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Abstract:

Central features of today's electronic communications markets are complementarities between the different layers of the value chain, substitutability between some applications, network effects in the provision of content and services, two-sided business models that partly involve indirect revenue generation (such as advertising and data profiling), and a patchwork of regulated and unregulated segments of the market. This complexity requires a fresh look at the market forces shaping the industry and a rethinking of market definitions and of the assessment of market power. This article presents the state of play in European electronic communication markets, with a particular emphasis on the recent development of "over the tops". We also use a stylised model of an electronic communications market to draw some central lessons from economic theory and to elaborate on market definition and market power.

Keywords: Telecommunications, OTT, relevant market, two-sided markets, market power

JEL-Classification: D82, L13, L41, L51, L86, L96

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1. Introduction

Local access networks of telecommunications and cable companies, as well as mobile broadband, have become a key infrastructure of the European and world economy, as they give users access to the Internet. In addition to communication services, content, on-line shopping requests, and advertising are delivered via the Internet to end-users. The Internet also allows users-citizens to interact in an unprecedented way and to offer user-generated content.

Content and service providers transfer their content and service to the end-user via a broadband network. Hence, Internet service providers (ISPs) should be seen as two-sided platforms as they provide the link between content and service providers on one side of the market, and end-users on the other side. Often, content providers obtain their revenues from advertisers. Therefore, content providers can also be seen as two-sided platforms when they provide the link between third-party content offers and end-users, or between advertisers and end-users. In some cases, there is a chain of more than two, two-sided platforms linking advertisers to end-users. An example of this could be an advertiser posting an ad on an online media, which is accessed via a news aggregator such as Google news, through a mobile device using an ISP, by an end-user. End-users care about the availability of content and services, and content and service providers care about participation and usage by end-users. End-users may also care about the volume and features of advertising. The term 'cross-group external effects' was coined to describe a situation where each side cares about participation and usage decisions on the other side. Thus, the market for connectivity products is characterised by cross-group external effects between two sides of the market.[3]

We observe varying degrees of competition, both at the connectivity provider layer, and at the content and service provider layer. In the case of the former, competition depends on the physical location (in particular, urban versus rural) and end-user segment (business versus residential). With respect to the latter, it depends on the type of application or market segments (e.g., digital music or travel services). Competition within a particular market segment may be complex and may involve different business models competing with each other. For instance, Google, Ebay, and Amazon directly compete with each other as different retail environments, with the three companies characterised by very different business models. The degree of competition depends on the specifics of the market, including how costly it is to switch to a competing offer (e.g., because personal data cannot be transferred easily) and how important participation and usage are by other potential participants. Moving to a competing offer can lead to switching costs that can be a source of market power. However, whether such costs are price-increasing or price-decreasing is in general ambiguous; for an illustration that higher switching costs can be price decreasing, see Dube, Hitsch and Rossi (2008); for a general analysis and a literature discussion, see Cabral (2014); for a broad survey of earlier literature, see Farrell and Klemperer (2007).

ISPs are often regulated, partly in an asymmetric way violating technological neutrality. In particular, following regulatory market analyses, traditional telcos are subject to wholesale access obligations and have to offer connectivity products to virtual operators and operators that lack part of the network, typically the last mile.

[3] These external effects are network effects. The seminal paper on network effects is Katz and Shapiro (1985). For theoretical analyses of cross-group external effects, see in particular Caillaud and Jullien (2003) and Rochet and Tirole (2003).

Standard instruments for market definition are not directly applicable to platform markets and require modification. Regulation of communication services typically neglects the effects of regulation on the behaviour of content and service providers. These effects are relevant even if the narrow focus of the regulator is on short-term consumer welfare. Due to possible market power issues at the content and service provider layer, neglecting the effect of regulation of connectivity products on that layer can turn out to be highly problematic. It risks that regulatory intervention is off the mark as the interaction due to complementarities and cross-group external effects is ignored. As is well known to a number of economists, ignoring the two-sided market nature may lead to fallacies in regulation and competition policy.

The article is organised as follows: section 2 sets out to present the state of play in European electronic communication markets, with a particular emphasis on the recent development of OTTs. Section 3 describes a stylised model of an electronic communications market. Section 4 draws some central lessons from economic theory on the interaction of ISPs and OTTs. In the following two sections 5 and 6, the article continues to elaborate on market definition and market power. Section 7 concludes.

2. State of play in electronic communications markets

An overview of electronic communications markets (ECMs)

Electronic communications markets are a key sector for the modern economy and society (see, e.g., Czernich et al., 2011; Greenstein and McDevitt, 2011). The Internet, together with local access networks, is a general-purpose technology. This is in contrast to the traditional telecommunication networks that allowed for the delivery of voice calls (and some data via fax) and traditional cable networks for live television and radio programs. On packet-switched networks, very different types of content are transported across the network.

Compared to the 'old' communication networks, the change to packet-switched networks, and a large increase in capacity both of access networks and core networks, have enabled the development of new services and the partial replacement of the traditional distribution of media content. Examples of 'new' offerings are online shopping, online gaming, online banking, social networking, video conferencing, and cloud services. The replacement refers to the delivery of television programming via broadband. Cable networks, by contrast, developed in the opposite direction. They were built to deliver media content and were upgraded to two-way communications, delivering Internet services including communication services. Media content includes offerings by traditional media (newspapers, radio stations, and television channels) as well as new, pure online players. Here, news aggregators have become an important access possibility for consumers. Some aggregators are currently moving into media production themselves (partly through long-term vertical contracting). Examples include Netflix and Amazon.[4] This poses challenges for media regulation. However, this issue is beyond the scope of this article.

Traditionally, fixed line telephony and, in the early days, mobile telephony were dominated by national incumbents. With the early liberalisation process, other firms, some of them operating only

[4] For a recent survey on Internet media, see Peitz and Reisinger (2014).

in one country, entered mobile telephony. Cable networks have become strong competitors for broadband access in several countries. In recent years, EU-wide players have emerged. In cable, Liberty Global has become the pre-eminent cable operator. It is active in 12 European countries and is the strongest cable operator in many of them. In mobile communications, Vodafone has become an important player in the EU with revenue of 44 billion pounds in 2012/2013 and adjusted operating profits of 14 billion pounds. It derived 18% of its revenues in Germany, 13% in Great Britain, 11% in Italy, and 9% in Spain.[5] A small number of former state-owned telcos have developed a strong presence in various member states (and outside the EU). A more recent phenomenon is cross-technology consolidation, as exemplified by the merger of Vodafone (which was active via unbundling in the fixed network) and Kabel Deutschland. This merger makes Vodafone a major player in cable in Germany.

Consumers can use different access networks as substitutes for one another, or as a mix. These include consumption 'on the go', consumption at hubs, and consumption at home. Depending on the location, information can be transmitted through copper and fibre networks, cable networks, WiFi networks, LTE networks, UMTS networks and via satellite. This overlap of different technologies is a challenge for market definitions, and will be analysed in Section 5. This suggests that operators able to make bundled offers have an advantage over those operators using only one technology. For instance, operators that include WiFi in their package may be able to reduce congestion on wireless networks by offloading to WiFi. Another example is 'triple play', which may allow network operators to differentiate their offering from competitors by including pay-tv content.

The role of OTTs

The infrastructure side cannot be separated from content and services, as users derive utility from services delivered to them via access networks. Broadly, the vertical value chain involves four different types of players, all supplying complementary products: content and service providers; content and service aggregators; ISPs as local access network providers (abstracting from other players on the Internet) [6]; device makers. There are various elements of vertical integration. In particular, we observe vertical integration (and vertical contracting) between ISPs and network operators; vertical contracting between ISPs and content and service aggregators; vertical integration between content and service aggregators on the one hand and content and service providers on the other hand; vertical integration between device makers and content and service aggregators. Market power issues play a role at all layers. We observe that network effects are key factors, at least for content and service aggregators and ISPs. Network effects are present if a user's benefit is directly or indirectly enhanced by more users on the same network or platform (see, e.g., Belleflamme and Peitz, 2010). Direct network effects are present if a user benefits directly from the presence of more users. Facebook and other social networks are good examples of OTTs exhibiting direct network effects. An important benefit of users is to be able to interact with friends and to re-establish or maintain contacts with offline contacts. Thus, the more popular a particular social network, the more likely that any given friend or contact is subscribed. Similarly, voice and messaging apps exhibit direct

[5] See Vodafone Group Factsheet 2013, available at: http://www.vodafone.com/content/dam/vodafone/investors/factsheet/group_factsheet.pdf.

[6] We do not distinguish local access providers from ISPs as separate players. We note that a local access provider may not provide Internet services, while another party may do so and contract with the access provider. In the early days of the commercial Internet, we observed the success of ISPs such as AOL providing Internet services relying on the local access network of a telco provider.

network effects because a larger popularity implies that a random offline contact is more likely to be using the app. Many OTTs exhibit an indirect network effect, for example, booking portals. Sellers are attracted to engines with many potential buyers and buyers are attracted to booking portals with many sellers. Thus, there are cross-group external effects that are mediated by the portal. Here, network effects are indirect, as a buyer does not directly care about the amount of participation on the buyer side. However, since a large number of potential buyers attract many sellers, this example exhibits positive indirect network effects.

Currently, due to interoperability, for ISPs these indirect network effects mostly play out at the industry level, as opposed to being firm-specific. Price-induced network effects in mobile communications are a possible exception. These arise when off-net calls are more expensive than on-net calls with the consequence that, with the same prices, a larger network is more attractive than a smaller network, as a larger fraction of calls can be expected to be terminated on net (see Laffont, Rey, and Tirole, 1998; Peitz, 2005). It is an empirical question to which extent such effects are still present today. For example, if consumers make most of their calls within a group of friends and family and they coordinate their subscription decision, the advantage of being on a bigger network, prices between networks for on-net calls being equal, can cancel out (see Hoernig, Inderst, Valletti, 2014). Thus, a small network would not be at a disadvantage to a bigger one. In addition, while price-induced network effect may have been relevant in the past, with the spread of bundled offers including free voice and messaging (partly as a response to OTTs), these firm-specific network effects playing out at the consumer side completely disappear.

Unique service proposals by ISPs are another cause of firm-specific, indirect network effects for ISPs. For instance, if only one ISP can offer a certain quality of service and particular OTT applications rely on such a quality, this ISP features cross-group external effects giving rise to firm-specific indirect network effects. Similarly, the possibility to vertically integrate or exclusively contract services gives rise to firm-specific indirect network effects.

Many OTTs allow interaction only among users who are subscribed to the particular service (e.g., messaging or VoIP provided by an OTT) or charge for calls to other users. Thus, due to very limited interoperability, network effects typically play out at the firm level for content and service aggregators and certain content and service providers. Whether network effects tend to lead to dominant players and affords market power shall be investigated in Section 6.

Observation 1: Firm-specific indirect network effects are present at the OTT level, while their presence at the ISP level depends on the characteristics of the ISP offer.

OTTs generate traffic for a number of different types of services on fixed and mobile networks. Noteworthy types of services are (1) communication, (2) real-time entertainment, (3) social networking, (4) marketplaces for downloads, (5) file sharing, (6) storage, (7) gaming, and (8) web browsing. Some traffic is also due to network administration (e.g., DNS, ICMP, NTP, and SNMP) and tunnelling, which allows for remote access to some network resources or masks application identity. The different types of services are detailed below:

1. Communication services by OTTs may partly replace services by traditional providers of electronic communications, but also offer new and differentiated services such as video calls, which are not part of the conventional package of services offered by traditional providers. The associated applications, services and protocols allow for email, chat, voice and video

communications as well as information sharing among users (e.g., photos). Particular OTTs include Skype, WhatsApp, iMessage, and FaceTime.[7]

2. Real-time entertainment by OTTs contains on-demand entertainment of viewing or listening. Audio and video may be streamed or buffered. With buffering, material can be consumed with a small time lag. Specific streaming services are provided by Netflix, Hulu, YouTube and Spotify.
3. Social networking sites enable communication and information sharing among specified groups of users. Examples are Facebook, Twitter, LinkedIn, and Instagram.
4. On marketplaces, users can purchase and download media such as software, music, movies, and books. Examples are Apple iTunes, Google Android Marketplace, and Amazon.
5. Filesharing services offer peer-to-peer or newsgroups as distribution models. Examples are BitTorrent, eDonkey, and Gnutella.
6. Storage services involve data transfers using the File Transfer Protocol (FTP) and its derivatives. Many firms such as Dropbox, Google, Apple, and Microsoft as well as traditional providers of electronic communications offer such services to users.
7. Gaming services may be simply game downloads for game consoles from dedicated game platform providers and games for PC or mobile phones. Traffic may also stem from interactive online gaming.
8. A standard activity on the Internet is web browsing (HTTP, WAP browsing).

Overall traffic data for Europe is reported by Sandvine (2014), and provides some interesting insights. In the second half of 2013, for peak period traffic on fixed networks, almost half of upstream traffic was generated by the file-sharing service BitTorrent (48.1%), which belongs to service type 5 in the above list. Other important sources of traffic volumes are YouTube (7.12%; service type 2), Skype (4.96%; service type 1), Facebook (3.54%; service type 3), Netflix (2.83%; service type 2), eDonkey (1.12%; service type 5), and Dropbox (1.12%; service type 6). Downstream traffic stems from the following applications, among others: Youtube (28.73%), BitTorrent (10.10%), Facebook (4.94%), and Netflix (3.45%).

Sandvine (2014) also reports peak-period traffic on mobile networks in Europe. The following OTT applications, among others, contribute to upstream traffic: Facebook, BitTorrent, Skype, YouTube, Dropbox, and Gmail. YouTube is the largest OTT contributor to downstream traffic with 20.62%. Other OTTs include Facebook (11.04%), BitTorrent (4.61%), and Skype (1.78%). YouTube and Facebook together contribute to more than 30% of all traffic on mobile networks. It is expected that video streaming and IP-based television will increase in traffic (OECD, 2014).

OTTs affect network operators' profits. On top of the list in terms of traffic at the end of 2013 are Youtube, Facebook, Skype, Viber, and Instagram. The most important OTTs mentioned in terms of lost revenues for traditional SMS and MMS are WhatsApp, Apple iMessage, Facebook Messenger, Twitter and Instagram. As substitutes for traditional voice services, Skype, Google Voice / Hangouts, Apple Facetime, Viber, and WeChat are mentioned. In addition, WhatsApp announced the launch of its own voice service. We note that these lists are susceptible to change due to the dynamic development of the market and may depend on the particular country and operator. All these players belong to service types 1 and 3 and provide close substitutes to voice and SMS by traditional telcos. Traditional telcos may even propose and favourably treat the application of an OTT-player as

[7] While OTT messaging traffic accounted for 8.31% of overall messaging traffic in 2010, this increased to 66.96% in 2013 in Western Europe (Analysis Mason, 2013).

in the case of E-Plus offering a prepaid SIM-card plan that exempts all traffic via WhatsApp from its data plan (see Fitchard, 2014). Here, WhatsApp effectively becomes the exclusive provider of IP-based communication for all users signing up to this pre-paid plan.[8]

Taking a closer look at OTTs, we observe that the business models of several of the leading OTTs are heterogeneous and some are likely to change over time. WhatsApp has, with 400 million users, the largest active user base worldwide for messaging services. Membership is free for the first year and is US$ 0.99 per year thereafter. China-based WeChat has 355 million active users, and offers its services, which include messaging and voice, free of charge. Its only revenue stream at the moment comes from selling digital goods and services. Skype, with 300 million users worldwide, offers its services for free to other Skype users, but charges calls when terminating on phones, when not using Skype. Other OTTs such as LINE and Viber sell digital goods such as stickers. It is an open question whether a subscription model will prove successful.[9] In addition, OTTs may offer additional premium services for sale. Furthermore, it is an open question whether advertising revenues can be generated. Thus, while OTTs have attracted many users and affected electronic communication, it is difficult to forecast their business model in the long run.

Clearly, if telcos stop charging for voice calls and messaging, they no longer face a revenue loss from OTT substitutes. Then, when users communicate with each other via OTT services, substitution only occurs if these services offer a higher utility. In mobile telephony, several telcos have started to offer contracts that do not monetise voice calls and messaging. For those consumers who switched to such a contract, the OTT threat has already been accommodated, and, for those consumers, telcos have already incurred the revenue loss due to OTT entry.

Observation 2: The success of OTT apps for communication and messaging is making the traditional revenue model of telcos unsustainable.

A high level of heterogeneity marks the types of active contracts within the EU and across mobile network operators. Several examples illustrate this. As reported by Nomura (2014), Telefonica Germany introduced its 'Blue All-in' tariffs for its O2 brand in February 2013, which includes flat voice and SMS charges on all networks. By November 2013, less than one fifth of all subscribers had migrated to this net tariff. Similarly, less than one in seven subscribers of Vodafone had subscribed to 'Vodafone Red', which provides flat tariffs for voice calls and messaging. The fraction of users at T-Mobile with flat rates was at a similar level. The situation in Spain appears to be even more prone to change, where, by November 2013, 8% of all subscribers had adopted contracts that allow for flat voice charges. This implies that traditional telcos may face substantial revenue losses in the future because more consumers will no longer be willing to pay for voice calls and messaging. However, since OTT-services provide value to users the issue is more complex, as discussed in the economic analysis in Section 4.

In France, the situation is different, as Orange introduced flat voice tariffs as a default option on all contract offers in January 2012. According to Nomura (2014), 50 to 60% of subscribers had contracts

[8] Similar in spirit are the agreements between Facebook and Orange in Eastern Europe and other parts of the world to exempt the social networking traffic from the latter's data plan. Another case in point is the agreement between Google and Orange in France to exempt Youtube traffic from the latter's data plan, as broadly reported in 2013. All these are examples of vertical contracting. They are subject to scrutiny by competition authorities in case they raise competition concerns.

[9] Information on subscriber numbers and current business models has been reported by Nomura (2014).

featuring flat voice tariffs in the third quarter of 2013, with the migration predicted to be more or less completed in summer 2014. Italy is difficult to place in this landscape as the vast majority of users have pre-paid calling plans.

Lost revenues due to OTT messaging services are hard to calculate. By 2012, these messages had overtaken SMS messaging and network operators could only charge for the latter. While globally, the latter still appears to be increasing, albeit at a low rate, in some countries the volume has been reported to decline. According to Sale (2014), worldwide volume of OTT messages are estimated to be 10.3 trillion, which is much larger than the estimated volume of SMS messages at 6.5 trillion.

One further aspect of the role of some OTTs may affect the device layer. Some OTTs can be used only on particular devices (which rely on particular software platforms). For instance, WhatsApp can only be used on handheld devices. By contrast, Skype is supported on multiple platforms. This includes desktops (Windows and MacOS), mobile devices (Android, Blackberry, iOS, Windows Phone), video game consoles (Xbox), and cable boxes (Comcast).[10] This implies that Skype's services are available on devices that cannot handle traditional voice calls and messaging. In other words, there is convergence at the device level. To analyse substitution patterns, one thus has to take into account that users may simultaneously have multiple devices at their disposal.

OTTs of type 2 may also lead to revenue losses of cable providers and, in case they have their own streaming offers, of traditional telcos. The extent to which this will happen depends on the substitutability between linear and non-linear programming. In Europe, the extent to which OTTs of type 2 will make content offers leading to a high level of substitution away from linear programming is unclear. For the moment, a more relevant issue is that live streaming generates a lot of additional traffic, an issue to be discussed in the context of the net neutrality debate.

While there has been quite some hype about some successful OTTs, some traditional telcos are struggling to adapt to the new communication landscape. Financial markets, by and large, tend to subscribe to this view. They appear to view the prospects of large, mostly U.S.-based OTTs more favourably than those of many access infrastructure providers. This, perhaps, reflects two features of the players. While service provision can be easily scaled up to be provided globally, access infrastructure providers are limited by their physical network, unless they operate as virtual operators. While service and content providers often provide a unique product with no restriction on their pricing, electronic communications regulation in Europe ensures virtual operators have access to wholesale products at low prices. This restriction on the pricing of wholesale products limits the mark-ups that network-based operators can charge to retail consumers and, thus, their profitability.

As follows from a look at market capitalisation, it seems that investors tend to bet their money on companies at the service and device layer, but at least in Europe, less so on infrastructure providers. In March 2014 some of the top IT and Internet companies in terms of market capitalisation were as follows (in US billion $; information from PwC, 2014): Apple 469, Google 409, Microsoft 318, Facebook 175, Amazon 166. While these companies have seen their market capitalisation increase, there are also examples of reductions (e.g., Yahoo). Looking at major European telco companies, market capitalisations are Vodafone 110, Deutsche Telekom 72, Telefonica 72, and Orange 39. These comparisons must be interpreted with caution as capitalisation of global Internet companies is not directly comparable with the capitalisations of telcos that reflect their regional or national scale of

[10] This information is reported in Nomura (2014).

operation. More important than absolute values are changes over time. Most major Internet and content companies have seen their market capitalisation increase; the opposite is true for various European telco companies.

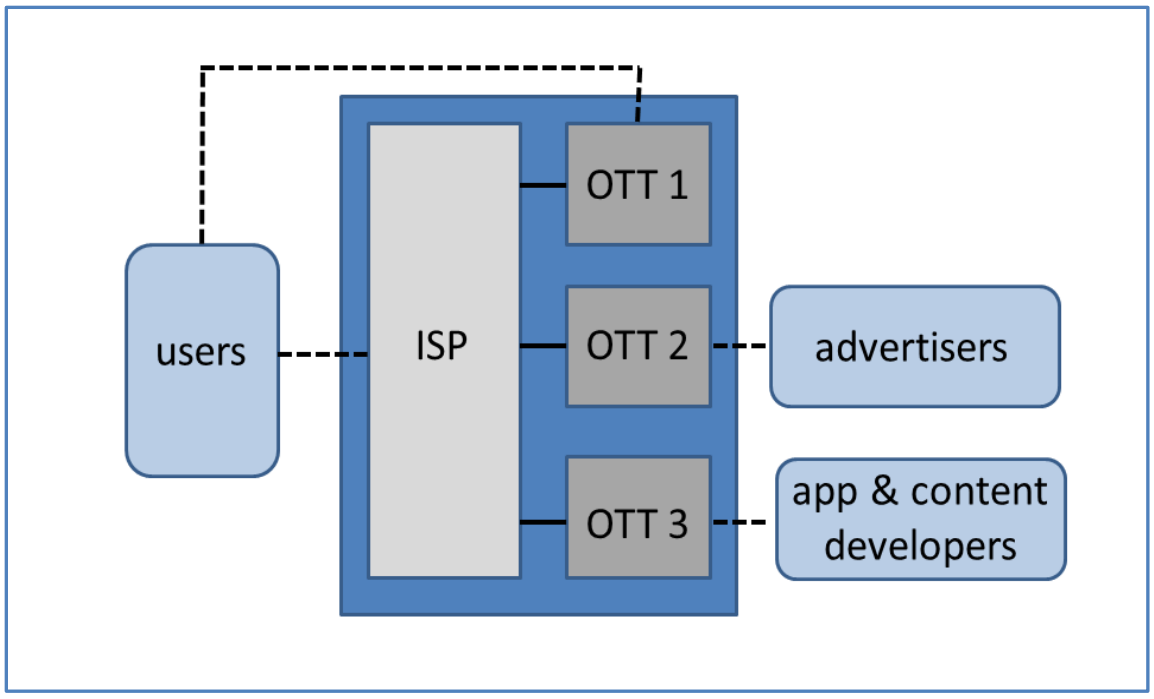
With these important changes in the landscape of electronic communications markets (ECMs) in mind, it is important to explore the major economic forces and mechanisms at work. To be able to do so, it is useful to provide a conceptual framework for ECMs.

3. A stylised model of ECMs

Central features of today's ECMs are complementarities between the different layers of the value chain, network effects in the provision of content and services, two-sided business models that partly involve indirect revenue generation, and a patchwork of regulated and unregulated segments of the market.

When subscribing to an ISP (e.g., a telco operator), users typically have in mind that they will consume services provided by the operator as well as those services available through OTTs. Figure 1 provides a stylised model of ECMs embedded into the wider market for communication, information and entertainment services. It depicts a single ISP carrying services and content by three different types of OTTs.

Figure 1: A stylised ECM



We note that OTT providers can deal directly with end users over networks whose owners are typically excluded from these transactions. Networks in the past assumed they would be providers of content. Indeed, some still try, such as BT acquiring sport rights. However, most of this delivery is coming from non-traditional operators that do not build the networks they rely on. This is particularly important for Netflix, or cloud services that put pressure on network capacity.

It is useful to distinguish between three idealised types of OTTs. OTT 1 offers services to users via the ISP. There are no other parties involved. Typically, the OTT charges users for its service, although a different contractual solution could be that the ISP offers the service of OTT 1 to users, charges users for this service, and pays the OTT. For instance, in cloud computing OTTs contract with users and offer storage services to users. Here, the typical revenue model of such an OTT is to charge users a subscription fee; there are no other revenue sources. A frequent strategy of such OTTs is to provide a limited service for free and offer a premium service for a fee ('freemium' business model). We note that there are other online businesses that follow the same principle. For instance, dating sites and some social networking sites also rely on a subscription fees for premium services.[11] Recently, several media outlets such as newspapers have restricted their use to non-paying members and provide the full offering of the electronic version to subscribers (e.g., New York Times). In addition, Skype is an example of OTTs of type 1 as it offers a free service (between users that are both on Skype) alongside a paid-for service if someone wants to call any phone number.

OTTs of type 1 may gain market power due to switching costs and direct network effects.[12] In the case of storage services in the cloud, for instance, switching costs arise since it is time-consuming to transfer data from one cloud service provider to another. In addition, to the extent that sharing content among users requires the respective users to be subscribed to the same cloud service provider, a larger user base provides an advantage to such a provider compared to smaller providers. This is an instance of direct network effects.

OTTs of type 2 offer their services to users without direct payments. There is, however, a contractual relationship between the OTT and its users, as users typically have to allow the OTT to place cookies. OTTs provide a service and consumers provide revenues indirectly, by being exposed to advertising and by providing data that the OTT can use to improve the ad effectiveness. Hence, the OTT's revenue model consists of creating an audience first, followed by raising advertising revenues. Several Internet media have adopted this business model. Facebook, Google and Youtube all belong to this type of OTT player.

OTTs of type 2 are characterised by direct and indirect network effects. In addition, switching costs may be present. The important difference compared to OTTs of type 1 is the presence of indirect network effects. Users exert a positive external effect on advertisers because the latter are attracted by OTTs with a large user base. There are two reasons for this to happen. The first reason is rather obvious: a larger user base enhances potential demand. Second, a larger user base allows advertisers to place any given ad more effectively, provided the OTT has technology in place that allows advertisers to better match their ads to prospective buyers. Here, a large user base gives more valuable consumer information to the OTT. There is also an external effect in the other direction, as users tend to dislike advertisers. Thus, advertisers exert a negative indirect external effect on users.

We note that in many examples, direct and indirect external effects are at work. For instance, on Youtube, a large user base attracts advertisers. In addition, a large user base attracts users themselves, as this gives rise to a large amount of user-generated content and a lot of information from its recommender system. A larger user base makes it more likely that, among available content,

[11] An example for such a social networking site is LinkedIn, which provides a premium service at a fee. We note, however, that LinkedIn does not conform to this idealised type since it has additional revenue sources.

[12] The seminal academic contribution on competition with network effects is Katz (1985). More recent contributions include Church and Gandal (1993) and Church et al. (2008). See also the handbook chapter by Farrell and Shapiro (2007) and the textbook treatment by Belleflamme and Peitz (2010).

any given user can more easily find material they like. Search engines offer another example. Advertisers are attracted by a search engine with many users. In addition, any given user tends to prefer a search engine with a large user base, as this tends to give more useful search results in the organic search. Thus, positive direct external effects are also present. We note that this tends to lead to a highly concentrated market, but that this does not necessarily imply that one search engine enjoys a monopoly position, let alone that it could abuse it.

With the advancement of technology for targeting ads, the negative effect of advertising on viewers is limited and possibly even converted into a positive one. As the matching between ads and users is improved, fewer irrelevant ads reach users. Consequently, OTTs can become more efficient by reducing the overall ad exposure of a user, while maintaining the level of purchases triggered through advertising. In addition, since the ad is more likely to feature a product or service the user is interested in buying, the buyer is more likely to appreciate the advertising. If advertising exerts a positive external effect on viewers, we would classify this case as an OTT of type 3, which we describe next.

OTTs of type 3 connect app and content developers to users. Here, the OTT may charge those app and content developers for selling their product or service to users. Similarly, the OTT may charge users on behalf of the app and content developers. The latter then receive part of those revenues from the OTT. For example, users pay money to Apple iTunes. Apple takes a cut and pays the record companies the remainder. OTTs of type 3 include market places such as Amazon Marketplace as well as game platforms. Netflix can also be subsumed into this category (excluding content produced by it).

The key difference compared to OTTs of type 2, in terms of economic forces at play, is that the indirect external effects are positive in both directions. Users are attracted by OTTs with a large offering and app and content providers are attracted by OTTs with a large number of users.

OTTs of type 2 and type 3 are often two-sided platforms, as they must manage the matching between two distinct groups of participants.[13] ISPs are also two-sided platforms, as they provide the connection between users and OTTs. However, ISPs were traditionally not flexible in managing this interaction, as they could derive profits from the users alone, often due to regulations imposed on ISPs. Questioning the traditional business model of only charging users has in part led to the net neutrality debate, an issue we return to later. In addition, richer contract menu on the user side (combined with vertical contracting between OTTs and ISPs) reflects the attempt of ISPs to obtain additional revenue streams linked to differential use of OTT services.

There are four caveats to consider regarding Figure 1. Firstly, the figure does not capture the possibility that users can select ISPs. While this is often a subscription decision, a user may obtain even some short-term flexibility if they, for instance, can select among multiple WiFi connections.

Secondly, virtual network operators, which make use of (regulated) access products, can become ISPs. These observations imply that users can often choose among competing ISPs. Hence, there is competition at the retail level that limits the market power of ISPs vis-à-vis users.

[13] We refer to Evans and Noel (2005) and Evans and Schmalensee (2007) for informal introductions to platform markets.

Thirdly, to keep the representation simple and to reflect this paper's focus on the interaction between OTTs and ISPs, the figure does not consider suppliers of devices, nor operating systems as players. However, we note that some OTTs are vertically integrated with device manufacturers and/or operating systems for these devices. Apple is an example of vertical integration of an OTT with a device and operating system. This may create market power issues at the OTT layer.

Finally, the above figure does not demonstrate that OTTs often have supranational or global offerings, whereas ISPs are typically active at the national or subnational level. This observation implies that the availability of the content or service of a dominant OTT may be critical for an ISP in attracting users. The availability of the infrastructure of a single ISP is less critical for a global OTT, as it only loses a fraction of its user base if an ISP were to block its content or services. This is likely to affect the bargaining power of the ISP vis-à-vis the OTT. Thus, market structure at the infrastructure and the content and service layer jointly determines profits and consumer welfare. To understand the market forces at play, it is useful to look at economic theory. This will allow us to derive some fundamental insights into the interplay of the two layers in two-sided markets.

4. Economic analysis of ECMs

Electronic communications markets have several economically significant characteristics, which are central to evaluating market outcomes. Firstly, the market exhibits direct and indirect external effects, which, depending on interoperability, play out at the operator, at the device, or at the industry layers. These external effects often give rise to two-sided platform markets in which a platform caters to two, or multiple, audiences. A two-sided platform then adjusts its business models to have both sides on board and to balance the demands.[14]

Secondly, providers of electronic communications services have different revenue models, which may involve screening among different customers and different revenue sources.

Thirdly, as already mentioned in Section 3, these markets feature complementarities between services and access products along the value chain. If OTTs offer new services, they tend to provide additional value to the combination of services and infrastructure. If instead OTTs offer perfectly substitute services to existing services bundled with the access product, absent quality improvements on existing services, they do not add value to the system and tend to reduce the incremental value of the offering of the ISP.[15]

Infrastructure and services as complements

A first very basic observation is that infrastructure and content are complements. In other words, users derive utility from a system consisting of Internet access and the content and services delivered over the Internet.

It is important to point out that it is not easy to disentangle the individual contribution to the social value of such a system. In particular, OTTs offering services rely on the infrastructure rolled out by telcos. To illustrate this point, suppose that a traditional connection with voice communication has a

[14] Seminal papers that study two-sided markets include Caillaud and Jullien (2003), Rochet and Tirole (2003 and 2006), and Armstrong (2006). For a strategy perspective on multi-sided platforms, see Gawer and Cusumano (2002).
[15] For a discussion of the economic relationship between ISPs and OTTs, see also Ganuza and Viecens (2013).

monetised social value of 50 Euro per user per month assuming that all users are subscribed. This social value is presumed to coincide with how much a user would be willing to pay. Suppose that OTTs introduce additional services such as social networking, streaming, gaming, etc., and that both a user's willingness to pay and the social value of the consumption of these services, including voice communications, is 200 Euro per user per month. One might therefore be inclined to say that content and service beyond traditional communication services has a social value of 150 Euro per user per month, while the social value of pure Internet access is 50 Euro per user per month. However, this is misleading since, in the absence of an Internet connection, willingness to pay and the social value of all those additional services is 0 Euro, as they are useless without an Internet connection. Thus, by making it possible that users can enjoy those services, telcos can claim that they rather than OTTs created value.

This shows that the two providers of a system, consisting of Internet connection and services, jointly add value and that it is impossible to disentangle their individual contribution. The system has a social value of 200 Euro per user per month. Clearly, in such a system market, each commercial provider of a component of the system wants to make profits. To do so, each provider has to somehow charge for the use of its service.

Observation 3: In a systems market with Internet connection and services, the system generates a joint value to society. Thus, the societal value from adding an OTT app cannot be solely attributed to the respective OTT.

In markets in which different firms offer complementary services, economic inefficiencies due to pricing externalities arise. Here, each separate firm may charge a higher price than the price charged by a vertically integrated firm. This is because each separate firm does not internalise the revenue loss of the other firm from lower sales due to the price rise.[16] In the context of electronic communications services, this provides an efficiency argument for vertically integrating ISPs with service and content provision. For instance, if a profit-maximising ISP offers storage services, it internalises the effect of a price increase for storage services on broadband uptake. If an independent OTT provided this service instead, this OTT would not internalise the revenue loss suffered by the ISP due to lower broadband penetration. This pricing externality of vertically disintegrated services is an issue, whenever the corresponding OTT has market power. Note that this does not imply that independent OTT services are bad *per se*, as OTT may provide innovative services or may offer other benefits that an ISP does not provide. However, it does point to the need for public authorities to take pricing inefficiencies of OTTs with market power into account.

While this insight is important, it may not be immediately obvious how it applies to electronic communications markets in which two providers of complementary services obtain revenues on different sides of the market. This is the case if OTTs are of Type 2 or 3. Taking Facebook Messenger as an example, Messenger, together with an Internet connection, allows users to interact with each other. If Messenger is not available, users can send an SMS for which the telecom provider can charge. According to claims made by telco providers, the availability of Messenger eats into the ISPs' revenues. Revenue numbers in line with this claim were presented in Section 2. However, Messenger does not charge users. Indeed this feature makes the service so attractive. Overall, users should feel happy about the additional service supplied by Messenger, and the question arises if ISPs can obtain

[16] This pricing externality has already been pointed out by Cournot (1838). A variation is the double marginalisation result by Spengler (1950) in the context of vertical monopoly. Pricing externalities are also present under imperfect competition.

higher revenues from Internet access as this service has become more attractive. Two economic mechanisms, however, make it difficult for an ISP to recover these lost revenues from the decrease of SMS volume. These mechanisms apply if ISPs have market power. In particular, these mechanisms also hold in the extreme if each ISP has monopoly power.

The first mechanism is due to a pricing externality that is present even if, in the observed market environment, the OTT decides not to charge users directly for its service and only obtains revenues from advertising and customer data profiling. This mechanism relies on network effects and a disutility from advertising and customer data profiling.

To make these two mechanisms explicit, we consider a numerical example. The example will illustrate that even though the ISP can adjust its pricing strategy in response to OTT entry, and charge more for Internet subscription, it may incur revenue losses.

Revenue loss of ISPs: Numerical example 1. Suppose that there are 50 high-usage consumers and 50 low-usage consumers. Let us first postulate that high-usage consumers have a total willingness to pay of 75 Euro for the combined package of Internet access and messaging. For simplicity, we assume they are indifferent whether messaging is done by traditional SMS or via the OTT's messenger service. Low-usage consumers have a corresponding willingness to pay of 50 Euro for the combined package.

When the OTT is absent, a telco provider, which can only offer an 'all-you-can-eat' contract to all consumers, will charge 50 Euro in total for Internet access and messaging. Its revenues are 5,000 Euro (100 x 50 Euro). This results in higher revenues compared to charging 75 Euro, which would only attract the 50 high-usage customers. With the entry of the OTT, messenger becomes available and consumers switch to messenger, assuming that it is slightly more user-friendly. Suppose that the OTT makes revenue of 10 Euro per consumer from advertising and selling customer data. We assume here that, due to its global reach, superior information technology, or different data protection standards, this revenue source of the OTT is not available to the telco provider. Thus, if nothing else changed, the OTT would have revenue of 1,000 Euro, and the revenue of the ISP remains unchanged, as the latter continues to obtain 50 Euro per customer for Internet access. Hence, if the ISP used to charge for SMS traffic, this is no longer possible, but revenues can be kept more or less neutral if, in the presence of the OTT, the ISP charges a higher subscription fee.

It is notoriously difficult to apportion revenues of bundles of services provided jointly to individual services. However, let us suppose that, in the absence of the OTT, the telco provider obtained 25 Euro from providing the Internet connection and 25 Euro from messaging. If the telco provider does not adjust its pricing, its revenue will be halved since consumers continue to pay for Internet access but not for messaging. However, in our setting, the telco provider may simply adjust its pricing strategy and charge 50 Euro for Internet service, and provide free messaging, which re-establishes revenue of 5,000 Euro.

However, as referred to above, messenger may be seen as a superior communication environment and, once in place, make SMS obsolete for some consumers. This may be the case if consumers first respond to messages on the app provided by the OTT, but less quickly to SMS. In the extreme, as everybody uses the app, sending any given message via the app becomes much more attractive than

using SMS. For the sake of the argument, let us suppose that this is the case for all consumers. This makes the messenger app essential.[17]

While the OTT now provides an essential service, we presume that the ISP has the advantage of being able to commit to its price for Internet subscription. That is, it sets its price for users before the OTT chooses which prices to charge advertisers and, possibly, users. If the ISP set a price of 50 Euro for Internet access, the OTT would not set a price on the advertiser side only. Rather, it would optimally set, in addition, a price of up to 25 Euro on the consumer side or, similarly, engage in advertising or the sale of data that would constitute an implicit price of up to 25 Euro on the consumer side. In our numerical example, this would imply that only half of all consumers purchase the service, as the price for the bundle is now 75 Euro. This is profitable for the OTT as long as the joint revenue from advertising and pricing to half of all potential users is more than deriving only advertising revenue from all users. For an implicit price of 25 Euro, this is the case: (50 x 25 Euro) + (50 x 10 Euro) is larger than (100 x 10 Euro).

In such a situation, the ISP would suffer, as its revenues would be reduced to 50 x 50 Euro. Foreseeing this two-sided pricing strategy of the OTT, the ISP provider optimally adjusts its price and commits to charge 75 instead of 50 Euro. This means that broadband penetration is smaller than with a vertically integrated offer. Then, the ISP's revenues are 3,750 Euro (50 x 75 Euro) which is the best it can achieve in the presence of an independent OTT. The OTT now only derives revenues from advertising (50 x 10 Euro). Industry profits of both the ISP and OTT are less than under vertical integration, that is, in a situation in which the ISP provides the service itself. Half of the consumers leave the market and the other half obtains zero surplus instead of 25 Euro under vertical integration. Thus, consumer surplus and total surplus are also reduced. More generally, the ISP will not invest in high-quality connection, in particular to those consumers with a lower willingness to pay.

The above numerical example has illustrated the pricing externality that arises if firms with monopoly power set prices for complementary services independently, even if in the prevailing business models the ISP charges consumers, whereas the OTT decides to charge advertisers only. Hence, we have shown that pricing externalities also arise in two-sided pricing settings in which one of the firms decides to make revenues on one side of the market and the other firm makes revenues on the other side of the market. The argument may not appear to be directly applicable to the current market environment, but it is a first step in understanding that ISPs may be negatively affected by OTT offerings, even if they are fully flexible in adjusting their pricing strategies.

A different and arguably more relevant argument that telco providers' revenues are hurt by the entry of an OTT is based on the possibility to screen between different types of consumers. This second mechanism points to the loss of screening possibilities between different types of users that the ISP suffers, if an OTT offers a free service. This reduction in the ability to engage in targeted pricing is another reason for lower revenues by the ISPs.

Revenue loss of ISPs: Numerical example 2. We return to the previous numerical example and now postulate that the network provider is able to extract all surplus from consumers, in the absence of OTT services, based on metering call and SMS traffic. For metering to be feasible, consumers with a higher willingness to pay also have a larger demand for calls and messages. With full surplus

[17] Essentiality arises more naturally if the OTT offers a service that lacks a substitute that can be offered by the ISP.

extraction, the ISP's revenues are 6,250 Euro: (50 x 75 Euro) + (50 x 50 Euro). With the entry of the OTT, this screening possibility no longer exists because messenger replaces SMS. In addition, download caps do not help here, as SMS does not generate much traffic relative to other services. Therefore, the network provider makes a profit of 5,000 Euro. Hence, the network provider's revenues are reduced since it loses its ability to extract surplus through screening between high-usage and low-usage consumers. In general, the welfare and consumer surplus consequences are unclear. In the present example, welfare and consumer surplus increase with the entry of the OTT. However, this takes the level of infrastructure investment by the network provider as given. The entry of the OTT reduces the ISP's expected surplus from each additional consumer. Taking everything else as given, this reduces the incentives of an ISP to invest in infrastructure.[18]

This second mechanisms shows that SMS and voice calls can no longer be used as metering devices by the ISP once substitute OTT services are available. This unambiguously reduces ISP profits. If the ISP reacts in its rollout decision, then consumers and society may be worse off under OTT entry.

Observation 4: OTT entry may lead to an essentiality of the OTT app or may undermine the ISP's metering of consumer calls and messages. In both cases, the ISP's profits suffer and undermine the ISP's investment incentives.

Pricing in two-sided platforms

A recent and very influential academic literature with seminal papers by Rochet and Tirole (2003) and Armstrong (2006) has developed pricing implications in such platform markets.[19] Consider the case of a monopoly ISP, which is the simplest case to consider. It has practical relevance when ISPs have market power. By choosing prices on both sides of the market, the ISP as a two-sided platform can manage indirect external effects. A profit-maximising monopoly ISP uses a modified monopoly pricing formula. The standard monopoly pricing formula states that the Lerner index, which is the per-unit profit margin as a percentage of the price, is equal to the inverse price elasticity of demand, which expresses the price sensitivity of end users. A profit-maximising two-sided monopoly platform uses a modified pricing formula on each side of the market. Essentially, per-unit costs are adjusted downward by the external effect exerted on the other side. Thus, the stronger the indirect network effect, the lower the price. The socially optimal prices would indeed be lower than monopoly prices and would take into account the indirect network effects.

Price structure: numerical example 1. Some of the results on the optimal price structure of a monopoly platform can be illustrated by a numerical example. Suppose that the platform charges a transaction price p_O per user to the OTTs and a price p_U per application to the user. For simplicity, we postulate that users have demand for all available apps and OTTs want to cater to all users. Each OTT offers a single app. Hence, the ISP generates interaction between all active OTTs and users and its revenues are the sum of price times number of participants on each side: $(p_O + p_U)n_O n_U$, where n_U is the number of users and n_O is the number of available applications. In a first numerical

[18] Returning to the situation in which the OTT's services become essential, with consumer screening and in the absence of the OTT, the network provider has revenue of 6,250 Euro (as we have seen above). However, with the entry of the OTT, the network provider's revenues are only 3,750 Euro (50 x 75 Euro). Here the revenue reduction results from the combination of the pricing externality and the lack of screening possibilities.

[19] For an informal discussion how two-sided market theory can be used to better understand the functioning of real-world platform markets, see Evans and Schmalensee (2007). A formal introduction into two-sided platform markets is provided by Belleflamme and Peitz (2010, chapter 22).

example, there are three users, each deriving a value of 2 Euro per month.[20] There are three OTTs. The OTTs derive different values per user. OTT 1 derives a value of 1 Euro per user per month, OTT 2 a value of 2 Euro per user per month and OTT 3 a value of 3 Euro per user per month. Hence, the average value of OTTs is 2 Euro, which is the same value as on the user side. Despite the same average value, the two market sides respond differently to price changes. If the platform were to set prices slightly below 2 Euro on both sides, all three users would participate, whereas only OTTs 2 and 3 would be active. With these prices, the ISP would make around 24 Euro per month. However, if the ISP reduces the price on the OTT-side to slightly less than 1 Euro, all OTTs will be active. While one may think that carrying two apps by charging 2 Euro for each of them is more profitable than carrying all three by charging 1 Euro each, this neglects the fact that a lower price leads to an overall higher trading volume which makes it possible for the ISP to obtain additional revenues on the user side. Overall, the ISP is better off to charge this lower price, as each of the three apps is used by all three users. Since the ISP obtains, per transaction, 1 Euro from each OTT and 2 Euro from each user the ISP has an overall revenue of 27 Euro.

This example illustrates that the values from interactions derived on the two sides, affect the optimal price strategy. In the example, since OTTs respond to the price reduction, whereas users would not do so for the same reduction, it is here profitable for the ISP to set a lower price for OTTs. In the reverse situation, users would pay a lower price. More generally, a price change on one side affects demand on both sides. Thus, to understand for example, the price set for consumers, demand conditions on both sides of the market have to be taken into account. This also applies to a competition authority or a regulator investigating a certain market with two-sided interactions. If this is confirmed, the user side cannot be considered in isolation.

The strength of the cross-group external effect plays a decisive role. The external effect from OTTs to users is particularly strong if users place a high value on the apps. This implies that it is important for an ISP to host many apps, which implies that the ISP should offer OTTs favourable terms to become active. If, by contrast, OTTs derive a high value from users, for example, because this allows them to obtain large advertising revenues, optimally the ISP may offer more attractive terms to users and less attractive terms to OTTs.

Price structure: numerical example 2. To illustrate the fact that cross-group external effects may even lead to zero pricing on one side of the market, we provide a numerical example with six OTTs and six users. Each user obtains a value of 6 Euro per month from each app. OTTs obtain different values: OTT 6 a value 3 Euro, OTT 5 of 2 Euro, and so forth until OTT 1 obtains a value of minus 2 Euro. This implies that even if the ISP does not charge OTTs, OTTs 1 and 2 will not be active on the market. If the ISP cannot subsidise OTTs, it will not charge OTTs and earn revenue only on the user side. It charges every user slightly less than 6 Euro per month; all users and four OTTs become active on the ISP and revenues are 144 Euro (24 x 6 Euro) per month. However, if the ISP can subsidise OTTs in this example it will optimally do so: the optimal price structure is to charge every user 6 Euro per available app and to give 1 Euro per user to every active app. Then, all six users and five OTTs contract via the ISP. For the 30 interactions between OTTs and users, the ISP receives 6 Euro per app per month from users and gives 1 Euro per user per month to OTTs. The ISP's revenue is 150 Euro per month, which is larger than 144 Euro.

[20] This and the following numerical example are adopted from Peitz (2006).

While monopoly pricing leads, of course, to higher prices than socially optimal pricing, the important insight from two-sided market analysis is that the monopolist's price structure is aligned to the socially optimal one. In particular, the side that exerts the stronger external effect on the other side tends to be charged a lower price. As illustrated in the above numerical example, this may even imply that one side of the market is subsidised, such that the price does not cover the cost of engaging an additional participant on this side. Subsidisation is profitable as it allows for the extraction of larger revenues on the other side. Competition authorities may suspect predatory intent if a price is negative or, more generally, below its average variable cost. However, in two-sided markets, cross-subsidisation simply reflects the management of cross-group external effects. Prohibiting such a negative price not only reduces the ISP's revenue but is also socially costly. This goes hand in hand with high prices on the other side. Such high prices are not necessarily excessive and simply reflect the optimal price structure to manage app availability and user participation.

Observation 5: ISPs can possibly manage the interaction between OTTs and users. The unregulated price structure chosen by the ISP may then resemble the socially optimal price structure (though typically not the optimal price levels), as the ISP internalises cross-group externalities. In particular, neither prices below cost nor very high prices are indications of anti-competitive behaviour.

In the extreme case that OTTs can extract the full surplus from every interaction with a user, users do not care about the amount of apps available. Thus, OTTs do not exert a positive external effect on users. In such a situation, it is likely that users receive a low price, while the ISP charges a large mark-up on the OTT side. It is also important to note that the socially optimal solution feature high prices on the content and service provider side.

We would therefore expect that in a mature market in which OTTs know their customers well and have found means to monetise interactions, there is a downward pressure on the price the ISP charges users. By contrast, in the early days when content and service providers offer their product for free, the ISP's optimal price structure tends to feature rather high prices on the user side. We would therefore expect that, as the market matures, fully flexible prices of the ISP become lower on the user side, while higher on the content and service provider side. As long as pricing restriction is imposed by net neutrality regulation, we will not, however, observe such adjustment of the price structure.[21]

In many market environments, users face a discrete choice between two or more ISPs. This means that they sign a contract with an ISP and make use of apps via this ISP. This introduces competition between ISPs for users. By contrast, OTTs typically provide their apps on multiple ISPs. Conditional on user participation, and absent the threat of not making some content available on an ISP, each ISP exerts monopoly power on the OTT side. Such a market environment has been called one of 'competitive bottlenecks'. It tends to lead to low prices for users and high prices for OTTs. While low prices are attractive to users, their overall surplus may be limited due to the limited availability of apps. The socially optimal price structure is not achieved under competition between ISPs since the latter are too concerned about user participation.

[21] The impact that the regulation of one price might have on other, unregulated, prices is often called the "waterbed effect" (see Genakos and Valletti, 2011 and 2014).

5. Market definition

To assess market power and eventually consider the type of regulatory intervention needed, it is customary to first define the relevant market, that is, the set of products that consumers find substitutable for each other.

A commonly used tool for market definition in a traditional market is the so-called 'Small-But-Significant-Non-Transitory Increase-in-Price Test' (SSNIP test), which defines the market as the smallest set of substitute products, such that a substantial (usually, five or ten percent) and non-transitory (usually, one year) price increase by a hypothetical monopolist would be profitable.

Starting from a set of candidate products for the relevant market, the SSNIP test is implemented by simulating a price increase above the competitive level by a hypothetical monopolist who owns only one product. As long as that leads to losses in profits, the test progressively increases the number of products owned by the monopolist. When profits are not estimated to decrease following an SSNIP by the hypothetical monopolist, the set of products owned by the monopolist in the last simulation constitutes the relevant market.

In merger and abuse of dominance cases, it is important to assess which services are substitutes to one another. For instance, a SSNIP test for mobile voice services must consider all relevant substitution possibilities. In particular, consumers may switch to OTT services if they experience a price increase for traditional voice services. In addition, they may substitute parts of their calls for messages, either SMS or substitute services by OTTs such as WhatsApp. In general, this is consistent with the view expressed by the European Commission: "product characteristics and intended use are insufficient to show whether two products are demand substitutes […] differences in product characteristics are not in themselves sufficient to exclude demand substitutability […]."[22] In the context of ECMs this needs further adaptation.

As referred to in the introduction, different technologies can belong to the same market. From a user's perspective, it is often irrelevant if a connection to the Internet is established through copper and fibre networks, cable networks, WiFi networks, LTE networks, UMTS networks or via satellite. Demand substitutability should be the key criterion for market definition. If multiple technologies can be used for the same purpose, all providers of these different technologies are competing in the same market. A possible complication is that a user may change his or her location. This will immediately affect the available offerings. Thus, geographic and inter-temporal demand substitutability for electronic communication services will have to be taken into account for market definition.

Further interesting and complex issues arise when attempting to extend the SSNIP test to ECMs, taking into account that these involve complementarities and various externalities. In particular, as ISPs are platforms that sit in between end users and OTTs, a related question is how to apply an SSNIP test to a two-sided market.[23] Firstly, given that in a two-sided market firms can, at least in principle, set two prices, one on each side of the market, the question is which price the hypothetical monopolist should be raising. Secondly, given that in a two-sided market, demands on both sides are

[22] Commission Notice on the definition of relevant markets for the purposes of Community competition law, 197 OJ C 372/5, paragraph 36.
[23] For a discussion of how to apply merger analysis to platform markets, see Evans and Noel (2008).

linked through cross-group external effects, and thus profits depend on the overall price structure, the issue is whether one should consider profits on one or on both sides of the market.

These issues have been addressed in some cases both by the EU Commission and by national competition authorities.[24] However, a clear conceptual framework for incorporating the economic specificities of two-sided markets into the market definition exercise has not yet evolved.[25]

One might be tempted to argue that, when one side of the market does not pay, only one market should be defined, namely, the one with paying customers. According to this view, in the context of telcos for instance, the market should be defined at the user's level and OTTs should not be included, as they generate no revenues for telcos. However, we will show this reasoning is flawed due to cross-group external effects and may lead to inappropriate conclusions.

To fix ideas, it may be useful to consider market definition in linear television. Television channels are platforms catering to consumers on one side and advertisers on the other, if they contain some advertising. In this context, many competition authorities distinguish between Pay-TV and free-to-air TV as separate markets, as the two adopt different business models. As such, they represent a choice of the firm and not a feature of the market itself. The point here is that the choice of the financing mechanism is not necessarily linked to demand substitutability between any pair of Pay-TV and free-to-air TV channels. Suppose that Pay-TV and free-to-air TV do not compete for advertisers. Nevertheless, if there is demand substitutability on the viewer side, they should be put in the same relevant market. In this case, Pay-TV competes with free-to-air TV for viewers even though the latter does not charge viewers directly.

It is only if Pay-TV and free-to-air TV are not substitutes for viewers, that the type of business model might be relevant to assess supply substitutability. Even if free-to-air TV and Pay-TV were not substitutes for viewers, arguably, one should take into account the other side of the market, even in a case involving Pay-TV stations. In fact, the decision by a Pay-TV station whether to rely on advertising financing or not is likely to depend on an assessment of the costs and benefits of advertising financing. The costs would then depend on the degree of advertising aversion of TV viewers, that is, the strength of the indirect external effect exerted by advertisers on viewers. The benefits would depend on the degree of competition on the advertising market for the viewers of Pay-TV. Hence, Pay-TV could be competing for advertisers with free-to-air TV. In this case, both Pay-TV and free-to-air TV should be put in the same relevant market.

An investigation into the demand substitutability is also needed to answer the question whether SMS and OTT messaging belong to the same market. Here it is not relevant that OTT messaging apps often do not directly charge customers. The key question is the substitutability between the services from the viewpoint of consumers to decide whether both types of services belong to the same market.

[24] For an analysis of the relevant case law, see Filistrucchi et al. (2014).

[25] For suggestions see, inter alia, Filistrucchi et al. (2014), Thépot (2013) and Zingales (2013) with the following suggestion: "… the most reasonable approach seems for competition authorities to make a *prima facie* product-specific market definition, involving a description of the market participants and the sources of competitive constraints and no more than a cursory look at market shares, namely in order to forego dominance inquiries in case of too little market power by the allegedly dominant company. In order to avoid type II errors (under-enforcement), such *prima facie* markets should be drawn as narrowly as possible, identifying the smallest subset of products for which there is consumer demand. Only at a second state would the picture become clearer, as authorities look into the scope for the exercise of market power, its relationship with potential entrants and whether any submarkets can be identified based on this particular relationship […]" (Zingales, 2013, p. 37).

Take the case of a two-sided platform, with sides A and B linked by positive cross-group external effects. The application of a one-sided SSNIP test on side A would only account for the direct effect that a price increase will have on the demand and profits of side A. It will not account for the fact that a reduction of the number of customers on side A is likely to lead to a reduction of the number of customers on side B. Given this, if the price on side B is kept constant, there would also be a loss in profits on side B. It would also not envisage the fact that the smaller number of customers on side B will in turn reduce the demand of side A, and so on. Hence, it would also underestimate the loss in profits on side A. Positive cross-group external effects between the different sides of the platform reduce the profitability of any price increase. Therefore, the risk of applying a standard SSNIP test, which does not account for feedback effects, is that in such cases the market will be defined too narrowly.

Observation 6: As ISPs and OTTs often operate as two-sided platforms, even when they only charge on one side, a proper SSNIP test in ECMs must include cross-group externalities, as they give rise to feedback effects. The risk of ignoring those feedback effects is an overly narrow definition of the market.

We also argue that, in ECMs, it would be wrong to start with market definitions based on the level of integration of a particular player, which is again a business model decision of a particular player and not a market. The initial starting point of any analysis must always be the end users and the final services they seek. We are not concluding here that OTTs and telcos are necessarily in the same market. It depends on circumstances. However, it is always essential to begin by asking what the set of products that end users want is. Having access to an ISP, per se, does not carry much value. The value is brought by the system containing communication and content services. Following current practice regarding after-markets,[26] one could define a single 'system' market. This comprises both the primary market for connectivity and the secondary market for content use. This is because it is usually the case that consumers will want the system and anticipate the utility from the secondary market when buying the primary product. Primary and secondary products then belong to the same system market.[27]

6. Assessing market power

The next step from a competition policy perspective, but also from a regulatory perspective (establishing regulatory obligations), is to consider whether any particular operator or service provider holds a position of market power in the market. Market power reflects the ability of a firm to behave in ways that are detrimental to the interests of end users (for example, by setting excessive prices, delivering poor quality, or failing to innovate) or that foreclose the market to more effective competition.

Among the many services that providers of electronic communication networks offer, the following are of particular relevance:

[26] An after-market is any market where customers who buy one product or service (the 'primary market') are likely to buy a related, follow-on product (the 'secondary market'). Printers and toner give a textbook example.

[27] If an element of a system is in perfectly competitive supply, it is immaterial whether it is included in the system market. Inclusion of both products is relevant in case firms with market power provide them.

- One-to-one communication at the receiving party. In Europe, the price for these services is typically zero;
- One-to-one communication by the initiating party. Traditional telcos charge for their service;
- Data sent;
- Data received.

To be able to enjoy these services, the end-user has to have network access. This may be provided by a third party, such as a free spot at a café or an employer, or may be a personal subscription. The end-user needs a device that can be connected via an access technology. Many devices are now able to deal with various access technologies.

Due to the services offered by application providers, traditional revenue sources from one-to-one communications are falling, as documented in Section 2. In particular, there are several substitutes for traditional SMS and MMS, as well as traditional voice services. Substitutes for traditional SMS and MMS include WhatsApp (recently taken over by Facebook), Apple iMessage, Facebook Messenger, Twitter, and Instagram. Substitutes for traditional voice services include Skype, Google Voice, Apple Facetime, and Viber. WhatsApp has announced plans to launch a voice service.

Clearly, with different types of operators being able to provide the same range of services, convergence should be expected to facilitate competition amongst a greater range of technologies. Largely, this is reflected in changing market definitions, with markets potentially becoming wider. This in itself would tend to reduce the scope for any particular firm to enjoy market power. For instance, among traditional telcos, widening the market to include both fixed and mobile broadband services would suggest that no single provider would enjoy market power in the retail market. This will both remove the need for promoting retail competition by imposing access obligations, and increase the likelihood that wholesale services will be supplied on commercial terms even without such obligations in place.

The importance of service availability for network choice means that vertical relations between network operators and service providers will have an important bearing on the assessment of market power. In particular, arrangements under which content or specific applications that might be characterised as ‘must-have’ would be provided exclusively over a particular network, would need to be assessed very carefully.

For instance, if market power of a broadband provider is linked to exclusive access to an OTT service, the source of this market power is not control over network infrastructure, but rather the nature of the service. Indeed, any advantage that a network operator may gain from being able to provide exclusive access to a particular type of content may have been competed away in the process of signing an exclusive agreement with the content provider. For example, a broadband provider that is in a position to offer exclusive video-on-demand access to premium movies might face reduced competition from other broadband providers and may be able to sustain higher prices, but the content provider will ultimately appropriate much of this benefit.

Any regulatory access obligation aimed at addressing this problem would have to be linked to access to the service. For example, an obligation to provide network access imposed on a broadband operator who enjoys market power because it provides exclusive access to on-demand premium

video services would do little to rectify the problem. An effective competitor would require access to content.

In the case of OTTs, for instance, web-based messaging services may have little pricing power on the consumer side, but when bundled with other services, such as social networking, this messaging service provides OTTs with information about the users, which can then be used to improve the targeting of advertising. This may give large OTTs an advantage over competitors that results in increased revenues on the advertiser side. This asymmetry implies that the traditional revenue model of telcos for SMS may break down and cannot be replaced by an advertising-based model, unless they are allowed and able to earn revenue from the information about users they obtain.[28]

In the presence of bundling strategies, the assessment of market power needs to consider whether and how other providers can replicate specific bundles with sufficient ease. Where bundles are difficult to replicate, competition concerns may arise. Replicability will need to be assessed on a case-by-case basis, and conclusions cannot easily be generalised. Particular competition policy concerns may arise where service bundles constitute separate markets, and the bundle includes components that are not under the remit of regulators. In the context of developing markets, mobile payment services and other business-enabling services as part of a bundle may deserve scrutiny by competition authorities.

Observation 7: The increasing importance of OTT services can augment or reduce SMP of some broadband suppliers and means that attention will need to shift to also include those who are able to supply such services.

The greatest challenge in dealing with bundling and exclusive vertical arrangements is that these practices can be beneficial and create substantial efficiencies. Bundling, for example, may simply allow the supplier to share some of the cost savings from economies of scale with its customers. It may reduce transaction costs and respond to customer preferences for a single bill or an integrated service proposal. It may avoid double marginalisation, and allow firms to engage in output-increasing price discrimination, broadening access to services. Whether a particular form of behaviour is anti-competitive or beneficial can only be established in the specific context. Thus, it is questionable to address such practices through regulatory policy. They should instead be scrutinised *ex post* by competition law.

While the analysis has been focusing on the interplay between ISPs and OTT services, another relevant layer at which market power concerns arise are operating systems, which, as in the case of Apple, are vertically integrated with devices. We observe that Apple, Google, and Microsoft are not only important OTT players, but also control mobile operating systems, albeit with varying degree of success. Thus, anti-competitive practices may occur at the operating system level and the behaviour of OS players is another issue on which competition authorities must keep a watchful eye. In particular, vertical integration between OS and OTT services may raise competition concerns.

Beyond the adjustment of market boundaries, there may also be changes in the nature of competition that need to be considered in any market power assessment. In many markets that involve network rollout, substantial investments have been, or will need to be, undertaken in order

[28] Therefore, telcos may want to make use of the services by OTTs. However, to be able (indirectly) monetise on their consumers, they would need to able to charge OTTs for accessing their subscriber base. By signing agreements, e.g., about preinstallation of certain services or differential treatment within a calling plan, telcos would be in such a position.

to serve the growing demand for bandwidth. Investments in new capacity tend to be lumpy, and create substantial excess capacity that will only be slowly filled. This is the case in the rolling out of fibre. The presence of such excess capacity may discourage further investment in competing infrastructure, as investments are largely sunk and the investor can expect to meet strong competition from those who have already built out their networks. For the same reason, however, where competing infrastructures are in place, competition can be expected to be intense even if the market is highly concentrated. Those who have invested in infrastructure have strong incentives to attract customers and fill existing capacity as additional business can be accommodated at little or no additional cost. This means that NRAs may have to give particular attention to the timing of investments and the plans for bringing new capacity on stream. They may also have to be wary about capacity expansion that discourages investment by competing infrastructure providers, but at the same time acknowledge that in geographic areas or market segments where facilities-based competition exists, concerns about market power should be greatly reduced.

7. Conclusion

The move to packet-switched networks and the increasing role of Over The Top (OTT) players in providing services over these networks require a fresh look at the market forces shaping the industry. It requires a rethinking of market definitions and the assessment of market power.

OTT apps have become a central element of the value proposition made by telcos to users. While they have made the combination of internet access, communication and media services more valuable, it is unclear to what extent telcos can monetise these developments. Partly, these apps replace formerly vertically integrated services by telcos, raising the possibility that telcos may actually suffer from the increased value stemming from additional OTT apps.

This article makes a number of fundamental points. First, there is a basic property of complementarity between infrastructure products and content services. Internet connections (possibly with certain quality characteristics) are necessary to enjoy the benefit of Internet content, and vice versa. It follows that the societal benefits from OTT apps and ISPs cannot be accounted for separately. To provide incentives for innovation at both layers, OTTs and Internet Service Providers (ISPs) must both benefit from this joint surplus creation. As a corollary, if the benefits exclusively go to OTT providers and consumers, the risk is that mutually beneficial investments in network infrastructure will be delayed or even not undertaken. A regulatory environment which heavily constrains the pricing and contracting of ISPs tends to lead to such an outcome. In the current regulatory environment ISPs may fear that the benefits from investments will be absorbed by consumers and content providers with little benefits left for the investing party.

Secondly, the business models of OTTs are diverse and evolving. Similarly, ISPs should be allowed to experiment with new business models, as their traditional revenue models have been challenged by the success of several OTT apps for communication and messaging. This includes specifying new types of contracts offered to consumers and OTTs. For instance, a mobile contract may include pre-installing certain apps or may provide bundled discounts for particular services on the basis of contracts signed with the respective content or app provider. While these contracts are subject to scrutiny by competition authorities, *ex ante* interventions that restrict such differentiated offers

appear to be misguided, provided of course that the parties involved, particularly consumers, are informed beforehand about the contractual terms in a clear and transparent manner.

Thirdly, the efficiency of pricing solutions should be analysed in light of recent economic theory that suggests that ISPs and OTTs are multi-sided platforms. For instance, ISPs cater to consumers and content providers and many OTTs cater to consumers and advertisers. General insights from multi-sided platform industries are therefore relevant: neither prices below cost nor very high prices on one side are indications, *prima facie*, of anti-competitive behaviour, rather they are means to internalise externalities among the various sides. Hence, competition authorities and regulators have to take these interactions into account and should not investigate one side of the market in isolation.

Finally, when defining markets, demand substitutability should be the key criterion for market definition. If multiple technologies can be used for the same purpose, all providers of these different technologies are competing in the same market. This applies also to specific services. For instance, a SSNIP test for mobile voice services must take all relevant substitution possibilities into account. In particular, consumers may switch to OTT services if they experience a price increase for traditional voice services. Also, they may substitute parts of their calls by messages (SMS or substitute services by OTTs such as WhatsApp). Allowing for flexible business models, including two-sided pricing and differential access, implies that an ISP operates as a platform that manages the interaction between content providers and end users. Here, a SSNIP test can still be carried out, but it must include cross-group externalities and associated feedback effects. Ignoring these interactions would lead to too narrow definitions of markets.

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