usually less than 300kbit/s), whereas the is a service with almost symmetrical uploading and downloading speed of at least 100 Mbit/s provided over fibre-to-the-home (FFTH) network. Even though these two services are not direct substitutes when both of them are affordable, in developing countries they can be perceived as perfect substitutes when the unique concern is to get broadband access, no matter the speed. Moreover, in both cases they belong to the same market as long as there is a chain of substitution between them. Such chain of substitution exists where the price of a broadband access service provided over ADSL is constrained by the price of the service provided over FFTH network. Such constraint, in turn, exists if substitution exists. In the other extreme case, when NGA is viewed as a superior connection by consumers and the service is affordable for a significant part of the population,

these market can be considered different markets. In this case, the chain of substitution becomes in one-way substitution.[12]

Under this premise, one-way asymmetric substitution is likely to arise with respect to narrowband and broadband services. It occurs when customers switch from less capable networks and services to more capable one, but not the other way around. This is the case since the deployment of NGA technologies and the increasing consumption of high-speed instead regular-speed broadband services took placed.[13] ADSL connection based in copper access to NGA technologies substitution has important implications for regulatory authorities. Usually it implies to review the extent to which the two networks compete because it affects a number of regulations as well as antitrust investigations.

This variety of broadband connections generates different costs. Termination rates or access fees can be established through different cost modelling approaches (ITU 2019, costing and pricing methodologies in the digital economy). Regulators need to choose the correct access fee that encourages operators to undertake network investments and promote competitiveness in the market. Moreover, the prices adopted in the retail market could emit wrong signal to investors or potential entrant, which would lead to inefficient making decision process.

In telecommunications markets it possible to identify direct and indirect costs. In our model we focus in the impact of the direct cost, related to those costs shared by multiple services that are supported by common platforms and systems. Moreover, there are incremental cost, which gives

[12] Various competition authorities includes the notion of chain of substitution. For instance, in the EU the Market Definition Notice states: "In certain cases, the existence of chains of substitution might lead to the definition of a relevant market where products or areas at the extreme of the market are not directly substitutable". Where product B is a demand substitute for products A and C, then "even if products A and C are not direct demand substitutes, they might be found to be in the same relevant product market since their respective pricing might be constrained by substitution to B" (Notice, para. 57. See also OFT Market Definition Guidelines, OFT 403, December 2004, para. 3.11. In Australia, the Merger Guidelines consider chains of substitution under the notion of indirect substitution).

[13] In 2003, the European Commission in the Wanadoo case concluded that given extremely asymmetrical substitution between low-speed and high-speed internet access "the relevant service market to be used in analyzing Wanadoo Interactive's conduct is the market for high-speed internet access for residential customers". (Include reference here).

its name to long-run incremental cost methodology, representing the cost a firm incurred in due to an increment of the outputs.

Concerning new technological progress, it implies an incremental cost, given that it generates new telecommunication networks supported by superior technologies. Indeed, the cost structure related to legacy networks becomes obsolete for NGA. Although there is a period where both technologies coexist, a different treatment of costs is required. Price regulation should consider these issues, in order to adopt the adequate cost model that incentivize the investment.

The telecommunication market has undergone considerable transformations over the last two decades. In particular, the regulation of the broadband market is complex and considered a burden for national regulatory authority because it implies many efforts to set up the optimal regulatory framework and the consecutive commitment to it. Furthermore, the investment in new networks and the upgrade of the existing ones yield higher expenditures which difficult the willingness of operators to invest.

For example, the entrant will delay its optimal investment date in new infrastructures and prefer to connect to the unbundled local loop, avoiding undertaking huge investments; i.e., the opportunity cost of investment is higher.

The regulatory authority has the difficult task to monitor operators' decisions, with the aim to enhance the competitiveness in the market (i.e., static efficiency) and encourage innovation (i.e., dynamic efficiency), these two objectives are difficult to reconcile, and the regulatory authority must trade-off between them. Thus, the optimal date of investment decision and the adequate access regime will contribute to reach the socially optimal objective of investment. In a static model, Inderst et al (2012) analyse the interaction of investment incentives and regulation in the context of an asymmetric market where an operator owns the old technology (e.g., the incumbent). In the absence of the regulation of the new network, a higher access charges for the old technology discourages the incumbent to invest while the entrant has more incentives to undertake the investment. In a dynamic setting, Hoernig et al (2008) analyse how access regime affects the time of investment. In a leader-follower duopoly, they show that the timing of invest in fiber infrastructure by the follower operator is crucial to reach the first-best investment objective. if the follower´s investment incentives are small. As the entrant operator compete as follower in

most of the cases, adopting the adequate access regime influences operator's decision to invest. Neumann & Vogelsang (2013) study the transition from copper to fiber access in a theoretic framework, assuming that during the transition phase both networks operate in parallel. In this situation, regulatory authorities have to decide how to price unbundled access to the copper loop. They determine the performance delta based on the market valuation of services provided over the copper and fiber access represented by the end-user prices of services and corrected by cost differences downstream of the access provision. Under this approach an access seeker becomes indifferent (on the margin) between using the copper or the fiber access network and wholesale pricing (or regulation) becomes competitively neutral towards technology choice between copper and fiber access.

OPTA in its 2010 report (OPTA, 2010) considers that the incumbent has more likelihood to first invest in new infrastructure. Hence, as the incumbent operator is a SOC, this investment was conducted in most of the cases by the government, leaving the decision of invest to the entrant operator. Tselekounis et al (2013) explore the incumbent´s investment incentives. They found that in the case where the slope of the marginal cost is not particularly steep in comparison to the impact of investment on demand, the incumbent underinvest considering the social optimal level of investment. Another work that analyses the incumbent´s incentives, Calzada et al, (2017) explore the determinants of Telefonica´s investment incentives in 6063 Spanish municipalities. They found that the incumbent decision is positively influenced by the entrant´s modes of access in the case of LLU contrary to the negative effect of bitstream. Moreover, in the municipalities where the cable operators compete with Telefonica, the deployment of NGA is spurred.

Regarding the entrant´ investment behaviour in the market, different studies have explored the determinants of entrant´s deployment of its own infrastructure. In particular, the ladder of investment approach is conceived to shape the regulatory conditions that might have an impact on entrant´s investment decision. Indeed, regulatory authorities have considered the entrant´s investment incentives as the main pillar of fostering competition within the market (reference). Furthermore, several studies have analysed the impact of the ladder of investment approach on entrant´s decision, some of these studies have found that the entrant fail to climb the ladder, i.e., do not invest in its own infrastructure (reference). Some works attempt to analyse the relationship between regulatory framework and investment incentives of the entrant. Bender et al (2010) study

the “make-or-buy”- decisions of the entrant in regional market with different population densities. They conclude that the entrant invests in own infrastructure at least in densely populated areas. Make-or-buy decision is influenced by two opposite factors: the investment lowers the cost of investment and induce the entrant to invest, while the predicted fierce retail competition dissuade the entrant from deploying infrastructures. The authors through their simulations established that a higher access fee might yield higher coverage and lowers the price in the retail market. Therefore, the trade-off between static efficiency and dynamic efficiency does not apply (references).

The aim objective of the regulation in the beginning of the market liberalization was to promote the competition on the market giving access to new operators to the legacy network, as well as fostering the entry of new operators. The aim of these measures is to minimize the existing obstacles of free entry in the market, by reducing the cost of investments and the uncertainties underlying the investment in network infrastructure such as demand uncertainties, technological progress, and financial market constraints. The ladder of investment approach (proposed by Cave, 2006) contributes to the reconciliation between service based-competition and facility-based competition, which are considered substitutes. The former allow the entrant to have access to incumbent´s infrastructure depending on its capacity of investment: the little capacity of investment, the lowest level in the ladder achieved. The other option to enter the market is facility-based competition. In this case, the entrant deploys its own entire infrastructure to compete with the incumbent. Service-based competition has the advantage of accelerating the competition in the market through an earlier entry of competitors helping them to make an efficient investment decision, preventing them from steering all their resources at once towards the deployment of their infrastructure with the risk of the failure of the business case. In contrast, facility- based competition guarantees a sustainable long-run competition. For instance, Kittl et al. (2007) show that facility- based competition has a positive impact on innovation. The ladder of investment approach allows the entrant to compete first through service-based competition, which contributes to the take-off of the entrant business in the market. The main profits of this first stage of competition is to gain a significant market share, forging loyalty and brand reputation. Furthermore, this first stage also allows new operators to increase the know-how process

thorough learning by doing, which has a positive impact on reducing costs. These benefits allow the entrant to compete through facility-based competition in a next step.

Bourreau et al. (2010) present a critical review of the ladder of investment approach. They set out their own theoretical view to discuss the elements of success of the service base competition as a stepping-stone to service-based competition. The key assumptions of ladder of investment in their work are the neutralization of the replacement effect[14] and the existence of efficient regulatory instruments to neutralize it. Such as instruments are considered a precondition for the success of the ladder of investment. However, several studies have questioned the possibility of applying the ladder of investment approach to promote the investment in NGA networks. Moreover, determining the relationship between regulation and investment incentives becomes blurrier in the context of next generation access networks. The coexistence of the two technologies side by side complicates the regulatory tasks.[15] Furthermore, the deployment of fiber yields geographic differences in terms of cost deployment, which makes it difficult for national regulatory authorities to adopt the appropriate regulatory remedies.[16] Bourreau et al. (2014) highlight the complexity of the relationship between access regulation and investment incentives. They analyse three issues that were hotly debated, (i) the coordination between regulatory access to old and new infrastructure and its impact on investment incentives, (ii) the implementation of differentiated access remedied depending on geographical differences in deploying NGANs, and (iii) possibility of co-investment and its interplay between regulatory accesses. European competitive telecommunication association in its 2011 report WIK (2011) shows that the incumbent´s investment incentives to switch from old to new infrastructure is determined by the interplay between copper and fiber access regulation. In this sense, they derive different scenarios through displaying the corresponding wholesale access fees for both technologies and their retail prices, and discuss their impact on the transition process.

In Morocco, the diffusion of NGA networks has increased in the last decade but it remains weak as compared with other less developed countries in the Europe sphere, such as Eastern

[14] The replacement effect was discussed in Bourreau et al (2014)
[15] The duplication of investment in some cases is not considered profitable or even worst because it could decrease the welfare. See Inderst and Peitz (2011)
[16] In many cases, regulatory authorities are prone to apply differentiated regulatory access regimes rather than uniform access fee, this tendency is justified by the variety of characteristics that each regional market displays, which requires distinguishable treatments.

European countries. The demand for fiber optic is weak because most Moroccans could not afford the fiber, and the preferences of the consumers are not oriented towards high-speed broadband. Indeed, in 2020 55.33% of subscriptions to ADSL corresponds to the lowest speed in the market (less than or equal to 4MB/s). Furthermore, subscriptions to fiber to the home (FTTH) in 2020 were only 0.53% of the total subscriptions of the fixed internet services.

Another issue that arise when considering the deployment of new infrastructures is the digital divide that exists between sparsely populated areas and densely ones. Is a topic that has occupied importance in the digital agenda for Europe 2010 and the Digital Single Market (2015), where actions were proposed to bridge the digital divide. In the context of developing countries, this problem is even worst, given the less developed infrastructures. The implication of the municipalities in the deployment of fiber could be the flagship of these initiatives. Indeed municipalities could reduce the cost investments through cooperation with operators or third parties in deploying infrastructure or leaving room for fibre in different works of digging. For instance, Casier et al (2008) analyse the local initiatives of city of Ghent to rollout the FTTH, and found that this kind of initiative reduces the digging costs, which increases the feasibility of investments in fibre network access. In Moroccan market, the municipalities are considered an obstacle to the deployment of broadband infrastructure in general (World Bank 2016).

Hamada (2020) study endogenous timing in a mixed duopoly game where a welfare-maximizing government sets the optimal degree of privatization for a partially privatized firm. Under quantity competition he founds that can be positive or zero whereas in price competition fully nationalization is advised. In our paper, we consider these two extreme cases, either a fully privatization or a pure state-owned company. Some studies reveals that market-oriented reforms, such as the privatization of state-owned companies, may directly affect in the adequate provision of basic household services like telecommunications (see for instance Clifton et al. 2011). The impact of European policies of liberalization in the telecommunications sector are reviewed in Bance (2007).

In our model, it is also important how the transition from copper to NGA technologies is affected by consumers' preferences and regulatory measures. In this vein, Grzybowski et. al (2018) found that when consumers' basic internet requirements can be satisfied with low internet speeds

provided by ADSL connections (usually of 1 to 8 Mbps) the extra valuation of NGA technologies is not significant. In this vein, they found that consumers' switching cost from ADSL to NGA technologies (in particular FttH) are the main factor, which slow down the transition. Crandall et. al. (2013) empirically review the effects of copper unbundling, analyzing broadband penetration in OECD countries from 2001 to 2010. Their results show that the long-run effect of copper unbundling has slowed the deployment of FTTP infrastructures, especially in Europe. They argue that based on this finding mandated unbundling of fiber networks would likely deter deployment of NGA technologies. This idea support our assumption that the new entrant may prefer to invest in NGA technologies and that regulatory measures should not support the strategy of unbundling both, the copper and the fiber network.

Entrant operators that depend on access regulation claim that the incumbent operator would gain an essential competitive first mover advantage. As Briglauer (2014) pointed out it implies to have appropriate ex ante regulation that facilitates the access to superior broadband connections. Traditional twisted copper-wire pairs deployed by incumbent (and in most of the cases state-owned) companies provided narrow broadband services by means of digital subscriber lines (DSL). As the demand for high quality services requiring higher bandwidth increased, DSL technologies were becoming obsolete. In order to get NGA connections it is necessary to locate the local loops closer to customers by placing equipment in the cabinets that house distribution frames (the so-called fiber to the cabinet, FTTC). The rest of the last mile the DSL technology is used. Further improvements can be achieved by placing coax television cable and even more, by installing optical fiber into the building (FTTB). Finally, if the optical fiber is connected to each individual household it is referred as fiber to the home (FTTH), providing almost unlimited bandwidth. In Mazzenga et. al. (2020) the improvements that can be achieved in the transition to the FTTH from copper technologies are studied. They show that the bit rate per user can be significantly increased from updating the FTTC network, extending the life of existing copper-based networks. They argue that it may facilitate the smooth transition to FTTH supported by the re-investing of revenues, which favor to gradually move toward a complete fiber technology.

Privatization might be a response to this question: The intervention of governments in the telecommunication market is it a suitable way to deal with broadband national agenda or it is better to delegate to private firms the achievement of these objectives? The gradual privatization

of the incumbent might not be an exclusive feature of the privatization process of developing countries. Indeed, in 2011 in Europe only 86% of the incumbents are fully or partially privatized (ITU 2011). For example, Telekom Austria is still partially privatized, the republic of Austria owns the 28.42% of the shares. Michael Breen et al (2013) consider that the process of privatization must be disaggregated into different stages rather than considerate it as a single transaction, their model has been set considering two stages, each one corresponds to a different making-decision process. Many factors shape the privatization process. In the context of developing countries, different factors have an important impact in the privatization process namely, population aspects, governance, and attractiveness for foreign investment. For instance, the population density has an important impact on the decision of privatization. As the state-owned operator have the mission to provide universal services to consumers, a country with a low population density would delay the full privatization of the incumbent. Indeed, the state would be reticent to completely delegate to a private operator the provision of basic communication services, in order to preserve the economic and social cohesion and reduce the digital divide. Therefore, the state deals with opposite objectives. On the one hand, the state wants to accelerate privatization to increase consumers' wellbeing through lowering prices, offering a high-quality service, and reaping the benefits of the privatization. On the other hand, the state is likely to deter the fully privatization to guarantee the social cohesion.

Furthermore, the consumers might exert a pressure over the state through demanding high quality communication service and access to several types of services. This change in consumers' preferences is positively related to high education level, digital culture of the population, and the weight of young cohorts over total population. This pressure leads the state to adopt the adequate reforms and accelerate the privatization.

The governance also plays a crucial role in making decision about privatization. The state will accelerate the privatization if it considers that the sale of its shares would contribute to balance its budget, in contrast, it could also delay the full privatization if the balance of its budget is possible through the turnover of its participation into the incumbent. Moreover, an efficient management of the privatization process that assures the effective control of the private operator concerning its duty to provide basic services would contribute to the full privatization of the incumbent.

The attractiveness of the country for foreign investment has a considerable impact on the process of privatization. Hung Lin (2008) in his work mentioned the importance of foreign direct investment in telecommunication market and states that since 1984, a date that corresponds to the earlier stage of privatization, one third of private investment into the incumbent resulting from privatization is from foreign origin. This relationship was also corroborated by the findings of Musa Foudeh (2015), through an econometric study he finds that the process of privatization of different sectors of the economy in MENA countries over the period (1990-2008) was accompanied by the growth of investment coming from outside.

In contrast to developed countries, developing countries suffer from lesser financial and structural means, which complicate the task of developing their own telecommunication market. International carriers trigger competition in the market and the diversification of the products and services. A country that is open already to the foreign investment and does not fear the loss of control of its strategic sector, is likely to undertake considerable or full privatization of its state-owned firm. Furthermore, it could also encourage joint ventures under the form of public and private partnership to create a new telecommunication national carrier.

All these factors are analysed under the scope of the scale of privatization. Indeed, they determine how many equities the state is willing to sell. The scale of privatization has more importance during the assessment of the development of the telecommunication market in developing economies was highlighted by Michael Breen et al (2013). They differentiated two processes of making-decision and each one is influenced by different factors. In the second stage, which corresponds with taking decision about the scale of privatization, they found that internal aspect of the country such as domestic political and economic conditions play an important role in determining the scale of privatization. Our predetermined factors discussed above are related to these aspects and their impact depend on political conditions. Contrary to Michael Breen et al (2013), in our discussion we include the foreign investment as a determinant of scale of privatization.

In this paper, we assess through an oligopoly model the impact of the degree of privatization on the investment in NGA. We set a Stackelberg model were the state-owned company acts as a leader and can be fully privatized. An entrant operator plays the role of follower and make the

decision of investment. Traditional ADSL connections and NGA are assumed to be substitutes. Overall, we found that consumer surplus is enhanced when the state-owned operator remains under public hands and the level of substitutability is high. Moreover, as NGA operators' costs decrease firms' profits and consumer surplus increases. As substitutability decreases, welfare also decreases. Thus, there is a trade-off between substitutability and welfare: as consumers identify NGA connections as a superior technology, operators may exert higher market power, only mitigated as costs decrease.

The rest of the paper is organized as follows. Section 2 present the model, whereas Section 3 solves it under the two market scenarios: mixed and private duopoly. Section 4 introduce the infinitely repeated game where the entrant operator decides whether to invest in NGA technologies or not. Section 5 conclude. The usual disclaimers apply.

2. The model.

We present a model where a state-owned company (SOC, hereinafter), the incumbent, S, compete with a new entrant provider, E. The incumbent offers fixed voice telephony and Internet access to customers by a traditional copper connection, c, or instead by NGA technologies, which includes a superior fiber technology architecture, f. From consumers' point of view, copper and fiber technologies have a degree of substitutability. In our approach, we are interested in the causality that percapita GDP may has in the perception of consumers regarding the access to telecommunications facilities. On the one hand, when percapita GDP is low, affordability of internet access no matter the quality of the service is the main customer objective and thus, both types of connection becomes perfect substitutes. On the other hand, as percapita GDP percapita increases, accessibility tends to be universal, and customers identify NGA technologies as a superior connection. Such is the case in developed countries where substitutability between these two types of technologies is almost zero and thus, both segments becomes in independent markets. However, in the case of developing countries affordability is the main concern. Following Singh and Vives (1984), we assume that a representative consumer maximizes the consumer surplus, $CS(Q_c, Q_f)$, which is defined as $U(Q_c, Q_f) - \sum_{h=c,f} p_h \cdot Q_h$. The quasi-linear utility function is given by

$$U(Q_c, Q_f) = (Q_c + Q_f) - \frac{Q_c^2 + 2\theta Q_c Q_f + Q_f^2}{2} + z,$$

where z is the numeraire. Here Q_c is the two-dimensional vector containing the quantity of cooper connections sold by each company, and Q_f stands for the fiber connections. Aggregate copper and fiber connections are $Q_h = \sum_{i=S,E} q_{ih}$, $(h = c, f)$, where q_{ih} stand for the quantity of subscribers each operator attains. Parameter $\theta \in (0,1)$ measures the degree of product differentiation. Inverse demand functions for each technology are at,

$$p_h(Q_h, Q_{-h}) = 1 - Q_h - \theta \cdot Q_{-h,} \text{ where } h, -h = c, f, (h \neq -h).$$

Concerning the substitutability of the network infrastructure, we focus in two extreme cases, depending on the consumers' point of view. As we pointed out above, when percapita GDP is higher enough, both type of connections become different markets as consumers identifies NGA based in fiber technology as a superior service and thus $\theta \to 0$. However, when percapita GDP is low, consumers preferences are determined by the affordability of the service instead the quality of it. In this case $\theta \to 1$. This is the situation in those countries where telecommunications are emerging because of economic development. When further steps of development are achieved, the mayor concern of consumers is the quality of the service so they are able to pay higher prices in order to get fast and safety connections and thus, both markets can be considered independent market in the limit (when $\theta \to 0$). In our reference case, when percapita GDP is low, the mayor concern is to get access to the service at moderate prices.

Taking into account this restriction, an interesting question is to investigate to what extent an entrant operator has incentives to invest in NGA technologies. This feature is relevant in order to study the evolution of the market in developing countries. For instance, countries as Morocco, Algeria and in general north African countries, where percapita GDP is growing but still remains low as compared with OECD countries, both types of services can be viewed as perfect substitutes, whereas in OECD countries customers look for superior quality internet connections based on NGA technologies.

In our model, the operator who enters the market has to decide whether to invest in NGA technologies or to offer ADSL internet access by joining the local loop of the incumbent company

S, that we assume unbundled by the regulatory authorities. In this case, the entrant has to pay a network access charge $\alpha_h > 0$, to the incumbent operator S.

Following the empirical evidence of liberalization processes in telecommunications markets around the world (see for instance Kok 1992, Li 2004 and Torero 2001), we introduce the possibility of fully privatization of the SOP. It is interesting because it may affect the decision of the entrant operator E when deciding whether to invest or not in NGA technologies. Moreover, it affects consumer surplus and the overall welfare. When the entrant operator invest, it incurs in fixed costs F depending on the level of NGA technology offered.

Therefore, we study two scenarios. In Section 3, we solve the model when the decision of the entrant operator E is not invest. In this framework, the entrant gets access to the incumbent infrastructure and pay access fees α_h to offer broadband services, either under copper and fiber technologies. Each scenario is solved under two possible market structures, depending on the government decision in an early stage of the game. A mixed oligopoly emerges when the incumbent provider S remains under public hands and compete with a private entrant ($\tau = 1$). Instead, we have a private oligopoly where the incumbent provider S is fully privatized ($\tau = 0$). In Section 4, we study the decision of invest by introducing an infinitely repeated game where the entrant compare the discounted payoff of invest versus the status-quo.

Summarizing, our game has two stages. In the first stage, the government decide whether to privatize the SOP or not. In the second stage, the incumbent operator S and the entrant operator E engage in Stackelberg competition, where S is the leader and E takes the role of follower. It seems a natural way to join competition at least when liberalization starts. We first study as a benchmark case, the situation where the entrant operator does not invest. Secondly, we introduce the case where the entrant operator invest on NGA technologies to compete with the incumbent operator.

3 The benchmark case: the entrant does not invest

In this case, the entrant operator E get access to the infrastructure by satisfying access fees α_h. With respect the costs function, we assume that copper connections have lower variable costs than NGA connections. In particular, costs of cooper connections are $C_{Sc}(q_c) = Q_c^2/2$, whereas

costs of NGA technologies are $C_{Sf}(Q_f) = (1+\sigma)Q_f^2/2, \sigma > 0$. We assume a quadratic cost function in order to introduce the above mentioned incremental costs. Indeed, get access to rural areas and remote locations in those countries where physical infrastructure is scarce, usually implies an increase in marginal costs greater than one for each unit of increment in the consumer location. The level of the network access charge α_h that the entrant operator has to satisfy in order to get the local loop is exogenously given by the regulatory authorities. Concerning this decision, there are different schemes (see for instance Sarmento & Brandao, 2007),

- Cost-based: in this case the access fee is based in the marginal costs, getting the operator a positive margin Δ above marginal cost: $\alpha_h = (1+\Delta)MC, \Delta > 0$.
- Retail-minus: under these scheme the regulator fix a margin Δ $(0 < \Delta < 1)$, over the market price p_h, and thus $\alpha_h = \Delta \cdot p_h$.
- Retail-cost based: this is a mixture of the both above mentioned schemes, where the margin is a proportion of the price-cost margin, $\alpha_h = \Delta \cdot (p_h - MC)$.

We assume that regulatory authorities choose a retail-minus scheme. This scheme is used when marginal cost vary enough. Hence, in our model, equilibria depends on the degree of substitutability, the relative costs differences between copper and NGE technologies, and the decision of the government on the privatization of the SOP. The latter, determines the profit function of the incumbent operator, which depends on the decision of the government in the first stage. The SOP profit function at the second stage is as follows,

$$\pi_S(Q_c, Q_f) = \tau \cdot CS(Q_c, Q_f) + \sum_{h=c,f}[p_h(Q_h, Q_{-h}) \cdot q_{Sh} + \alpha_h \cdot q_{Eh}] - C_{Sc}(Q_c) - C_{Sf}(Q_f),$$

where the strategic variables are q_{Sc} and q_{Sf}. Now we are in position to solve the model under the two possible scenarios.

3.1 Mixed oligopoly ($\tau = 1$)

In this case, S remains under public hands and compete with a private entrant E. The profit function that E maximizes is as follows:

$$\pi_E(Q_c, Q_f) = \sum_{h=c,f}[p_h(Q_h, Q_{-h}) \cdot q_{Eh}] - \sum_{h=c,f} \alpha_h \cdot q_{Eh}.$$

The game is solved by backward induction. The entrant takes as given the strategy of the incumbent. Taking the first order conditions with respect the strategic variables q_{Ec} and q_{Ef}, we characterize best response functions,

$$q_{Eh}(q_{Sh}) = \frac{1}{2}\left[\frac{1}{(1+\theta)} - q_{Sh}\right].$$

The incumbent company S incorporates this information into the profit maximization problem. Therefore, in the mixed oligopoly the incumbent´s maximizes the following profit function with respect its strategic variables,

$$\pi_S(q_{Sc}, q_{Sf}) = \tau \cdot CS\big(q_{Sc}, q_{Sf}\big) + \sum_{h=c,f} [p_h\big(q_{Sc}, q_{Sf}\big) \cdot q_{Sh} + \alpha_h \cdot q_{Eh}(q_{Sh}) - C_{Sh}(q_{Sh})].$$

In the above function, consumer surplus, prices, and costs only depends on the strategic variables of the company S because the substitution of the entrant's best response functions in the maximization program. First order conditions are evaluated in the special case under study, i.e., when the two products are considered perfect substitutes. Thus,

$$\left.\frac{d\pi_S(q_{Sc}, q_{Sf})}{dq_{Sh}}\right|_{\theta \to 1} = 0.$$

The system of equations of the above first order conditions provides the set of optimal strategies for the company S. The outcome of the mixed oligopoly is reported in the Proposition 1.

Proposition 1. In our model of mixed oligopoly where copper and fiber connections are considered perfect substitutes ($\theta \to 1$) the following equilibrium holds,

a) ${q_{Sc}}^M = \frac{5+8\sigma-2\Delta(2+3\sigma)}{\emptyset(\Delta,\sigma)}$, ${q_{Sf}}^M = {q_{Sc}}^M + \frac{2\sigma(2\Delta-3\sigma)}{\emptyset(\Delta,\sigma)}$,

b) ${q_{Ec}}^M = \frac{1-2\sigma-2\Delta(1-\Delta)}{\emptyset(\Delta,\sigma)}$, ${q_{Ef}}^M = {q_{Ec}}^M + \frac{\sigma(3-2\Delta)}{\emptyset(\Delta,\sigma)}$.

where $\emptyset(\Delta, \sigma) = 7 + 4\sigma - 2\Delta(2+\sigma)$.

Proposition 1 states that there is an incentive for the incumbent company to provide ADSL based on copper connections as the direct costs of NGA increases, and the contrary holds for the entrant firm. Moreover, as the access fee increases (measured by the parameter Δ), the incumbent company prefers to enhance NGA connections whereas the entrant company prefer to offer ADSL. The intuition behind is that, as the entrant only pay to access the local loop there is a trade-

off between the incentives of the incumbent company and the entrant. This is because the incumbent company supports the direct costs.

Prices, providers' profits, and consumer surplus are reported in Proposition 2.

Proposition 2. In our model of mixed oligopoly where copper and fiber connections are considered perfect substitutes $\theta \to 1$, prices, companies' profits and consumer surplus are at,

a) $\pi_S^M = \frac{rellenar}{2\emptyset(\Delta,\sigma)}$, $\pi_E^M = \frac{(1-\Delta)(1-\sigma)^2}{\emptyset(\Delta,\sigma)}$,

b) $CS^M = \frac{1}{2}[\frac{(3-2\Delta)(2+\sigma)}{\emptyset(\Delta,\sigma)}]^2$.

Proposition 2 states that profits negatively depend on the cost parameter σ. Moreover, $\pi_S^M > \pi_E^M$. This is because the access fee the entrant company pay to the incumbent company has a larger impact on the profitability that the negative effect of the production costs. The effect on price as σ increases is larger than one: companies exert higher market power as costs increase. Accordingly, consumer surplus decreases as σ increases.

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3.1 Private oligopoly ($\tau = 0$).

In the case of the private oligopoly, we have two private companies that compete in the market. From the follower point of view, the environment does not change, because no matter the incumbent company remains under public hands or not, the entrant decides its strategic variables under the same environment. Hence, the entrant's profit function is as [X], yielding best response functions as in [X].

The incumbent company now behaves as a private firm with a profit function,

$$\pi_S(q_{Sc}, q_{Sf}) = \sum_{h=c,f}[p_h(q_{Sc}, q_{Sf}) \cdot q_{Sh} + \alpha_h \cdot q_{Eh}(q_{Sh}) - C_{Sh}(q_{Sh})]. \qquad [X]$$

In the above function, prices, and costs only depends on the strategic variables of the company S because the substitution of the entrant's best response functions in the maximization program.

First order conditions are evaluated in the special case under study, i.e., when the two products are considered perfect substitutes. Thus,

$$\frac{d\pi_S(q_{Sc},q_{Sf})}{dq_{Sh}}\Big|_{\theta\to 1} = 0. \qquad [X]$$

The system of equations of the above first order conditions provides the set of optimal strategies for the company S. The outcome of the mixed oligopoly is reported in the Proposition 3.

Proposition 3. In our model of private oligopoly where copper and fiber connections are considered perfect substitutes ($\theta \to 1$) the following equilibrium holds,

a) $q_{Sc}{}^* = \frac{1}{2}[\frac{3+7\sigma-2\Delta(2+3\sigma)}{(2+\sigma)+\emptyset(\Delta,\sigma)}]$, $q_{Sf}{}^* = q_{Sc}{}^* + \frac{2\sigma(2\Delta-3\sigma)}{(2+\sigma)+\emptyset(\Delta,\sigma)}$,

b) $q_{Ec}{}^* = \frac{1}{2}[\frac{3+\sigma(2\Delta-1)}{(2+\sigma)+\emptyset(\Delta,\sigma)}]$, $q_{Ef}{}^* = q_{Ec}{}^* + \frac{\sigma(3-2\Delta)}{(2+\sigma)+\emptyset(\Delta,\sigma)}$.

As in the previous section, Proposition 3 states that there is an incentive for the incumbent company to provide ADSL based on copper connections as the direct costs of NGA increases, and the contrary holds for the entrant firm. However, the quantity of both services is lower than in the mixed oligopoly. This is because here there is no output expansion effect. Indeed, both companies behaves as private firms and thus, the exercise of market power is high. Prices, companies' profits, and consumer surplus are reported in Proposition 4.

Proposition 4. In our model of private oligopoly where copper and fiber connections are considered perfect substitutes $\theta \to 1$, prices, companies' profits and consumer surplus are at,

$a)$ $\pi_S^* = \frac{2\Delta(1+\sigma)-\sigma}{(2+\sigma)+\emptyset(\Delta,\sigma)}$, $\pi_E^* = \frac{(3+2\Delta)^2(1-\Delta)}{((2+\sigma)+\emptyset(\Delta,\sigma))^2}$,

$b)$ $p^* = \frac{(3+2\sigma)}{(2+\sigma)+\emptyset(\Delta,\sigma)}$, $CS^* = \frac{1}{2}\cdot[\frac{(3-2\Delta)(2+\sigma)}{(2+\sigma)+\emptyset(\Delta,\sigma)}]^2$.

Proposition 4 states that profits negatively depend on the cost parameter σ. Moreover, $\pi_S^* > \pi_E^*$. This is because the access fee the entrant company pay to the incumbent company has a larger impact on the profitability that the negative effect of the production costs. The effect on price as σ increases is larger than one: companies exert higher market power as costs increase. Accordingly, consumer surplus decreases as σ increases.

We conclude this section with the comparison between the two market structures. One can see that quantities offered of both copper and fiber are larger when the market is a mixed oligopoly, whereas the profitability of both companies and the price decrease. Accordingly, consumer surplus is larger under mixed oligopoly.

4 The extended model: the entrant investment decision in an infinitely repeated game.

In this section, we extend our previous findings by introducing an infinitely repeated game with discounting $\mu \in (0,1)$, where the entrant may decide whether to invest or not in each of the environment presented previously. We also discuss the results depending on the grade of substitutability of the services.

No matter the incumbent company remains under public hands or not, when the entrant company invest the incumbent company does not share the local loop. Then, access fees α_h are set at zero. Moreover, each company bears its direct costs in order to provide the service. In this setting, costs of cooper connections are at $C_{ic}(q_c) = q_{ic}^2/2$, whereas costs of NGA technologies are $C_{if}(q_f) = (1+\sigma)q_{if}^2/2\,, i = S, E$. In what follows we first present the stage game and finally the analysis of the incentives in the infinitely repeated game is reported.

4.1 The stage game under mixed oligopoly.

As in the previous section, companies play a Stackelberg game were E is the follower. Now, company E have to incur in fixed costs F in a given period in order to deploy NGA infrastructure. In addition, it bears the direct costs to offer broadband access by copper and fiber. Accordingly, company E maximizes,

$$\pi_E(q_c, q_f) = p_c(q_c, q_f) \cdot q_{Ec} + p_f(q_c, q_f) \cdot q_{Ef} - C_{Ec}(q_{Ec}) - C_{Ef}(q_{Ef}) - F.$$

Taking the first order conditions with respect the strategic variables q_{Ec} and q_{Ef}, we characterize best response functions,

$$q_{Ec}(q_{Sc}, q_{Sf}) = \frac{(3-\sigma-2\theta)-(3-\sigma-2\theta^2)q_{Sc}-\theta(1+\sigma)q_{Sf}}{3(3+\sigma)-4\theta^2}, \qquad q_{Ef}(q_{Sc}, q_{Sf}) = \frac{(3-2\theta)-(3-2\theta^2)q_{Sf}-\theta q_{Sc}}{3(3+\sigma)-4\theta^2}.$$

The incumbent company S incorporates this information into the profit maximization problem. Therefore, in the mixed oligopoly ($\tau = 1$), the incumbent´s maximizes the following profit function with respect its strategic variables,

$$\pi_S(q_c, q_f) = \tau \cdot CS(q_c, q_f) + \sum_{h=c,f}[p_c(q_c, q_f) \cdot q_{Sh} + \alpha_h \cdot q_{Eh}] - C_{Sc}(q_{Sc}) - C_{Sf}(q_{Sf}). \quad [X]$$

As in the previous section, consumer surplus, prices, and costs only depends on the strategic variables of the company S because the substitution of the entrant's best response functions in the maximization program. Taking the first order conditions evaluated when the two products are considered perfect substitutes

$$\left.\frac{d\pi_S(q_{Sc}, q_{Sf})}{dq_{Sh}}\right|_{\theta \to 1} = 0$$

gives a system of equations which provides the set of optimal strategies for the company S provided in Proposition 3.

Proposition 5. In our model of mixed oligopoly where $\theta \to 1$ and the entrant company invest in NGA technologies the following equilibrium holds:

a) ${q_{Sc}}^{MI} = \frac{8\sigma^3+34\sigma^2+47\sigma+21}{\varphi(\Delta,\sigma)}$, ${q_{Sf}}^{MI} = \frac{8\sigma^2+26\sigma+21}{\varphi(\Delta,\sigma)}$, where $\varphi(\sigma) = 17\sigma^3 + 81\sigma^2 + 128\sigma + 67$.

b) ${q_{Ec}}^{MI} = \frac{6\sigma^3+25\sigma^2+34\sigma+15}{\varphi(\Delta,\sigma)}$, ${q_{Ef}}^{MI} = \frac{3\sigma^2+8\sigma+5}{\varphi(\Delta,\sigma)}$.

No matter the level of the variable costs parameter, the quantity offered by copper is larger than the quantity of fiber for both companies. This is because the cost effect directly affect the profitability of the operators. Only when the costs parameter is lower than zero (i.e., the fiber connection becomes cheaper than copper connection) the contrary holds.

Proposition 6. In our model of mixed oligopoly where copper and fiber connections are considered perfect substitutes $\theta \to 1$, prices, companies' profits and consumer surplus are at,

$a)$ $\pi_S^{MI} = \frac{9\sigma^3 + 47\sigma^2 + 81\sigma + 46}{2\varphi(\Delta,\sigma)}$, $\pi_E^{MI} = \frac{(5+3\sigma)^3(1+\sigma)^2(2+\sigma)}{2(\varphi(\Delta,\sigma))^2}$,

$b)$ $p^{MI} = \frac{6\sigma^3+25\sigma^2+34\sigma+15}{\varphi(\Delta,\sigma)}$, $CS^{MI} = \frac{1}{2} \cdot [\frac{11\sigma^3+56\sigma^2+94\sigma+52}{\varphi(\Delta,\sigma)}]^2$.

Profitability of the state-owned operator is larger than the private operator. Finally, price and consumer surplus is higher as Δ decreases and σ increases.

4.2 The stage game under private oligopoly.

The entrant firm, *E*, plays as the second stage the same game that in the previous section. Hence, this firm maximizes [x] with the strategic variables q_{Ec} and q_{Ef}. Accordingly, we obtain the same best response functions as in Subsection 4.1. The incumbent company S incorporates this information into the profit maximization problem. Therefore, in the private oligopoly ($\tau = 0$), the incumbent´s maximizes the following profit function with respect its strategic variables,

$$\pi_S(q_c, q_f) = \sum_{h=c,f} [p_c(q_c, q_f) \cdot q_{Sh} + \alpha_h \cdot q_{Eh}] - C_{Sc}(q_{Sc}) - C_{Sf}(q_{Sf}).$$

As in the previous section, consumer surplus, prices, and costs only depends on the strategic variables of the company S because the substitution of the entrant's best response functions in the maximization program. Taking the first order conditions evaluated when the two products are considered perfect substitutes

$$\left.\frac{d\pi_S(q_{Sc}, q_{Sf})}{dq_{Sh}}\right|_{\theta \to 1} = 0$$

gives a system of equations which provides the set of optimal strategies for the company S provided in Proposition 4.

Proposition 7. In our model of private oligopoly where $\theta \to 1$ and the entrant company invest in NGA technologies the following equilibrium holds:

a) ${q_{Sc}}^{*I} = \frac{8\sigma^3+34\sigma^2+47\sigma+21}{\varphi(\Delta,\sigma)}$, ${q_{Sf}}^{*I} = \frac{8\sigma^2+26\sigma+21}{\varphi(\Delta,\sigma)}$, where $\varphi(\sigma) = 17\sigma^3 + 81\sigma^2 + 128\sigma + 67$.

b) ${q_{Ec}}^{*I} = \frac{6\sigma^3+25\sigma^2+34\sigma+15}{\varphi(\Delta,\sigma)}$, ${q_{Ef}}^{*I} = \frac{3\sigma^2+8\sigma+5}{\varphi(\Delta,\sigma)}$.

Proposition 8. In our model of private oligopoly where copper and fiber connections are considered perfect substitutes $\theta \to 1$, prices, companies' profits and consumer surplus are at,

$a)$ $\pi_S^{*I} = \frac{9\sigma^3 + 47\sigma^2 + 81\sigma + 46}{2\varphi(\Delta,\sigma)}$, $\pi_E^{*I} = \frac{(5+3\sigma)^3(1+\sigma)^2(2+\sigma)}{2(\varphi(\Delta,\sigma))^2}$,

$b)$ $p^{*I} = \frac{6\sigma^3+25\sigma^2+34\sigma+15}{\varphi(\Delta,\sigma)}$, $CS^{*I} = \frac{1}{2} \cdot [\frac{11\sigma^3+56\sigma^2+94\sigma+52}{\varphi(\Delta,\sigma)}]^2$.

The above two propositions state that, under private oligopoly, both the former state-owned provider and the entrant attain higher profits, whereas the final price is higher than under a mixed

oligopoly and the consumer surplus is lower. This is a consequence of the market power exerted under a private oligopoly.

4.3 Incentives to invest in the infinitely repeated game.

With the information from the previous sections, we are in position to analyze the incentives to invest of the entrant company. When the entrant operator *E* invest, it incurs in a fixed cost $F > 0$ during a period. Then, the net profitability at period t is $\pi_E^N - F$. From the period $t+1$ profits are at π_E^I. Hence, the entrant operator invest in the infinitely repeated game if and only if,

$$(\pi_E^N - F) + \frac{\mu}{1-\mu}\pi_E^I > \frac{1}{1-\mu}\pi_E^N.$$

By solving this inequality we may characterize the Subgame Perfect Nash Equilibrium (SPNE, hereinafter). The entrant company invests if and only if,

$$\mu > \frac{F}{\pi_E^I + F - \pi_E^N}.$$

Notice that the following partial derivatives holds:

$$\frac{\partial \mu}{\partial F} > 0, \quad \frac{\partial \mu}{\partial \pi_E^I} < 0, \quad \frac{\partial \mu}{\partial \pi_E^N} > 0.$$

First, as the fixed cost of deployment of the new infrastructure increases, the incentive to invest decreases. The same result holds if the profitability when the entrant does not invest increases. Second, when the profitability of invest in NGA increases, the incentive to invest also increases.

5. Concluding remarks.

In this paper we are addressed the issue of investment incentives in NGA infrastructure by an entrant company in the broadband telecommunications market in developing countries. We assume that the incumbent company either is privatized or remains under public hands. Moreover, ADSL and NGA access are considered perfect substitutes due to that the main concern of consumers when the percapita GDP is low is the affordability of the broadband services, no matter the quality and speed it may provide. We consider both scenarios: where the entrant company does not invest and when the entrant company decide to invest.

First, we found that for consumers is always better if the government decide not to privatize the state-owned firm, as it provides a higher consumer surplus than when this company is privatized. However, from companies' point of view it is better to privatize, as it provides higher profits. The level of direct cost and the access fees to access the unbundled local loop also affect the equilibrium values.

Second, when we analyze in an infinitely repeated game the investment decision by the entrant company, we found that as access fees decrease and direct cost also decrease, the incentive to invest is weak. Moreover, fixed (and sunk) cost due to the deployment of infrastructure also negatively influences in the investment decision. The contrary holds when these parameters evolve inversely. Finally, consumer surplus is higher than in the previous situation when the entrant company invest. The intuition is that this decision enhance competitiveness.

Our results call for attention of the regulatory authorities. In particular, access fees can be used to incentive the investment decision but, at the same time, decrease (at least in the short run) consumer surplus. Moreover, as technology improvements facilitates the use of NGA technologies, direct cost may decrease which enhance the investment decision.

This paper study a particular case of the broadband access in developing countries. The assumptions undertaken in order to facilitate the tractability of the model yields to particular results. Future research may include the study of the market under different specifications. In particular, a market with more than two companies, different assumptions on product substitutability, and other costs specification to cope with different market situations. All these extensions are out of the scope of this work and there will be undertake in a future research.

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

Abstract

This study analyses operators' behavior in the Moroccan mobile market and the regulatory measures adopted since the liberalization process began. We use market and regulatory explanatory variables to explain the evolution of the market during the period 2004-2020. First, we present concentration indexes. Second, we conduct statistics and econometric analysis. Overall, we can argue that, although concentration remains high, the extent to which competition is enhanced strongly depends on the interconnection fees and the penetration rate, whereas the grade of privatization of the state-owned firm has a lower impact. Moreover, our findings reveal that telecom operators exert a high market power although market shares change over the period. These features suggest that mobile operators did not follow anticompetitive practices in order to restraint competition.

Keywords: Liberalization, Privatization, Regulatory measures, Mobile telecom market, Market power.

JEL Classification: D21, D22, L13, L40

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 telecommunications sector began in the last decades of the 20th century. A general assessment of the Latin America context can be found in Gutiérrez and Berg (2000), while Singh (2000) studies the Asia context, and Lee (2002) investigates the case of Malaysia. 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 partially been or totally privatized.[17] 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, telecommunications 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 telecommunications markets in developing countries. Moshi and Mwakatumbula (2017) analysed how regulation and political conditions

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

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 play in telecommunications 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 is low whereas digital exclusion remains at a high level. 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 Nationale de Réglementation des Télécommunications* (ANRT, hereinafter), the national regulatory authority of the Moroccan telecommunications 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 telecommunications market that took place in the early 21st 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.[18] The former state-owned mobile operator Itissalat al-Maghrib (IAM, hereinafter) and two private operators are the main providers of mobile services that account for the majority of all internet connections.[19] Since 2015, the three mobile network operators have benefited from new long-term evolution (LTE, hereinafter) licenses to exploit mobile data services.[20] These new LTE licenses ensured conditions to reach at least 65% of the population by 2020. Moreover, within the Maroc Digital

[18] 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).

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

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

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 telecommunications 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 21st century. A number of studies investigate competition, policy measures, investments, consumers' attitude, and other aspects related to the market. Valaskova et al. (2019) analyse 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 postpaid subscribers, the outgoing voice traffic, and the population dimension affect market shares; which in turn determines the competitiveness between companies.[21]

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

[21] Thorough the paper we call *prepay* to prepay customers (also referred to as pay-as-you-go). It refers 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 connection. We call *subscribers* to postpaid subscribers. It refers 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.

study. Moreover, other market indexes show that the companies capture customers from each other. Overall, we have not found evidence 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 telecommunications 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 telecommunications 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 21st century. It put pressure on liberalization of the market, breaking the natural monopoly of the state-owned telecommunications provider. The first step 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 telecommunications operator IAM, and the postal operator BAM (Barid al Maghrib). On the other hand, the national regulatory authority of the Moroccan telecommunications 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 Itissalat 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 might also be a response to governmental financial interest (World Bank, 2016).

Since the early 21st century, the government reduced entry barriers by granting new licenses 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,).

OM began to operate in 1999 after getting a GSM (Global System for Mobile Communications) license.[22] 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.

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

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 telecommunications 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. Although the ANRT is dependent on the Moroccan government, it is very important that the agency has already defined regulatory rules keeping transparency in order to enhance competition among operators. It will incentivize foreign investment that improves the telecommunications network as well as the potential entry of new competitors.[23] 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

[23] In the EU and US, regulatory agencies also depend on the government, issuing independent assessments about the market under study that, in most of the cases, are binding. Accordingly, sectorial polices are launched in line with them.

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. From Figure 1.a, we can observe that 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. Moreover, from 2010III ANRT applied an asymmetric policy between the two incumbent operators as well. Since then (see Figure 1.b), it has been the usual policy except for the period 2013III to 2017I, when symmetric termination rates were applied once more. From 2017II, asymmetry has been applied according with the inverse order of the observed market shares. 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 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.

Figure 1.a. Termination rates, in US$.

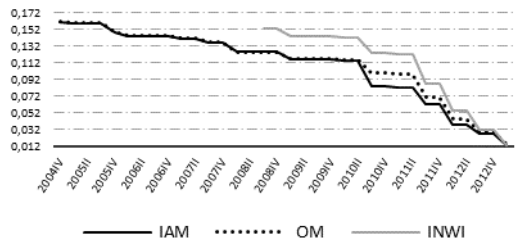
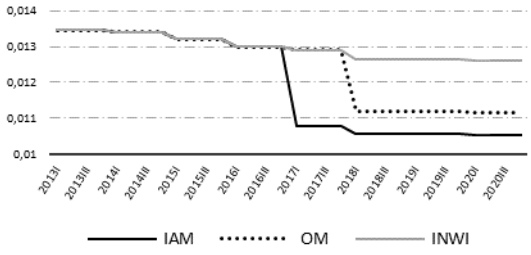


Figure 1.b. Termination rates, in US$.



Source: own elaboration.

The impact of termination rates on prices, welfare and companies' profits has already been studied. Termination rates may affect the differential between on-net and off-net prices. Hoernig (2007) find that if the utility of receiving calls is taken into account, the equilibrium pricing structures will indeed depend on firms' market shares. In particular, he found that larger operators would charge higher off-net prices. In the case of Morocco, INWI has the highest termination rate, which might contribute to increase the off-net price that a customer of IAM and OM, the two largest operators, pay to call a customer of INWI. It favors INWI, which may extract surplus by charging an off-net price similar (but below) to its competitors, increasing the income from off-net calls. Moreover, 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.[24] 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.

Finally, 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

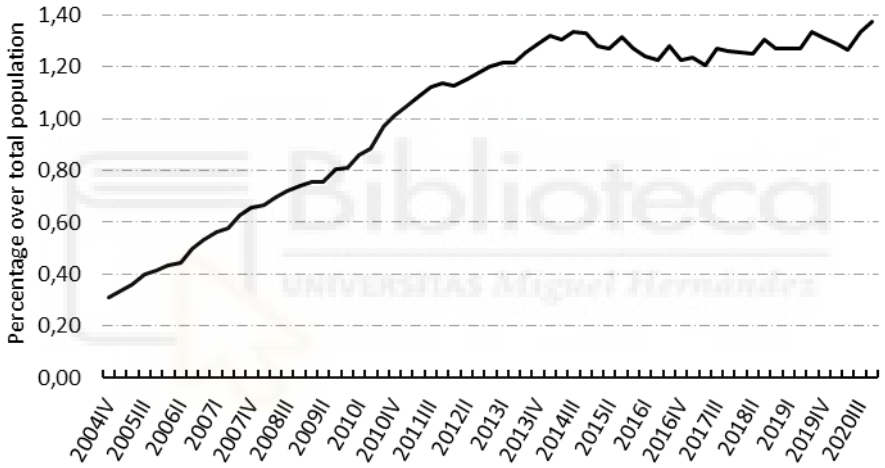
[24] Mobile termination rates in the presence of network externalities is studied in Hurkens and López 2014.

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 telecommunications market. The expansion of the mobile market benefited from the huge penetration rate (see Figure 2), which rose from 34.23% in 2004 to 137.47% in 2020 (ANRT, 2020).

Figure 2. Mobile penetration rate.



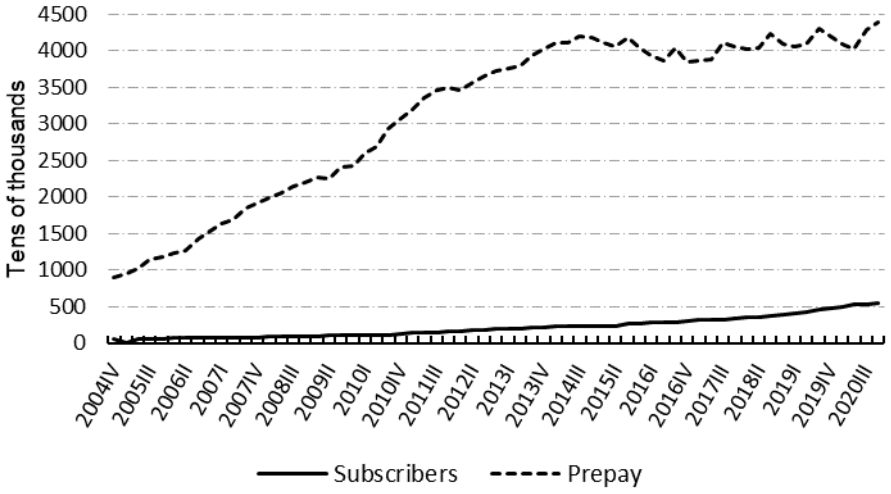
Source: own elaboration.

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 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 analysed 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 and Verboven (2001) analysed mobile service diffusion in Europe. They found that the transition to the digital technology and the increase in spectrum capacity contribute to the diffusion of mobile telecommunications. Moreover, in a study focused on Eastern Europe, Gruber (2001) 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 telecommunications 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 a 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.

Figure 3. Customers by type of contract.



Source: own elaboration.

The widespread contract to access mobile services is prepay, whereas a subscriber contract exhibits a flat evolution within the period studied (see Figure 3). 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's ARPM (average revenue per minute) has decreased more than subscribers' ARPM (ANRT, 2020). It may indicate that, as long as the amount of prepay customers increases, companies compete in quantities attracting customers through programs of promotions, which in turn encourage competitiveness in the prepay segment.

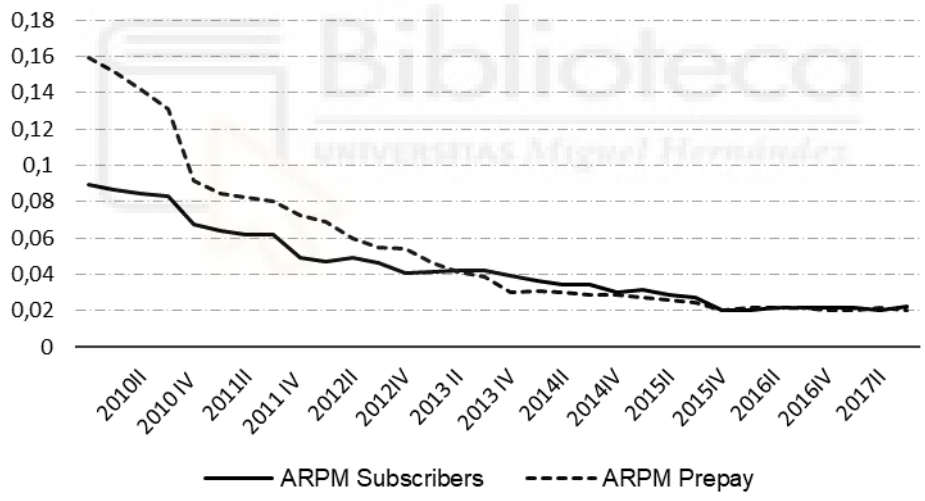
The analysis of pricing structure is difficult, because the availability of data having time-series structure is scarce. Overall, we can argue that prices decreased over the period under study. To support this insight we provide in Figure 4 available quarterly ARPM from 2010 to 2017.[25] One can see that both, prepay and subscriber ARPM decrease over the period. Indeed, although the continuous growth of the penetration rate has presented new opportunities for the operators, it has led to a reduction in price margins because of the aggressive price competition. Moreover, the asymmetry of termination rates may affect the price formation. The intuition behind is that, as marginal cost are almost constant, termination rates affect off-net prices and consequently, the

[25] According to ANRT, available ARPM data only covers the period 2010-1017.

ARPM. Thus, if ARPM is decreasing over the period, it may come from to the fact that prices are decreasing as well.

In addition, mobile plans and sales promotions vary during the year, although operators offer similar products to capture customers. It also reveals a fierce competition among operators. For instance, in 2013, where termination rates were symmetric and the market shares of the firms become stable, operators offered similar products (*Jawal* by IAM, *Tic Tac* by INWI, and *Meditel jahiz mix* by OM).[26] Furthermore, the tariff was unique across operators and the billing structure were per second instead per minute. Operators put the emphasis on capturing high-income customers to offer them added-value services such as data services and the upcoming 5G broadband network. In viewing the pricing evidence available, we may argue that the liberalization favored competition.

Figure 4. ARPM, in US$.



Source: own elaboration.

It is also interesting to revise the government strategy in the telecommunications sector. The development of the liberalization process has in large part been guided by a series of rules known as General Orientation Directives (Notes de Orientation Générale) launched by the ANRT. The first of these directives was the 2004-08 NOG, which underlined the importance of market liberalization, followed by the 2006-08 NOG, which focused on the expansion of

[26] A webpage to check the available products is at https://www.tic-maroc.com/.

telecommunications services across the more isolated areas. The third NOG was announced by the ANRT in 2010 to encourage the continued development of the sector, putting an emphasis on the need to attract private investment into telecommunications. Finally, the fourth NOG covers policy goals for the sector from 2018, and it is expected to focus on new areas of growth for telecommunications, such as the expansion of data services (Oxford business group, Morocco Report 2018).

Other regulatory and governmental 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 telecommunications 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 unaffordable by a significant part of the Moroccan population.

4. Data collection and methodology

The procedure used to analyse 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.[27]

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

[27] Although it is out of the objective of this paper, the issue of privatization and its impact on competition can be modelled by using a Cournot competitive model. Letting the number of operators free and the level of privatization between zero and one, should be a good approximation if the aim of the paper was to model the operators' strategic behavior from a theoretic point of view. Assuming constant marginal cost (as it is usual in telecommunications markets), a general result in this setting is that there is a trade-off between the number of operators and the level of privatization. In particular, the higher the number of operators, the lower the number of equities in public hands, keeping constant a given level of social welfare. As we have a constant number of operators, the level of privatization and the asymmetry among market shares are relevant to study the evolution of this market.

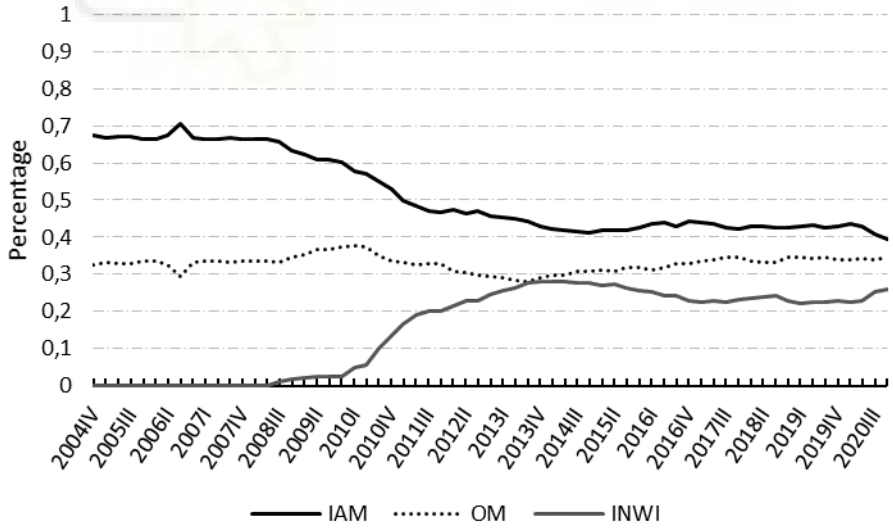
contracts a customer may subscribe are different (duration, capacity and quality, among other features), the final service is considered homogeneous. Because of that, and the low elasticity of demand (once the service is affordable, a given customer pays to get access) market shares become a good approach to measure the evolution of competitiveness. Table 1 presents the descriptive statistic of companies' market shares. Figures 5 and 6 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

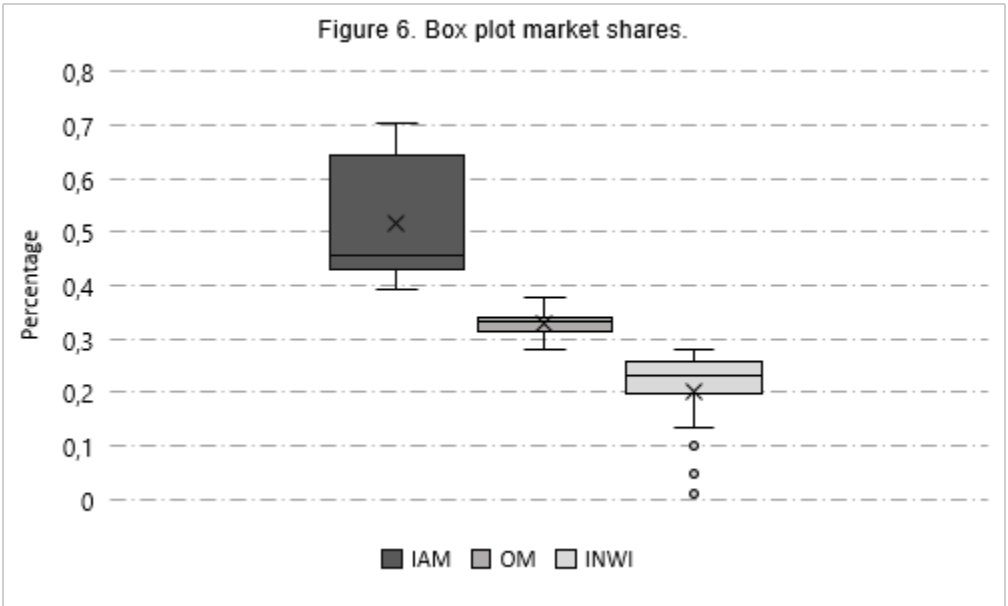
The mean ($Mean$) and standard deviation (sd) indicate that, although IAM has the highest mean, its coefficient of variation (CV) presents an average value. The mean of the market share of INWI is minimum whereas for OM it is in the middle with the lowest coefficient of variation. These observations 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 5 shows the evolution of market shares of the three companies.

Figure 5. Market shares.



Source: own elaboration.

Overall, one can see that IAM's market share declines over the whole period. As the number of customers increases (see Figure 3), it seems that most of them were captured by INWI that continued such an active behavior during its first periods in the market.



Source: own elaboration.

Figure 6 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,

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

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 a few dominant companies or pure monopoly in the limit. Otherwise, it is considered that the industry is non-concentrated if the index equals the inverse of the number of firms

(assuming that all the firms are equal), while the market is moderately concentrated when the index approaches this value.[28]

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.[29]

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,

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

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 7 presents the evolution HHI, CR_2, and RE over time.

[28] When the number of firms is relatively high, a value of HHI above 0.25 represents a highly concentrated industry where firms exert a very high market power (US Horizontal Merger Guidelines, 2021). However, in a market with only three firms a high concentration should approach an observed HHI well above 0.333.
[29] Notice that we can use CR_2 in a dynamic sense because the position of the companies regarding the level of market shares remains unaltered during the whole period.

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

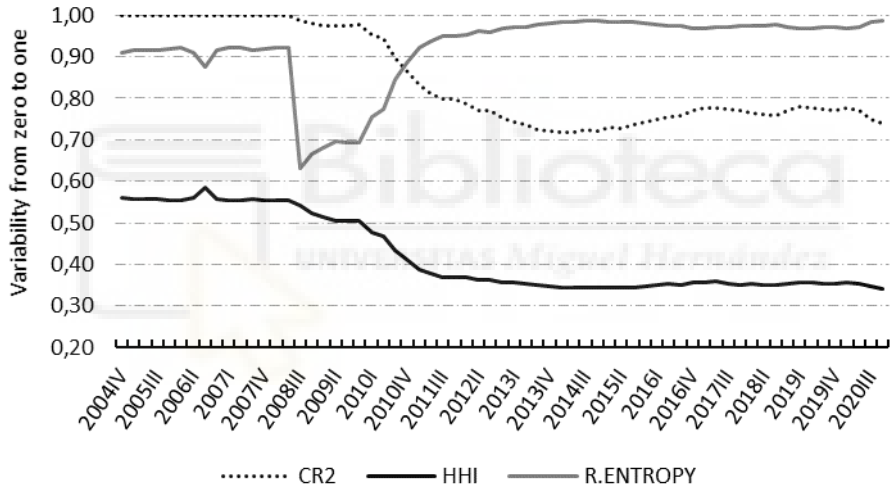
P-value (p): $*** \ p < 0.01$

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. 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. Moreover, RE is inversely correlated with HHI and CR_2; i.e., as concentration indexes decrease, the probability to lose a customer increases. In other words, 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. Finally, relative RE is high, which implies significant movements of customers among companies during the period.

Figure 7 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. Indeed, in a market with three operators the lower bound value is 0.333. According to US antitrust authorities, we may argue that, this value is lower enough, so 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.[30] The inclusion of the index CR_2 is also relevant because the ranking of the two operators with the highest market share, MEDI and OM, remains unaltered under the period of study. It reinforce the idea that these operators are dominant firms, whereas INWI is the operator who fight against them to capture customers, inducing competition in the market. 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 authority stablished a standard termination rate for the three firms, the index remained stable around the value 0.98.[31]

Figure 7. Concentration indexes.



Source: own elaboration.

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,

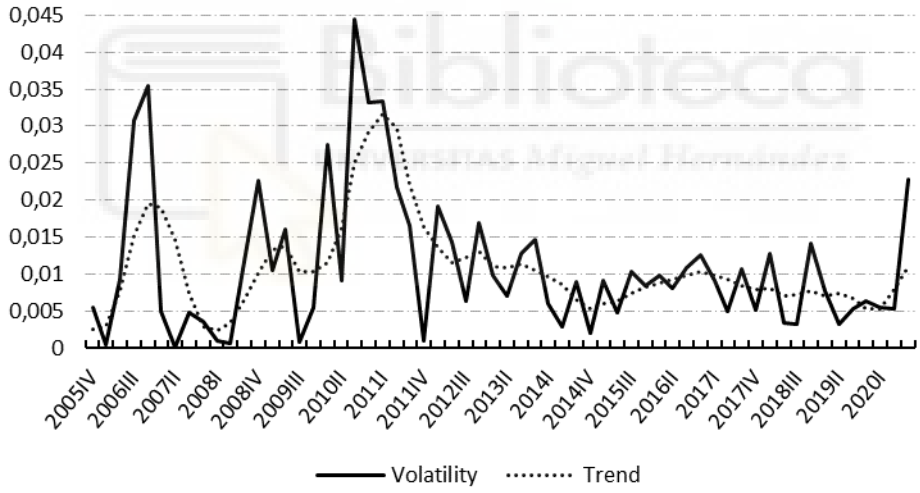
[30] Average prices of mobile telephone services decreased over this period by 50% according to ANRT reports (https://www.anrt.ma/en/publications/notes-dorientations-generales).
[31] The drop observed in 2008III was due to a technical reason: the denominator of the index jumped from $ln2$ to $ln3$.

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

where $S_{i,t}$ and $S_{i,t-1}$ are the firms' market shares in two correlative periods.

Figures 8.a and 8.b report the volatility index and trend, and its seasonality, respectively. Figure 8.a points out that the volatility index has experienced a huge increase during some quarters since 2008III, when the company INWI entered the market. Later on, it became stable within the period 2013-2019, when market shares were stable as well (see Figure 5). It coincides with the period when penetration rate was stabilized and termination rates were symmetric. At the end of the period under study the index shows a slight increase in its evolution, which coincides with the increase of INWI's market share.

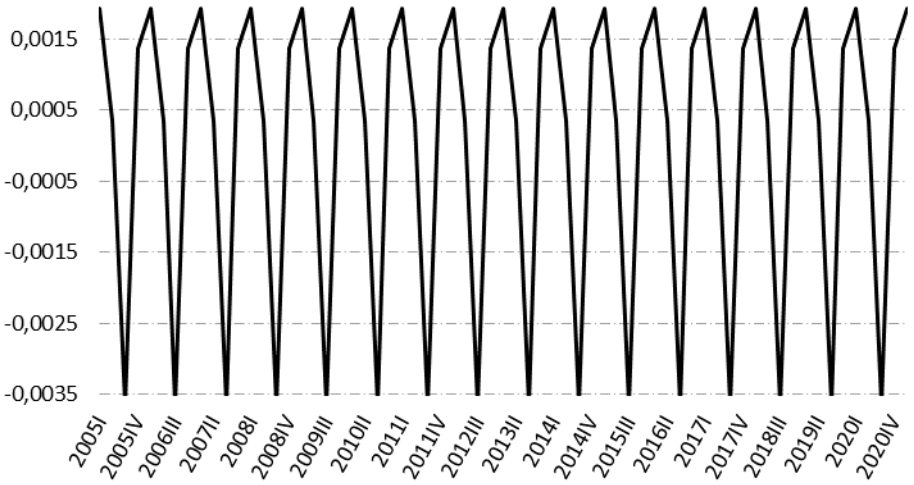
Figure 8.a. Volatility and trend.



Source: own elaboration.

Seasonality (Figure 8.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 8.b. Seasonality.



Source: own elaboration.

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, which in turn explains the evolution of the concentration indexes. 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 (adjusted 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.

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. 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 5) and the explanation further below when analyzing the population characteristic.

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
Pre	-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): $***\ p < 0.01,\ **\ p < 0.05,\ *\ p < 0.1$

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. We argue 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.[32]

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.

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

[32] 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.

share can be positive, the number of OM subscribers may decrease whereas increases in the OM prepay lines offset the subscribers' negative effect.

Finally, we run a supplementary analysis in order to investigate the extent to which the new operator INWI affects concentration (HHI) and the outgoing voice traffic (OVT). By using the available data, we run two linear regression models. The first one takes as dependent variable the Herfindahl-Hirschman index (HHI), whereas the second one takes the outgoing voice traffic (OVT). We take the data set from 2008III, when INWI enters the market. As explanatory variables, we include the weighted mean termination rate of the two incumbents (the two largest operators),

$$WMTRI_t = \frac{\sum_{i=1}^{2} MS_{it} \cdot TR_{it}}{\sum_{i=1}^{2} MS_{it}}.$$

Termination rate asymmetry between incumbents and the entrant operator is,

$$TRA_t = \left|WMTRI_t - TR_{INWI_t}\right|$$

As we lack of prices' data set, we use market shares as a proxy of prices (the larger the market share, the higher the ability to set prices above marginal costs). First, we define the weighted average market share of the two incumbent operators (*WAMSI*),

$$WAMSI_t = \frac{\sum_{i=1}^{2} {MS_{it}}^2}{\sum_{i=1}^{2} MS_{it}}.$$

Hence, the market share differences, $MSDIF_t$, as a proxy of price differences is defined as the difference between $WAMSI_t$ and MS_{INWI_t},

$$MSDIF_t = \left|WAMSI_t - MS_{INWI_t}\right|.$$

Finally, we take the difference between one and two periods lagged values of $MSDIF_t$. We denote this differential as follows,

$$\Delta MSDIF_t = MSDIF_{t-1} - MSDIF_{t-2}.$$

We take as dependent variables the HHI_t and OVT_t. As independent variables, we take average termination rate ($WMTRI_t$) of the two incumbents, average termination rate asymmetry (TRA_t), and lagged market shares differential between the incumbents and the new entrant operator ($\Delta MSDIF_t$):

$$HHI_t = \alpha + \beta_1 \cdot WMTRI_t + \beta_2 \cdot TRA_t + \beta_3 \cdot \Delta MSDIF_t + \varepsilon_{it},$$

$$OVT_t = \alpha + \beta_1 \cdot WMTRI_t + \beta_2 \cdot TRA_t + \beta_3 \cdot \Delta MSDIF_t + \varepsilon_{it}.$$

Table 6 reports estimated values ranked by adjusted R^2. Additional statistical test have been run to withdraw those specifications with multicollinearity (which can be caused by a linear combination between the average termination rate and the average termination rate asymmetry).

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Table 6. Econometric analysis of *HHI* and *OVT* since the entrance of *INWI*.

VARIABLES	(1) HHI	(2) HHI	(3) HHI	(4) HHI	(5) OVT	(6) OVT	(7) OVT	(8) OVT
$WMTRI_t$			0.130*** (0.00763)	0.147*** (0.00677)			-10.30*** (0.522)	-9.681*** (0.567)
TRA_t		0.362*** (0.0403)				-32.61*** (2.076)		
$\Delta MSDIF_t$	-0.703 (0.440)			0.846*** (0.151)	131.0*** (29.72)			29.27** (12.67)
Constant	0.375*** (0.00881)	0.347*** (0.00623)	0.330*** (0.00432)	0.330*** (0.00338)	11.22*** (0.594)	13.13*** (0.321)	14.18*** (0.296)	14.19*** (0.283)
Observations	50	50	50	50	50	50	50	50
Adjusted R^2	0.031	0.620	0.855	0.911	0.273	0.834	0.888	0.897

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

We observe that the regression with the highest R^2 includes the average termination rate of the two incumbents and the proxy of the lagged price differential. They have positive and statistically significant effects on the *HHI*. The intuition behind is that, as the convergence among the operators' market share takes place, the *HHI* decreases. Indeed, the estimated coefficient in regression (4) of the lagged market share differential (the proxy of price), $\hat{\beta}_3$, is positive. Moreover, the estimated coefficient of the average market share of the incumbents, $\hat{\beta}_1$, is positive.

When we move to the analysis of the *OVT*, the highest R^2 also corresponds to the multiple linear regression including the average termination rate of the two incumbents and the proxy of the lagged price differential (regression 8). In the case of the average termination rate the estimated coefficient, $\hat{\beta}_1$, is negative whereas the coefficient $\hat{\beta}_3$ is positive for the lagged market share differential, both being statistically significant. A possible explanation of decreasing *OVT* when the average termination rate of the incumbents increases, is that customers switch from the traditional voice communication channel towards the new communication opportunities through the social networks platforms that use data. Indeed, the new entrants may compete by offering data at lower prices as a result of the easy technology access. We still may observe the direct effect of the lagged market share differential (the proxy of prices) on *OVT*; i.e., the higher the convergence, the lower the *OVT*, which reinforces the intuition of the technology substitution as the competitiveness increases.

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 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.

The evolution of operators' competitive behavior during the period under study seems to be determined by the technology access, the regulatory body of rules, the evolution of the demand, and the level of privatization of the state-owned operator. As the technology is widely spread, the quality of the services is similar no matter the company that provides the network connection, and the demand has continuously increased, the only way to increase profits is to compete for attracting customers, which yields to lower prices. Indeed, as the market share increases off-net prices decrease because the termination rates payment also decreases, yielding to overall lower prices. As long as all the companies follow this behavior, market power cannot be exerted largely, keeping operators' profitability in relative normal levels and thus, enhancing consumer surplus. Moreover, policy measures of privatization of the state-owned company, as well as market forces, such as the increase of the penetration rate, have incentivized companies to capture new customers contributing to become the market more competitive, especially with regard to prepaid programs.

Concerning the opportunity to enter a fourth operator, although desirable in order to increase competitiveness that keeps prices relative low, it depends on a number of reasons. First, the increase of data services and the expansion of the 4G and the recent 5G technology may increase the expected profits in the mobile market. Second, it is necessary that increases on the demand could be maintained over time, which in turns depends on the further increases of the penetration rate, the consumers' affordability for telecommunication services, and the variety and quality of services that operators may offer to the customers. Third, price-cost margins should be enough to incentivize the entry of a new operator, which strongly depends on the ability to exert market power by part of the operator companies. Fourth, the regulatory authorities must provide a clear and stable regulation framework. In addition, after some years of mergers and acquisitions among

telecommunications companies, the number of main operators in OECD countries ranges from three to five. Thus, it seems that the entry of the fourth operator in the Moroccan market could be in line with the situation observed in developed countries, but it depends on the fulfillment of the above features. Moreover, 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.

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5. Conclusiones

En esta tesis doctoral hemos analizado varios aspectos de la evolución del mercado de telecomunicaciones marroquí. En el capítulo 2, analizamos la evolución de la competitividad en el mercado marroquí de las telecomunicaciones a través de las medidas de la concentración del mercado. Presentamos una descripción del mercado haciendo hincapié en la evolución del mercado minorista en el sector fijo y móvil y realizamos un análisis de la concentración de mercado para ver cómo ha evolucionado la competencia desde que se produjo la liberalización. También realizamos un análisis econométrico sobre los determinantes de la concentración del mercado tanto a nivel agregado como dentro de cada mercado, fijo y móvil, considerando indicadores sociodemográficos y microeconómicos sectoriales como sus determinantes.

En general, encontramos que el mercado es competitivo a nivel agregado. Sin embargo, un análisis más detallado de los mercados revela que el sector fijo sigue concentrado, principalmente porque el acceso a la banda ancha es escaso. Por el contrario, el mercado móvil es competitivo, principalmente porque el acceso a los dispositivos móviles es más barato en comparación con las conexiones fijas. Además, la expansión de Internet móvil ha aumentado el número de abonados, lo que favorece a los operadores que invierten en la red móvil.

El análisis econométrico nos permite sacar conclusiones interesantes. En efecto, El mercado de las telecomunicaciones es complejo y la determinación de los factores relevantes que estimulan la inversión es una información útil para que las autoridades reguladoras adopten un marco político óptimo. Nuestros resultados sugieren la existencia de dos mercados diferentes, aunque la competencia en cada uno de ellos puede estar determinada por factores similares. Encontramos algunos efectos robustos de las variables exógenas que explican la evolución del HHI. El atractivo del sector para la inversión desempeña un papel crucial en el fomento de la competitividad en el mercado, teniendo en cuenta la relación negativa y significativa entre la probabilidad de conexión a Internet móvil y el HHI para el mercado móvil. Además, en cuanto al impacto del PIB per cápita en la competitividad del mercado, encontramos que tiene un impacto negativo en el HHI, tanto a nivel agregado como a nivel de cada mercado: a medida que el PIB aumenta el nivel del HHI disminuye, lo que afecta positivamente a la competitividad.

Por último, queremos señalar que nuestro estudio ofrece un panorama general del mercado de las telecomunicaciones. Es cierto que, aunque nuestros resultados son relevantes en el marco de un análisis micro econométrico y puede ofrecer algunas ideas a las autoridades de competencia, es deseable que se realicen más investigaciones en el mercado marroquí de telecomunicaciones. En este sentido, las futuras investigaciones podrían incluir el papel que desempeñan los distintos agentes en el mercado, como las empresas industriales, los municipios y otras autoridades gubernamentales. Además, un análisis en profundidad de los servicios de telecomunicaciones en paquete puede mejorar la comprensión del mercado.

En el capítulo 3, abordamos la cuestión de los incentivos a la inversión en infraestructuras NGA por parte de una empresa entrante en el mercado de las telecomunicaciones de banda ancha en los países en desarrollo. Suponemos que la empresa incumbente se privatiza o permanece en manos públicas. Por otra parte, el ADSL y el acceso NGA se consideran sustitutos perfectos debido a que la principal preocupación de los consumidores cuando el PIB per cápita es bajo es la asequibilidad de los servicios de banda ancha, independientemente de la calidad y la velocidad que puedan ofrecer. Consideramos ambos escenarios: cuando la empresa entrante no invierte y cuando la empresa entrante decide invertir.

En primer lugar, descubrimos que para los consumidores siempre es mejor que el gobierno decida no privatizar la empresa estatal, ya que proporciona un mayor excedente al consumidor que cuando esta empresa se privatiza. Sin embargo, desde el punto de vista de las empresas es mejor privatizar, ya que proporciona mayores beneficios. El nivel de costes directos y las tarifas de acceso al bucle local desagregado también afectan a los valores de equilibrio.

En segundo lugar, cuando analizamos en un juego infinitamente repetido la decisión de inversión por parte de la empresa entrante, encontramos que a medida que las tarifas de acceso disminuyen y el coste directo también, el incentivo para invertir es débil. Además, el coste fijo (y hundido) debido al despliegue de la infraestructura también influye negativamente en la decisión de inversión. Lo contrario ocurre cuando estos parámetros evolucionan de forma inversa. Por último, el excedente del consumidor es mayor que en la situación anterior cuando la empresa entrante invierte. La intuición es que esta decisión mejora la competencia.

Nuestros resultados podrían ser útiles para las autoridades de competencia. En particular, las tarifas de acceso pueden utilizarse para incentivar la decisión de inversión, pero, al mismo

tiempo, disminuyen (al menos a corto plazo) el excedente del consumidor. Además, a medida que las mejoras tecnológicas facilitan el uso de las tecnologías NGA, el coste directo puede disminuir, lo que mejora la decisión de inversión.

Este trabajo estudia un caso particular del acceso a la banda ancha en los países en desarrollo. Los supuestos asumidos para facilitar la concepción del modelo arrojan resultados particulares. La investigación futura puede incluir el estudio del mercado bajo diferentes especificaciones. En particular, un mercado con más de dos empresas, diferentes supuestos sobre la sustituibilidad de los productos, y otras especificaciones de costes para hacer frente a diferentes situaciones de mercado. Todas estas extensiones están fuera del alcance de este trabajo y se acometerán en una futura investigación.

En el capítulo 4, investigamos en qué medida el mercado de la telefonía móvil marroquí es un mercado competitivo durante el periodo 2004III-2020IV. Nuestros resultados sugieren que, tras casi 20 años de proceso de liberalización, el mercado marroquí de la telefonía móvil presenta un grado creciente de competencia, en el que operan tres empresas activas. El antiguo monopolio, la empresa estatal IAM, ha sido privatizado en gran medida. En 2020, el 78% de las acciones totales estaban en manos privadas. Las cuotas de mercado de los tres operadores tienden a ser similares. Esto se debe principalmente a las continuas pérdidas de cuota de mercado de IAM en favor de INWI, que parece ser más agresiva a la hora de captar clientes. Además, la evolución de los índices de concentración, las estadísticas descriptivas y los resultados del análisis econométrico han arrojado luz sobre el grado de competencia.

El panorama general de la evolución del mercado es que IAM ha perdido clientes a medida que el mercado se hacía más competitivo. Durante el periodo de duopolio, OM robó clientes a IAM, mientras que desde 2008III, INWI ha sido más agresivo y OM ha mantenido una evolución relativamente plana de su cuota de mercado. Una posible explicación para sostener estas conclusiones es la siguiente. Con el objetivo de retener a los clientes, OM ha estado aplicando una estrategia conservadora mediante el uso de programas de fidelización, lo que reduce la competencia al mantener una menor variación de la cuota de mercado. Además, OM podría haberse concentrado en las zonas urbanas, donde los costes operativos son menores que en las zonas rurales. Por lo tanto, OM podría dejar el mercado rural a INWI y centrarse en la

captación de clientes en las zonas urbanas, donde la población aumenta considerablemente. Por último, dado que una empresa financiera gubernamental posee el 8% del total de las acciones de OM, podría evitar estrategias agresivas para mantener la rentabilidad de la empresa reduciendo el nivel de incertidumbre.

La evolución del comportamiento competitivo de los operadores durante el periodo estudiado parece estar determinada por el acceso a la tecnología, el cuerpo normativo, la evolución de la demanda y el nivel de privatización del operador estatal. Como la tecnología está muy extendida, la calidad de los servicios es similar independientemente de la empresa que proporcione la conexión a la red, y la demanda ha aumentado continuamente, la única forma de aumentar los beneficios es competir por la captación de clientes, lo que se traduce en precios más bajos. De hecho, a medida que aumenta la cuota de mercado, los precios fuera de la red disminuyen porque el pago de las tarifas de terminación móvil también disminuye, lo que da lugar a precios más bajos en general. Mientras todas las empresas sigan este comportamiento, el poder de mercado no podrá ejercerse en gran medida, manteniendo la rentabilidad de los operadores en niveles relativamente normales y, por tanto, aumentando el excedente del consumidor. Además, las medidas políticas de privatización de la empresa estatal, así como las fuerzas del mercado, como el aumento del índice de penetración, han incentivado a las empresas a captar nuevos clientes contribuyendo a hacer el mercado más competitivo, especialmente en lo que respecta a los programas de prepago.

En cuanto a la oportunidad de entrar de un cuarto operador, aunque es deseable para aumentar la competitividad que mantiene los precios relativamente bajos, depende de una serie de razones. En primer lugar, el aumento de los servicios de datos y la expansión de la tecnología 4G y la reciente 5G pueden aumentar los beneficios esperados en el mercado móvil. En segundo lugar, es necesario que los aumentos de la demanda se mantengan en el tiempo, lo que a su vez depende de los nuevos aumentos de la tasa de penetración, la asequibilidad de los consumidores para los servicios de telecomunicaciones y la variedad y calidad de los servicios que los operadores pueden ofrecer a los clientes. En tercer lugar, los márgenes precio-coste deben ser suficientes para incentivar la entrada de un nuevo operador, lo que depende en gran medida de la capacidad de ejercer poder de mercado por parte de las empresas operadoras. En cuarto lugar, las autoridades reguladoras deben proporcionar un marco de regulación claro y estable.

Además, tras algunos años de fusiones y adquisiciones entre empresas de telecomunicaciones, el número de operadores principales en los países de la OCDE oscila entre tres y cinco. Así pues, parece que la entrada del cuarto operador en el mercado marroquí podría estar en consonancia con la situación observada en los países desarrollados, pero depende del cumplimiento de las características anteriores. Por otra parte, cabe mencionar que, según resultados recientes, la difusión de las tecnologías de las telecomunicaciones favorece el aumento del PIB y la reducción de la desigualdad (Banco Mundial, 2016). Por lo tanto, el despliegue de los servicios móviles y su asequibilidad pueden mejorar el desarrollo de la economía marroquí.

5’. Conclusions

In chapter two, we analyze the evolution of competitiveness in the Moroccan telecommunications market through market concentration. We present a description of the market emphasizing the evolution of the retail market in the fixed and mobile sector and conduct an analysis of market concentration to see how competition has evolved since liberalization took place. We also carry out an econometric analysis on the determinants of market concentration both at an aggregate level and within each market, fixed and mobile, contemplating sociodemographic and sectoral microeconomic indicators as its determinants.

Overall, we found that the market is competitive at an aggregate level. However, a further inspection by markets reveals that the fixed sector remains concentrated, mainly because broadband access is scarce. In contrast, the mobile market is procompetitive mainly because the access to mobile devices is cheaper compared to fixed connections. Moreover, the expansion of mobile internet has increased the number of subscribers, which favors operators investing in the mobile network.

We can also extract interesting results from the econometric analysis. The telecommunications market is complex and the determination of the relevant factors that stimulate investment is useful information for regulatory authorities to adopt an optimal policy framework. Our findings suggest

the existence of two different markets, although the competitiveness in each market can be determined by similar factors. We find some robust effects of variables that explain the evolution of the HHI. Sector attractiveness for investment plays a crucial role in fostering competitiveness in the market, considering the negative and significant relationship between probability of internet connection having mobile internet and HHI for the mobile market. Furthermore, regarding the impact of GDP per capita on the market competitiveness, we find that it has a negative impact on the HHI, both at an aggregate level and by markets: as GDP increases the level of HHI decreases, which positively affects competitiveness.

Finally, we want to point out that our study gives a general picture of the telecommunications market. Admittedly, although our results are relevant in the framework of a microeconometric analysis and it may offer some insight for competition policy authorities, further research is desirable in the Moroccan telecommunications market. In this vein, future investigations may include the role that different players have in the market, such as industrial firms, municipalities and other governmental authorities. Moreover, a deep inspection of bundled services may enhance the understanding of the market.

In chapter three, we are addressed the issue of investment incentives in NGA infrastructure by an entrant company in the broadband telecommunications market in developing countries. We assume that the incumbent company either is privatized or remains under public hands. Moreover, ADSL and NGA access are considered perfect substitutes due to that the main concern of consumers when the percapita GDP is low is the affordability of the broadband services, no matter the quality and speed it may provide. We consider both scenarios: where the entrant company does not invest and when the entrant company decide to invest.

First, we found that for consumers is always better if the government decide not to privatize the state-owned firm, as it provides a higher consumer surplus than when this company is privatized. However, from companies' point of view it is better to privatize, as it provides higher profits. The level of direct cost and the access fees to access the unbundled local loop also affect the equilibrium values.

Second, when we analyze in an infinitely repeated game the investment decision by the entrant company, we found that as access fees decrease and direct cost also decrease, the incentive to

invest is weak. Moreover, fixed (and sunk) cost due to the deployment of infrastructure also negatively influences in the investment decision. The contrary holds when these parameters evolve inversely. Finally, consumer surplus is higher than in the previous situation when the entrant company invest. The intuition is that this decision enhance competitiveness.

Our results call for attention of the regulatory authorities. In particular, access fees can be used to incentive the investment decision but, at the same time, decrease (at least in the short run) consumer surplus. Moreover, as technology improvements facilitates the use of NGA technologies, direct cost may decrease which enhance the investment decision.

This paper study a particular case of the broadband access in developing countries. The assumptions undertaken in order to facilitate the tractability of the model yields to particular results. Future research may include the study of the market under different specifications. In particular, a market with more than two companies, different assumptions on product substitutability, and other costs specification to cope with different market situations. All these extensions are out of the scope of this work and there will be undertake in a future research.

In chapter four, 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 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.

The evolution of operators' competitive behavior during the period under study seems to be determined by the technology access, the regulatory body of rules, the evolution of the demand, and the level of privatization of the state-owned operator. As the technology is widely spread, the quality of the services is similar no matter the company that provides the network connection, and the demand has continuously increased, the only way to increase profits is to compete for attracting customers, which yields to lower prices. Indeed, as the market share increases off-net prices decrease because the termination rates payment also decreases, yielding to overall lower prices. As long as all the companies follow this behavior, market power cannot be exerted largely, keeping operators' profitability in relative normal levels and thus, enhancing consumer surplus. Moreover, policy measures of privatization of the state-owned company, as well as market forces, such as the increase of the penetration rate, have incentivized companies to capture new customers contributing to become the market more competitive, especially with regard to prepaid programs.

Concerning the opportunity to enter a fourth operator, although desirable in order to increase competitiveness that keeps prices relative low, it depends on a number of reasons. First, the increase of data services and the expansion of the 4G and the recent 5G technology may increase the expected profits in the mobile market. Second, it is necessary that increases on the demand could be maintained over time, which in turns depends on the further increases of the penetration rate, the consumers' affordability for telecommunication services, and the variety and quality of services that operators may offer to the customers. Third, price-cost margins should be enough

to incentivize the entry of a new operator, which strongly depends on the ability to exert market power by part of the operator companies. Fourth, the regulatory authorities must provide a clear and stable regulation framework. In addition, after some years of mergers and acquisitions among telecommunications companies, the number of main operators in OECD countries ranges from three to five. Thus, it seems that the entry of the fourth operator in the Moroccan market could be in line with the situation observed in developed countries, but it depends on the fulfillment of the above features. Moreover, 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.

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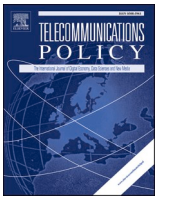

An assessment of the liberalization and the evolution of competition in the Moroccan mobile market

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Market Shares

ABSTRACT

This paper analyses the liberalization process of the Moroccan mobile market since the beginning of the 21 st century. Our database ranges from 2004 to the end of 2020. First, operators' market shares are presented and analysed. 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 restrain competition.

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 telecommunications sector began in the last decades of the 20th century. A general assessment of the Latin America context can be found in Gutiérrez and Berg (2000), while Singh (2000) studies the Asia context, and Lee (2002) investigates the case of Malaysia. 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 favored the liberalization processes in the region. Besides that, in the majority of cases, the former monopolist, the state-owned provider, has partially been or totally privatized.[1] 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

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

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of controlling the market power of service providers and the prosecution of anticompetitive practices to protect consumers.

Traditionally, telecommunications 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 telecommunications 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 play in telecommunications 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 is low whereas digital exclusion remains at a high level. 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 Réglementation des Télécommunications* (ANRT, hereinafter), the national regulatory authority of the Moroccan telecommunications 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 telecommunications market that took place in the early 21st 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. Indeed, IAM has been accused of abuse of dominant position in the fixed-line market by competitors under the period under study (Reuters, 2020). The former state-owned mobile operator Itissalat al-Maghrib (IAM, hereinafter) and two private operators are the main providers of mobile services that account for the majority of all internet connections.[2] Since 2015, the three mobile network operators have benefited from new long-term evolution (LTE, hereinafter) licenses to exploit mobile data services.[3] 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 telecommunications 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 21st century. A number of studies investigate competition, policy measures, investments, consumers' attitude, and other aspects related to the market. Valaskova et al. (2019) analyse 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

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

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

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, p. 8675), 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 postpaid subscribers, the outgoing voice traffic, and the population dimension affect market shares; which in turn determines the competitiveness between companies.[4]

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 evidence 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 telecommunications 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 telecommunications 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 21st century. It put pressure on liberalization of the market, breaking the natural monopoly of the state-owned telecommunications provider. The first step in the liberalization process was the Law 24/96 (Law 24/96, 1997), 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 telecommunications operator IAM, and the postal operator BAM (Barid al Maghrib). On the other hand, the national regulatory authority of the Moroccan telecommunications 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 Itissalat 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 might also be a response to governmental financial interest (World Bank, 2016).

Since the early 21st 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).

OM began to operate in 1999 after getting a GSM (Global System for Mobile Communications) license.[5] 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

[4] Thorough the paper we call *prepay* to prepay customers (also referred to as pay-as-you-go). It refers 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 connection. We call *subscribers* to postpaid subscribers. It refers 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.

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

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 telecommunications 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. Although the ANRT is dependent on the Moroccan government, it is very important that the agency has already defined regulatory rules keeping transparency in order to enhance competition among operators. It will incentivize foreign investment that improves the telecommunications network as well as the potential entry of new competitors.[6] 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 (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 (ANRT, 2015), 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. From Fig. 1 a, we can observe that 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. Moreover, from 2010III ANRT applied an asymmetric policy between the two incumbent operators as well. Since then (see Fig. 1b), it has been the usual policy except for the period 2013III to 2017I, when symmetric termination rates were applied once more. From 2017II, asymmetry has been applied according with the inverse order of the observed market shares. 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 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. Termination rates may affect the differential between on-net and off-net prices. Hoernig (2007) find that if the utility of receiving calls is taken into account, the equilibrium pricing structures will indeed depend on firms' market shares. In particular, he found that larger operators would charge higher off-net prices. In the case of Morocco, INWI has the highest termination rate, which might contribute to increase the off-net price that a customer of IAM and OM, the two largest operators, pay to call a customer of INWI. It favors INWI, which may extract surplus by charging an off-net price similar (but below) to its competitors, increasing the income from off-net calls. Moreover, 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 (ANRT, 2021; Lancaster

[6] In the EU and US, regulatory agencies also depend on the government, issuing independent assessments about the market under study that, in most of the cases, are binding. Accordingly, sectorial polices are launched in line with them.

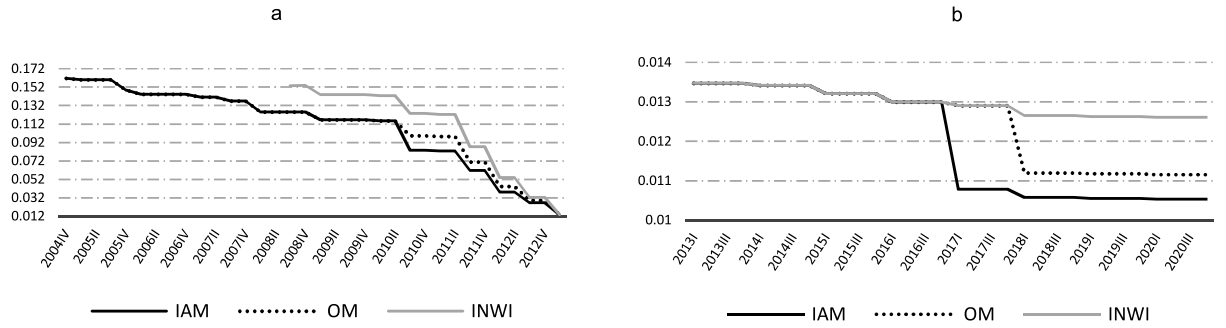

Fig. 1. a. Termination rates, in US$. .b. Termination rates, in US$.
Source: own elaboration.

and Lange 2020). In Hurkens and López (2012), the effect of termination rates in companies' market shares is studied.[7] 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.

Finally, 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 telecommunications market. The expansion of the mobile market benefited from the huge penetration rate (see Fig. 2), which rose from 34.23% in 2004 to 137.47% in 2020 (ANRT, 2021).

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 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 analysed 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 and Verboven (2001) analysed mobile service diffusion in Europe. They found that the transition to the digital technology and the increase in spectrum capacity contribute to the diffusion of mobile telecommunications. Moreover, in a study focused on Eastern Europe, the speed of mobile diffusion is positively linked to the number of firms in the market (Gruber, 2001). 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 telecommunications 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 a 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, Belabes 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.

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

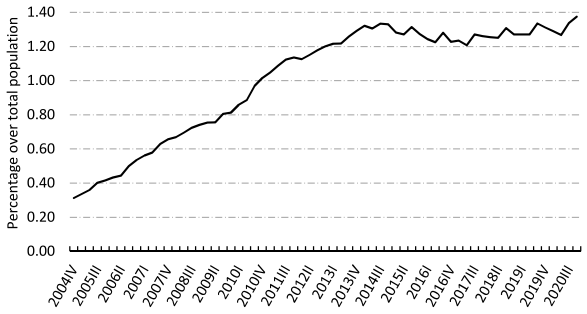

Fig. 2. Mobile penetration rate.
Source: own elaboration.

The widespread contract to access mobile services is prepay, whereas a subscriber contract exhibits a flat evolution within the period studied (see Fig. 3). 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's ARPM (average revenue per minute) has decreased more than subscribers' ARPM (ANRT, 2021). It may indicate that, as long as the amount of prepay customers increases, companies compete in quantities attracting customers through programs of promotions, which in turn encourage competitiveness in the prepay segment.

The analysis of pricing structure is difficult, because the availability of data having time-series structure is scarce. Overall, we can argue that prices decreased over the period under study. To support this insight we provide in Fig. 4 available quarterly ARPM from 2010 to 2017.[8] One can see that both, prepay and subscriber ARPM decrease over the period. Indeed, although the continuous growth of the penetration rate has presented new opportunities for the operators, it has led to a reduction in price margins because of the aggressive price competition. Moreover, the asymmetry of termination rates may affect the price formation. The intuition behind is that, as marginal cost are almost constant, termination rates affect off-net prices and consequently, the ARPM. Thus, if ARPM is decreasing over the period, it may come from to the fact that prices are decreasing as well.

In addition, mobile plans and sales promotions vary during the year, although operators offer similar products to capture customers. It also reveals a fierce competition among operators. For instance, in 2013, where termination rates were symmetric and the market shares of the firms become stable, operators offered similar products (*Jawal* by IAM, *Tic Tac* by INWI, and *Meditel jahiz mix* by OM).[9] Furthermore, the tariff was unique across operators and the billing structure were per second instead per minute. Operators put the emphasis on capturing high-income customers to offer them added-value services such as data services and the upcoming 5G broadband network. In viewing the pricing evidence available, we may argue that the liberalization favored competition.

It is also interesting to revise the government strategy in the telecommunications sector. The development of the liberalization process has in large part been guided by a series of rules known as General Orientation Directives (Notes de Orientation Générale) launched by the ANRT. The first of these directives was the 2004-08 NOG, which underlined the importance of market liberalization, followed by the 2006-08 NOG, which focused on the expansion of telecommunications services across the more isolated areas. The third NOG was announced by the ANRT in 2010 to encourage the continued development of the sector, putting an emphasis on the need to attract private investment into telecommunications. Finally, the fourth NOG covers policy goals for the sector from 2018, and it is expected to focus on new areas of growth for telecommunications, such as the expansion of data services (Oxford business group, Morocco Report 2018).

Other regulatory and governmental 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 telecommunications 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 unaffordable by a significant part of the Moroccan population.

4. Data collection and methodology

The procedure used to analyse telecommunications markets differs from one market to another. It depends on the available data

[8] According to ANRT, available ARPM data only covers the period 2010–1017.
[9] A webpage to check the available products is at https://www.tic-maroc.com/.

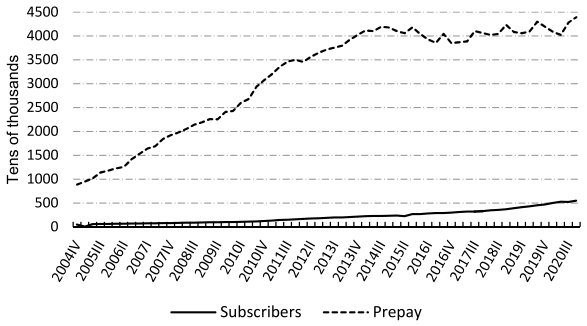

Fig. 3. Customers by type of contract.
Source: own elaboration.

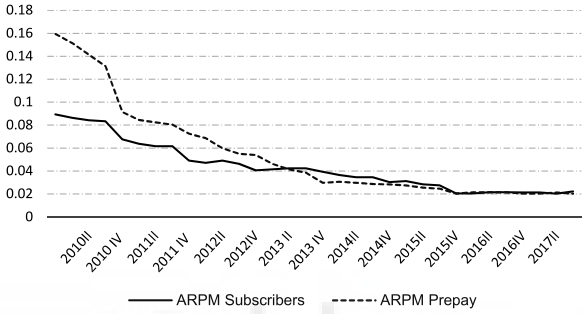

Fig. 4. ARPM, in US$.
Source: own elaboration.

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.[10]

[10] Although it is out of the objective of this paper, the issue of privatization and its impact on competition can be modelled by using a Cournot competitive model. Letting the number of operators free and the level of privatization between zero and one, should be a good approximation if the aim of the paper was to model the operators' strategic behavior from a theoretic point of view. Assuming constant marginal cost (as it is usual in telecommunications markets), a general result in this setting is that there is a trade-off between the number of operators and the level of privatization. In particular, the higher the number of operators, the lower the number of equities in public hands, keeping constant a given level of social welfare. As we have a constant number of operators, the level of privatization and the asymmetry among market shares are relevant to study the evolution of this market.

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. Figs. 5 and 6 present its graphical evolution.

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. Fig. 5 shows the evolution of market shares of the three companies.

Overall, one can see that IAM's market share declines over the whole period. As the number of customers increases (see Fig. 3), it seems that most of them were captured by INWI that continued such an active behavior during its first periods in the market.

Fig. 6 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, 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,

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

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,

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

The value of *HHI* ranges from near zero, as in the case of perfect competition, up to one, as in the case of a few dominant companies or pure monopoly in the limit. Otherwise, it is considered that the industry is non-concentrated if the index equals the inverse of the

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

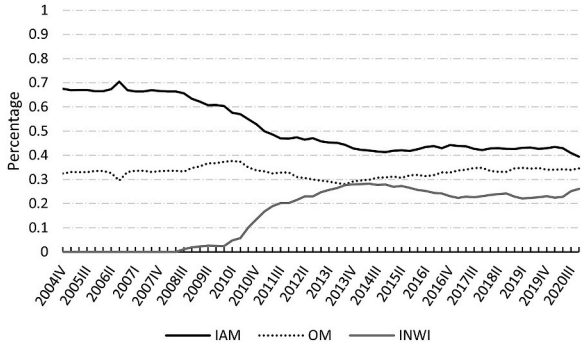

Fig. 5. Market shares.
Source: own elaboration.

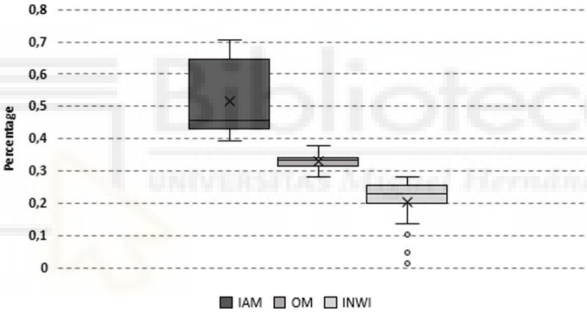

Fig. 6. Box plot market shares
Source: own elaboration.

number of firms (assuming that all the firms are equal), while the market is moderately concentrated when the index approaches this value.[11]

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.[12]

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

[11] When the number of firms is relatively high, a value of HHI above 0.25 represents a highly concentrated industry where firms exert a very high market power (US Horizontal Merger Guidelines, 2021). However, in a market with only three firms a high concentration should approach an observed HHI well above 0.333.

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

$E < \ln(N)$.

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 3a and Table 3b present the correlation matrix for the duopoly period and the triopoly period, respectively. Fig. 7 presents the evolution *HHI*, CR_2, and *RE* over time.

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. 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. Moreover, *RE* is inversely correlated with *HHI* and CR_2; i.e., as concentration indexes decrease, the probability to lose a customer increases. In other words, 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. Finally, relative *RE* is high, which implies significant movements of customers among companies during the period.

Fig. 7 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. Indeed, in a market with three operators the lower bound value is 0.333. According to US antitrust authorities, we may argue that, this value is lower enough, so 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.[13] The inclusion of the index CR_2 is also relevant because the ranking of the two operators with the highest market share, MEDI and OM, remains unaltered under the period of study. It reinforce the idea that these operators are dominant firms, whereas INWI is the operator who fight against them to capture customers, inducing competition in the market. 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 authority stablished a standard termination rate for the three firms, the index remained stable around the value 0.98.[14]

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,

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

where $S_{i,t}$ and $S_{i,t-1}$ are the firms' market shares in two correlative periods.

Fig. 8a and 8 b report the volatility index and trend, and its seasonality, respectively. Fig. 8 a points out that the volatility index has experienced a huge increase during some quarters since 2008III, when the company INWI entered the market. Later on, it became stable within the period 2013–2019, when market shares were stable as well (see Fig. 5). It coincides with the period when penetration rate was stabilized and termination rates were symmetric. At the end of the period under study the index shows a slight increase in its evolution, which coincides with the increase of INWI's market share.

Seasonality (Fig. 8b) 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.

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, which in turn explains the evolution of the concentration indexes. To this end, we propose an econometric analysis with the set of variables listed in Table 4. According to the information available in our

[13] 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).

[14] The drop observed in 2008III was due to a technical reason: the denominator of the index jumped from *ln*2 to.*ln*3.

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
$\boldsymbol{CR_2}$	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 3a
Pearson correlations, 2004III-2020IV

	$\boldsymbol{CR_2}$	***RE***	***HHI***
$\boldsymbol{CR_2}$	1	−0.6612***	0.9847***
RE		1	−0.598***
HHI			1

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

Table 3b
Pearson correlations, 2008IV-2020IV

	$\boldsymbol{CR_2}$	***RE***	***HHI***
$\boldsymbol{CR_2}$	1	−0.9721***	0.9790***
RE		1	−0.998***
HHI			1

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

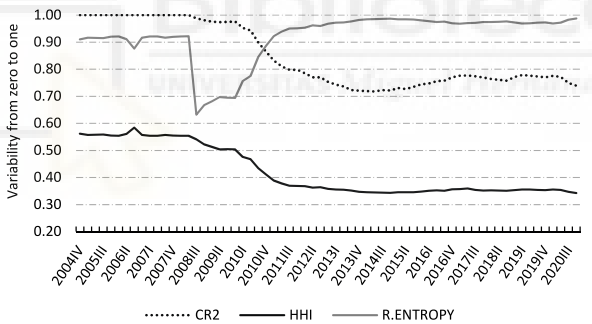

Fig. 7. Concentration indexes.
Source: own elaboration.

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.

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 (adjusted 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

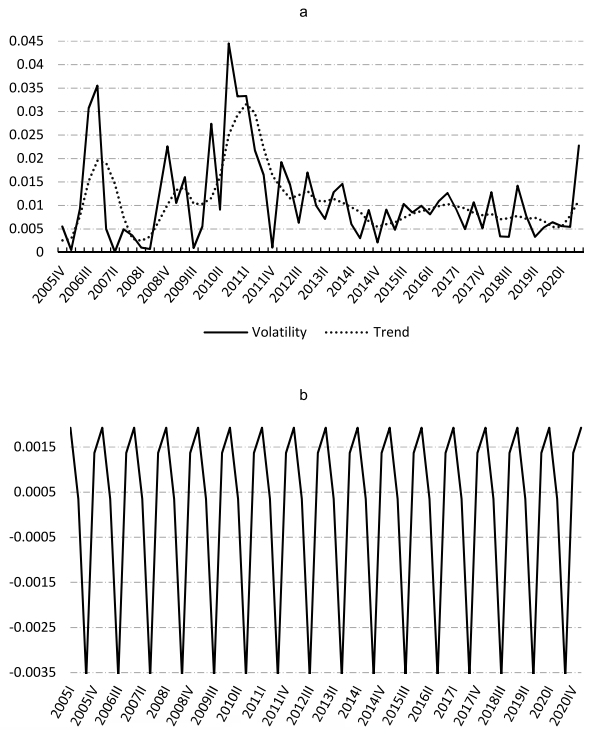

Fig. 8. a. Volatility and trend. .b. Seasonality.
Source: own elaboration. Source: own elaboration.

Table 4
Determinants of market shares in the Moroccan 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}	0161	0124	0011
	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$.

can see that it is equal to 50 for company INWI, since it entered the market in 2008III.

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. 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 Fig. 5) 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. We argue 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

Table 5
Econometric analysis of the determinants of market shares.

	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
VARIABLES	IAM	IAM	IAM	OM	OM	OM	INWI	INWI	INWI
Pre	−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).*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

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.[15]

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.

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.

Finally, we run a supplementary analysis in order to investigate the extent to which the new operator INWI affects concentration (*HHI*) and the outgoing voice traffic (*OVT*). By using the available data, we run two linear regression models. The first one takes as dependent variable the Herfindahl-Hirschman index (*HHI*), whereas the second one takes the outgoing voice traffic (*OVT*). We take the data set from 2008III, when INWI enters the market. As explanatory variables, we include the weighted mean termination rate of the two incumbents (the two largest operators),

$$WMTRI_t = \frac{\sum_{i=1}^{2} MS_{it} \cdot TR_{it}}{\sum_{i=1}^{2} MS_{it}}.$$

Termination rate asymmetry between incumbents and the entrant operator is,

$$TRA_t = |WMTRI_t - TR_{INWIt}|$$

As we lack of prices' data set, we use market shares as a proxy of prices (the larger the market share, the higher the ability to set prices above marginal costs). First, we define the weighted average market share of the two incumbent operators (*WAMSI*),

$$WAMSI_t = \frac{\sum_{i=1}^{2} {MS_{it}}^2}{\sum_{i=1}^{2} MS_{it}}.$$

Hence, the market share differences, $MSDIF_t$, as a proxy of price differences is defined as the difference between $WAMSI_t$ and MS_{INWIt},

$$MSDIF_t = |WAMSI_t - MS_{INWIt}|.$$

Finally, we take the difference between one and two periods lagged values of $MSDIF_t$. We denote this differential as follows,

$$\Delta MSDIF_t = MSDIF_{t-1} - MSDIF_{t-2}.$$

We take as dependent variables the HHI_t and OVT_t. As independent variables, we take average termination rate ($WMTRI_t$) of the two incumbents, average termination rate asymmetry (TRA_t), and lagged market shares differential between the incumbents and the new entrant operator ($\Delta MSDIF_t$):

$$HHI_t = \alpha + \beta_1 \cdot WMTRI_t + \beta_2 \cdot TRA_t + \beta_3 \cdot \Delta MSDIF_t + \varepsilon_{it},$$

$$OVT_t = \alpha + \beta_1 \cdot WMTRI_t + \beta_2 \cdot TRA_t + \beta_3 \cdot \Delta MSDIF_t + \varepsilon_{it}.$$

Table 6 reports estimated values ranked by adjusted R^2. Additional statistical test have been run to withdraw those specifications with multicollinearity (which can be caused by a linear combination between the average termination rate and the average termination rate asymmetry).

We observe that the regression with the highest R^2 includes the average termination rate of the two incumbents and the proxy of the lagged price differential. They have positive and statistically significant effects on the *HHI*. The intuition behind is that, as the

[15] 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.

Table 6
Econometric analysis of ***HHI*** and ***OVT*** since the entrance of *INWI*.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	HHI	HHI	HHI	HHI	OVT	OVT	OVT	OVT
$WMTRI_t$			0.130***	0.147***			−10.30***	−9.681***
			(0.00763)	(0.00677)			(0.522)	(0.567)
TRA_t		0.362***				−32.61***		
		(0.0403)				(2.076)		
$\Delta MSDIF_t$	−0.703			0.846***	131.0***			29.27**
	(0.440)			(0.151)	(29.72)			(12.67)
Constant	0.375***	0.347***	0.330***	0.330***	11.22***	13.13***	14.18***	14.19***
	(0.00881)	(0.00623)	(0.00432)	(0.00338)	(0.594)	(0.321)	(0.296)	(0.283)
Observations	50	50	50	50	50	50	50	50
Adjusted R^2	0.031	0.620	0.855	0.911	0.273	0.834	0.888	0.897

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

convergence among the operators' market share takes place, the *HHI* decreases. Indeed, the estimated coefficient in regression (4) of the lagged market share differential (the proxy of price), $\widehat{\beta}_3$, is positive. Moreover, the estimated coefficient of the average market share of the incumbents, $\widehat{\beta}_1$, is positive.

When we move to the analysis of the *OVT*, the highest R^2 also corresponds to the multiple linear regression including the average termination rate of the two incumbents and the proxy of the lagged price differential (regression 8). In the case of the average termination rate the estimated coefficient, $\widehat{\beta}_1$, is negative whereas the coefficient $\widehat{\beta}_3$ is positive for the lagged market share differential, both being statistically significant. A possible explanation of decreasing *OVT* when the average termination rate of the incumbents increases, is that customers switch from the traditional voice communication channel towards the new communication opportunities through the social networks platforms that use data. Indeed, the new entrants may compete by offering data at lower prices as a result of the easy technology access. We still may observe the direct effect of the lagged market share differential (the proxy of prices) on *OVT*; i.e., the higher the convergence, the lower the *OVT*, which reinforces the intuition of the technology substitution as the competitiveness increases.

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 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.

The evolution of operators' competitive behavior during the period under study seems to be determined by the technology access, the regulatory body of rules, the evolution of the demand, and the level of privatization of the state-owned operator. As the technology is widely spread, the quality of the services is similar no matter the company that provides the network connection, and the demand has continuously increased, the only way to increase profits is to compete for attracting customers, which yields to lower prices. Indeed, as the market share increases off-net prices decrease because the termination rates payment also decreases, yielding to overall lower prices. As long as all the companies follow this behavior, market power cannot be exerted largely, keeping operators' profitability in relative normal levels and thus, enhancing consumer surplus. Moreover, policy measures of privatization of the state-owned company, as well as market forces, such as the increase of the penetration rate, have incentivized companies to capture new customers contributing to become the market more competitive, especially with regard to prepaid programs.

Concerning the opportunity to enter a fourth operator, although desirable in order to increase competitiveness that keeps prices relative low, it depends on a number of reasons. First, the increase of data services and the expansion of the 4G and the recent 5G technology may increase the expected profits in the mobile market. Second, it is necessary that increases on the demand could be maintained over time, which in turns depends on the further increases of the penetration rate, the consumers' affordability for

telecommunication services, and the variety and quality of services that operators may offer to the customers. Third, price-cost margins should be enough to incentivize the entry of a new operator, which strongly depends on the ability to exert market power by part of the operator companies. Fourth, the regulatory authorities must provide a clear and stable regulation framework. In addition, after some years of mergers and acquisitions among telecommunications companies, the number of main operators in OECD countries ranges from three to five. Thus, it seems that the entry of the fourth operator in the Moroccan market could be in line with the situation observed in developed countries, but it depends on the fulfillment of the above features. Moreover, 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 (Word Bank, 2016). Hence, the deployment of mobile services and its affordability may enhance the development of the Moroccan economy.

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