

THE ECONOMICS OF DIGITAL GOODS: A PROGRESS REPORT

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ABSTRACT. I first review the theoretical apparatus that has been largely used so far to analyze information goods industries. I argued then that although this apparatus was fairly appropriate in the analog era and in the early digital era, it now needs to be significantly updated. The advent of streaming challenges indeed the main assumptions that underlie the existing models. This observation leads me to propose two main directions for future research efforts. First, one needs to better understand, and model, how streaming modifies the way content is accessed and consumed. Second, more attention should be given to the roles and strategies of streaming platforms, which become inescapable intermediaries regarding the distribution and consumption of digital goods.

1. INTRODUCTION

Following Shapiro and Varian (1998), information can be broadly construed as anything that can be digitized, i.e., encoded as a series of ones and zeros. To be shared, information needs to be formatted in some way, so as to be transformed into an ‘information good’. When the chosen format is digital, the information good is called a ‘digital good’. To illustrate these definitions, think of the novel that is built in a writer’s mind as information; for readers to access this information, it must be written down in some form, which can be analog (a printed book) or digital (an e-book); the same goes for music, images, films, television programs, software, applications, games, etc.

Digital goods are inherently non-rival, as the consumption by one individual does not prevent consumption by another individual. From the supply point of view, non-rivalry implies that at any level of production of the good, the marginal cost of delivering it to an extra consumer (i.e., the cost of reproducing) is close to zero. Absent any policy intervention, digital goods are also largely non-excludable, as it is hard for anyone to exclude another individual from consuming them; from the supply point of view, this is equivalent to saying

that the reproduction cost is negligible not only for the creator of the good, but also for anyone else. If creators cannot exclude non-buyers, they will not be able to appropriate the revenues of their creation, which will undermine their incentives to create (given that the fixed costs of creation may be substantial and, mostly, sunk). This is the classical problem of ‘underproduction’ that plagues public goods: the number (and quality) of digital goods that is produced through private forces may be inferior to what society would deem as optimal. One solution to restore incentives so as to increase private production is to make information goods excludable by legal means. We find here the economic rationale behind copyright, which grants the creator of an original work exclusive rights for its use and distribution.

Like any Intellectual Property (IP) right, copyright can only play its economic role efficiently if it can be enforced at a reasonable cost. This is where the Internet and the digitization of information goods have dramatically changed the game by allowing end users to reproduce copyrighted works at very low cost and in almost perfect quality. ‘Digital piracy’ (i.e., the illegal reproduction and distribution of copyrighted digital goods by end-users) became an ubiquitous phenomenon, and deeply affected the interaction between copyright holders, technology companies and consumers. In particular, the existing business models, relying on the distribution of information goods through controlled channels, were gradually replaced by new innovative strategies, exploring alternative distribution modes and sources of revenues.

As usual, it takes some time for economists to describe and analyze properly the latest technology and business developments. Although an abundant theoretical literature has addressed issues related to the pricing of information goods and to piracy (see Belleflamme and Peitz, 2012 and 2014, for recent surveys), the modeling framework that this literature has largely relied upon may now seem ill-suited to apprehend the current evolution in information goods industries and, in particular, the development of streaming as an alternative channel of distribution and consumption of digital goods. However, I will argue in this paper that the existing modeling framework should not be discarded too quickly: it still provides researchers

with a parsimonious and tractable setting on which richer analyses can be built. Therefore, I first briefly review the existing model in Section 2. Then, in Section 3, I describe the main recent developments in digital goods industries, and I explain how they question the underlying assumptions of the existing model. Finally, in Section 4, I propose two main directions for future research: deepen the understanding of consumers choices and modes of consumption, and focus on the roles and strategies of digital platforms. I conclude in Section 5.

2. PRICING DIGITAL GOODS: A SIMPLE MODEL

The objective of this section is to briefly describe a simple model that has been largely used in the industrial organization literature to analyze the pricing of information goods in the presence of end-user piracy (see, e.g., Yoon, 2002; Belleflamme, 2003; Bae and Choi, 2006). I focus here on a technical description of the model and its main results. I will amply discuss the suitability of its assumptions and possible extensions in the next two sections.

2.1. The baseline setting in the analog era. Let us consider the market for a single information good. The copyright holder faces a fixed cost of production $F > 0$ and a constant marginal cost of production $0 \leq c < 1$. A mass one of end users are characterized by their valuation v for the information good. For simplicity, we assume that v is drawn from the uniform distribution on the interval $[0, 1]$. Each user has a unit demand for the good. Hence, if the good is sold at price p , the total demand for the good is equivalent to the mass of users for whom $v \geq p$. That is, $q(p) = 1 - p$.

Before digitization took place, illegal copies were not only expensive to make, but they were also of drastically inferior quality than originals. It was therefore reasonable to assume that copyright was (almost) perfectly enforced. In that case, the copyright holder behaves as a monopolist and sets the price of the information good so as to maximize its profit $\pi = (p - c)(1 - p)$. The optimal price is easily found as $p^m = (1 + c)/2$; the corresponding (gross, per period) monopoly profit is then equal to $\pi^m = (1 - c)^2/4$. Given the copyright

length, the expected future demand for the good, and the copyright holder's discount factor, one can compute the present discounted value (PDV) of the flow of future profits, which is denoted V^m . For the copyright holder to start the production of the information good, it must be that $V^m \geq F$.¹ As for end users, their (per period) surplus is computed as $CS^m = (1 - c)^2 / 8$.

2.2. Effects of digitization. The effects of digitization on the pricing of information (now digital) goods can be separated into two broad categories: the 'static' effects, which concern the pricing of existing goods, and the 'dynamic effects', which concern the production of new goods.

2.2.1. Static effects. Digitization has been shown to affect the pricing of existing digital goods in three contrasting ways. On the one hand, and most obviously, there is the displacement of sales due to digital piracy. The digitization of information goods and the fast penetration of the Internet have indeed led an increasing number of end users to copy and distribute digital goods without the authorization of their legal owners. On the other hand, digitization also affected the demand and the supply of digital goods in ways that contributed to mitigating the negative impacts of piracy for copyright holders. I now show how these effects can be integrated, one by one, into the previous model.

Piracy and sales displacement. The first effect of digitization is to enlarge the end-users' set of options. Besides buying a unit of the original information good, they now have the possibility to access a pirated copy. Let us assume here that end users can access this copy free of charge, but perceive it as an imperfect substitute for the original good. In particular, end user v attaches a value $(1 - \alpha)v$ to the pirated copy, where $\alpha \in (0, 1)$ can be seen as the level of 'quality degradation' of the copy with respect to the original. It is then easily seen that end users are no longer willing to pay the full price p to acquire a unit of the original product, but

¹We note here that a longer copyright term increases V^m and, thereby, raises the incentives for the creation of information goods. This is the well-known dynamic efficiency rationale of IP rights.

only the additional value that the original brings on top of the copy. That is, user v prefers the original to the copy insofar as $v - p \geq (1 - \alpha)v$, which is equivalent to $p \leq \alpha v$. As a result, the demand facing the copyright owner decreases from $q(p) = 1 - p$ to $q(p, \alpha) = 1 - p/\alpha$. The optimal price that maximizes $\pi = (p - c)Q(p, \alpha)$ is found as $p_1^d = (\alpha + c)/2$. As long as $\alpha > c$, the corresponding profit is $\pi_1^d = (\alpha - c)^2/4$. It is obvious that $\alpha < 1$ implies that $\pi_1^d < \pi^m$: not only does the copyright holder sell fewer copies (as $q_1^d = (\alpha - c)/2\alpha < q^m = (1 - c)/2$) but she also sells them at a lower price ($p_1^d = (\alpha + c)/2 < p^m = (1 + c)/2$). It follows that digital piracy reduces the PDV of future profits and, hence, the incentives to create. In other words, digital piracy has a negative impact on welfare from a dynamic efficiency point of view. However, by reducing the market power of the copyright holder and by allowing more consumers to access the good, digital piracy enhances welfare from a static point of view.² These contrasted findings illustrate the usual trade-off of IP rights: static efficiency comes at the expense of dynamic inefficiency.

Lower marginal costs. As stressed by Wunsch-Vincent (2013) and Pénin (2015), digital technologies reduce the marginal cost of reproducing and distributing information goods. For digital goods, this cost becomes negligible. If we set $c = 0$ in the above analysis, we have that the copyright owner facing digital piracy sets a price of $p_2^d = \alpha/2$ for the original good, and achieves a profit of $\pi_2^d = \alpha^2/4$. Putting the two effects of digitization together (sales displacement and lower marginal cost), we observe that digitization has a negative impact on the copyright holder's profits if and only if $\pi_2^d < \pi^m$, which is equivalent to $\alpha < 1 - c$. Unsurprisingly, the latter condition is more likely to be satisfied the higher the quality of pirated copies (i.e., the lower the quality degradation α) and the lower the reduction in marginal cost (i.e., the lower the pre-digitization value of the cost, c). As for end users, the lower marginal cost further increases their surplus.

²Welfare under piracy, noted W_1^d , is computed as the addition of the copyright holder's profit (π_1^d), the surplus of the consumers of the original, $\int_{p_1^d/\alpha}^1 (v - p_1^d) dv$, and the surplus of the consumers of the pirated copy, $\int_0^{p_1^d/\alpha} (1 - \alpha) v dv$. It is readily shown that $W_1^d > W^m$, where $W^m = \pi^m + CS^m = 3(1 - c)^2/8$.

Mitigating factors. Even if digitization reduces the marginal cost of reproducing and distributing information goods, it also eases the access to high-quality pirated copies and, thereby, tends to harm copyright holders. However, digitization entails other effects that may mitigate this negative impact. The theoretical literature has identified three mechanisms by which piracy may have a *positive* effect on the profits of copyright holders.³ The first is a *sampling effect*. The argument is the following: insofar as information goods are complex experience goods, the copyright holder may want to use samples of its good so as to let consumers discover their preferences before, hopefully, buying the good. Yet, producing samples and organizing their distribution may be costly for the copyright holder, who may therefore prefer to let pirated copies play the role of free samples. A larger availability of pirated copies may then increase the demand of the original good: when consuming a pirated copy, users learn their valuation of the good and if the latter is large, they decide to purchase the (higher-quality) original.

The second mechanism stems from the *network effects* that numerous digital goods exhibit: the more they are consumed, the larger the value they generate for their users. Sources of network effects are, e.g., word-of-mouth in the case of cultural goods, or compatibility benefits in the case of software. In the latter two examples, it is fair to assume that original and pirated copies contribute equally to the network effects, which introduces another channel through which digital piracy may improve the demand for the original good.

The third mechanism, called *indirect appropriation*, refers to the idea that the ability to make copies may increase a user's willingness to pay for the original good and, thereby, allow the copyright holder to capture (partially or even fully) the value of these copies. As argued by Watt (2005) or Johnson and Waldman (2005), the digitization of information goods seems to have rendered this mechanism inoperative, at least across users for a given digital good. A similar effect may, however, work across complementary goods for a given user: if pirated

³See the references in Belleflamme and Peitz, 2012 and 2014.

copies are consumed together with private goods that can hardly be copied, then they can be used as a ‘loss leader’ so as to increase alternative sources of revenues. This may explain why an artist may welcome the diffusion of pirated copies of her work, as it may boost her popularity and, thereby, the revenues from ticket sales and merchandising.

A oversimplified way to introduce these effects into the previous model would be to denote by $r > 0$ the additional revenue that each copy allows the copyright owner to raise (either because of increased demand of original goods through sampling or network effects, or because of increased sales of complementary products). In the presence of digital piracy, we have seen above that if the original good is priced at p , then the quantity of pirated copies is equal to p/α . The copyright holder then chooses p to maximize $\pi = p(1 - p/\alpha) + (p/\alpha)r$. The optimal price is found as $p_3^d = (\alpha + r)/2$ and the corresponding profit is $\pi_3^d = (\alpha + r)^2/4\alpha$. Comparing to the initial situation absent piracy, we have that digital piracy harms the copyright holder if and only if $\pi_3^d < \pi^m$, which can be rewritten as $r < \sqrt{\alpha}(1 - c) - \alpha$. The latter condition is more likely to be met if (i) the revenues from the mitigating factors (r) are small, and (ii) the cost reduction induced by digitization (c) is small. As for the effects of the the quality degradation of pirated copies (α), it is ambiguous: higher quality copies displace more sales of the original goods but generate larger complementary revenues.

A more proactive approach: Freemium. The previous analysis suggests that digital piracy may not be as harmful for copyright holders as it appears at first glance. Theoretically, the net effect of piracy could even be positive. Yet, this should not lead us to conclude that copyright holders should welcome digital piracy. Such a conclusion would be based on an incorrect counterfactual, as the mechanisms that were just described do not need piracy to work. The copyright holder may indeed decide to market cheaper (possibly free) versions of her digital good in order to offer samples, increase network benefits, and/or generate complementary revenues. Clearly, this option is more costly than letting pirated copies do the job, but it allows the copyright holder to regain the control over the distribution of the digital good.

This is the idea behind the ‘freemium’ strategy, which consists in offering a menu of versions of the digital goods; typically, a free version with limited features is proposed along a premium version, which has the full features and is sold at a positive price. In the context of digital piracy, this scheme is not just a tactic of (second-degree) price discrimination: the objective is also to propose a legitimate version of the digital good that directly competes with pirated copies. As Halmenschlager and Waelbroeck (2014) nicely put it, the aim is “Fighting piracy with free”. To depict this strategy within the above framework, let the original good correspond to the premium version (with a net utility of $v - p$), and let the free version be a degraded version conferring a net utility of $(1 - \beta)v$. It is then easily seen that any user prefers the legitimate free version to the pirated version if and only if $(1 - \beta)v \geq (1 - \alpha)v$, or $\beta \leq \alpha$. That is, the copyright holder must make sure that the quality of her free version is slightly above the quality of pirated copies.⁴

2.2.2. *Dynamic effects.* Insofar as digital piracy negatively affects the copyright holders’ profits, then incentives to produce new works or works of higher quality decrease. In other words, although a static welfare analysis may see piracy in a favorable light, the dynamic effects are more likely to be negative.⁵

However, digitization may also have some positive dynamic effects. As indicated above, digitization contributes to reducing a number of costs related to the creation, production and distribution of information goods. This implies that, for a given level of future profits, a wider range of authors and creators may be incentivized to create new works (or works of higher quality). In the model used so far, we could think of creators as being heterogeneous in terms of their fixed cost of creation, F , and assume that F is drawn from some probability distribution. Digitization would then make this distribution more skewed to the left, which could somehow counterbalance the reduced incentives due to lower profits. In sum, although

⁴Naturally, to evaluate properly the overall profitability of that option, we would need to know the costs for the copyright holder of organizing this form of menu pricing.

⁵See, e.g., Novos and Waldman (1984), Johnson (1985), or Bae and Choi (2006) for arguments along these lines.

the condition for creation to be profitable becomes more stringent (because profits decrease), a larger mass of creators would be in a position to satisfy it (because costs decrease as well). The net dynamic effects of digitization are thus, a priori, ambiguous.⁶

3. RECENT DEVELOPMENTS IN DIGITAL GOODS INDUSTRIES

In this section, I briefly describe three intertwined innovations that have deeply altered digital goods industries (in particular music and video) over the last decade. I then explain how these innovations question the assumptions that underlie the models presented in the previous section.

3.1. Three disruptive forces. Over the last decade, *new intermediaries* have proposed *new modes of distribution and consumption* of digital goods, and developed *new business models* to monetize them.

- The new *intermediaries* are digital companies such as Spotify, Deezer, Soundcloud, Google Play Music, Apple Music, Tidal and YouTube for music, or Netflix, Hulu, Amazon Instant Video, Showtime, HBO Now for video. As I will argue below, an important feature of these companies is that they can be seen as *platforms*, as they bring together a large number of users who interact with each other, namely content producers, consumers and, possibly, advertisers.
- The novelty in terms of *distribution* is that these platforms propose a streaming service; that is, they supply content in real time over the internet. End users can thus access the content of their choosing without the need to download files, which is a major innovation as far as *consumption* is concerned. Compared to the purchase of physical media or the download of (legal or illegal) files, streaming does not convey permanent ownership of the content to the users but only provide them with a non-durable access

⁶Waldfoegel (2012) finds no evidence of a decline in recorded music quality since the advent of peer-to-peer sharing (his results even suggest an increase in quality). Aguiar and Waldfoegel (2016) revisit this question by using a more comprehensive data set; they conclude that music quality “has increased in the eyes of consumers around the world.”

to this content. In exchange, streaming platforms offer a single point of access to huge libraries of contents; they also provide users with a number of value-added services (e.g., creation and sharing of playlists, synchronisation on several devices, recommendation systems), which allow them to access content any time and anywhere, as well as to discover new content more easily.

- The new *business models* used by streaming platforms are predominantly based on subscription, embedded advertising, and freemium offers. In the subscription model, users pay a flat rate for a given period of time, which allows them to consume the content available on the platform on an unlimited basis during that period. In the embedded advertising model, content can be accessed for free but is bundled with advertising; the advertising nuisance can then be seen as the shadow cost of free content. Finally, as explained above, the Freemium model is a hybrid of the two previous models: users can choose between the free version, with advertising embedded into it, and the premium version, which offers ad-free content and other add-ons in exchange for a flat fee.

As I now show, the model described in the previous section appears as ill-suited to analyze the impacts of these three innovations.

3.2. Inadequacy of previous modeling. In regards of the recent changes in digital goods industries, a number of simplifying assumptions of the previous model no longer seem appropriate. First, the model assumed a unique decision-maker, the copyright holder. This was seen as a reasonable approximation of a longer value chain, where objectives were fairly aligned; for instance, in the music industry, it was sensible to assume that record companies and artists had similar views regarding, for instance, piracy. This may still be so nowadays but, as just explained, a major difference comes from the emergence of digital platforms, which increasingly stand as inescapable intermediaries between content producers and end users. There are at least two reasons for incorporating these platforms into the model. On

the one hand, platforms control what becomes the dominant distribution channel for content, which gives them increasing bargaining power in terms of price fixing. On the other hand, the objectives of platforms and copyright holders do not necessarily converge; for instance, in the music industry, platforms relying on advertising revenues have a clear incentive to make the access to content cheaper, which artists and music labels may resent.⁷

Second, the model considered a copyright holder in a monopoly position, selling a single information good at a uniform price. The monopoly assumption was usually justified by the large horizontal differentiation that exists across digital goods. When the only (legal) way to consume content was to acquire the ownership of it, it was also reasonable to consider that a consumer's utility for several digital goods could be approximated by the sum of the utilities of the different goods, which made it possible to consider separately the market for each good. Finally, the uniform price assumption made sense as very little price discrimination was observed. In the era of streaming platforms, these assumptions look obsolete. Streaming makes the demands for different digital goods interdependent, because of the subscription model (the average cost of consuming one particular good decreases with the quantity consumed of other goods) and of recommendation systems (the discovery of some goods depends on the consumption of other goods). Also, platforms propose a menu of prices for their services (the freemium model is nothing but a form of second-degree price discrimination).

Third, as indicated above, streaming enlarges the set of options for end users in a non-trivial way. The simple binary choice between a legal and an illegal copy has to make way to a more complex choice between permanent ownership of a limited set of goods and non-durable access to a seemingly unlimited library of content.⁸ To clarify the latter choice, users' preferences need to be elucidated, regarding not only the content itself, but also the way it is consumed

⁷For example, the Financial Times reported in March 2015 that Universal Music Group “(was) using licence negotiations with Spotify to push for changes to the company’s free service, privately arguing that it is not sufficiently distinct from the its paid-subscription tier.”

⁸What may further complicate users’ (and copyright holders’) choices is that legal and illegal content often coexist on the same platform (as is, for instance, the case on YouTube).

(convenience, conditions of availability, search and discovery possibilities, interaction with other users, etc).

4. BUILDING NEW MODELS

To summarize the previous discussion, there are two clear directions in which existing models of digital goods need to be updated to account for the impacts of streaming: on the demand side, users' choices must be better understood; on the supply side, decision-making must shift from copyright holders to platforms. In this section, I explore these two issues by proposing my own thoughts and by reviewing some recent theoretical and empirical contributions.

4.1. Understanding consumer choices. As already stressed, streaming extends users' consumption possibilities for digital content. It would be wrong, however, to consider streaming as just one additional channel through which users can access content. That is, extending the previous model by simply adding one option in the users' utility maximization programme would miss the major changes that streaming is bringing. First, the unit of consumption has changed: instead of adding up demands for individual contents, users pay for accessing an almost bottomless library of contents. Second, the conditions of access have changed as well: instead of a guaranteed access through permanent ownership, streaming provides users with a temporary access that ceases once the subscription has expired. Finally, and perhaps more importantly, streaming has the potential to reduce significantly consumers' search costs for content and, thereby, to enhance their ability to discover not only new content but also their own tastes. This is due to the subscription model (for a monthly fee, the user has access to any content available on the platform) and to the value-added services that the platform offers (recommendation systems, custom radios, content sharing on the platform itself or on social networks, etc).

Any modeling of digital industries in the presence of streaming should thus rely on a careful analysis of how streaming affects individual consumption behavior. To address this issue, I first review recent empirical contributions that try to estimate how streaming affects the existing channels of content consumption. Next, I propose some preliminary thoughts as to how streaming technology may transform music consumption.

4.1.1. *Choice of consumption channel.* A number of insightful observations emerge from recent empirical work regarding the impact of streaming on other consumption channels. As far as the choice between renting (i.e., streaming) and purchasing is concerned, it is not entirely clear whether the two channels are substitute or complement to one another. Aguiar and Waldfogel (2015) suggest substitutability: according to their study based on song-level digital sales, streaming displaces legal downloads. Wlömert and Papies (2016) reach a similar conclusion: after observing a panel of more than 2500 music consumers repeatedly over more than one year, they find that the adoption of free and paid streaming services cannibalizes consumers' music expenditures on other channels. The research by Hiller (2016) also indicates substitutability; using, as a natural experiment, the removal from YouTube of Warner Music content (and its restoration some time later), Hiller shows that the displacement from YouTube videos is significant, especially for albums that have a very successful debut. Noteworthy is the fact that even though streaming cannibalizes other channels, the net effect on content producers' profits may still be positive. For instance, Wlömert & Papies (2016) estimate that the overall effect of streaming on industry revenue is positive (the positive effect of paid streaming outweighs the potentially negative effect of free streaming).

Other studies suggest, however, the existence of some form of complementarity between streaming and other channels. Relying on individual-level clickstream data of a representative sample of 5,000 French Internet users, Aguiar (2015) finds that ad-supported streaming services stimulate alternative channels of music consumption that offer mobility; an explanation could be that some consumers first use the free streaming service to discover the existence

of and their match value for new content and next, turn to downloading channels to enjoy the benefits of mobile consumption. Aguiar and Martens (2016) document a similar stimulating effect of music streaming on digital music sales: using clickstream data on a panel of more than 16,500 European consumers, they find a positive relationship between the use of licensed streaming websites and licensed websites selling digital music. Finally, Kretschmer and Peukert (2014) are able to estimate that the free music videos available on YouTube trigger the sales of music albums, but have no effect on the sales of individual songs; identification comes from comparing Germany (where music videos are blocked because of an ongoing royalties dispute between YouTube and the German collecting society) and other countries (where the same content is easily accessible).

As far as the impact of streaming on piracy is concerned, empirical evidence is limited. Sinclair and Green (2016) conclude, from 35 in-depth qualitative interviews, that streaming services are a more efficient way to tackle the problem of digital piracy than previous methods of copyright enforcement. Yet, other studies suggest that music streaming acts more as a complement than as a substitute of digital piracy. Borja, Dieringer and Daw (2015) use a representative survey of 197 college students (with questions regarding their online shopping habits); they find a positive correlation between frequent use of streaming services and illegal downloading. Borja and Dieringer (2016) reinforce the previous result via their analysis of 1052 surveys conducted on undergraduate students in two universities in South Florida. The implication of the latter findings for theoretical works is that any analysis of streaming services needs to be carried out in the shadow of piracy (even if piracy is no longer making the headlines).

4.1.2. *How does streaming affect consumption?* In the previous discussion, the impact of streaming on other consumption channels was largely made under the implicit assumption of stable consumption patterns. However, there are reasons to believe that streaming contributes to modifying the way users consume content. To understand the changes brought

by streaming, Seabright (2016) compares streaming and downloading in terms of accessing content once (“first play”) and accessing it repeatedly afterwards. As content is an experience good, the first play generates a discovery value for the user. In the download option (involving permanent ownership), the cost of first play is high and creates an (uncertain) discovery value, while guaranteeing an option value of accessing the content again for ever. From the point of view of the content producer, revenue is invariant to the discovery value of accessing the content. In contrast, in the streaming option, the subscriber faces a zero marginal cost of first play, but gets value of first play, as well as a non durable option value of accessing the content again (as it is limited to the expected lifetime of the subscription). Here, the revenue generated is much lower for the first play but is potentially much larger for content with higher discovery value. All in all, Seabright (2016) explains that there are three ways in which streaming generates increased social value for the same average revenue: (i) it considerably reduces the costs of the first play for users; (ii) it lowers the users’ incentive to resort to alternative inefficient discovery mechanisms (e.g., radio or television) so as to avoid this high cost; (iii) it allows content producers to capture much larger revenues for content with high discovery value.

In the same vein, Datta, Knox and Bronnenberg (2016) conjecture that streaming may affect consumption behaviour in three potential ways. First, because streaming widens the variety of accessible content, it may generate additional content consumption instead of displacing it from other channels. Second, streaming may have an impact not only on the quantity of content that is consumed but also on its variety. Like Seabright (2016), the authors argue that in the streaming option, variety is free at the margin (whereas it is costly in the download or purchase options). Finally, streaming may transform content discovery by allowing users to find high-value content more efficiently.

To test these hypotheses, Datta, Knox and Bronnenberg (2016) construct a unique panel data set of individual consumers’ listening behavior on digital music platforms (streaming

and ownership-based). Their results tend to validate the three hypotheses: after subscribing to a streaming service, users increase their consumption of music both in quantity and in variety; they also discover more new music, and tend to play repeatedly their best discoveries. An important challenge for future theoretical research would be to build a model of consumer behaviour that generates the same predictions, while shedding light on the underlying mechanisms.

4.2. The rising power of streaming platforms. As streaming becomes a major mode of content consumption, as well as a major source of revenues for content producers,⁹ the operators of streaming services secure an increasing market power in digital goods industries. It is thus essential to understand correctly how they function, what are their roles, and how they affect market outcomes. As indicated above, the streaming operators can be seen as *platforms*, i.e., as *intermediaries that facilitate and manage the interaction between a large number of users*. This broad definition encompasses multi-sided platforms, which facilitate the interaction between users belonging to separate groups (or ‘sides’). More precisely, streaming services are *digital platforms*, as the interaction takes place on the Internet and concerns digital goods.

The industrial organization literature studying the economics of platforms provides thus important insights into the working of streaming services.¹⁰ I focus here on three main issues: the identification of external effects, the strategies that platforms deploy to internalize these effects, and the peculiarities of the competition among platforms.

4.2.1. Identifying cross- and within-group external effects. The main function of platforms is to internalize the various external effects that the interaction between the users generate.

⁹Friedlander (2016) reports that streaming became in 2015 “the largest component of [the music] industry revenues, comprising 34.3% of the market, just slightly higher than digital downloads.” Datta, Knox and Bronnenberg (2016) add that “[a] similar shift from ownership-based to streaming-based business models is taking place in other copyright-related industries (e.g., movies, games, books).

¹⁰For seminal contributions on two-sided markets, see Rochet and Tirole (2003) and Armstrong (2006). For a recent review of the literature on these two topics, see Belleflamme and Peitz (2016).

What are the main external effects at work on streaming platforms? Streaming platforms connect up to three categories of users: content producers (artists, record companies, movie studios, etc), consumers and, possibly, advertisers. External effects exist across and within these three groups. As far as *cross-group external effects* are concerned, there are first obvious positive effects across content producers and consumers: on the one hand, the larger the variety of content that a streaming platform distributes, the more attractive it is for consumers; on the other hand, the more consumers subscribe to a streaming platform, the larger the revenues that content producers can hope to gain if their content is available on this platform. Next, effects across advertisers and consumers are likely to have opposite signs: advertisers clearly appreciate the presence of more consumers on a given platform, but consumers generally see advertising as a nuisance. That is, consumers exert a positive external effect on advertisers, whereas advertisers exert a negative external effect on consumers. Note that the Freemium business model exploits the fact that consumers differ in their valuation of this negative effect of advertising: the free version is targeted at consumers with a relatively low disutility from advertising, and the premium version at the other consumers. Finally, there does not seem to be any direct cross-group external effect across content producers and advertisers. There are, however, indirect effects: as advertisers care about consumers (i.e., eyeballs) and consumers care about content variety, advertisers prefer platforms giving access to more content; as for content producers, their attitude towards the presence of advertisers on the platform depends on a number of factors: the effect of free access on consumers' participation, the payments (royalties) received from the platforms for, respectively, free and paying consumers, the share of advertising revenues that content producers obtain, etc. As mentioned above, the fact that some music labels put pressure on Spotify to reduce the amount of music that consumers can access for free indicates that some content producers perceive the net effect of advertising as negative.¹¹

¹¹This is probably due to Spotify's price structure: the per-stream rate that Spotify pays to artists is lower for the free service than for the premium service (see Singleton, 2016).

Turning now to *within-group external effects*, they are mainly to be found within the group of consumers. Positive network effects exist among streaming consumers for at least two reasons. First, the benefits of interacting with other users (for instance, by sharing playlists) increase with the size of the user base. Second, recommender systems (which allow users to discover high-value content) gain in precision as more consumers use the platform. Within the other two groups, external effects are likely to be negative as both content producers and advertisers compete for the attention of consumers.

4.2.2. Platform strategies. How do streaming platforms manage user participation and volumes of interaction? As Hagiu and Wright (2015) explain, they can choose between two basic ways to function: either as a marketplace (allowing ‘suppliers’ to sell their product directly to ‘buyers’) or as a reseller (purchasing products from ‘suppliers’ to resell them to ‘buyers’). Actually, most streaming platforms (e.g., Spotify, Netflix) combine the two ways: they act as resellers for content, but as marketplaces for advertising. As far as content is concerned, streaming platforms buy it from content producers and resell it to consumers; that is, they pay royalties to content producers for the right to make their content accessible to consumers. As a result, there is no direct interaction between consumers and content producers (as would be the case under the marketplace mode): consumers and content producers interact with the platform only. The opposite prevails as far as advertising is concerned. Here, the platform first sets participation fees for advertisers and for consumers and then, let them interact as they please. Typically, advertisers pay a fee to have their ads seen along with content, and consumers are given free access if they accept to consume content along with ads. In this regard, streaming platforms resemble media platforms, which mainly rely on advertising as a source of financing but which increasingly turn to freemium-like models (e.g., paywalls).¹² There is, however, a major difference between the two types of platforms: media platforms

¹²For recent surveys on the economics of media in the digital era, see Anderson and Jullien (2015), and Peitz and Reisinger (2015).

produce the large part of their content themselves, whereas streaming platforms buy their content from third-party producers.

In terms of price strategies, one major decision facing streaming platforms is the choice of business model: subscription, embedded-advertising, or a combination of these two (i.e., freemium). Thomes (2013) addresses this issue by considering a monopoly streaming platform that chooses to offer either a free service, which is ad-financed and of low quality, or a paid service of higher quality. The platform will optimally choose the former service as long as consumers are sufficiently tolerant to advertising; in that case, streaming is shown to be an effective tool to fight piracy. Although this paper usefully introduces two-sided aspects, it ignores the effects that streaming has on content consumption. In this regard, the analysis by Carroni and Paolini (2016) is more innovative: they also examine a platform's choice between a freemium and a pure subscription model and show that the consumers' attitude with respect to advertising plays a critical role; what they add is a richer modeling of the consumers' utility function (utility increases with the number of contents that are available on the platform) and of the content producers' participation decisions (content producers, who are assumed to have different outside options, decide whether or not to let the platform distribute their content).

Streaming platforms also use non-price strategies to manage the external effects across and within groups. I already mentioned the value-added services that streaming platforms propose: recommendation systems, sharing of playlists, portability across devices. These services contribute to reinforce the positive network effects among consumers. If these services are platform specific, they also create switching costs for consumers, which is a potential source of competitive advantage for the platform (see the discussion below).¹³ Another common strategy is to sign exclusivity agreements with some content producers so as to attract, and retain,

¹³For a review of the impacts of network effects and switching costs on competition, see Farrell and Klemperer (2007).

consumers interested in this exclusive content.¹⁴ Finally, some platforms have started to produce their own content. A priori, this strategy may have contrasting effects for the platform: it may attract additional consumers, while scaring away third-party content producers.¹⁵

4.2.3. Platform competition. As clearly explained by Armstrong (2006), the competitive game among platforms may differ fundamentally according to whether users have the possibility or not to ‘multihome’, i.e., to be active on different platforms at the same time (if not, they are said to ‘singlehome’). As far as streaming platforms are concerned, it is generally the case that content producers and advertisers multihome, while consumers singlehome. More precisely, content producers usually sell the right to distribute their content to several platforms; as a result, consumers just need to subscribe to a single platform to access all the content they may want to consume; and because consumers singlehome, the only way for advertisers to reach them all is to place their ads on several platforms. This logic is, however, challenged when platforms sign exclusive deals with particular content producers. In that case, consumers may be forced to multihome (i.e., to have multiple subscriptions to different streaming platforms) if they do not want to forgo the access to some content they value.¹⁶

The literature on two-sided platforms explains that in a market with competing platforms where one group of users multihomes while the other group singlehomes, platforms usually tend to compete fiercely on the singlehoming side, while ‘milking’ the multihoming side. This is because the platforms are in a monopoly position on the multihoming side (as they control the access to the singlehoming users that have registered with them); yet, to acquire and reinforce this monopoly position, platforms have to court users on the singlehoming

¹⁴For instance, in 2016, Tidal and Apple Music secured the exclusive release of, respectively, Beyoncé’s and Frank Ocean’s latest album (see Behr, 2016). For economic analyses of this strategy and its impact on competition, see, e.g., Armstrong and Wright (2007), Lee (2013), and Stennek (2014).

¹⁵The typical example of a streaming platform investing in in-house content is Netflix with series like *House of Cards* or *Fargo*. Thomes (2015) analyses this strategy in the video game industry.

¹⁶Currently, in the music streaming industry, exclusive deals are only temporary: an album is released on a single platform for some period of time, before being made available on other platforms as well (a tactic called ‘windowed release’). Permanent exclusivities are very rare, probably because most consumers are reluctant to subscribe to more than one platform.

side. Applying this intuition to streaming platforms, we would thus expect consumers to pay a low price and content producers, a high price to access the platform. However, as I indicated above, streaming platforms do not operate as marketplaces but as resellers: instead of selling access to the platform to content producers, they buy their content and resell it to consumers. The analogy with two-sided platforms is thus imperfect, but not entirely irrelevant: consumers do pay relatively low prices (especially in the freemium model), and content producers often complain that they receive too low compensations (with some of them even deciding to withdraw their content from streaming services).¹⁷

The various positive external effects that are at work on streaming platforms are likely to create positive feedback loops: a bigger platform can buy more content and, thereby, attract more users; this, in turn, raises the platform's revenues (either through subscriptions or through advertising revenues as more users also attract more advertisers), which allows the platform to grow. Moreover, platforms propose value-added services, whose benefits cannot easily be ported to other platforms; the resulting switching costs also tend to benefit more to large platforms than small ones. One expects thus the competition between platforms to lead to strong dominant positions ('winner-takes-most' types of situations). It is too early to tell whether the main streaming industries (music and videos) are indeed following this trend, but earlier entrants (such as Spotify and Netflix) seem to benefit from a first-mover advantage and currently lead their respective market. It also appears that later entrants are forced to adopt differentiation strategies to try and gain market shares.¹⁸

5. CONCLUSION

I started this paper by briefly reviewing the theoretical apparatus that has been largely used so far to analyze information goods industries. I argued then that although this apparatus was fairly appropriate in the analog era and in the early digital era, it needs now to be significantly

¹⁷For instance, in 2014, the singer Taylor Swift decided to remove all of her albums from Spotify.

¹⁸For instance, Tidal entered the music streaming market in 2014, proposing a better sound quality and claiming to pay higher royalties to music artists than the rival platforms.

updated. The advent of streaming challenges indeed the main assumptions that underlie the existing models. This observation lead me to propose two main directions for future research efforts. First, one needs to better understand, and model, how streaming modifies the way content is accessed and consumed, as evidenced by recent empirical work. Second, more attention should be given to the roles and strategies of streaming platforms, which become unescapable intermediaries regarding the distribution and consumption of digital goods; to this end, useful insights can be gained from the recent literature on intermediation, two-sided platforms and advertising-financed media.

Hopefully, the thoughts that I assembled in this paper will inspire other scholars to revive the theoretical research on digital goods industries. This is, I believe, necessary to grasp the significance of the fascinating developments that these industries currently undergo and, thereby, to inform business practices and public policy alike.

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