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Revisión de los Fundamentos Económicos Aplicados a la Regulación de los Mercados de Comunicaciones Electrónicas

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Presentación

Se puede afirmar sin género de dudas que la teoría que subyace detrás de la regulación de los servicios de comunicaciones electrónicas se basa hoy en día prácticamente en los mismos principios económicos que justificaron hace ya más de 20 años el proceso de liberalización del sector de las comunicaciones electrónicas, muy especialmente en lo que se refiere al marco aplicado en Europa.

Con pocas excepciones, las mismas herramientas que se utilizaron para describir los mercados de aquel entonces, caracterizados por producir servicios homogéneos sobre una sola tecnología ya madura, con el objetivo último de poner fin a los monopolios sobre los que se había materializado la extensión y desarrollo de las redes de telecomunicaciones, se siguen aplicando hoy en día, aun a pesar de que la dinámica competitiva de los mercados ha cambiado sustancialmente.

Los mercados de las comunicaciones electrónicas pertenecen a una industria que tradicionalmente se caracterizaba por contar con importantes barreras de entrada, economías de escala y atender de forma general a todo tipo de clientes, y a la que se consideraba susceptible de mostrar comportamientos monopolistas, motivo por el que los reguladores siempre pensaron, en línea con la teoría económica tradicional, que era su deber encontrar la asignación más eficiente de los recursos existentes, fijándose como modelo ideal el del equilibrio general de un mercado de competencia perfecta, aunque finalmente ese concepto derivó en lo que ha venido en denominarse mercados perfectamente contestables.

Aceptado como válido este marco teórico general, las autoridades regulatorias han ido desarrollando instrumentos que a su entender permitían lograr el objetivo de una asignación más eficiente de los recursos, pero sin tener en cuenta los efectos dinámicos adversos que su intervención podría ocasionar sobre la competencia, la inversión y la innovación de productos, pues, al fin y al cabo, la extensión de la red se consideraba ya realizada.

En ese mundo ideal del equilibrio general bajo un modelo de competencia perfecta se supone que el mercado habría de contar con un gran número de oferentes, cuantos más mejor, todos afrontando el mismo coste de producción, porque en él no se contemplan economías de escala ni las ventajas derivadas de una concentración de oferentes.

Sin barreras de entrada ni salida del mercado, se supone que una empresa puede decidir ofrecer sus servicios sin incurrir en costes significativos de puesta en marcha, ni de creación de marca, ni costes de aprendizaje, ni inversiones iniciales de otra índole, y si sus expectativas de beneficio no se cumplen, sale del mercado sin asumir pérdidas adicionales. En ese ideal de mercado todos los productos son homogéneos y solo se compite por el precio, no hay diferencias de calidades o características que hagan que unos bienes sean más valorados que otros, todos los productores se enfrenten a un único precio, el mismo para todos, que lo fija el mercado, o en ausencia de una referencia de mercado lo fija el regulador, y tampoco hay excesos de capacidad, porque esta es absorbida instantáneamente por la demanda, ni tampoco escasez.

Pero la gran contradicción de este modelo es que en él tampoco tiene lugar la innovación, porque esta, por definición, rompería el propio equilibrio competitivo. En este modelo de equilibrio idealizado por la teoría económica neoclásica la tecnología está ya dada y es conocida y usada de igual manera por todos los agentes. En esas condiciones el precio del mercado tendería a igualarse al coste marginal de producción.

Como resultado de la aplicación de esta teoría, el acceso a las redes de los operadores tradicionales fijos sigue siendo, después de casi 15 años de apertura de los mercados a la competencia, obligatorio a precios mayoristas orientados a costes, incluso ha ido más allá de los ámbitos inicialmente previstos de aplicación, extendiendo la misma regulación, bajo la aplicación estricta de los mismos criterios teóricos que la inspiraron, a los mercados de servicios móviles y a las denominadas redes de nueva generación.

Sin embargo el sector ha cambiado drásticamente, en términos tanto de tecnología como de demanda. La escala necesaria para competir se ha reducido significativamente, transformándose aquellos mercados que eran considerados históricamente como monopolios naturales más bien en lo que podríamos llamar oligopolios dinámicos, si bien el sector se sigue caracterizando por tener economías de escala e importantes costes de entrada.

Pero no solo la tecnología, también la teoría económica ha evolucionado y las nuevas herramientas y teorías disponibles han cambiado la visión tradicional o neoclásica que se tenía de los mercados, si bien, ni unos ni otros, ni avances tecnológicos ni avances doctrinales, acaban de incorporarse al marco regulador del Sector, o lo hacen con tanta lentitud que quedan rápidamente superados por la realidad dinámica de los propios mercados.

Tenemos, por tanto, por un lado, la teoría neoclásica actual sobre la que se asienta la metodología aplicada por los reguladores sectoriales, que supone considerar los mercados como de productos homogéneos, con precios únicos para todos los clientes, sus activos productivos (las redes) ya disponibles y en gran parte amortizados, y los operadores tradicionales en una situación potencial de ejercer su poder. Por otro lado, la realidad de un mercado en el que los servicios evolucionan al ritmo que impone la constante innovación, ofrecidos a través de distintas tecnologías que se adaptan a diferentes necesidades de demanda, con un consumo creciente de ancho de banda, con oferentes que convergen de diversos sectores afines a las comunicaciones y con funciones de costes muy diferentes, ya no solo hablamos de operadores tradicionales, algunos de los cuales se especializan en determinados segmentos de clientes o mercados geográficos, frente a otros con vocación global, sino a emprendedores de todo tipo sometidos a un ritmo de innovación tecnológica constante que erosiona con gran rapidez las ventajas competitivas adquiridas, lo que impide a su vez el mantenimiento de las posiciones de dominio. Y dentro de todo este complicado proceso evolutivo, distorsionando la toma de decisión de los distintos agentes, encontramos una regulación que no es neutral ni simétrica en cada eslabón de la cadena productiva de los nuevos servicios.

Dada esta situación de caótica "destrucción creativa", si se nos permite la expresión adoptada por el economista austríaco Joseph Shumpeter a mediados del siglo pasado, pero en un escenario de convivencia con la "intervención violenta de los mercados", como definió el economista norteamericano Murray Rothbard a las regulaciones del Estado en sus diversas formas, nos pareció interesante recavar la opinión de diversos expertos que han analizado la regulación sectorial desde la óptica de la teoría económica, dedicando el presente número monográfico de la revista precisamente a la revisión crítica de los principios económicos que justificaron en su momento el desarrollo de la actual regulación de los mercados de comunicaciones electrónicas.

Esperamos de esta forma poder contribuir a iluminar los pasos de quienes tienen en sus manos la posibilidad de facilitar que las cosas simplemente sucedan, analizando a través de las distintas contribuciones aquí publicadas las principales deficiencias detectadas en la regulación y los efectos no deseados que genera y que han sido descritos por la literatura económica, al mismo tiempo que intentaremos aportar algunas herramientas y/o alternativas teóricas que podrían convertirse en nuevos principios de regulación, más compatibles con la inversión, la innovación y la potenciación de un círculo virtuoso de mejora constante de las redes y servicios.

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Presentation

It be said without any doubts that the underlying theory beyond the regulatory framework of electronic communications services is based today in the same economic principles that justified the liberalization of the telecommunications sector twenty years ago in Europe.

With few exceptions, the same tools that were used to define the boundaries of the markets at that time, characterized by producing services over a single homogeneous mature technology, with the ultimate goal of ending the monopoly regime, are still applied today, even though the competitive dynamics of the markets have changed substantially.

The electronic communications markets have traditionally be characterized by high entry barriers, economies of scale, which have likely shown monopolistic behavior. Consequently, regulators -aligned with the traditional economic theory- believed that their role was finding the most efficient allocation of existing resources, setting as the ideal model of general equilibrium based on a "perfectly competitive market", but ultimately resulted in the so called "perfectly contestable markets".

Once accepted as valid this general framework, regulatory authorities have developed tools that have allowed them to achieve the goal of a more efficient resource allocation, but without taking into account adverse dynamic effects on competition, investment or innovation caused by their intervention, after all, the extension of the network was considered already done.

In this ideal world of general equilibrium under perfect competition model it supported on the assumption that the market would have a large number of companies, the more the better, all of the facing the same production costs, because neither economies of scale nor the benefits from mergers were considered.

Without entry or exit barriers, it is assumed that a company might decide to offer their services without incurring neither significant implementation, branding or training costs, nor other set up investments, and if their profit expectations are not met, they could leave the market without incurring in additional losses. In this ideal market all products and services are homogeneous and competition is exclusively based on pricing, where there are no differences of quality or other characteristics that could make some assets more valuable than others, all producers face the same single price, which is set by the market, or in the absence of a market benchmark it is set by the regulator. There is neither excess capacity, because it is absorbed instantly by the demand, nor scarcity.

But the great contradiction of this model is that innovation does not take place, because this, by definition, breaks the competitive equilibrium. In this equilibrium model idealized by neoclassical economic theory, technology is already given and it is known and used equally by all agents. Under these conditions the market price would tend to equalize the marginal cost of production.

As a result of the application of this theory where cost-oriented wholesale access to incumbents' networks remains mandatory after 15 years from liberalization, it has gone even further than initially planned areas of application, extending based in the same theoretical criteria the same regulation to mobile markets and so-called next generation networks.

However, the industry has changed dramatically, both in terms of technology and demand. The needed scale to compete has been significantly reduced, transforming markets that were historically considered natural monopolies into what we might call "dynamic oligopolies", although the market is still characterized by significant economies of scale and set up costs.

Technology as well as economic theory have evolved and new available tools and theories have changed the traditional/neo-classical perspective of the markets, although they have neither be included yet in the regulatory framework or nor a pace fast enough to avoid being overtaken by market dynamism.

Therefore, on one hand, neo-classical theory which current regulatory framework is based on, considers markets with homogeneous products, single prices for all customers, production assets (networks) already available and largely written off, and incumbents in a position to exercise their market power. On the other hand, the real market where services are evolving at a pace that requires constant innovation, offered through various technologies to suit heterogeneous demand, increasing bandwidth consumption, with companies converging from adjacent sectors and different cost structures, where incumbents can no longer exercise their market power. And within such a complex evolutionary process, a non-neutral asymmetrical regulation distorts even more the decision-making of individual agents on each link in the value chain of new services.

Given the chaotic situation of "creative destruction", if we use the expression adopted by the Austrian economist Joseph Schumpeter in the middle of last century, combined with the "violent intervention in the markets," as regulation was defined by the American economist Murray Rothbard, it seemed interesting to test the opinion from many experts who have analyzed industry regulation from the economic theory perspective. Consequently, this special issue of the Review is devoted to the critical review of the economic principles that underpinned the current regulatory framework of electronic communications markets.

This our modest contribution to put some light on next steps of those stakeholders who hold in their hands the possibility of making things happen, through various contributions regarding main shortcomings and unwanted effect caused by regulation, and at the same time try to provide some tools and / or theoretical alternatives that could become new economic principles of regulation, more compatible with the investment, innovation and empowerment of a virtuous cycle of continuous improvement networks and services.

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Introducción

Resultaría difícil entender la regulación actual aplicada al sector de las comunicaciones electrónicas si no hiciésemos mención a los principios económicos que la inspiraron y justificaron, principios que se han ido materializando con el tiempo en una serie de instrumentos diseñados básicamente para facilitar la entrada de nuevos operadores a los antiguos mercados monopolísticos.

Dado que en su origen el modelo predominante en casi todos los países era precisamente el de una red única explotada en monopolio, la regulación encontró su soporte teórico en el modelo neoclásico de competencia perfecta, pues tanto la tecnología como la disponibilidad de las redes habían alcanzado un cierto grado de madurez y una disponibilidad prácticamente universal de los servicios soportados por ellas. El objetivo de la regulación, por tanto, era lograr una rápida entrada de nuevos competidores y maximizar el bienestar de los consumidores mediante una bajada sustancial de los precios de los servicios, soportados estos, básicamente, sobre una misma red de cobre.

Como consecuencia de la aplicación de la teoría neoclásica, los reguladores tuvieron, en primer lugar, que crear un mercado de servicios mayoristas, a través de los cuales los operadores propietarios de la red garantizasen el acceso de los nuevos operadores con criterios transparentes y no discriminatorios. Pero lógicamente había que asignarles un precio, que tendría que ser equivalente al que fijaría un hipotético mercado mayorista en competencia, pues solo en este caso podría considerarse que los precios fuesen eficientes desde el punto de vista de la asignación de los recursos, de aquí que uno de los principios básicos aplicados por los Reguladores haya sido, y siga siendo, la orientación de los precios mayoristas a los costes eficientes, principio sin el cual no se entendería buena parte de la regulación actual.

Obviamente, cuando se sustituye un mecanismo tan complejo de asignación de recursos como es el que representa el propio mercado, por un proceso de decisión centralizado en un organismo, se está produciendo una alteración del valor realmente percibido por los distintos agentes, por lo que en el medio y largo plazo las decisiones de los reguladores pueden llegar a tener un impacto notable en la evolución de los mercados intervenidos.

Probablemente en la evolución de la normativa reguladora del Sector se haya echado en falta durante estos años precisamente esa doble visión del corto y del medio/largo plazo, es decir, una mayor ponderación de los beneficios obtenidos en el corto plazo, generados por una bajada más pronunciada de los precios, con la pérdida de bienestar que en un plazo mayor podría tener alterar las decisiones de inversión de los operadores.

La falta de esta doble visión es quizás una de las contradicciones más importantes inherentes al propio modelo neoclásico que inspira la regulación, dado que son modelos estáticos de equilibrio general, no sometidos a ningún tipo de innovación ni cambio tecnológico.

En este sentido, el artículo del economista y estadístico **Crisanto Plaza Bayón**, Ex-Consejero de la Comisión del Mercado de Telecomunicaciones en España, con el que iniciamos esta sección, se centra precisamente en las debilidades de la propia teoría de la regulación aplicada a las telecomunicaciones europeas, especialmente con aquellas decisiones que se han centrado en la regulación de los precios y su impacto sobre la inversión. En el análisis que hace el autor al modelo regulatorio actual describe las debilidades de la teoría regulatoria y pone de manifiesto los problemas que esta puede plantear al desarrollo del acceso a las redes de nueva generación (NGA) en Europa. Más concretamente, pone de manifiesto cómo la combinación de costes "eficientes" LRIC y la rápida innovación tecnológica provoca que no puedan recuperarse las inversiones realizadas, debido a que la metodología de costes "eficientes" regulados no incluye buena parte de los costes hundidos, ni los riesgos e incertidumbres en los que incurre la operadora incumbente, generándose una desvalorización de los activos, no solo los del incumbente, sino también los de todos los operadores que quieran invertir en activos similares.

La rentabilidad del conjunto de las operadoras, manifiesta finalmente el autor, está bajando en un momento en que las necesidades de inversión no paran de crecer, por lo que respecto a la decisión entre alquilar o invertir una red, existe una elevada probabilidad de que las operadoras se decanten por la opción de no invertir, o hacerlo a niveles muy inferiores a los necesarios, para cumplir con los objetivos proclamados por la Agenda Digital Europea.

No obstante, los reguladores no siempre siguieron estrictamente las propuestas teóricas que emanaban de los modelos neoclásicos, por ejemplo de los monopolísticos, pues en estos se acepta que la estructura de precios eficiente de una empresa multiservicio no solo deba responder a la estructura de sus costes, sino también a la disponibilidad a pagar por los distintos servicios. Es decir, no solo el coste determina el precio, sino también el valor que el consumidor asigna a cada servicio consumido.

Sin embargo los reguladores no han sido capaces de llevar a la práctica una teoría del oligopolio a los mercados de comunicaciones electrónicas, probablemente por la dificultad de capturar su complejidad, lo que conduciría a resultados poco coherentes con la realidad.

Este es un hecho que ha sido puesto de manifiesto por diversos autores, que hacen ver que la competencia entre operadores no es fruto únicamente de los precios aplicados a los servicios, sino que se apoyan también en la búsqueda de la diferenciación de productos y, por tanto, en la diferenciación de precios, ajustándose los mismos a las preferencias de cada tipología de cliente.

Se hace preciso, por tanto, evolucionar la política regulatoria desde el actual enfoque estático hacia uno más dinámico, circunstancia que es destacada en su artículo por **Antonio García Zaballos**, Senior Advisor on Telecommunications del Inter-American Development Bank y profesor asociado de la IE Business School, quien opina que resultaría recomendable un específico análisis costo-beneficio previo a la realización de una intervención ex-ante.

Para el autor, puesto que la idea de competencia perfecta no deja de ser una utopía, las políticas regulatorias deberían dejar de aplicar los principios económicos clásicos que establecen que los precios deben igualarse a los costes marginales, visto que tal aproximación conduce a que los operadores regulados no puedan recuperar todos sus costes. Es precisamente en este punto donde el artículo pone su foco, demostrando a través de varios ejemplos cómo la política regulatoria aplicada por la autoridad nacional de regulación puede afectar a la función de beneficios de los dominantes y de los operadores entrantes, además de las estrategias de precios minoristas y a la propia intensidad competitiva. Así, por ejemplo, demuestra que la imposición de obligaciones de provisión de servicios de terminación a otros operadores genera efectos que desde el punto de vista del óptimo social deberían ser considerados en la regulación de los precios.

Aun aceptando el autor que la regulación podría ser necesaria para garantizar un cierto nivel competitivo, concluye que ese enfoque dinámico tendría que considerar, además de los efectos sobre las decisiones de inversión y financiación, también la elasticidad de la demanda de los diferentes servicios y la estructura de costes de las empresas reguladas, de tal forma que no solo se garantice que la totalidad de sus costes son recuperados, sino además que es compensado adecuadamente el nivel de riesgo asumido.

Por otra parte, parece razonable preguntarse si hoy en día se mantienen las circunstancias que en su momento justificaron la imposición de un marco regulador específico a nuestro Sector. Básicamente estas razones se explicaban por la existencia de tres características que lo definen, como son los efectos de red, las economías de escala y densidad y el riesgo de extensión del poder de mercado a mercados conexos (ver, por ejemplo, Nuechterlein y Weiser).

Sin embargo las economías de red también están presentes en toda la cadena de producción de productos y servicios que hoy en día se han desarrollado en torno a Internet, desde la distribución de aplicaciones o contenidos, pasando por las plataformas de aplicaciones, o los sistemas operativos y navegadores, como el Windows de Microsoft o el iOS de Apple. En todos ellos se da la circunstancia de que cuantos más usuarios se conectan usando esos dispositivos o aplicaciones o contenidos, más atractivas resultan tanto para los usuarios actuales como para los que aún no lo son, incrementando su hipotético poder de mercado.

Sin embargo, diversos autores han destacado cómo en sectores de alta tecnología la propia transformación tecnológica puede amenazar con eclipsar los mercados monopolísticos existentes y, ante tal riesgo, obligar a estos agentes a reaccionar comportándose eficientemente y pensando en el cliente; precisamente la mejor manera de inducir a los inversores a arriesgarse en desarrollar tecnologías innovadoras es dejarles que disfruten temporalmente de una situación de monopolio si tienen éxito, porque el beneficio social que genera la innovación compensa sobradamente el coste de imponer precios de monopolio durante un cierto tiempo.

Aquí llegamos al segundo de los argumentos esgrimidos para justificar la regulación: las economías de escala, cuya replicabilidad resulta muy costoso para cualquier empresa que desee entrar al mercado, por lo que únicamente resultan viables aquellas que cuenten con mayor tamaño.

Pero es obvio que este hecho tampoco es exclusivo de este sector y se da en otros muchos como el del automóvil o el farmacéutico, si bien en nuestra industria la economía de escala no tiene por qué aplicarse en toda la extensión del mercado, ya que es posible alcanzar el mínimo de escala de producción buscando la especialización. Más concretamente, la evolución geográfica de los mercados de comunicaciones electrónicas ha demostrado que algunos operadores han logrado sus mayores éxitos dedicándose exclusivamente a nichos y geografías concretas.

También los avances tecnológicos y el uso de nuevas aplicaciones han permitido que las economías de escala tradicionales sean actualmente abordables por más agentes, pues los costes de despliegue han disminuido considerablemente con la irrupción de las redes inalámbricas y el crecimiento del tráfico y las conexiones de nuevos dispositivos.

Finalmente, el último y tercer motivo esgrimido para imponer la regulación en las comunicaciones electrónicas fue el de tratarse de industrias integradas verticalmente, susceptibles de trasladar su dominio en el acceso a otros mercados adyacentes. Pero tampoco es el único sector donde esto se produce, y tenemos el caso emblemático de Apple, que vende su sistema operativo, sus aplicaciones y sus propios dispositivos de acceso para los usuarios, o Microsoft, o Google. El sector se ha vuelto más complejo, integrado y convergente, pero al mismo tiempo también más inestable.

Servicios y tecnologías han ido perdiendo con el paso del tiempo la asociación biunívoca que les mantenía tradicionalmente unidos. La telefonía de voz se consideraba asociada a las redes de cobre, la televisión y la radio a las ondas de radiodifusión, y así sucesivamente. La regulación, de hecho, ha seguido un esquema similar, de tal forma que los mercados de comunicaciones electrónicas eran definidos pensando también en la tecnología que facilitaba su prestación. La llegada de las tecnologías IP, además, ha barrido por completo la separación tradicional entre servicios y tecnologías, incluso entre dispositivos de recepción de información.

Adicionalmente la llamada convergencia horizontal (cualquier plataforma puede prestar cualquier servicio), unida al desarrollo de nuevos servicios que se sirven de las redes pero que no son suministrados por operadores de comunicaciones electrónicas, hace que la premisa del suministrador único con poder de mercado se deba cuestionar. No solo hay cada vez más alternativas, sino que las economías de escala o de red hoy en día se encuentran también en el mundo de las aplicaciones, pero únicamente las redes de comunicaciones electrónicas cuentan en general con obligaciones de interoperabilidad.

Sin duda estos nuevos mercados convergentes están sujetos a efectos de red, lo que tiene ventajas derivadas de ser el *first-mover*, pero también importantes riesgos a la hora de apostar por la tecnología y estrategia más adecuada (ver, p. ej., David Evans). En ellos no existe ninguna relación entre precios y costes marginales, además de que son significativos los costes fijos en los que se incurre. Incluso la existencia de un agente dominante no llega a impedir que los mercados sean perfectamente contestables, pues es fácil esperar que entren al mercado tecnologías más avanzadas que pongan en riesgo el liderazgo alcanzado por las empresas hasta entonces existentes.

La innovación ha demostrado ser un buen antídoto para evitar conductas monopolísticas en ciertos mercados, como ya se observó en USA en el mercado de la TV de cable (pronto apareció la TV por satélite), en el mercado de acceso a Internet (con la irrupción del cable), de la mensajería instantánea, los sistemas operativos, etc., porque finalmente hace desaparecer el carácter de recurso esencial sobre el que se apalancaba la posición de dominio.

De hecho existen otras vías alternativas al actual marco europeo, y en este sentido el profesor **Robert W. Crandall**, miembro de The Brookings Institution, nos describe en su artículo la situación actual de desregulación general existente en los Estados Unidos en lo que se refiere a las telecomunicaciones, precisamente debido en gran parte al rápido cambio tecnológico que registra este sector y a la gran concurrencia de nuevos agentes y servicios. Los mercados de telefonía fija y móvil presenta hoy en día un intenso nivel de competencia entre plataformas, la de los incumbentes, los operadores de cable, móviles o de satélite, por lo que la Federal Communications Commission (FCC) fija su atención en otros aspectos del Sector como el servicio universal y la regulación de los cargos por interconexión, que si bien generan una gran controversia resultan difíciles de cambiar por los subsidios que suponen a las áreas rurales.

Por otra parte, el autor destaca la escasa regulación existente en USA en los servicios inalámbricos y de banda ancha, y la mayor preocupación que suscita el tema de la neutralidad de red, cuyos principios no han sido concretados explícitamente en una normativa formal, por lo que no pueden ser impuestos por el regulador norteamericano y quedan fuera del ámbito de sus funciones, a pesar de que el debate permanece en el horizonte político, si bien, como indica el autor, la competencia entre redes y fabricantes de dispositivos disciplinarán el comportamiento de los proveedores que intenten denegar el acceso a cualquier contenido o aplicación que deseen los clientes, en la medida que han de competir con los propios contenidos de los operadores o de los fabricantes, por lo que da la sensación de que la regulación a favor de la neutralidad de red se estuviera rápidamente evaporando en USA al ritmo que remonta el valor de las acciones de Apple.

Introduction

It would be difficult to understand the current regulation applied to the electronic communications sector if its economic principles are not mentioned, principles that have been transformed over time in a set of regulatory instruments designed primarily to facilitate the market entry of new operators in former monopoly markets.

Since the predominant model in telecommunication in most countries was a single network exploited under a monopolist regime, regulation found its theoretical support in the neoclassical model of perfect competition, because both technology and network availability had reached a certain degree of maturity. Therefore, the goal of regulation was to achieve a fast entry of new competitors and maximize consumer welfare by a substantial drop in prices of services, supported basically on the same legacy copper network.

As a result of the application of neoclassical theory, regulators created first a wholesale services market, where non-discrimination network access was granted to new operators. Network access price should be set at a level equivalent to that in a hypothetical competitive wholesale market, where prices would have been efficient from the resource allocation point of view, hence one of the basic principles applied by the regulators has been, and remains, the wholesale prices orientation to efficient costs, principle without current regulatory framework cannot be understood.

Obviously, when such a complex mechanism as market-drive resource allocation is replaced by a centralized decision process, the value actually perceived by the different agents is distorted, so regulatory decisions can have a significant medium and long term impact on the evolution of the regulated markets.

Probably, regulation has not properly weighted short term profits generated by sharp prices reduction, and long term welfare losses caused by change investment decisions of operators.

The lack of this double vision (short term vs long term) is perhaps one of the most important contradictions inherent in the neoclassical model that inspires the current regulation, since it based on static general equilibrium models not subjected to any innovation or technological change.

In this sense, this section is opened with the article by the economist and statistician **Crisanto Plaza Bayón**, a former member of the Board of Spanish National Regulatory Authority (Comisión del Mercado de las Telecomunicaciones) which focuses specifically on the weaknesses of the regulatory theory applied to telecommunications in Europe, with an special focus on those decisions on wholesale prices control and their impact on investment. In the analysis, the author highlights the problems it may pose to the development of next generation access networks (NGA) in Europe. More specifically, he shows how the combination of cost "efficient" LRIC access prices and rapid technological innovation hinders timely investment recovery as the cost methodology does not include many of the stranded costs, or risks and uncertainties incurred by the incumbent operator, reducing the asset value, not just for the incumbent, but also of all operators who want to invest in similar assets.

The profitability of all operators, the author proceeds, is going down at a time when investment needs are growing, so when operators faces the decision whether to rent or invest a network, there is a high probability that they finally opt for not to invest, or at levels far below those needed to meet the objectives set by the European Digital Agenda.

However, regulators did not always strictly follow the theoretical proposals coming from neoclassical models, i.e even in a monopoly regime it is commonly accepted that efficient pricing structure for a multi-service company must not respond just to their cost structure, but also to the willingness to pay for different services. That is, costs do not solely determine the price, but also the value that consumers assign to each service consumed.

But regulators have not been able to apply an oligopolistic theory to electronic communications markets, probably due to its complexity, leading results which were inconsistent with reality.

This is a fact that has been highlighted by various authors, which make clear that competition between operators is not just price competition but also it relies on product differentiation, and therefore, price differentiation, adjusting to the preferences of each type of customer.

Therefore it becomes essential an evolution of the regulatory policy from the current static approach to a more dynamic one, a fact which is highlighted by **Antonio García Zaballos**, Senior Advisor on Telecommunications of the Inter-American Development Bank and associate professor at IE Business School, who believes that it would recommend a specific cost-benefit analysis prior to any ex-ante intervention.

For the author, since the idea of perfect competition is no longer more than an utopia, regulatory policies should stop applying classical economic principles which state that prices must equal marginal costs, given that such an approach determines that regulated operators are not able to recover all their costs. It is precisely at this point where the article puts its focus, demonstrating through examples how regulatory policy applied by the NRAs may affect the profit function of both incumbents and new entrants, as well as retail pricing strategies and competitive intensity.

Even if regulation might be necessary to ensure a competitive playing field, a dynamic approach should also consider the effects on investment decisions and funding.

On the other hand, it seems reasonable to wonder if nowadays the circumstances which justified in the past the imposition of an specific regulatory framework to our industry still remain. Basically these reasons were explained by the existence of three defining characteristics, such as network effects, economies of scale and density and the risk of leveraging the market power to related markets (see, eg, Nuechterlein and Weiser).

Here we reach the second argument which justifies ex-ante regulation: economies of scale, whose replication is very expensive for any company wishing to enter the market, so only those that have more size are viable. But it is obvious that this is not exclusive of this industry and it occurs in many others such as automobiles and pharmaceuticals, although in our industry economy of scale does not have to be applied throughout the extent of the market, as it is possible to achieve the minimum scale of production throughout specialization.

Also, technological advances and new applications have enabled traditional economies of scale to be now affordable for more agents, because roll-out costs have dropped considerably with the advent of wireless networks and traffic growth.

And last, the third reason given for imposing ex-ante regulation was vertical integrated industries, capable of leveraging its dominance in the network access to other adjacent markets. However, telecom industry has become more complex, integrated and convergent, but at the same time also more unstable.

Services and technologies close relationship has been eroded over time. Voice telephony was considered associated with copper networks, television and radio to airwaves, and so on. The regulation, in fact, has followed a similar pattern, so that electronic communications markets were defined based on technologies they were provided on. IP technologies have also completely swept the traditional correlation of services and technologies, or devices.

The so-called horizontal convergence (any platform can provide any service), together with the development of new services that use the networks but are not provided by its owner, makes the single supplier with SMP is not longer valid.

Undoubtedly these new converging markets are subject to network effects, with first mover advantages as well as significant risks in betting on the most appropriate technology and strategy (i.e. David Evans). In these markets there is no correlation between prices and marginal costs, as well as significant fixed costs. Even the existence of a dominant player does not preclude perfectly contestable market, disruptive technologies are expected which could jeopardize the leadership.

Innovation has been proved as a good antidote to prevent monopolistic behavior in certain markets: Cable TV, Internet Access, Instant Messaging, Operating Systems, because ultimately essential facility factor which leverage a dominant position on has disappeared.

In fact there are other alternatives to the current European framework, and in this sense Professor **Robert W. Crandall**, a member of The Brookings Institution, describes in his article the current status of existing general deregulation in the United States regarding telecommunications, largely due to rapid technological change which records this sector and the large turnout of new agents and services. Fixed and mobile markets shows an intense level of inter-platform competition, incumbents, cable operators, mobile or satellite operators, so that Federal Communications Commission (FCC) has been focusing its attention on other aspects of the industry as universal service or interconnection charges.

Moreover, the author highlights the lack of regulation in the USA in wireless and broadband, and a greater concern about the issue of net neutrality, whose principles have not been specified explicitly in a formal regulation, so that can not be imposed by

U.S. regulators and fall outside the scope of their duties, even though the debate remains on the political horizon. The author states that competition between networks and devices manufacturers would discipline service providers attempting to deny access to any content or application demanded by customers. The author has the impression that net neutrality regulation stream is rapidly evaporating at the same speed of the increase of Apple shares value.

Los límites de la Teoría Regulatoria

Crisanto Plaza Bayón
Economista y Estadístico

Resumen

El artículo se centra en las debilidades que el autor ha detectado en la teoría de la regulación de las telecomunicaciones, fundamentalmente las telecomunicaciones fijas, al ponerla en relación con las posibles decisiones regulatorias, centradas especialmente en la relación precios regulados e inversión, y siempre en el contexto de la regulación europea.

Este análisis del modelo regulatorio actual trata de describir las debilidades de la teoría regulatoria basada en la relación precios e inversión de la red legada, red de cobre, y poner de manifiesto los problemas que puede plantear en la inversión para el desarrollo del acceso a las redes de nueva generación (NGA) en Europa.

Abstract

The article focuses on the weaknesses that the author has detected in the theory of telecommunications regulation, specially referred to the fixed telecommunications, in conjunction to possible regulatory decisions, particularly concentrating on the relationship between regulated prices and investment, and always in the context of European regulation.

This analysis of the current regulatory model describes the regulatory weaknesses of the theory based on the price and investment in the legacy network, i.e. the copper network, and highlight the problems that may arise in the investment for the development of the next generation access networks (NGA) in Europe.

1. Introducción

La regulación de las telecomunicaciones fijas en el mundo desarrollado se ha basado, prácticamente desde su inicio, en controlar los precios finales de los operadores que actuaban en monopolio, no permitiendo sobreprecios excesivos, es decir, se controlaban únicamente los precios al consumidor final. Sin embargo, a partir de 1996 en USA y de 1997 en Europa, la regulación cambia de forma importante y lo que se regula son los precios mayoristas, de la interconexión primero y con posterioridad los de los activos de la red del incumbente, con el fin de permitir el alquiler de estos activos a los operadores entrantes y alcanzar la competencia en los servicios finales.

El modelo elegido fue el de un mercado en competencia basado en la hipótesis de que, en un periodo de tiempo, existirían varias infraestructuras de redes de los operadores entrantes, pero hasta entonces la regulación promovería el alquiler de activos de la red del incumbente a precios regulados, para que poco a poco los entrantes fueran ganando cuota de mercado y obteniendo beneficios, que les permitiera aumentar sus infraestructuras hasta llegar a una red total.

El periodo 1996-2001 se caracterizó por una valoración elevadísima de las cotizaciones en Bolsa de las empresas punto.com, comprendidas en parte las telecomunicaciones, y en el que las posibilidades de este sector parecían ilimitadas.

Pero la "burbuja" de las punto.com estalló en 2001 y volvió a la realidad al sector. Sin embargo, el modelo ya había sido establecido y no se planteaba su reconsideración, aunque las Sentencias de la Corte Suprema de USA de Verizon versus Trinko de 2004, y posteriormente ATT vs. Linkline de 2009, corrigieron de una forma importante la "Implementación" de la *Telecommunications Act of 1996*.

La regulación de las telecomunicaciones fijas de la Unión Europea, en adelante UE, eligió un modelo de competencia en infraestructuras, pero las infraestructuras en un sector intensivo en capital y con alta innovación tecnológica, como el de las telecomunicaciones, supone, para un operador entrante, una relación Capex/Ingresos superior al 70-80% en los primeros años, una rentabilidad medida por la relación EBITDA/Ingresos muy baja y un endeudamiento creciente durante un largo periodo de tiempo. Por tanto, un proyecto de creación de una infraestructura propia, aunque sea construido paulatinamente, necesita un gran respaldo financiero y una alta rentabilidad a medio y largo plazo.

Dada la regulación existente, y la situación de las operadoras entrantes, su elección fue el alquiler de activos de red del incumbente a precios mayoristas regulados, orientados a costes TELRIC en USA y a costes corrientes y LRIC en la UE, para lograr un mercado de servicios en competencia, articulada fundamentalmente en precios finales, ya que los servicios prestados eran muy similares.

El objetivo era conseguir que los operadores alternativos fueran paulatinamente completando una infraestructura propia, consiguiendo beneficios y cuotas de mercado, que les permitiera ir subiendo por la "escalera de inversión" en la UE y los "*stepping stone*" en USA, hasta completar su propia infraestructura.

El razonamiento del artículo trata de incidir en la relación precios e inversión en la regulación de la red legada, la red de cobre, que era una red en gran parte amortizada y que no precisaba de altos niveles de inversión, ni por tanto de financiación[1]. El problema actual para Europa es que necesita desplegar las redes de nueva generación (NGA), tanto las redes fijas como las móviles[2]. En el caso de las redes fijas, que precisan altos niveles de inversión, el modelo de precios regulados LRIC se caracteriza precisamente por no hacer atractiva la inversión, ni a los incumbentes ni a los operadores alternativos.

La inversión resulta actualmente más difícil para los incumbentes porque tanto sus ingresos como su rentabilidad (EBITDA) están estabilizados o bajando, aunque el EBITDA parte de niveles elevados (40% en términos de EBITDA/Ingresos). En coherencia, tampoco las cotizaciones bursátiles son especialmente atractivas.

Si se quieren desarrollar las redes NGA, la relación CAPEX (Inversión)/Ingresos necesitaría incrementarse en 5 o 6 puntos, elevándose al 17-18%. Además, las posibilidades de financiación interna de las inversiones dependen en gran parte del EBITDA, pero la relación EBITDA/Ingresos está

(1) La evolución de la inversión en las telecomunicaciones, medida por la relación Capex (Inversión) / Ingresos, ha sido muy diferente según los diferentes ciclos de inversión, desde más del 70% (Capex/Ingresos), incluso superior, en los momentos de gran desarrollo de las telecomunicaciones , o sea durante el gran despliegue de la red, hasta porcentajes de 9-11% en el periodo 2005-2009, debido a que ya se habían realizado los grandes despliegues, además de la digitalización y otras mejoras de la red, y solamente en este periodo el desarrollo del ADSL supuso una inversión moderada, pero aún no había entrado el desarrollo de las nuevas redes de acceso, la fibra óptica, etc.

(2) La reducida regulación de los móviles ha contribuido a un gran éxito en la penetración y uso de los mismos. La forma de competencia ha sido un oligopolio de infraestructuras de red, que ha conseguido que en los últimos quince años se haya realizado el fenómeno de mayor crecimiento mundial en la historia, al pasar de 100 a 5.500 millones de suscriptores. No ha habido otro fenómeno de tan elevado crecimiento en ningún otro producto o servicio en la historia.

bajando varios puntos, mientras que la proporción de CAPEX/Ingresos está subiendo. Es decir, la rentabilidad baja y las necesidades de inversión suben, y en un momento en que los mercados financieros están pasando grandes dificultades.

Por tanto, la situación de la financiación interna y externa de la inversión se hace más complicada, cuestión que es necesario tener en cuenta si se quiere hacer un desarrollo en la línea de la Agenda Digital para Europa.

Además, el entorno de las telecomunicaciones fijas está cambiando radicalmente, y la regulación de futuro debería tener en cuenta alguno de los siguientes cambios. En primer lugar, la globalización de la economía; en segundo, la convergencia de la voz, datos e imagen en una conectividad digital, sobre protocolos IP, que homogeniza en un mismo lenguaje las telecomunicaciones fijas, móviles, audiovisuales e Internet, en un momento de explosión de la demanda de datos, con un tráfico que se multiplicará por 30 en los próximos cuatro años; y tercero, una nueva cadena de valor en la que la conectividad, aspecto fundamental de las telecomunicaciones, es una parte importante, pero solo una parte de la cadena de valor del sector de la información.

Efectivamente, la globalización de la economía plantea un problema decisivo para Europa, ya que hasta hace veinte años las operadoras de telecomunicaciones eran operadoras nacionales, consideradas monopolios naturales, y la mayoría ligadas al sector público.

Actualmente la situación del sector es totalmente diferente, las grandes operadoras de telecomunicaciones europeas son generalmente privadas y tienen vocación multinacional. Por ello, sus decisiones de inversión se adoptan en función de las rentabilidades futuras de las diferentes áreas geográficas donde operan, y desde luego las inversiones en Europa no se caracterizan especialmente por resultar atractivas, ya que las telecomunicaciones representan en Europa un sector con ingresos estancados o en descenso, mientras que es en otras áreas geográficas como China, India, Brasil, Rusia, etc. donde se producen los fuertes crecimientos.

Europa no se encuentra hoy en día entre las áreas más rentables, y sin embargo se sigue efectuando una regulación como si fuera el centro del mundo, cuando desgraciadamente la UE se está alejando cada vez más del centro del sistema.

Adicionalmente, el sector, empujado por el desarrollo tecnológico, tiende a la convergencia, y se solapan cada vez más las telecomunicaciones fijas y móviles, el audiovisual e Internet. La relación entre empresas y consumidores a través del mundo de Internet necesitará de la conectividad de las redes de las operadoras. Las empresas exigirán una garantía de nivel de servicio *end-to-end* para trasladar sus datos y aplicaciones a "la nube" (*the cloud*), garantizar su seguridad y la calidad del servicio a sus clientes.

La cadena de valor describe el conjunto de actividades que se requieren para llevar un producto o servicio a través de las diferentes fases de la producción hasta el consumidor final. Actualmente se está articulando una nueva cadena de valor a dos niveles: el primero, debido a la ampliación y convergencia en el propio segmento de las telecomunicaciones; el segundo y fundamental, por el surgimiento de un macrosector de la sociedad de la información que agrupa a un conjunto de segmentos: desarrolladores de contenidos y aplicaciones, agregadores, plataformas de software, conectividad (telecomunicaciones), dispositivos, redes sociales, buscadores- navegadores, publicidad, consumidores, etc. Es en este macrosector en el que se integran las telecomunicaciones, y en él cada uno de los diferentes segmentos necesita de activos y la aportación de valor de los otros, existiendo entre ellos una gran interdependencia.

Todos estos cambios se derivan tanto de la innovación tecnológica como de los hábitos sociales. En primer lugar, de la *"cloud computing"* o la nube, que supone la "virtualización" del software, de las plataformas y de las infraestructuras de los particulares y las empresas, un cambio que solo está comenzando y que ya parece espectacular; en segundo lugar, de la aparición de los smartphone, como los iPhone y otros, y las tablets, como los iPad, que han inaugurado una nueva forma de comunicación, que supone una cierta ruptura con las formas anteriores, que contribuirá a un incremento de capacidad en 2016 de más de 30 veces el tráfico actual, según Alcatel-Lucent, lo que plantea urgentemente la necesidad de más espectro radioeléctrico. La fortaleza de los smartphone y tablets reside en la gran cantidad de aplicaciones y contenidos que permiten, pero también habrá que contar con la extensión de los e-book; en tercer lugar, nos encontramos con las nuevas formas de comunicación entre los particulares, como Facebook, Tuenti, y finalmente, de la extensión de *Internet of Things* (IoT), el Internet de las cosas, que supone que los objetos tengan conexión a Internet en cualquier momento y lugar. En un sentido más técnico, consiste en la integración de sensores y dispositivos en objetos cotidianos, conectados a Internet a través de redes fijas e inalámbricas y que, al igual que las personas, pueden conectarse a Internet en cualquier momento y lugar.

El IoT forma parte de esa "virtualización", en el que las barreras que separan el mundo real del virtual se difuminan en algunos aspectos, construyéndose un campo de información global (con el "cloud computing") en el que la cantidad de datos que circulan por las redes seguirá creciendo exponencialmente. Esta "virtualización" conllevará la transformación de una red global de personas en una red global de personas y cosas.

Todo este conjunto de circunstancias da lugar a un macrosector con un nuevo ecosistema, en el cual los operadores se encuentran incorporados en una nueva cadena de valor, cualitativamente diferente y mucho más variada y amplia que la primitiva, y tiene escasa relación con aquel limitado al sector de las telecomunicaciones fijas de mediados de los noventa.

Efectivamente, el segmento de las telecomunicaciones ha cambiado radicalmente. En 1995 los móviles suponían algo más de 100 millones y actualmente hay más de 5.500 millones de suscriptores. Sin embargo, en las telecomunicaciones fijas las líneas descienden ligeramente entre 2008 y 2010, creciendo únicamente las líneas y los ingresos de la Banda Ancha, que en aquel periodo eran inexistentes.

Por tanto, la situación actual se parece muy poco a la cadena de valor que fue la base de la regulación de 1996 en USA y de 1997 en la UE. Sin embargo el modelo regulatorio aplicado hoy en día sigue centrado básicamente en aquel reducido sector de los años 1996-97 y su tradicional y más reducida cadena de valor.

Hay que matizar que el incremento de líneas fijas se mantuvo hasta 2008, y a partir de ese momento descendió, ya que cada vez hay más personas que solo disponen de móviles. Ello significa que con la entrada de la Banda Ancha en móviles, Internet, los smartphone y tablets, que incorporan miles de aplicaciones, la hegemonía móvil a nivel mundial respecto a la red fija se irá haciendo cada vez mayor.

2. La Regulación Sectorial

La regulación sectorial se ha localizado, casi exclusivamente, en sectores que se caracterizan por ser intensivos en capital, y por lo tanto contar con una relación Capex/Ingresos relativamente elevada, normalmente más del doble del conjunto de la economía, y por ser instalaciones esenciales, "essential facilities", instalaciones difícilmente replicables, que tendían a crear monopolios, como es el caso de la energía, los ferrocarriles y las telecomunicaciones.

Sin embargo, en consonancia con el nuevo entorno de la economía del conocimiento, es en la innovación del propio conocimiento donde se están construyendo actualmente esas "*essential facilities*", instalaciones esenciales, en algo tan etéreo como un algoritmo, que hace que dominen o monopolicen amplias áreas de ese macrosector. En la regulación de las telecomunicaciones, cuando se crea la de 1996 en USA y la de 1997 en la UE, se basa en un modelo en el que las redes de telecomunicaciones de los incumbentes, redes con acceso fijo de cobre, estaban ya desplegadas y las grandes inversiones ya habían sido realizadas, poniéndose el foco en la regulación de la interconexión y, posteriormente, del alquiler de activos de la red de estos incumbentes a los nuevos operadores entrantes a precios mayoristas.

El modelo regulatorio de las telecomunicaciones fijas ha funcionado hasta ahora sobre la base de que no se precisaban fuertes inversiones. Actualmente, sin embargo, hay que desplegar unas nuevas redes de acceso, las denominadas Next Generation Access (NGA[3]), y la inversión todavía

	1990	% INCREMENTO	2000	% INCREMENTO	2010
LÍNEAS FIJAS	519	6.5	976	2.8	1197
MÓVILES	11	52.2	739	21.7	5282
TOTAL	530	12.5	1715	14.8	6379

Figura 1:
Cuadro de Nº de líneas (millones de accesos)

Fuente:
ITU

(3) La Recomendación NGA abre algunos elementos importantes, pero no suficientes para desarrollar la inversión.

no se ha realizado. Además, se han tenido en cuenta únicamente a los operadores de telecomunicaciones, o sea la conectividad, cuando debería contemplarse el conjunto de la cadena de valor del macrosector de la información. Sería preciso, por tanto, o bien estructurar otra teoría regulatoria, o bien introducir cambios importantes en la actualmente vigente, que hagan atractiva la necesaria nueva inversión, ya que en caso contrario los ambiciosos objetivos de la Agenda Digital para Europa no se cumplirán y Europa perderá las posibilidades de crecimiento económico del que tan necesitada está.

La inversión en un sector intensivo en capital y con alta innovación tecnológica, como el de las telecomunicaciones, o el macrosector de la información, se convierte en uno de los temas centrales del análisis económico y de la regulación.

La intensidad de capital se traduce en una alta relación CAPEX/ingresos o una alta proporción de costes CAPEX[4] respecto a los costes totales, lo que en el sector de las telecomunicaciones produce fuertes costes hundidos, y riesgos e incertidumbres, que deberían ser incorporados en la valoración de los activos de capital, ya que son una parte muy importante de su valoración.

Pero la teoría de la inversión no solo plantea un problema sobre su utilización en la teoría regulatoria, sino sobre todo en su formulación en la teoría económica. El análisis de la inversión o el capital es uno de los mayores problemas que tiene la teoría económica, y esta dificultad se acrecienta en un sector intensivo en capital y con una gran innovación tecnológica, como son las telecomunicaciones, y en la medida en que es preciso introducir en la inversión la variable tiempo. La introducción del tiempo, el futuro, supone una enorme dificultad, porque la teoría económica y su paradigma, el modelo de equilibrio general competitivo, no introduce el tiempo, sino que es un modelo estático.

La principal dificultad de la teoría del capital la sintetiza Pasinetti[5], quizás uno de sus teóricos mas destacados, en las dos maneras diferentes en que el capital puede ser concebido "*a) as a "free" fund of resources, which can be switched from one use to another, without any significant difficulty: this is what called the "financial" conception of capital; b) as a set of productive factors that are embodied in the production process as it is carried out in a particular productive establishment; this is what may be called the "technical" conception of capital*". Es decir, desde un punto de vista financiero o desde un punto de vista "technical" o productivo.

La teoría económica que Pasinetti llamaría técnica o productiva, que ha sido la teoría económica más extendida, ha tenido enormes dificultades en el cálculo de los activos de capital, y es principalmente a través de la teoría financiera de Markowitz, Sharpe, Litner, Merton, Black, Scholes, Fama, etc., como se está tratando de dar respuesta al cálculo de los precios de los activos, siendo esta última la línea elegida por la regulación de las telecomunicaciones.

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Las decisiones de inversión están íntimamente relacionadas con los precios, en este caso precios mayoristas regulados, que es el precio de alquiler de los activos de la red, y tiene una influencia decisiva sobre la evolución del sector a largo plazo, ya que los precios regulados determinan en gran parte el retorno, el beneficio, de las inversiones en redes, y adicionalmente el atractivo de los operadores entrantes para alquilar o invertir.

El soporte de los precios mayoristas regulados son los costes regulados, lo que significa crear una metodología de costes regulados. La primera pregunta es por qué se necesita crear esta metodología y contabilidad diferentes.

La diferencia entre el cálculo de los costes de la contabilidad financiera (empresarial) y la regulatoria se basa en que los operadores entrantes, y en consecuencia los consumidores, no tienen por qué pagar las "ineficiencias" del despliegue de las redes del incumbente, por lo que se puede poner en cuestión la tecnología utilizada, el diseño de la red, incluso la propia organización del incumbente.

(4) Una alta proporción de costes fijos no significa obligatoriamente elevados costes hundidos, véase por ejemplo en aviación, los activos son los aviones, que tienen movilidad y se pueden vender.
(5) Capital Theory (paradox), New Palgrate p. 12.

Los precios habrán de fijarse sobre costes "eficientes", y por tanto la regulación necesita, como eje de su fundamento, definir el concepto de "eficiencia", con el fin último de conseguir la máxima satisfacción para los consumidores.

3. El Concepto Eficiencia

El primer problema que plantea la definición de unos costes "eficientes" es que es preciso conocer previamente el significado del concepto de "eficiencia" en la economía y más concretamente en la regulación, y sobre qué operador considerado "eficiente" se calculan los costes, siempre con el fin de maximizar la satisfacción de los consumidores.

Por tanto hay que buscar cuáles son los soportes teóricos de la eficiencia, que es el principal objetivo de la regulación, convirtiéndose en el centro teórico de la misma.

El concepto de eficiencia en la teoría económica está ligado a Pareto[6]; así, en el *Manuel d'economie...*, cap. 6, sección 33, se define el máximo de optimalidad o eficiencia: *"Nous dirons que les membres d´une collectivité jouissent, dans une certaine position, du maximum d´ophélimité, quand il est impossible de trouver un moyen de s´eloigner très peu de cette position, de telle sorte que l´ophélimité dont jouit chacun des individus de cette collectivité augmente ou diminue. C'est-à-dire que tout petit déplacement a partir de cette position a nécessairement pour effet d´augmenter l´ophélimité don't jouissent certains individus, et de diminuer celle don't jouissent d´autres: d´être agréable aux uns, désagréable aux autres".*

Las condiciones de óptimo de Pareto son que la asignación de recursos de la economía será óptima si no existe otra asignación productiva en la que, al menos, todos los individuos estén en igual situación, o que alguno mejore su posición y ninguno la empeore. Por lo tanto su teoría sugiere que si uno mejora y nadie empeora se consigue un *máximum d´ophémalite* (de eficiencia).

El problema es que estas condiciones deberían ser comunes para todos los agentes que componen el sistema económico, lo que supone uno de los mayores obstáculos para conseguir el óptimo de Pareto. Y es a partir de esta consideración, relativa a que el cumplimiento de unas pocas reglas de la optimalidad no garantiza la mejora de la eficiencia económica, que se elabora la teoría del *"second best"*[7], que trata de acotar el campo para obtener un óptimo de eficiencia. Sin embargo las referencias a esta última teoría son muy limitadas, o casi inexistentes, en la teoría de la regulación.

Este posicionamiento paretiano, traducido en términos del modelo de la síntesis neoclásica, significaba que los precios son iguales a los costes marginales, y que requieren la igualdad entre la tasa marginal de sustitución y la tasa marginal de transformación, lo que quiere decir que hay igualdad en la maximización del modelo entre consumidores y productores.

Y así Dorfman, Samuelson y Solow, en su libro *Programación lineal y análisis económico* (Traducción en Ed. Aguilar, 1964), afirman que "todo equilibrio competitivo es un óptimo de Pareto, y todo óptimo de Pareto es un equilibrio competitivo", o lo que es lo mismo, "el equilibrio general competitivo de Walras es un óptimo de Pareto y todo óptimo de Pareto es un equilibrio walrasiano", que es como la clave de la síntesis neoclásica, en los que el "óptimo" es la "eficiencia" de Pareto, los costes eficientes, razonamiento que fue nuevamente modelizado principalmente por Arrow y Debreu.

4. Baumol y la Eficiencia

El conjunto teórico de la "eficiencia" sobre el que se sustenta en gran parte la teoría de la regulación de las telecomunicaciones es el libro de Baumol y Sydak, *Towards competition in local telephony*, MIT 1994, que tuvo una gran incidencia, comenzando en la "Implementation" de la FCC de la "Telecomunications Act 1996" en USA, y posteriormente en Europa con su modelo de contestabilidad, que es un intento de integrar la teoría de la regulación dentro de un modelo de equilibrio general competitivo.

Baumol, en su discurso de apertura en la reunión anual de la American Economic Association de 1981, enuncia los conceptos de contestabilidad, cuyos principales ejes de razonamiento eran los siguientes: "Un mercado contestable es aquel en el que la entrada es completamente

(6) El libro fundamental es el *Manuel d´economie politique*, 1909, versión francesa ampliada de su primitiva versión italiana del *Manuale...* y especialmente con el añadido del apéndice matemático en el que se establece el "primer teorema de la Economía del Bienestar", en el que la definición de equilibrio competitivo, lo que el autor llamó la "optimalidad", que se ha conocido como el "óptimo", y posteriormente "eficiencia" de Pareto, es la referencia a una asignación óptima de recursos en economía.
(7) Lipsey y Lancaster, "The General Theory of Second Best". Review of Economic Studies, Oct 1956.

libre y la salida resulta absolutamente carente de costes", cuya concreción para los entrantes en ese mismo discurso es "hit and run", o "golpea y corre". Ello significa que el entrante no sufre las barreras de entrada y salida, por lo que libremente puede optar por recoger los beneficios de un mercado y salir del mismo sin coste hundido alguno. Aunque a continuación matiza la frase anterior, pues el significado de que el *"freedom of entry"* sea sin coste realmente quiere decir más bien que el entrante no sufra desventaja en términos de producción técnica y calidad del producto en relación al incumbente, lo que en cierta medida tiende a una inversión sin riesgo o con mínimo riesgo, y desde luego sin costes hundidos. Hay que recordar, sin embargo, que la inversión se caracteriza por la presencia de costes hundidos, riesgos e incertidumbres, lejos de las características de la inversión que define Baumol.

Baumol es quien ha elaborado el modelo teórico más complejo de la regulación, integrando precios, la eficiencia de Pareto, el modelo de equilibrio general competitivo de Arrow y Debreu o la preferencia de los consumidores, resumido en los siguientes términos: *"We need not review the details of the Arrow–Debreu theorem, because its pertinence to economic regulation is limited. Its main implications for our purposes are that in equilibrium in a perfectly competitive market production will always be carried out only by firms that can do so with lowest costs; that inputs will always be allocated among firms in a way consistent with economic efficiency in production; and that output quantities will always be tailored to the preferences of consumers, and will consequently never fail to take advantage of an opportunity to introduce a Pareto improvement. With their belief in the value of economic efficiency, economists are driven to accept the competitive-market standard for regulation, because competition serves as the viable instrument capable of moving the economy toward their ideal".*[8]

El razonamiento parte del equilibrio de producción en un mercado contestable a costes, "lowest cost", y sus recursos serán asignados de una manera eficiente en la producción, consiguiendo la maximización de las preferencias de los consumidores.

El modelo de contestabilidad, o el modelo regulatorio europeo actual, invierte el razonamiento, ya que como no hay mercado en competencia que fije los precios mayoristas a costes "lowest cost", serán los precios regulados a "lowest cost", los llamados costes LRIC, los que permitirán conseguir un mercado de servicios finales en competencia, pero basando esta competencia en el alquiler de la red, y no en una inversión en infraestructuras de red propias, como suponía el modelo regulatorio de USA de 1996 y de la UE de 1997.

Este modelo plantea una cierta incoherencia que se va a mantener en todo el proceso regulatorio, por un lado, fijar precios mayoristas a costes "eficientes" del incumbente, que van a definir en gran parte el valor de sus activos y el de los operadores entrantes que inviertan en esos mismos activos, y por otro, hacer atractiva la inversión para el incumbente y para cualquier operador alternativo que pretenda invertir en activos de la red, siempre sobre la base de que los precios regulados de los activos se fijen a costes "eficientes", o "lowest cost".

El Juez de la Corte Suprema Easterbrook sintetiza lo anterior: *"Prices for unbundled affect not only the allocation of income among producers, but also new investment and innovation: if the price to rivals is too low, they won't build their own plant (why make capital investment when you can buy for less, one unbundled element at a time?), and the incumbents won't maintain or upgrade their facilities (why make costly capital investment if you have to sell local loops to rivals for less it costs to produce them?)".*

Este modelo regulatorio tiende a hacer más atractivo el alquiler que la inversión en esos activos regulados, excepto en escasas áreas geográficas, pues al ser el precio regulado una media, puede haber zonas muy limitadas cuya posición sea mejor.

5. Operador Eficiente

La regulación, por tanto, trata de calcular los costes eficientes eliminando las ineficacias de los mismos en su cálculo. El cálculo de operador eficiente se podría hacer sobre el operador entrante, pero como este no tiene desplegada la red, la alternativa que se utiliza es calcular los costes "eficientes" sobre el operador incumbente, aunque también hay otra posibilidad, asimismo utilizada en bastantes ocasiones, que es la creación de un modelo "Bottom-Up".

(8) P. 29.

El modelo "Bottom-Up" consiste en la optimización tecnológica de las redes y su rediseño "ex novo" como una forma de calcular los costes a partir de modelos de ingeniería representativos de una infraestructura "inventada", que tiene la ventaja, para el regulador, de no depender de los datos del operador regulado, pero la desventaja de no representar los costes reales del mismo. Regulatoriamente se supone que la ventaja de esta optimización es que perjudica al incumbente y le incentiva a innovar, y además no perjudica al nuevo entrante, ya que una red bottom-up "se supone" que es la que construiría el operador de infraestructuras alternativas entrante. Este modelo inventa unos costes regulados tan bajos que no ayuda a la inversión e innovación, ni del incumbente ni de ningún operador alternativo. Realmente está próximo a un disparate económico.

6. Directivas Europeas y el Coste Eficiente

Las normas europeas sobre la regulación de los precios de los servicios de telecomunicaciones se fundamentan en la eficiencia, y por tanto en el concepto de costes "eficientes". Así, la Directiva de Acceso 2002/19/CE en el Art. 13, apartado 2, enuncia que "las autoridades nacionales de reglamentación velarán por el mecanismo de recuperación de costes o el método de fijación de precios que se imponga sirva para fomentar la eficacia[9] y la competencia sostenible y potencie al máximo los beneficios de los consumidores".

Y en el Considerando (23) se recoge que "con objeto de garantizar la eficacia y la eficiencia del mercado de las telecomunicaciones..."

Los precios y costes han sido más concretamente definidos en la Recomendación de 8/01/1998 sobre la interconexión, en su parte 1, "Las tarifas de interconexión", en el Recomienda (3), que es el armazón en el que se basan los precios regulados, y establece que "los costes de interconexión deben calcularse sobre la base de los costes incrementales medios[10] a largo plazo prospectivos, ya que estos costes se aproximan mucho a los de un operador eficiente que emplee tecnología moderna".

Los costes LRIC son recomendados en el Considerando 13 de la Recomendación sobre tarifas de terminación de la telefonía fija y móvil (7-5-2009): "Teniendo en cuenta las características particulares de los mercados de terminación de llamadas, los costes de los servicios de terminación deben calcularse en función de los costes incrementales prospectivos a largo plazo LRIC". Y los LRIC "...promueven una producción y un consumo eficientes y reduce al mínimo los posibles falseamientos de la competencia".

Y sigue: "Cuanto más se aparten las tarifas de terminación del coste incremental mayores serán los falseamientos de la competencia....". Pero resulta interesante recordar que el economista que más definió los costes incrementales, Alfred Kahn, no encontraba relación entre los costes incrementales, que él había definido, y los TELRIC, similar a los LRIC, que los denominaba "abominables".

Los precios basados en costes LRIC reducen la valoración de las amortizaciones y del coste del capital y, en consecuencia, reducen el valor de los activos y por tanto del valor del capital de la empresa. Esta reducción del valor de capitalización de la operadora significa una menor rentabilidad de la inversión, y en consecuencia es otra forma de hacer menos atractiva la nueva inversión del incumbente o de cualquier otro operador que invierta.

Por tanto, el modelo regulatorio europeo de operadores "eficientes" a costes "eficientes" en una red muy amortizada ha potenciado mayoritariamente el alquiler, y solo excepcionalmente la inversión.

En este razonamiento regulatorio habría que distinguir dos situaciones muy diferentes en relación a la inversión: si la inversión estaba ya realizada y en gran parte amortizada, o si es una nueva inversión. Si la inversión en la red legada estaba realizada por el incumbente, prácticamente la alternativa era alquilar la red de este a precios orientados a costes "eficientes" LRIC, pero invertir muy poco en infraestructura de red; pero si la inversión no está realizada, con este modelo regulatorio es muy difícil potenciar la inversión, pues es un modelo de alquiler de activos de red, en el que potenciar las inversiones de las nuevas redes NGA, aun con las variantes que ha introducido la "Recomendación relativa al acceso regulado a las redes de acceso de nueva generación NGA (20-9-2010)", será muy difícil.

(9) La eficacia está poco o nada tratada en la teoría económica, es una palabra más bien vacía. Realmente está mal traducido, se traduce "...to promote efficiency...", o sea eficiencia, por fomentar la eficacia.
(10) Los costes incrementales medios son algo contradictorios, ya que los costes incrementales tienen más relación con los costes marginales, que son diferentes de los costes medios.

Esta Recomendación tiene ya más en cuenta los riesgos del despliegue de la red de NGA, como los riesgos e incertidumbre relativos a la demanda al por mayor, el despliegue de la obra civil, la dinámica del mercado, la incertidumbre macroeconómica, etc., y el riesgo sistémico de la inversión. Adicionalmente obliga a que los operadores incumbentes permitan a los entrantes el acceso a sus infraestructuras de obra civil, en las mismas condiciones de uso que ellos mismos, a un precio regulado. Sin embargo, mantiene el criterio de alquiler de los activos de las nuevas redes NGA a precio orientados a costes incrementales “eficientes”, por lo que el problema que se plantea con la nueva red NGA es que la inversión no está aún realizada, y la disponibilidad de la nueva inversión para alquilar a “eficientes”, aún con las variantes introducidas por esta Recomendación, pueden hacer la inversión poco atractiva.

El negocio de las empresas es obtener beneficios en un entorno en competencia y para eso se invierte e innova, para diferenciarse y capturar mercado propio, mientras que la regulación establece reglas para facilitar una situación beneficiosa a los competidores. Esta situación no era muy problemática en un periodo de tiempo en que los niveles requeridos de inversión eran bajos, pero en un periodo en el que se van a necesitar mayores inversiones, con estas condiciones es muy difícil promocionar las inversiones del incumbente o de cualquier otro inversor, que se verá obligado a competir con el alquiler a precios a costes “eficientes”, y esto es algo que la regulación parece haber olvidado, lo que antes no era un gran problema con la red legada e inversiones amortizadas, pero sí lo es con las NGAs.

7. La Eficiencia y los Costes

El problema de la regulación de las telecomunicaciones, como se comentó anteriormente, es que no hay competencia en el mercado mayorista, y por tanto no hay precios en competencia, sino precios regulados, que deben ser orientados a costes eficientes. Pero la eficiencia en la teoría económica no está suficientemente definida, por lo que se necesita relacionar la “eficiencia”, costes “eficientes”, con los costes regulados.

La “eficiencia” en la regulación es fundamental, pero no es un concepto muy concretamente definido, ya que se aproxima a un operador eficiente con tecnología moderna, pero que varía en función de criterios de eficiencia utilizados, lo que da lugar a diferentes tipos de costes regulados (corrientes, LRAIC, TELRIC, TSLRIC, LRIC, etc.), pero los más usados en la UE han sido los costes corrientes y más recientemente los LRIC, en sus diferentes versiones. La principal diferenciación de estos costes se produce en la cuantificación de los costes CAPEX.

7.1 Los Costes CAPEX

Los costes, como gastos por naturaleza, se pueden clasificar en: costes OPEX (operational expenditure), los gastos operativos; y costes CAPEX (capital expenditure), gastos de capital. Esta división es útil en cuanto separa los costes CAPEX, que son fundamentales en la regulación.

La diferencia más importante entre la contabilidad financiera o empresarial y la contabilidad regulatoria se produce casi en su totalidad en los costes CAPEX, no en los costes reflejados OPEX, que son los gastos operativos de personal, aprovisionamiento, suministros exteriores, gastos financieros, gastos extraordinarios, tributos y otros, entre los cuales las principales diferencias, aunque no muy importantes, se producen en los gastos extraordinarios[11].

Los costes CAPEX (amortizaciones y gastos de capital)[12], son costes calculados con una metodología regulatoria basada en costes “eficientes”, y por tanto con una determinada valoración de los activos, y estos dependen en gran parte de la introducción o no de nuevas tecnologías.

El cálculo de la rentabilidad de la inversión en la Regulación, que son los costes calculados CAPEX, se basa fundamentalmente en: primero, costes “eficientes”, que influyen decisivamente en las valoraciones de las amortizaciones y en el coste de capital, y por tanto en la valoración de los activos; y en segundo lugar, el cálculo del coste de capital o tasa de retorno, WACC (Weighted Average Cost of Capital), que trata la compensación por las inversiones realizadas, y especialmente el cálculo de la rentabilidad de los Fondos

(11) Aunque el elemento más importante para definir los costes regulados sean los costes CAPEX, hay que matizar que uno de los problemas de los incumbentes está en los costes OPEX, concretamente en los gastos de personal, porque los incumbentes tienen unas plantillas sobredimensionadas y además el número de líneas está bajando. Si se compara la relación líneas por trabajador en los incumbentes fijos con los operadores móviles en Europa, son cerca de nueve veces más líneas por empleado en los móviles que en las fijas.

(12) Puede haber diferencias en otras partidas como planta desmontada, material recuperado, financiero, desmontaje, pero lo fundamental son las amortizaciones y el coste de capital.

Propios con el CAPM (Capital Asset Pricing Model), que son decisivas en la regulación al ser un sector intensivo en capital.

La regulación de costes CAPEX depende de la valoración de los activos, que puede ser a precios de adquisición o a precios de reposición. Los precios de adquisición están claramente definidos, es el precio en el momento de compra del activo, que definirían precios históricos, pero normalmente no es el criterio regulatorio seguido, ya que los precios de adquisición, históricos, no integran el criterio de "eficiencia".

Los precios regulados "eficientes" se basan en precios de reposición, pero este concepto es muy amplio, ya que puede referirse al valor de los activos, en función de diferentes precios de reposición, a la propia estructuración de estos activos, con un despliegue de redes reales o la creación de una red con criterios de optimización, o bien a la optimización del conjunto de la organización. Los precios y la estructuración de los activos, o sea, la valoración de los activos, puede hacer variar los precios regulados en una proporción enorme.

El precio de reposición en los costes corrientes es el coste de la sustitución de un activo determinado por otro de características y edad semejantes; sin embargo, cuando la tecnología cambia rápidamente, un activo puede no ser sustituible (por ejemplo, porque ya no se fabrica) y, en este caso, es necesario calcular el valor del activo equivalente moderno (MEA), que es el valor de un activo con la misma capacidad y funcionalidad que el existente, pero a precio de compra actual, normalmente más barato que a precios históricos de adquisición[13], lo que condiciona los costes calculados de amortización y costes de capital.

Pero es sobre todo en los costes LRIC (Long Run Incremental Cost)[14], los costes más recomendados últimamente por la regulación europea, donde se plantean con toda su crudeza los precios de reposición, ya que utiliza una visión prospectiva, a varios años, lo que significa que la mayoría de los activos se convierten en MEA (valor del activo equivalente moderno). Por tanto, la influencia de los costes LRIC sobre la menor valoración de las amortizaciones y el coste de capital puede ser importante.

7.2 Amortizaciones y Costes Hundidos

La amortización se produce por el descenso del valor de los activos y la necesidad de imputar su coste en los periodos en que han sido usados o que se espera que sean usados, y esa imputación se asigna como gasto. Los métodos de imputación son muy variados.

Dado que la regulación actual parte de los costes históricos e introduce, como hemos visto, la valoración de las amortizaciones de determinados activos bien a costes corrientes, generalmente algo más bajos que los históricos (aunque depende mucho de la obra civil), o a costes LRIC, cuyos precios son aún más bajos, se crea un déficit de recuperación de las amortizaciones de los costes históricos, dando lugar a lo que se designa como costes hundidos.

El concepto de costes hundidos (o costes fijos del inmovilizado no recuperables en los precios regulados) se refiere tanto al concepto clásico, en que los costes no se recuperan en la amortización cuando finaliza la actividad, como a los activos que no se amortizan en el cálculo de los costes regulados (al valorarse como costes corrientes, o especialmente si son costes LRIC).

Los costes "eficientes" regulados, especialmente los LRIC, transforman el sentido de la amortización al reducir la vida útil de esos activos, que son sustituidos por otros de nueva tecnología a precios de reposición, lo que crea unos costes hundidos que generalmente reducen su valor, pero no solo de los incumbentes, sino también de los operadores entrantes que han invertido en esos mismos activos. La introducción de una nueva tecnología en los costes "eficientes" regulados convierte en obsoleta la anterior y hace que normalmente no se finalice su amortización.

Si a este efecto añadimos el acelerado cambio tecnológico del sector de las telecomunicaciones, nos encontramos ante el hecho de que muchos activos no puedan amortizarse, porque antes de finalizar su vida técnica el modelo regulatorio pasa a valorarlos a un precio de reposición más barato y, en consecuencia, parte del activo no se amortiza nunca y se convierten en costes hundidos[15], especialmente en el método de cálculo de los costes LRIC que hace que casi todos los activos sean MEA (Activos Modernos Equivalentes), y la diferencia de amortización pueda ser importante.

(13) Excepto la obra civil.
(14) Los LRIC suponen un modelo contable "Top down" en la que el coste se calcula en relación con la cantidad producida, sobre la base de "cuánto cuesta producir un incremento de producto" (IC), y el "largo plazo"(LR) es una concesión necesaria al hecho de que, en actividades basadas en costes fijos, o se considera un período suficientemente largo o el resultado del coste incremental es cero.
(15) La utilización de coste hundido es similar a un coste irreversible, no recuperable en el modelo regulatorio.

La regulación introduce, por tanto, una valoración muy diferente en los activos en función de los diferentes precios de reposición que considere en los costes regulados "eficientes" (corrientes, LRAIC, LRIC, TSLIR, TELRIC, etc.)[16] generando, en consecuencia, diferentes valores de amortización y costes hundidos.

Supongamos un ejemplo muy simplificado, que un operador compra una central de conmutación en el año 2000 por 10 millones de euros, que espera mantener en operación hasta 2010, y que en 2005 se produce una innovación que introduce un nuevo sistema, por ejemplo una softswitch conectada a un backbone IP, sustitutivo del anterior y más "eficiente", pero con un precio de compra, de reposición, de 5 millones, o sea la mitad que el anterior, por tanto con una gran diferencia respecto a los costes históricos o precios de adquisición anteriores, y que es introducido en la "hipotética" red regulada y en los cálculos de costes regulados. Si el sistema de amortización aplicado es la financiera constante, siendo diez los años de amortización, representa 1 millón de euros anualmente.

El coste de capital, supuesta una tasa de beneficio normal de 5%, equivalente a rentabilidades de inversiones de riesgo similar, supondría 5 millones en el periodo de diez años. El total, la suma de la amortización y el coste de capital, es de 15 millones de euros en los diez años.

Pero la amortización a precio-coste "eficientes" TELRIC en USA, y similar para los LRIC "eficientes" europeos, supone que al sexto año se considere la nueva tecnología, que no se tiene que incorporar realmente a la red, pero sustituye a la anterior en la regulación, y cuyo precio es de 5 millones; en este caso, la amortización durante los cinco primeros años es de 5 millones con la tecnología antigua y durante los cinco últimos, con la tecnología nueva, de 2,5 millones, con un total de amortización de 7,5 millones.

De forma similar, los costes de capital se valoran a costes de reposición en los cinco primeros años, con la tecnología antigua, y los últimos cinco con la tecnología nueva, en total 3,75 millones. El total CAPEX será la amortización (7,5 M) más el coste de capital (3,75 M), que hacen 11,25 millones.

Las diferencias entre los dos cálculos, 15 M frente a 11,25 M, es decir, 3,75 M, son en gran parte costes hundidos para el operador incumbente, que no podrán ser recuperados vía precios regulados, siendo este el efecto inmediato que tiene la introducción en los precios de reposición de la tecnología más moderna en los modelos regulatorios de la red, especialmente TELRIC o LRIC. La innovación tecnológica lleva a una continua desvaloración de activos y, en consecuencia, de los precios regulados.

La conclusión es que bajo el sistema de costes corrientes, TELRIC o LRIC con la introducción de nuevas tecnologías, aunque no necesariamente incorporadas realmente a la red, es muy posible que no se recupere parte de la amortización y coste de capital de las inversiones realizadas.

Los costes que se toman en consideración en la regulación de la UE son costes de los servicios, ya que la contabilidad de gastos por naturaleza se transforma en costes por actividades para finalmente convertirse en costes de los servicios, pero la incidencia de la regulación LRIC sobre los costes CAPEX, amortizaciones y costes de capital, es conceptualmente muy similar a la regulación TELRIC en USA, aunque referida a los elementos de red.

La construcción teórica TELRIC fue muy criticada por Alfred Kahn[17], uno de los profesionales más sólidos de la regulación y que había sido el impulsor de los costes incrementales, la base de los LRIC: "*I never dreamed, however, in proclaiming that efficient prices should be based on incremental costs, that policymakers would then proceed to ignore the actual incremental costs of the incumbent suppliers and instead adopt as the basis for policy the costs of a hypothetical, most efficient new entrant, constructing an entire set of facilities as though writing on a blank slate (with the one qualification that it take as given the existing wire center locations of the incumbents).*[18]

(16) LRAIC, Long Run Average Incremental Cost. TELRIC, Total Element Run Incremental Cost. TSLRIC, Total Service Long Run Incremental Cost.
(17) En su libro *Whom the gods Would destroy or How not to deregulate* y sobre todo en el capítulo 2, "Telecommunications deregulation: The abominable TELRIC-BS", o sea, define con la palabra de "abominable" la construcción teórica de los precios TELRIC, y lo mismo lo hubiera hecho de sus sucedáneos europeos.
(18) También fue criticado por los mejores economistas de la regulación, como Laffont: "This broad regulatory consensus in favor of LRIC unfortunately is supported by little economic argument", en su libro con Tirole *Competition in Local Telephony* p. 148.
Igualmente, Eli M. Noam: "Forward-looking long run incremental cost (LRIC) ...is supplemented by a planned-economy style, engineering-based proxy cost models that are advanced by the staunchest advocates of free markets. ...There are some good theoretical arguments for such methodology (FL-LRIC), but is doubtful that this approach would have been chosen if the price would not trend conveniently down." En Handbook of Telecommunications Economics, Vol 1, Elsevier 2002 , Ch 9.

Adicionalmente los costes LRIC pueden incorporar en otras versiones nuevos costes hundidos, por ejemplo, si el regulador decide, para valorar los costes, utilizar un determinado diseño óptimo de red, generalmente más barato y con poca o nula relación con el despliegue de la red real, dando lugar a importantes costes hundidos. Esto puede ocurrir especialmente cuando se utiliza el modelo Bottom-Up.

La obsolescencia tecnológica de los activos del incumbente, potenciada por la introducción de nuevas tecnologías en la regulación, acorta la vida útil de los activos y reduce su amortización. Esta situación quizás se pueda compensar como riesgo tecnológico, de acuerdo con la Recomendación NGA (de 20/09/2010) que acepta introducir en el cálculo de costes los riesgos tecnológicos, pero lo lógico sería valorar el activo al coste del MEA, ajustar el activo a la nueva vida útil y llevar el valor perdido de la inversión a una cuenta de pérdidas por obsolescencia tecnológica que debería ser provisionada.

7.3 El Coste de Capital

La regulación necesita definir una tasa de retorno o beneficios regulatorios, porque dentro de su esquema no puede admitir unos beneficios determinados por el mercado para los servicios mayoristas, fundamentalmente porque el mercado mayorista solo existe bajo la forma de un monopolio u oligopolio, por lo que tiene sentido definir unos criterios regulatorios para calcular una tasa de retorno o beneficio.

La regulación trata de calcular el beneficio a través del WACC (Weighted Average Cost of Capital o Coste de capital medio ponderado), que se define como la tasa de rentabilidad media requerida por los inversores que financian los activos de la empresa:

$$WACC = k_p\, E(E + D) + k_d\, D/E + D$$

El WACC es la suma de la rentabilidad de los fondos propios k_p por la proporción de fondos propios E sobre el total de financiación E/E+D, más la rentabilidad de los fondos ajenos por la proporción de fondos ajenos D sobre el total de financiación D/E+D.

El cálculo del coste de capital regulado está soportado en la composición del pasivo, coherente con la definición del WACC como "la tasa de rentabilidad media requerida por los inversores que financian los activos de la empresa", o sea, los que financian el pasivo.

La primera duda es si es muy lógico calcular la rentabilidad de un activo por la composición del pasivo y, en consecuencia, los precios regulados. Por ejemplo, un activo es más rentable si la proporción de fondos propios es mayor, porque normalmente la rentabilidad de los fondos propios es superior a la de los fondos ajenos, ya que tienen más riesgo.

El cálculo de la rentabilidad del activo por el pasivo plantea problemas, por ejemplo, si se quiere regular servicios, como interconexión, acceso desagregado, o las redes de nueva generación NGA, etc., aplicándoseles la tasa de rentabilidad requerida por un inversor y referida al conjunto de la empresa, porque es difícil separar en un balance el activo y pasivo aplicado a un negocio parcial, por ejemplo a las NGAs, y en consecuencia su rentabilidad puede ser totalmente diferente de la rentabilidad del conjunto de la empresa.

Como hemos visto, el WACC se analiza en dos partes diferenciadas, los fondos ajenos y los fondos propios. El cálculo de los fondos ajenos es más fácil de estimar, porque se conoce fácilmente el tipo de interés libre de riesgo, por ejemplo del Bono del Tesoro, más algún premium de riesgo de la deuda de la empresa.

Pero un problema mayor supone calcular la rentabilidad de los fondos propios k_p, el equivalente a una tasa de beneficios, que bajo los supuestos de regulación se realiza por las Agencias Nacionales Regulatorias mayoritariamente por el método del CAPM (Capital Asset Pricing Model).

La importancia del CAPM para el cálculo del coste de capital en la teoría regulatoria es fundamental, especialmente en un sector intensivo en capital como las telecomunicaciones, y por eso merece la pena analizarse con mayor detenimiento.

Sharpe es el creador del CAPM, que trata de establecer la relación de rentabilidad y riesgo de los diferentes valores de un inversor en el mundo financiero.

Sharpe, en su importante artículo "Capital Asset Prices: a Theory of market equilibrium under conditions of risk"[19] , afirmaba que uno de los

(19) "The Journal of Finance", Sep 1964: "One of the problems which have plagued those attempting to predict the behavior of capital markets is the absence of a body of positive microeconomic theory dealing with conditions of risk".

problemas que ha dificultado las predicciones del comportamiento del mercado de capitales es la inexistencia de una teoría microeconómica que la relacione con las condiciones del riesgo[20], y busca construir un modelo de determinación de los precios de los activos de capital[21].

El proyecto de Sharpe se centra en intentar cubrir ese gran vacío de determinación de los precios de los activos de capital, pieza importantísima de la inversión.[22]

La construcción de una teoría de precios de los activos bajo condiciones de riesgo en equilibrio de mercado, supone ampliar la teoría financiera hacia precios de los activos con diferentes componentes de riesgo, que Sharpe trata de integrar en esta fórmula:

$$E(Rp) = R_f + \beta(E(R_m) - R_f)$$

Las expectativas de rentabilidad de un porfolio $E(Rp)$, en el caso de la regulación de la rentabilidad de los fondos propios de una operadora, es función de R_f, retorno de un activo sin riesgo, normalmente el tipo de interés libre de riesgo (por ejemplo el Bono del Tesoro), de $E(R_m)$, que es el retorno del índice del mercado de la Bolsa o un índice similar, y la β.

Las variables R_f, $E(R_m)$ no tienen relación concreta con la rentabilidad del porfolio elegido $E(Rp)$, en este caso el operador regulado, y por lo tanto no intervienen en este cálculo, ni sus ingresos, costes, *cash-flow* o beneficios, y los valores de la operadora solo intervienen en el cálculo de la rentabilidad a través de la β, variable que puede representar el riesgo o sensibilidad del retorno del porfolio o de la operadora al retorno del mercado. Aunque realmente el numerador de β es la covarianza entre el retorno de la operadora y el mercado.

Este es un modelo bursátil, que en el mejor de los casos se refiere a empresas cotizadas en Bolsa, pero las grandes operadoras, las incumbentes, véase DT, FT, Telefónica, Vodafone, etc., tienen sus filiales extendidas por el mundo, que normalmente no cotizan, y por lo tanto es imposible establecer unas relaciones estadísticas (covarianzas) entre la evolución del mercado (CAC 40, FT, IBEX, Dow Jones, etc.) y la evolución del incumbente en la Bolsa, en la que no cotiza como filial, sino formando parte de una multinacional.

Cuando el incumbente no cotiza en Bolsa, los posibles métodos de cálculos de β son dos: partir de la empresa “madre” e ir retirando cada una de las filiales hasta llegar a la operadora “filial” regulada, o fijar un benchmarking en relación a empresas similares.

Generalmente el cálculo de β para poder estimar el CAPM se establece con un *benchmarking*, una media entre empresas parecidas del mismo sector, aunque esta solución puede tener una alta autocorrelacción entre todas ellas, teniendo poca relación con la covarianza.

Sharpe calcula el coste capital como la rentabilidad del mercado, o tipo de interés libre de riesgo, R_f más un “Premium”, que es el beneficio expresado como $\beta(E(R_m) - R_f)$, que representa la diferencia entre la rentabilidad del mercado y el tipo de interés libre de riesgo, es decir, la compensación al riesgo del mercado, aunque tiene escasa o nula relación con el operador regulado.

Por tanto, solo en β es donde interviene la relación de la operadora con el mercado, a través de la covarianza $Cov(R_p R_m)$, que representa la relación del retorno del incumbente al retorno del mercado, dividido por la varianza de la operadora.

Las críticas al CAPM de Sharpe han sido numerosas, y entre ellas cabe destacar la de Markowitz[23] sobre los supuestos que aquel utiliza, dado que cuando se aplican en el mundo real sus conclusiones no se cumplen, así como las de E. Fama y K. French[24]: “*We continue to teach the CAPM as an introduction to the fundamentals of portfolio theory and asset pricing … but we also warn students that, despite its seductive simplicity, the CAPM´s empirical problems probably invalidate its use in application*”, es decir, ponen énfasis a la dificultad de la puesta en práctica de sus teorías.

El problema de la utilización de las β se complica, aún más, en la medida que se utiliza la β de la

(20) Actualmente aún sigue siendo uno de los mayores problemas de la teoría económica, y es en gran parte causa de la crisis de 2007-2008.
(21) Los apoyos teóricos en el modelo de Sharpe son fundamentalmente Markowitz, para los activos con riesgo, y en un aspecto concreto Tobin, que introduce los activos sin riesgo.
Además Sharpe coloca su CAPM en un nivel teórico más elevado, en relación con una teoría del equilibrio general; Varian afirma que “*The Capital Asset Pricing Model was truly a revolutionary discovery for financial economics. It is a prime example of how to take a theory of individual optimizing behavior and aggregate it to determine equilibrium pricing relationships. Furthermore, since the demand for an asset inevitably depends on the price of all assets, due to the nature of the portfolio optimization problem, it is a general equilibrium theory*”. La relación con el modelo de equilibrio general significaba una elevación en su análisis, sin embargo, actualmente la relación con el modelo de equilibrio general ha perdido su especial significado.
(22) Sharpe en su artículo anteriormente citado, p. 427, “*Although all the authors cited use virtually the same model of investor behavior, none has yet attempted to extend it to construct a market equilibrium theory of asset prices under conditions of risk*”. Los autores citados son Hicks, Tobin, etc.
(23) “Market efficiency: a theoretical distinction and so what?”. Financial Analysts Journal, 2005.
(24) E. Fama y K. French, “The Value Premium and the CAPM”. Journal of Finance, Oct 2005.

operadora global, por ejemplo DT o FT, para cada uno de los servicios de la empresa, cuando puede haber diferencias muy importantes entre ellos. La alternativa es calcular una estructura financiera de un servicio determinado (interconexión, acceso desagregado, NGA, etc.): primero, el WACC, que es el cálculo de la rentabilidad de los fondos propios y ajenos de esa actividad, pero que es muy difícil de estimar para un servicio concreto, y casi nunca se ha estimado; y en segundo lugar, el CAPM y la β para ese servicio determinado, si bien en un modelo purista habría que calcular las covarianzas de un servicio o realizar métodos de estimaciones indirectas. La realidad es que las estimaciones de la β de diferentes servicios dentro de una misma operadora han sido mínimas, prácticamente no se han realizado nunca.

La conclusión es que se ha de ser muy escéptico sobre el uso del CAPM y la β en los cálculos de la rentabilidad de los fondos propios en las operadoras de telecomunicaciones cotizadas en Bolsa, y aún más en los cálculos de rentabilidad de operadoras no cotizadas, por lo que no deja de ser sorprendente la amplia gama de aplicaciones que se están dando al uso de la β.

7.4 Los Precios de los Activos

Las estimaciones anteriores se refieren a la valoración del precio de los activos, y la teoría económica, que ha pasado a ser la teoría financiera, se soporta en la idea de que el precio de un activo financiero[25] refleja toda la información válida que es relevante a su valor, y por lo tanto representa la mejor estimación de los riesgos de los respectivos activos.

Esta posición enlaza con las teorías financieras, y especialmente con las Opciones Financieras, cuya evolución comienza en Markowitz, Sharpe, Litner, Merton, Black y Scholes, lo cual no quiere decir que no tengan diferencias muy importantes en sus posiciones.

La información válida de las valoraciones, generalmente en Bolsa, se trata en la teoría financiera suponiendo que su distribución sigue una distribución normal, la curva de Gauss, pero las aportaciones recientes muestran que si se utiliza esta distribución puede no incorporar parte del riesgo.

Aunque la moderna teoría macroeconómica se ha ocupado de los precios de los bienes y servicios, lo cierto es que ha olvidado los precios de los activos. Este olvido se basa en la seguridad que se tenía en que los precios fijados por los mercados financieros representaban la mejor información.

Por otra parte, las valoraciones de las teorías financieras del futuro pueden ser analizadas y comprendidas a través de análisis estadísticos o econométricos, y la distribución mayoritariamente utilizada es la distribución normal, suponiendo, por lo tanto, que la distribución de los valores financieros se aproxima a una curva de Gauss. Esta distribución permite un amplio manejo, conociendo la media y la desviación típica.

Pero la actual crisis financiera de 2007-2008 y las continuas crisis anteriores han puesto en cuestión gran parte de esta teoría, en la que la previsión de los valores de mañana se basa en las cotizaciones conocidas de hoy, y en suponer que en el futuro se van a comportar como en el pasado, bajo el supuesto de que en el mañana las expectativas y las desviaciones típicas se comportarán como una distribución normal, o curva de Gauss.

Las teorías basadas en las opciones financieras de Markowitz, Sharpe, Litner, Merton, Black y Scholes se basan en razonar sobre una distribución normal, cuya utilización quedaba limitada con las aportaciones de Bachelier y Malebranch y las "fat tails" sobre la distribución normal, y los Cisnes Negros de Nassim N. Taleb.

La distribución de probabilidades de que un acontecimiento ocurra, si se mide por la distribución normal, y como la media más/menos una vez la desviación típica, $\bar{x}+\sigma$, genera unas expectativas racionales con una probabilidad de ocurrir dentro de este entorno en un 68,3%; si se considerase la media más/menos dos veces la desviación típica, $\bar{x}\pm 2\sigma$, sería del 95,4%; y la media más/menos tres veces la desviación típica $\bar{x}\pm 3\sigma$, sería del 99,7%. Por tanto, fuera de este último entorno las probabilidades de un suceso no son altas, el número de veces que ocurre son muy pequeñas, pero la realidad nos ha demostrado que ocurren más de lo previsto con una distribución normal, y es lo que se ha venido en llamar *"fat tails"* o *"thin tails"* o "alas".

La realidad, por tanto, es que las crisis han aparecido en muchas más ocasiones que las previstas bajo los supuestos de previsión de una distribución normal, y esto tiene una influencia en el riesgo.

(25) Fama, con su "Efficient-Markets hypothesis (EMH)", es su principal valedor.

La explicación más extendida actualmente procede precisamente del análisis de las "fat tails" en la distribución de la curva de Gauss, en la que las alas tienen una muy pequeña probabilidad de suceder, aunque en la realidad suceden más habitualmente.

Desde un punto de vista teórico este fenómeno fue analizado por Louis Bachelier en su innovadora tesis doctoral en Paris en 1900, que fue rechazada por el gran matemático Poincare, aunque redescubierto por Benoit Maldelbrot[26] en 1963, el creador de la geometría fractal, quien argumenta que las finanzas son más propensas a una desenfrenada aleatoriedad que lo usualmente visto en la naturaleza, y añade que los mercados *"rare big changes can be more significant than the sum of many small changes"* (The Economist 13/02/10).

Posteriormente ha habido una serie de análisis que encontraron que los "fat tails", contrariamente a la creencia de que eran inusuales y, por tanto, una excepción, son la norma, en el sentido que se repiten con mayor frecuencia de lo previsto. De hecho, los trabajos sobre las "fat tails" de Malebranch, o los de Black Swans de Nassim Taleb, están ligados a la distribución del riesgo, y mostraron que estos acontecimientos extremos ocurren más a menudo de lo que los modelos sugieren; véanse las crisis de 1987, 1992, 1998, 2001 y 2007-08.

Desde el punto de vista de la regulación, la Recomendación de las Redes de Acceso NGA (de 20/09/2010) introduce por primera vez más riesgos de los previstos anteriormente en la definición de los precios regulados, como los de la demanda, el progreso tecnológico, o la incertidumbre macroeconómica, pero el cálculo del coste de capital sigue estando muy en relación con las teorías financieras y la utilización de la distribución normal. Pero si la distribución es una "fat tail", entonces el modelo de la distribución normal infravaloraría las opciones que tienen más de 5 o 7 veces la desviación típica, cuando realmente son más probables que las previsiones dadas bajo la consideración de la distribución normal, lo que significaría más riesgos en la inversión que las previstas por la teoría financiera y, por tanto, por el regulador.

8. Estática y Dinámica. La escalera de inversión

Como se comentó inicialmente, el problema de la regulación es que se basa en modelos estáticos que se soportan en el modelo de equilibrio general competitivo, o modelos contestables fijos en un periodo de tiempo, mientras que la introducción del factor tiempo requiere el uso de modelos dinámicos, que superen la construcción teórica en la que se basa el modelo regulatorio actual. A decir verdad, este no es solo un problema de la regulación, sino de la propia teoría económica, que tiene enormes dificultades en introducir el factor tiempo, que es sinónimo también de introducir el riesgo y la incertidumbre.

Los intentos teóricos para dinamizar este hueco en el razonamiento regulatorio de la inversión, en un sector intensivo en capital como las telecomunicaciones, han sido dos: primero, el cálculo del coste del capital, por el WACC y el CAPM, ya tratadas anteriormente; en segundo lugar, mediante el uso del concepto de la "escalera de inversión" ("ladder of investment") de Martin Cave, aunque finalmente utilizada en la regulación europea en una versión diferente de la ideada inicialmente por el propio Martin Cave.

La "escalera de inversión" de Martin Cave se caracteriza porque el operador entrante sube la escalera por los sucesivos "peldaños"[27], cada vez con mayor valor añadido, ganando beneficios y clientes, alquilando activos de red e incorporando paulatinamente infraestructuras propias, lo que le permite avanzar en la adquisición de activos, peldaño a peldaño, hasta conseguir al final una completa red propia, partiendo del alquiler de los activos del incumbent en los diferentes "peldaños" de la escalera, a precios regulados bajos, a costes "eficientes".

La "escalera de inversión" es propia de la regulación de las telecomunicaciones y ha sido un concepto muy importante de ella, véase el grado de utilización que ha alcanzado en la totalidad de los reguladores, y la importancia dada por el Body of European Regulators for Electronic Communications (BEREC)[28], organismo de los reguladores europeos, no solo referido a la escalera de la red legada, sino también para las NGAs.

La experiencia de varias infraestructuras de redes compitiendo, como preveía el modelo regulatorio

(26) "The Fractal Geometry of nature" (1982). Freeman, San Francisco.
(27) Como ejemplo de peldaños en la cadena de valor de la Banda Ancha, cita Martin Cave, en "Encouraging infrastructure competition via the ladder of investment" Telecommunications Policy (2006) pags 230 y ss., el retailing y reventa, IP Network, Backaul, usando ATM u otras redes, DSLAMs, Bucle local. El ERG (grupo de reguladores europeos) definió otra escalera.
(28) "Next Generation Access - Implementation Issues and Wholesale Products", p. 11. March 2010.

europeo, después de subir por los peldaños de la "escalera de inversión" hasta el despliegue de una red propia, en la realidad no se ha producido, o solo excepcionalmente. Y es que muy probablemente, en el marco de ese modelo regulatorio, no tenga ningún sentido económico invertir en una red propia, sino alquilar activos de red.

El razonamiento de los costes "eficientes" LRIC, plantea el mismo razonamiento entre el alquiler y la inversión en cada uno de los peldaños. Invertir en los peldaños supone costes para la operadora entrante, superiores a los precios basados en costes regulados "eficientes" del incumbente. El alquiler es siempre preferible a la inversión.

Solamente los cableoperadores, que además de los servicios de telecomunicaciones introducen nuevos servicios, como la TV, han mantenido una competencia en infraestructura de redes. Esta infraestructura, con su DOCSIS 3.0, es fundamental para empujar a los operadores de telecomunicaciones a desplegar sus redes de acceso de nueva generación NGA, porque en caso contrario, los operadores de telecomunicaciones quedarán a niveles de transmisión de capacidad muy inferiores.

La "escalera de inversión" parte del supuesto de que la competencia en servicios en el corto plazo sería coherente con la competencia en infraestructuras en el largo plazo, y la regulación trataba de conseguir esta coherencia. Así, la "escalera de inversión" trataría de reducir la contradicción entre precios bajos e inversión y compatibilizar la eficiencia estática y dinámica: la eficiencia estática, que supone bajos precios en el corto plazo, conseguidos por la competencia en servicios; y la eficiencia dinámica, basada en inversiones en despliegue de infraestructuras a largo plazo.

Sin embargo, al esquema regulatorio anterior le falta una pieza fundamental que es la coherencia de los precios regulados y su relación alquiler-inversión, porque el modelo regulatorio empuja a los precios mayoristas a costes "eficientes", corrientes o LRIC, a "lowest cost", induciendo a los operadores entrantes al alquiler, y no a la inversión. Martin Cave hace algunas referencias a los precios[29] regulados, en las que muestra que una inversión en condiciones de costes hundidos, riesgo e incertidumbre hace irresistible la opción de "buy", o sea, alquilar.

La Comisión Europea tomó solo una parte del razonamiento de Martin Cave, pero este era más completo, en cuanto que procuraba aligerar la permanencia en los peldaños limitándola en el tiempo y estableciendo una fecha de caducidad.

Martin Cave introducía dos formas que permitirían establecer esta caducidad: fijando una fecha límite, "*sunset clauses*"[30], a partir de la cual la operadora entrante dejaría de disponer de acceso a precios mayoristas regulados en cada peldaño; o sin necesidad de poner fecha límite, pero estableciendo una senda ascendente de crecimiento en los precios del acceso regulado, de forma que evolucionase el precio orientado a coste LRIC al precio LRIC más el coste de la opción de invertir, es decir, introducía las opciones de riesgo.

Sin embargo, esta parte fue orillada en la regulación europea, y la escalera de inversión se vertió en los moldes de la Comisión sin tener en cuenta esas limitaciones.

El problema regulatorio es que la limitación temporal en un peldaño de la escalera, dentro del modelo de regulación de la Comisión, sería incompatible con el criterio de discriminación del derecho de la competencia, tal como se entiende en Europa.

La modesta analogía de la "escalera" tuvo un éxito fulgurante en la regulación, y fue recogida en el desarrollo de las Directivas de 2002, y posteriormente ARCEP, el regulador francés, lo citaba en su informe de 2006 como elemento clave de su política regulatoria.

El ERG, anterior organismo regulatorio europeo, apoyaba este razonamiento en 2004: *"Due to the high risk involved in investment with a high share of sunk cost, alternative operators are likely to follow a step-by-step approach, continuously expanding their customer base and infrastructure investment. The initial availability of the incumbent's infrastructure at low prices will make it easier for alternative operators to enter the market and develop a customer base. Equipped with a customer base, uncertainly is considerably reduced and the operator may then be ready to take further investment."* El ERC esperaba que los precios bajos regulados promovieran la inversión de los entrantes.

Este párrafo es muy representativo de una cierta incomprensión de la relación alquiler e inversión,

(29) "Snakes and ladders: Unbundling in a next generation world". Telecommunications Policy 34 (2010), p. 82.
(30) La utilidad del "sunset clauses" ha sido criticada por Bourreau y Dogan (2006) y Avenali y otros (2010).

y en la que los precios a costes "eficientes" regulados, corrientes o LRIC, sin consideración de costes hundidos, riesgos e incertidumbre, conducen a "low prices" de alquiler, por lo que, en contra de lo que preveía la ERG, que *"operator may then be ready to take further investment"*, no han potenciado la inversión, sino el alquiler.

El problema de la utilización de la "escalera de inversión" como concepto teórico se plantea con mucha más dificultad con la inversión en las redes de acceso de nueva generación, y por tanto es interesante tomar como primera reflexión la del propio Martin Cave, como creador de este concepto. Este autor plantea otra nueva visión de la "escalera de inversión" en las nuevas redes NGA, en el artículo "Snakes and ladders[31]: unbundling in a next generation world"[32], de 2010.

La conclusión del artículo es que "si los principios gobernando la operación de la escalera de inversión pueden ser "read across" a las redes de nueva generación *"it has been argued that an equivalent ladder exits with NGAs and that regulators can use their power to nudge operators upwards. There are however, important differences"*.

Las diferencias entre la escalera antigua y la nueva que Martin Cave describe en sus conclusiones son las siguientes:

- Mientras el coste de la red de cobre tenía costes hundidos desde hacía largo tiempo, las redes de nueva generación están en curso de construcción, lo que supone que el regulador está enfrentado a un insoluble conflicto entre promover la competencia en la red y crear incentivos a construir la nueva red.

- La dicotomía está entre introducir competencia en servicios minoristas o introducir competencia "en infraestructuras". La competencia en infraestructuras promueve la inversión, mientras que la competencia en servicios no lo hace tan claramente si se puede recurrir a la red alquilada.

- La desaparición del acceso desagregado del bucle local forzará a los operadores a cambiarse a redes de fibra; el ritmo de ese cambio dependerá de una variedad de condiciones como el estado de los conductos, o la densidad de los hogares, entre otras condiciones.

- El cierre de la red de cobre es un objetivo significativo, y ello hace que ambas redes sean interdependientes, y existe la posibilidad de que los reguladores aceleren el traspaso a la red NGA, incrementando para ello el precio regulado del acceso desagregado de la red de cobre con el fin de acelerar la emigración.

Por tanto, la importancia de la "escalera de inversión" para las NGAs viene dada porque la Comisión Europea sigue considerándola una pieza clave de su regulación, hasta el punto que BEREC[33](Body of European Regulators for Electronic Communications), el organismo de los reguladores europeos, ha creado su propia "escalera" con sus respectivos peldaños, muchos peldaños, a la cual ha añadido los productos mayoristas que alcancen puntos de acceso, en un apartado que titula "The Ladder of Investment and FTTx scenarios", lo que significa que la "escalera de inversión" puede continuar teniendo una gran importancia en la regulación futura si el modelo regulatorio no cambia.

Pero la cuestión crucial es que los razonamientos en los que se basa la nueva escalera de inversión vuelven a plantear las mismas debilidades que tenía la anterior, referida a la red legada, más los nuevos problemas que Martin Cave plantea en su artículo "Snakes and Ladders"[34], incrementados por el hecho de que la inversión en la nueva red NGA realmente no está realizada.

9. Conclusión

El artículo incide en las debilidades observadas en la metodología de la regulación de la red legada, fundamentalmente en las relaciones precios regulados e inversión. Si esas mismas debilidades se mantienen en la metodología de la regulación de las nuevas redes de acceso, NGA, la inversión no será suficiente para que se cumplan los objetivos de la Agenda Digital para Europa.

(31) La referencia de "snakes and ladders" es un juego de dados en el que se tiene que responder a las preguntas, que aparecen en la pantalla, correcta o incorrectamente; si es incorrecta, vuelves a la casilla donde estabas, si es correcta, avanzas. El avance es de la casilla 1 hasta llegar a la 64. Hay serpientes, en las que puedes bajar, y escaleras, que puedes subir y bajar, y en el caso del sol puedes volver a empezar, por lo tanto no es una "escalera de inversión" antigua, en la que solo subías, sino que en la "Snakes&Ladders" puedes subir, bajar y hasta comenzar de nuevo.
(32) Telecommunications Policy 34 (2010).
(33) "Next generation Access- Implementation Issues and Wholesale Products" y en el Apartado B "The ladder of investment and FttX scenarios"
(34) Grajek, M y Roller, L.H. The effect of regulation on investment in network industries: Evidence from the telecommunications. ESMT. Berlin.

La combinación de costes "eficientes" LRIC e intensidad de capital y rápida innovación tecnológica, clásica en el sector de las telecomunicaciones, hace que no se compensen parte de las inversiones realizadas, tanto en la amortización como en los costes de capital. El modelo regulatorio está desajustado, aún más considerando su objetivo de potenciar las inversiones en red.

La teoría económica regulatoria no incorpora, en la metodología de los costes "eficientes" regulados, gran parte de los costes hundidos, riesgos e incertidumbres en los que incurre la operadora incumbente. Esto supone unos precios regulados bajos para el alquiler de activos de red por parte de los operadores alternativos, con la consecuencia de que si estos últimos decidieran invertir en esos mismos activos de red, aflorarían en su contabilidad costes hundidos y riesgos e incertidumbres relacionados con esa inversión que se evitan alquilando la red del incumbente.

Es decir, esta desvalorización de los activos producida por los precios regulados bajos, no solo incide sobre los del incumbente, sino sobre los de todos los operadores que hayan invertido o quieran invertir en activos similares.

El desarrollo de las NGAs precisa de fuertes inversiones, y por tanto sería necesario hacer atractiva su inversión. Por otro lado, la inversión necesita financiación, tanto externa como interna. La financiación externa, dada la situación de los mercados financieros, presenta actualmente grandes dificultades.

Respecto a la financiación interna, es preciso tener en cuenta que la rentabilidad media del sector de las telecomunicaciones, medida por el EBITDA/Ingresos, tiende a la baja, mientras que la inversión medida por la relación Capex/Ingresos está subiendo, es decir, la rentabilidad del conjunto de las operadoras está bajando en un momento en que las necesidades de inversión suben. Ante este escenario, otra posibilidad podría ser la financiación pública, pero es poco probable dada la situación económica de Europa y la inestabilidad actual de los mercados de deuda.

El entorno económico y la situación de las propias operadoras inclina la decisión al alquiler y no a la inversión, y con el mantenimiento del alquiler de la red a precios mayoristas orientados a costes incrementales "eficientes" existe una elevada probabilidad de que las operadoras elijan la opción de no invertir, o hacerlo a niveles muy inferiores a los objetivos que Europa se plantea.

Por tanto, las posibilidades de que se cumplan las previsiones de inversión necesarias para el cumplimiento de lo previsto por la Agenda Digital para Europa son mínimas si no se modifica el modelo regulatorio europeo.

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Economic foundations of price setting and the effect of regulatory policy on case studies

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Resumen

Los principios de la teoría económica clásica utilizada por las autoridades nacionales de regulación (ANR) en todo el mundo no tienen en cuenta que el sector de las telecomunicaciones, además de ser intensivo en capital, también se caracteriza por su continuo cambio tecnológico, que hace que la política regulatoria deba evolucionar de un enfoque estático hacia un enfoque más dinámico, en el que resulta recomendable un específico análisis costo-beneficio previo a la realización de una intervención ex-ante. El artículo parte de los fundamentos de la teoría económica que se aplica a la fijación de precios para centrarse en la aplicación de los mismos a ejemplos reales, con el fin de demostrar cómo la política regulatoria definida e implementada por la ANR podría tener un efecto sobre: a) la función de beneficios tanto de los dominantes como de los operadores entrantes, b) las estrategias de precios minoristas, y c) la intensidad competitiva.

Abstract

The principles of classic economic theory used by the National Regulatory Authorities (NRAs) around the world do not take into account the telecommunication sector in addition to be capital intensive it is also characterized by a continuous technological change which makes the regulatory policy evolve from a static approach towards a more dynamic approach where specific cost-benefit analyses are highly recommended prior to any ex ante intervention. The article departs from the basics of economic theory applied to price setting and then is focused on the application of those foundations to specific real examples so that it is proven how the regulatory policy defined and implemented might have an effect on: a) the benefit function of both the incumbents and the entrants' operators, b) the retail pricing strategies, and c) the level playing field competition.

1. Introduction

The telecom sector is considered to be very intensive in terms of the investment requirements related to the deployment of infrastructure as well as very innovative due to the services and applications that are launched. These two characteristics have a great impact in the business plan of telecom operators and National Regulatory Authorities (NRAs) should be well aware of it when deciding to intervene either at the wholesale or the retail level.

The aim of this article is to evaluate through specific examples how the regulatory policy might affect the investment decision, and the level playing field competition at retail as well as wholesale level.

The regulation of either wholesale or retail prices might have a direct impact on the benefit function so that the investment decisions and the financial decisions which go hand in hand could be compromised.

This article not only describes specific examples on how the regulatory policy might affect the business plan and feasibility of the investments that the telecom operators intends to do, but also focuses on the way in which those regulatory policies might affect the existing level playing field competition. The article deals with the economics of pricing policy applied to regulated services in the telecommunication sector, and also introduce the approach on how a regulatory policy applied to the prices of the different regulatory services might affect the level playing field competition, the innovation in the sector and the leverage to alternative sectors of the economy.

Firstly, a brief description of the principles of economic theory applied to pricing regulation is describes. In particular, the correct setting of equilibrium prices by National Regulatory Authorities (NRAs) taking into consideration the different level of competition is presented. It is proven that socially optimum equilibrium prices as Ramsey Prices allow telecom operators to recover the different types of costs (variable and fixed costs). Next, different examples of applied theory to the regulation of fixed and mobile termination rates are presented. Finally, an analysis on how a drastic reduction in the mobile termination rate might affect the retail prices, and eventually how the asymmetric regulation in the regulation of mobile termination rates might have the level playing field competition and the retail prices eventually paid by final users. The article concludes with recommendations.

2. Basics of economics applied to pricing policy

One of main companies objectives is to maximize the benefits or to maximize the economic value, so that, external investors become interesting in the company and the business plan could be sustained.

In this regard, companies in general and telecom operators in particular, try to find out which is the relationship in terms of quantity and prices so that the benefits they obtained for the provision of those services are maximized by providing those services in a efficiently way.

The behavior of the elasticity of the demand is a key variable in finding such equilibrium. Another important aspect to take into consideration in the determination of the equilibrium prices is the level of investment associated to the deployment of a telecom infrastructure, and in particular, the level of fixed costs which at some moment on time, due to the technological change, could become sunk costs. In this regards aspects such as: (i) entry barriers, (ii) asymmetric information, and (iii) market power, could explain the reasoning behind that equilibrium.

Thus, in a situation of perfect competition, the equilibrium prices are said to be equal to the marginal costs associated to the provision of those services (P=MC). However, in a situation of monopoly the equilibrium prices will be set in such a way that on top of the marginal costs it is added a margin or mark up. Therefore, the margin which will maximize the benefits will be given by the following well known expression:

$$\frac{(P_{mon} - MC)}{P_{mon}} = \frac{1}{\varepsilon(P_{mon})}$$

As can be seen from the previous equation, the more elastic is the demand to price variations, the lower will be the margin. In the same way, the less elastic (more inelastic) is the demand the greater will be the margin.

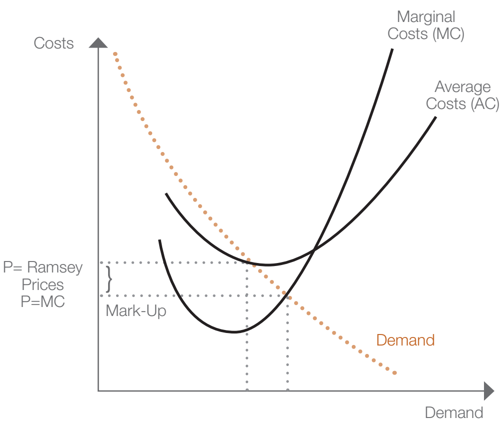
It is difficult to find markets which are perfect in terms of competition. Even in the case of financial markets, economics have not been able to prove that they show a level of efficiency greater than semi-strong efficiency.

Given the fact that perfect competition is a utopia, regulatory policies should not regulate according to the classic economic theory, which states that prices must be equal to the marginal costs. The reason why this approach is not right grounds on the fact that by doing so, we would not allow the regulated telecom operators to recover all the associated costs. Setting prices equal to marginal costs would make the operators face losses, so that, prices should be set in such a way that the regulated company would be able to recover the variable and the fixed costs. In short, prices should be equal to the average costs.

Not doing so might have a direct impact on investors' perception about the expected profitability of the business and the company would have to increase the efficiency in terms of costs, so that the fact of not recognizing fixed costs could be absorbed in the benefit function. Therefore, a regulatory policy grounded on setting regulated prices equal to marginal costs would force the operators to assume losses which probably would not be acceptable within the financial community and which could compromise the future investment plans.

The discussion on whether the equilibrium prices should be equal to the marginal or the average costs leads us to talk about Ramsey Prices. Ramsey prices are the equilibrium prices which maximizes the consumer and the producer surplus so that the benefit function becomes zero. That is to say, under a Ramsey pricing regime we are setting prices in such a way that they cover the average costs. See figure below for a better understanding:

Figure 1:
Foundations of Ramsey Prices



The result of this maximization problem gives us the Ramsey prices PRam that are presented in the following equation:

$$\frac{(P_{Ram} - MC)}{P_{Ram}} = \frac{K}{\varepsilon(P_{Ram})}$$

It is interesting to note that K represents the shadow price and it varies between 0 and 1. So when K takes the value of 0 then the equilibrium prices are the perfect competition prices (price equal to marginal costs), however, when K takes the value 1, then we have the monopoly prices. So, in addition to the elasticity of the demand, the value of K, which depends on the level playing field competition, might affect the equilibrium prices.

Therefore, the more inelastic is the demand and the lower the competition level (K close to 1) the greater will be the equilibrium prices, however the more elastic is the demand and the more competitive is the market, the smaller are expected to be the equilibrium prices.

The next section presents the application of this basic theory to three case studies: (i) setting fixed and mobile termination rates, (ii) effect of drastic reduction of mobile termination rate on retail prices, and finally, (iii) impact of asymmetric regulation in mobile termination rates to the level playing field competition and the pricing strategies of the telecom operators.

3. Examples of applied regulatory theory to retail and wholesale prices

3.1 Setting the fixed and mobile termination rate

It is well known that termination charges are a very important component of retail prices. In fact, the regulatory policy applied to those wholesale prices could determine the level of investment and the entrant into the market of alternative operators.

The convergence of network, services and handsets as well as the launch of new technologies goes hand in hand with changes in the consumer calling pattern. The sum of all these facts eventually impact on the pricing strategies.

Following this reasoning, let's suppose that the marginal costs of a call would be the sum of the following costs:

$$\begin{aligned} \text{Marginal Cost} = (&\text{Marginal Cost of Originating} + \\ &+ \text{Marginal Cost of Termination} + \\ &+ \text{Marginal Cost of Conveyance} \cdot \text{Margin} \end{aligned}$$

So, by regulating the termination charges the regulator would be somehow regulating the retail prices. In fact, it is recommended to regulate first at the wholesale level than introduce intrusive regulation at retail level which might affect the bottom line of the profit and loss account and thereafter, the investment plan of the telecom operators.

We may say thus, that the marginal price of a call is given by the following expression:

$$\text{Marginal Price} = \text{Marginal Cost} \cdot \text{Margin}$$

Let's suppose that there is just one incumbent operator owner of the telecom infrastructure which charges w_1 and w_2 for terminating minutes in the fixed and the mobile network respectively.

The number of minutes between two fixed networks will be denoted as p_{ff}. In the same way, the number of minutes originated in the fixed network and terminated in the mobile network will be given by p_{fm}.The number of minutes originated in the mobile network and finishing in the fixed network will be given by p_{mf}. Finally, we will denote as p_{mm} the number of minutes originated and terminated in the mobile network.

Prices of the different type of calls are affected by the number of minutes and the elasticity of the demand to the variation in those prices. In fact, we will suppose that always holds:

$$p_{mf} > p_{fm} > p_{mm} > p_{ff}$$

To estimate the values of the fixed (w_1) and the mobile (w_2) termination rates, a two-stage model need to be defined, where in stage 1, the termination charges will be estimated and then, in stage 2, entrant's (mobile) prices are set in a competitive framework given the prices estimated at stage 1. This problem will be solved under two different approaches, firstly a private optimum where the decision taken by the entrants and the incumbent operators are totally independent. Then, the same problem will be solved from a socially optimum approach so that the social welfare is maximized.

Scenario 1: The Private Optimum

Let's suppose that the incumbent's (fixed) marginal costs of terminating the number of minutes originated in the mobile network is, w'_1 whereas the marginal cost of terminating minutes in the mobile network is given by w'_2.

In this regard, the cost function of the fixed telecom operator is given by

$$C_f\,(\hat{q}_{ff}, \hat{q}_{fm}, \hat{q}_{mf}, \hat{q}_{mm}, w'_1, w'_2)$$

whereas the costs function for the mobile operator is:

$$C_m\,(\hat{q}_{mm}, \hat{q}_{mf}, w_1, w_2).$$

The Entrant's -mobile- profits function to maximize will be the sum of the expected revenues and costs associated to the number of minutes originated in the mobile network and which finish either in the mobile or the fixed network:

$$\max_{p_i \geq 0} \Pi_m \left(p_{mm}, p_{mf}, w_1, w_2\right) = p_{mm} q_{mm} + p_{mf} q_{mf} - C_m \left(\hat{q}_{mm}, \hat{q}_{mf}, w_1, w_2\right)$$

Working out in the same way, the profit function for the fixed will be:

$$\Pi_f\left(p_{ff}, p_{fm}, w'_1, w'_2\right) = p_{ff}\hat{q}_{ff} + p_{fm}\hat{q}_{fm} + w'_1\hat{q}_{mf} + w'_2\hat{q}_{mm} + \\ - C_f\left(\hat{q}_{ff}, \hat{q}_{fm}, \hat{q}_{mf}, \hat{q}_{mm}, w'_1, w'_2\right)$$

The incumbents maximization problem consist on maximizing the profit function taking into account that the retail prices set by entrants' (mobile) are such that makes them be better off by entering into the market and providing mobile services than not entering into the market at all. Through the maximization of the incumbents' profit function can be derived the values for w_1 and w_2.

The termination charges w_1 and w_2 are achieved from solving backwards a two stage model. In stage 2, entrants' operators compete and set retail prices, and then in stage 1, given these retail prices, the incumbent decides the termination charges. The expected termination charges w_1 and w_2, which maximize the incumbent's benefits, are:

$$w_1 = C_{1,3} + \sigma_1\left(p_{ff} - C_{1,1}\right) + \sigma_2\left(p_{fm} - C_{1,2}\right) + \frac{\hat{q}_{mf}}{-\left(\dfrac{\partial \hat{q}_{mf}}{\partial w_1}\right)}$$

$$w_2 = C_{1,4} + \sigma_1\left(p_{ff} - C_{1,1}\right) + \sigma_2\left(p_{fm} - C_{1,2}\right) + \frac{\hat{q}_{mm}}{-\left(\dfrac{\partial \hat{q}_{mm}}{\partial w_2}\right)}$$

Notice that the estimated values for w_1 and w_2 are in line with the efficient component pricing rule (ECPR)[1], so that, the termination charges set by the owner of the infrastructure will be equal to the direct costs associated to the provision of the termination services plus the opportunity costs of providing those services to the entrants operators. These prices, as we will see when we compare then with a socially optimum equilibrium prices, corresponds to monopoly prices.

Working out similarly, but under a socially optimum scenario, we get slightly different results for w_1 and w_2.

Scenario 2: The Socially Optimal Approach

The social welfare is made up of the consumer surplus plus the benefits of the industries operating in the market. Let's denote by $V\left(p_{ff}, p_{fm}, \hat{p}_{mm}, \hat{p}_{mf}\right)$ the consumer surplus.

$$\max_{p_{ff}, p_{fn}, w_1, w_2} S\left(p_{ff}, p_{fn}, w_1, w_2\right) = V\left(p_{ff}, p_{fm}, \hat{p}_{mf}, \hat{p}_{mm}\right) + \Pi_m\left(\hat{p}_{mm}, \hat{p}_{mf}, w_1, w_2\right) + \\ + \Pi_f\left(p_{ff}, p_{fm}, w'_1, w'_2\right)$$

$$s.t. \quad \Pi_f\left(p_{ff}, p_{fm}, w'_1, w'_2\right) \geq 0$$

Working out the first order conditions, and applying the envelope theorem[2], we get that w_1 and w_2 depend on θ. This parameter represents the shadow price and could be interpreted as a proxy

(1) See Armstrong et al (1996) and Laffont and Tirole (1994) for a comparison.

(2) When w_1 increases, q_{ff}, q_{mf}, decrease because the prices are expected to be higher. However, a customer with mobile and fixed telephone will be willing to phone from the fixed telephone rather than the mobile because.

Therefore, $\frac{\partial q_{fm_1}}{\partial w_1} \neq 0$. On the other hand, when w_2 increases, $q_{m_1m_1}$, q_{fm_1} decreases because the prices are higher. However, as shown above, a customer with mobile and fixed telephone will prefer to call using the fixed, increasing in this way $q_{m_1m_1}$ but without affecting q_{m_1f}, the rational behaviour would be to use mobile whenever you do not have a fixed near, hence, $\frac{\partial q_{m_1f}}{\partial w_2} = 0$.

In general, we will assume that prices will follow: $p_{m_1f} > p_{fm_1} > p_{m_1m_2} > p_{m_1m_1} > p_{ff}$

of the level playing field competition in the market, i.e. when q is close to 1, the values of w_1 and w_2 would be those obtained from a monopoly situation (see scenario 1); however, as θ approaches to 0, the market becomes more competitive. When θ = 0, then the market is considered to be perfectly competitive.

Solving out the maximisation of the problem highlighted above, the socially optimum charges w_1 and w_2 would be:

$$w_1 = C_{1,3} + \sigma_1\left(p_{ff} - C_{1,1}\right) + \sigma_2\left(p_{fm} - C_{1,2}\right) + \frac{\theta \hat{q}_{mf}}{-\left(\frac{\partial \hat{q}_{mf}}{\partial w_1}\right)}$$

This is the sum of a weighted efficient component pricing rule plus a Ramsey term.

Multiplying the last factor by

$$\frac{\partial p_{mf}}{p_{mf}} \frac{p_{mf}}{\partial p_{mf}},$$

we could express w_1 in terms of elasticities:

$$w_1 = C_{1,3} + \sigma_1\left(p_{ff} - C_{1,1}\right) + \sigma_2\left(p_{fm} - C_{1,2}\right) + \frac{\theta p_{mf}}{\eta_{mf} \frac{\partial p_{mf}}{\partial w_1}}$$

Being η_{mf} the demand elasticity between mobile to fixed calls.

The values of

$$\sigma_1 = \frac{\frac{\partial \hat{q}_{ff}}{\partial w_1}}{-\left(\frac{\partial q_{mf}}{\partial w_1}\right)}$$

and

$$\sigma_2 = \frac{\frac{\partial \hat{q}_{fm}}{\partial w_1}}{-\left(\frac{\partial q_{mf}}{\partial w_1}\right)}$$

are the *displacement ratio*, i.e. the opportunity costs that the incumbent has to bear because of terminating q_{mm}, q_{fm} minutes.

Working out the same way for w_2:

$$w_2 = C_{1,4} + \sigma_1\left(p_{ff} - C_{1,1}\right) + \sigma_2\left(p_{fm} - C_{1,2}\right) + \frac{\theta p_{mm}}{\eta_{mm}\dfrac{\partial p_{mm}}{\partial w_2}}$$

Being η_{mm} the access demand elasticity between mobile to mobile operators.

The values of

$$\sigma_1 = \frac{\dfrac{\partial \hat{q}_{ff}}{\partial w_2}}{-\left(\dfrac{\partial q_{mm}}{\partial w_2}\right)};\sigma_2 = \frac{\dfrac{\partial \hat{q}_{fm}}{\partial w_2}}{-\left(\dfrac{\partial q_{mm}}{\partial w_2}\right)}$$

are the displacement ratio as was stated above.

Conclusions

In sum, given the impact that termination rates might have on the retail prices, it is important that NRAs take specific action to guarantee a level playing field competition. However, in addition to the costs directly achieved from the cost accounting methods provided by the regulated operators, the NRAs should be aware and somehow recognize that by imposing the incumbent operator the obligation of providing those termination services is also guaranteeing the entrance of new operators which are expected to attract traffic that prior to the entrance were only incumbents traffic. So, under a socially optimum approach, where neither the entrant nor the incumbent can be negatively affected, the consideration of a displacement ratio should be considered within the regulated wholesale prices.

The decision on the values for w_1 and w_2 goes beyond the mere figure. Indeed, it affects whether the NRAs would like to set an access based competition or an infrastructure based competition model. As can be seen from the expressions described, the greater the effect of the displacement ratio, the greater the value of w_1 and w_2. The reason grounds on the fact that the entrants are being able to attract more traffic from the incumbent operator, so that, instead of using the incumbents' infrastructure they should decide to deploy their own network.

Therefore, regulatory policy defined by the NRA should estimate the displacement ratio, the level playing field competition given by the shadow price q and the elasticity of the demand to variations in the price of the different type of calls.

The next example focus on the consequences of an intrusive regulation on mobile termination rates and how the retail prices should be increased in order to guarantee the commitments with the financial community in terms of revenues and maximization of the economic value.

3.2 The regulation of MTR and the waterbed effect

As it has been stated, it is clear that by regulating wholesale prices NRAs would be directly affecting the benefit function of both the incumbent and the entrants' operators. Therefore, when NRAs decide to introduce a strong reduction in the mobile termination rates, the operators need to adjust their benefit function to accomplish the business plan and the commitments with the financial community. The unique way out to do so is by increasing the prices of some other services so that the benefit function does not deviate from the expected scenario. It is important to understand that since this is a capital intensive sector, then it is important to quantify the impact that the regulatory measures might have on investors and thereafter on the operators' investment and financial decisions.

The example presented below shows how changes in the mobile termination rate might have an impact on the retail prices of other services. This effect is named waterbed effect and it should be part of the cost-benefit analysis that NRAs should undertake whenever they think about introducing a regulatory policy affecting the prices of either wholesale or retail prices.

Let's suppose that the benefits that a mobile operator obtains from the provision of mobile communication services will be given by the sum of retail profits, which comes from the product of the bill (P) and the number of subscribers (N), minus the costs related to the provision of those mobile communication services, which will be denoted as c; these costs are the sum of the network and non-network costs needed to provide the services. Another source of profits is the termination calls; these incomes will be the product of MTR, which will be denoted as T, and the termination traffic denoted as Q1. Therefore, the profit function will be given by the following expression:

$$\Pi = \underbrace{(P-c)\cdot N}_{\text{Retail Incomes}} + \underbrace{TQ_1}_{\text{Wholesale Incomes}}$$

Under a scenario of perfect competition (prices will be equal to costs), the prices of the different communication services would be set in such a way that equals the benefit function to cero:

$$P = c - \frac{TQ_1}{N}$$

Therefore, we can conclude saying that in a static scenario of perfect competition any reduction in MTR is transferred to retail prices.

The *waterbed effect* can be defined by $\frac{\partial P}{\partial T}$, that is to say, the retail price variation that occurs when there is a variation in MTR.

Then, the waterbed effect under a dynamic approach can be expressed in terms of elasticities as it is shown in equation 1 below[3]:

$$\varepsilon_w = \frac{1+\varepsilon_1}{-\frac{c}{\tau}+1+\varepsilon_N}$$

(3) According to the following proof:

$$\frac{\partial (P-c)\cdot N}{\partial T} = -\frac{\partial T\cdot Q_1}{\partial T}$$

$$\frac{\partial P}{\partial T}\cdot N + (P-c)\frac{\partial N}{\partial T} = -\left(Q_1 + T\cdot\frac{\partial Q_1}{\partial T}\right)$$

$$N\cdot\frac{\partial P}{\partial T}\left[1+\frac{\partial T}{\partial P}\cdot(P-c)\frac{\partial N}{\partial T}\cdot\frac{1}{N}\right] = -Q_1\cdot\left(1+\underbrace{\frac{\partial Q_1}{\partial T}\cdot\frac{T}{Q_1}}_{\varepsilon_1}\right)$$

$$N\cdot\frac{\partial P}{\partial T}\left(1+\varepsilon_N\cdot\left(\frac{P-c}{P}\right)\right) = -Q_1\cdot(1+\varepsilon_1)$$

$$being\ \varepsilon_N = \frac{\partial N}{\partial P}\cdot\frac{P}{N}$$

$$\varepsilon_w = \frac{1+\varepsilon_1}{-c/\tau+1+\varepsilon_N}$$

$$being\ \tau = \frac{T\cdot Q_1}{N}$$

This equation can be interpreted as the elasticity of the waterbed effect, where:
ε_w: Elasticity of the waterbed effect.
ε_1: Elasticity of the traffic of termination to MTR variations.
c: Costs related to the provision of retail services. These costs include besides the wholesale costs, the subscribers' acquisition costs (SAC)[4] and the subscribers' retention costs (SRC)[5].
τ: Per minute and user termination cost. It is given by the following expression:

$$\tau = \frac{T \cdot Q_1}{N}$$

Let's study which is the sign of the numerator and the denominator of this expression:

Sign of the numerator

ε_1 is expected to be negative and smaller than 1, so that the numerator will always be positive, moreover, it will become more positive the more inelastic is the traffic of termination to variations in the MTR prices.

Therefore, if the traffic of termination does not change significantly when MTRs prices vary, then the waterbed effect is expected to be greater since mobile operators will be keener on compensating the MTR reductions to the retail prices.

The elasticity of this type of traffic is expected to remain quite inelastic as it can be depicted from NRAs quarterly information data[6].

Notice that the value of ε_1 is affected as well by the fixed to mobile traffic. Indeed, if MTR charges are transferred to fixed to mobile retail prices up to the extent in which fixed to mobile and mobile to mobile retail prices are very similar, then the elasticity of termination traffic in the mobile network could be greater the larger the amount of fixed to mobile traffic. This effect would diminish the waterbed effect.

Sign of the denominator

The denominator can be divided in two:

- $-\frac{c}{\tau} + 1 < 0$
- ε_N

The retail costs c also includes the wholesale costs, it will always happen that c divided by τ is a positive number greater than 1, since c>τ.

However, since it is preceded by a negative sign, then the first term of the denominator will be always negative and greater than 1. Therefore, the elasticity of the waterbed effect will depend on the value ε_N, that is to say, the elasticity of the market share to variation in the retail prices (P). The value of ε_N will be negative and ranged between 0 and 1.

○ If $\varepsilon_N \to -1$ the denominator becomes smaller and so the waterbed effect does.

Under this scenario, the more elastic is the demand to variations in the retail prices, the mobile operators will not be so keen on transferring the variation to the retail prices, since the subscribers would be more willing to change the mobile service provider.

Nonetheless this scenario seems not to be realistic since $\varepsilon_1 > \varepsilon_N$, because subscribers are more willing to diminish the monthly consumption than give up the usage of mobile services.

○ If $\varepsilon_N \to 0$, then the denominator becomes larger and so the waterbed effect does.

Therefore, the more inelastic is the market share to variations in the retail prices the keener the mobile operators to transfer the reductions to the retail prices, since subscribers are not very sensitive to changes in these prices.

(4) SAC: *Subscriber Acquisition Costs*, are costs related to the acquisition of customers. They are expected to be greater the more competitive is the market.
(5) SRC: *Subscriber Retention Costs*, are costs related to customers' retention, and are expected to be greater the more mature is the market.
(6) See quarterly reports from the Spanish Regulator (CMT). Genazos and Valletti (2007): Testing the "Waterbed" Effect in Mobile Telephony estimate the value of (ε_1) in -0.22

Conclusions

In sum, the denominator will be larger (and therefore the waterbed effect smaller) when $\varepsilon_N \rightarrow 1$, that is to say, when subscribers are very sensitive to price variations (either on net or off net prices). However, due to number portability it is difficult for subscribers to know in advance that the people they are phoning belong or not to their own network.

On the other hand, the smaller the difference between the retail costs (c) and the unitary and per user termination charge (τ)[7], and the more inelastic is the market share to retail price variation, $\varepsilon_N \rightarrow 0$, then, the greater is expected to be the waterbed effect, since mobile operators are expected to be able to increase retail prices without losing market share. In other words, when,

$$-\frac{c}{\tau}+1 \rightarrow 0,$$

then the waterbed effect is greater if $\varepsilon_N \rightarrow 0$.

In addition to the conclusions stated above, we may say that the introduction of a RPP scheme as well as a deep reduction in MTRs might have a negative effect on retail prices in the medium term due to the so-called waterbed effect. In this regard, the regulation of MTRs should be carried out taking into account the impacts that the regulatory policy might have on the investment decision and the spread of mobile technologies as for instance UMTS. On top of that, the social welfare in terms of costs and benefits of each agent (consumers, fixed and mobile operators and vendors) should be analysed.

3.3 Effect of MTR on retail prices

Finally, this article focuses on how the asymmetric regulatory policy applied to MTR might have consequences on the retail prices and, in particular, on the existing level playing field competition.

Strategies grounded on setting access prices greater than termination charges could lead to off net retail prices larger than on net prices. Pricing strategies which differentiate between on net/off net could become, at some point, as we will prove below, a competitive advantage for those operators with greater economies of scale. The impact that on net/off net price discrimination may have on competition will mainly depend on two variables: (i) The symmetry of the networks, and (ii) the substituibility level.

Thus, the more similar are the networks the less likely is that the on net/off net discrimination would have any impact. Similarly, the greater the substitution and the smaller the shift costs, more similar the networks are expected to be and less important would be the effect that the discrimination may have.

To prove these statements, we will depart from a model where there is just one mobile network operator, which has a dominant position in the retail market. In addition, we will consider that this operator discriminates between on net and off net prices. Then, we will have an entrant operator whose retail prices are affected by the pricing policy of the mobile network operator[8].

We will also assume that the market share of the mobile network operator (S_1) is greater than the market share of the entrant operator (S_2).

Assuming that costs are symmetric $c_1=c_2$ and the termination rates are given by t_1, y t_2[9]. The benefits that are obtained by each operator will be:

(7) It is important to stress that the difference between these two variables will become larger when the competition level is greater due to the importance of SAC and SRC. However, when the market share is inelastic, the difference between c and τ tends to diminish since the network cost are reducing thanks to MTR cut down. In particular, MNO will have incentives to become more efficient since any reduction in the costs above the reduction in the MTRs will be of advantage to him.
(8) See Laffont, J.J; Rey, P and Tirole, J (1998): "Network competition: II. Discriminatory pricing". Rand Journal of Economics, 29, pp. 38-56.
(9) In general it is always hold that ti>ci

$$\prod_1 = S_1 \left[\underbrace{S_1\left(p_{1,on-net} - 2c_1\right) \cdot q_{1,on-net}}_{\substack{\text{On net Tráfico from MNO} \\ (1)}} + \underbrace{S_2\left(p_{1,off-net} - c_1 - t_2\right) \cdot q_{1,off-net}}_{\substack{\text{Off net Traffic originated in MNO} \\ (2)}} + \underbrace{S_2\left(t_1 - c_1\right) \cdot q_{2,off-net}}_{\substack{\text{Off net Traffic originated} \\ \text{in the entrant} \\ (3)}} \right]$$

Similarly the benefits obtained by the entrant operator will be:

$$\prod_2 = S_2 \left[\underbrace{S_2\left(p_{2\,on-net} - 2c_2\right) \cdot q_{2,on-net}}_{\substack{\text{On net Traffic from MNO} \\ (1)}} + \underbrace{S_1\left(p_{2,off-net} - c_2 - t_1\right) \cdot q_{2,off-net}}_{\substack{\text{Off net Traffic originated in MNO} \\ (2)}} + \underbrace{S_1\left(t_2 - c_2\right) \cdot q_{1,off-net}}_{\substack{\text{Off net Traffic originated} \\ \text{in the entrant} \\ (3)}} \right]$$

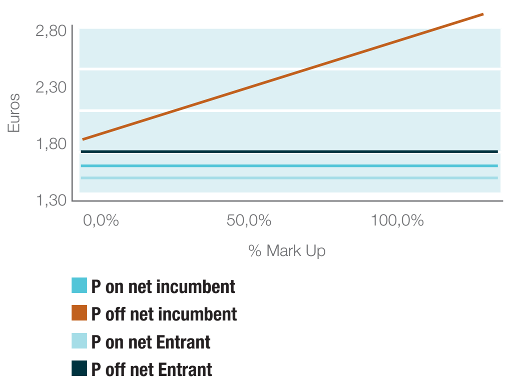
Taking in account these two functions of benefits, a simulation[10] on how the equilibrium off net and on net prices might vary as a consequence of an asymmetry in the mobile termination rate of the entrants' operator[11] will be presented. In particular, the simulation will be done for the following two scenarios:

- Scenario 1: Short term impact on *on net and off net* retail prices of the MNO and the entrant due to an increase in the level of asymmetry in the MTR.
- Scenario 2: Long term Impact on *on net and off net* retail prices of the MNO and the entrant operator due to an increase in the asymmetry and on the substitution effect.

Scenario 1: Short term impact on on net and off net retail prices of the MNO and the entrant due to an increase in the level of asymmetry in the MTR

Within the symmetric mobile termination rates (MTR), the operator with smaller economies of scale will be forced to set on net prices as low as possible to maintain the customer base and be able to capture new customers.

However, as the asymmetry increase, the Mobile Network Operator (MNO) is expected to increase the off net pricing to disincentive the outgoing traffic. The behavior of the on net retail prices of the MNO operator, as can be seen from the figure below, is that they will reduce the prices slightly and this reduction will depend on the importance of the entrant operator.

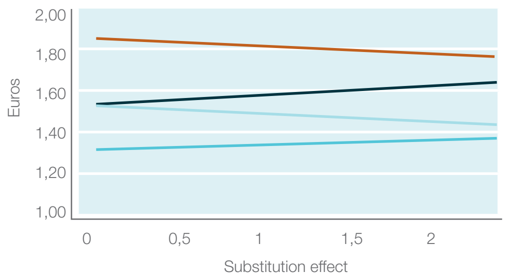


(10) See Carter, M, and Wright, J (1999): "Interconnection in network industries", *Review of Industrial Organization*, 14, pp. 1-25. Carter, M and Wright, J (2003): "Asymmetric network interconnection", *Review of Industrial Organization*, 22, pp. 27-46.
(11) The equilibrium prices are achieved from maximizing the benefit function of each operator taking in account the demand they have to attend.

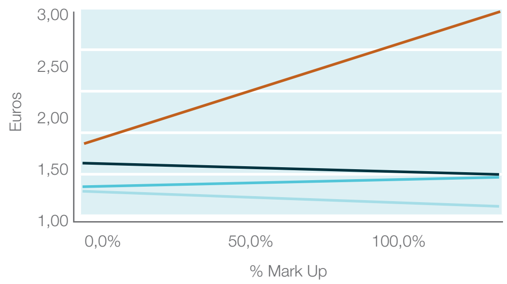
Scenario 2: Long term impact on on net and off net retail prices of the MNO and the entrant operator due to an increase in the asymmetry and on the substitution effect

As the substitution effect between the services provided by the MNO and the entrant increases, the market share of the incumbent telecom operator is expected to decrease. This effect is due to aggressive pricing strategies launched by the entrant operators in terms of low on net and off net retail prices.

As a consequence, the on net retail prices of the MNO and the entrant operator is expected to become similar.



However, when the mobile termination rate are asymmetric, the strategy followed by the MNO operator will be to increase the off net retail prices to disincentive the outgoing traffic and even slightly reduce the on net retail prices to retain the final user.



Due to this strategy, the entrant telecom operator will be forced to reduce as well the retail on net pricing.

Conclusions

Taking in account the results achieved from the simulation of the aforementioned scenarios we could conclude:

- The on net/off net retail price discrimination done by the MNO could have a direct impact on the benefit function of the entrants' operator and the pricing strategy that those operators intend to implement.
- Asymmetric mobile termination rates are likely to provoke in the retail prices of off net services provided by the MNO. This increase in the off net retail prices responds to the maximization of the benefit function of the MNO.

In sum, NRAs should be aware that introducing asymmetric prices could affect the way in which competition takes place in the markets and the benefits of the players which are operating. Again, the development of cost benefit analysis is highly recommended prior to the implementation of any regulatory measure.

4. Conclusions

The telecom sector is characterized by being very intensive in terms of capital as well as by having a continuous technological change. The sum of these two characteristics implies that the Regulatory Policy designed by National Regulatory Authorities (NRAs) must be aware of the impact that the implementation of those ex ante measures might have within the financial community and, in particular, on the fulfillment of the commitments with the investors in terms of economic value.

It is time for NRAs to take into consideration how the investors and the financial markets might receive the ex-ante regulatory policies that are intended to be implemented. It is naive to think that they will not have any impact. Thus, the realization of cost-benefit analysis is highly recommended prior to any ex ante decision that is intended to be implemented.

Regulation is needed to guarantee a level playing field competition; however, the regulation should be dynamic and consider the investment and the financial decision within the analysis. In my opinion NRAs should think about the regulatory model they want to set in the future. That is to say, a regulatory model where there is just one network and different operators providing services through that unique infrastructure or a regulatory model where there is a network competition, where operators seek differentiation of products, services and even quality and speed, so that final users take advantage of this competition and see how prices decreases and the portfolio of services broaden.

From the examples provided in this article we can conclude that, in a dynamic regulatory policy approach, NRAs should take into consideration the level playing field competition and the elasticity of the demand to the different services. Also, the costs structure of the regulated companies should be considered within the analysis so that both the fixed and the variable costs could be recovered. If a regulatory policy is defined, either at wholesale or retail level, and it does not allow the costs recovery, then the operator might find that it is not worthy to assume the risk associated to the investment. In addition, they might have difficulties in finding the required fund resources to continue investing in the deployment of new technologies and/or the launch of innovative services and applications.

In my opinion, prior to introduce any intrusive regulation at wholesale level, specific analysis should be undertaken by NRAs regarding the impact that such a regulation might have at the retail level and the existing level playing field competition.

The introduction of the financial perspective in the regulatory policy as well as the dynamic approach should be part of a strategic regulation that take into account that the telecom sector has been traditionally an engine for economic growth, productivity, employment and social inclusion. Coordination between the country strategy, the regulatory policy and the private sector is needed. Not doing so might scare the financial markets whose investors might decide to go to other more profitable or stable sectors.

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Looking the Other Way: Telecom Deregulation in the United States

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Resumen

No puede describirse la época actual en los Estados Unidos precisamente como una de desregulación general. Por ejemplo, el fracaso de la regulación de los mercados de servicios financieros antes de la reciente recesión económica ha servido como catalizador para impulsar una regulación financiera sustancialmente mayor. El calentamiento global, o más recientemente, el "cambio climático", proporciona un impulso político para obtener más regulación energética y ambiental. Una vez más, hay un considerable debate sobre
la creciente necesidad de establecer normas en el uso del fuel en los vehículos de motor o requerimientos para que las refinerías utilicen etanol. Sin embargo, en las telecomunicaciones, la regulación se está marchitando en gran parte debido al rápido cambio tecnológico en este sector, a la existencia de multitud de entrantes y nuevos servicios que abruman (y confunden) a la clientela política a quienes los reguladores normalmente sirven. En este artículo, se revisa la singular e implícita decisión del principal regulador de EE.UU., la Federal Communications Commission (FCC), de fijar su atención en otro lado, dada la ausencia de una demanda enfocada a la regulación.

Abstract

One cannot describe the current era in the United States as one of general deregulation. For example, regulatory failure in financial services markets prior to the recent economic recession has served as a catalyst for substantially more financial regulation. Global warming, or more recently "climate change," provides political momentum for more energy and environmental regulation. Once again, there is considerable debate about raising fuel-economy standards for motor vehicles and requiring refiners to use ethanol. But in telecommunications, regulation is withering away in large part because, given the rapid technological change in this sector, there are so many entrants and new services that they are over-

whelming (and confusing) the political clients that regulators normally serve. In this paper, I review the remarkable implicit decision of the principal U.S. regulator, the Federal Communications Commission (FCC), to simply look the other way because of this lack of focused demand for regulation.

A) The History

Telecommunications regulation in the United States was propelled in the 1970s by the competition authorities' decision in 1974 to bring antitrust charges against AT&T for aggressively maintaining its market power in traditional voice telephony. Subsequently, AT&T agreed to be broken up into separate "long distance" and "local" companies in 1984 in order to settle the monopolization suit that had been filed in federal courts.[1] The resulting decree created a set of regional operating companies and a national long-distance company, AT&T, which was forced to compete with new entrants, such as MCI, who were provided with equal access to the operating companies' local switches. The divested local companies were barred from offering long-distance services outside their immediate areas ("LATAs"). [2]

All of this occurred before the development of the Internet and, indeed, even before wireless cellular services began to be widely deployed. As wireless services developed and then the new mass medium, the Internet, began to grow, the weakness of the 1984 AT&T divestiture began to be exposed. Why should regulators focus so intently on developing competition in fixed-wire voice services when it was becoming obvious that wireless entry would provide the easier and more effective route to providing competition? And how could regulators determine which services were "local" and therefore the domain of the divested Regional Bell Operating Companies (RBOCs) and which ones were "interstate"[3] and therefore could not be provided by these quarantined companies? Is connecting to the Internet a "local" or a "long-distance" service? Is such service a telecommunications service or an "information" service under U.S. communications law?

These vexing questions and others made the 1984 AT&T decree very difficult to administer. As a result, in response to constant complaints from the RBOCs, who were eager to be freed from their local-service quarantine, and what proved to be the misguided hopes of the new long distance companies that they could enter the RBOCs' local markets through new regulations, the 1996 Telecommunications Act was passed by Congress and signed into law by President Clinton.[4]

The 1996 Act unleashed a torrent of new regulation and launched a new concept – local loop unbundling (LLU) – that was later hoisted upon the rest of the world after failing badly in the United States. LLU failed in the United States because it was launched before the deployment of broadband Internet services. The FCC's new unbundling policy was focused on providing entrants with access to the incumbent carriers' local loops so that they could deliver local voice services at a monthly price that was a few dollars below those charged by the RBOCs. Such entry proved to be a daunting task because it required hundreds of dollars in marketing expense to convince a single household to purchase precisely the same local service from a new, largely unknown carrier for a monthly saving of perhaps $2 to $5. Within a few years all but a very few of the scores of new entrants, who were attracted into this market by the FCC and willing investors during the telecom/high-tech bubble, descended into bankruptcy. By 2002, only a handful of entrants remained, and they began to focus almost entirely on offering broadband and other services to small and medium-sized businesses. At the end of 1999, the publicly-traded new entrants had a market capitalization of approximately $115 billion; two years later those that remained had a market cap of just $5 billion.[5]

The FCC tried to breathe life into the entrants by providing them with deep wholesale discounts through an artifice called the "UNE-P" – or the Unbundled Network Element Platform. This was network unbundling without any unbundling because the entrant was allowed to access the entire incumbent platform at very

(1) United States v. American Telephone and Telegraph Co., 552 F. Supp. 131 (D.D.C. 1982), aff'd. sub nom., Maryland v. United States, 460 U.S. 1001, 103 S. Ct. 1240, 75 L. Ed. 2d 472 (1983).
(2) For a discussion of the results of this antitrust settlement, see Crandall (1991).
(3) Or, more precisely, "interLATA" services.
(4) The Telecommunications Act of 1996, 47 U.S.C. 229.
(5) For details of this failed experiment, see Crandall (2005).

low bottom-up wholesale rates. This artifice was struck down by the courts in 2004.[6] The UNE-P was phased out by 2005.

After this dramatic failure, the FCC next turned to broadband policy. Mass-market broadband services developed much more quickly on U.S. cable television systems than through ADSL deployed by the incumbent telecommunication companies. This was due in large part to the difficulty that the quarantined RBOCs had in offering narrowband Internet access during the pendency of the 1984 antitrust decree. After 1996, a few entrants attempted to offer ADSL services over the RBOCs' unbundled loops to residential customers, but they did not succeed. The RBOCs started to offer their own ADSL services in 1998-99, but by this time the cable companies enjoyed a substantial lead in the number of households connected and were expanding rapidly. Thus, the argument that the incumbent telecom companies enjoyed "market dominance" in broadband infrastructure could not be made by regulatory proponents, and U.S. law does not provide the FCC with the apparent authority to require cable television companies to unbundle their last-mile facilities.

After substantial litigation, state and local governments' attempts to regulate cable companies' broadband services were denied by the courts, and the FCC was then forced to determine where cable-modem services fit in its regulatory portfolio. The FCC decided that such services were "information services" and thus not subject to the array of regulations that can be imposed on telecommunications common carriers, a decision that was upheld by the Supreme Court in 2005.[7] Following this court decision, the FCC then decided to refrain from regulating all broadband services, including those provided by the incumbent telcos. As a result, the U.S. no longer mandates line-sharing, the form of ULL that predominates in most other OECD countries today. Entrants may lease an entire local loop, but they may not share the incumbent's copper line at a negligible cost, as they do in the EU and most other developed countries. Moreover, the FCC has decided not to require any unbundling of fiber-based services. Nor are retail broadband services subject to rate regulation. For all practical purposes, broadband services are unregulated in the U.S. today, and no one is clamoring for new broadband regulation.[8]

Along the way, the U.S. also decided to forbear from regulating wireless services. At a very early date in the development of cellular wireless services, state and local officials were deprived of the right to regulate these carriers – specifically, the mandating of wholesale access for resellers. Later, the law passed by Congress[9] establishing auctions for wireless spectrum also deprived the FCC of the right to regulate retail or wholesale wireless rates unless carriers had "market dominance." When spectrum auctions and spectrum caps combined to produce six national carriers, the FCC's prospects for regulating wireless essentially evaporated.[10] In addition, the U.S. was fortunate not to adopt "calling-party pays" in pricing cellular mobile services. This development plus what is essentially a "bill and keep" form of interconnection charges among carriers allowed competition to determine usage rates for both call origination and termination, thereby eliminating the need for terminating access regulation that continues *ad infinitum* in most other developed countries. Finally, in 1999, AT&T introduced single-rate national calling plans, thereby eliminating roaming charges throughout the country. All other carriers quickly followed, taking roaming charges off the table as a regulatory issue. As a result of these developments, the U.S. wireless sector is essentially unregulated today. The only source of demand for new wireless regulation comes from some consumer advocates who are concerned about the confusing array of service plans offered in the intensely competitive wireless environment.

B) Current Market Structure in the United States

Fixed and mobile telephony are very competitive in the U.S. today because of intense inter-platform competition among incumbent telecommunications carriers, cable companies, and wireless carriers as well as satellite and fixed-wireless companies to a more limited extent.

(6) U.S. Telecom Industry Association, et. al. v. FCC and USA, (D.C. Cir. 2004).
(7) National Cable & Telecommunications Assn. v. Brand X Internet Services, 545 U.S. 967 (2005).
(8) The exception may be "network neutrality," which I address below.
(9) Omnibus Budget Resolution Act of 1993, P.L. 103-66.
(10) After a series of mergers, the U.S. may be left with three large national carriers and a host of smaller ones (see below). This trend to greater concentration may open the way for some form of FCC regulation, but there has been no formal announcement of new regulatory initiatives yet.

1. Traditional Fixed Wire Services

The fixed-wire sector has coalesced into three major companies, AT&T, Verizon, and CenturyLink[11] –whose territories are largely non-overlapping. A few smaller companies, such as Windstream, Frontier, and Cincinnati Bell offer services in a variety of regional markets. In addition, every large cable television system in the United States now offers residential and small-business voice services over VoIP. The growth in VoIP and the substitution of wireless for fixed-wire service has led to a marked decline in incumbent telecommunications carriers' fixed copper lines since 2005.

Table 1 provides a snapshot of the development of narrowband fixed-wire services since 2005, shortly after the FCC was essentially forced by the courts to scale back its unbundling policies. In June 2005, entrants offered service over 34 million lines, most of which were leased from the incumbents under the FCC's low wholesale-price ULL regime. There was no measurable VoIP service at this time. By June 2010, competitors served 48.8 million subscribers through fixed lines or VoIP, more than half of which were VoIP connections. A very large share of the VoIP connections is offered by the cable television companies. The 22 million non-VoIP lines were provided by competitors, 6.3 million of which were connected by their own lines in 2010. Thus, in just five years, the number of lines served by competitors through wholesale lines leased from the incumbents fell from about 25 million lines to about 15 million. Total access lines plus VoIP declined precipitously from 178 million in 2005 to 151 million in 2010, according to FCC statistics, leaving the incumbents with 42 million fewer lines than they had in 2005.[12]

It is very difficult to assess the effect of the changes in the competitive structure of the fixed-wire sector on the price of telephone service because few people now buy single, standalone fixed-wire services. Most have the choice of "triple-play" services – video, data, and voice – at bundled prices from cable companies and, increasingly, from incumbent telecom firms. Many buy packages with unlimited local and national calling. The Bureau of Labor Statistics (BLS) used to measures the prices of "intrastate" and "interstate" calls, but these series are no longer produced. Instead BLS now publishes a price series for "landline" services, but this series has only been available since the end of 2009 and therefore of no use in assessing how prices have moved since the FCC severely cut back its ULL policy.

2. Wireless Services

A detailed analysis of the evolution of mobile wireless services in recent years is beyond the scope of this article. Suffice it to say that wireless devices are evolving rapidly as are the networks required to serve them. As described above, the U.S. emerged from its mid-1990s series of spectrum auctions with six major national carriers and a number of other smaller national and regional carriers. Today, after a series of mergers, four major national carriers remain: AT&T, Verizon, T-Mobile and Sprint Nextel.[13] A number of other carriers compete with these four major companies, including U.S. Cellular, Leap Wireless, and Metro PCS.

The U.S. wireless sector may change substantially in the next few years as consumers migrate to devices that are capable of downloading more sophisticated video material. The demand for

DATE	TOTAL ACCESS LINES PLUS VOIP	SERVICE PROVIDED INCUMBENT	SERVICE PROVIDED COMPETITORS (INCLUDING VoIP)	TOTAL VoIP SERVICES	VoIP PROVIDED BY COMPETITORS	SERVICE PROVIDED OVER COMPETITORS´ OWN LINE (Other than VoIP)
JUNE 2005	177.8	143.8	34.0	NA	NA	9.1
JUNE 2010	151.2	102.4	48.8	28.9	26.9	6.3

Table 1:
U. S. Fixed-Wire Access Lines and VoIP Subscriptions (millions)

Source:
FCC. (Note: NA=Data not available)

(11) Century Link had been essentially a smaller, rural carrier until it acquired a large number of fixed lines from Verizon and GTE between 2000 and 2002 and subsequently acquired two large carriers, Embarq and Qwest in 2009 and 2010.
(12) The data for 2005 and 2010 on total lines are not entirely consistent because the FCC changed its reporting requirements in 2008.
(13) As this article is being written, a proposed merger of AT&T and T-Mobile is under regulatory review.

bandwidth is increasing rapidly and may increase even more rapidly in the near future. Of the major carriers, Verizon has been the first to build out a 4G LTE capability nationwide. AT&T is now beginning to deploy its own 4G network and has a pending deal to purchase T-Mobile. Sprint Nextel has wired out 4G for about 15 percent of the country's population using WIMAX technology.

Undoubtedly, the best measure of the wireless industry's performance would be its ability to provide access to an ever-expanding set of services, including bandwidth-intensive data services at reasonable prices, but there are no such measures available. The most widely used measure involves voice services. A version of such an index is published annually by the FCC, the latest of which is reproduced as Table 2.

At one time, the U.S. was viewed as lagging its OECD counterparts in wireless penetration, allegedly because of its failure to adopt calling-party pays. Now, the U.S. has virtually universal mobile penetration. Many countries in the EU show more than 100 percent penetration because of subscribers' use of multiple SIM cards to avoid roaming charges. U.S. subscribers have no such need because all major carriers offer national calling and data plans without roaming charges. Moreover, "receiving-party pays" – or, more accurately, "both parties pay" – creates competition for outgoing and terminating access, thereby generally leading to much lower rates than those observed in calling-party pays countries. The deregulated U.S. wireless sector has certainly performed well along these dimensions. As we shall see, deregulation has also stimulated more carrier investment than in the more regulated countries.

3. Broadband Services

The United States entered the broadband era at a time when telecommunications regulation and competition policy had forced an artificial separation of "local" carriers from "long distance"

Table 2: 2009 Mobile Market Performance in Selected Countries (Merrill Lynch)

Source: FCC (2011)

COUNTRY	PENETRATION (% OF POPs)	PREPAID (% OF SUBS)	VOICE MOUs PER MONTH	VOICE RPM	ARPU	DATA (% OF ARPU)
RECEIVING PARTY PAYS						
USA	93%	19%	824	$ 0.04	$ 49.91	29.3%
CANADA	68%	20%	426	$ 0.09	$ 55.14	22.1%
SINGAPORE	144%	50%	380	$ 0.06	$ 33.01	31.0%
CALLING PARTY PAYS						
UK	129%	59%	194	$ 0.11	$ 33.52	33.0%
GERMANY	132%	56%	109	$ 0.16	$ 22.08	29.8%
ITALY	147%	87%	141	$ 0.15	$ 29.12	26.1%
SWEDEN	131%	35%	211	$ 0.10	$ 31.11	25.3%
FRANCE	96%	33%	237	$ 0.15	$ 48.40	23.7%
FINLAND	144%	13%	218	$ 0.13	$ 33.52	20.5%
JAPAN	88%	1%	137	$ 0.25	$ 58.06	44.5%
SOUTH KOREA	99%	3%	311	$ 0.09	$ 33.63	19.1%
AUSTRALIA	115%	42%	222	$ 0.14	$ 47.27	36.1%

carriers. In the breakup of AT&T, the divested local Bell carriers had even been barred from the provision of "information" services for a few years in the pre-broadband era, although there was little consensus on what constituted information services. The AT&T divestiture and the subsequent 1996 Telecom Act spawned a host of "local" entrants, but few concentrated on offering mass-market broadband services and those that did so ultimately failed.

The U.S. was fortunate, however, that a direct broadcast satellite video service was launched in 1994, thereby creating a competitive threat to established cable television companies with their limited channel capacity. When the cable companies responded by beginning to upgrade their systems, they discovered a new potential service – broadband Internet service. The incremental cost of adding this service, which requires two-way capability, was much lower at a time when they were upgrading their entire distribution plant; hence, building the capability to deploy cable broadband service was an easy choice for the cable operators.

The result of the regulatory quagmire in fixed-wire telecommunications during the period following the passage of the 1996 Act and the upgrading of cable networks was to provide cable operators with an early lead in broadband subscriptions in the United States. As Table 3 shows, broadband services offered by cable modems attracted than twice as many subscribers as ADSL, the mass-market service offered by telecom carriers, by 2000. The cable operators maintained a 1.5:1 lead even as late as June 2005, when the FCC moved to essentially eliminate broadband regulation for telecom companies.

Since 2005, the incumbent telecommunications carriers have steadily closed the gap in subscriptions relative to the cable television companies. They have done this by increasing the speeds of their ADSL services, reducing prices, and deploying higher-speed fiber connections (FTTH) directly to the final subscriber. The FCC's latest statistics show that cable modem service accounted for 43.9 million subscribers, ADSL service enrolled 30.7 million subscribers, and the new FTTH services attracted 4.4

Table 3:
High Speed Lines[1] (Over 200 Kbps in at least one direction)

TECHNOLOGY[2]	2000	2001	2002	2003	2004		2005
	JUN	JUN	JUN	JUN	JUN	DEC	JUN
ADSL	951,583	2,693,834	5,101,493	7,675.114	11,398,199	13,817,280	16,182,076
SDSL and tradicional Wireline	758,594	1,088,066	1,186,680	1,215,713	1,407,121	1,468,566	905,648
SDSL	-	-	-	-	-	-	423,716
Traditional Wireline	-	-	-	-	-	-	481,932
Cable Modem	2,284,491	5,184,141	9,172,895	13,684,225	18,592,636	21,357,400	23,938,908
Fiber[3]	307,151	455,593	520,884	575,613	638,812	697,779	864,831
Satellite and Wireless	65,615	194,707	220,588	309,006	421,690	549,621	970,133
Satellite	-	-	-	-	-	-	377,291
Fixed Wireless	-	-	-	-	-	-	213,306
Mobile Wireless	-	-	-	-	-	-	379,536
Power Line and Other	-	-	-	-	-	-	4,872
TOTAL LINES	4,367,434	9,616,341	16,202,540	23,459,671	32,458,458	37,890,646	42,866,469

Source:
FCC (2006)

million subscribers as of June 30, 2010. Total fixed wire, fixed wireless, and satellite subscriptions were 81.7 million in 2010, almost double the number recorded in June 2005.

An equally important development since 2005 has been the growth in mobile wireless broadband subscriptions. By the FCC's definition of "broadband" – 200 kbs in at least one direction – the U.S. had 71.2 million mobile wireless subscriptions as of June 2010, or nearly as many as the number of fixed-wire subscriptions. As higher-speed networks are deployed by the two or three largest U.S. wireless carriers, it is a safe prediction that eventually there will soon be more truly high-speed mobile subscribers than fixed broadband subscribers.

C) Current U.S. Policy Issues

For the most part, the United States deregulatory approach to telecommunications is well accepted politically. Nevertheless, a number of issues remain or have arisen that could occupy the FCC for the foreseeable future. These include (1) net neutrality, (2) "universal service" and interconnection charges, (3) and broadband deployment. In addition, the FCC and the Department of Commerce are focused on obtaining a more efficient allocation of the electromagnetic spectrum by freeing up spectrum now used unproductively so that mobile wireless can continue to grow. The use of spectrum auctions to reallocate this spectrum and the political issues deriving from the redistribution of wealth that transpires from reallocating this spectrum are beyond the scope of this paper.

1. Net neutrality

The continuing development of the Internet as the perhaps most important channel for consummating a variety of consumer transactions and distributing information and entertainment has generated anxiety among many entities that use this medium. Given that broadband internet access is generally provided to subscribers by only two major fixed-wire carriers – the incumbent telephone company and the local cable television company – many commercial entities that use the Internet to distribute their services or products are concerned that the last-mile carriers will be in a position to discriminate against them by degrading the subscriber's access to these entities' services or by imposing fees to receive the incoming bitstream. These fears were initially raised by an impolitic remark made by the chief executive of AT&T in 2005 when asked about the continued use of AT&T's last-mile facilities to deliver content from various media companies:

"How do you think they're going to get to customers? Through a broadband pipe. Cable companies have them. We have them. Now what they would like to do is use my pipes free, but I ain't going to let them do that because we have spent this capital and we have to have a return on it. So there's going to have to be some mechanism for these people who use these pipes to pay for the portion they're using. Why should they be allowed to use my pipes?

The Internet can't be free in that sense, because we and the cable companies have made an investment and for a Google or Yahoo! (YHOO) or Vonage or anybody to expect to use these pipes [for] free is nuts!"[14]

This immediately provoked a concern that the carriers that provide broadband connectivity to households and small businesses would begin to charge not only their customers but the suppliers of content, or intermediaries, for transmitting the content that their subscribers wish to download. Large Internet companies, such as Google, began to press for rules that would prohibit favoritism, in the form of differential charges or degradation of network quality, or perhaps even any charges at all to accept content originated by thirds parties.

The FCC responded by articulating a set of "network neutrality" principles:

- *To encourage broadband deployment and preserve and promote the open and interconnected nature of the public Internet,* consumers are entitled to access the lawful Internet content of their choice.

- *To encourage broadband deployment and preserve and promote the open and interconnected nature of the public Internet,* consumers are entitled to run applications and use services of their choice, subject to the needs of law enforcement.

(14) Quoted in http://arstechnica.com/old/content/2005/10/5498.ars.

- *To encourage broadband deployment and preserve and promote the open and interconnected nature of the public Internet,* consumers are entitled to connect their choice of legal devices that do not harm the network.

- *To encourage broadband deployment and preserve and promote the open and interconnected nature of the public Internet,* consumers are entitled to competition among network providers, application and service providers, and content providers.[15]

Unfortunately, or perhaps fortunately, these principles were not codified into explicit rules through the legally-required rulemaking process. Therefore, they probably cannot be enforced by the FCC. In 2007, Comcast challenged the FCC's attempt to impose these principles and deny Comcast the right to block subscribers' access peer-to-peer Internet services when such services impose a substantial strain on network capacity. The U.S. Court of Appeals overturned the FCC in 2010, concluding that the FCC lacked "statutorily mandated responsibility" to regulate Comcast's broadband network management practices.[16] Were the FCC to reconsider its decision to define broadband Internet service as an "information service", it might be able to codify its net neutrality principles into formal rules, but there is little demand for the FCC to do so.

The principles enunciated by the FCC are thus difficult for it to enforce. Moreover, they now are being questioned on their own merits, given the success of Apple's "walled garden" approach of licensing applications for its devices, such as the iPhone. Given that consumers can access the Internet over one of at least two fixed-wire carriers and a number of wireless networks, why should these carriers or the device manufacturers be required to provide access to any devices, content or software of their subscribers' choosing? Presumably, competition among networks and device manufacturers will discipline the providers who attempt to deny access to any content or software that consumers desire but that competes with the carrier's or the manufacturer's own content. As this article is being written, it appears that the demand for network neutrality regulation is rapidly evaporating in the U.S. as the value of Apple's stock continues to soar.

2. Universal Service and Interconnection Charges

Among the most contentious issues for the FCC is the reform of its "universal service" and interconnection-charge policies. Both are anachronisms of an era when fixed-wire service was thought to be much more expensive in rural areas and when, therefore, rural telephone companies allegedly required explicit and implicit subsidies for their survival. There never was any evidence that supported the need for such subsidies, nor is there any evidence that the current subsidies reduce rural rates and/or increase rural telephone penetration.[17] It is notable that rural cable television service survives in the U.S. without such subsidies.

The U.S. universal service subsidy system is largely operated by the FCC, which levies a tax on telephone services and uses the revenues to contribute to a high-cost fund for rural carriers. This fund is also used to fund advanced telecommunications services for schools, libraries and rural health services. The high-cost fund now absorbs nearly $5 billion per year. Because of a legal anachronism that derives from the U.S. federal system of government, the FCC cannot tax local and intrastate services to raise the revenues for rural subsidies. Therefore, it must impose a very large tax on its estimate of "interstate and international services," which are now difficult to measure because of the prevalence of flat-rated local and long-distance plans, not to mention "triple-play" voice, data, and video plans. Because the universal service taxes services whose demand elasticities were relatively high when they were priced separately, these taxes have been responsible for very large losses in economic welfare.[18] Given that the revenues are used to subsidize about 16 million lines, changing this program is politically very difficult.

Another anachronism from the old, paired copper wire era is the regulation of interexchange charges or "access charges." These charges are levied on carriers for the origination or termination of calls, and the charges vary depending on the type of call involved –local, intrastate, or interstate. In modern telecommunications, these

(15) FCC (2005), *Policy Statement*, Dockets No. 02-33, et.al., September.
(16) *Comcast Corporation v. FCC and U.S.A.*, U.S. Court of Appeals (D.C. Cir.), April 2010.
(17) See, for example, Eriksson, Kaserman, and Mayo (1998), Rosston and Wimmer (2000), Crandall (2008), and Wallsten (2011).
(18) Hausman (1998) estimates that each dollar raised by the FCC tax results in an additional welfare loss of $1.25.

charges can simply be negotiated by the carriers; indeed, the Internet backbones do so with little difficulty. Unfortunately, the U.S. access charge system has been designed to provide rural carriers with still more subsidies by requiring other carriers to pay the rural carriers much larger fees for terminating access than are received by other, urban carriers. Thus, reform of interexchange charges is subject to the same political forces as the reform of explicit universal service payments.

The best possible solution for reforming these various rural subsidy programs would be to collapse them into a single program that is gradually phased out over time. This fund should be supported by a more efficient tax, perhaps a flat fee on telephone numbers that would create much lower economic welfare losses. Such a reform has been on the FCC's agenda for a very long time, but political pressures from rural interests and from those worried that a tax on telephone numbers would be regressive has made it difficult for this supposedly "independent" regulatory commission to eliminate these wasteful and unnecessary regulations.

3. Stimulating Broadband Deployment

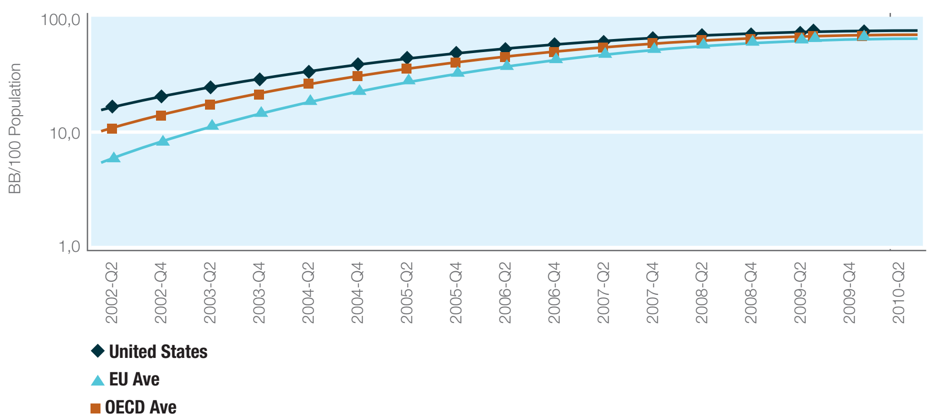
As explained above, broadband services in the U.S. are now essentially unregulated. Nevertheless, broadband has been an important issue for the FCC because of the perception that the U.S. lags other countries in broadband deployment and the concern for rural broadband deployment. The focus of the FCC's effort in devising broadband policy was the development of a National Broadband Plan (NBP) in 2010. In the proceedings leading up to the publication of the NBP, there was a debate over reviving FCC regulation of broadband through a more aggressive unbundling/line-sharing regime. Ultimately, the FCC rejected this approach, but the debate that preceded its decision provided a useful review of the empirical literature on unbundling.

In preparation for its broadband plan, the FCC commissioned a study from Harvard University's Berkman Center.[19] A preliminary draft of this study concluded that the U.S. lagged other countries in broadband penetration and then surprisingly offered a strong endorsement of unbundling/line-sharing as a means to reduce the alleged U.S. broadband subscription gap.[20] This recommendation was based on a misreading of the empirical evidence, which the authors were forced to acknowledge implicitly in their final report and thus substantially weaken their endorsement of expanded unbundling. As a result, the Berkman Report was essentially ignored in the FCC's final National Broadband Plan, which did not endorse further network unbundling.

As a prelude to the review of this 2010 debate, I provide the latest OECD data on broadband penetration in the U.S., the EU, and the overall OECD. Figure 1 shows the growth of broadband "penetration" – broadband subscriptions per 100 households – over time in these three areas.[21] This measure is far from ideal because it combines business and residential lines and fails to

Figure 1:
Broadband/100 Household United States, EU, and OECD Average

Source:
OECD, adjusted for average household size by the author



(19) Berkman Center for Internet and Society (2010).
(20) Berkman Center for Internet and Society (2009).
(21) The data are drawn from the OECD website. Because OECD reports broadband penetration in terms of subscriptions per 100 perssons, not per 100 households, I adjust these data for the average household size in each country.

account for wireless broadband subscriptions. Nevertheless, note the substantial convergence of the three series over time. The EU average conceals substantial variation across countries; the Benelux countries have substantially greater penetration than, for example, the eastern or southern European countries. Korea, Luxembourg, Iceland, and Switzerland lead in measured penetration, but none of these countries bears a close resemblance to the sprawling United States. Thus, there may not be much of a problem for the U.S. to address, through regulatory or other measures.

a. Summary of Prior Empirical Studies

In response to a draft of the Berkman Report, Crandall, Ehrlich, and Eisenach (2010) analyzed the empirical evidence on unbundling. Their results are shown in Table 4, which summarizes the empirical literature on broadband penetration, availability, and mandated unbundling. As the table shows, the bulk of the studies surveyed did not support the proposition that mandated unbundling increases broadband penetration or deployment. Most studies find the relationship to be either a negative, denoted "N" in the table, or insignificant. The few studies reporting positive effects, denoted "Y" in the table, fail to provide persuasive evidence, owing to a variety of factors.

One of the problems with all of these studies is that they fail to control for the fact that the passage of time should have a substantial effect on penetration, as Figure 1 clearly demonstrates,

Table 4: Summary of Empirical Studies

Source: Crandall, Ehrlich and Eisenach (2010)

STUDY	DATA	UNBUNDLING INCREASES BROADBAND PENETRATION/ AVAILABILITY?	INTER-PLATFORM COMPETITION INCREASES PENETRATION?
STUDIES SHOWING NEGATIVE AND/OR INSIGNIFICANT EFFECTS OF UNBUNDLING ON PENETRATION			
Aron & Burnstein (2003)	Cross-Section, 46 U.S. States	N	Y
Bauer, Kim, & Wildman (2003)	Cross-Section, 30 OECD Countries	N	N/A
Denni & Gruber (2005)	Panel, 50 U.S. States	N	Y
Distaso, Lupi & Mantenti (2005)	Panel, 14 European Countries	N*	Y
Cava-Ferreruela & Albau-Muñoz (2006)	Panel, 30 OECD Countries	N	Y
Wallsten (2006)	Panel, 30 OECD Countries	N	N/A
Waverman Meschi, Reillier and Dasgupta (2007)	Panel, 12 European Countries	N	N/A
Boyle, Howell, and Zhang (2008)	Panel, 30 OECD Countries	N	N
Wallsten and Haulsaden (2009)	Panel, 27 European Countries	N	N/A
STUDIES SHOWING POSITIVE EFFECTS OF UNBUNDLING ON PENETRATION			
García-Murillo (2005)	Cross-Section, 18 Countries	Y	N/A
Grosso (2006)	Panel, 30 OECD Countries	Y	Y
deRidder (2007)	Panel, 30 OECD Countries	Y	N/A

*Distaso, Lupi & Mantenti (2005) find that inter-platform competition is a substantial driver of broadband penetration, and that competition within the market for DSL services does not play a significant role. Somewhat paradoxically, the researchers also find that a decrease in the local loop unbundling price has a positive and significant effect on penetration. However, as noted above, their econometric analysis assumes that mandated access prices are exogenous, implying that this effect may reflect reverse causality.

due to technology diffusion. So-called general purpose technologies, such as broadband, tend to follow a well-known "S-shaped" curve as they mature.[22] While initially only early adopters find it worthwhile to purchase the technology, eventually the technology achieves mass-market acceptance and adoption accelerates. Finally, the rate of adoption begins to level off as saturation approaches, and the few remaining non-adopters tend to be those who place a relatively low value on the technology.

Boyle et. al. (2008) have shown that failure to control for diffusion over time can lead to spurious correlations between unbundling and penetration.[23] Furthermore, this effect will be exacerbated by endogenous regulatory outcomes, to the extent that regulatory commitment problems become more acute with movements along the diffusion curve. This conclusion was confirmed in Crandall, Ehrlich, and Eisenach's re-estimation of the deRidder (2007) regressions, upon which the Berkman Center's initial draft relied heavily. When a variable for time since introduction of the service is included with the deRidder unbundling variable – years of unbundling regulation – the latter variable becomes statistically insignificant in a regression that attempts to explain broadband penetration. The inevitable conclusion is that unbundling does not increase broadband penetration.

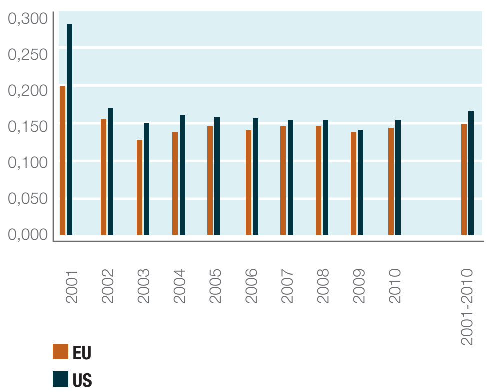
b. The Effect on Capital Expenditures

In addition to the studies summarized in Table 4, there is also a large body of empirical work focusing on the relationship between mandatory unbundling and network investment, which has demonstrated that mandatory unbundling discourages investment by both incumbents and entrants. These results call into question the "stepping stone" hypothesis,[24] which posits that mandatory unbundling can create a set of "rungs" on a "ladder of investment" allowing entrants to invest gradually in their own facilities. A recent review of the literature on unbundling and investment examines more than 20 empirical studies of access regulation and investment incentives, and concludes that while additional research could be useful, "most of the evidence shows that local loop unbundling…discourages both ILECs and CLECs from investing in networks."[25]

There is further *prima facie* evidence that the more aggressive regulatory regimes in the EU have impeded investment by the incumbent ILECs, who face much more expansive unbundling requirements than their U.S. counterparts and who are also confronted with regulated wireless termination and unbundling charges, unlike U.S. carriers. For the last decade, U.S. incumbents have invested much more per unit of revenue than have the EU incumbents. Figure 2 provides the data for the three major U.S. incumbents and for 12 of the EU-15 incumbents for which data are available.[26] The average difference over the entire 2001-10 period is 2.4 percent of revenues, equal to approximately $8 billion per year at recent years' aggregate carrier revenues. Given similar technological opportunities, similar demographics, and relatively similar capital costs, this perpetual difference in investment intensity suggests that the U.S. regulatory/economic environment is more conducive to capital spending than is the EU environment.[27]

Figure 2: Incumbent Telecom Companies. Capital Expenditures/Revenues (All operations)

Source: Company Annual Reports



(22) See, e.g., Helpman (1998).
(23) When Crandall, Ehrlich, and Eisenach (20010) included a variable for time as well as unbundling and other exogenous variables in their econometric analysis of broadband penetration, they found that unbundling was not statistically significant.
(24) Cave (2006).
(25) Cambini and Jiang, (2009).
(26) The EU incumbents are Telekom Austria, Belgacom, BT,TELIA-Sonera, France Telecom, Deutsche Telekom, KPN, OTE (Greece), Portugal Telecom, TDC, Telecom Italia, and Telefonica. All EU data are converted to U.S. dollars at PPP exchange rates calculated by the International Monetary Fund.
(27) Major cable television companies in the EU have recently had a higher capital expenditure/revenue intensity than the major U.S. cable companies. Between 2002 and 2007, the U.S. cable companies invested substantially more per unit revenue than their EU counterparts, but over the last three years the U.S. companies have sharply reduced their capital spending while the major EU companies' capex has remained fairly constant.

Even more evidence of unbundling's effect on network investment may be gleaned from the extent of fiber deployment by incumbent carriers in the U.S. and the European Union. Chaillou (2010) finds that the U.S. had 5.7 million FTTH connections at the end of 2009 while Western Europe had only 2.0 million. The difference is even greater for incumbent telecommunications carriers since little or no fiber had been deployed by incumbents in Western Europe, but virtually all of U.S. FTTH has been deployed by incumbents, particularly Verizon. It is notable that the EU continues to debate whether new fiber must be unbundled by incumbents, but the U.S. has resolved this issue by firmly deciding against fiber unbundling. This difference is reflected in the differences in fiber deployment on the two sides of the Atlantic.[28]

Given this unfavorable evidence on the effects of aggressive unbundling, the U.S. Federal Communications Commission decided not to recommend a more aggressive unbundling policy to stimulate broadband penetration. Instead, the U.S. moved in the direction of direct subsidies for rural carriers in its massive $787 billion economic stimulus program that was enacted in February 2009. A total of $7.2 billion of this stimulus was dedicated to subsidizing broadband services in underserved and un-served areas.[29] In addition, the FCC has moved to free up more spectrum for wireless broadband applications.

D) Conclusion

Despite a dramatic shift in the political orientation of the U.S. government in 2008, there has been little movement towards reregulating U.S. telecommunications. As in most other countries, fixed-wire voice services are declining rapidly or are simply becoming a minor part of much larger packages of video, data and voice services. Regulating fixed-line voice services today makes little economic sense, but the U.S. Federal Communications Commission finds it difficult to move away from its long-standing policies of regulating "universal service" and interconnection charges because these programs are largely designed to confer subsidies to rural areas.

Otherwise, the U.S. has very little regulation of wireless or broadband services. Wireless regulation could reappear if the wireless market becomes highly concentrated because of mergers, and potential concerns about "net neutrality" remain on the political landscape. At this moment, however, both are simply distant possibilities. The U.S. telecommunications sector is, for the most part, deregulated and likely to remain so for the foreseeable future.

(28) For an analysis of the effects of mandating unbundling and the P2P network architecture required to facilitate it, see Soria and Hernandez-Gil (2011).
(29) A recent study of the effectiveness of the $2.5 billion portion of this subsidy program administered by the U.S. Department of Agriculture found that the cost per incremental home passed by broadband was between $30,000 and $350,000. (Eisenach and Caves (2011))

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Modelos Alternativos de Análisis en la Teoría Económica

Alternative Models of Analysis in the Economic Theory

The Theory of Value: Applications to the ICT Sector
Dr. Fernando Herrera González (Dirección Política Regulatoria, Telefónica España)

The impact of multisided markets on the debate over optional transactions for enhanced delivery over the Internet
J. Gregory Sidak (Chairman, Criterion Economics L.L.C and Ronald Coase Professor of Law and Economics, Tilburg Law and Economics Center (TILEC))

Introducción

Como hemos visto en la sección anterior, la regulación dirigida a orientar los precios de los servicios de comunicaciones a sus costes incrementales a largo plazo está limitando la inversión e innovación del sector. Años de aplicación de la teoría económica neoclásica para justificar las intervenciones de las autoridades de regulación, tratando de conseguir capturar todas las eficiencias estáticas posibles, están llevando a la industria a una pérdida de valor sin precedentes.

¿Realmente podemos aceptar que la innovación no reside en la red, donde todo está inventado, y que el marco actual ya garantiza suficientemente la renovación de las redes actuales? ¿Se puede compatibilizar el principio de red abierta, que ha dado lugar a la gran explosión de aplicaciones y contenidos de Internet, con un incentivo adecuado a la renovación constante de las redes de comunicaciones electrónicas?

Lo cierto es que son muchas las voces que se levantan reclamando más inversión por parte de los operadores para no socavar la capacidad de progreso de la economía, pero los operadores se muestran reacios a hacerlo porque los analistas y agencias de valoración de riesgo miran con no poca incredulidad cualquier anuncio de aumento de su esfuerzo inversor.

Por otra parte, el crecimiento del uso de Internet se ha hecho bajo un modelo de gratuidad en el que la única fuente de financiación ha procedido de la propia conexión a la red y la publicidad, lo que ha contribuido a que el tráfico crezca a una velocidad mucho mayor que los ingresos. Este sistema de precios, que ha sido muy beneficioso para generar el éxito actual de Internet, elimina el “riesgo moral” de un consumo excesivo de los recursos disponibles y conduce inevitablemente a la denominada “tragedia de los comunes”, poniendo en duda la sostenibilidad en el largo plazo del propio modelo, debido a que no se generan los mismos incentivos a la inversión en toda la cadena de valor del mercado, siendo la renovación de las redes de telecomunicaciones su eslabón más débil.

Sería necesaria la restauración de la figura del emprendedor en la teoría aplicada a la regulación y, en particular, al papel que juega la innovación para explicar la asignación de los recursos, pero al mismo tiempo también sería necesario aceptar que la discriminación de precios es un hecho consustancial a un mercado en competencia.

Ya comentamos anteriormente que el problema del modelo regulatorio vigente es que se basa en modelos neoclásicos que parten de la hipótesis de que los mercados son estables y no sufren cambios estructurales, por lo que, lógicamente, no cabe hablar en ellos de innovación. Como los modelos teóricos aplicados en la regulación siempre han obviado su componente dinámico (la inversión y la innovación), se corre el riesgo añadido de que las distintas administraciones públicas, de forma aislada y sin coordinación entre ellas, traten de sustituir la iniciativa privada mediante la asignación de dinero público a proyectos de despliegue de red, con el riesgo de involución de todo el proceso de apertura del mercado a la competencia y provocar la atomización del mercado en operadores locales de dimensión inadecuada.

Los propios fundamentos de la teoría económica nos pueden servir para reorientar el cambio en la regulación actual, sin más que revisar lo que nos dice sobre la forma en que los individuos toman sus decisiones, para constatar que realmente los precios de un mercado no son determinados por los costes de sus factores de producción, mucho menos los costes marginales, sino la propia utilidad o valor que los individuos asignan a las mercaderías que le son ofrecidas.

Precisamente la Teoría del Valor está relacionada con la eficiencia en la asignación de los recursos de una economía, en el sentido de que debiera alentarse la producción de aquellos servicios más valorados por una sociedad, si bien detrás del concepto de valor hay una fuerte dosis de subjetividad que hace muy difícil cualquier intento de dirigismo o planificación, porque no nos enfrentamos a una única curva de utilidad agregada sino a infinidad de preferencias subjetivas que únicamente es posible materializar en un mercado no intervenido.

El concepto de valor está intrínsicamente unido, por tanto, a la utilidad que percibe individualmente cada consumidor, por lo que el valor de un determinado bien para un individuo difícilmente podrá coincidir con su coste marginal, con lo que costó producir la última unidad vendida, sino con algo mucho más complejo de medir que es su utilidad marginal. En palabras del economista austriaco Böhm-Bawerk a finales del siglo XIX: “el valor de un bien se mide por la importancia de la necesidad concreta, que es la de menor urgencia de entre aquellas que se pueden satisfacer con la cantidad disponible de bienes similares”.

Al margen de los postulados teóricos, las evidencias que encontramos al analizar la situación de los nuevos mercados de las tecnologías de la información y comunicación (TIC), es que distintos agentes provenientes de diferentes eslabones de la cadena de producción compiten a través de sus propias plataformas de servicios y aplicaciones, consiguiendo generar nuevas formas de consumo, produciendo a su vez “valor” a distintos agentes del mercado.

Efectivamente, el enfoque de la regulación hasta hoy ha sido el coste, no el valor. Sin embargo, incentivar la creación de valor es lo que debería guiar la acción regulatoria, y el mercado ha demostrado hasta ahora ser el mejor instrumento de creación de valor, sin necesidad de regulación.

Precisamente este tema es esbozado en su artículo por **Fernando Herrera González**, doctor ingeniero de telecomunicaciones por la Universidad Politécnica de Madrid y responsable de la unidad de Regulación Europea de Telefónica España, en el que aporta una aplicación de la conocida como Teoría Subjetiva del Valor, originaria de la escuela austriaca de economía, al sector de las TIC. Según explica el autor la teoría del valor, la teoría de los precios y la ley de costes, vistas desde la tradición “subjetivista” de la escuela austriaca de economía suponen un punto de ruptura respecto a la escuela neoclásica, incluso de la escuela austriaca propiamente dicha, con profundas diferencias metodológicas.

De acuerdo a esta teoría, el valor de un bien es determinado por su utilidad marginal que, a su vez, no solo depende de las preferencias de los individuos sino también de la escasez del bien. De forma similar, el valor de los factores productivos requeridos para elaborar los bienes depende del valor de este último, pues los factores por sí mismos carecen de valor mientras no entran a formar parte del bien final, lo cual tiene importantes implicaciones cuando es puesto en relación con los precios y los costes. Por tanto, los costes dependen también de precios de los bienes producidos, es decir, de su utilidad y su escasez.

La intervención de los mercados, prosigue el autor, rompe las anteriores relaciones entre valor y precio, provocando generalmente que los precios se sitúen por debajo del precio de mercado, reduciendo artificialmente el valor para los productores y provocando el agotamiento del recurso regulado, y concluye afirmando que el valor no es un número, ni los precios son la intersección de puntos entre funciones continuas de oferta y demanda, ni los costes son los precios de los factores productivos y, por tanto, los precios no pueden ser calculados como la suma de los costes.

De hecho, la realidad actual nos muestra un sector de las TIC evolucionando rápidamente a una mayor integración, diluyendo las barreras tecnológicas que hasta ahora les mantenía en segmentos estancos de la cadena de producción de los servicios. Precisamente gracias a esa integración se consigue complementar los bienes intermedios procedentes de distintos mercados para generar un mayor valor para el consumidor final; en los términos que manejaba Böhm-Bawerk, diferentes empleos implican también diferentes deseos, y las relaciones entre los deseos y las provisiones da lugar a distintos valores de los bienes, distintos grados de utilidad y, por tanto, distintas utilidades marginales.

Rochet y Tirole (2001) fueron los primeros autores que empezaron a denominar a estos mercados bajo el concepto de mercados bilaterales o multilaterales, caracterizados por la existencia de agentes que ofrecen un producto gratis con el fin de conseguir atraer ingresos de otros productos (pensemos en la publicidad, p. ej.).

Los estudios realizados sobre estos mercados suponen un avance al reconocer un papel a los operadores de telecomunicación que va más allá del mero suministro de servicios de red. Los operadores pueden, además, facilitar el desarrollo de nuevos servicios y aplicaciones, al ser un eslabón imprescindible en la relación entre usuarios finales y proveedores de contenido.

Concretamente, los modelos teóricos desarrollados hasta el momento para estudiar el funcionamiento de los “multi-sided markets” han puesto su foco en establecer las estructuras de precios más eficientes para el mercado, con el fin de determinar si un operador, modificando la estructura de precios entre proveedores y usuarios finales (por ejemplo bajando el precio del acceso al usuario final a cambio de subir el precio a los proveedores de contenido), puede influir sobre la penetración de los nuevos servicios.

Los efectos indirectos de red son esenciales para entender esta teoría. De hecho, fueron minusvalorados durante mucho tiempo. Hoy en día las plataformas de negocio o servicios son habituales, compitiendo en mercados multi-sided, pero el precio óptimo de cada uno de estos lados obviamente no pueden tener relación con los costes marginales, sino con el valor agregado del mercado. Las plataformas fijan cargos en uno de los lados o en ninguno, por lo que el coste no determina en ningún caso el precio a cobrar (David S. Evans, 2003). De hecho el precio eficiente podría resultar en la fijación de un precio por debajo del coste medio o marginal en uno de los lados del mercado y por encima de ellos en el otro.

La literatura sobre mercados de doble cara ha abierto un camino que debiera ser explorado por la regulación sectorial, poniendo el foco en la relación entre proveedores de contenido y operadores de telecomunicación, en facilitar que mediante acuerdos libres entre ambos se pueda conseguir maximizar el valor que los usuarios finales extraen de los servicios.

Es probable que el enfoque actual del desarrollo de contenidos "Walled Garden" (sobre plataformas propietarias) se mantenga, al menos mientras organismos de regulación no intenten controlar el comportamiento de estas plataformas, aunque la intervención conllevaría unas distorsiones en los mecanismos de mercado que debieran ser previamente analizados, aunque la realidad es que no está muy claramente definido en qué casos deberían actuar y en cuáles abstenerse, y las intervenciones realizadas hasta ahora han tenido más que ver con operaciones de concentración entre empresas que en disputas surgidas entre distintos agentes.

Precisamente a los multi-sided market y al debate sobre la regulación de la red está dedicado el artículo de **J. Gregory Sidak**, Chairman de Criterion Economics LLC y profesor del Tilburg Law and Economics Center (TILEC), quien nos explica que la regulación de Internet supone un nuevo campo en la regulación mundial de las telecomunicaciones, estando en el centro del debate la llamada regulación de la "neutralidad de red", que es una serie de recomendaciones políticas que tienden a limitar la capacidad de los operadores de red de gestionar su tráfico, prohibiendo la realización de transacciones "business-to-business" para mejorar la calidad de servicio (QoS) en la entrega de paquetes. El autor defiende que los responsables políticos deben tener en cuenta adecuadamente las implicaciones que tiene la naturaleza multilateral de los mercados de banda ancha, que permite que los acuerdos entre negocios para dar una calidad de servicio mejorada puedan reforzar los efectos positivos de red y disminuir las externalidades negativas. Adicionalmente, estos mercados de varias caras evitan que los operadores de redes tengan incentivos a perjudicar o discriminar a determinados contenidos, circunstancia que no ha sido ponderada adecuadamente en la regulación de la neutralidad de red.

Introduction

As it has been seen in the previous section, the regulation focused on cost orientation (long-run incremental costs) is hindering sector investment and innovation. After several years of neoclassical economic theory in the regulation appliance, seeking to capture all possible static efficiencies are driving down the global value of the industry.

Can we really accept that innovation is not in the network, where everything is invented, and that current framework ensures the renewal of existing networks? Is it possible to reconcile the principle of open network, which has led to the explosion of Internet applications and content, with an adequate incentive to the constant renewal of electronic communications networks?

Many voices have risen demanding more investment by operators in order not to undermine the progress of the economy, but operators are reluctant to do so because analysts and rating agencies watch with disbelief any announcement of investment increment.

On the other hand, Internet development took place under the free-of-charge model where funding sources came solely from network access fees and advertising, which has helped traffic to grow much faster than revenues.

This pricing system, which has been very beneficial to generate the current Internet success, eliminating the "moral hazard" of excessive consumption of resources and leads inevitably to the so-called "tragedy of the commons", challenging the long run model sustainability, because it does not generate the same incentives to invest in the entire value chain market, where the renewal of telecommunications networks is the weakest link.

It would be necessary to restore the figure of the entrepreneur in the regulation theory and, in particular, the role that innovation plays in explaining the allocation of resources, but at the same time it would also be necessary to accept that price discrimination is an intrinsic element in a competitive market.

It has been discussed earlier that the problem of current regulatory model is that it is based on neoclassical models which depart from the assumption that markets are stable and do not suffer structural changes, so logically they cannot be told as innovative. As these theoretical models have always ignored the dynamic component (investment and innovation), it cannot be discarded public administration intervention, without any coordination with private initiative, with a crowding out effect, leading to a fragmented market with plenty of local operators with an insufficient dimension.

The economic fundamental can help us to reorient the current regulatory framework, simply by reviewing what it is told about how individuals make their decisions, in order to understand that market prices are not determined by the marginal production costs, but the actual use or value that individuals assign to goods that are offered (utility).

Precisely the Theory of Value is related to the efficient allocation of resources in an economy, that it should encourage the production of those services most valued by society, unfortunately, behind the concept of value there is a strong dose of subjectivity that makes extremely difficult any attempt of intervention or planning, because we do not face a single aggregate utility curve but a lot of subjective preference that can only materialize in an unregulated market.

Therefore, the concept of value is intrinsically linked to the perceived utility of each consumer, so that the value of a certain good for an individual is unlikely to match its marginal cost, that is, the production cost of the last unit sold, but something much more complex to measure, the marginal utility. In the words of the Austrian economist Böhm-Bawerk in the late nineteenth century, "the value of an asset is measured by the importance of specific need, which is the least urgent among those that can be satisfied with the quantity of similar goods".

Evidences found in analyzing the status of new ICT markets unveil that different players from different stages of the production chain compete through their own services platforms and applications, being able to generate new forms of consumption, generating "value" to other market players.

Indeed, up to date regulation has focused on costs, not on value. However, encouraging value creation should guide regulatory intervention, and market itself has so far proven to be the best instrument for creating value without any need regulatory intervention.

Precisely this issue is outlined in the article written by PhD **Fernando Herrera González**, telecommunications engineer from the Polytechnic University of Madrid and head of the European Regulation unit of Telefonica Spain, which provides an application to ICT sector of the so-called subjective theory of value, originated in the Austrian school of economics.

According to this theory, the value of a good is determined by its marginal utility, which depends not only on individual preferences but also the shortage of that good. Similarly, the value of the inputs required to produce that good depends on the value of the latter, because the factors themselves have no value until they become part of the final good, which has important implications when placed in relation to prices and costs. Therefore, costs also depend on prices of produced goods (i.e. its utility and scarcity).

According to the author, market intervention breaks the previous relations between value and price, usually causing the prices to be below market price by artificial reduction the value to producers and generating scarcity in the regulated good. He concludes stating that neither the value is a number, nor prices are the intersection between continuous functions of supply and demand, nor costs are the prices of productive factors and, therefore, prices cannot be calculated as the sum of the costs.

As a matter of fact, ICT industry is fast evolving to further integration, and it generates greater value to the final consumer. In words of Böhm-Bawerk, different jobs also involve different desires, and relations between desires and supplies results in different valuation of goods, varying degrees of utility and hence different marginal utilities.

Rochet and Tirole (2001) were the first authors who began to call these markets "two-sided or mult-sided markets", characterized by the existence of agents offering a product for free in order to generate revenues from other products (i.e. advertising).

Studies on these markets represent an advance in recognizing the role of telecom operators that goes beyond the mere provision of network services. Operators can also facilitate the development of new services and applications, being an essential link in the relationship between end users and content providers.

Specifically, theoretical models developed so far to study "multi-sided markets" have put their focus on establishing more efficient pricing structures for the market in order to determine whether an operator, changing the price structure between suppliers and end users (eg lowering the price of end-user access in exchange for raising the price to content providers) could influence on new services penetration.

Indirect network effects are essential to understand this theory. Indeed, they were undervalued for a long time. Today, business or service platforms compete in multi-sided markets, whist the optimal price of each of these sides obviously cannot be related to marginal costs, but the added value of the market. The platforms could charge the customer just in one side or even no charges at all, so costs does not determine the retail price (David S. Evans, 2003). In fact, the efficient price could result in setting a price below the average or marginal cost on one side of the market and above them on the other.

The literature on two-sided markets has opened a path that should be explored by industry regulation, putting the focus on the relationship between content providers and telecom operators, to encourage commercial agreements between them which could maximize the value extracted by end users.

It is likely that the current approach to content development "Walled Garden" (on proprietary platforms) is maintained, as long as regulators do not try to control these platforms, although the intervention would lead to a distortion of market mechanisms. Up to date, regulatory intervention has addressed M&A operations rather that disputes between different agents.

Multi-sided markets and network regulation are addressed in the article by Professor **J. Gregory Sidak**, Chairman of Criterion Economics LLC and professor at the Tilburg Law and Economics Center (TILEC), who explains that Internet regulation is a new field in the global telecommunications regulation, where net neutrality regulation is located in the center of the debate, which tends to limit the freedom of network operators to manage their traffic, prohibiting the execution of "business-to-business" transactions for enhanced quality of service (QoS). The author argues that policy makers should take into account the implications of the multilateral nature of broadband markets, which allows commercial agreements to improve service quality to enhance the positive effects and reduce network negative externalities. Additionally, these multi-sided markets prevent network operators from having incentives to harm or discriminate against certain content, a fact that has not been properly weighted in the regulation of net neutrality.

The Theory of Value: Applications to the ICT Sector

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Resumen

En el presente artículo se expone la teoría del valor aceptada en la actualidad. Sobre ella, se construyen la teoría del precio y la ley de los costes, siguiendo la tradición subjetivista. Una vez introducidas estas teorías, se muestra que es posible su aplicación a fenómenos económicos actuales, usando dos ejemplos del mercado de las TICs: la evolución en el valor de los contenidos tras la generalización de Internet y la interacción entre precios regulados y valor en el mercado de telecomunicaciones.

Abstract

In the present paper, the current theory of value is exposed. Starting from it, the theory of price and the law of costs according to subjectivist tradition are also depicted. Once these tools introduced, it is shown that its application to current economic phenomena is feasible, using two examples from the ICT market: evolution in the valuation of entertainment contents as consequence of Internet, and interaction between regulated prices and value in the telecommunications market.

Introduction

"In economics the most fundamental of these central problems is the theory of value." In such a way referred to the subject of this paper no other than G.J. Stigler (1982, p. 61) in his Nobel Memorial Lecture.

Value is at the root of all economic phenomena, that which economic theory tries to explain. Without a theory of value, goes on Stigler, no theory of international trade or theory of money is possible. In fact, it may be added, no theory of price would be possible. For how can anyone try to explain the price of a good without understanding how individuals value it?

Prices are the ratios at which two individuals interchange goods. So, in order to explain the existence of prices, it is necessary to explain why individuals do such an action. Empirical evidence reveals that individuals do interchange goods, giving birth to prices in the process. Economic theory explains that this happens (in a context without coercion) because each of the involved individuals places more value on the received good than on the given good. Thus, there is an undoubted relation between value and price, at least in a market where interchanges are voluntary.

If value is the cornerstone of economic theory, prices constitute the main observable economic phenomenon. It was the existence of prices in the world that first attracted the attention of economists. And it is from the observation of prices by individuals that all economic activity stems.

In this paper, the theory of value will be revisited, together with the theory of price and, the other side of the coin, the theory of costs. In spite of the importance of the phenomena, it is very unusual to see direct applications of these theories to actual cases. Most mainstream economists assume all these theories as known, and prefer to directly jump into the formulation of mathematical models, without much reflection on what these models actually represent or why they do what they are doing.

The applications proposed in this paper relate to the Information and Communications Technologies (ICT) sector. The goal is to show that the direct application of these theories is possible, even to complex markets such as this is, and that such an application may show economic insight that is not so easily grasped by means of the current economic models.

The paper is structured as follows. After this introduction, the second part will depict the theory of value as it is generally accepted. Starting from here, the third part will expose the theory of prices and the law of costs, in a road that will take us away from the mainstream, sacrifice that we are willing to make in exchange for consistence and soundness. The fourth part will show a couple of direct applications of the previously exposed theories: a possible explanation for the evolution of the value of contents in the context of the Internet, and an analysis of the interaction between value and regulated prices. The fifth part concludes and closes the paper.

The theory of value

A brief historical review

The current theory of value may be traced to the end of the XIX century. It was formulated at the same time by three economists: the Austrian Carl Menger, the English William Jevons and the French Léon Walras. However, it is fair to say that scholars from the "Escuela de Salamanca" had already in the XVI century similar views to that of Menger that will be exposed below. It is the case of Francisco de Victoria, who was influenced by the ideas of San Bernardino de Siena; this takes the first insight on the marginal theory of value, back at least to the XV century (Chafuen, 2009, p. 148-149).

This theory supposed the breaking point with the Classical School of Economics; and it is generally considered the origin of both the Austrian School and the Neoclassical School of Economics.

Up to that moment, it was thought that value of a good depended on the labour required to produce it. In fact, Ricardo (1817) begins its treatise by stating: *"The value of a commodity, or the quantity of any other commodity for which it will exchange, depends on the relative quantity of labour which is necessary for its production, and not as the greater or less compensation which is paid for that labour"* (underline added). This theory of value is also assumed by Marxian economics. Other theories had contended that value was intrinsic to the good, as it is the color or the weight.

Menger proposed that value did not depend on labour (or costs), but on preferences and scarcity. With this starting point and based on methodological individualism, Menger developed a theory of interchange and prices; his work was completed by the Austrian economists of the second generation, Eugene von Böhm-Bawerk and Friedrich von Wieser, with a theory of prices for production factors ('costs') and a theory of interest.

Walras and Jevons, using the same starting point, abandoned methodological individualism, and chose to use mathematical formulation in order to progress in their economic research. From these works, general equilibrium and the rest of neoclassical models derive.

The marginal theory of value

Value may be defined as the *"importance which goods or complexes of goods acquire, as the recognised condition of a utility which makes for the wellbeing of a subject, and would not be obtained without them"* (Böhm-Bawerk, 1891, p. 135).

It is clear from this definition that value does not depend on the physical or any other concrete features of the good, but only on its serviceability, its capacity to satisfy the needs of the individual. For example, with regard to value, "ice-in-winter" is a good completely different from "ice-in-summer", even if physically they could be regarded as the same good. From the economic point of view, the homogeneity of goods is thus not related to its physical features but on its capacity to satisfy the ends of the individual.

Normally, the same good may be used to satisfy various concrete wants. Moreover, several goods of one and the same kind are frequently available, thus the decision between one or another to satisfy the need is arbitrary. From this, it may be inferred that the value we bestow on a concrete good *"is measured by the importance of that concrete want, or partial want, which is least urgent among the wants that are met from the available stock of similar goods"* (Böhm-Bawerk, 1891, p. 148, underline added). In sum, the value of a good is determined by the amount of **its marginal utility**.

The more individual goods there are available in any class, the smaller is the marginal utility which determines the value. If there are available so many individual goods of one class that, once all needs satisfied, there still remains a number of goods without further useful employment, the marginal utility is equal to zero. That good is valueless: it is not scarce and is not the subject of economics.

In fact, we have just formulated the law of diminishing marginal utilities: each additional unit of a commodity has less value for the individual, because it will be allotted to satisfy a need of lower order in his individual hierarchy.

It should be noted that the individual ranking of needs consists in a list of hierarchized ends. The individual may identify which end is more important for him, but he is not able to quantify the value of that end. Because of this, it is said that preferences have ordinal value, but no cardinal (or absolute) value.

Usefulness and scarcity are the ultimate determinants of the value of goods. As this relation is completely different from one individual to another, one and the same good may have different values for each individual. Moreover, none of these subjective values may be apprehended by an external observer. Finally, it is not possible to compare the rankings of values of two individuals, as these values are not cardinal.

Summing up, the value of a good depends on its usefulness and on the available stock. However, in the current society, interchange of goods with other individuals is possible. In this context, another possible value appears for each good, together with that of direct use: the exchange value, which coincides with the amount of the use value of the goods got in exchange (Böhm-Bawerk, 1891, p. 166).

Thus, the value of a good is determined by the larger of these two values: use value and exchange value. Producers of a specific good have a use value of zero for the produced commodity; for these individuals, the value of the produced good equals its exchange value.

The value of productive factors

So far, the focus has been on goods with a direct usability for individuals. Unfortunately, most of the commodities found in nature are not of such kind, but they need to combine with other commodities in other to become a final good, ready for direct use.

According to this criterion, goods of first order may be distinguished from goods of higher order, which require further production before becoming of first order. Goods of higher order are usually known as productive factors.

In order to explain the value of productive factors, it must be noted that these elements are complementary goods with regard to some productive process of a good of lower order. According to Böhm-Bawerk (1891, Book IV chapter 10, Book V chapter 7), *"the total value of the complete group (of goods) adapts itself to the amount of the marginal utility which it is capable of affording as a group."*

In most cases, productive factors involved in a process may be also used in other processes, and may also be substituted in a concrete process by other similar productive factors. For these non-specific replaceable factors, the value is established at a certain level independently of their concrete complementary employment, and this value they have when we distribute out the total value of the group among its individual members. The value of specific non replaceable factors is fixed by difference between the value of the produced good and the value of the non-specific factors.

Thus, the value of specific productive factors directly depends on the value of the final good. For example, the value of a telecommunications network depends on the value of telecommunications services to end users. However, the value of the buildings in which the equipment sits, being non-specific productive factors, does not depend on that value, at least not so heavily as the network does.

What about non-specific factors? In this case, the formation of the value is more complex. These factors may be used for several processes, each of which will produce a different good. In turn, each of these goods has a different value according to its marginal utility. Considering this, Böhm-Bawerk (1891, p. 186) proofs that *"the value of the productive unit adjusts itself to the marginal utility and value of that product which possesses the least marginal utility among all the products for whose production the unit might, economically, have been employed".* Thus, the value of non-specific factors is also determined by the value of the possible end goods for which it can be used.

In summary, the value of productive factors is determined by the value of the end goods they contribute to, value which in turn depends on the preferences of the individuals. It is these preferences which guide the preferences of the producers, and together with the available stock for the factor, the value is established by its marginal utility.

The value of a specific factor directly depends on the value of the final good to whose production is directed, whereas the value of non-specific factors depends on its convertibility to other uses.

A clarifying example

Assume that a football match may only be broadcast by one of the following modalities: free TV, for net revenues of 1000; Internet, for net revenues of 500, or pay TV, for net revenues of 2000. Which is the value for the football match?

FINAL PRODUCT	USE VALUE FOR FANS	MATCH VALUE FOR PRODUCER
Free TV football	1000 + Costs Free Broadcast	1000
Free Internet football	500 + Costs Internet Broadcast	500
Pay TV football	2000 + Costs Pay TV Broadcast	2000

Obviously, the value of the football match is 2000, because this is the higher marginal utility for the producers. The free TV producer only values the match in 1000, the net revenue he may attain for delivering the product.

Suppose now that there is another football match of similar interest for fans. The available stock is increased in one unit, and the value of the second match is only 1000. A possible third match would only have a value of 500, whereas other possible matches would lack any value, because they can not be broadcast (in this stylized model).

Note that this example refers to the value of each match, not to its price. The relation between value and price will be shown in the next section.

Before progressing, it is worthwhile to observe that the marginal theory of value, being the breaking point with the Classical School of Economics, is also the point from which the Austrian School and the Neoclassical School of Economics start diverging. While Menger sticks in its approach to the methodological individualism and subjectivism, Walras and Jevons prefer a positivist/scientific (in the methodological sense) approach.

The problems of the scientific approach for economics have been largely discussed by Austrian economists (see for example Hoppe (1993) or Mises (1998)). Moreover, this view of the world has also relevant consequences when used to take regulatory decisions (see Huerta de Soto (2009) and Herrera-González (2011)). In the rest of the paper, starting from the theory of price presented below, we depart from the mainstream: instead, the approach proposed by Menger will be followed.

The theory of price

Direct exchange and the formation of prices

As already stated, individuals may obtain resources to satisfy their needs by interchange with other individuals. A voluntary interchange will only happen if both individuals think that they are going to profit from it (not necessarily in monetary terms, it may be in psychic terms, ser Rothbard (1962, chapter 3)). In other words, a voluntary interchange happens when the marginal utility of the received good is higher than that of the given good, for both individuals. The received good satisfy a need of higher rank in the hierarchy of each individual, than that satisfied by the given good. In the unhampered market, where no coercion exists, all exchanges are voluntary.

There are three concepts related to an exchange. The **revenue** is the utility provided by the goods received in exchange of the given good. The **cost** of the transaction is the utility renounced because of the interchange; that is, the utility that could have been obtained if the given good would have been allotted to the next need in the ranking of preferences. The **profit** is the difference between both magnitudes, and as can be seen, is subjective and not quantifiable.

The more units of good are available for an individual, the lower becomes the marginal utility and the higher is the probability that the individual prefers to exchange the good. Producers of a good are in the extreme situation of always preferring to exchange that good.

Price may be defined as the ratio of exchange between two commodities, expressed as the number of units of one of the commodities. Prices are historical phenomena that only appear when an interchange is consummated.

It will now be described how the price of a good is formed starting from the value it has for individuals, following Böhm-Bawerk (1891, Book V). The initial assumption is that the individual, when exchanging goods, will adhere to the following rules: 1) he will exchange only if the exchange brings him an advantage; 2) if several exchanges are possible, he will prefer the one supposing a greater advantage; 3) he will rather exchange for a small advantage than not exchange at all. These rules do not preclude that individuals may be wrong in their appraisal of the anticipated advantage from the exchange; but this alters neither the accomplishing of the act nor its consequences.

Following the above set of rules, it is clear that the price of the sold good[1] is determined somewhere between the valuation of the commodity by the buyer as upper limit, and the valuation by the seller as lower limit. If the value of the good is lower for the buyer than for the seller, no exchange will happen.

If several sellers exist, the range of possible values of exchange narrows. The lower bound for the price is now set by the value given by the seller who puts the lowest value on the good, and the upper limit is set by the next higher value given by the sellers. It may be observed that the value for the buyer is irrelevant when setting the price (unless it is below both thresholds, as explained above).

The analysis is dual if several buyers and only one seller exist. In this case, the upper limit for the price is set by the buyer who most values the good, and the lower limit by the next lower value given by buyers. The effect is once again the narrowing of the range for possible prices.

Combining both analyses for the case in which several sellers and several buyers exist, price will be in the range between the following values.

- Upper limit: minimum of 1) valuation of the last buyer who actually exchanges (the last or marginal buyer), and 2) valuation of the first excluded seller (the lowest of the values given by those sellers who did not achieve the exchange).

- Lower limit: maximum of 1) valuation of the least capable seller who actually effects a sale (the last or marginal seller), and 2) valuation of the first excluded buyer (the highest of the values given by those buyers who did not achieve the exchange).

(1) In an interchange, both parties act are buyers and sellers. For example, an interchange of shoes for money may be interpreted as a sale of shoes (for money) or as a buy of money (for shoes), and the contrary for the other party. Usually, the buyer is the party who interchanges the more liquid commodity (i.e, money) for the less liquid one. For the sake of simplicity, one individual will be called the buyer and the other one the seller.

As can be seen, the market price is limited and determined by the subjective valuations of the two marginal pairs, and the rest of valuations have no impact in the price of the market.

A clarifying example

An example may be useful for better understand the above depicted process. Assume the following values of a good for the following set of individuals; sellers have the good, and buyers desire it[2].

BUYER	VALUATION	SELLER	VALUATION
A	1000	Z	800
B	500	Y	400
C	2000	X	1100

Suppose in first place that only A and Z exist. Good will be exchanged, and at a price between 800 and 1000. Within this range of prices, both parties win: Z attains a profit over his value of 800, and the same does A, because he gets the good for less than 1000.

Assume now that there is only one seller (Z) and all three buyers. As Z values the good in 800, more than B does, this buyer is immediately excluded. On the other side, Z will try to sell at the higher price possible. Thus, the price will be fixed somewhere between 1000 (valuation of A) and 2000 (valuation of C). Exchange will happen between Z and C at a price between 2000 and 1000 (the valuation of the first excluded buyer).

In the dual example, there is only one buyer (A) and all three sellers. A will exchange the good at a price of 1000 or less, which immediately excludes X, who values the good more than that amount. The seller will be Y, and the price will be between 400 (valuation of Y) and 800 (valuation of Z, the first excluded seller).

Finally, assume that all sellers and buyers concur in the market. Y sells for sure, as all buyers put a higher value on the good than he does. C will buy for sure, for dual reasons. Neither of these valuations has, thus, any effect on the price.

BUYER	VALUATION	SELLER	VALUATION
A	1000	Z	800
B	500	~~Y~~	~~400~~
~~C~~	~~2000~~	X	1100

Let us go on. A may exchange with Z, but not with X; B may not exchange with anyone, and the same happens with X. The only possible exchange is between A and Z, and thus the price is set in the range 800-1000.

Summing up: A and C get one unit of the good at a price between 800 and 1000, which are sold by Y and Z. B and X do not accomplish any exchange. Price is set between the valuations given by the marginal buyer and the marginal seller.

This "final" price is compatible with the existence of exchanges at other prices while the market is forming. In any case, if all the parties know the market price, they become conscious of the exchange value of the good and will re-appraise their valuation.

It should be stressed that this "final" price is always changing in the real world. No definitive price exists for a good, because prices depend on values, and values depend on the preferences of lots of individuals, which are in perpetual motion. Thus, both theories of value and price should be interpreted in terms of trends. Only if the preferences of people were frozen at a given moment and nothing changed for a long while, the price of the commodities would end up at the level anticipated by the theory.

Simplification of the theory of price for large markets

After having developed in general terms the theory of price, we can now focus on the usual markets, for which that theory admits a great simplification.

In the first place, the sellers side of the market is usually conformed by producers. For these individuals, the produced commodity has no use value, only exchange value. As a consequence, their valuation has no role in forming the price. This implies that price will be confined between the valuation of the marginal buyer

(2) For the sake of simplicity, the value will be expressed with a cardinal number, even if it has been explained that this has actually no sense, because values are ordinal and unquantifiable.

(the buyer who places the less value on the commodity) and that of the first excluded buyer.

If, in the second place, buyers are very numerous (as happens in large markets), the difference in value between marginal buyer and the first excluded buyer grows so narrow that it may be considered as a point.

As a conclusion, in large markets the price is determined by the valuation of the last or marginal buyer. In other words, the price is set by the valuation of the buyer that puts the LESS value on the good. Recall, finally, that this value equals the marginal utility for the buyer, which in turns depends on his ranking of preferences and on his available stock.

It should also be clear that exchange only happens if each party values the acquired good more than the given good. In consequence, the existence of interchange does not imply that the value of a good for an individual equals the paid price; on the contrary, the value is always higher than the price, because otherwise no exchange would occur. Finally, the difference between value and price is not quantifiable, because preferences have ordinal but not absolute value.

The price of productive factors: the law of costs

It has already been explained that the value placed on the final good is which gives value to the productive factors, for only final goods may be used by the individuals to solve their needs. Productive factors are only demanded in their condition of potential final goods.

The price of productive factors is formed in their respective markets, in the same way explained in the theory of prices for final goods. In the markets for productive factors, the buyers are the different producers requiring the factor for their production processes. The only specificity is how the value for the buyers (the producers) is formed, which has also been described in the previous section.

Using the example of the football match, in the following table it is shown the valuation of the match by each producer, according to the revenues each modality is able to generate. With this value, each producer participates in the market for the productive factor “football match” as a buyer. And the price for the productive factor will be set depending on the available stock, as explained in the theory of price.

PRODUCER	FINAL PRODUCT	OBTAINED PRICE	OTHER OUTLAYS	INDUCED VALUE FOR THE MATCH
A	Free TV football	1200	200	1000
B	Free Internet football	700	200	500
C	Pay TV football	2200	200	2000

Note that the same would happen with any other of the productive factors required for the broadcasting of the match (for example, the microphone for the speaker). In the table, a parallel example is shown:

PRODUCER	FINAL PRODUCT	OBTAINED PRICE	OTHER OUTLAYS	INDUCED VALUE FOR THE MICROPHONE
A	Free TV Football	1200	1190	10
D	Pub with Karaoke	600	480	120
E	Movie	1000	995	5

The only difference with the previous case is that the microphone is a non-specific resource (at least, less specific than the football match). Because of this, producers of several other sectors concur in the market for microphones, such as singers, karaokes or movie producers.

As a consequence, producers A, B and C may consider the price of the microphone as given (the ‘cost’ of the microphone), as apparently independent from the valuation given by their clients to the football match. But the fact is that this ‘cost’ has been set in a market for productive factors, also depending on the valuation and prices for end customers in the respective final markets.

According to Rothbard (1993), the price of each productive factor tends to the discounted marginal value of the product. Marginal product is the additional amount of product that is obtained by adding one unit of the specific productive factor. This value has to be discounted because production is not instantaneous, but always takes some time.

In any case, it is clear that the prices of the productive factors (what mainstream economists call costs) do NOT determine the price of the final good, but the other way around. It is the price of the final good which sets the prices for their productive factors, as stated in the theories exposed above.

In fact, if it were the 'costs' which set the prices, any good could be sold, regardless of the resources required for its production, because the 'costs' would always be recovered. No bankruptcies would happen, nor would any product disappear from the market. This shows the absurdity of considering that prices are equal to the sum of 'costs' involved in its production, as mainstream economists seem to contend.

Moreover, it has been proved that prices depend on the value of the marginal buyer, that is, on preferences and on scarcity. In consequence, *there is no dependence on other magnitudes, such as the prices of the productive factors.*

Before going on, it seems in order to refer to the mainstream concept of cost, and its relation with the costs as understood by the theory of value (recall that the theory of value is common for the Neoclassical and for the Austrian School). As we have seen, cost is a subjective magnitude: the sacrificed utility of the second need in the ranking, which will not be satisfied because the good has been allotted to the need of higher order.

Buchanan (1999, chapter 2) defines the mainstream concept of cost as *"the market value of the alternate product that might be produced by rational reallocation of resource inputs to uses other than that observed. As "this market value is reflected in the market prices for resource units; cost is measured directly by prospective money outlays."* As can be seen, there is a common ground with the subjective concept of cost, because it refers to the *"alternate product".*

But, apart from that, Buchanan reckons that this concept of cost is only relevant to *"the automaton, the pure economic man, who inhabits the scientist's model"*. Cost so understood is just the computation of the resource units required to carry on an action, and as such has no relation to the subjective cost implicit in any decision, which is the relevant cost according to the theory of direct exchange.

This, among other reasons, led the Nobel laureate Buchanan to suggest that welfare economics *"has been based on simple methodological confusion"*.

Two illustrative applications

In this section, two simple analyses using these economic theories are proposed. Both of them refer to the ICT market. The first one deals with the market of contents, and tries to provide an explanation for the evolution of that market as a consequence of the advent of Internet. In the second one, the focus changes to the telecommunication market: specifically it will deal with the price regulation that is currently generalised in it, trying to identify the possible interaction between regulated prices and value and its eventual consequences.

Case 1: Content value in the context of Internet

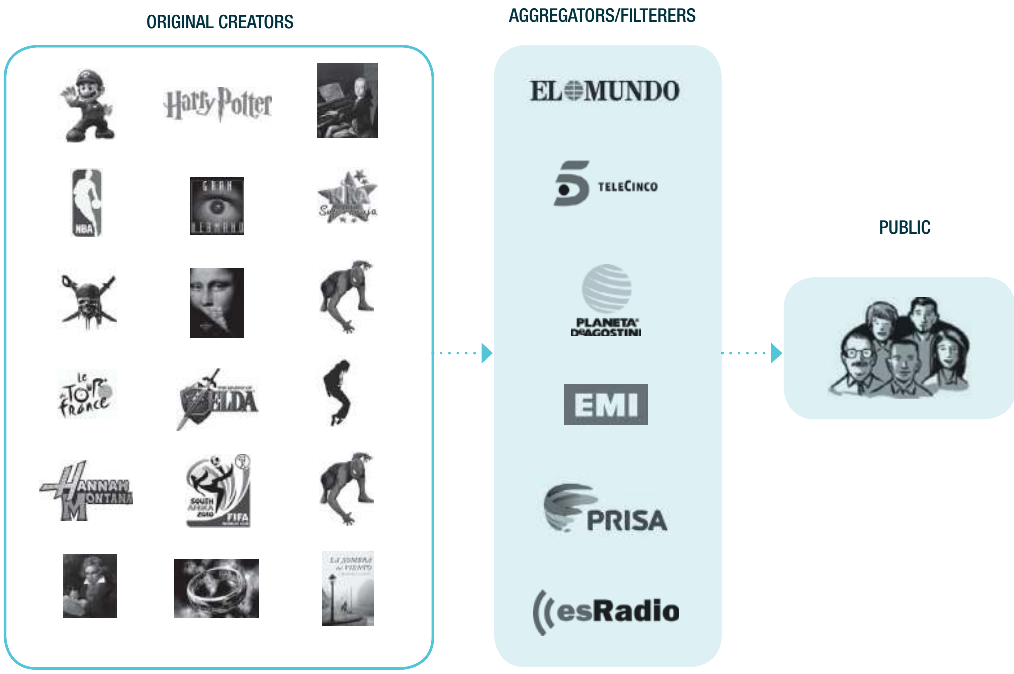
It is hard to find industries immune to the changes that Internet has brought, but the contents industry is arguably one of the more, if not the most, affected. In the context of this analysis, we define content as any kind of information that may be processed or consumed by individuals for the purpose of entertainment (financial or consultant reports, for example, are not "content" in this sense).

Examples of entertainment content are:

- Movies or documentaries, projected in a cinema, broadcast by TV, in DVD or in any other media.
- Music, coming from Spotify, by radio or downloaded by P2P.
- Books.
- Sport events...

For our purpose, it is useful to categorize the agents in the market into two categories:

- **Original creators:** the actual source of the content. It includes the writer; the music composer; movie stars and other technical personnel involved in the production of a movie; the football team and the players; or journalists. The production of the content depends on its kind, involving a variable number of what we have called original creators.
- **Content aggregators /filterers:** these agents somehow "qualify" the content. They decide which of the several contents produced by the original creators have a chance of success in the final market. This category includes:



- Radio and TV broadcasters, who decide which audiovisual contents to broadcast.

- Editorial groups, who decide which writers to publish or translate, or which singers to produce and distribute.

- Press, who choose which news will be covered.

Of course, there is no a clear-cut line between both groups, and neither there exist one between these two groups and other activities involved. Still, it seems necessary the distinction, because its respective functions are affected in completely different ways as a result of the generalisation of Internet.

As any other product, diffusion of contents may be specified in terms of a group of complementary goods. We will focus in two of the possible productive factors (original creators, aggregators/filterers) and assume that the value of the remaining ones does not alter with Internet. It will also be assumed that the preferences of the individuals do not change. In the first place, we will describe the valuation in the scenario with no Internet, and after that, the effects of the generalisation of Internet.

Valuation of contents without Internet

Absent Internet, distribution of contents is based on physical media or on telecommunications media with limited capacity. This distribution is mainly unidirectional, from the aggregator/filterer to the end user; interaction, even if not impossible, is neither easy nor immediate.

The need of physical media requires a logistic and production chain, consuming a lot of resources. On the other hand, radio and TV broadcasters have a limited capacity, more reduced in the past than now. In consequence, it is not possible that all created contents reach the public.

In this context, the only viable contents are those whose value once available for the public, is above the value of all required physical resources for the distribution, plus the value of the resources invested in the content creation. How to know which contents are these?

This role is played by agents with the suitable experience and the will to take the risk. These agents decide which contents are to be distributed and which are not. Mistaken decisions will impose a loss on them, because of the consumed resources (for example, if a published book is a failure) or of the lost opportunity (for example, if an event in prime time has no audience).

This explains the activity of aggregators/filterers in a context with no Internet. It is these agents which have to decide, in a context of scarce resources for distribution, which concrete content may be of interest for the public. They choose which books to publish, which songs to broadcast, or which events or movies to project.

They assume the risk of failing in their reading of the preferences of the public, but if they are right their activity is rewarded according to the value that individuals place on it.

Valuation of contents with Internet

Of course, we are not able to anticipate all the effects that Internet will have in the content industry, possibly not even the more important ones. But it is clear that the main effect so far is the elimination of the requirement of physical media for the distribution of contents.

Thus, assuming that the value of the "content-ready for the public" (vs. original content) does not change, it is immediate to deduce that the value of original content increases. This is so because there is no need anymore for one of the productive factors for the final product: the logistic and production chain, which supposed a large amount of value. As the value of the final product is assumed unaltered and the rest of complementary factors are not assumedly affected by Internet, the value of the original content tends to increase.

Moreover, Internet eliminates the limits of the traditional mass media. This fact, together with the already referred elimination of the logistic and production chain, implies a loss of value in the activity of aggregators/filterers. Note that the value provided by these agents relied on the need of choosing among contents before its distribution (due to the limitations in it). Once these limitations disappear, the same end user can make his own selection among original creators, and the aggregator/filterer is, in principle, not required.

This situation is intensified if we consider the interactivity provided by Internet, of which the previous distribution media were not capable. This feature allows users to access the contents he wishes and at the time of his convenience, in a practical and cheap way.

In consequence, the value of the original content also increases due to the loss in value for the aggregation/filtering activity.

Let analyse now the evolution for the value of "content-ready for the public". The said value depends, as explained, on the preferences of individuals, but also on the available stock. In the previous scenario, with scarce distribution channels, the stock of "content-ready for the public" was also very limited: only a few singers and performers have a real chance of selling CDs; only a few writers see their novels published, and only a few TV programs are chosen for broadcasting.

Once the bounds in distribution disappear, any creator may put his original content at disposition of the public, with small consume of resources. It is as easy as publishing the book in .pdf format in any website, or the song in Spotify, or the video in YouTube. As a result, the stock of final products largely increases. If the preferences of end users do not alter, the value for the contents decreases.

One example may clarify the identified trends. In a world with no Internet, only JK Rowling (among all authors that could be considered of the same kind) is able to justify the investment required to produce and distribute a book. The rest of authors in that group are marginally worse than Rowling, and no distribution is possible for them. The only content that reaches the end user is the book by Rowling, so that consumers do not even have the opportunity of buying a book of I.J. Bowling, who may have provided a slightly lower satisfaction at a much lower price.

With Internet, IJ Bowling is able to reach the public, so imposing some pressure on the books of JK Rowling. Some clients may substitute her books by those marginally worse, because of the lower price. As a result, the book by JK Rowling loses value, and this is channelled back to a loss in the original content and its creator.

Summary

For aggregators/filterers, the generalisation of Internet unambiguously supposes a loss of value. Because Internet eliminates the bounds of the traditional channels of distribution, the activity of aggregation/filtering (as we have known it) is no more necessary and the affected agents will tend to disappear unless they change their activity. This analysis contributes to explain the crisis that mass media and publishing firms are currently suffering.

Results are more ambiguous for original creators. On one side, their value tends to increase, because the value of the complementary factors required to reach the public (logistic and production chain, aggregation/filtering) decreases. But, on the other side, the value tends to decrease, due to the ability of more original creators to reach the public.

Case 2: Interaction between regulated price and value in the telecommunications market

Value and price in the intervened market

The theory of price assumes that all exchanges are voluntary. However, this is not always the case in the real world, where governments may impose transactions or conditions for the same by using the threat of violence, due to political reasons. So, in presence of the government, exchanges may exist in which one of the parties does not value more the received good than the given good.

If this is the case, and depending on the kind of government intervention, the link between price and value is broken. Price regulation is one of the more widespread types of government intervention. If price is regulated, then it is the government which sets the price for the commodity, according to political or other non economic criteria. Both buyers and sellers are obligated to transact at the regulated price; if they do not comply, they may be subject to prosecution. Price regulation may take one of several forms: fixed price, maximum or minimum price.

It is clear that if the price is set by coercive methods, the exposed theory of price does not hold. Most importantly for our purpose, this means that the price will not reflect anymore the value of the commodity. The consequences of price regulation have been widely explored by economists both from the Neoclassical and the Austrian School (see Mises (1977) or Reisman (1990)).

The regulated price is necessarily different from the free-market price. In the first place, if they were to be equal, no need of regulation would appear. But, in the second place, it has been shown that prices depend on subjective magnitudes that are dispersed among a lot of individuals; so, it is impossible for any external observer to collect the entire information required to calculate the free-market price (Huerta de Soto, 2009). In sum, the regulated price would be set above or below the free-market price.

If the regulated price is below free-market price, then it is also below the marginal value given by the first excluded buyer. In fact, depending on the level of the regulated price, lots of individual may find now that they value the commodity more than its price. However, the number of supplied units has not changed. So, it is obvious that some potential buyers will not achieve the exchange, even if willing to do it: there are not enough units of the good for everyone; in other words, shortages will appear.

There is also a feedback mechanism from price to value, as has been shown, through the exchange value. This implies that producers will value less the productive factors required to provide the good. So, the regulation of a price below its free-market level will suppose a loss of value on the assets of the regulated producer. The effect is more intense the more specific is the productive factor. It could even be the case that the acquisition of a productive factor is no longer viable for the producer, because the price offered by other production processes is above the value that the regulated producer bestows on it; or, said in a more conventional way, it could be the case that the price of productive factors (the 'costs') would become above the value of the produced good.

The case of the telecommunications market in Europe

Price regulation is pervasive in the telecommunications market. For example, across the European Union, the following prices are usually regulated:

- Fixed interconnection rates.
- Mobile termination rates.
- Unbundled local loop prices.
- Bitstream access prices.
- Mobile roaming services, both wholesale and retail (Voice, SMS and data).
- Leased lines.

Other services, as retail broadband access, are usually regulated in an indirect way by establishing a soft or hard relation with the wholesale service. Price control also affects duct provision and plenty of supplementary facilities that cannot be regarded properly as telecommunication services (for example, co-location). It is very likely that these regulated prices are below free-market prices.

From this, we may conclude that price for telecommunication capacity does not reflect anymore its value, as explained above. However, at first sight, there seems to be no shortages in the provision of telecommunications service. This may be explained by the nature of the telecom industry, whose assets are in general durable and capable of economies of scope. Herrera-González (2011, section 9.2.1) provides a detailed explanation for this phenomenon, and also shows that the current debate about net neutrality regulation is in fact a warning of those impending shortages.

Moreover, the regulated price on telecommunications services supposes a reduction on the value on its productive factors. Obviously, the telecommunication network is the more specific factor on this production process: its application is confined to the provision of telecom services, and it is very difficult to think of other possible uses with its current configuration. In consequence, it is the telecom network which is more intensely suffering the decrease in value. Other assets of telecom operators (for example, buildings, vehicles or office material), being non-specific, will hardly resent the price regulation of telecom services.

The loss of value of the telecommunications network will eventually extend to the productive factors of higher order, i.e., those required to establish the network, following similar rules: the more specific the factor, the greater is the reduction in value. As a consequence, specialised workers (such as telco technicians) or specialised equipment (such as routers, switches, or transmission media) also lose value due to regulated prices.

Eventually, all specific factors dissolve into generic factors, whose price is set in concurrence with other production processes, for which the value is correctly reflected. So, even if individuals place more value on telco services that on other products using the same input, it may be the case that the telco service producer is not able to assure the availability of such resource for its purpose, and leave individuals without service.

An extreme example could refer to copper. Copper has been used by most incumbents as material for the access network, the last mile reaching the costumer premises. Copper is clearly non-specific, and can be used for plenty of production processes outside the telecommunications market.

Price regulation of telco services makes the copper less valuable for the provision of telco services. Suppose that new uses are discovered for the copper that make its price rise (alternatively, we could suppose that governments start an inflationary process of the currency, with the same effect). In principle, this could preclude the incumbent operators from buying copper to deploy further access network, and force them to resort to other cheaper transmission media.

But if the price for the copper keeps rising (or the price for telco services is reduced), it could be even become profitable to dismount the current plant of copper. Note that price reduction of telco services could also obey to changes in customer preferences; in this case, what individuals are telling the market is that they prefer that the copper is used somewhere else, where it is more valued. The problems appear only when telco price reductions are due to regulation and thus do not reflect those preferences. In that case, end users would like the copper to remain in its current use, but it is the action of government which channels the copper to other less desired uses.

Conclusions

In this paper, we have exposed the theory of value, the theory of price and the law of costs, the two later following the subjectivist tradition of the Austrian School of Economics. While the marginal theory of value supposes a breaking point with the Classical School, it is also the diverging point of the Neoclassical and Austrian Schools, with deep methodological differences.

According to the theory of value, the value of a good is determined by the amount of its marginal utility; thus, it depends on the preferences of individuals and on the scarcity of the good. It has also been shown that the value of the productive factors required to elaborate a good, depends on the value of this one; productive factors do not have value by themselves, but only when regarded as part of an end good. This has important implications when applied to the relationship between prices and 'costs'.

The theory of price that has been exposed differs from the mainstream one, based on Neoclassical Economics. It shows that the market price in an unhampered market is determined by the subjective valuations of the two marginal pairs (that is, those of the marginal seller/buyer and the first excluded buyer/seller). In large markets, it can be shown that the price is set by the valuation of the buyer that puts the less value on the good; this value equals the marginal utility for the buyer, which in turns depends on his ranking of preferences and on his available stock.

Finally, the relation between prices of final goods and prices of productive factors ('costs', as understood by the mainstream) has been exposed. In the same way that the value of factors depends on the value of the end good, 'cost' depends on the price of the produced good, and no the other way around. Recall that the theory of value proofs that this is dependent on usefulness and scarcity, not on the price of productive factors.

Using the referred economic theories, two applications have been proposed.

First, an explanation has been provided for the evolution of the value of entertainment contents as a consequence of the widespread adoption of the Internet. It has been shown that Internet significantly reduces the value of aggregators/filterers, because there is no need of a pre-selection for costly distribution; this explains the current troubles that media groups are suffering in these moments.

It has also been described that the effect on original creators is ambiguous. On one side, both the reduced value of aggregators/filterers and the suppression of the logistic/production chain, tend to increase the value of the original content (assuming that value for "content-ready to consume" does not change). But, on the other side, the value for "content-ready to consume" tends to lower, because more original creators are able to reach the public, precisely because there is no need of a costly distribution chain.

Secondly, intervention in the market has been introduced. Governments may decide to regulate prices due to political reasons; in this case, it is clear that the exposed theory of price does not hold, because it relies on assuming voluntary exchange, i.e., that each of the involved parties wins with the transaction, which does not necessarily happen when conditions are compulsory for the parties.

In the intervened market, the link between value and price is broken. Price does not reflect anymore the value; however, it may affect the value through the exchange value of the commodity. Producers are only concerned about exchange value, and, in large markets, this is informed by the price.

So, if regulated prices are below market prices, value for producers is reduced, and so is the value they place on productive factors, more intensely affecting the specific factors. Price regulation in the telecommunications market tends to reduce the value of the telco network (more specific productive factor). Eventually, this could lead to difficulties to gather generic productive factors somewhere downstream in the production process, if they start being more valued for other uses than the regulated (through price) value.

In conclusion, it has been shown that application of the theories of value and price to current economic phenomena, even with the complexity of those happening at the ICT sector, is feasible. Not only that, its application explains phenomena and throws light on issues that could hardly be grasped by using the mainstream approach.

Given this and the central role played by the theories of value and price, it is surprising that mainstream economists tend to forget about them or just assume them, without thinking about its consequences: Value is NOT a number; prices are NOT intersection points between continuous functions of supply and demand; costs are NOT the prices of productive factors, and, definitely, prices CANNOT be calculated as the sum of the 'costs'.

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The impact of multisided markets on the debate over optional transactions for enhanced delivery over the Internet

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Resumen

La regulación de Internet supone un nuevo campo en la regulación mundial de las telecomunicaciones. En el centro del debate sobre la regulación de Internet está la llamada regulación de la "neutralidad de red", que es una serie de recomendaciones políticas que tienden a limitar la capacidad de los operadores de red de gestionar su tráfico. Una de las políticas más controvertidas de la regulación de la neutralidad de red es la prohibición de la opción de transacciones "business-to-business" entre los proveedores de servicios de banda ancha de Internet (ISP) y los proveedores de contenido para mejorar la calidad de servicio (QoS) en la entrega de paquetes a través de Internet. Los responsables políticos deben tener en cuenta adecuadamente las implicaciones de la naturaleza multilateral de los mercados de banda ancha sobre los riesgos y ventajas de las transacciones opcionales con calidad de servicio mejorada. Debido a que el mercado de acceso de banda ancha es multilateral, los acuerdos entre negocios para dar una calidad de servicio mejorada reforzarían los efectos positivos de red y disminuiría las externalidades negativas. Por otra parte, estos mercados de varias caras evitan que los operadores de redes tengan el incentivo a perjudicar o discriminar a determinados contenidos, obviándose este aspecto en la regulación de la neutralidad de red.

Abstract

A new arena of global telecommunications regulation is regulation of the Internet. Central to the debate over Internet regulation is so-called "network neutrality" regulation, which is a series of policy prescriptions that would restrict the ability of network operators to manage network traffic. One of the more controversial policies of network neutrality regulation is a ban on optional business-to-business transactions between broadband Internet service providers (ISPs) and content providers for enhanced quality of service (QoS) in the delivery

of packets over the Internet. Policy makers must adequately consider the implications of the multisided nature of broadband markets on the risks and merits of optional transactions for enhanced QoS. Because the market for broadband access is multisided, business-to-business transactions for enhanced QoS would foster positive network effects and diminish negative externalities. Furthermore, multisided markets prevent network operators from having the incentive to harm or discriminate against certain content, obviating this facet of network neutrality regulation.

1. Introduction

The new battle in telecommunications regulation—said by some to decide the future of the Internet—centers on an arcane notion dubbed "network neutrality." Based on theories that innovation in Internet content and applications is threatened by Internet service providers' (ISPs') network-management practices, proponents of network neutrality regulation have called for regulations that would ban network operators from blocking certain content and charging content and application providers for higher quality transmission across their networks (known as quality of service, or QoS). The issue has sparked a decade-long debate involving top industry players and scholars in law and economics. The question of whether telecommunications regulators should ban network operators and content providers from entering into optional business-to-business transactions for QoS has become the center of the network neutrality debate.

However, proponents of network neutrality regulation ignore that, due largely to the multisided market for broadband access, permitting network operators to charge content providers for enhanced QoS in optional, voluntary transactions would foster innovation in both network infrastructure and Internet content and applications. Moreover, because complementary demand for broadband and content exists, network operators have no incentive to impede the development of Internet content.

Regulators should support policies that promote positive network effects and reduce negative network externalities. Network effects exist when demand for a service increases as the size of the network increases. By increasing broadband penetration, optional transactions for QoS foster positive network effects. Charging content providers instead of end users for QoS would yield a Pareto efficient outcome because content providers are more willing and able to pay for enhanced QoS than are end users. Permitting optional business-to-business transactions for QoS would also help network operators recover their sunk investments, which would promote innovation in the core of the network. Proponents of network neutrality regulation justify a ban on optional business-to-business transactions for QoS by arguing that such transactions would hinder innovation in Internet content and applications. Consequently, they argue, such transactions would reduce positive spillovers to end users created by Internet content. However, business-to-business transactions for QoS would not threaten positive spillovers from content, because innovation in network infrastructure promotes innovation in content and applications. Conversely, without network capabilities that can support bandwidth-intensive Internet applications, end-user demand for those applications is limited.

In addition to fostering positive network externalities, policy makers aim to reduce negative externalities. A ban on business-to-business transactions for QoS would exacerbate negative network externalities. If enhanced QoS were free, content providers would be more likely to overconsume bandwidth, which would worsen network congestion and thereby degrade the quality of service for all content and applications, particularly those applications that are latency sensitive, such as real-time video. Optional business-to-business transactions for QoS would create a market mechanism to mitigate such network congestion.

Finally, proponents of network neutrality regulation argue that in business-to-business transactions for QoS, network operators would ignore content-related spillovers and thus overcharge for enhanced QoS, which would reduce investment in content. However, because of the complementary demand between broadband access and Internet content, network operators would have the incentive to internalize such positive spillovers. Again, increasing demand for content would increase demand for broadband access. Therefore, network operators have the incentive to promote investment in and demand for Internet content. The multisided market for broadband access should mitigate regulators' concerns for innovation in Internet content.

2. The Multisided Market for Broadband

Telecommunications services have joint demand. For example, a telephone call is valued by both the caller and the recipient, and a visit to a website is valued by both the consumer doing the browsing and the owner of the website.

In a "two-sided" market of this sort, the demand that one party has for the product is complementary to the demand that the other party has.[1] Over-the-air television programs are free to the viewer because advertisers pay broadcasters to assemble audiences to receive advertisements. Google searches are free to Internet users because Google sells highly focused advertising that responds to the interests revealed by the Internet user's search request. The owner of a broadband network faces a multisided market because it needs content providers to supply content and applications on the Internet, and it also needs end users to demand access to the Internet content. In this way, a network operator can be considered an intermediary that brings together two parties —the end user and the content provider— to an exchange that occurs over the Internet.

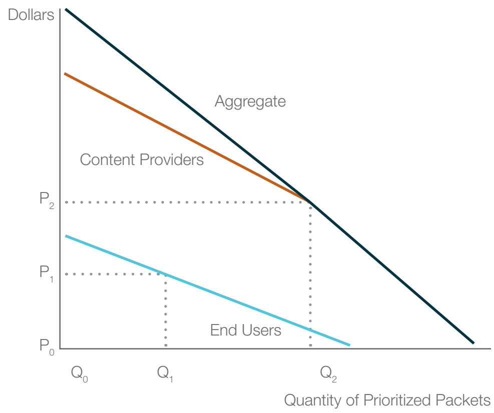
In the multisided market for broadband access, complementarity of demand exists among the network, content, applications, and devices. Network operators rely on Internet content, applications, and devices to attract end users to subscribe to Internet access. Email was the "killer-application" that generated the demand for dial-up Internet access. Without email, there would have been significantly less need for dial-up Internet access. Downloading graphics-intensive images and videos was made possible by broadband connections, but broadband penetration did not really accelerate in the United States until the price of broadband access approached the price of dial-up access and a second telephone line.

3. Should Content Providers or End Users Pay for Enhanced QoS?

Both content providers and end users benefit from, and thus have complementary demand for, use of the broadband network. When a consumer uses the network to search on Google, the search is valued by both the user, who gains information, and by Google (the content provider), which earns advertising revenues. Both sides of the market exhibit positive demand for broadband use, and both sides should therefore pay a positive price. The same principle applies to specific network features, such as enhanced QoS in the delivery of data packets over the Internet.

If the quality of an application such as video conferencing would improve from enhanced QoS, both the end user and the content provider are willing to pay for this service. The user enjoys a superior broadband experience, and the content provider benefits from increased demand for its product as a result of the improved end-user experience. Figure 1 depicts the demand for priority delivery. If, as a consequence of network neutrality regulation, only end users are permitted to pay for priority delivery, then end users would purchase only a limited quantity of prioritized packets, Q_1. If the content provider is permitted to pay for enhanced QoS, then a higher quantity, Q_2, of prioritized packets would be purchased, which results in a larger consumer benefit. Additionally, allowing content providers to pay for service would help contribute to covering the sunk costs borne by network operators, thus increasing their incentives to invest and innovate.

Figure 1:
The Multisided Market for Enhanced QoS



Content providers are also in a better position to pay for enhanced QoS than end users. Network operators can achieve lower transactions costs by contracting with content providers rather than end users, because there are significantly fewer content providers than end users, and therefore fewer negotiations required. End users have high

(1) See, e.g., David S. Evans, *The Antitrust Economics of Multi-Sided Platform Markets*, 20 Yale J. on Reg. 325 (2003); Jean-Charles Rochet & Jean Tirole, *Platform Competition in Two-Sided Markets*, 4 J. Eur. Econ. Ass'n 990 (2003). The seminal article on two-sided markets is William F. Baxter, *Bank Interchange of Transactional Paper: Legal and Economic Perspectives*, 26 J.L. & Econ. 541 (1983).

uncertainty regarding which applications they will use and which applications will require enhanced QoS. In contrast, content providers have a better understanding of whether the applications they offer require real-time delivery.

Ramsey pricing indicates that the price (more precisely, the markup above marginal cost) for products sharing common cost should be based on the inverse of the elasticity of demand. If content providers are less price-sensitive than end users, as depicted in Figure 1, then it is optimal to charge content providers a higher share of the common cost for enhanced QoS. There is no economic reason why end users should cover all the costs of the network when both parties benefit from its use. Furthermore, the economic literature on two-sided markets recognizes that increasing the overall level of charges to one side results in rate reductions on the other side, regardless of the competitiveness of the market.[2] Thus, even a monopolist network operator would reduce rates to one side of the market if, concomitantly, it charged higher rates to the other.

The multisided market for broadband delivery therefore has significant implications for achieving Pareto improvements. Conditional on content providers and advertisers having a greater willingness to pay for enhanced QoS than end users, the ability to charge content providers (and their advertisers) for enhanced QoS of data packets would generate a greater quantity of prioritization and a correspondingly greater level of consumer surplus. This economic insight is hardly new. Robert Crandall and I made this identical point in 1995 concerning universal service policy for (then-unbuilt) interactive broadband networks:

> [P]olicymakers should consider that advertisers are, in a manner of speaking, a potential source of subsidies for access to, and usage of, interactive broadband networks. Advertisers, of course, have long subsidized the consumption of "free" programming offered by radio broadcasters and over-the-air television stations. Similarly, the presence of advertising on cable television enables consumers to pay a lower subscription fee than they otherwise would be charged. Moreover, the interests of advertisers are closely aligned with those of consumers of programming in the sense that both groups seek policies that expand output and reduce prices for telecommunications services of all kinds, irrespective of the technological mode of signal delivery. Regulation that restricts output in telecommunications markets impairs the welfare of both viewers and advertisers. This commonality of interests arises from the fact that the demand for broadcast programming—and, by extension, the demand for interactive broadband services—is the vertical summation of two demand curves: the viewers' demand for programming and the advertisers' demand for audiences. As in the case of any multiproduct firm, the provider of interactive broadband services will likely have common fixed costs of production that are high relative to the incremental costs of programming or infrastructure deployment. Those common fixed costs are optimally distributed in inverse relation to the elasticity of demand. Access charges and usage charges can be borne either by the advertiser or the subscriber. If, however, the advertiser has the more price-inelastic demand, it is optimal from the perspective of economic efficiency for the advertiser to bear the disproportionate share of those costs. This result may also be considered equitable in the sense that it advances the goal of universal service by keeping the prices of access to, and usage of, interactive broadband networks lower than they would be in the absence of advertiser support.[3]

In short, each party in a multisided market can contribute to the recovery of the sunk costs required to build a broadband network. There is certainly no basis in economic theory to presume that it would be socially optimal for end users to pay for the entire cost of building a high-speed broadband network while the companies that deliver content or applications to those same end users over that network —and therefore derive substantial economic advantage from its use— pay nothing.

The ability to charge content providers for enhanced QoS in optional business-to-business transactions would also increase economic welfare by increasing broadband penetration, because it would enable network operators to

(2) See, e.g., Evans, *supra* note 1; Rochet & Tirole, supra note 1; Baxter, *supra* note 1.
(3) Robert W. Crandall & J. Gregory Sidak, *Competition and Regulatory Policies for Interactive Broadband Networks*, 68 S. Cal. L. Rev. 1203, 1219-20 (1995).

subsidize access prices for income-constrained or price-sensitive end users who currently forgo broadband entirely. Such marginal customers tend be minorities with lower incomes and less education, relative to the overall population.[4] By charging content providers for enhanced QoS in voluntary transactions, a broadband network operator could recover sunk costs, reduce prices to consumers, and subsidize access to more price-sensitive customers, thereby increasing overall broadband penetration.

4. Promoting Positive Network Effects and Minimizing Negative Network Externalities

Regulators should seek to promote positive network effects while mitigating negative network effects. Positive network effects accrue as broadband penetration rises. Optional business-to-business transactions for QoS would increase broadband penetration and therefore increase network effects. Proponents of network neutrality regulation have argued that charging for enhanced QoS would reduce investment in Internet content, presumably because it would raise the cost of supplying new content. However, permitting network operators to charge for enhanced QoS in voluntary business-to-business transactions would encourage investment in network infrastructure, which would promote investment in content.

a. The Goal of Increasing Positive Network Effects

One of the most important results from the literature on network economics is the creation, in some product markets, of network externalities.[5] Positive network externalities are benefits to society that accrue as the size of a network grows. For example, an individual consumer's demand to use (and hence her benefit from) a telephone network increases with the number of other users on the network whom she can call or from whom she can receive calls.[6] Some telecommunications regulations, such as policies promoting universal service, are justified as a means to capture, for consumers as a whole, the benefits of network externalities that accrue as the size of the network grows.[7] Such externalities will vary with both the number of consumers having access to the network and the amount by which each consumer uses the network.

This economic relationship has substantial public policy implications, as it is essential that legislators adequately consider the positive network effects that could be eliminated by potential regulatory actions. In terms of proposed network neutrality regulation, as explained above, pricing policies that produce Pareto improvements that increase the size of the broadband Internet network should be encouraged, not prohibited. Thus, the ability of optional business-to-business transactions for QoS to increase the size of the broadband network through the multisided market for broadband delivery weighs against a ban on such transactions.

b. Positive Network Externalities at All Levels of the Internet Value Chain

The multisided nature of the broadband market means that both end users and content providers benefit from improvements in broadband delivery. Therefore, both end users and content providers benefit from innovations in network infrastructure. Proponents of network neutrality regulation have focused on the effects of optional business-to-business transactions for QoS on spillovers created by Internet content and applications. They argue that permitting network operators to charge for enhanced QoS would reduce the supply of Internet content and thereby reduce positive spillovers accruing from Internet content. However, although innovation in content produces spillovers, so does infrastructure innovation and broadband adoption by end users. In particular, when a network operator makes investments in bandwidth, capacity, or efficient routing to improve its services, those investments benefit not only its subscribers and non-subscriber end users whose messages may be routed through the network operator's system, but also content providers that supply

(4) *See, e.g.*, Fed. Commc'n Comm'n, Connecting America: The National Broadband Plan 5 (2010); J. Gregory Sidak, *A Consumer-Welfare Approach to Network Neutrality Regulation of the Internet, 2 J. Competition* L. & Econ. 349, 467 (2006).
(5) The seminal paper in the literature on network effects is Jeffrey Rohlfs, *A Theory of Interdependent Demand for a Communications Service*, 5 Bell. J. Econ. & Mgmt. Sci. 16 (1974).
(6) *See, e.g.*, Massimo Motta, Competition Policy: Theory and Practice 82 (Cambridge Univ. Press 2004); Lester D. Taylor, Telecommunications Demand in Theory and Practice 9 (Kluwer Academic Press 1994); Bridger M. Mitchell & Ingo Vogelsang, Telecommunications Pricing: Theory and Practice 11 (Cambridge Univ. Press 1991); Jean Tirole, The Theory of Industrial Organization 405 (MIT Press 1988); Stanley J. Liebowitz & Stephen E. Margolis, *Network Effects*, 1 Handbook of Telecommunications Economics 76 (Martin E. Cave, Sumit K. Majumadar & Ingo Vogelsang eds., 2002).
(7) *See, e.g.*, Milton L. Mueller, Jr., Universal Service: Competition, Interconnection, and Monopoly in the Making of the American Telephone System (MIT Press & AEI Press 1997).

content to such subscribers. Both ISP subscribers and content providers that send their data over the network operator's equipment typically receive consumer surplus, in that the value that they receive exceeds the price that they pay. Investment by network operators thus creates "spillover" benefits that the network operators do not capture entirely.

All of these spillovers, not only the spillovers on which proponents of network neutrality regulation focus, should be considered in assessing the social welfare impacts of any proposed regulation of network operators' network-management practices. Optional business-to-business transactions for QoS encourage innovations in network functionality that increase the efficiency of packet delivery. Such enabling innovation encourages and facilitates innovation in real-time and other latency-sensitive content and applications. Proponents of network neutrality regulation have provided no explanation as to why it is necessary or desirable to subsidize content providers whose offerings yield spillover benefits without it being similarly desirable to subsidize ISPs whose offerings likewise yield such benefits.

c. The Goal of Reducing Negative Network Externalities

When economists speak of network externalities, they usually refer to positive spillovers that arise from higher levels of network access and usage. Economists have given less attention to the negative externalities resulting from higher levels of telecommunications network usage. Nonetheless, negative network externalities relating to congestion plainly arise, notwithstanding the conventional view that networks have such expansive economies of scale that capacity is seemingly unlimited. Telecommunications networks are certainly susceptible to congestion. For that reason, correct price signals must be used at every possible point in the network so that users who congest the network bear the social cost of their behavior.[8] If, instead, the owner of a broadband network were constrained to charge the same price to every content provider, regardless of the amount of network congestion that the content provider created, the result would be excess demand and reduced supply—which is to say, shortages of bandwidth and slower transmission speeds.

Internet users are increasingly straining the capacity of broadband networks. For example, peer-to-peer applications were first used to share music files, but have since expanded into other uses. In March 2006, the European Center for Nuclear Research (CERN) in Geneva, the world's largest particle physics laboratory and birthplace of the World Wide Web, banned the use of the Skype voice over Internet protocol (VoIP) service.[9] Among CERN's reasons for blocking Skype were (1) Skype's procedure of relying on users' computers for processor speed and Internet bandwidth to route traffic to store database information, and transforming some computers into so-called "supernodes" that carry disproportionately large burdens, (2) the potential security risks associated with Skype's ability to pass calls through firewalls, and (3) the existing or potential legal ramifications for passing a large amount of telecommunications traffic.[10] Other large institutions and corporations around the world —including the multinational pharmaceutical company Novartis, universities in the United Kingdom and the United States, and European government agencies— barred Skype for similar reasons.[11] CERN's decision to block Skype suggests that network owners may have legitimate reasons to block certain services, such as peer-to-peer applications, based solely on their effect on computer performance and network integrity.

While emphasizing positive network externalities, proponents of network neutrality regulation ignore negative network externalities, especially those relating to congestion. Network capacity is a limited resource. Users who create congestion should internalize the social cost of their behavior. Price signals help achieve that efficient allocation. Suppose that content providers were forbidden to pay broadband ISPs for enhanced QoS of the performance-sensitive content they send to the ISPs' other customers. In the unlikely event that network operators agreed to enhance the QoS of certain traffic anyway at

(8) *See* Christopher S. Yoo, *Network Neutrality and the Economics of Congestion*, 94 Geo. L.J. 1847 (2006); J. Gregory Sidak & Daniel F. Spulber, *Cyberjam: The Law and Economics of Internet Congestion of the Telephone Network*, 21 Harv. J.L. & Pub. Pol'y 327 (1998).
(9) Bruno Giussani, *The Fine Print*, Wall St. J. Eur., Mar. 29, 2006.
(10) *Id.*
(11) *Id.*

the behest of particular content providers, all such providers would have powerful incentives to over-consume QoS resources by always signaling to the ISP that their traffic is performance-sensitive and should therefore be prioritized. In other words, they would disregard the costs to the network of supplying enhanced QoS, including the opportunity costs of reducing shared bandwidth available for other content that may have a greater need for enhanced QoS to create greater social value —as price signals would have shown, had they been allowed. At a price of zero, what provider of content or applications would not demand enhanced QoS? The only economically efficient way to allocate finite QoS resources to content that needs them in the manner that consumers value most is to allow the market to attach prices to them to signal scarcity and cost to market participants.

5. Would Business-to-Business Transactions for QoS Reduce Innovations in Content?

Internet content generates positive spillover effects to end users. Proponents of network neutrality regulation justify a ban on optional business-to-business transactions for QoS on the notion that network operators would fail to account for, or internalize, content-related spillovers when setting prices for QoS. Consequently, the price of enhanced QoS would be prohibitive, discouraging content providers from bringing content to the Internet marketplace or investing in content. The multisided market for broadband delivery gives network operators the incentive to internalize those positive content-related spillovers, contrary to the fears of proponents of network neutrality regulation.

The complementary demand in the multisided market for broadband access and Internet content obviates a ban on business-to-business transactions for QoS. It is a well-established economic principle that if the demand for A increases with the demand for B, then even a monopoly provider of A would have absolutely no incentive to harm the demand for B. Given the strong complementarity of demand for broadband access and broadband content, network operators have no incentive to harm the demand for Internet content, applications, or devices, because to do so would harm the demand for broadband access. Network operators in the United States have invested billions of dollars to build third-generation and fourth-generation Internet access networks. One feature of these "core" networks is to allow for enhanced QoS for real-time applications, whatever they eventually might be. It would be foolish for a network operator to stymie the development of, and the demand for, real-time applications. Doing so would squander billions of dollars in sunk investments.

The conjecture that network operators would disregard positive content-related externalities entirely in setting prices for enhanced QoS services is unsupported. Because such positive externalities exist, network operators have the incentive to internalize positive spillovers in optional business-to-business transactions for QoS. This logic, formalized by Joseph Farrell and Philip Weiser in their development of the concept of "internalization of complementary efficiencies" (ICE), holds even in a market with a monopolist network operator.[12] Rivalry between network operators —cable broadband and telephone DSL providers, for instance— further enhances this incentive. Each network operator competes for the other's customers by striving to offer a better quality experience to consumers. In other words, they have no incentive to degrade their services or induce quality-adjusted price increases that could diminish the supply of Internet content.

The incentive to internalize positive spillovers is not unique to broadband Internet access services. In markets with network effects and demand complementarities, firms typically have incentives to internalize complementary externalities. One such example is the wireless industry, where providers attract customers to their networks by promoting the latest technology in wireless devices and compatible applications. Although wireless carriers typically do not produce these devices and applications themselves, they nonetheless promote them because wireless access and wireless phones and applications are complements. As a result, the number of applications available to wireless service customers —offered by handset manufacturers, wireless service providers, and third-party operators—

(12) Joseph Farrell & Phil Weiser, *Modularity, Vertical Integration, and Open Access Policies: Towards a Convergence of Antitrust and Regulation in the Internet Age*, 17 Harv. J.L. & Tech. 85, 89 (2003).

has increased dramatically over the last decade, notwithstanding the absence of legally binding and enforceable price regulation on wireless network operators. For example, Figure 2 shows the growth in the number of applications available for download on Apple's iPhone App Store. Apple launched its application store in July 2008 with 500 third-party applications available for download.[13] By the end of July 2009, Apple's App Store offered more than 65,000 applications.[14] As of July 2011, the App Store included more than 425,000 applications.[15]

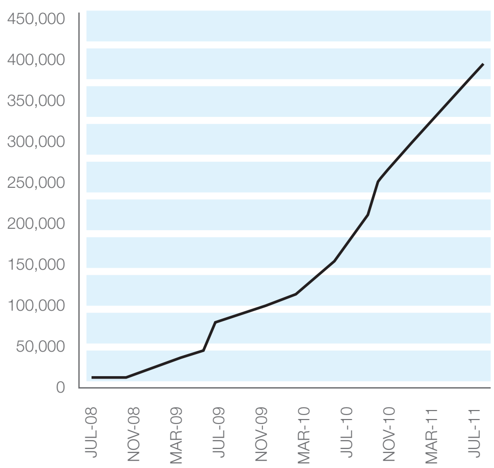


Figure 2:
iPhone Applications available for download, July 2008-July 2011

Source:
Press Release Library, Apple Inc., http://www.apple.com/pr/library

Due to complementary demand for broadband delivery and Internet content, one would expect that network operators would similarly promote the growth of innovations in content and applications.

6. Conclusion

Broadband network operators face a multisided market. End users have complementary demand for broadband access and Internet content. Although proponents of network neutrality regulation advocate a ban on option transactions between network operators and content and application providers for QoS on the rationale that such transactions would impede the development of content, the multisided market for broadband delivery ensures that network operators have incentive to foster innovations i n content. Doing so would increase demand for broadband access. Permitting optional business-to-business transactions for QoS would not reduce investment in Internet content.

Furthermore, permitting content providers to purchase enhanced QoS would contribute to network operators' recovery of sunk investments in their networks. Because content providers are better positioned than end users to pay for QoS, optional business-to-business transactions for QoS would promote investment in network infrastructure. Innovations in the network would further support innovation in real-time applications. Telecommunications regulators considering regulation of broadband networks must account for the ramifications of the multisided market for broadband when assessing proposals to ban optional business-to-business transactions for QoS. By permitting practices such as optional business-to-business transactions for QoS that increase broadband adoption, regulators would reduce negative network externalities such as network congestion while promoting positive network effects.

(13) Press Release, Apple Inc., iPhone 3G on Sale Tomorrow (July 10, 2008), http://www.apple.com/pr/library/2008/07/10iphone.html.
(14) Press Release, Apple Inc., Apple's App Store Downloads Top 1.5 Billion in First Year (July 14, 2008), http://www.apple.com/pr/library/2009/07/14apps.html.
(15) *See* Press Release, Apple Inc., Apple's App Store Downloads Top 15 Billion (July 7, 2011), http://www.apple.com/pr/library/2011/07/07Apples-App-Store-Downloads-Top-15-Billion.html.

Hacia un Nuevo Modelo Regulatorio

Towards a New Regulatory Model

An Application of Game Theory to Electronic Communications Markets
Bernhard von Stengel (London School of Economics)

Regulating Next Generation Access Networks in Europe
Sumit Sharma (Consultant, NERA Economic Consulting)
Nigel Attenborough (Director, NERA Economic Consulting)
Maria Maher (Senior Consultant, NERA Economic Consulting)

Regulación e incentivos
Germán González Rodríguez, Juan Carlos Huertas Sánchez (Gabinete de Estudios de Economía de la Regulación, Telefónica España)

Competition In The Wholesale International Roaming Market: Are there Theoretical Grounds for Regulation?
Javier Domínguez Lacasa (Gabinete de Estudios de Economía de la Regulación, Telefónica España)

Introducción

Si los mercados TIC se caracterizan, como hemos visto, por ser multi-sided, debería ser objeto de una especial atención, por parte de la teoría económica aplicada a la regulación, precisamente el estudio de las circunstancias que hacen posible que varios agentes puedan colaborar en un mercado en la búsqueda de un objetivo común que genera un mayor bienestar a la sociedad.

En la medida que esos acuerdos lo que facilitan es la innovación, la posibilidad de cubrir nuevas necesidades y generar más bienestar a los consumidores, podemos estar de acuerdo en que el foco de atención de los reguladores debería dirigirse a entender el funcionamiento de los mecanismos que permiten o impiden llegar a esos acuerdos.

En el ecosistema de Internet los agentes que interactúan cuentan con un fuerte incentivo a llegar a acuerdos, pues solo colaborando consiguen generar más utilidad a los consumidores y, por tanto, más margen para los agentes que colaboran, porque obviamente el beneficio (los incentivos) también juega un importante papel en los mercados de doble cara.

El objetivo del regulador sería asegurar que se desarrollan servicios valiosos para los usuarios finales, y cualquier remedio o intervención tendría que ser analizado bajo esta perspectiva. Al fijar una obligación de acceso mayorista a las redes, por ejemplo, no basta con suponer que gracias a ello y al precio regulado los servicios de red serán más baratos y, por tanto, habrá más usuarios finales. Es preciso tener en consideración cómo se está afectando a los múltiples lados del mercado, conocer qué pasa si en uno de ellos se altera el incentivo para invertir.

El planteamiento teórico de este tipo de intercambios ha tenido su desarrollo más extenso en la conocida como Teoría de Juegos. En estos modelos teóricos un número finito de agentes interactúan, cooperando en coalición o individualmente, buscando su máximo valor individual, de tal forma que la única vía de maximizar sus respectivas utilidades es llegando a un acuerdo. Finalmente la colaboración produce un valor agregado mayor que en el escenario en el que los agentes actúan individualmente.

Quizás una de las principales ventajas de plantear el análisis de los mercados bajo la visión de un juego competitivo es que se incorpora la componente dinámica que no tienen los modelos neoclásicos. Bajo esta nueva perspectiva, es posible que en el corto plazo la intervención del regulador pueda provocar un incremento del bienestar social, pero obliga a considerar también el impacto en el medio y largo plazo sobre el valor agregado del mercado, analizando el efecto sobre los incentivos del agente intervenido.

La teoría del valor entendida como el resultado de un juego fue introducida por Shapley en 1953. El valor de un juego para sus jugadores es analizado como la evaluación que inicialmente hacen sobre sus expectativas de recompensa, pero fue Von Neumann quien definió el resultado del juego como la utilidad para el jugador, siendo la utilidad de los agentes una medida de los resultados prospectivos.

Lo que finalmente se pone de manifiesto con estos modelos es la importancia que adquiere el concepto “cooperación”, lo cual es perfectamente aplicable al funcionamiento de los mercados en general y de los nuevos mercados TIC en particular: aunque lo natural sería buscar las formas de imponerme a mi competidor, aunque mi competidor tenga ganas de hacerme lo mismo, con determinadas condiciones y sin ninguna comunicación entre ambos, ni intención a veces de llegar a ninguna negociación, puede surgir un comportamiento que haga innecesaria la intervención de un regulador.

Para introducirnos en el tema de la Teoría de Juegos, contamos en esta tercera sección de la Revista con el artículo de **Bernhard von Stengel**, profesor de la London School of Economics, en el que desarrolla precisamente varios ejemplos de la Teoría de Juegos aplicados a situaciones de los mercados de las tecnologías de la información y comunicación. Según el autor la Teoría de Juegos es una herramienta para modelizar y analizar decisiones interactivas que podrían ser aplicadas a situaciones con un número reducido de jugadores o a dinámicas de población con un gran número de jugadores similares.

Respecto a su aplicación en la toma de decisiones en el mundo de los negocios, prosigue el autor, la Teoría de Juegos favorece la posibilidad de considerar el punto de vista del oponente, en un análisis donde adquieren una importancia relevante tanto los incentivos individuales como la información disponible por los jugadores y las propias normas del juego. Las soluciones ofrecidas por esta Teoría, de forma particular el concepto central de equilibrio, no son únicas, lo cual abre una perspectiva importante de análisis que debe ser tenida en cuenta, encontrando precisamente en Internet un rico dominio donde poder ser aplicada.

Si hacemos caso de la teoría económica tradicional, ésta predice que, en ausencia de competencia, un operador dominante nunca invertiría. Pero curiosamente en Europa, habiéndose creado un marco regulador para favorecer la competencia, se está dando el fenómeno contrario, los operadores dominantes y entrantes son reacios a invertir en fibra por sus negativas perspectivas de rentabilidad. Por tanto, ¿qué incentivo puede tener el operador regulado para renovar sus infraestructuras por redes de nueva generación? ¿Realmente los operadores que basan su despliegue en el alquiler del bucle cuentan con algún tipo de incentivo competitivo para construir su propia red?

Utilizando el pensamiento de Schumpeter, quizás sea conveniente que en los momentos iniciales el operador inversor pueda contar con la ventaja de ser el primero en llegar a un mercado, lo cual servirá de incentivo para que los demás también asuman sus propios riesgos.

En este sentido, **Sumit Sharma, Nigel Attenborough** y **Maria Maher**, de NERA Economic Consulting, nos explican qué circunstancias tendrían que tener presentes los reguladores ante una posible regulación de las redes de acceso de nueva generación en Europa, abogando por la adopción de un enfoque que considere la creciente competencia efectiva de las redes de cable DOCSIS 3.0 y las redes móviles LTE, así como las diferencias entre las redes de acceso de cobre existentes y las de próxima generación basadas en fibra óptica, lo que implicaría una modificación de la definición utilizada hasta ahora para los mercados de banda ancha y la determinación de operadores con poder de mercado. En su opinión cualquier intervención reguladora sobre las redes NGA, si fuese necesaria, debería ser ex post, basada en la normativa de competencia, con un enfoque tecnológicamente neutral, y evitando imponer controles de precios mayoristas sobre los productos NGA o determinadas arquitecturas de despliegue.

En cualquier caso la libertad de precios debería ser garantizada, prosiguen los autores, como única forma de mitigar la importante incertidumbre asociada al despliegue de estas redes, pudiéndose compartir el riesgo con los operadores que demanden accesos mayoristas, porque intentar mitigarlo mediante el reconocimiento de una prima de riesgo probablemente conducirá a errores de evaluación, dada la dificultad que tiene medir la incertidumbre.

Por tanto podríamos concluir que allí donde es posible que los agentes lleguen a acuerdos pro-competitivos, quizás lo prudente sería que el regulador se abstuviera de regularlos o, en caso de intervenir, hacerlo afectando lo mínimo posible el propio juego competitivo, preocupándose más bien de crear las condiciones adecuadas para reconducir el modelo a un equilibrio socialmente más óptimo a través de los incentivos regulatorios adecuados.

De hecho la Regulación por Incentivos no es un concepto nuevo, aunque su aplicación práctica no ha sido muy extensa. El origen de un comportamiento no pro-competitivo suele estar en la falta de información, pero se da la circunstancia de que los reguladores se enfrentan precisamente a un contexto de información imperfecta: no conocen las funciones de utilidad o de coste de oportunidad de productores y consumidores, y por tanto difícilmente pueden fijar las condiciones económicas de las transacciones.

Sin embargo, los reguladores sí pueden crear mecanismos que atemperen los problemas que plantea la información imperfecta, tal y como resaltaron Laffont y Tirole, por ejemplo haciendo al operador partícipe de las ganancias de eficiencia que obtenga.

Por su parte Donald Campbell afirmaba que la regulación por incentivos consistiría precisamente en crear mecanismos que permitiesen lograr mayor información y transparencia al mercado, de tal forma que redundase en una disminución del coste de la regulación y conseguir, por tanto, más eficiencia en las medidas tomadas.

Precisamente el primero de los dos artículos presentados por el Gabinete de Estudios de Economía de la Regulación de Telefónica España, firmado por **Germán González Rodríguez** y **Juan C. Huertas Sánchez**, incorpora una reflexión al tema de la regulación por incentivos. En opinión de los autores, la teoría de juegos puede servir como marco teórico para entender la pugna que surge entre competidores y explicar los desenlaces de este tipo de juegos estratégicos. A su vez, la teoría de mecanismos permite conocer cómo las reglas del juego influyen en los resultados y puede servir para "reorientar" el juego para conseguir que los intereses de las partes conduzcan a un objetivo global más óptimo.

A su vez, la aplicación de la teoría de mecanismos, según los autores, sugiere un nuevo estilo de regulación basado en el diseño de incentivos, con el que se lograría impulsar la inversión. Así, nos proponen un ejemplo de aplicación a la posible regulación de las redes de nueva generación, simulando el comportamiento de los agentes y analizando sus posibles estrategias dominantes antes las opciones de invertir o alquilar las nuevas redes de acceso, ejercicio que permite identificar las situaciones de equilibrio de Nash que correspondería a los desenlaces más probables del juego.

Con este tipo de mecanismos el Regulador estaría en mejor disposición de diseñar los incentivos más adecuados para reorientar el equilibrio del mercado en función de los objetivos sociales más deseables, pero evitando distorsionar la fijación de los precios, dejando que el propio mercado actúe como mecanismo para revelar la información relevante en la toma de decisiones de los agentes, logrando, al mismo tiempo, preservar el incentivo a invertir.

El segundo artículo del GEER que cierra el presente número de la revista, escrito por **Javier Domínguez Lacasa**, desarrolla precisamente una aplicación de la teoría de juegos al análisis de los mercados mayoristas de roaming internacional, que cuentan con una fuerte regulación en Europa. El roaming internacional es modelado como un juego en el que los operadores en cada país compiten por llegar a acuerdos con el socio extranjero más rentable. El resultado del juego, nos cuenta el autor, es que el operador con mayor base de clientes finales viajando fuera de su país está en mejor posición negociadora y puede utilizarla para fijar precios supracompetitivos cuando las técnicas de direccionamiento del tráfico utilizadas por los operadores no son perfectas.

Los Reguladores han intentado resolver este problema estableciendo un “cap mayorista” a los servicios de roaming, pero si éste se fija en un nivel demasiado bajo se produce un desincentivo a las inversiones dirigidas precisamente a mejorar las técnicas de direccionamiento del tráfico, provocando finalmente que la regulación sea inevitable y se convierta en una profecía autocumplida. Una mejor alternativa, argumenta el autor, sería facilitar la adopción de las técnicas de direccionamiento, con lo que se conseguiría reducir los precios modificando el poder de negociación de los diferentes operadores, sin alterar el mecanismo de fijación de precios del propio mercado ni los incentivos de los operadores.

Introduction

We have seen in previous sections that ICT markets are by nature multisided, which roughly speaking means that the two sides that make use of a platform can't by themselves extract its full value, because there are externalities that are most efficiently accounted for through the pricing decisions of the platform owner.

The economic analysis of multisided markets has up to now been mostly static, in the sense that the services offered through the platform are taken as given: platforms exist as a means of getting different parties together, but in the economic models there is no role for the platform owner besides setting a price for their intermediation services, and internalize the externalities. However, it is obvious that platforms are much more than that, because their design has a direct impact on the services being offered.

To take a simple example, the AppStore of Apple is not only a meeting point for users and developers where Apple decides how to charge both sides. Perhaps more importantly, Apple also decides the operating system and the technical features of the i-phones and i-pads, which in turn determine to a large extent the type of applications that developers can create and users can enjoy, and the value that they can extract from their interaction.

The function of the platform owner as a designer has been largely overlooked by the literature, but it is very relevant, and regulatory economics should not limit its scope to the costs and prices charged by the platform. Instead, more attention should be paid to the circumstances that make it possible that platform owners can collaborate with certain sides of the market, generally content providers, in the search for a common goal that also benefits the other users of the platform.

To the extent that those agreements are at the heart of innovation, the appearance of new products and the generation of well-being to consumers, we can agree that the focus of regulators should be directed to understand the functioning of the mechanisms that incentivize or prevent them.

The objective of ICT regulators should be to ensure that valuable services for end users develop, and any remedy or intervention would have to be analyzed under this perspective. When establishing obligations for wholesale access to the networks and non-discrimination, for example, it is not enough to assume that as a result of a low regulated wholesale price end users will have access to cheaper services. It is necessary to take into account how the multiple sides of the market are affected, to know what happens to network quality and indirectly to the incentives to generate content and applications.

The economic modeling of cooperative agreements has developed mainly through the field known as Game Theory. These models generally assume a finite number of agents interacting, who can act cooperatively or not. Perhaps one of the main advantages of this analysisis that it provides a dynamic component that is lacking in the neo-classical models. Under this new perspective, it is possible that an intervention by the regulator can cause an increase in social welfare in the short term, but we are forced to also consider the impact in the medium and long term on the added value of the market, trough the impact on the incentives to invest and innovate.

What finally becomes clear with these models is the importance of the concept "cooperation", which is perfectly applicable to the functioning of markets in general and the new ICT markets in particular. Although there is a tendency to assimilate cooperation and collusion, the truth is that negotiations along the value chain are an integral part of the innovation process. Creating value generally involves more than one player, and deciding how to share investment costs and divide the benefits is not as straight forward as many regulatory models assume. Indeed, through a cooperative process a behavior can arise that actually makes unnecessary the intervention of a regulator, and vice-versa, a certain policy can be counterproductive once its impact on cooperation is taken into account.

To bring us into the topic of game theory, we open this third section of the Review with a collaboration from **Bernhard von Stengel**, Professor at the London School of Economics, in which he develops several examples of game theory applied to real examples taken from different ICT markets. According to the author, game theory is a tool to model and analyze interactive decisions that could be applied to situations with a small number of players or with a large number of similar players.

With regard to their application in decision-making in the business world, continues the author, game theory facilitates the possibility of considering the point of view of the opponent, in a context where individual incentives, the information available to the players and the game's rules are the most important modeling decisions. The solutions offered by the theory are not unique, and should be analyzed on a case by case basis, finding a rich testing ground in the internet economy.

The traditional economic theory predicts that, in the absence of competition, a dominant operator would have fewer investment incentives. But curiously in Europe, where the Regulator has created a framework to promote competition, incumbents and entrants are both reluctant to invest in fiber for its negative profitability prospects. Therefore, it is appropriate to ask ourselves what incentives regulated operatorshave to renew its infrastructure for new generation networks. The second question would be whether operators which based its deployment on the rental of the loop have some sort of competitive incentive to build their own network.

Following Schumpeter, an exit of the vicious circle would be to let the investing operator profit from the advantage of being the first to arrive at a market, which will serve as an incentive to ensure that others also take their own risks.

In this sense, **Sumit Sharma, Nigel Attenborough** and **Maria Maher**, from NERA Economic Consulting, describe the circumstances that regulators would have to bear in mind before a possible regulation of next generation access networks in Europe, advocating for the adoption of an approach that considers the increased effective competition of DOCSIS 3.0 cable networks and LTE mobile networks as well as the differences between access networks of existing copper and optical fiber-based next-generation, which would imply a modification of the definition used so far for the determination of operators with market power and broadband markets. In their view any regulatory intervention on NGA networks, if needed, should be ex post, based on the rules of competition, with a technologically neutral approach, and avoiding imposing price controls wholesale NGA products or selective deployment architectures.

In any case pricing freedom should be guaranteed, continue to the authors, as the only way to mitigate the significant uncertainty associated with the deployment of these networks, opening the door to voluntary risk sharing between those who demand wholesale access and those who offer it. This is preferable to trying to give incentives through the recognition of a risk premium that probably will lead to errors of assessment, given the difficulty inherent in measuring the uncertainty.

The current regulatory model for telecommunications in Europe has been founded on the belief that regulators are in a position to calculate the efficient prices through the use of cost models. This approach has worked fairly well as a redistributive tool, to transfer income from incumbent operators to end users and entrants. However, the fact that Europe is lagging behind other regions in NGA coverage shows that investment has been negatively affected, and regulators should find ways to incentivize it.

Incentive Regulation is not a new concept, although its practical application has not been extensive. It originated as a normative theory that tried to solve a problem of asymmetric information: regulators do not know the functions of utility and costs of producers and consumers, and therefore they can't determine the efficient prices, nor can they impose investment decisions.

However, regulators can create mechanisms which mitigate this problema, for example by letting the regulated operator keep at least part of the efficiency gains obtained by a particular investment decision, as suggested by Laffont and Tirole in the early nineties.

The first of the two articles included in the Review from the Research Unit of Regulatory Economics of Studies (GEER) of Telefónica España, written by **Germán González Rodríguez** and **Juan C. Huertas Sánchez**, is precisely a reflection on the subject of regulation by incentives. In the opinion of the authors, the theory of games can serve as a theoretical framework for understanding the struggle arising between competitors and explain the outcomes of this type of strategic games. Regulators should use it more extensively, to anticipate how the rules of the game set by the Regulator can influence the results. Mechanism Theory is an extension of game theory that describes how the rules can be modified to "reorient" the game and ensure that the interests of the parties will lead to a more optimal overall objective, without necessarily having to set the exact terms of the transactions.

The theory of mechanisms, according to the authors, suggests that a new style of regulation, based on the design of incentives, is possible and the best way forward for the sector in Europe.

They propose as an example the possible regulation of new generation networks, modeling the behavior of an incumbent and an entrant and its possible dominant strategies when the options for the entrant are to invest in new infrastructure or hire the access networks of the incumbent. The authors identify the Nash equilibriums that would correspond to the most likely outcomes of the game, concluding that voluntary agreements for wholesale access are very likely in the absence of a regulated obligation.

The lesson that the authors draw from the literature is that by focusing on incentives rather than actual or theoretical costs the regulator would be better able to design the most appropriate policies. The regulator should refrain from trying to impose the exact terms of wholesale transactions, and aim instead at rebalancing the bargaining power of the players on the basis of the most desirable social objectives, leaving the market itself disclose the relevant information.

The Review closes with another contribution from the GEER, written by **Javier Domínguez Lacasa**. His article is an application of game theory to the analysis of the wholesale international roaming market, which is heavily regulated in Europe. International Roaming is modeled as a game in which operators in each country compete for the most profitable foreign partner. The result of the game is that the operators with a large customer base of end users travelling abroad are in a better bargaining position and can use it to charge supracompetitive prices when traffic steering techniques are not perfect.

Regulators have tried to solve this problem setting a regulated wholesale cap, which if it is set too low discourages investments on traffic steering and makes regulation inevitable. A better alternative, the author argues, would be to facilitate the adoption of traffic steering techniques. This approach would reduce prices by modifying the bargaining power of the different operators, without any need for calculating and enforcing access prices.

An Application of Game Theory to Electronic Communications Markets

Bernhard von Stengel
London School of Economics

Resumen

Este artículo ofrece una introducción a la teoría de juegos no cooperativos. Las ideas principales se ilustran mediante ejemplos, a menudo referidos a aspectos económicos y empresariales del sector de las telecomunicaciones y de las tecnologías de la información. La teoría de juegos nos brinda diversas reflexiones. El comportamiento basado en intereses particulares puede conducir a resultados peores para todos, si el comportamiento cooperativo global no es estable respecto a cambios individuales de estrategia. Dicha idea de estabilidad queda recogida en el concepto de "equilibrio" del juego. El diagrama de árbol de un juego sirve para representar la interacción dinámica entre los jugadores, tal y como se muestra en el ejemplo sobre entrada en un mercado y disuasión a hacerlo. Un juego puede tener más de un equilibrio, lo que es importante tener en cuenta si se quiere predecir el resultado de una interacción. En el "juego de elección de ancho de banda" se pone en evidencia cómo el que una tecnología represente una solución de equilibrio depende del número de usuarios que ya la hayan adoptado. Las reglas concretas del juego importan, como puede verse en el "juego de la calidad", donde se trata el concepto de compromiso vinculante. Los jugadores pueden disponer de diferente información sobre el escenario en que se desarrolla el juego, y puede resultarles óptimo ocultar dicha información actuando voluntariamente de manera aleatoria. En lo que respecta al enrutamiento del tráfico de una red, los comportamientos basados en intereses particulares promueven la congestión de la misma, efecto que paradójicamente puede agravarse si se incrementa su capacidad. Todos estos ejemplos e ideas sirven para demostrar la versatilidad de la teoría de juegos a la hora de analizar la dinámica de los mercados y la forma en que interactúan sus participantes.

Abstract

This article gives an introductory survey of non-cooperative game theory. Its central concepts are illustrated by means of examples, often with reference to economic and business situations in information and communication technology. Game theory provides a number of insights. Selfish behavior may lead to inferior outcomes for all players, because a more cooperative solution is not stable with respect to individual changes in behavior. The concept of equilibrium captures this stability. Game trees represent dynamic interactions, as illustrated with an example of market entry and entry deterrence. A game may have more than one equilibrium, which is important to note when predicting the outcome of an interaction. Different technologies may be adapted as equilibrium solutions due to the number of users already using a technology, as shown with the "bandwidth choice game". The rules of the game matter, for example when introducing commitment power in the "quality game". Players may have different information about scenarios, and it may be optimal to hide that information from an opponent by actively randomizing one's actions. In network routing, selfish behavior may lead to congestion, which can even become worse when increasing network capacity. These concepts and examples show the versatility of game theory for analyzing the dynamics of markets and the interactions of cooperating and competing participants.

1. What is game theory?

Game theory provides mathematical tools for modeling and analyzing interactive decisions. It considers *players* that represent decision-making firms or persons, and their possible actions, and models their incentives by payoffs that the players want to maximize. If needed, possible scenarios can be represented as "states of nature". The players may have different information about that state and about the actions taken by the other players.

A game defines how the interaction results in payoffs. The game can have various levels of abstraction. Game trees and other dynamic games show sequential moves of players. The strategic form is a table where players' strategies are simply listed and not detailed as in the dynamic setting. At the most abstract level, cooperative games show only the outcomes that coalitions of many players can achieve, without detailing how these coalitions are formed.

We will describe how some economic situations are analyzed by games in strategic form and by game trees. These are the basic tools of non-cooperative game theory, which has become the language of modern economic theory. Its basic tenet is that players will cooperate (if they do) out of self-interest, and that their incentives to do so have to be explicitly described.

Given a game in some description, the game-theoretic analysis proposes a solution that suggests how players should behave, in their own interest. Such solutions may be compelling to varying degrees. Sometimes a player's action may be dominant in the sense that it gives her a best possible payoff irrespective of what the other players do. However, as the famous Prisoner's Dilemma demonstrates, even a dominant solution may be worse than a more cooperative but unstable outcome.

Not all games admit a dominant solution. A solution that always exists is an equilibrium (where we here mean Nash equilibrium), which recommends a plan of action to every player that is optimal if all other players follow their recommendations. Unfortunately, there may be more than one equilibrium, which reduces the use of this concept as a recommendation.

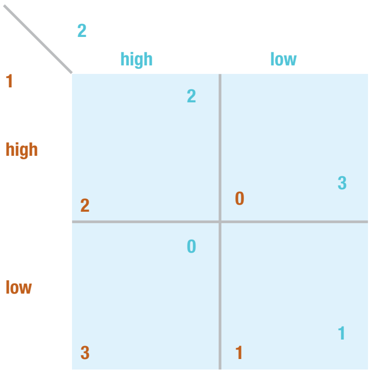
However, inferior dominant solutions that result from selfish behavior, or equilibrium predictions that are not unique, are one of the insights provided by game theory, which we will elucidate in the following sections.

2. Explaining selfish behavior

Figure 1 shows a table that represents a two-player price-setting "duopoly" game in strategic form. Two firms can sell their competing products at a **high** or **low** price. Firm 1 (in red) chooses a row and, at the same time, firm 2 (in blue) chooses a column of the table as an action. The resulting cell gives two payoffs in the respective colors to the two players. The payoffs are staggered (in each cell, in the lower left corner for firm 1, in the upper right corner for firm 2) so that each player's payoff matrix (red or blue) is more easily seen when looking at the entire table.

The best possible pair of actions to the two firms seems clearly that both charge a **high** price. However, if firm 2 charges a high price,

Figure 1:
Strategic-form price-setting game with dominant solution (low, low)



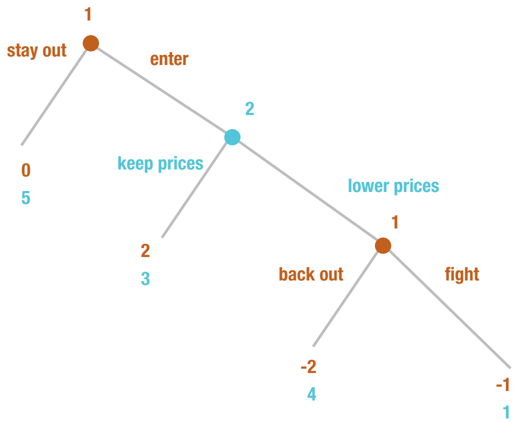
then firm 1 can increase her payoff from 2 to 3 by playing **low** rather than **high**, and if firm 2 charges a low price, then firm 1 can increase in the same way her payoff from 0 to 1. Hence, **low** is a dominant action for firm 1 because it gives her a higher payoff for each possible action of firm 2. The same applies when the roles of the players are exchanged because the game is symmetric. So both players choose **low**, and get payoff 1 each. This is smaller than the payoff 2 they would get if both chose **high**, but that pair of actions is not "stable".

The game in Figure 1 is the well-known "Prisoner's Dilemma" game (whose name derives from a different story, see, for example, Osborne 2004). In the context of a duopoly, the pair of dominant actions that hurts the players has the positive side effect of low prices for the firms' customers. In other situations where this type of game applies, the resulting selfish behavior may hurt all, typically in problems of "free-riding" or the "tragedy of the commons" such as fish stocks that are depleted by overfishing – which may be individually rational. The game-theoretic analysis explains this behavior, and illustrates the necessity of regulations that enforce the "cooperative" outcome.

3. Thinking strategically

Our next example illustrates the use of game trees. It shows how game theory might have helped the printer company Epson when it entered the market for laser printers (the example is inspired by Dixit and Nalebuff, 1991; the actual game we consider is different). In the 1980s, the market for office laser printers was dominated by Hewlett-Packard (HP) who sold them with a high profit margin. Epson was the market leader for the cheaper and lower-quality dot-matrix printers. Epson decided to develop a laser printer, assuming it could enter that market profitably. However, Epson did apparently not take into account that HP was another player who would react. HP lowered its prices and a price war resulted. After that, apart from lower profits and lower market share for Epson than expected, laser printers had become so cheap that much fewer people now bought dot-matrix printers – in effect, Epson had destroyed its own market.

Figure 2:
Game tree modeling entry of player 1 into a market with incumbent player 2



The game tree in Figure 2 reflects one possible view of the game between player 1 (Epson) as market entrant and player 2 (HP) as incumbent. In a game tree, play progresses sequentially by players making *moves* at *decision nodes*, until a terminal node is reached where each player receives a *payoff*. Here the game starts at the first node (at the top, the tree grows downwards) with a move of player 1. Player 1's first move is either to **stay out** of the market, or to **enter** it. If player 1 stays out, play ends with payoff 0 to player 1 and payoff 5 to player 2 (in some units, for example profits in ten million dollars). If player 1 chooses to **enter** the market, then player 2 may react by choosing to **keep prices** or to **lower prices**. After keeping prices, the game ends with payoff 2 to player 1 and payoff 3 to player 2. If player 2 chooses to lower prices, player 1 has another move and may decide to **back out** from the market, getting negative payoff -2 and player 2 a payoff of 4 (although player 2 has regained the market, profits are now lower). Player 1 may also decide to **fight** a price war, resulting into payoff -1 for player 1 and payoff 1 for player 2.

One way to analyze a game tree like in Figure 2 is by a *roll-back analysis* (also called “backward induction”), which essentially means thinking ahead about what players will do. In that analysis, the most advanced move one has to consider is when player 1 has to choose between **back out** and **fight**, where she will prefer **fight** because the resulting payoff -1 is less negative than -2. Anticipating that move, player 2 would get payoff 1 when choosing to **lower prices**, versus getting payoff 3 when keeping prices, so his best action is to **keep prices**. In turn, the best move at the beginning for player 1 is then to **enter** the market because she will get 2 rather than 0 when staying out.

If players play according to the roll-back analysis, then player 1 will enter the market and player 2 will keep prices and the game terminates with payoffs 2 and 3 for the two players. However, the result of the roll-back analysis is more than just a prediction of the path that a play of the game will take, because it also gives a strategy for each player. The term “strategy” for a game tree has a precise technical meaning, which agrees with the intuitive understanding of “being prepared for every eventuality”. In a game tree, a strategy is a complete plan of action that specifies a move for every decision node that a player can reach. Here player 2 has only one decision node, so his strategies are just his two moves, **keep prices** and **lower prices**. Player 1 has two decision nodes, and the result from the roll-back analysis is his move combination enter-fight, that is, to enter the market and then, also, to be prepared to fight a price war in case player 2 decides to lower prices.

The roll-back analysis specifies a strategy to each player. It can be shown that these strategies always define an *equilibrium*, which means that each player’s strategy is optimal for that player, given that the other player or players adhere to their strategies. Why is the strategy pair (**enter-fight**, **keep prices**) an equilibrium in the game tree in Figure 2. For player 1, **enter-fight** is optimal because her payoff of 2, given that player 2 keeps prices, can only change to 0 with **stay out**, or stays the same when changing to the strategy **enter-back out**, so player 1 cannot improve her payoff. For player 2, given that player 1 chose **enter-fight**, his strategy **keep prices** gives him payoff 3 whereas changing to **lower prices** would give him a payoff of 1 which is worse. Note that the anticipated move of player 1 to **fight** will not take effect, but is needed to assert that player 2 plays optimally. This is why strategies, that is, complete plans of moves are needed to specify an equilibrium, not just those moves that lead to a particular terminal node of the game tree.

When Epson entered the market for laser printers, the above prediction of the roll-back analysis that HP would keep its prices did not happen, but instead the players wound up at the strategy pair (**enter-fight**, **lower prices**) with payoff -1 for player 1 and payoff 1 for player 2. What went wrong? Did Epson not think strategically at all (assuming that HP would just keep its prices), or miscalculate the best response of HP, and was HP responding irrationally? We will show that our game-theoretic model, assuming it is correct, gives one possible explanation because the game has *another equilibrium* which is not predicted by the roll-back analysis.

1 \ 2	keep prices	lower prices
stay out	0, 5	0, 5
enter-back out	2, 3	-2, 4
enter-fight	2, 3	-1, 1

Figure 3:
Strategic form of the market-entry game tree in Figure 2. For player

In order to identify all equilibria of a game tree, it is converted to strategic form. The strategic form tabulates the players’ strategies and the resulting payoffs when these strategies meet. Figure 3 shows the strategic form for the game tree in Figure 2. There are six cells in that table, some of which list the same payoff pair because the game tree has only four terminal nodes. The first row is the strategy **stay out** of player 1 (in fact, there is no need to combine that move of player 1 with the later moves **back out** or **fight** because player 1 will not reach that stage due to her own first move **stay out**, so this suffices as a plan of action). Both cells in that row give the payoffs that result after stay out, namely 0 and 5 to the two players; note that the columns **keep prices** and **lower prices** do not have an effect in that first row. The second and third row are the two strategies **enter-back** out and **enter-fight**, and both cells in the left column (**keep prices**) have the same payoffs 2 and 3 to the two players. The remaining two cells in the right column (**lower prices**) give the payoffs from the last two nodes in the game tree.

Given the strategic form, an equilibrium is easily found by finding for each row and column the other player's optimal strategy (or best response) and checking the cells where these best responses coincide. In addition to the cell (**enter-fight**, **keep prices**) found by the roll-back analysis, there is another such cell: (**stay out**, **lower prices**). The reason is that **lower prices** is a best response to **stay out** (player 2 is no worse off than when choosing to **keep prices**), and conversely player 1 gets the best possible payoff (0, rather than -1 or -2) by choosing to **stay out**.

This second equilibrium (**stay out**, **lower prices**) is known as *entry deterrence* in the "Chain Store paradox" (Selten, 1978). Player 2 threatens a move that is self-hurting if it where to implemented, because player 2 would be better off to keep rather than lower prices if player 1 entered the market. However, given the threat that player 2 executes his move to lower prices, player 1 will not enter the market, and so the threat does not result in a lower payoff and is therefore a best response.

The game in Figures 2 and 3 has more than one equilibrium, and if the players do not have the same view on which equilibrium should be played, their strategies might fail to match, as when player 1 chooses **enter-fight** and player 2 chooses to **lower prices**. This is one possible view of why Epson and HP did not play equilibrium. In practice, the game tree is of course very simplified. Even if Epson and HP planned their moves that way, HP might have had a different view on Epson's cost for fighting a price war, for example a more negative payoff (like -3) after **fight** and thus expected that Epson would choose to **back out**. In order to be successful, a game-theoretic analysis in management consulting must be sufficiently flexible and robust, by testing various scenarios, rather than considering a single detailed model (Lindstädt and Müller, 2010).

4. Equilibrium selection by evolution

We give another example of a game (from Turocy and von Stengel, 2002) that has two equilibria, and where either equilibrium may be selected via a dynamical process according to an evolutionary interpretation (Maynard Smith, 1982; Sandholm, 2010).

Figure 4:
Bandwidth choice game with two equilibria, (high, high) and (low, low)

1 \ 2	high	low
high	5, 5	0, 1
low	1, 0	1, 1

Two firms want to invest in communication infrastructure. They intend to communicate frequently with each other using that infrastructure, but they decide independently on what to buy. Each firm can decide between **high** or **low** bandwidth equipment. A low bandwidth connection works equally well (payoff 1) regardless of whether the other side has **high** or **low** bandwidth. However, changing from low to high is preferable only if the other side has high bandwidth (payoff 5), otherwise it incurs unnecessary cost (payoff 0).

The game is shown in Figure 4 and has the two equilibria (**high**, **high**) and (**low**, **low**). The strategy **low** has the better *worst-case* payoff, as considered for all possible strategies of the other player, no matter if these strategies are best responses or not. The strategy **low** is therefore also called a *max-min strategy*. In a sense, investing only in low bandwidth equipment is a safe choice. Moreover, this strategy is part of an equilibrium, and entirely justified if the player expects the other player to do the same.

The bandwidth choice game in Figure 4 can be given a different interpretation where it applies to a large population of individuals, each of which can adopt one of the two strategies. The game describes the payoffs that result when two of these individuals meet randomly. The dynamics of this game depends on the fraction of individuals adopting the respective strategies. Given this distribution of strategies, individuals with better average payoff will be more successful than others, so that their proportion in the population increases over time. In this game, if more than 1/5 of all individuals play the strategy **high**, then **high** will get an average payoff of more than 1 and be more successful than **low**, so that the fraction of individuals that play **high** increases and eventually the equilibrium (**high**, **high**) will result where everyone plays **high**. If the fraction for **high** is less than 1/5, then **low** will become ever more successful and eventually everyone will play **low**. This typical network effect shows how starting conditions can influence whether a desirable or undesirable equilibrium gets established.

Evolutionary games, not discussed here, can also demonstrate that an initially small fraction of players adopting a superior strategy can rapidly invade an existing population. A modern book on evolutionary game theory is Sandholm (2010).

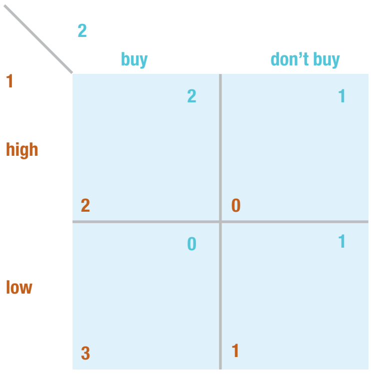


Figure 5:
The quality game

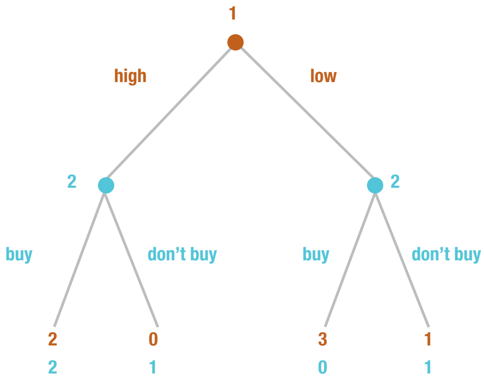


Figure 6:
Changed quality game where player 1 can commit to his strategy

5. Rules of the game and commitment power

The rules of the game matter, as changing the rules for the quality game in Figure 5 will demonstrate. The two non-symmetric players are a service provider (player 1) and potential customer (player 2). The provider can decide between two levels of quality of service, high or low. High-quality service is more costly to provide, and some of the cost is independent of whether the contract is signed or not. The level of service cannot be put verifiably into the contract. High-quality service is more valuable than low-quality service to the customer, in fact so much so that the customer would prefer not to buy the service if she knew that the quality was low. Her choices are: buy or don't buy the service.

This game can be solved by *iterated dominance*, not unlike the price-setting game in Figure 1. For each choice of player 2, player 1 prefers low to **high**, so **low** is his dominant strategy, and **high** is never played in an equilibrium. Given that player 2 knows this, she will only react to **low** and choose **don't buy** as her best response. The resulting payoff 1 for each player is worse than payoff 2 for the strategy pair (**high**, **buy**), which is, however, not stable.

Suppose this game can be changed so that player 1 moves first and can credibly commit to providing **high** (or **low**) quality service. Then player 2 can react and choose a different move in response, as displayed in the game tree in Figure 6. Roll-back analysis then shows that player 2 will **buy** after player 1 chooses **high** (with payoff 2 to both players), and **don't buy** after player 1 chooses **low** (with payoff 1 to both players), so player 1 chooses **high** at the first stage – which is the desired outcome.

Here, the game has been changed by *introducing commitment power* for player 1. This change is beneficial for both players. This is not so in bargaining, where a player who can make a "take it or leave it" offer has all the power, as described in the "ultimatum game" (see, for example, Osborne, 2004). More refined models of bargaining (Rubinstein, 1982; Binmore, Rubinstein, and Wolinsky, 1986) describe rounds of alternating offers. Roll-back analysis for this model shows that a player who is more patient (in the sense of paying a lower "interest rate" for waiting) has greater *bargaining power* in the sense of getting a larger share of the object under negotiation.

Because the rules of the game matter so much for what can be achieved, a game-theoretic analysis often shows the value of changing the game. Brandenburger and Nalebuff (1996) have coined the term co-opetition to achieve an improvement for all players in business settings, with the help of game theory.

The spectacular success of game theory in defining the rules of the game has been demonstrated in *auction design* (Milgrom, 2004). In Britain, the 2000 sale of 3G spectrum licenses raised billions of pounds (about 2.5 percent of GDP). The auction was designed by game theorists, who also found it crucial to test their behavioral predictions by *laboratory experiments* (Binmore and Klemperer, 2002).

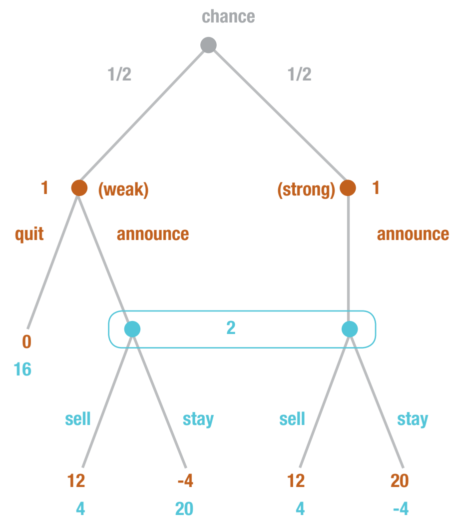


Figure 7: *Imperfect-information game between a market leader (player 1) and startup company (player 2)*

6. Getting and hiding information

Game theory also provides tools to describe and analyze different *information* that players have, which often determines their behavior. In settings without perfect information, especially when there are conflicting incentives, optimal play may prescribe some unpredictability in order to leave the opponent in the dark. This is known as a *mixed strategy* where a player chooses his action *randomly*.

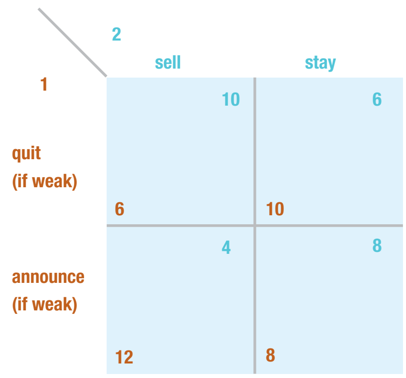


Figure 8: *Strategic form of the game in Figure 7. Equilibrium requires randomized strategies*

In Figure 7, different scenarios are represented by a *chance move* at the first stage. A small technology startup company (player 2) has just developed a new product. The market leader (player 1) is also known to have worked on such a product, but it is only known to him if the product can be credibly announced as coming to the market soon (in which player 1 is in a **strong** position), or not (player 1 being **weak**). To the outsider, these two scenarios where player 1 is either weak or strong have equal probability 1/2. When player is in a weak position, he can decide to quit the competition, with payoff 0 to him and payoff 16 to player 2. He can also decide to "bluff" and *announce* that he has a competing product that is coming to market soon, which he would do anyhow if he has such a product and is therefore in a strong position.

Player 2 does not know whether player 1 is weak or strong after getting the announcement. In Figure 7, the two decision nodes of player 2 are in an information set, indicated by the oval around the two nodes, which means that player 2 knows he is in one of the two nodes but not which one, and has to make the same move in both situations. The startup can either sell to the big company, who will then take over the product, or stay, in the hope that player 1 is in fact weak. The two moves sell and stay have different payoffs to player 2 (and opposite payoffs to player 1) depending on whether player 1 is strong or weak.

The strategic form of this game is shown in Figure 8. The numbers in the cells are expected payoffs calculated from the chance probabilities and the terminal payoffs resulting from the two strategies for that cell. For example, the combination of **quit** and **sell** gives payoff $1/2\times\mathbf{0} + 1/2\times\mathbf{12} = \mathbf{6}$ for player 1, and $1/2\times\mathbf{16} + 1/2\times\mathbf{4} = \mathbf{10}$ for player 2.

Interestingly, no cell in this game is an equilibrium, because the best responses are circular. If player 1 chooses **quit**, then player 2 knows that an announcement comes only from player 1 in strong position and prefers to **sell**. Against **sell**, the best response for player 1 is to **announce** even in the weak position. If player 1 does that, however, then player 2 knows that player is bluffing half of the time, where on average it is better to **stay**, but then player 1 would prefer to **quit** in response.

Optimal play in this game is the following randomized behavior of the players (for details see Turocy and von Stengel, 2002). Player 1 chooses **quit** and **announce** exactly half of the time, so that player 1 will get expected payoff 7 for either **sell** or **stay**. Because player 2 is now indifferent between his two actions, he can also randomize as a best response, and will choose **sell** with probability 1/4 and **stay** with probability 3/4. Only then player 1 will get 9 for either **quit** or **announce**, so that his randomization is also a best response.

In summary, conflicting moves with lack of information may require randomized actions. These randomized actions preserve the lack of information which is necessary for randomization to be optimal, and thus for obtaining an equilibrium. The probabilities used in randomized actions can sometimes also be seen as fractions of a large population adopting the chosen actions, as already discussed for the bandwidth choice game in Figure 4.

7. Selfish routing in networks

Network routing games are another class of games with a large number of individuals, and where one studies which fractions of these individuals are choosing particular actions. The actions are here routes in a transport or communication network. With the decentralized nature of the internet and its protocols, packet routing can indeed be considered as a such game (Akella et al., 2002).

The network is specified by points and links connecting them, a certain amount of flow that has to be routed between given source and destination points, and delay functions that describe the delay for each link depending on how much flow is routed through that link. Individuals always seek the route with shortest delay until they cannot do better and an equilibrium results (Wardrop 1952). In the internet, routing algorithms also choose or predict the best route without central coordination.

A game-theoretic analysis shows that the equilibrium flow resulting from this "selfish routing" (roughly corresponding to "best effort" in internet parlance) is typically worse than optimal flow if network traffic was centrally managed. The simplest example, due to the economist Pigou, is shown in Figure 9. Points A and B are connected by two links, and a flow of 1 is to be routed from A to B. If the top link (in red)

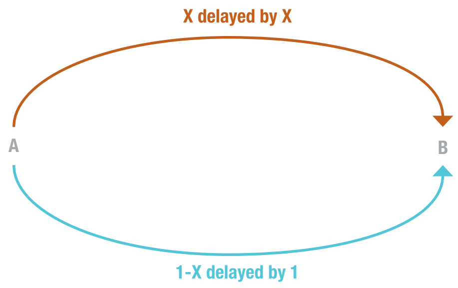


Figure 9:
Pigou's network routing game with two links and flow 1 to be routed from A to B

takes flow x, then users of that link experience delay x. The remaining flow 1-x through the bottom link (in blue) has constant delay 1 independent of the flow. Optimal flow, which has the smallest average delay, results for x = 1/2 were users of the top link have delay 1/2, and those on the bottom link have delay 1, so that the average delay is 1/2×1/2 + 1/2×1 = 3/4. However, this flow is not in equilibrium: all users on the bottom link would switch to the top link which has less delay as long as x<1, so the unique equilibrium flow has x=1 with everyone experiencing delay 1, which is a third larger than 3/4. (Roughgarden and Tardos, 2002, have shown that this

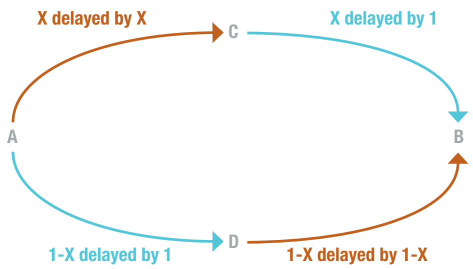


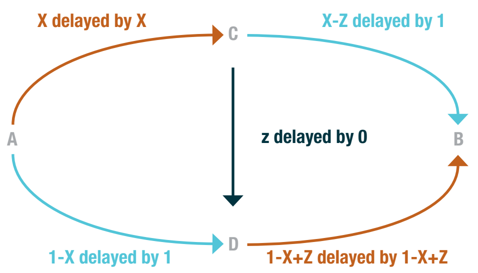
Figure 10:
Network with flow 1 to be routed from A to B where selfish routing is optimal

is the worst possible ratio between equilibrium and optimal flow in any network where delay functions are linear.)

Equilibrium flow due to selfish routing and optimal managed flow can be the same. Figure 10 shows a network with two routes from A to B, where the total flow 1 is split into x and 1-x. The top and bottom route have delays x+1 and 2-x. Equilibrium results when these are equal, for x=1/2, which is also the optimal flow.

Figure 11 shows the same network as Figure 10, except that its capacity is increased by introducing a zero-delay link (in blue) between C and D, which now takes flow z away from x at point C. In effect, these are now two Pigou networks as in Figure 9 put in sequence. The first Pigou-style network has two routes from A to D, the top route via C of delay x, and the bottom blue link of delay 1. A second Pigou network connects C to B via two routes, the top blue link from C to B of delay 1, and the bottom link from C via D to B where the only delay is along the red link whose delay is exactly the flow through that link. Now the only equilibrium flow is given by x=1 and z=1 where all individuals take the shortcut through the new blue link. As in Pigou's network, they fully congest the red links and do not use the green links any more. The average delay has increased from 1.5 to 2.

Figure 11:
The network from Figure 10 with an extra link of zero delay. Network capacity increases but delay of equilibrium flow worsens (Braess's paradox)



The comparison between the networks in Figures 10 and 11 is interesting because it shows that increasing network capacity can create worse congestion in a routing equilibrium, which is known as Braess's paradox (Braess 1969).

In traffic networks, it is usually assumed that there is a certain traffic to be routed, and network capacity should be found to meet that demand. Braess's paradox shows that increasing link capacity should not be done blindly but in concert with equilibrium considerations. In communication networks like the internet, new network capacity creates new demand which is often vastly larger than before. It is an interesting research question to analyze such an increase in demand, and possible effects on congestion, with the help of game theory.

8. Summary

Game theory is a tool for modeling and analyzing interactive decisions. It can be applied to situations with a small number of players, or to population dynamics with a large number of similar players. It is also very suitable to model competitive dynamics of markets. In business decisions, game theory enhances the ability to think ahead and to consider the perspective of one's opponent. A game-theoretic analysis demonstrates the importance of individual incentives, which can lead to unexpected global behavior, of the information that players have, and of the rules of the game. The solutions offered by game theory, in particular the central concept of equilibrium, are not always unique, and this can be an important insight of the analysis. The internet with its selfish users and ever-growing economic importance is a particular rich domain for game-theoretic studies.

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Regulating Next Generation Access Networks in Europe

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Resumen

Los operadores que invierten en redes NGA se enfrentan a grandes inversiones hundidas, a la importante incertidumbre de demanda, al cambio de la dinámica competitiva y al hecho de que las NGA son una tecnología en evolución. Esto hace que sea especialmente importante adoptar un correcto enfoque en su regulación. De lo contrario, existe el peligro de que una intervención regulatoria inadecuada nos lleve a una insuficiencia de inversión que haga difícil alcanzar el objetivo de la Agenda Digital 2020 de la Comisión Europea de disponer de una conexión rápida a Internet en toda Europa. Antes de imponer remedios regulatorios sobre las redes NGA, los reguladores deberían considerar la creciente competencia efectiva de las redes NGA por TV cable DOCSIS 3.0 y las redes móviles LTE, y tener en cuenta las diferencias entre las redes de acceso de cobre existentes y las de próxima generación basadas en fibra óptica. Sostenemos que cualquier intervención reguladora sobre las redes NGA, si es necesaria, debe ser tecnológicamente neutral y no imponer controles de precios mayoristas sobre los productos NGA.

Abstract

Operators building NGA network are faced by large sunk investments, significant demand uncertainty, changing competitive dynamics, and the fact that NGA is an evolving technology. This makes it particularly important to adopt the correct approach to NGA regulation. Otherwise there is the danger of inappropriate regulatory intervention leading to underinvestment which will make it difficult to achieve the European Commission's 2020 Digital Agenda of achieving fast internet connectivity throughout Europe. Before imposing regulatory remedies on NGA networks, regulators should consider the increasingly effective competition to NGA networks from DOCSIS 3.0 Cable TV and LTE mobile networks, and take into account the differences between existing copper and next generation fibre based access networks. We argue that any regulatory intervention in NGA networks, if required, should be technology neutral, and not impose wholesale price controls on NGA products.

1. Introduction

One of the aims of the European Commission's Digital Agenda is that by 2020 "(i) all Europeans have access to much higher internet speeds of above 30 Mbps and (ii) 50% or more of European households subscribe to internet connections above 100 Mbps" in order to facilitate economic growth, create jobs, and prosperity, and *"to ensure citizens can access content and services they want."*[1] Achieving these aims will require substantial investments in next generation access networks.

Currently copper based DSL (Digital Subscriber Line)[2] access is the dominant fixed broadband technology in Europe (Figure 0.1), and upgrading DSL access will be crucial in meeting the Commission's aims with regard to fast and very fast broadband. This will require substantial investment to roll out fibre (and active equipment in some deployment scenarios) closer to the end user. These next generation access (NGA) networks will be able to deliver broadband speeds that meet or exceed the speeds required in the Commission's Digital Agenda.

Commercial deployment of NGA is challenging given the high levels of investment required, and the investment risks associated with NGA. Regulators therefore need to tread a fine line between encouraging efficient investments and encouraging competition, and the European Commission's regulatory approach to copper based current generation access (CGA) networks may not be appropriate for NGA networks.

Faster broadband speeds can be delivered via other technologies which will also play a role in achieving the Commission's Digital Agenda goals. These technologies include data delivered over Cable TV networks using DOCSIS 3.0, fourth generation (4G) mobile technologies such as LTE, and fixed wireless access based on WiMAX. The importance of different technologies in delivering fast and super fast broadband will vary between and within countries. For example, mobile technologies may be more important in delivering fast broadband in rural areas with low population densities.

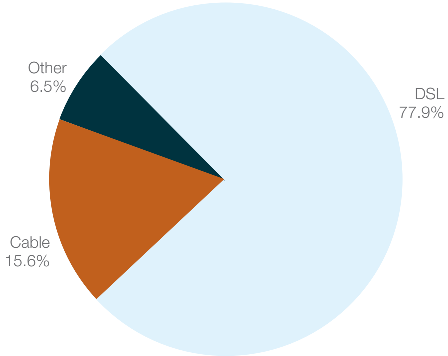


Figure 1:
Fixed Broadband Technology Market Share in Europe – July 2010

Source:
European Commission DG INFSO, Unit C4: Economical and Statistical Analysis

2. Why is NGA Different

The European framework for identifying telecommunications markets that require regulatory intervention is set out in the European Commission's 2007 Recommendation.[3] The recommendation lists the retail and wholesale telecommunications markets identified as being susceptible to the need for ex-ante regulation. It replaces an earlier 2003 Recommendation that had a more extensive list of markets. This framework does not distinguish between the regulatory treatment of copper and fibre, and provides the same remedies for both access technologies. The aim is to promote efficient investment, and to drive infrastructure based competition.[4]

The European Commission recognizes that "The transition to NGA particularly affects two markets listed in Commission Recommendation 2007/879/EC: the market for wholesale (physical) network infrastructure access (including shared or fully unbundled access) at a fixed location (LLU, Market 4), and the market for wholesale broadband access (WBA, Market 5)."[5] However there are crucial differences between copper based (CGA) and fibre based (NGA) access networks, and remedies developed in the context of CGA networks are unlikely to be appropriate for NGA networks. The crucial differences, from a regulatory perspective, between the two technologies are:

- CGA is a relatively stable technology whereas NGA is an evolving technology with multiple deployment scenarios.

(1) *A Digital Agenda for Europe*, European Commission, 26 August 2010, Pg.19.
(2) Digital Subscriber Line is a family of technologies generically referred to as DSL, or xDSL, capable of transforming ordinary local loops into high-speed digital lines, capable of supporting advanced services such as fast Internet access and video-on-demand. ADSL (Asymmetric Digital Subscriber Line), HDSL (High bit rate Digital Subscriber Line) and VDSL (Very high bit rate Digital Subscriber Line) are all variants of xDSL. (Source: Ofcom).
(3) *European Commission Recommendation*, December 17, 2007, on relevant product and service markets within the electronic communications sector susceptible to ex-ante regulation in accordance with Directive 2002/21/EC of the European Parliament and of the Council on a common regulatory framework for electronic communications networks and services, (2007/879/EC).
(4) *European Commission Directive*, 2002/21/EC as amended and 2002/19/EC.
(5) *Commission Staff Working Document Accompanying document to the Commission Recommendation on regulated access to Next Generation Access Networks (NGA)*, European Commission, 2010, pg 14.

Figure 2:
Fibre-to-the-cabinet (FTTC)

Source:
Ofcom

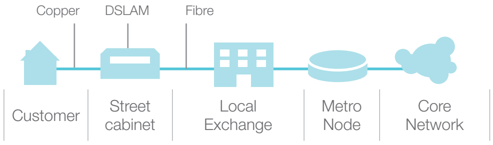


Figure 3:
Fibre-to-the- premises point-to-point (FTTP P2P)

Source:
Ofcom

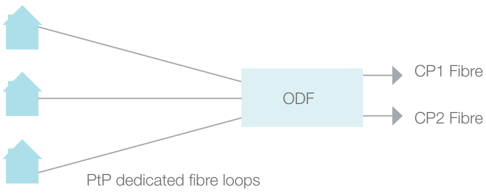
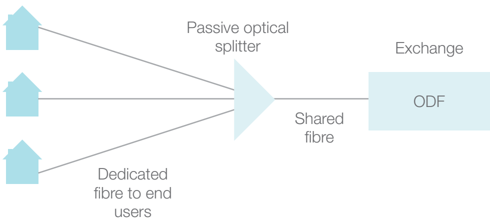


Figure 4:
Fibre-to-the- premises point-to-multipoint (FTTP PON)

Source:
Ofcom



- The development of NGA requires substantial new investment whereas CGA is based on existing copper networks, and does not require the same level of investment.

- There is significant investment risk associated with NGA investments –in our opinion the most crucial of these risks from a regulatory perspective are demand uncertainty, and the changing competitive dynamics in the broadband market.

These differences should be taken into account in any proposed regulatory framework applied to NGA. We discuss these differences below, before commenting on the potential regulatory implications in Section 3.

Evolving Technology and Deployment Scenarios

There are two main variants of NGA – fibre to the cabinet or node (FTTC or FTTN) and fibre to the premises or home (FTTP or FTTH). A FTTC deployment (Figure 0.2) involves the installation of active electronics, such as VDSL DSLAM or MSAN (Multi-service Access Node), in the street cabinet that is connected to the local exchange via a fibre link. FTTC continues to use the existing copper cables from the cabinet to the customer premises. As the final leg of the connection is copper, FTTC deployments use DSL based technologies, but the shorter loop lengths mean that advanced DSL technologies such as VDSL2 can be used. Currently VDSL2 can provide speeds of 50 Mbps on lines where the distance between the end user premises and street cabinets is 1 Km, and 100 Mbps where the distance is 0.5 Km.[6] A new array of technologies currently being tested offer the prospect that these speeds could be further improved.[7]

A FTTP deployment replaces all of the existing copper loop between the customer premises and the exchange with fibre, and can provide higher speeds (up to 1000 Mbps depending on the particular configuration) than FTTC deployments. However FTTP is more expensive to deploy given the significant civil works required to lay fibre from the local exchange to the terminal equipment at the customer premises. FTTP deployments can either be based on point to point (P2P) fibre (Figure 0.3) where each customer premises has a dedicated fibre connection or a passive optical network (PON) where a single fibre from the exchange serves many customers (Figure 0.4).

Currently it is not clear which of these deployment scenarios will be widely adopted. It is likely that different deployment scenarios will be appropriate in different countries, and in different geographic areas within countries. These different deployment scenarios have implications for wholesale (physical) network infrastructure access at a fixed location (LLU, Market 4) that can be provided to alternative operators.

Physical unbundling of fibre is only practical in a FTTP P2P deployment scenario, and would be similar to full LLU access, with the copper replaced by fibre. In a point-to-multipoint architecture such as PON, unbundling could be based on wavelength unbundling where competing operators are each allocated a different wavelength. However this would require additional equipment to manage and combine different wavelengths, and the standards for

(6) *Review of the wholesale local access market*, OFCOM, 23 March 2010, Pg 26.
(7) *Next Generation Access Networks and Market Structure*, OECD Digital Economy Papers, No. 183, OECD, 20 June 2011, Box 2.1.

these equipments are still being developed.[8] With FTTC deployments LLU access cannot be provided, but alternative operators can use sub-loop unbundling (SLU). In SLU it is the physical connection between the customer and the street cabinet that is unbundled instead of the whole physical connection between the customer and the local exchange.

Substantial New Investment Required

The development of NGA requires substantial fixed and irreversible investment in long lived fibre assets. Given the high level of fixed investment, unit costs are lower in densely populated areas and in areas with shorter loop lengths.[9] NGA deployments may not be feasible in less densely populated areas, and the practicability of different deployments will depend on population density and the existing network layout or loop lengths. The average deployment cost per household connected but not served is about €150-300 for VDSL (based on FTTC) and about €1500 for FTTH, with higher costs in rural compared to urban areas.[10] The scale of investments required to rollout these networks is in the range of many billions of euros. For example, in the UK the cost of deploying FTTC/VDSL nationwide is estimated to be GBP 5.1 billion, which is about a fifth of the cost of deploying FTTH/GPON (GBP 24.5 billion), with FTTH/PTP costing about 18% more than FTTH/GPON (GBP 28.8 billion).[11]

The higher costs of FTTH and the investment risks associated with deploying NGA, which we discuss next, mean that the majority of deployments by incumbents so far have been FTTC based VDSL deployments with FTTH deployments undertaken mostly on a small scale by incumbents and/or alternative operators.[12]

Investment Risks

The investments required for NGA rollouts are sunk and irreversible (i.e. they cannot be redeployed for other purposes). Their outcome is also uncertain. The European Commission notes the following: [13]

"(i) uncertainty relating to retail and wholesale demand; (ii) uncertainty relating to the costs of deployment, civil engineering works and managerial execution; (iii) uncertainty relating to technological progress; (iv) uncertainty relating to market dynamics and the evolving competitive situation, such as the degree of infrastructure-based and/or cable competition; and (v) macroeconomic uncertainty".

Of the various factors identified by the European Commission, the uncertainty with regard to the level of retail demand (and the wholesale demand derived form this) and the changing competitive landscape are, in our opinion, crucial from a regulatory perspective, and we discuss these below.

Demand Uncertainty

The value that retail consumers place on broadband connections will depend on the services that are available, not on the underlying technology used to deliver these services. Consumers who primarily use their broadband for surfing and checking emails will not place additional value on faster broadband connections that can be provided using NGA. At the same time, advanced services can be delivered over CGA networks. For example in the UK, "*in the short to medium term, providers already using LLU have connected their customers' phone lines directly into their network at unbundled exchanges. This bypasses BT's core network and enables them to provide ADSL2+ lines, which offers speeds of up to 24 Mbit/s. At these speeds, it is possible to deliver current requirements of high definition TV (HDTV) streaming (which requires around 15 to 20 Mbit/s), massively multi-player online (MMO) gaming and other interactive applications".*[14]

BEREC also points out that the actual take-up of NGA products in most Member States of the European Union falls significantly short of the coverage already achieved, that customers may not be willing to pay higher prices for high speed broadband services as they can access the services they want using existing broadband connections, and that *"Killer applications that strictly require speeds of 50 or even 100 Mbit/s do not exist so far".*[15]

This suggests that, in the short to medium term, CGA based LLU broadband could act as an

(8) Review of the wholesale local access market, OFCOM, 23 March 2010, Pg 100.
(9) Loop lengths are a major determinant of costs because they determine the level of civil works that will need to be undertaken to deploy fibre, and civil works are a main driver of costs in fibre deployment.
(10) Commission Staff Working Document Accompanying document to the Commission Recommendation on regulated access to Next Generation Access Networks (NGA), European Commission, 2010, Pg. 15 and Annex 3Chart 5.
(11) The costs of deploying fibre-based next-generation broadband infrastructure, Analysys Mason for Broadband Stakeholder Group,8 September 2008.
(12) Next Generation Access – Collection of factual information and new issues of NGA roll-out, BEREC, Feb 2011.
(13) Commission Recommendation 2010/572/EU, NGA, 20 September 2010, Annex 1.
(14) Review of the wholesale local access market, OFCOM, 23 March 2010, Pg 26.
(15) Next Generation Access – Collection of factual information and new issues of NGA roll-out, BEREC , Feb 2011, Pg 26.

effective demand-side substitute for NGA, and this will constrain the prices that operators can charge for NGA based broadband connections. There is a risk that demand for NGA based products and consumer willingness-to-pay for such services will be low initially which will make it difficult to recoup the investment in deploying these networks.

Market dynamics and the evolving competitive situation

The competitive dynamics of the broadband market are evolving. The market can be expected to become more competitive in the short to medium term as competition from Cable TV and mobile networks increases. This will make it more difficult for operators to break even on their investments in NGA.

Cable TV operators have been upgrading their networks to DOCSIS 3.0 which provides fast and very fast broadband connections – up to 160-240 Mbps downstream and 120 Mbps upstream speeds can be delivered to end users.[16] It is worth noting that 15.6% of broadband connections in the EU were provided via Cable networks in 2010 (Figure 0.1), and that DOCSIS 3.0 deployments are much cheaper than NGA deployments including FTTC and FTTH (Figure 0.5).

Mobile technology is also evolving. LTE is a 4G mobile technology that is likely to succeed 3G mobile technology in Europe, and it is expected that LTE networks will be widely deployed in Western Europe by 2014-15 (Figure 0.6) LTE based mobile broadband will provide download peak rates of at least 100 Mbps, and uplink rates of at least 50 Mbps.[17]

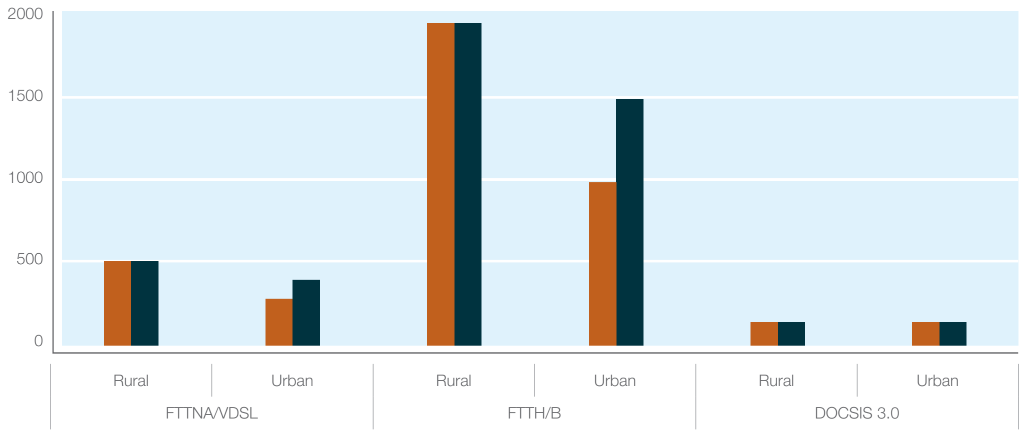
The EU average penetration rate for mobile broadband (dedicated data service using data cards) was 6.1% in 2010. This average figure masks large differences between countries, with the penetration rate varying from 1.5 % in Cyprus to 21.5% in Finland. These penetration rates will increase with the roll out of LTE, as mobile broadband becomes a much closer substitute, and not just a complement for fixed broadband. As Ofcom notes, *"In addition, future developments such as 4G (LTE) technology could mean that mobile broadband plays an increasingly prominent role in the household for voice and data access if more people substitute all fixed telecommunications services for mobile."*[18]

3. Implications for Potential Regulatory Remedies for NGA

The fact that NGA is a developing technology with different deployment scenarios, and that it requires substantial new investment with significant investment risks needs to be reflected in any regulatory framework applied to it. Remedies

Figure 5:
Average Unit Costs of NGA Deployment in the EU (€)

Source:
EC NGA Explanatory Note



Note: Orange bars represent average cost per home passed, and blue bars represent average cost per home connected.

(16) Next Generation Access Networks and Market Structure, OECD Digital Economy Papers, No. 183, OECD, 20 June 2011, Pg 18.
(17) Review of the wholesale local access market, OFCOM, 23 March 2010, Pg 21.
(18) Ibid, Pg 21.

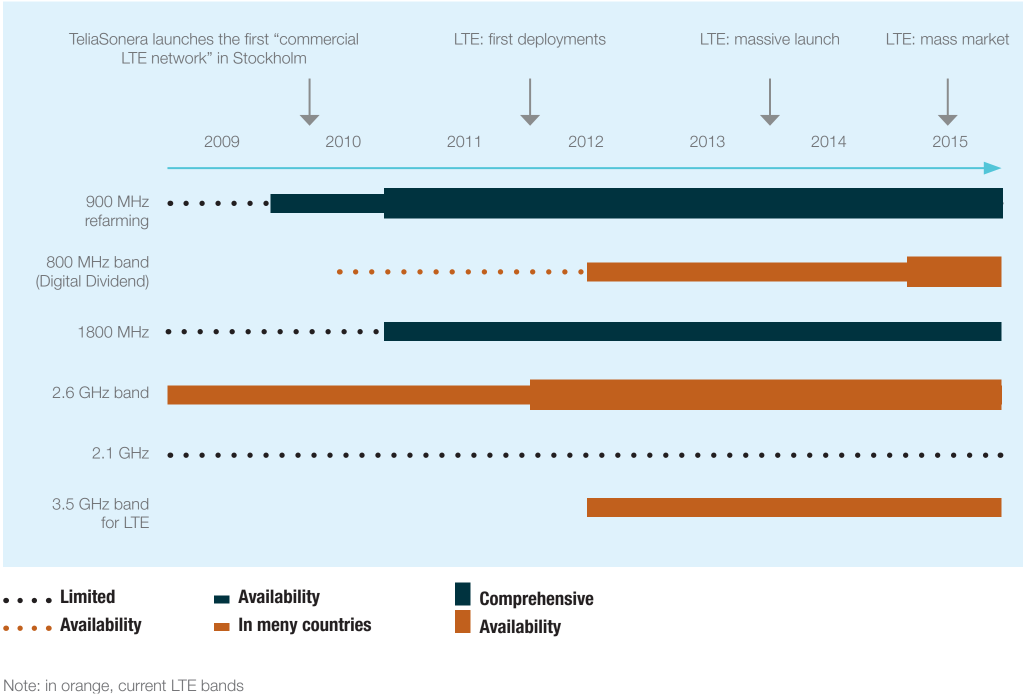


Figure 6:
Timetable for LTE Spectrum in Western Europe

Source:
IDATE DigiWorld Yearbook 2011

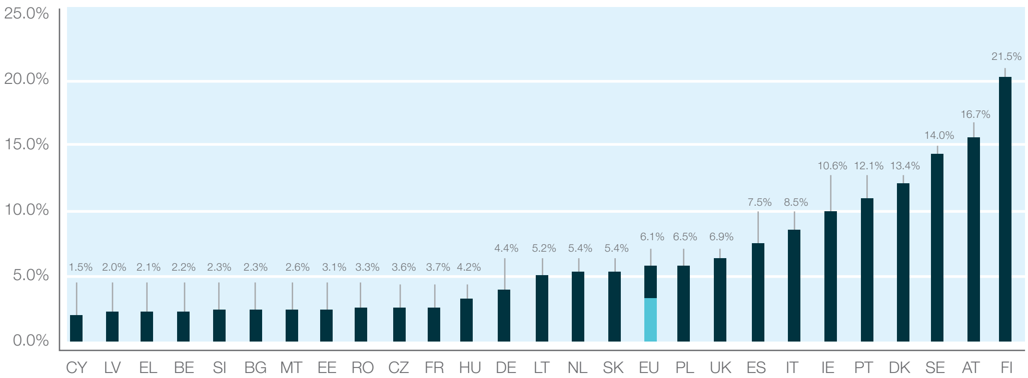


Figure 7:
Mobile Broadband Users – Dedicated Data Users

Source:
European Commission DG INFSO, Unit C4: Economical and Statistical Analysis

developed in the context of CGA networks are likely to be inappropriate for NGA networks.

Evolving technology and the requirement for substantial investment

As discussed above there are a number of different technologies for NGA. Within these, physical unbundling of fibre is only practical in the case of FTTP P2P deployment, in which case it would be similar to full LLU access, but with the copper replaced by fibre. However regulators should be indifferent regarding which type of NGA network is deployed (i.e. regulation should be technology neutral), and not push for FTTP P2P just because it would be similar to full LLU access. There are two reasons for this.

First, given the many and complex factors which determine the practicability and commercial viability of different deployment scenarios, decentralised decision making by operators and the market will lead to better outcomes. Regulators will not have access to all the information that operators do. The OECD in its recent publication on NGA emphasises the importance of technology neutrality, and states "*The reason for highlighting the debate over technology here is to reiterate, that in this area, policy makers and regulators should be wary of shifting from a technology-neutral stance. Unless there are persuasive reasons for placing to one side this principle, it seems sensible to allow operators to make* *their decisions based on commercial criteria and strategies."*[19]

Adopting a technology neutral stance will in our opinion encourage efficient investment in NGA networks. Mandating a particular type of deployment might lead to no investment in NGA in areas where a different network topology would have been commercially viable, or raise costs, or both.

Secondly, there are ways to promote competition other than mandating LLU access. Mandating access to passive physical infrastructure such as duct and poles (Physical Infrastructure Access – PIA) can ensure that any operator, not just the incumbent operator, can roll out a NGA network. Given that deploying passive infrastructure represents about 50% to 70% of the costs of building a NGA,[20] mandating PIA should make it easier for alternative operators to develop business cases to invest in NGA, and encourage facilities based competition. Regulators could also take the lead in developing standards for wavelength unbundling, and help set standards, and mandate non-physical access remedies in the Wholesale Broadband Access (WBA) market[21] which replicate many of the features of a physical access remedy. A good example of the latter is Virtual Unbundled Local Access (VULA), a non-physical NGA access remedy mandated by OFCOM.[22] Mandating WBA access will ensure that existing CGA based LLU operators who do not want to invest in their own network have an alternative product to which they can migrate.

Demand Uncertainty

The European Commission in its recommendation on regulated access to NGA networks suggests that once a suitable risk premium reflecting various uncertainties is allowed for, regulating access prices for WBA and WLA (Wholesale Local Access which includes LLU) based NGA products would be appropriate. However pricing freedom for NGA products (i.e. no wholesale price controls for WLA and WBA NGA products) may lead to higher investment in NGA while not having any adverse impact on competition because the price for broadband services will be constrained by potential demand substitutes in the form of strong competition from CGA based LLU operators, cable and mobile operators.

Trying to allow for uncertainty via a risk premium will be prone to errors given that both the uncertainty associated with NGA investment and the necessary premium to offset it are very difficult to measure. Pricing freedom will be more effective in mitigating this uncertainty by allowing operators who invest in NGA to share the risks with wholesale access seekers. For example, wholesale access providers could offer discounted long term contracts to wholesale access seekers which would allow them to share the risk that demand is lower than expected. Also, as the market for NGA develops, and data from previous deployments becomes available, some of the investment uncertainty will be resolved, and operators can react to these evolving market dynamics if they have pricing freedom. Wholesale price controls will constrain operators, and restrict their ability to share risks and to react to market developments. This may lead to lower investment in NGA.

Market dynamics and the evolving competitive situation

The competitive situation in the broadband market is evolving. As stated already, Cable TV networks are increasingly competing with NGA using the DOCSIS 3.0 standard, and LTE networks will be widely deployed in Western Europe by 2014-15. These different network platforms offer increasingly similar speeds and services. Regulators need to take these developments into account before imposing regulatory remedies on NGA networks.

The details of appropriate access remedies in any country will need to reflect the particularities of that country – for example, the expected rollout

(19) Next Generation Access Networks and Market Structure, OECD Digital Economy Papers, No. 183, OECD, 20 June 2011, Pg 16.
(20) Review of the wholesale local access market, OFCOM, 23 March 2010, Pg 109.
(21) The WBA market includes Bitstream access, and sits between the WLA (Wholesale Local Access) market and the retail broadband market and relates to the wholesale broadband products that service providers supply to themselves and sell to each other (Review of the wholesale broadband access markets, OFCOM, 3 December 2010).
(22) The details of VULA are as follows, "VULA provides a connection from the nearest 'local' aggregation point to the customer premise. In a NGA context, this would be an Ethernet-based connection product where the CP (or access seeker) has access to 'empty' transmission frames over the physical link provided by the NGA network provider (or access provider). Whilst the transmission of the data would not be controlled by the CP, the structure of the transmission technology (Ethernet frame) would be.
This level of control would be sufficient to allow significant product differentiation and innovation, potentially similar to the opportunities available using physical access products. For example, the CP would be able to provide a multitude of different services over this connection, e.g., voice, video, internet services, and would still have total control over the dimensioning of the backhaul and core network that are needed to support these services."
(Source: Review of the wholesale local access market, OFCOM, 23 March 2010)

of LTE networks and/or the coverage of Cable TV networks.[23] Countries with high Cable TV and/or mobile broadband penetration (likely to increase with the launch of LTE) might need to amend the broadband market definition used to designate NGA operators as having SMP to include broadband provided via Cable TV and mobile networks. If competition in this broader market is effective, then the case for ex-ante regulation of NGA networks is weaker, and regulators should consider moving toward ex-post regulation via competition policy. Otherwise, there is a risk of erroneous regulatory intervention. At a minimum a commitment should be made to review the regulatory framework for NGA at regular intervals, for example when LTE networks have been deployed, so these changing competitive dynamics can be taken into account.

Conclusion

Operators building NGA network are faced by large sunk investments, significant demand uncertainty, changing competitive dynamics, and the fact that NGA is an evolving technology. This makes it particularly important to adopt the correct approach to NGA regulation. Otherwise there is the danger of inappropriate regulatory intervention leading to underinvestment which will make it difficult to achieve the European Commission's 2020 Digital Agenda of achieving fast internet connectivity throughout Europe.

Regulators should consider the increasingly effective competition to NGA networks from DOCSIS 3.0 Cable TV and LTE mobile networks. In some cases this may mean that the broadband market definition used to designate NGA operators as having SMP should be amended to include Cable TV and mobile networks. If competition in this broader market is effective, then the case for ex-ante regulation of NGA networks is weaker, and regulators should consider moving toward ex-post regulation via competition policy.

If regulatory intervention is required, then the European Commission's regulatory approach to CGA networks may not be appropriate for NGA networks. Any regulatory intervention in NGA networks should be technology neutral, and not impose wholesale price controls on NGA products.

Regulators should not mandate a particular NGA deployment like FTTP P2P just because this would be similar to full LLU access. Instead they should mandate access to passive physical infrastructure such as duct and poles. Mandating PIA should make it easier for alternative operators to develop business cases to invest in NGA, and encourage facilities based competition. Regulators can also mandate wholesale broadband (or Bitstream) access which will ensure that existing CGA based LLU operators who do not want to invest in their own network have an alternative product to which they can migrate.

Pricing freedom should be provided because it will be more effective in mitigating the substantial uncertainty associated with NGA investments by allowing operators who invest in NGA to share the risks with wholesale access seekers. Trying to allow for uncertainty via a risk premium will be prone to errors given that both the uncertainty associated with NGA investment and the necessary premium to offset it are very difficult to measure.

(23) For example, in Belgium, and the Netherlands over 90% of households have access to Cable TV, and over 80% subscribe to it for basic television series. In the UK, Virgin's Media's DOCSIS 3.0 network passes 12.6 million households (Source: Next Generation Access Networks and Market Structure, OECD Digital Economy Papers, No. 183, OECD, 20 June 2011; and The Communications Market 2010, OFCOM).

Regulación e incentivos

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Resumen

El control de precios mayoristas de acceso a redes fijas, que el marco regulatorio actual considera fundamental para promover la competencia y evitar el abuso de posición dominante por parte del operador tradicional, está teniendo como consecuencia una paralización del proceso inversor en redes de nueva generación y un estancamiento muy grave del sector.

Uno de los motivos de este problema es asumir que los precios de los servicios deben estar vinculados a costes, para promover así una mayor eficiencia en el proceso productivo. Esta visión neoclásica olvida el papel informacional que los precios aportan sobre el valor de los bienes. Cuando los precios son regulados se destruye esta información y ya no se desencadenan incentivos a la estrategia inversora y a la innovación tecnológica.

La teoría de juegos sirve como marco teórico para entender cómo se produce la lucha estratégica entre competidores y cuál es el desenlace más probable en un escenario de pugna entre partes que buscan optimizar cada una su propio beneficio, pero que se ven influidas por las decisiones del resto. La teoría de mecanismos estudia cómo las reglas del juego influyen en dicho desenlace y cómo puede "reorientarse" el juego para conseguir que los intereses de las partes conduzcan a un objetivo global óptimo.

Esta teoría de mecanismos sugiere un estilo regulatorio más basado en el diseño de incentivos, que impulsen la inversión en un escenario competitivo, que en el de reglas coercitivas y de manipulación de precios, que es el que ha conducido a la situación actual de falta de interés inversor.

En el presente artículo se hace una reflexión sobre la aplicación de la Teoría de Incentivos a la regulación del sector de las comunicaciones electrónicas en general, y en particular a las redes de nueva generación, proponiendo un mecanismo de análisis alternativo al tradicionalmente aplicado por las autoridades de regulación, que permitiría simular el comportamiento de los agentes y establecer cuáles podrían ser sus posibles estra-

tegias dominantes antes las opciones de invertir o alquilar las nuevas redes de acceso, así como las situaciones de equilibrio de Nash que corresponderían a los desenlaces más probables y acordes a los intereses particulares de dichos agentes.

Con este tipo de mecanismos el Regulador estaría en mejor disposición de diseñar los incentivos más adecuados para reorientar el equilibrio del mercado en función de los objetivos sociales más deseables, pero evitando distorsionar la fijación de los precios, con lo que se conseguiría, al mismo tiempo, que el propio mercado actuase como mecanismo para revelar la información relevante en la toma de decisiones de los agentes.

Abstract

The current regulatory framework takes for granted that a tight control of the wholesale prices for access to fixed networks guarantees a competitive market and prevents the abuse of an incumbent dominant position. But this control has a very serious collateral damage, the investment slowdown and the sector stagnation.

One of the reasons that could explain the problem is the belief in the linkage between prices and costs, as a way to promote efficiency. This way of thinking makes us forget the information that prices give regarding the value of goods. Price regulation destroys this information and makes investment and technological innovation incentives disappear.

Game theory provides a useful framework to explain and simulate the competitors' strategic conflicts and find the most likely outcome, when different parties compete with each other in order to achieve the maximum benefit, each of them being affected by the other's decisions. Mechanism theory analyzes how game rules can affect this outcome, and the way a game can be "redirected" in order to get a globally better goal.

Mechanism theory proposes a new regulatory approach, incentive-orientated, with the aim to bolster investment while, at the same time, maintaining the competion level, instead of establishing coercive rules and strict price controls, the very responsibles of the current market stagnation.

This work raises up how incentives theory can be an alternative way to regulate the telecommunications sector, specially the NGN. This method can identify the competitor's most likely behaviour and its interests in investing in new access networks, depending on the regulatory policy applied.

This way, the regulator can seize incentives design to redirect the market, trying to reach the most desirable social goals, while avoiding the distortion caused by price control. That would allow the market to work as a revelation mechanism, offering operators very important and relevant information to use in the decision making process.

Introducción

Por definición, los agentes que intervienen en una economía de mercado lo hacen libremente, sin coacción alguna. Cualquier transacción que estos agentes negocien se produce porque las partes perciben que saldrán ganando con dicho acuerdo, ya que si alguna de ellas creyera que saldría perjudicada, dicha transacción simplemente no se llevaría a cabo. Por tanto, la regulación como acción coercitiva buscaría forzar un intercambio que, de otro modo, no se habría producido, porque supone una pérdida de bienestar de al menos una de las partes implicadas[1]. En ese sentido, podría pensarse que la regulación es siempre negativa, ya que impone cambios no positivos para todos.

Ahora bien, pueden darse situaciones en que una de las partes (**A**) tiene un poder de negociación mucho mayor que la otra (**B**), y puede limitar enormemente la capacidad de elección de **B**, de manera que aunque el mercado libre impulsa una transacción (**I**) que beneficia a los dos, dicho beneficio es mucho mayor para **A** que para **B**. En este contexto, la regulación puede incentivar otra transacción diferente (**II**) que siga generando beneficio para ambas partes, pero con un balance mucho más equilibrado. No es que II no se produzca en el mercado libre porque **A** pierda, sino porque **A** gana mucho más con **I** y utiliza su posición de dominio para que sea **I** la que se lleve a cabo. Incluso aunque el beneficio extra total sea mayor con **I**, el reparto más justo y ecuánime de **II** puede hacer de esta última una acción socialmente más

(1) Al revés, la regulación puede vetar una transacción, que sí se hubiese producido en un mercado libre, impidiendo que se genere el bienestar que los agentes esperaban conseguir con ella.

deseable, por lo que el papel de la acción regulatoria estaría más que justificado[2].

También hay que tener en cuenta la eventual existencia de agentes que pueden verse afectados de manera indirecta por dicha transacción, por lo que si de lo que se trata es de contabilizar el bienestar global, ya no está tan claro que sea óptima la acción decidida por unos pocos, en busca de su propio beneficio, si otros muchos se ven afectados por la misma[3].

Citando a Pigou: *"En cualquier industria donde hay razones para creer que el juego libre de los intereses propios haría que una cantidad de los recursos fuesen invertidos de manera distinta de la que sería necesaria para favorecer los intereses del bienestar nacional, hay prima facie*[4] *una ocasión para una intervención pública*".

Ahora bien, al margen de que determinar cuáles son esos intereses no es una tarea trivial, porque siempre existirá una carga de subjetividad importante y la valoración será fruto de las presiones de distintos grupos sociales (llevado al límite, todo bien o servicio tiene un interés social que fomenta el bienestar nacional), y reconociendo ese papel potencialmente beneficioso de la acción regulatoria a la hora de solventar algunos fallos de mercado que producen resultados socialmente no deseados, también hay que tener en cuenta que una regulación incorrecta puede tener efectos contrarios a dicho objetivo y que, a veces, el daño causado al perturbar artificialmente un mercado puede superar los beneficios que se esperaban de dicha intervención. Frecuentemente se olvida que cualquier intervención tiene un coste, y éste rara vez es estimado.

Dada la enorme complejidad del funcionamiento del sistema económico, que genera una ingente cantidad de información privada y difícilmente monitorizable, el regulador debería entender su misión como un problema de agencia, de delegación, y no intentar convertirse en sustituto del mecanismo de mercado. Son los intereses propios de consumidores y empresas los motores últimos de la dinámica económica y resulta mucho más efectivo realinear dichos intereses mediante el uso de incentivos que la acción intervencionista directa, cuyas consecuencias a medio y largo plazo resultan frecuentemente imprevisibles y posteriormente difíciles de subsanar.

En su teoría del control de precios, Mises ya postuló que el intento de establecer precios máximos, inferiores a los que un mercado libre habría gestado, conlleva de manera ineludible un aumento gradual de la acción del gobierno, y en caso de obstinarse éste en mantener dicho control se ve abocado, quizá lenta pero inexorablemente, a una planificación centralizada de todo el proceso productivo[5]. Es decir, la destrucción de determinados incentivos supone una cada vez mayor necesidad de intervención del Estado, intervención que será tremendamente ineficiente, dada la no disponibilidad de mucha de la información dispersa que se encuentra en manos de los agentes de mercado, anulándose los procesos de señalización que aportan los precios no intervenidos y que determinan el ajuste adecuado de oferta, demanda y distribución de factores.

Sobre este punto, la excesiva distorsión de la dinámica natural del mercado, gravitaría la principal crítica al enfoque regulatorio actualmente aplicado al sector de las telecomunicaciones, cuyo trasfondo teórico se fundamenta en perseguir la panacea neoclásica del mercado perfectamente competitivo, el cual precisa para su existencia de una serie de condiciones muy difícilmente concurrentes en la práctica, algunas de las cuales son claramente imposibles de conseguir en este sector, por ejemplo, que no existan ni economías de escala, ni economías de alcance, ni externalidades.

Con el fin de "corregir" este problema y evitar el supuesto poder de mercado que concedía al incumbente, y las negativas consecuencias que para la sociedad se derivarían de tal circunstancia, se ha intervenido el sector de manera progresiva, y en vez de suponer ello una solución transitoria hacia una paulatina desregulación, estamos asistiendo al proceso descrito por Mises, que podría cristalizarse en un futuro no demasiado lejano en

(2) La prestación de Servicio Universal de determinados servicios básicos es un claro ejemplo de algo que no se haría en un mercado exento de regulación, ya que no existe incentivo comercial, pero que sin embargo tiene, con todos los matices que se quieran añadir, una justificación social.
(3) Se alude aquí al concepto de externalidad. Ésta puede ser positiva o negativa, según el signo del efecto externo generado. Una externalidad negativa, p.e. la polución asociada a una actividad industrial, debe ser controlada, ya que ni el "productor" ni el "comprador" están demasiado incentivados a reducirla, puesto que solo reciben una parte mínima del daño total causado. Por el contrario, una externalidad positiva debe ser potenciada exógenamente, ya que los agentes involucrados directamente la infravaloran, al no percibir todo el beneficio creado.
(4) En principio, a primera vista.
(5) Sin querer entrar a detallar todo el proceso, el argumento de Mises se basa en que precios regulados artificialmente bajos aumentan la demanda y reducen el incentivo a la oferta, por lo que el objetivo inicial del gobierno de dar acceso a todo el que desee el producto a ese precio bajo, solo se puede llevar a cabo mediante venta forzada y racionamiento. Posteriormente y una vez que se haya agotado el stock inicial de capital, será necesaria la regulación adicional de los factores de producción, ya que en un mercado libre serían destinados a otro fin más rentable.

la necesidad de proceder a la separación funcional de las redes. La necesidad última de esta regulación, cada vez más compleja y omnipresente, surge porque el intento de convertir al sector en ese mercado ideal de competencia perfecta ha destruido muchos de los beneficios que se derivaban precisamente de las economías de escala y alcance, sin generar al mismo tiempo las hipotéticas virtudes derivadas de la genuina competencia, que ha sido sustituida por un marco de operadores subvencionados, sin incentivos ni inclinación por la eficiencia y la innovación.

Ello no significa, sin embargo, que se infravaloren las bondades asociadas a la existencia de dichos competidores. La competencia es el mecanismo más eficiente y equitativo a la hora de organizar y disciplinar los mercados. Un mercado competitivo distribuye los recursos eficientemente, maximizando el beneficio social a través de la consecución de tres objetivos:

- Eficiencia asignativa: Los recursos, productos y servicios son para quien los valore más, porque espere obtener un mayor bienestar de ellos.

- Eficiencia productiva: Los recursos escasos se usan de la manera más productiva posible, ya que ello implica una ventaja competitiva (vía precios menores).

- Eficiencia dinámica: Se generan incentivos a la innovación y a la inversión en nuevas tecnologías más eficientes que las anteriores (por ejemplo en costes) o en productos/servicios sustitutivos superiores a los existentes, o en otros nuevos que cubran las necesidades del consumidor.

Ahora bien, la pregunta que es necesario plantearse es si tiene sentido intentar orientar artificialmente el mercado hacia un ideal tan alejado de su propia esencia. Y lo que es más importante, si dicho "mercado perfectamente competitivo" aseguraría, en caso de ser alcanzable, esa "verdadera competencia" que estimule la eficiencia en costes, un mayor excedente de consumidor y la eficiencia dinámica e innovación que debieran caracterizar al sector. También es cuestionable que la actual regulación asimétrica genere una verdadera competencia sostenible en el tiempo, salvo que lo haga a costa de despojar de incentivo inversor al incumbente y de dar un cobijo artificial y duradero a operadores sin otra vocación que la replicabilidad de su oferta, y que pueden estar apropiándose de rentas que, de otra forma, estarían destinadas a la mejora de la oferta al cliente[6].

En palabras de Stiglitz: "Por su propia esencia, la regulación restringe al particular o empresa de hacer algo que habría hecho si aquella no existiese. El objetivo de dicha intervención es abordar las potenciales consecuencias que van más allá de las partes directamente implicadas, en situaciones en las que el beneficio privado no es una buena medida del impacto social". Pero una regulación apropiada debe, por tanto, favorecer también las innovaciones que contribuyan a mejorar el bienestar social, evitando aquellas medidas que a la larga suponen el estancamiento, especialmente en sectores basados en la rápida evolución tecnológica.

La regulación es necesaria siempre que exista un desalineamiento entre beneficios públicos y particulares, pero es precisamente la innovación tecnológica, que genera ventajas competitivas, el paradigma de situación en la que la búsqueda del beneficio empresarial va a aportar un gran beneficio social, y el regulador puede truncar algo tan positivo si destruye ese incentivo, en el intento de evitar un (supuesto y no demostrado) peligro de dominio de mercado, mediante el desacople entre precio y valor generado y reorientando aquél a través de la vinculación a unos costes ideales o, podríamos decir, idealizados.

Por ejemplo, la regulación de precios mayoristas de acceso al bucle, buscando la orientación a costes incrementales según modelos LRIC, tiene como meta el incentivo a la eficiencia en dichos costes por parte del dominante, pero genera un cortocircuito lógico que impide el pretendido objetivo de impulsar el ascenso en la escalera de inversión, ya que desincentiva a los potenciales competidores a arriesgarse a desplegar su propia infraestructura, si pueden alquilarlas al dominante y asegurarse así la producción a lo que el regulador especula que será el mínimo costo en que incurriría una firma eficiente que la construyera nueva. La competencia que dicho control del mercado mayorista ha transmitido al mercado minorista se ha traducido, es cierto, en una bajada

(6) Es decir, se estaría produciendo una transferencia de bienestar de los consumidores a los entrantes, como consecuencia de una regulación excesivamente proteccionista con los mismos.

de precios al cliente final, pero con la contrapartida de hacer desaparecer totalmente del proceso productivo el incentivo a la inversión e innovación en la mejora de la red o en redes de nueva generación. Efectivamente, si la situación no se corrige, el Estado tendrá ineludiblemente que aumentar su grado de intervención en los términos que predecía Mises, para forzar lo que de forma natural no se produce, pasando a realizar directamente el despliegue de la red y desplazando de forma definitiva la iniciativa privada[7].

En definitiva, la "mano visible" (regulador) y la "mano invisible" (competencia perfecta) coinciden en sus fines: amoldar el objetivo del beneficio privado en acciones socialmente óptimas. Pero, mientras que el mercado actúa como un dispositivo natural de intercambio de información, ajustando las preferencias subjetivas de multitud de individuos y en función de ellas establece los precios de intercambio, el regulador no cuenta con medios equivalentes para replicar esta dinámica, por lo que el riesgo de errar en esta tarea puede ser enorme y las consecuencias impredecibles. La tarea principal del regulador debe ser, en cambio, descubrir formas de inducir a las empresas a comportamientos que, desde la óptica del máximo beneficio propio, redunden en el bienestar de los ciudadanos y minimicen los efectos de la intervención. Toda intervención tiene un coste económico para la sociedad, aunque frecuentemente no se materializa de forma inmediata, lo que amplifica el riesgo de sobrevalorar los efectos positivos inmediatos de la intervención, en detrimento de ese coste, a veces de mayor cuantía, que se generará en el futuro.

Algunas palabras y expresiones han aparecido o aparecerán insistentemente en el presente trabajo: incentivos, alineamiento de intereses, interés privado frente a interés global y otras relacionadas. El estudio formal de la dinámica generada por los conflictos de intereses, entre partes forzadas a interaccionar entre sí, es el objetivo de una de las teorías más revolucionarias del pasado siglo, y que introdujo avances notables en la conceptualización del funcionamiento económico en general, y del diseño de políticas regulatorias en particular: la teoría de juegos.

Teoría de juegos

De forma sucinta puede decirse que la teoría de juegos se ocupa de abordar los problemas de decisión multiagente, es decir, aquellas situaciones donde varios participantes, persiguiendo cada uno de ellos su beneficio individual, deben tomar decisiones, sabiendo que el resultado final estará supeditado no sólo a su propia elección, sino también a las del resto. Por ejemplo, en un "juego" bilateral el "jugador" **A** elegirá su estrategia dependiendo de cuál cree que será la de **B**, pero debe tener en cuenta que la elección de **B** dependerá también de su propia previsión del comportamiento de **A**. Es decir, el desenlace del juego estará determinado (pero de una manera en absoluto obvia) tanto por los intereses particulares de cada uno de los jugadores, como por la información de que dispongan de sus respectivos oponentes.

El ámbito de aplicación de esta teoría es inmenso, ya que abarca tanto la variada gama de situaciones de intereses enfrentados, donde la ganancia de uno de los jugadores se produce necesariamente a costa de la pérdida de algún otro, como de escenarios aparentemente colaborativos, en los que, aunque no se busca directamente el perjuicio de nadie, la prevalencia del interés individual sobre el bienestar global puede llevar a un daño o subóptimo para todos los participantes.

En concreto, uno de los campos de acción más fructíferos de esta teoría es precisamente la Economía, que al abordar los problemas derivados de la "gestión de los recursos escasos" reconoce implícitamente los enfrentamientos de intereses que dicha escasez genera. Como ejemplo clásico de dicha aplicación, puede mencionarse el caso de la lucha oligopolística, en concreto en una situación a la Cournot[8]. ¿Por qué dos duopolistas producen conjuntamente más de lo que habría decidido producir un monopolista, si éste era el nivel óptimo, el que extraía el máximo excedente de consumidor y generaba el mayor nivel de beneficios? La razón es simple de enunciar, pero más sutil de lo que en principio podría pensarse: el óptimo global no se consigue intentando obtener óptimos particulares. La decisión de producción de cada duopolista repercute en sus

(7) Hasta abril de 2011 se habían contabilizado, solo en España, un total de 160 iniciativas para el despliegue de redes públicas por parte de las administraciones locales y autonómicas, de las cuales 111 se refieren a despliegues de redes locales WIFI, 4 más para el despliegue de fibra óptica de acceso, 24 planes de extensión de la banda ancha a medios rurales, 7 iniciativas para despliegue de redes troncales de transporte, además de varias iniciativas para crear operadores neutros y convenios especiales con operadores de telecomunicaciones.
(8) En el modelo de Cournot los oligopolistas son tomadores de precio. Cada uno de ellos decide su nivel de producción y será la oferta agregada la que determine dicho precio.

beneficios, pero también tiene un efecto externo negativo sobre los beneficios de su competidor (vía alteración del precio de mercado) que no es tenido en cuenta desde una valoración particular. Esta perspectiva "local" es más ineficiente que la de un monopolista. Curiosamente, la búsqueda del interés particular conduce no solo a un subóptimo global, sino también a resultados peores para todas y cada una de las partes.

Las situaciones de las que se ocupa la teoría de juegos se caracterizan, por tanto, porque los agentes no toman decisiones basadas en la creencia de un entorno estático e imperturbable, sino sabiendo que dicho entorno se verá afectado por esas decisiones y reaccionará a ellas, lo que dificulta enormemente el enfoque clásico de búsqueda de relaciones causa-efecto. ¿Es rentable bajar precios ante una demanda elástica? Depende de cuál sea la reacción de mi competidor y de su disposición a entrar en una guerra de precios, que a su vez estará justificada por la percepción que éste tenga de, por ejemplo, mi capacidad financiera. Se sustituye así el concepto de decisión por el de **estrategia**, que podría definirse como el conjunto de posibles acciones a tomar según cuál crea que es la que decidirá mi oponente.

Uno de los conceptos clave que surge del análisis de las situaciones estratégicas es el de "equilibrio de Nash", o equilibrio estratégico, que representa a un conjunto de estrategias de los distintos jugadores que se justifican entre sí como mejores opciones, es decir, la estrategia de cada uno de los jugadores en un equilibrio de Nash es óptima si los demás se ajustan también a las suyas. La palabra equilibrio refleja el hecho de que, aceptando que el resto mantenga sus estrategias, ningún jugador tiene incentivos a cambiar unilateralmente la suya[9]. Los equilibrios de Nash pueden ser simétricos, como en un duopolio de Cournot, o asimétricos, como en el duopolio de Stackelberg[10], donde uno de los jugadores consigue un resultado mejor que su oponente, pero no de manera coercitiva, sino porque el competidor sabe que cualquier otra decisión que tome redundará en su propio perjuicio.

La información que cada uno de los participantes tenga del entorno y de los demás jugadores es un factor muy relevante a la hora de determinar los equilibrios de Nash a que dará lugar un determinado juego. Lo paradójico es que no siempre más información conduce a un mejor resultado, porque a veces carecer de ella puede hacer que una posible amenaza de mi oponente no sea creíble, reforzando mi posición ante una situación estratégica o de negociación.

Pero además, para que un jugador elija su estrategia de equilibrio, es necesario que conozca las estrategias de equilibrio de los demás y que presuponga que éstos son racionales a la hora de decidir. No solo eso, sino que también debe suponer que los otros conocen su estrategia de equilibrio y le suponen racional a él. Muy frecuentemente falla alguna de estas hipótesis, principalmente por la capacidad limitada del ser humano para evaluar relaciones causa-efecto complejas, lo que conduce a tomar decisiones diferentes de las que hubiese generado la racionalidad e información perfectas.

La asimetría e imperfección informacional, añadida a los errores de juicio e interpretación de dicha información, hacen que, en la mayoría de juegos, el concepto de equilibrio de Nash no sea realista, siendo sustituido por el de equilibrio bayesiano, que sería "grosso modo" el conjunto de estrategias que, para cada jugador, maximizaría su bienestar esperado (medio), dada la incertidumbre sobre las estrategias óptimas de los demás[11].

Para terminar este brevísimo acercamiento a la teoría de juegos, hay que destacar la crucial diferencia que representa el que el juego se desarrolle una vez (o un número previamente determinado de veces), frente a que lo haga de forma repetida y con un horizonte temporal indefinido[12], lo cual nos aleja de la simplicidad de los modelos neoclásicos y nos acerca más a la realidad de los mercados. En este último caso, la cooperación entre jugadores puede surgir espontáneamente, no por motivos altruistas sino porque a medio y largo plazo aporta soluciones de valor superior a la de mayor beneficio instantáneo, que si causa un perjuicio a otro jugador puede

(9) Por ejemplo, si cada conductor supone que los demás conducirán por la derecha, ninguno tendrá incentivos a conducir por la izquierda, dado el riesgo de colisión que ello supondría. Que todos conduzcan por la derecha (o todos por la izquierda) es un equilibrio estratégico, un equilibrio de Nash.
(10) En un duopolio de Stackelberg, uno de los duopolistas acepta como dada la producción del otro. Aunque a veces se usa la expresión "sigue al líder" en referencia a que "quien decide primero se impone", en realidad el liderazgo no es tanto una cuestión de anticipación como de conseguir convencer al otro de que no se tendrá en cuenta su decisión, es decir, de romper la simetría informacional.
(11) En definitiva, supondría asignar distintas probabilidades de ocurrencia a los distintos escenarios de decisión.
(12) Este tipo de juegos se denominan repetidos, y pueden encontrarse multitud de casos en el ámbito de la Economía. La interacción entre competidores en un mercado no suele producirse una única vez, sino que se repite en el tiempo, lo que permite ajustar estrategias en función de la experiencia, de las expectativas a futuro y de la incertidumbre sobre la duración de dicha interacción.

desencadenar represalias más adelante. Este "miedo a la venganza" es el que alienta dicha cooperación, al menos mientras los jugadores no sepan hasta cuándo durará su interrelación[13].

Teoría de mecanismos. El modelo agente-principal

Matemáticamente puede definirse un juego como la función, multivariable y multivaluada[14], que asocia a cada conjunto de estrategias de los jugadores un resultado para cada uno de ellos. Tomemos por ejemplo el juego representado por un duopolio de Cournot. La función de demanda del mercado, la función de costes de cada duopolista y el grado de simetría informacional son los elementos que definirán dicho juego, es decir, establecen la relación entre oferta agregada y beneficios para cada duopolista, y determinarán por tanto los posibles equilibrios estratégicos existentes. Modificar alguno de estos elementos redefine la función juego, y puede suponer que esos equilibrios estratégicos sean radicalmente distintos[15].

No hay que olvidar que los equilibrios de Nash se alcanzan a partir de las motivaciones particulares de cada uno de los jugadores, los cuales intentan maximizar su propio bienestar según el margen de acción que el juego definido les permita. Desde este planteamiento nace la teoría de mecanismos, que se denomina a veces "teoría de juegos inversa", ya que en vez de buscar cuáles son los equilibrios estratégicos a que conduce un juego, lo que pretende es descubrir cómo puede modificarse su estructura, para que el nuevo juego dé lugar a otros determinados equilibrios. Dichas "perturbaciones" de la estructura del juego se denominan mecanismos y en su diseño pueden utilizarse tanto la inclusión de nuevos elementos de valor para los jugadores[16] como la manipulación de los flujos de información utilizados en la toma de decisiones.

La deslumbrante puesta en práctica de la teoría de mecanismos se pone en evidencia en el llamado modelo agente-principal, que analiza el problema de la delegación de una tarea por parte de un principal a uno o varios agentes. El principal carece (o le es muy costoso conseguirla) de mucha de la información relativa y relevante a la ejecución de la tarea. Esta información privada está en manos de los agentes, que no tienen interés en compartirla y cuyo comportamiento es total o parcialmente inobservable, por lo que el principal únicamente puede valorar el resultado final de dicha ejecución[17]. Por otra parte, el desempeño de los agentes encargados de la tarea estará determinado por su interés en maximizar su propio bienestar, por ejemplo intentando obtener la mayor retribución, realizándola con el menor esfuerzo posible o dedicándole más tiempo del necesario. El problema del principal es cómo conseguir compatibilizar dicho interés privado del agente con el desempeño eficiente de la tarea, partiendo de esa escasez de información y de la dificultad de monitorización mencionadas. La "solución" radica en diseñar un mecanismo incentivador que alinee ambos objetivos, el del principal con el particular del agente.

Sirvámonos de un ejemplo sencillo para explicar el concepto de mecanismo. Cuando un taxista recoge turistas en el aeropuerto de una ciudad, dispone de información sobre cuáles son las mejores rutas para alcanzar un destino, información que normalmente no es accesible a los usuarios de dicho servicio[18]. Si el pago que recibe por la carrera fuese simplemente proporcional a la distancia recorrida, el taxista tendría un fuerte incentivo a elegir una ruta poco eficiente, para asegurarse así una alta recaudación. Basta un cambio adecuado del sistema de tarificación

(13) De hecho esta idea de la cooperación como fruto de la interacción con horizonte indefinido es muy importante en sociología, y algunos teóricos la utilizan para explicar cómo surgen las sociedades humanas, y cómo desde el egoísmo individual se pueden desarrollar estándares de comportamiento que faciliten la convivencia y hagan estable y fuerte al grupo, lo que finalmente repercute en el bienestar individual de cada uno de ellos.
Aunque cueste admitirlo, nuestro comportamiento frente a alguien que no nos sea especialmente simpático dependerá de lo cercana que vaya a ser nuestra relación con él en el futuro.
En una situación de duopolio, la interacción repetida entre los competidores puede dar lugar a pautas de comportamiento colusorio (no explícito), a medida que éstos descubran que les es más beneficioso reducir su producción y conseguir un mayor beneficio a largo plazo. Pero también puede ocurrir lo contrario, porque uno de ellos obtenga una ventaja competitiva, p.e., menores costes de producción, lo que le inducirá a romper el equilibrio colusorio y tratar de capturar una mayor cuota de mercado a costa de su rival. Como ambos saben que esa posibilidad existe, cualquiera de los dos puede anticiparse a ese movimiento rompiendo el acuerdo implícito. Por este motivo, en mercados donde la tecnología y la innovación son característica básica es difícil que se generen escenarios colusorios estables.

(14) Multivariable, ya que el argumento es el vector de las estrategias de cada uno de los jugadores (además, cada una de estas estrategias puede estar definida por diferentes parámetros). Multivaluada, ya que el "valor" de la función es el vector de los resultados (o pagos) que obtendrán los distintos jugadores.

(15) Por ejemplo, si una de las empresas mejora su eficiencia reduciendo costes, tiene incentivos a producir más, ya que su beneficio unitario aumenta. Se produce así un desplazamiento del equilibrio de Nash, ya que al otro competidor le interesa entonces producir menos. Curiosamente puede conseguir un efecto similar simplemente con convencer al competidor de dicha mejora en la eficiencia, aunque ésta en realidad no sea cierta.

(16) Estos elementos de valor serían los incentivos, que pueden ser positivos o negativos ("premios" o "penalizaciones").

(17) Pensemos, por ejemplo, en el papel del Regulador evaluando el grado de competitividad alcanzado en el mercado.

(18) A pesar de todas las posibilidades que ofrece Internet, cuesta imaginar que un turista japonés, que llega a Barajas tras un vuelo de muchas horas, analice el callejero y la información actualizada de tráfico, para decirle al taxista cuál es la ruta que desea para llegar a su hotel.

para modificar este comportamiento. Dicho cambio consistiría en reducir el pago por kilómetro adicional y, a cambio, implantar una tasa inicial de "bajada de bandera" y/o por recogida en el aeropuerto. Si estas tarifas están bien calibradas, el ingreso medio por kilómetro puede ser más o menos el mismo que antes, pero ahora el incentivo para el taxista consiste en realizar el mayor número de carreras posible, para obtener así la recaudación extra que le reporta ese pago inicial, por lo que intentará que cada recorrido sea lo más corto posible, es decir, su empeño será conseguir la ruta óptima. La nueva tarificación (el mecanismo) ha conseguido alinear el interés "social" en la eficiencia con el interés particular del taxista en obtener el mayor ingreso posible. Además, dicho mecanismo ha promovido la revelación voluntaria de la información privada que tenía el taxista sobre cuál era, a su juicio, la ruta más adecuada[19].

Este último punto, la información privada del agente revelada voluntariamente gracias al mecanismo, puede ser absolutamente vital en el proceso de formación de precios, y por tanto en la distribución adecuada de recursos. El diseño de subastas es un ejemplo claro de ello. En principio, una subasta es un mecanismo de asignación de un bien al postor que más lo valore. Puesto que dicha valoración debe reflejar el beneficio que se espera obtener, la eficiencia se presume asegurada, ya que el ganador sería quien mejor uso hará del bien subastado. Sin embargo, ya que las valoraciones de los postores son privadas (el subastador las desconoce), y cada uno de ellos tiene incentivos a ocultar la suya, si así puede conseguir ganar la subasta al precio más bajo posible, puede ocurrir que el precio final de venta no refleje las verdaderas valoraciones, e incluso que el ganador no sea aquél para quien hubiese sido más beneficioso conseguirla. El incentivo a no revelar esa información puede ser anulado mediante un mecanismo de subasta muy ingenioso: la denominada subasta de Vickrey o de "segundo precio", que consiste en que gana la subasta la puja más alta pero pagando solo el valor de la segunda. En esta subasta lo óptimo para cada participante es pujar exactamente por el verdadero valor que otorga al bien subastado, ni más ni menos, ya que una puja menor disminuye sus probabilidades de ganar, sin suponerle ningún beneficio a cambio, pues el precio a pagar en caso de ganar seguiría siendo el mismo. Es decir, el mecanismo ha generado un incentivo a la declaración honesta del valor, lo que asegura que gana quien valora más el bien y que paga un precio muy orientado a dicho valor.

Pero tan importante es el mecanismo en sí mismo como el objetivo que subyace en su utilización, a saber, dejar que el mercado fije los precios, en lugar de intentar suplantarlo por la visión subjetiva del regulador. La utilización de mecanismos permite además hacer que se manifieste el valor real de los intercambios, porque los precios, en contra de lo que afirman los modelos neoclásicos, no se fijan en función de los costes de producción, sino que dependen del valor (utilidad) que asigne al bien quien lo consume. Este valor está vinculado a su vez al grado de satisfacción que se atribuya a los bienes a los que se renuncia como consecuencia de dicho consumo. Es el concepto de utilidad marginal lo que está detras de las decisiones de los individuos y no el coste marginal, tal y como la tradición neoclásica en general y la regulación en particular han supuesto erróneamente.[20]

Los mecanismos de revelación de información pueden servir también como forma indirecta de discriminación de precios, con efectos muy positivos en cuanto a creación de excedente total. Supongamos que un producto se vende en un supermercado a un precio inicial **B**, e imaginemos el siguiente mecanismo: Subamos un poco el precio hasta el valor **A** (**A**>**B**) y ofrezcamos un descuento "**d**" a quien rellene y entregue un determinado formulario, de manera que para aquellos que lo hagan, el precio efectivo será **A**-**d**, que es menor que el antiguo precio **B**, es decir, **A**>**B**>**A**-**d**. El mecanismo es beneficioso para el vendedor, pero no porque haya incrementado su precio (con un d adecuado el precio medio resulta ser aproximadamente el mismo), sino porque habrá conseguido un aumento de la demanda, ya que hay clientes que antes no podían acceder

(19) Pero, como se ha dicho, es fundamental la calibración adecuada de dicho mecanismo, para conseguir el objetivo deseado, ya que si p.e. "la bajada de bandera" es demasiado alta y el precio por kilómetro adicional demasiado bajo, el taxista solo estaría interesado en realizar recorridos muy cortos, desechando el resto de clientes. Por otra parte, el objetivo debe ser que el usuario consiga un precio medio más asequible, y que el taxista esté incentivado a conseguir más ingresos por un desempeño más eficiente del servicio (sirviendo a más clientes), por lo que es fundamental que en dicho sistema de tarificación se tenga en cuenta la demanda y el coste de oportunidad.
(20) En este sentido, Buchanan recuerda que Adam Smith ya estableció que el valor de intercambio entre las mercancías es lo que establecía realmente su coste de producción, pero ello no debe interpretarse como que el precio de mercado deba ser igual al coste de producción, sino que se refiere más bien a un coste de oportunidad. James M. Buchanan. Costs and Choices. P.5.

al producto a un precio **B** y ahora sí lo hacen a un precio **A**-**d**. El mecanismo ha servido para que los clientes revelen voluntariamente información sobre su disposición a pagar por el producto, ya que el descuento solo se aplica a aquellos que han realizado el esfuerzo de cumplimentar el folleto, lo que significa que valoran más dicho descuento. Quienes no lo hacen, revelan que están dispuestos a pagar el precio **A**, por lo que puede considerarse que el mecanismo ha servido para transferir parcialmente parte del excedente de dichos consumidores y destinarlo a la subvención que supone el descuento, y que permite la entrada a nuevos consumidores[21].

Regulación por incentivos en el sector de las Telecomunicaciones

Históricamente la regulación se ha planteado como un medio de corregir algunos fallos de mercado (según una perspectiva neoclásica del mismo), fallos que permitían o fomentaban comportamientos de las empresas y que no eran deseables, por su incompatibilidad con determinados objetivos sociales. La dificultad básica de esta misión es la derivada de la asimetría informacional, ya que el regulador no suele disponer de información suficiente sobre la demanda del mercado o sobre la estructura de costes del proceso productivo, lo que hace muy difícil establecer un objetivo óptimo que aúne maximización del bienestar social con eficiencia en el uso de recursos y rentabilidad/viabilidad para las empresas.

Incluso en un mercado monopolista es muy complicada la determinación de dicho objetivo regulatorio, a pesar de que aparentemente se trata sólo de conseguir que el monopolista alcance la producción óptima y no permitirle contraerla hasta el nivel que a él más le beneficia.

En principio, podría pensarse que la producción óptima es aquella que maximiza el excedente total[22], es decir, el nivel en el que el beneficio global de consumir una unidad adicional supera el coste de producirla, o equivalentemente, producir con un precio igual al coste marginal. Ahora bien, en presencia de economías de escala (fruto, por ejemplo, de la existencia de costes fijos), los costes medios son decrecientes y, por tanto, superiores a los costes marginales, lo cual significa que la facturación a coste marginal implica pérdidas para la empresa, y es insostenible a medio plazo[23].

Es necesario entonces hacerse otro planteamiento y buscar un óptimo que sea compatible con dicha viabilidad empresarial. Este “segundo óptimo” consistiría en facturar a precio medio, lo que implica precios mayores y una demanda menor. Se reduce el excedente de consumidor, pero a cambio se permite al productor recuperar costes. En presencia de economías de alcance, los mismos factores pueden utilizarse para la producción de diversos productos, por lo que la asignación de costes no está predeterminada, los precios medios se podrían establecer de muchas formas y hay que encontrar cuál de ellas maximiza el excedente total. La resolución de este problema conduce a los llamados “precios de Ramsey” que, permitiendo recuperar costes, cumplen esa misión de maximizar el bienestar social[24]. Estos precios son básicamente una modulación por la elasticidad precio-demanda de cada producto, de manera que se aumenta el precio de aquéllos que son menos elásticos y se reduce el de los que lo son más.

A todas las dificultades inherentes a la determinación de ese supuesto objetivo ideal de bienestar global desde la perspectiva neoclásica, hay que añadir las puramente técnicas, derivadas de la complejidad de recopilar información sobre la demanda del mercado y su análisis para determinar las elasticidades directas y cruzadas de los productos.

Además, y lo que quizás es el punto más importante, los supuestos teóricos de los que se partía no acaban de reflejar la verdadera esencia del mercado que se pretende regular, precisamente por la propia interpretación que subyace del concepto de precio. La verdadera pugna conceptual es aceptar que éstos deben servir de instrumento de control de costes, frente a la idea más novedosa de que dichos precios son un simple reflejo de la utilidad apreciada por el mercado. Es el mercado el que, mediante un complicado proceso de priorización de alternativas y de valoración de la

(21) De hecho, esta discriminación de precios es algo muy común en los mercados de Internet y en general en los conocidos como multi-sided markets (ver David S. Evans: The Antitrust Economics of Multi-Sided Platform Markets. Global Competition Policy. LECG. 2004. P. 246).
(22) Suma de excedente del consumidor y del beneficio de la empresa.
(23) Efectivamente el excedente total es máximo, pero se ha producido a costa de aumentar mucho el excedente de consumidor a costa de beneficios negativos para las empresas. Dado que son éstas las que deciden sus niveles de producción, no cabe esperar que anhelen alcanzar este “máximo social” del que resultan ser la parte perjudicada.
(24) Ver, por ejemplo, la aplicación que desarrolla Antonio García Zaballos en su artículo “Economic foundations of price setting and the effect of regulatory policy on case studies”, publicado en este mismo número de la *Revista Política Económica y Regulatoria en Telecomunicaciones*.

utilidad que aporta cada una, establece dichos precios, que no son más que un sistema de señalizar cuál es la manera óptima de distribuir los recursos de producción, y es por esta vía indirecta por la que finalmente se deciden los costes.

El método que más se utilizó durante décadas para regular de manera indirecta los precios de los antiguos monopolistas del mercado de telecomunicaciones fue el de la tasa de retorno, es decir, no permitirles obtener un beneficio relativo a sus costes superior a un determinado valor. La intención evidente era evitar que hiciesen uso de su posición de dominio del mercado, desanimándoles a establecer precios excesivamente por encima de costes. Sin embargo, el famoso estudio de Averch y Johnson (1962) demostró que este método fallaba en el objetivo de incentivar a minimizar el coste, pues una empresa maximizadora de beneficios que operase bajo este tipo de regulación, haría un uso ineficiente de los factores de producción, ya que si dicha tasa es mayor que el tipo de interés, le interesa hacer un uso de capital mayor del necesario[25]. Dicha empresa tampoco tendría demasiado interés en incrementar sus ingresos si el beneficio derivado superaba la tasa, lo que conducía a una falta de impulso innovador y de creación de valor.

La liberalización del sector supuso la aparición de competencia que, junto con el acelerado cambio tecnológico, pusieron de manifiesto que era necesario encontrar vías regulatorias nuevas, que proporcionasen incentivos a aumentar la eficiencia del mercado, mediante la participación de las empresas en las ganancias que dicha eficiencia generase a la sociedad.

Este nuevo planteamiento se denomina regulación por incentivos, y puede definirse como la implementación de reglas que, concediendo a las empresas un grado parcial de discrecionalidad, las impulsen a alcanzar determinados objetivos deseables. Discrecionalidad parcial significa que aunque a la empresa se le incentiva a conseguir determinados objetivos, no se le especifica la manera de conseguirlos. Pero es parcial, de manera que sí que hay ciertas restricciones que han de ser observadas. En definitiva, se puede considerar que la regulación por incentivos consiste en el diseño de mecanismos que, "perturbando" solo lo necesario el "juego estratégico" que se desarrolla en un mercado, consigan alinear, lo más posible, los intereses particulares de maximización del beneficio empresarial con objetivos sociales de prestación de los mejores servicios al mayor número de usuarios.

Uno de los ejemplos más conocidos y utilizados de regulación por incentivos fue el método price-cap. A diferencia de la regulación por tasa de retorno, en el que los costes son indirectamente el factor de control, el sistema price-cap permite a la empresa regulada decidir los precios de su cesta de productos, siempre que el precio medio ponderado[26] no crezca más que el IPC menos un valor, previamente establecido, que representaría la ganancia de eficiencia deseada.

La regulación por price-cap demostró rápidamente su superioridad frente a la regulación orientada a costes a la hora de desencadenar incentivos deseables en las empresas, simplemente porque permitía a éstas poner el foco en la consecución de ingresos. El hecho de poder disfrutar de los beneficios extra que consiguiesen generar, espoleaba la competencia, pero también la eficiencia en costes, tanto a nivel estático, por ahorro de recursos, como dinámico, mediante el desarrollo de nuevas y mejores tecnologías. El principal problema residía, otra vez, en el hecho de que si no se establecían correctamente los márgenes de libertad de los precios, estos podían verse distorsionados gravemente, perdiendo su capacidad de señalización a la hora de atraer inversiones allí donde el mercado lo requiriese y donde se presentase la oportunidad emprendedora.

La conclusión que se puede obtener, a la vista de los resultados cosechados por éstos y otros muchos modelos de regulación, es que, en general, son mucho más fructíferos aquellos que desechan la vinculación precio-coste y persiguen más bien la promoción de la eficiencia dinámica y de la creación de valor[27]. Resulta intuitivo que los incentivos a la innovación quedan destruidos si se anula la ventaja competitiva que aporta la misma. Además, los mecanismos de orientación a valor son los que menos distorsionan el funcionamiento competitivo natural del mercado.

Por otra parte, se puede argumentar en contra de la creencia de que el mercado competitivo y la eliminación del peligro de abuso de posición

(25) Si es menor la situación se simplifica, ya que al empresario le resulta más rentable meter su dinero en un banco.
(26) Esta ponderación no es en absoluto trivial, y debe hacerse con cuidado para evitar incentivos perversos de subvenciones cruzadas que subvencionarían poder de mercado en los sectores donde la competencia sea más fuerte.
(27) Ver, por ejemplo, Cañizares Pacheco, E., "La regulación de las telecomunicaciones en España: una visión prospectiva, *Política Económica y Regulatoria en Telecomunicaciones*, nº6, marzo 2011.

dominante solo pueden conseguirse mediante la existencia de un gran número de competidores y la atomización de las cuotas de mercado. De hecho, incluso un mercado con un único productor puede ser competitivo, si se le dota de lo que Baumol denominó contestabilidad[28]. Esta idea está profundamente ligada a la teoría de juegos y al concepto de amenaza creíble. Un mercado es contestable si se reducen suficientemente las barreras de entrada y salida, de manera que el comportamiento del monopolista (de facto) se autodisciplina, ya que sabe que un margen excesivo se convierte automáticamente en una llamada a la entrada de competidores, que pueden entrar, hacerse con dicho margen (mediante un precio ligeramente inferior) y salir cuando el negocio deje de ser rentable. Esta disciplina se reflejaría también en la eficiencia, ya que costes innecesarios suponen una posibilidad de margen mayor y, de nuevo, una invitación a la entrada. La contestabilidad también asegura que no haya precios predatorios ni subsidios cruzados, ya que si se intentan aplicar precios menores al coste medio, se estaría también fomentando la entrada de competidores, que con una producción un poco menor pueden aplicar precios inferiores, puesto que los menores ingresos se ven compensados con un mayor ahorro en costes[29].

Las medidas regulatorias enfocadas a lograr esa contestabilidad conformarían, por tanto, un verdadero mecanismo, ya que "incentivarían" al monopolista a no hacer uso de su potencial poder de mercado, bajo la amenaza creíble de la entrada de competidores. Curiosamente, en esta situación la ausencia de dichos competidores no sería una señal de vicio sino de virtud, ya que indicaría que el mercado está funcionando de manera competitiva.

Ahora bien, en Europa este mecanismo se ha intentado aplicar mediante la implementación de la denominada "escalera de inversión"[30], con un gran impacto negativo en el desarrollo de redes de nueva generación, precisamente porque se establecieron unos precios mayoristas inferiores a los que habría establecido el propio mercado si los operadores hubiesen negociado entre ellos los precios, lo que ha generado una preferencia por la opción de alquilar la red a un tercero frente a la de invertir en una red propia.

Es necesario insistir en que el Regulador debería evitar caer en la tentación de fijar los precios del mercado, porque hacerlo conlleva un riesgo muy elevado de error, dada la imposibilidad de que pueda contar con toda la información necesaria y en manos de los agentes que intervienen, siendo el propio mercado el mejor mecanismo de revelación de esta información[31]. Si no se deja actuar al mercado según su dinámica natural la consecuencia será una evolución gradual hacia una economía cada vez más planificada, con lo que dejaría de tener sentido el proceso liberalizador iniciado en Europa en 1998.

Un ejemplo de mecanismo aplicado a la regulación del acceso a las NGN

La barrera de entrada más importante en la industria de las telecomunicaciones fijas es la red de acceso, también conocida como "última milla", que, por su grado de capilaridad, requiere para su despliegue de unos ingentes niveles de inversión. Con el fin de impedir que dicha barrera supusiese un obstáculo infranqueable a la competencia, la solución ampliamente aceptada fue considerar la red de acceso, propiedad del incumbente, como una "utilidad esencial", y crear un mercado mayorista de servicios de interconexión a dicha red, de prestación obligatoria a precios basados en modelos de costes de tipo LRIC, es decir costes incrementales de una red ideal construida nueva y con la tecnología más eficiente posible.

Ahora bien, la reducción de barreras de entrada, con el fin de promover la contestabilidad del mercado o de directamente reducir la cuota del incumbente, no debería suponer la subvención

(28) Ver Baumol, W., J. Panzar y R. Willig (1982), "Contestable Markets and the Theory of Industry Structure".
(29) Dado que los costes medios son decrecientes (al haber costes fijos y/o economías de escala), el beneficio sería "crecientemente" negativo con el diferencial coste medio – precio.
(30) El concepto de escalera de inversión se debe a Martin Cave y consiste en un modo de promover la competencia en infraestructuras, haciendo disponible de manera transitoria el acceso, de una manera fácil y barata, a los activos del incumbente, que no son fácilmente replicables por los operadores entrantes. Estos pueden así desarrollar su negocio y alcanzar niveles críticos de masa de clientes, que hagan viable la inversión en infraestructura propia y desligarse de su dependencia del incumbente, facilitándose un mayor dinamismo en la oferta de servicios. La transitoriedad en la disponibilidad de dichos servicios mayoristas y el ajuste adecuado de los precios de los mismos son factores clave para evitar el estancamiento en alguno de los peldaños de dicha escalera, que se produciría si desaparece la ventaja diferencial del ascenso al peldaño siguiente. El propio Cave ha planteado serias dudas sobre la eficacia del mecanismo en recientes artículos.
(31) Resulta notable el incremento de información solicitada por parte de la ANR para conocer los datos de los operadores del mercado, a un nivel cada día más exhaustivo, respecto a ingresos, promociones, tipos de servicios, empaquetamientos, segmentos de mercado y un largo etc. Solo para calcular los costes de las redes fijas, el regulador español contará en breve con 6 modelos distintos (costes históricos, corrientes, incrementales top-down, modelo bottom-up LRAIC para redes de banda ancha y modelo bottom-up LRAIC para redes de acceso de cobre, estos últimos, a su vez, con distintas hipótesis sobre tecnología, dimensionado, despliegue y criterios de amortización) y otros 3 para las redes móviles (históricos, corrientes y LRAIC, este último también en sus diversas variantes e hipótesis).

de aquellos operadores que, siendo potencialmente ineficientes, se ven amparados por el uso a precio de coste de unas infraestructuras que pueden terminar convirtiéndose en simples comodities[32], destruyendo el incentivo a conseguir las ventajas competitivas que su mantenimiento y mejora supondrían. La orientación de precios a costes LRIC implica además obviar el coste de oportunidad del incumbente, y trasladarle a él todo el riesgo asociado a las inversiones necesarias para la migración a las nuevas tecnologías de acceso. Este riesgo, ya de por sí enorme en una situación de evolución técnica lenta, se multiplica ante la posibilidad de aparición de otras nuevas tecnologías rupturistas que dejen obsoletas las previamente elegidas, o por la incertidumbre sobre cómo responderá la demanda ante los nuevos productos/servicios que se desarrollen.

Vamos a intentar describir, desde la perspectiva de la teoría de juegos, el impacto de la regulación de precios mayoristas en el acceso a la red de acceso fija, especialmente en lo relativo al futuro desarrollo de redes de nueva generación. En primer lugar, hay que tener en cuenta que, a pesar de que en principio se trata solo de regular a costes incrementales los precios mayoristas, de ello se deriva también un control indirecto sobre los precios minoristas, dado que los operadores usuarios de dichos servicios mayoristas deben poder replicar, inmediata y ventajosamente, la oferta del incumbente. La regulación mayorista induce, por tanto, una orientación a costes de los precios minoristas. Esto significa que el incumbente no tiene incentivos a desplegar nuevas redes que aporten mayor calidad y permitan el desarrollo de nuevos servicios, ya que la obligación de ofrecer el acceso a las mismas a precios LRIC significa diluir cualquier posible ventaja competitiva que dicho riesgo inversor hubiese podido aportarle. A su vez, los operadores entrantes, usuarios de dichos servicios mayoristas, no sienten tampoco necesidad de arriesgarse a desplegar sus propias infraestructuras, dado que pueden disfrutar de las del incumbente (las actuales o las nuevas si se decidiese a implantarlas) a unos costes probablemente menores de aquellos en los que habrían incurrido con redes propias. Por tanto la no inversión en NGN, si bien no es una estrategia estrictamente dominante[33] para ninguno, se convierte en un equilibrio de Nash, por la comodidad de unos y la desmotivación del otro.

El problema a resolver por el regulador consiste en prever cuáles son las estrategias de que dispondrán los operadores, cuáles serían sus decisiones más probables a la hora de elegir una de estas estrategias, y a qué resultados conducirán las mismas, en función de que se decida o no a regular los precios mayoristas del acceso a banda ancha.

En un mercado no regulado, el operador entrante debe decidir entre dos posibles estrategias, invertir o alquilar, y en el caso del operador incumbente la disyuntiva se reduce a negociar condiciones de precios mayoristas con su competidor, o no hacerlo y evitar alquilarle un acceso mayorista. A cada uno de los pares de decisiones posibles le asignaremos un valor y su representación, mediante la clásica bimatriz de pagos. Nos permitirá descubrir la existencia de equilibrios de Nash.

Supongamos que el valor total del mercado generado por los servicios vendidos sobre las nuevas redes de fibra se estima en 100 y que el coste de construir una red de fibra para atender esa demanda es de 40. El valor neto de ganancia para los operadores que vendan servicios sobre fibra es por tanto 60.

Ahora bien, si el operador dominante decide negociar un servicio mayorista, consigue maximizar el número de conexiones y captura, por ejemplo, la mitad del mercado[34], ganando 50-40+20, siendo 20 los ingresos mayoristas, por lo que su valor neto es 30. El operador entrante facturaría por valor de 50 y pagaría 20 por el servicio mayorista, obteniendo también un valor de 30.

También puede ocurrir que uno de los dos no quiera negociar o que no lleguen a un acuerdo, por lo que cada uno de ellos tendría que desplegar su red en solitario; el dominante generaría un valor de 50-40=10, y el entrante tendría que hacer lo mismo, generando también 10 de valor neto.

(32) Mercancía sin apenas diferenciación. Existe una cierta tendencia a ver a las redes de telecomunicaciones como simples tuberías por las que circulan los datos. Esto es un grave error ya que infravalora entonces la capacidad de diferenciación y de añadir valor que tienen los operadores, cuando deciden invertir en la mejora tecnológica de dichas redes.
(33) Una estrategia estrictamente dominante es aquella que resulta óptima independientemente de lo que haga el oponente. En este caso, no invertir en NGN no es estrictamente dominante para el incumbente, ya que solo sería óptimo (o menos malo) mientras los entrantes tampoco lo hagan. Sin embargo, para los entrantes dicha estrategia será estrictamente dominante o no, en función de si se ven amparados por el paraguas regulatorio en el acceso mayorista a las redes del incumbente.
(34) Por simplicidad, suponemos en nuestro ejemplo que en el mercado hay solo dos operadores. Esta limitación, como veremos más adelante, no cambia la conclusión del ejercicio sino que la refuerza.

El juego así planteado es de información completa e imperfecta[35] (es decir, simultáneo), que podríamos representar de la siguiente manera:

Jugadores: {Incumbente, Entrante}

Mapa estratégico del Incumbente:

» Negociar Servicios de Alquiler de Red (S)

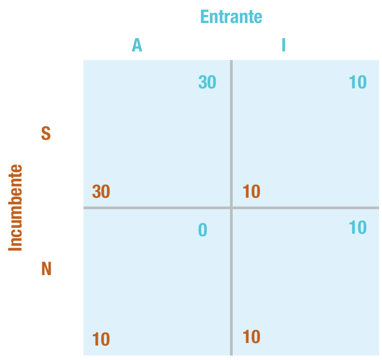
» No prestar dichos Servicios (N)

Mapa estratégico del Entrante:

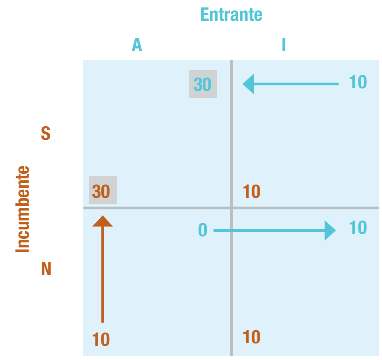
» Alquilar Red al Incumbente (A)

» Invertir en Red propia (I)

Matriz de pagos



Esta matriz presenta dos equilibrios de Nash, uno estable y otro cuasi-indiferente, como veremos a continuación:



- La situación (S,A) es un equilibrio de Nash estable, ya que unilateralmente ninguno de los dos jugadores saldría ganando si cambiase su estrategia.

- En la situación (N,A) el incumbente tendría incentivos a alquilar su red, ya que optimizaría ingresos vendiendo servicios mayoristas, servicios que el entrante estaría deseando poder utilizar.

- En la situación (S,I) el entrante tiene incentivos a cambiar su estrategia de invertir en red propia, ya que reduce sus costes si alquila los servicios mayoristas ofrecidos por el incumbente.

- La situación (N,I) es, en principio, un equilibrio de Nash, porque llegados a este punto ninguno de los dos operadores podrían mejorar su valor mediante una modificación unilateral de estrategia[36]. Sin embargo, la falta de incentivos a cambiar de estrategia por parte del incumbente, simplemente refleja indiferencia ante dicha acción, ya que si el entrante decide invertir en su propia red, al incumbente le va a dar igual ofrecer servicios mayoristas o no, ya que estos no serán ya requeridos. Por otra parte, si el entrante es consciente de que no dispondrá de servicios mayoristas, su única opción de permanencia en el mercado es invertir en red propia.

En este escenario, el equilibrio de Nash al que el juego competitivo conduce de forma espontánea sería simultáneamente un óptimo paretiano, un óptimo global y un óptimo particular para cada uno de los jugadores, de manera que no sería necesaria la acción reguladora (contemplada como mecanismo de un principal que quisiera reorientar el juego), puesto que tanto el mercado como los operadores salen beneficiados en el escenario competitivo natural y no regulado.

Ahora bien, cabe la posibilidad de plantear críticas a la forma tan sencilla en la que se ha planteado el juego, por lo que es necesario valorar la robustez de las conclusiones obtenidas y hasta qué punto son sensibles a las hipótesis de partida planteadas.

(35) Se refiere a que cada jugador debe tomar su decisión sin saber previamente cuál es la que ha tomado o tomará su oponente, y sabiendo que el oponente tampoco conoce previamente la del primero, por lo que éste no tiene forma de influir en la decisión de aquél mediante amenazas o promesas de colaboración.
(36) El incumbente podría decidir unilateralmente cambiar de (N,I) a (S,I). El valor obtenido pasaría de 10 a 10 (indiferencia). El entrante podría decidir unilateralmente cambiar de (N,I) a (N,A). El valor obtenido pasaría de 10 a 0 (peor estrategia).

El nivel de precios mayoristas

En primer lugar, el mapa de estrategias, aunque cualitativamente correcto, quizás debería ser contemplado como un rango de precios mayoristas posibles, en lugar de establecer como únicas opciones negociar un precio determinado o no hacerlo. Un rango de precios induciría también un rango de ingresos mayoristas para el incumbente y uno de costes para el entrante, y por tanto rangos diferentes de beneficios para cada uno de ellos, que podrían determinar nuevos equilibrios de Nash.

Aun siendo cierta la anterior afirmación, lo cierto es que la conclusión principal no se ve alterada, sino más bien reforzada, porque finalmente al Regulador no le importa tanto el precio mayorista final que se acuerde (que en cualquier caso puede verificar a posteriori, una vez se ha cerrado el acuerdo). Le sería suficiente con saber que el valor para el operador entrante podría estar entre un mínimo de 10 y un máximo de 30, pues el dominante tratará de ofrecer un precio a su competidor lo suficientemente bajo para desincentivarlo a invertir (por tanto el precio mayorista debería ser inferior al 20 de nuestro ejemplo), pero nunca tan bajo que anule el incentivo a alquilar su red.

Por tanto, el equilibrio de Nash reflejará el hecho de que el mejor escenario estratégico para ambos jugadores es negociar, aunque seguramente el valor neto que obtenga cada operador difiera del inicialmente planteado aquí, y dependerá finalmente de la revelación de información que se produce durante el proceso de negociación (precisamente la información que el Regulador nunca podría obtener mediante la regulación de los precios del mercado). No cabe duda de que si la amenaza de desplegar una red propia por parte del entrante es creíble, el precio mayorista del dominante tenderá a ser más bajo y el valor a ganar por ambas partes tenderá a igualarse, porque las opciones de alquilar o invertir, finalmente y desde el punto de vista del propio mercado, debieran ser económicamente neutrales. El mecanismo de revelación del mercado habría funcionado precisamente porque el Regulador no ha intervenido.

Hay otra conclusión adicional que se deriva de este juego competitivo y que habitualmente no es tenida en cuenta por los reguladores: en la medida en que los despliegues de red se realizan selectivamente, según la demanda concreta de cada zona, el escenario al que más probablemente se llegaría en un mercado no regulado sería el de un amplio abanico de precios mayoristas, ajustados a las características de demanda y costes de despliegue de cada zona en particular. La revelación de esta información a través del mecanismo natural del mercado es tremendamente útil para la toma de decisiones de los operadores, porque consigue una optimación de recursos que un Regulador jamás podría simular. Al mismo tiempo, el incentivo a invertir se ampliaría a un mayor número de zonas, cada una de ellas con el precio mayorista adecuado para hacer viable un despliegue de redes de fibra.

Competencia y precios finales del mercado

Tampoco es realista asumir que los ingresos minoristas del incumbente no se ven afectados por la estrategia del entrante (la mitad del valor del nuevo mercado), o lo que es lo mismo, que las cuotas de mercado no se ven alteradas como consecuencia de que se alquile o se invierta en la nueva red, ya que la cuota del entrante probablemente sea algo menor si se decide a alquilar la red del incumbente en vez de construir una propia, pues dispone entonces de un margen menor para diferenciar y añadir valor a sus servicios.

Sin embargo, este es un efecto que, de producirse, supondría un precio mayorista algo inferior al que existiría si el impacto sobre las cuotas de mercado fuese nulo, porque el incentivo a desplegar red propia es en ese caso algo mayor, y siendo la estrategia dominante de ambos operadores negociar, el incumbente tendría que hacer un mayor esfuerzo para convencer a su rival de que alquile la red. El valor neto de ambos tendería a aproximarse y la conclusión para el Regulador sigue siendo la misma: se produce la inversión y los operadores entrantes acuerdan con el incumbente un servicio mayorista.

La segunda duda que puede surgir en este apartado, es si los niveles de precios finales que se generan en un escenario con alquiler de red, frente a otro con inversión en infraestructuras alternativas, son necesariamente los mismos. En ausencia de una intervención regulatoria sobre los precios mayoristas, los precios minoristas serán sin duda superiores, pero esto es debido, de manera ineludible, a que los reguladores han fijado tradicionalmente esos precios por debajo de los de mercado, circunstancia que ha conducido a la ausencia de inversión en nuevas redes.

Sin esa intervención, será el proceso de revelación del propio mercado el que finalmente establezca si hay o no diferencias en el valor agregado del mercado minorista, pero es precisamente la negociación lo que permite traducir esa información revelada en un mayor o menor valor de la opción de alquilar la red, lo que a su vez se traslada al precio mayorista acordado, neutralizando las posibles ventajas de una de las opciones. Al final, insistimos, ambas tenderán a ser económicamente neutrales.

Es cierto que sería necesario ligar los ingresos y costes mayoristas y minoristas para tener una visión más real de la matriz de pagos. Pero este análisis no es relevante para la conclusión ni es el objetivo que persigue el Regulador, que en este caso quiere simplemente asegurarse de que existe el incentivo a negociar y no tanto estimar el precio final que, en cualquier caso, podrá conocer en un proceso de análisis ex post.

Otros modelos de juego posibles

También podría parecer poco realista plantear el juego como si fuese simultáneo, ya que se trata más bien de que el incumbente debe decidir si despliega o no su red (o a qué ritmo lo hace) teniendo en cuenta el precio al que cree que podrá ofrecer servicios mayoristas. Esto nos sugiere otras alternativas de representación.

Así por ejemplo, en un mercado no regulado podría considerarse un juego tipo Stackelberg, en el que existe información perfecta[37] y supuestamente completa por parte de cada operador sobre la función de costes que caracteriza a su rival, por lo que el incumbente sabe hasta qué nivel de precios mayoristas estaría dispuesto a pagar el entrante antes de tomar la decisión de incurrir en inversiones costosas para construir su propia red. Con esta información el incumbente decidiría su estrategia, ya que sabe si le interesa (y dónde) ofrecer o no servicios mayoristas. El nivel de precios mayoristas finalmente establecido decidiría el margen que le queda al entrante para construir su oferta sobre la red del dominante, y en teoría también el precio minorista óptimo con el que maximizar sus beneficios (si bien la incertidumbre existente sobre la demanda real de este nuevo mercado hace difícilmente abordable esta estimación sin un modelo de simulación adecuado).

El regulador, que debe decidir si el equilibrio de Nash a que conduce el juego es "bueno" o se puede mejorar, puede plantearse reconducir el juego (mediante la imposición de precios mayoristas regulados) hacia precios minoristas mejores, hacia una demanda agregada mayor o hacia una limitación de la estrategia del dominante (reduciendo así la capacidad de un posible abuso de dominio de mercado). Es decir, el regulador sería el principal, que diseñaría un "mecanismo" que reoriente el juego hacia un fin más "social".

El problema en este caso es que la acción del principal (el Regulador) debe estar claramente preestablecida y ofrecer estabilidad temporal para conseguir el objetivo perseguido (que se invierta en una nueva red), ya que si no es así, la estrategia menos arriesgada y que ofrece un mejor valor esperado es la de "esperar y ver", que es lo que actualmente está ocurriendo y que supone una gravísima ralentización del proceso inversor en infraestructuras.

El valor del mercado, en este escenario de juego dinámico, sería probablemente un resultado intermedio entre los teóricos límites 0 y 100, ya que el despliegue se haría de manera más selectiva y buscando economías de densidad, pero el problema es que a posteriori es imposible saber a cuánto asciende la pérdida de bienestar social como consecuencia de la pérdida de inversión (en un sector tan críticamente estratégico) que una intervención no acertada pueda provocar.

Esto nos lleva a un problema crucial de la regulación actual, como es la falta de un escenario predecible y creíble sobre su propio comportamiento. Si los operadores regulados han de tomar una decisión que les condicionará al menos durante los próximos 15 años, no pueden asumir el riesgo adicional de que el escenario de precios les sea cambiado sobre la marcha. De ser así el caso, nos encontraríamos ante un juego cuasi-repetido, con un mapa estratégico que iría variando (reduciéndose) con el tiempo y con él la capacidad de utilizar la amenaza de no despliegue por parte del operador inversor, a medida que la inversión física se hubiese ido realizando. A pesar de la complejidad teórica de este tipo de juegos, sí que es posible extraer una conclusión similar a la que se deduce de los juegos repetidos de duración finita, en los que al haber una

(37) Es decir, un jugador sabe que su decisión estratégica será conocida por su oponente antes de tomar su propia decisión. Pudiendo estimar la reacción del segundo ante los "hechos consumados" ofrecidos por el primero, éste puede elegir su estrategia óptima sin ninguna incertidumbre. Paradójicamente la desventaja del segundo proviene de disponer de más información y de que el primero lo sepa, lo que hace no creíbles sus amenazas de actuar de otra manera que no sea la racional y prevista por el primer jugador.

última etapa en la que no hay un futuro sobre el que influir, la no colaboración es unilateralmente beneficiosa, lo que se induce a la fase anterior, y así sucesivamente, hasta resultar que es unilateralmente beneficioso no colaborar, desde el inicio del juego hasta su fin. En efecto, si un jugador presiente que al finalizar la última fase del juego, o antes, puede sufrir un "castigo", su estrategia más óptima es anticiparlo al momento presente y, ante el riesgo de no poder reaccionar en su momento, asumir la no colaboración como mejor estrategia desde el principio.

Es decir, la falta de un escenario regulador creíble puede hacer inviable la negociación de las condiciones de prestación del servicio mayorista, ante el temor de que en algún momento posterior los precios pasen a estar sometidos a regulación, modificando radicalmente la matriz de pagos que veíamos en el ejemplo. Lo mismo puede afirmarse si alguno de los operadores tiene la expectativa de que el conflicto puede darle una ventaja frente a su competidor, pues en este caso acabará solicitando la intervención del regulador haciendo imposible que la colaboración surja.

La teoría de juegos y los nuevos mercados TIC

Un enfoque parecido puede hacerse en relación al asunto de la Neutralidad de la Red. Hay que tener en cuenta que las redes de telecomunicaciones actúan como plataformas que sustentan diversos mercados bilaterales, por ejemplo entre empresas de servicios de Internet y usuarios. Google o Spotify generan ingresos gracias a la publicidad o al pago directo de los usuarios de sus servicios. Ambas partes, empresas de servicios y usuarios, se ven beneficiadas por el desarrollo de transacciones que no serían posibles sin la participación de la red, a la cual acarrean unos costes derivados del tráfico generado. La neutralidad de red se puede entender como una cortapisa que impide el flujo natural de valor, desde los servicios hacia el operador de red que ha facilitado su desarrollo, impidiendo por tanto que se generen los incentivos a mejorar dicha red. Es más, por el lado de los usuarios, la neutralidad de la red incrementa la falta de riesgo moral en el consumo, exacerbando su heterogeneidad al no existir vinculación de éste con el precio, lo que finalmente conduce a un reparto cada vez más injusto de un recurso escaso, como es la capacidad de transmisión de datos por la red, así como a abortar el desarrollo de nuevos servicios, dada la imposibilidad de que funcionen correctamente sin una gestión adecuada de dicho recurso.

La neutralidad fomenta el equilibrio de Nash menos deseado, aquél en el que los operadores no tienen incentivos a mejorar su red, ya que esto supondría más tráfico y la canibalización total de sus servicios propietarios, sin apenas obtener ningún rendimiento del valor creado, y las empresas de servicios de alto valor añadido no se sienten impulsadas a la innovación, si saben que no contarán con una red que soporte con calidad dichos servicios y transmita al usuario todo el atractivo potencial que tienen.

Tal y como se mencionó al principio, uno de los objetivos del regulador debería ser fomentar las externalidades positivas e inhibir en lo posible las negativas. La bilateralidad del mercado de telecomunicaciones genera precisamente una enorme cantidad de externalidades positivas, es decir, de creación de valor a terceros. Las redes son el sustento de dichas externalidades positivas, pero sufre directamente la externalidad negativa que supone el coste asociado al incremento de tráfico creado por el uso de los servicios desarrollados. La Neutralidad de Red, si bien nace de buenas intenciones, puede tener consecuencias secundarias desastrosas, porque funciona como un dique que impide que fluya la marea de creación y transferencia de valor entre partes, deteniéndose también el flujo de transferencia de incentivos a crear dicho valor. Y sin incentivos no hay innovación en una parte fundamental de la cadena de producción de los servicios, llevando al colapso la red de telecomunicaciones, provocando precisamente el efecto que trataban de evitar los defensores de la neutralidad de red, que no era otra cosa que eliminar el riesgo de que la red se convirtiera en un cuello de botella a la expansión del mundo de las aplicaciones y contenidos en Internet.

Conclusión

Bastaría con que se constriñeran menos los precios mayoristas, eliminando la obligación de la vinculación a costes, para dinamizar el mercado y hacerlo verdaderamente competitivo. Para empezar, el posible abuso de posición dominante en dichos precios estaría prácticamente anulado por la existencia de las restricciones indirectas que sobre el mercado minorista impone la existencia de operadores de cable, que disponen de infraestructura propia[38]. Unos precios mayoristas adecuados y libremente acordados seguirían cumpliendo su función de apoyo a la entrada en el mercado, pero no anularían el incentivo a invertir, ya que una infraestructura propia y moderna aportaría mayores posibilidades de diferenciación y margen (vía efectividad en costes) que la utilización de la red del incumbente a precios ya no tan cómodos. Por su parte, el incumbente sería ahora consciente de que podrá disfrutar de gran parte del beneficio ligado a la creación de valor. Es decir, le interesaría invertir en conseguir redes más eficientes, para reducir costes, y también desarrollar una oferta lo más atractiva posible, basándose en las posibilidades técnicas de dichas redes. En resumen, los incentivos de ambas partes se refuerzan entre sí, ya que en este nuevo escenario a ninguno le interesa quedarse rezagado, de manera que la competencia en infraestructuras se convierte en el nuevo equilibrio de Nash. Es más, el operador incumbente contará con un fuerte incentivo a mejorar las condiciones mayoristas del operador entrante, para disminuir su incentivo a invertir en su red alternativa, con un impacto positivo sobre el mercado final, pues las ganancias de eficiencia se irían trasladando al mercado.

Como veíamos también con los procesos de subasta, el incumbente ofrecerá al entrante un precio mayorista que sea algo mayor al valor incremental que esperaba obtener con su inversión el entrante (pues en caso contrario preferiría invertir) y algo menor al valor incremental que perdería el dominante si el entrante dejase de comprar el servicio mayorista (pues si valor es el mismo preferiría no venderle). Sin necesidad de regularlo, el propio mecanismo de mercado sería capaz de revelar información para formar los precios mayoristas más eficientes, respetando los incentivos a la inversión. Si ya la simple dinamización de la oferta, y la eficiencia dinámica que aportaría este proceso, justificarían su apoyo regulatorio, no hay que olvidarse de las enormes externalidades positivas que se generarían, por ejemplo de creación de empleo o de impulso al desarrollo tecnológico del país, así como el avance de la tan anhelada sociedad de la información.

Si la política regulatoria persiste en su empeño de mantener una competencia artificial, creada a partir de unos precios mayoristas regulados, se acentuará el estancamiento del sector, dada la falta de incentivo inversor, y puesto que se ha desactivado el impulso natural a la evolución tecnológica de las infraestructuras, deberá ser el Estado, tal y como preveía Mises, el que se vea abocado a un gradualmente mayor intervencionismo.

El mercado mayorista de acceso a precios regulados orientados a costes incrementales, que pretendía ser una solución transitoria que impulsase el ascenso de la escalera de inversión, se está convirtiendo en realidad en un vehículo de descreme del mercado y de vaciado de capital, y en definitiva, en un status quo rígido pero insostenible en el tiempo. Las ventajas iniciales de reducción del precio minorista, gracias a la feroz competencia promovida, se van a ver ampliamente anuladas por el daño que la esclerosis del mercado causará al consumidor.

La teoría de juegos permite simular en gran medida el comportamiento de los agentes cuando se enfrentan a diversas situaciones, permitiendo establecer cuáles podrían ser las posibles estrategias dominantes y las situaciones de equilibrio de Nash, que corresponden a los desenlaces más probables y acordes a los intereses particulares de dichos agentes. Conocidas éstas, el Regulador estaría en mejor disposición de diseñar los mecanismos de incentivos más adecuados para reorientar el equilibrio del mercado en función de los objetivos más deseables, pero evitando fijar los precios, porque al regular éstos se anula por completo el mejor mecanismo existente para revelar la información relevante, que es el propio mercado.

(38) Sobre las restricciones indirectas en los mercados de banda ancha puede consultarse a Juan Carlos Huertas, Antonio García y Germán González, "Efecto de las restricciones indirectas de precios en el mercado español de acceso indirecto al bucle". *Política Económica y Regulatoria en Telecomunicaciones*. Nº1 Telefónica España. Septiembre 2008.

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Competition in The Wholesale International Roaming Market: Are there Theoretical Grounds for Regulation?

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Resumen

Los altos precios del roaming internacional han preocupado a los reguladores y ocupado a los analistas durante bastante tiempo. Desde una perspectiva minorista, los altos márgenes pueden explicarse teniendo en cuenta que el roaming no es un servicio que los usuarios, en general, tengan en cuenta al decidir suministrador, por lo que la competencia se centra en otros servicios en los que hay más posibilidades de que una disminución del precio incentive un cambio de operador.

Desde la perspectiva mayorista, sin embargo, la imagen no está tan clara. Contribuciones recientes encuentran justificaciones para la regulación basadas en la imperfección de las técnicas de enrutamiento del tráfico y en el carácter bilateral de los contratos mayoristas, que pueden llevar el precio de equilibrio por encima del nivel de precios competitivo, incluso cuando los operadores pueden elegir con total fiabilidad una red preferida. Este artículo tiene por objeto investigar si esas preocupaciones tienen una base sólida y si la fijación de precios regulados es la mejor solución regulatoria. Para ello se modelizan las negociaciones bilaterales en el mercado mayorista de itinerancia internacional, y se muestra que cuando es posible elegir la distribución del tráfico generado en un país extranjero entre las posibles redes visitadas la regulación no está justificada. Contrariamente a las conclusiones a las que llegaban estudios anteriores, asentadas sobre el supuesto de que sólo es posible seleccionar una red preferente por cada país visitado, la naturaleza bilateral de los acuerdos es en realidad, en este modelo, una fuente adicional de competencia, porque cuanto más tráfico generan mis clientes en el extranjero, más tráfico de los extranjeros en mi país estoy en disposición de captar.

Paradójicamente, la medida regulatoria elegida desincentiva las inversiones en técnicas de direccionamiento, por lo que la necesidad de intervención se convierte en una profecía autocumplida.

Abstract

High international roaming prices have puzzled and occupied analysts and regulators for quite a time. While on the retail side the problem seems to be well understood, and the high margins can be justified using Ramsey pricing logic, on the wholesale side the picture is not so clear.

Recent contributions find reasons for regulation at the wholesale level based on the existence of random traffic and on the bilateral nature of the wholesale deals, which raise the equilibrium prices even when operators can choose a preferred network. This paper intends to investigate whether or not those concerns are justified. This is done by modelling the bilateral roaming negotiations and extending the current models, assuming that home operators (the ones with a retail contract with the customer in its country of residence) can decide not only their preferred network in each visited country, but also the distribution of their outbound traffic among the visited operators. There are technological solutions that allow this steering, and the results change dramatically.

We find that when traffic steering is perfect the wholesale market is competitive, and that the lower prices are passed on to end users through competition for retail customers. Contrary to previous findings, the bilateral nature of international roaming wholesale deals is actually an additional source of competition, because the roaming out traffic (the traffic of an operator's retail customers abroad) and the roaming in traffic (the traffic of foreign customers that an operator is able to attract) are directly linked, and this creates an incentive for operators to lower the prices of retail roaming compared with a scenario of anonymous wholesale trading.

1. Introduction

Whether international wholesale roaming should be regulated is not a straightforward question: there are several suppliers per country and traffic steering techniques, which get more efficient by the day, allow visiting operators to direct traffic to preferred networks in the visited country. It is not obvious that there is a bottleneck that calls for regulators to intervene. Nevertheless, International roaming is regulated in the European Union since 2007. On the wholesale side, visited operators (those who host foreign users on their network and allow them to make calls and establish data sessions) have to comply with a cap on the average revenue per minute, per SMS and per Megabyte. The cap has to be complied on a yearly basis for each visiting operator (i.e. host operators cannot charge some visiting operators above the cap and others below the cap).

Previous papers on international roaming, most notably Bühler (2009), Shortall (2010) and Lupi & Manenti (2009), have focused on two possible market failures. One comes from what we can call "random traffic", the portion of traffic that cannot be controlled at all by the home operator (the one who has a retail contract with the customer) and is shared randomly among the visited operators. A second, more subtle, market failure, arises from the bilateral nature of the market (a single agreement involves operators acting as both sellers and buyers), which as the literature shows can under certain conditions give rise to high prices and inefficiencies even when traffic steering is completely reliable and a single preferred network can be selected.

The European Commission has shown sympathy for these views, and in fact it opened to consultation the idea of effectively banning bilateral trading as a "structural solution" to the problem of high roaming tariffs. For practical reasons it seems unlikely that such a solution will be implemented, but nevertheless the argument of lack of competition in the wholesale market remains uncontested and is commonly used by regulators to justify other measures like cost oriented price controls.[1]

The main purpose of this paper is to investigate whether the results of the previous literature still hold when we relax some of their assumptions. In particular it will be assumed, more realistically, that visiting operators can choose more than one preferred network, and decide the distribution of traffic among the networks in the visited country. As will be shown, this new assumption changes the outcome dramatically, and it no longer holds that the wholesale price is inefficiently high.

The remainder of the paper is organised as follows: sections 2 and 3 serve as a prologue,

(1) BEREC (2011) states that "... wholesale price regulation continues to be appropriate. There is no strong reason to believe that wholesale competition will be more intensive in the future than it has been in the past. On the other hand, costs of provision should reduce rather steeply, for example as a result of anticipated reductions in regulated mobile termination rates"

with a reflection on how to define the competitive wholesale price and a brief discussion of the "random traffic" market failure. Sections 4 and 5 contain the core of the analysis, first with a model in which there is no random traffic, but the home operator can only steer its outbound traffic (the communications of its customers abroad) to a single visited network, and then extending the analysis to the case of perfect steering. Section 6 discusses the link between the wholesale and retail international roaming markets. Section 7 concludes.

2. On the competitive wholesale prince

Mobile telephony, with its competing infrastructures and its large scale economies, presents a considerable challenge to traditional economics: it is obvious that marginal cost pricing is not a sustainable pricing strategy, but economists and regulators haven't been able to find a consensus on an alternative definition of the competitive price. This paper will not solve this issue, although a brief discussion is needed before we go on.

International wholesale roaming is in some senses not different from the rest of services provided through a mobile network. In fact, foreign operators could be thought of as another retail segment. We have come to accept naturally that it is not anticompetitive to use price discrimination and apply Ramsey pricing logic for retail pricing, just like it is done for instance in the airline industry. It is awkward then to insist on the need to price wholesale roaming at the level of marginal costs, or to suggest that the margin above marginal costs should be the same for all services.

Furthermore, there is an additional argument in favour of setting the price of wholesale above marginal costs: foreign operators can become competitors in the domestic market if the wholesale price is too low. Wholesale roaming is an access service that gives the buyer the possibility to connect end users to the network of the seller, and in principle nothing prevents buyers from using it for providing retail services other than international roaming, and particularly to use it as a substitute wholesale service to national roaming. Pricing it at marginal cost would induce competition in the home country from entrants who don't have to recover the fixed and common network costs. This is simply not sustainable, and even operators competing aggressively to attract inbound traffic (the traffic from foreigners visiting the country) can't price it below a certain level. In sum, it should be assumed that wholesale roaming prices have what we could call a competitive floor. When this floor is reached, competition is not on price but on other factors like quality and product differentiation.

For our purposes, it will be enough to define the competitive price as the price level below which operators are not willing to sell any inbound traffic. We will also assume that at that price or above it operators are not capacity constrained and can meet all the demand created by foreign visitors. Whenever prices are above this level, we will assume that the market is not competitive.

3. On the relevance of random traffic

The standard line on the history of roaming is that random traffic is a source of trouble, because it gives visited operators monopoly power and leads to high wholesale prices that are ultimately paid by travellers using their phone abroad. Lupi and Manenti (2009) show that when home operators have agreements with several networks in the visited country and there is some random traffic, the perceived wholesale price will always be above the competitive level.

The logic is as follows: each operator in the home country has roaming agreements with all networks in the visited country, but only one of them is selected as the preferred network. This network receives a certain percentage of the traffic, while the rest is "uncontrolled". If all networks had the same coverage, random traffic would be shared evenly. With *n* visited operators, each would receive 1/n of the random traffic. All the networks not selected as preferred networks are actually monopolists on their share of random traffic, and the only constrain for them is the impact of their decision on the retail price and indirectly on end user demand. The conclusion is that the expected wholesale price is above the competitive level. In fact, just like we see in mobile termination models, the higher the number of suppliers the higher the market price, because when the number of suppliers is large, each wholesale supplier taken individually thinks that their price has a low impact on the retail price.

No doubt, there are countless stories about the tricks used by visited operators to be the first to connect a foreign customer and keep it on a particular network. However, the devilish nature of random traffic should not be overestimated, for several reasons.

First of all, as long as there are several networks available in the visited country home operators have strong incentives to invest in traffic direction technologies, and there are several suppliers of solutions that make it affordable even to the smallest operators. Under these circumstances, it is doubtful that there is a market failure that requires regulation. It might just be that traffic routing is simply another cost element that enters into the production function like any other.

Secondly, we must not forget that random traffic can only take place when the home operator decides to permit their customers to connect to several networks. If an operator feels it is being overcharged in its random traffic, and cannot afford traffic steering, there is always the alternative of barring connections to all networks but one. The end users would have access to the same quality that the residents of the visited country get, and the home operator would be able to choose among competing networks. Barring can also be used as a temporary measure to put pressure on visited operators and force them to lower the price, with the effect that after some time the measure is lifted, the perceived wholesale price is reduced and the roamers can continue enjoying the benefits of multi-network coverage.

Finally, random traffic is many times just lack of coverage from the preferred operators. Good coverage is expensive, and the operators who have invested on it are entitled to use it as a competitive tool, and charge a premium for it. Again, it is not clear that regulators should step in and set a price cap, and if they do they should consider that the "problem" exists only in high cost areas.

4. Traffic steering to a single network

Up to 2009 random traffic was considered by regulators and analysts as the only source of inefficiency in international wholesale roaming, and the justification for regulation. An influential paper by Tony Shortall then hinted that there could be something else. In short, he showed that the wholesale price is not the only competing tool in the hands of visited network operators: those with a large retail roaming customer base have an advantage because they can use it to exchange traffic and attract the biggest visiting operators to their network.

This section extends the model of Shortall (2009), looking more in depth at the "wholesale game" but keeping the main assumption, namely that traffic can only be steered to a single network. To begin, a simple numeric example is useful to grasp the main insights of this scenario.

Let's suppose that there are two countries and two operators in each country. Following Shortall (2009) we will suppose that each operator has a fixed amount of traffic to "send" to the other country, and that this amount is not affected by the wholesale price. This might seem at first sight like a quite strong assumption, but it helps focus the analysis in a simple way in the strategic game being played at wholesale level[2].

Country "B" sends 50% more traffic to country "A" than it receives, and in both countries there is an incumbent with a 70% market share and an entrant with a 30% share. Incumbents are denoted in capital letters, and entrants in small letters. The fixed amounts of outbound traffic are:

Operator A	70	Operator B	105
Operator a	30	Operator b	45
Total traffic country "A"	100	Total traffic country "B"	150

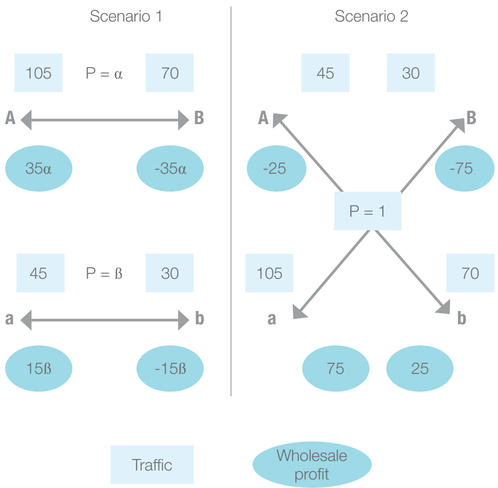
Let's normalize the competitive wholesale price to 1, and assume that it is the same for all four operators. Recall that this means that none of them finds it worthwhile to offer international wholesale roaming below that price level.

We first want to find out if, at the competitive wholesale price, there is a combination of bilateral relationships that dominates the rest, in the sense that a pair of operators, one from each country, can't find a better alternative than to buy from each other.

The following graph shows the wholesale profit (outbound costs minus inbound revenues)

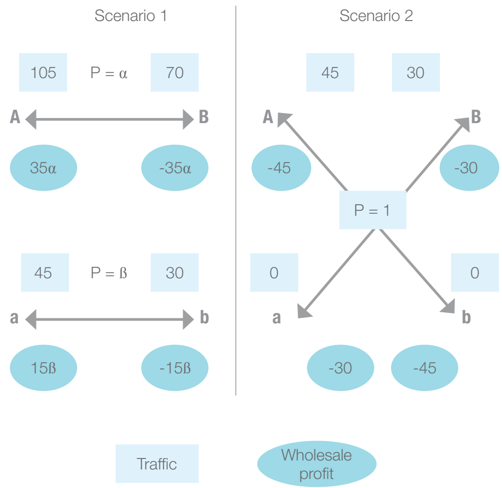
(2) We discuss the impact of the wholesale game on the retail market in a later section of the paper, but for the moment note that introducing elasticity in the retail demand would reduce the equilibrium wholesale prices as visited operators try to increase wholesale revenues.

for the different operators under the two possible combinations of bilateral agreements. Under scenario 2 the incumbents commit their traffic to the entrants in the foreign country, and use their negotiating power to force them to accept the competitive wholesale price (p=1). Under scenario 1 the incumbents and the entrants partner with their respective peer in the foreign country, and agree on a price that potentially could be above the competitive price.



It is clear from the graph that for the incumbents the best alternative is to exchange their traffic: if "B" pays "A" anything between 35 and 75 monetary units they both end up better off than under scenario 1, and for "A" it is a feasible agreement because the price agreed "a" is at least equal to one. We cannot anticipate what the wholesale price between the incumbents would be, but we can define a range: the result of the game is that "A" and "B" mutually agree to exchange their traffic at between one and 2.14 times (75/35) the competitive price[3].

Regarding the entrants, once the customers of the incumbents are out of their reach their options are to commit their traffic to each other or to buy from the incumbents at the competitive price. The outcome of the two alternatives is represented in the next graph.



Scenario 1 is feasible (p≥1) and better for both entrants if "b" makes a payment to "a" which lies anywhere between 15 and 45. Again, the net seller has more to lose than the net buyer if an agreement is not reached and we could expect the price agreed to be closer to the lower end of the range.

We are now in a position to develop the game algebraically and draw some general conclusions:

Assume there are two countries, "A" and "B". The operators with more outbound traffic in each country (the "incumbents") are denoted with capital letters, and the other two with small letters (the "entrants"). Without loss of generality, we will suppose that:

$$T_B > T_A > T_a$$

And

$$T_B > T_b$$

The game begins with the incumbents agreeing on a price. Staring with "B", there are two alternatives open: choosing the entrant or the incumbent in the other country. These are the outcomes in each of the two alternatives:

$$\Pi_B(A) = P_A \cdot (T_A - T_B)$$
$$\Pi_B(a) = P_a \cdot (T_a - T_B)$$

(3) Note however that "A" has more to lose if an agreement is not reached, and therefore we could expect the price to be closer to 1 than to 2.14.

Where P_i is the price agreed by operator "B" with operator i, and Ti is the outbound traffic of operator i.

If we normalize to 1 the lowest price at which the operators would provide wholesale roaming services (the "competitive floor"), we obtain that "B" would choose "A" as long as

$$P_A \cdot (T_A - T_B) > (T_a - T_B),$$

which gives us the highest price that "A" can ask for without losing the traffic of operator "B":

$$\max(P_A) = \frac{T_a - T_B}{T_A - T_B} = \frac{T_B - T_a}{T_B - T_A}$$

This price is higher than pa=1, because TB>TA>Ta, and we can therefore conclude that if "B" acts as a price taker, he would be paying a price above the competitive price.

If "B" does not act as a price taker, but instead recognizes that the bilateral agreement is also the best alternative for "A", and negotiates the price accordingly, its negotiating power would increase, and would be determined by the best alternative open to "A", namely to sign an agreement with "b". Exactly how good this alternative is for "A" depends on its negotiating power with "b", which in turn depends on how much "b" would lose if it signed with "a" as an alternative to "A". Intuitively, the bargaining power of each incumbent when setting the conditions of their bilateral deal depends on the attractiveness of the entrant in its home country as an alternative partner. The following graph tries to make this clearer:

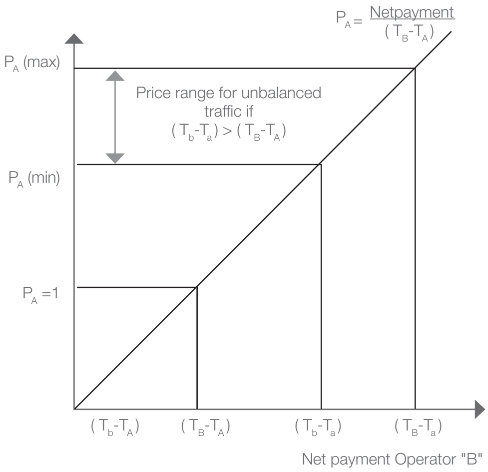


Figure 1:
The negotiation betwen incumbents

The negotiation between incumbents

The x-axis contains the wholesale net payments (outbound costs minus inbound revenues) made by operator "B" to operator "A". First note that at most "B" would accept to pay a total of (TB-Ta), which is the payment he would have to make if it partnered with "a" at the competitive price. To determine the minimum price that "A" would offer to "B", we need to look at his alternative, that is, at the wholesale profit it would make partnering with "b". At the competitive price, the profit of "A" would in this case be (Tb -TA), but as the graphic shows, "A" is in a good bargaining position vs. "b" because "a" (the alternative for "b" as a partner) has less outbound traffic to offer. At the competitive price, "b" would pay "a" a net payment of (Tb-Ta), which is also the most that "b" would accept to pay to "A", and as consequence the least that "A" would offer to "B"[4].

Some interesting insights can be extracted from the graph:

When outbound traffic from country "A" is divided evenly between operators "a" and "A" (Ta and TA are equal), operator "B" can reach an agreement at the competitive price, irrespective of its share in the outbound traffic of country "B".

When "A" has a large market share in outbound traffic, and operators "b" and "B" share the outbound traffic of country "B" evenly, "A" can extract from any of them the maximum they are willing to pay, and charge above the competitive price. However, this maximum is lower than it would be if outbound traffic market shares in country "B" were more asymmetric.

As outbound market shares in both countries become more asymmetric, the range between the minimum and maximum prices that could be agreed between the two incumbents grows, but it is not possible to say beforehand what the agreed price would be.

Regarding the entrants, let's assume that "b" is the net outbound operator. Since "A" and "B" have already committed their traffic, the options open to "b" are the following:

$$\Pi_b(A) = -P_A T_b$$
$$\Pi_b(a) = P_a \cdot (T_a - T_b)$$

Let's also set PA=1 as the lowest price that "A" is willing to offer. Following the same logic as before,

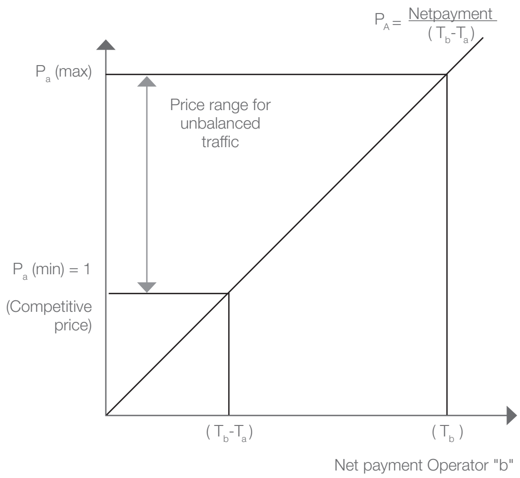
(4) More rigorously, the least that "A" would offer is the maximum between (TB-TA) and (Tb-Ta), because "A" would never sell below PA=1

this means that "a" can charge "b" a maximum price of:

$$\max(p_a) = \frac{T_b}{T_b - T_a},$$

which is above the competitive price. The bargaining power of "b" comes from the fact that for "a" the agreement between entrants is also the best alternative. Without an agreement, "a" would have to pay to "B" a quantity equal to Ta at the competitive price. Taking into account that "a" would never sell below the competitive price, the two entrants would agree to exchange their traffic for a net payment that lies somewhere between (Tb-Ta) and (Tb).

Figure 2:
The negotiation betwen entrants



The negotiation between entrants

It is interesting to see that when Tb is sufficiently large, the entrants could end up agreeing on a higher unbalanced price than the incumbents. The difference between the two maximum prices is given by

$$\frac{T_a}{T_B - T_A}.$$ [5]

Simplifying a bit, this means that smaller operators in outbound countries are at a disadvantage, and that this disadvantage is reduced as the entrants in the visited country gain market share, and is greater when the two countries have roughly balanced roaming traffic between them.

Summarizing the main results, this section has shown that when traffic steering is limited to a single network, the incumbents and the entrants in the two countries would naturally match with each other. It has also shown that being tied to just one partner is problematic for the net outbound operators, who usually (but not always) would pay a price above the competitive wholesale price. The root of the problem lies in the fact that the unbalanced traffic has to be routed to a network that is not (or at least not only) selected based on the price, but on the amount of traffic that can be exchanged. This takes us to the next section, where it will be taken into account that operators can select more than one preferred partner and decide how much traffic is sent to each of them.

5. Perfect traffic steering

Up to now the analysis has developed along the lines of the previous literature, reaching similar conclusions, namely that even when the traffic is steered to a preferred network there is something inherent in the wholesale dynamics of international roaming that drives the wholesale price up and calls for regulatory intervention of some short. However, it would be wrong to conclude that this is always the case, because we assumed that all the traffic is steered to a single network, and that was the

(5) To see why, note that

$$P_A = \frac{T_a - T_B}{T_A - T_B} = \frac{T_B}{T_B - T_A} - \frac{T_a}{T_B - T_A}$$

and with equal market shares

$$\frac{T_b}{T_b - T_a} = \frac{T_B}{T_B - T_A}$$

key that gave net inbound operators the power to leverage on their outbound traffic and charge a premium. In reality, nothing prevents operators from committing traffic with several partners, and those paying a premium have a big incentive to work on that direction and develop better traffic steering techniques. Unsurprisingly, operators usually sign preferred network agreements and volume discounts with more than one operator per country, which suggests that the technology already permits the control of the supplier mix[6].

With perfect traffic steering and identical network coverage, it is evident that any unbalanced traffic will be charged at the competitive wholesale price, because if it were not the buyer would just route it to another network. Outbound traffic still serves as a magnet to attract foreign customers, but it does not affect the price of unbalanced traffic, and its attraction power is lower. To see the impact of traffic steering on inbound traffic market shares and total profits, we can use the numeric example of the previous section.

Country "A" receives a total of 150 units of traffic, which can be steered to operator "A" (70 units of outbound traffic) and operator "B" (30 units). Each operator can, through traffic commitment agreements, at least equal the inbound traffic and the outbound traffic[7], and the remaining 50 units would be shared between them in an undefined way.

Country "B" receives 100 units of traffic, and operator "B" could get at most all of it, and at least 55, if operator "b" manages to balance its traffic completely and therefore gets 45 units of inbound traffic, which is the maximum it can aim for.

The results in monetary units are shown in the following chart. For simplicity, it is assumed that all traffic, and not only the unbalanced portion, is charged at the wholesale competitive price. This does not change the net outcome. The results from the previous section are also included.

In terms of inbound traffic market shares, the differences between the two scenarios are the following:

OPERATOR	SINGLE NETWORK STEERING	PERFECT STEERING
A	70%	min 45%, max 80%
a	30%	min 20%, max 55%
B	70%	min 55%, max 100%
b	30%	min 0%, max 45%

The main point to take away from the charts is that outbound traffic market shares still have an impact on inbound market shares, but the link is severely weakened because now there is an additional competitive tool that was not present under single network steering. Since it is assumed, as discussed in section 2, that the competitive wholesale price is higher than the short term marginal cost, there is a powerful incentive for operators to compete for inbound traffic through means different than price. The quality of the wholesale service itself becomes a critical factor, and more relevance is now given to issues like whether or not intelligent services are available, or whether or not the wholesale invoicing platforms are flexible and make it possible to differentiate prices based on end user identities. For operator A in our example, for instance, quality of service can mean raising their inbound market share from 45% to 80%.

It is important to highlight the differences and similarities between the scenario just described and a hypothetical organised exchange where by definition buyers and sellers are anonymous and mutual roaming agreements are not possible. The most important similarity is that in both cases the price would be the competitive wholesale price. One difference is that under perfect steering outbound market shares have an effect on inbound market shares, whereas under anonymous trading outbound and inbound shares are independent. A second and more important difference is that the incentives for innovation on wholesale services are very different. To ensure liquidity, the owners of the exchange would have to standardise the wholesale service, and any innovation would have to come from them, or agreed by the users of the exchange through a painful coordination process. Besides, there would be no competitive gains from innovation, because everyone would have access to it at the same time. On the

(6) Indeed, a simple query in Google shows that the first results for "traffic steering" are links to suppliers of steering solutions. These claim that their solutions can "... monitor and detect the smallest deviation of roamers' usage levels, profile them, and automatically initiate adjustments of the Steering of Roaming settings to where network targets have not been met, for voice, SMS and data." In addition, they also provide operators "with an immediate snapshot of the usage status and distribution of roamers **across all networks in each visited country**. The automated solution provides efficient steering results by focusing on usage distribution rather than the number of roamers." (emphasis added)
(7) Note that with short term excess capacity operators in country "B" would always prefer to pay the wholesale price of outbound traffic in kind (i.e. carry a unit of inbound traffic) rather than cash.

contrary, under perfect steering innovation takes place more naturally because it is the consequence of a competitive process.

OPERATOR	PERFECT STEERING			SINGLE NETWORK STEERING PROFIT
	INBOUND REVENUES	OUTBOUND COSTS	PROFIT	
A	min 70, max 120	70	min 0, max 50	min 35, max 75
a	min 30, max 80	30	min 0, max 50	min 15, max 45
B	min 55, max 100	105	min (-50), max (-5)	min (-75), max (-35)
b	min 0, max 45	45	min (-45), max (0)	min (-45), max (-15)

It could be argued that steering solutions are expensive and not worth investing in for small operators, and even for big operators when their customers are travelling to remote destinations. However, this does not imply that there is a market failure that calls for regulators to step in. The incentives of operators are in the right place: they would save money by dedicating resources to traffic steering. If anything, a case could be made for regulators to facilitate access to traffic steering, or to ban visited operators from using "counter steering" techniques[8]. Other measures, like wholesale price controls oriented to cost, would be a step in the wrong direction and would set the incentives for operators in the wrong place: it would no longer make sense to invest in traffic steering, and the need for regulation would be a self-fulfilling prophecy.

6. Consequences for the retail market

Retail roaming is one small piece in the set of services provided to retail customers. Mobile Operators with large sunk and common costs compete for end users, for which on average roaming represents currently below 5% of their expenditure. Although Ramsey pricing is an analytical tool to model regulated monopolies, its basic insight is also applicable to an oligopoly situation where competitors try to find the combination of prices that maximizes customer satisfaction for a given level of revenue per user. Under this premise, and recalling that Ramsey pricing states that for each service prices are equal to the marginal cost plus a premium that is inversely proportional to the impact of a price reduction on total revenues, we can derive some consequences from the results obtained in the previous sections:

The first thing to note is that, in a bilateral relationship, the marginal cost of one unit of outbound traffic is equal to the price of unbalanced traffic[9]. From the previous section we know that, under perfect steering, competition will drive the price of unbalanced traffic down to the level of the competitive wholesale price. Therefore, the benefits of wholesale competition are completely passed on to the retail market.

Secondly, we have seen that outbound traffic has an impact on inbound traffic market shares, which creates additional incentives for increasing the outbound traffic, beyond what would be implied by the price elasticity of the retail roaming service itself. In the Ramsey pricing context, the conclusion is that the bilateral nature of roaming helps bring the retail price down because the mark up is lower than it would other ways be.

In sum, a competitive wholesale market has built-in incentives for retail competition on roaming services. The competitive relative retail price of roaming in the "mobile basket" is then set based on how much value end users give to roaming. Regulators could decide, for instance to foster the idea of a Europe without frontiers, that it would be good to put a cap to the retail roaming price, but it is hard to accept that this policy is based on a market failure in the retail market.

7. Conclusions

The main point raised by this paper is that, as long as operators are capable of steering traffic reliably to more than one network in the visited

(8) Note in any case that operators already have "best practice" rules agreed on GSMA that go in this direction.
(9) For an operator "B" partering with an operator "A" and a price p for unbalanced traffic we have that,

$$\Pi_B = p \cdot (T_A - T_B) = p \cdot T_A - p \cdot T_B$$

and .

$$(\partial \Pi_B / \partial T_B) = -p\,.$$

market, and control the amount of traffic sent to each network, the wholesale market is competitive and there are no solid grounds for regulation. When traffic steering techniques are imperfect, the operators making positive net payments have a big incentive to make them better, and the fact that mobile operators in Europe sign bilateral contracts with prices for unbalanced traffic well below the regulated caps suggests that these techniques are already available.

If wholesale price controls are continued, as seems likely at least in the short term, regulators should adopt a cautious approach, because if the regulated price for wholesale international roaming is set too low, it can be used by foreign operators to enter the domestic markets, which in practice would amount to using the Regulation of roaming to set a price for the wholesale national roaming across the EU. This contrasts with the fact that there are no price controls obligations for that market anywhere in Europe, and it is not even one of the relevant markets that National Regulators have to analyse because the European Commission itself has considered it structurally competitive.

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