

Understanding the Challenges of the Digital Economy: The Nature of Digital Goods

Thierry RAYNA
Imperial College London

Abstract: This article investigates the economic nature and characteristics of digital goods. Such goods are, due to their replicability, shown to be public goods (albeit in an evolutionary way) and durable goods. Furthermore, the content of such goods, combined with their durability, makes them experience goods. While only one of these characteristics would be sufficient to create difficulties for producers and lead to market failure, this article demonstrates that each of the characteristics reinforces the other. The framework presented in the article is then applied to two important issues: the new trend of massive consumer piracy and the overall problem of value of digital goods.

Key words: digital goods, public goods, durable goods, experience goods, piracy.

The last decade has seen the advent and growth of two strongly linked phenomena which have led to important changes in the worldwide economy. The first is the development of the digital economy, based on the digitalisation of previously existing goods and on the development of new purely digital goods. This technology has not only permitted the creation of many new goods or services, but has also dramatically changed the way an entire category of goods in the economy are created, produced, distributed, exchanged and consumed. Digital technology has caused a drastic decrease in reproduction costs and distribution costs (and even, sometimes, in initial production costs), thereby leading to important structural changes in the economy and potentially a global rise of social welfare, due to the increase in quantity, quality and variety of goods and services available in the economy. While originally restricted to a few types of good (software, mostly), the scope of use of digital technology has progressively increased to encompass many kinds of goods: music, films, photos, books, etc.

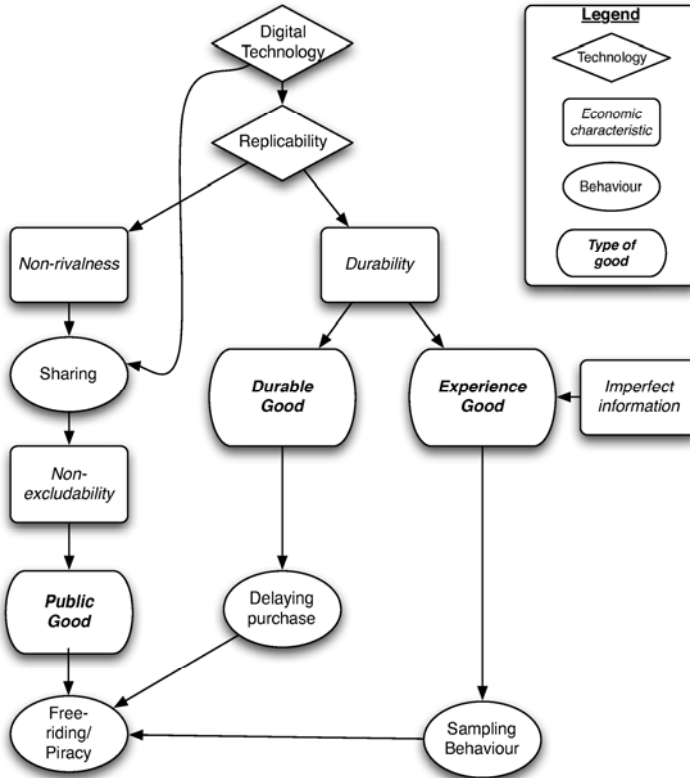
The second phenomenon, which has followed the same increasing trend as the first, is the development and generalisation of consumer piracy. Although consumer piracy has always existed and had already become an important issue since the release of early consumer-oriented duplicating technologies, the piracy phenomenon has never been as strong as it is

nowadays. Furthermore, none of the many attempts (legal and/or technological) of firms and governments has been able to curb piracy. The link between these two phenomena is clear, since, nowadays, consumer piracy is almost entirely related to digital goods. In fact, the benefits created by digital technology, in terms of distribution and reproduction costs, have been brought to the economy as a whole, thereby allowing the consumers to reproduce, distribute and exchange digital goods (virtually) without incurring any cost. The overall effect on the economy of digital technology is, thus, ambiguous. On the one hand, it has enabled a strong potential growth. On the other hand, consumer piracy endangers firms, since it undermines their ability to recover initial investment. In fact, beyond the sole problem of consumer piracy, digital technology has greatly affected the way companies do business. While some traditional business models have revealed themselves as unsuitable (e.g. paid directory services), firms have had to find new ways to appropriate returns on investment and have increasingly relied on personalisation and indirect funding (e.g. advertisement) (SHAPIRO & VARIAN, 1999).

The thesis developed in this article is that the challenges brought by the advent of the digital economy can be more easily apprehended once the economic nature of digital products has been examined. While it has often (wrongly) been said that traditional economics do not work within the context of the digital economy and that 'new economics' are needed, this article aims to demonstrate, that, on the contrary, sound economic concepts can be used to explain and comprehend the challenges brought about by digital technology. The arguments developed in the article aim to demonstrate that, because of their digital nature, digital goods are fully replicable (can be copied without loss of quality or information). This results in the following fundamental economic characteristics: digital goods are public (1st Section) and durable (2nd Section). These two characteristics are important, since they are known, in the literature, for the loss of market power they induce for the firms that produce such goods and for the market failure they may entail.

In addition to these two fundamental characteristics of digital goods, which exist regardless of the content of the goods, this article considers a third feature. The content of a digital good may be such that its actual value can only be fully realised once the good has been consumed. Thus, in addition to being public and durable, some digital goods are also experience goods (3rd Section). In this respect, it is important to note that, while not a defining characteristic feature of digital goods, many digital goods are, due to the nature of their content (music, films, books, etc.), experience goods.

Figure 1 - The economic nature of digital goods: how technology, characteristics and behaviour interact



Some of these characteristics have been recently discussed in the literature. VARIAN (1998) and SHAPIRO & VARIAN (1999) discuss the consequences of information goods being experience goods. Furthermore, VARIAN (1998) discusses the public aspect of information goods. SHAPIRO & VARIAN (1999) also, briefly, mention the durability of information goods. However, these works are devoted to the study of information goods and, while digital goods are information goods (since they are composed of a stream of 0s and 1s) not all information goods are digital goods. The scope of these works is, thus, broader and less specific than the one of this article. Furthermore, a large emphasis in SHAPIRO & VARIAN (1999) is put on the strategies firms can develop to remain successful in the information economy and the economic nature and characteristics are mentioned solely as a support of these arguments. QUAH (2003) analyses in detail the public nature of digital goods and investigates the issue of efficient private

provision of such goods. The novelty of the analysis presented in this article lies in its acknowledgement that the three important economic characteristics of digital goods have, not only similar roots, but also interact with each other. Instead of studying each element separately, a combined analysis of these three main features of digital goods is conducted in order to fully comprehend the challenges raised by digital goods for both firms and policy makers.

After introducing each of the characteristics (1st to 3rd Sections), the 4th one revisits the issue of consumer piracy in the light of the analysis conducted in the previous sections. Finally, we investigate how the three characteristics interact and how this interaction affects the value of digital goods.

■ Digital goods are public goods

Public goods¹ are defined as goods that are both non-rival in consumption and non-excludable (SAMUELSON, 1954; BUCHANAN, 1965)². A good is non-rival in consumption if the consumption activity of each consumer does not decrease the quantity of good available in the economy. A good is non-excludable if no one can be prevented from consuming it. Public goods hold a particular place in the economic literature. The first reason for that is that, until recently, such goods were considered as extremely rare, so rare, in fact, that they were little more than a curiosity. Besides goods such as street lighting, lighthouse and nuclear deterrence, all goods in the economy display at least some degree of rivalness and/or excludability. The second reason is that public goods are the only cause of market failure that cannot be corrected by appropriate market mechanisms and, therefore, require public intervention to be produced at a socially satisfactory level.

Indeed, the non-excludability property of public goods leads consumers to adopt a free-riding behaviour (SAMUELSON, 1954; BUCHANAN, 1965),

¹ The economic literature distinguishes between the nature (private/public) of a good and the way (privately/publicly) it is provided. The fact that a good is provided privately does not mean that it is not, by nature, public. Likewise, most goods provided publicly (education, health) are, by nature, private.

² Public goods are, thus, the exact opposite to private goods, which are both rival in consumption and excludable.

as they are able to enjoy the good even if they do not contribute to its provision. Thus, they do not have any reason to pay for the good or, when the provision is organised through a governmental action, to reveal their actual valuation of the good. Moreover, this free-riding behaviour is rational, as it maximises the individual utility and economic agents are expected to be guided solely by their private interest (BUCHANAN, 1965).

If everybody adopts such (rational) behaviour, the public good cannot be produced because nobody contributes to its provision. However, since individuals actually do value the public good, and everybody would be better off if the public good were, in fact, produced, the private provision of a public good is sub-optimal and leads to market failure. Governments have, thus, to intervene so that the public good can be produced. However, in addition to the potential bias introduced by public intervention, the quantity of public good produced is arbitrary and has no reason to be efficient, as governments do not have the power to make consumers reveal their valuation (because it would translate into an equivalent amount of tax being paid). The fact that digital goods are public goods bears important consequences. The considerably large number of these goods in the economy, as well as their ever growing importance, greatly affects the traditional balance between public goods and private goods in the economy. It also makes market failure more likely to arise and, thereby, leads to an increased public intervention. However, understanding the public nature of digital goods is essential to comprehend one of the biggest challenges of the digital economy: consumer piracy.

The rivalness of digital goods

It is important to note that digital goods may seem, at first, rival in consumption: if a CD is used by a consumer, this particular CD is no longer available for the consumption of other consumers and the consumption activity of one consumer, indeed, reduces the number of units available for other consumers. However, there is rivalness only as far as the medium used to distribute the digital good (floppy disc, CD, DVD, etc.) is concerned, and not the digital good itself. The medium is indeed unique: if a consumer is using it, then the plastic component referred to as "CD" cannot be used at the same time by another consumer. The digital good itself (i.e. the binary code of the software, music file, etc.) can be replicated on another medium for a small (often negligible, cost). While rivalness exists if a consumer borrows a CD from another consumer, it is not present if the digital good is

copied instead, as both consumers can enjoy the same unit of good at the same time. Since digital goods can be copied without any loss of quality or information and are, in general, independent from the medium used to distribute them (the good matters, not the medium), they can be considered as non-rival. In fact, creating a copy can be seen as part of the consumption process (this is definitely the case with digital goods distributed online, legally or not, when they are downloaded), thus the consumption activity of one consumer does not decrease the potential consumption of other consumers. This is, by definition, the case when goods are non-rival.

The excludability of digital goods

The main difference between digital goods and the other traditional public goods is that the producers of digital goods always retain the ability to directly exclude consumers. While nobody can be prevented from consuming a lighthouse once it has been produced, a producer of a digital good is still able to prevent its direct customers from consuming the good (regardless of the number of pirated copies available, an online merchant is always able to prevent people from downloading digital goods from his website if they did not pay). However, since digital goods can be replicated, anybody owning a digital good is a potential supplier of this good. Thus, once the first unit of the good has been sold, the producer starts losing control over the production of the good and part of its power to exclude consumers. As the producer does not have the ability to exclude consumers indirectly, the more the good spreads among consumers, the less it is possible for the producer to actually exclude anybody from the consumption of the good.

Thus, as for any public good, only the first unit of a digital good produced is actually excludable, since as long as nobody else owns the digital good, the producer remains the sole supplier of that good. In contrast to other public goods, though, the next units sold remain partially excludable. This is due to the fact that digital goods are not infinitely expandable: in order to avoid getting the good through the producer, the consumer needs to know another consumer who owns a copy of the digital good. Because of technological limitations, the diffusion of the digital good into the population does not occur instantly. However, as the number of consumers owning the good grows, the number of potential suppliers increases and the number of consumers able to obtain the good from other consumers instead of the producer rises. The rate of consumers in a position to supply the good is

likely to grow exponentially with time, up to the point where every consumer can potentially obtain the good without having to purchase it from the producer. Therefore, the excludability of the digital good, which remains actual for the first units produced, decreases rapidly until the good becomes (virtually) non-excludable. Although the producer always remains able to directly exclude consumers from the consumption of the good, his inability to exclude consumers indirectly is such that the digital goods become *de facto* non-excludable when the number of consumers owning the good becomes large.

Another difference between digital goods and other public goods comes from the fact that non-excludability, which is intrinsic for other public goods, directly results from the non-rivalness of digital goods. Indeed, for a digital good to be non-excludable, consumers should be able to obtain the good from other consumers. For this to happen, digital goods have to be non-rival: no consumer would let other consumers copy from him if this action would deprive him from the usage of the good. Thus, if digital goods were rival, they would also be excludable. This is a particular feature of digital goods, since other goods, such as common pool resources (e.g. pasture, clean water), are, at the same time, rival and non-excludable.

Private provision of digital goods

Understanding the public nature of digital goods enables to make sense of the massive scale of consumer piracy associated with these goods. Since digital goods are public goods, piracy can be considered as a rational behaviour: pirating digital goods is, in fact, free-riding. Leaving aside questions of ethics and morals, this fact is important because it means that consumers cannot be blamed for adopting such behaviour, since it is the individual rational behaviour in presence of a public good. Therefore, the problem of piracy is not caused by consumers, but is instead due to the nature of digital goods itself: if these goods were private, the piracy phenomenon would not exist. This certainly helps to explain the extent of "stolen" digital goods in comparison to the small number of other goods that are stolen: digital goods are subject, due to their publicness, to free-riding, whereas private goods are not.

However, despite the high level of piracy, many digital goods are produced and a large number of companies producing these goods are still able to obtain some profits. In the light of the theoretical prediction that

public goods cannot be provided privately, this could be, somewhat, puzzling. Several reasons can be given to explain this difference between theory and practice.

The first reason is that, even for a traditional public good, consumers are more likely to weakly free-ride (i.e. they contribute to the provision of the public good, albeit insufficiently for an efficient provision) than totally free ride (BRUBAKER, 1975). This phenomenon has been confirmed experimentally (ISAAC *et al.*, 1985; ANDREONI, 1988; WEIMANN, 1994) and empirically (HAAN & KOOREMAN, 2002). Consequently, although consumers do not pay for all the digital goods they consume, they might still be inclined to pay for some of them.

A second reason was already discussed above. Since digital goods are not infinitely expansible, they remain excludable for a short period of time. Consumers who are not willing to wait have, thus, no choice but to pay. Furthermore, even when the publicness of a digital good is total, pirating a digital good usually involves costs (reproduction cost, learning and search costs). Since these costs are likely to vary greatly from one consumer to another, it is not always, and for everybody, worthwhile to pirate, as opposed to purchasing digital goods (RAYNA, 2006b).

Furthermore, the actions of the producers of digital goods are also likely to induce additional costs for pirates. Technologies, such as Digital Right Management Systems, may have an adverse effect on consumers willing to pirate (RAYNA, 2006b).

Once all these reasons have been accounted for, it is then possible to envisage another defining feature of digital goods. While other goods are either private or public (or have a mixed, but fixed, status, such as club goods or common pool resources), the publicness of digital goods is not constant and evolves according to factors such as technology, consumer behaviour, firm strategies, government policies. However, regardless of the obstacles, digital goods all become, eventually, public. Digital goods are, thus, *evolutionary public*. Government interventions, through laws and law enforcement, also play an important role in the degree of publicness of digital goods. In countries that either do not have intellectual property rights, or have such property rights but do not enforce them, digital goods are (virtually) fully public. In contrast, strong IPR laws that are strictly enforced tend to decrease the publicness of digital goods.

However, while the effectiveness of IPRs to deter counterfeiting goods is commonly admitted, their ability to impede consumer piracy is more than questionable. Due to the inability to monitor all consumer activities, IPRs can, at best, target public exchange of digital goods (e.g. exchanges taking place on the internet via public servers), which is only the tip of the piracy iceberg. Furthermore, it is important to note that such laws only temporarily alter the level of publicness of digital goods and do not affect their intrinsic public nature. In this respect, QUAH (2003) points out that:

"Excludability [...] can arise from the law or from technology or from both, but it is not itself intrinsic to digital goods." (p. 13).

To this date, none of the technologies or laws developed to prevent piracy has been anything but marginally effective, and it is quite likely that it will remain so (RAYNA & STRIUKOVA, 2008). Moreover, recent technological progress has always resulted in lowering the costs of piracy, while, at the same time, many consumers have become used to operating pirate software and networks. Consequently, it is quite unlikely that the piracy phenomenon will scale down in the future. The increasing supply of digital goods in the economy, over the past few years, has certainly been the fact that has hidden one of the most important aspects of the economic nature of digital goods: their publicness. Although the evolutionary aspect of this publicness has left enough room for goods to be produced (and profit to be made), it is likely that the quantity and variety of goods produced is sub-optimal and, thus, leads to a lower social welfare. For this reason and, because of the constantly broadening consumer piracy, there have been increasingly frequent public interventions with regard to public goods. In this respect, understanding the public nature of digital goods is a key element in designing efficient public policies.

■ Digital goods are durable goods

From durable to infinitely durable

The media used to store digital goods are durable but not infinitely durable. While the life expectancy of optical media (such as CDs and DVDs) ranges from a few years up to several decades, the durability of magnetic equipment (such as floppy discs, hard-drive and tapes) does not exceed a few years. Moreover, these media are prone to early failure, because of

manufacturing defaults, and can be damaged during usage. In this respect, the media used to store digital goods are thus not significantly more durable than the material out of which non-digital cultural and information goods (vinyl disks, audio tapes, books, etc.) are made. Yet, in contrast to other information goods, digital goods can be replicated, and the available technology is such that the cost of replicating is nearly null. Therefore, although the medium used to store and distribute a digital good is finitely durable, the digital good itself is potentially infinitely durable, provided that it is transferred onto a new medium before the current one fails. Although most non-digital information goods rarely last for more than one or two generations, digital goods can potentially last forever and each digital good purchased is likely to suppress the need for the descendants of the original consumer to purchase this good ever again.

This potential infinite durability is a particular characteristic of digital goods and no other good in the economy, apart from information and land, is thought to have such a property. The advent of digital technology is therefore expected to have important consequences on the economy.

The immediate expected effect of such durability is a progressive decrease of the demand. Indeed, the two main reasons that can cause consumers to purchase a particular cultural or information good more than once are:

- deterioration of the medium (due to usage),
- change of technology.

A damaged medium is, of course, the first reason that could lead to several purchases of the same recording. Vinyl discs and magnetic tape were known to be particularly fragile, and before the advent of digital era, this limitation would insure regular sales, since the copy of the recording to another medium (from a vinyl disc to an audio-tape for example) would result in a loss of quality. Beyond that, the medium technology is short-lived. When a new technology appears, consumers may have to buy the same good once again as no players compatible with the old technology are available anymore. For non-digital cultural and information goods such an issue cannot be resolved by transferring the good from the old medium to the new one, since it would result in a loss of quality. As the digital technology enables to create perfect copies of digital recordings, these two limitations of the durability do not exist anymore because it is always possible to make a backup copy of a recording before the medium gets damaged and because it is possible to transfer a recording on the next generation medium without loss of quality (music from a CD can be transferred onto a DVD).

Durability and loss of market power

However, the consequences of durability of digital goods go far beyond a progressive decrease in demand. Indeed, as stated by Coase (1972), the sole fact that a good is durable may lead to a total loss of market power for the firms producing it. More precisely, COASE (1972) shows that even a monopolist producing a durable good will end up losing all its market power due to the fact that consumers expect the monopolist to lower its price over time.

The reason for that is that the monopolist always has interest to gradually decrease the price in order to sell more³ (as long as the price is above marginal cost, there is a residual demand that is a potential source of profit). Since the consumers are rational, they expect this decrease in price and delay their purchase until the price has fallen to the marginal cost. The only price at which the good can be sold is, thus, the competitive price, equal to the marginal cost (which corresponds to a total loss of market power), even when there is only a single firm supplying the good.

Furthermore, the extent of the loss of market power depends negatively on the time lag between the periods of sales (COASE, 1972; STOKEY, 1981; BULOW, 1982; THÉPOT, 1998): it is large if sales take place continuously and low if a large amount of time takes place between the periods of sales. One could add that if the good is really and urgently needed, it is unlikely that the loss of market power will arise. However, in the case of digital goods, it is quite likely it will, since none of these goods is usually a first necessity good nor have they many substitutes. Consumers can wait.

The best known strategy to recover market power is to rent the good instead of selling it (COASE, 1972). A monopolist renting a durable good will see no interest in decreasing its price over time, since a decrease in price for new consumers necessarily means a decrease in price for all consumers (everybody pays the same rent⁴). Consumers have, thus, no incentive to delay their purchase of the good and therefore accept to pay the monopoly

³ This would not be the case for a non-durable goods as consumers renewing their purchase would then also expect a lower price. With a durable good, consumers never renew their purchase.

⁴ When the good is sold, a decrease in price for new consumers leaves unchanged the higher price that was paid before by the other consumers.

rental price. Renting a durable good makes it equivalent to a non durable good that would last only the duration of a rental period.

Unfortunately, such a strategy cannot be efficiently used as long as competition exists⁵, which is particularly problematic, since the existence of (even potential) competitors also prevents reducing the negative effects of durability by spreading periods of sales (since competitors would find an advantage in staying continuously open).

Another traditional solution is to make the durable good non-durable (BULOW, 1986; KARP, 1996). This type of strategy is usually referred to as "planned obsolescence" (BULOW, 1986) and can take two forms. Either the intrinsic durability of the good (its quality) is reduced (e.g. components of a TV set which are designed to fail a few days after the guarantee period expires), or a new substitute good with better features is produced and makes the previous durable good obsolete (e.g. Pentium processors made 486 processors obsolete and was itself made obsolete by Core Duo processors).

The economic impact of the durability of digital goods

While far from being fully competitive, there is still a significant amount of competition in most sectors of the digital goods industry. This makes the fight against the negative effects of durability particularly difficult for firms.

In spite of the theoretical inadequacy of renting strategies in such an environment, firms have nonetheless attempted to use renting strategies. While such strategies have encountered a relative success in the context of offline renting of some particular digital goods (Blockbuster has been, until recently, able to establish a quite profitable renting service of Video-DVDs), the advent of online trade of digital goods has considerably undermined the ability to rent digital goods.

The reason for that is essentially technological. Renting out a digital good through the internet necessarily requires a copy of the digital good to be created on the computer (or similar device) of the consumer. Once the lease period is over, not only this copy, but also all the other copies the consumer

⁵ BULOW (1986) and BUCOVETSKY & CHILTON (1986) show that a monopoly operating in a contestable market will better deter entry of competitors if it is selling. Likewise, PODDAR (2004) demonstrates that, within an oligopoly, selling is a dominant strategy.

might have made in the meantime have to be destroyed. The problem is that the digital technology itself does not permit that. This is the reason why Digital Rights Management Systems have been designed. Such systems encrypt digital goods in such a way that they cannot be consumed without authorisation. Hence, the problem of renting digital goods was expected to be solved, since after the lease expired, consumers would not be able to consume the (encrypted) copies made on their devices without obtaining the authorisation to do so and would have to pay to renew the lease in order to gain such authorisation.

However, besides the issue that ways were found by consumers to circumvent all existing DRM systems (RAYNA & STRIUKOVA, 2008), such systems require a permanent connection between the devices used to consume the protected digital goods and the authorisation server. This makes DRM fit only for some digital goods (those consumed once and over a short period of time, such as films) and some devices (those permanently connected to the internet, such as computers, but not Digital Audio Players). While the rental of videos online is still at an early stage, online renting of music was introduced to the market some years ago. The companies that used such a strategies (Napster, Rhapsody, Yahoo) have been relatively unsuccessful. While this may be because of the renting strategies being inadequate when there is competition, the technological issues related to DRMs have also played an important role (RAYNA, 2006a).

When renting cannot be used to reduce the negative effect of durability, planned obsolescence (either intrinsic or through substitutes) is often considered. However, in the case of digital goods, the intrinsic durability cannot be reduced (they are intangible) and reducing the durability of the medium or the technology is not effective, because of replicability.

Nonetheless, new substitute goods, making the old ones obsolete, can still be produced. Such a strategy is often used for software. New versions of software and operating systems are released, making the previous version obsolete and pushing consumers to renew their purchase. In this respect, as long as firms release new versions of software, the problems caused by durability do not arise. However, other digital goods, such as music, films or books cannot, as easily, be made obsolete.

Although examples can be found of successful planned obsolescence used for such goods (for example, when CD versions of records previously available on vinyl discs were released) it is usually difficult to produce new versions of the same digital goods that would be improved enough for

consumers to renew their purchase (for example, Audio-DVDs were a commercial failure). The reason for that technological progress has made the quality of digital goods very close to the limit of perception of humans, making any improvement marginal. Only the film industry has been able to release significantly improved versions of their products twice (from VHS to DVD and, more recently, from DVD to Blu-Ray). Nonetheless, although the difference of quality between a film in DVD format and the same film in Blu-Ray format is significant, it is still quite arguable that more than a small proportion of consumers will repurchase films they already own. Besides, there will eventually be a point, as it is the case for other digital goods, when the existing quality of films will be such that any improvement will be imperceptible for most consumers.

However, obsolescence is not necessarily solely due to the production of a new version of the same good, but can be caused by the production of a close enough substitute. In this respect, the impact of the production of a substitute essentially depends on the behaviour of the consumers, in other words on the degree of substitutability between goods. Digital films or books, for example, are seldom consumed repeatedly, despite their durability. In such a case, releasing new products might be enough to overcome the problems caused by durability and any new product may be considered as a close enough substitute.

In contrast, other digital goods, such as music, are consumed repeatedly. In such a case, the definition of a close enough substitute depends strongly on the tastes of the consumers and, as such, is heterogeneous. For example, a die-hard devoted fan of Elvis Presley is only interested in recordings of Elvis, and the degree of substitution with recordings of another singer is likely to be low. As the number of records of Elvis, although large, is fixed, and, as there are no close substitutes, Elvis records are durable, since the demand for records of this consumer will decrease to zero after the consumer has achieved to purchase all the existing Elvis records. In contrast, a consumer who is a dedicated follower of fashion is likely to consider any new record as a substitute close enough to make the previous ones obsolete, since such consumer only consumes the latest hits. In this situation, the durability of a music recording is reduced, since it is not likely that this type of consumer will listen to a record older than a few months.

Between these two extremes, given that the time consumers can devote to the listening of music is fixed, the impact of a new release will depend mostly on the "satiation factor", e.g. the time the consumers devote to old

and newly acquired records and on the difference of quality (or utility) between the newly released record and the previous ones.

It is worthwhile noting that, in contrast to most other digital goods, such as movies and e-books, it is difficult to reduce the durability of music, since music records usually have a high satiation point and can be consumed over and over during years⁶. Only consumers particularly fond of novelties may see music as a non-durable good. Thus, the common strategy consisting of introducing planned obsolescence in order to avoid the loss of market power associated with the selling of a durable good is not likely to be efficient in the case of music.

If the durability of digital goods cannot be reduced, consumers are likely to expect a decrease in price and to defer their purchase. The public nature of digital goods tends to aggravate the problem, since consumers, while they wait for prices to drop are, nonetheless, able to consume illegal versions of the goods. Of course, this means that even if prices eventually decrease to a level they deem acceptable, they have little incentive to purchase something that they own (albeit illegally) already.

Furthermore, even though firms selling digital goods have to progressively decrease their prices, they are usually able to obtain a high profit margin on the units of goods sold to impatient consumers who cannot wait for the prices to drop to the marginal cost. Because of the publicness of digital goods, even impatient consumers have few reasons to buy legally at a high price what they can obtain illegally at a low cost. Consequently, the remaining market power that firms retained on impatient consumers is likely to be completely absorbed by the publicness of digital goods, leaving firms no choice but to sell at marginal cost.

■ Digital goods are experience goods

NELSON (1970, 1974) defines experience goods as goods whose qualities cannot be determined prior to purchase. KLEIN (1998) builds on this definition and states that there are two circumstances in which a good is considered an experience good: either when full information on the main

⁶ Software also has a high satiation point and can be consumed over and over during years, but, as mentioned above, can be easily made obsolete.

attributes of the good cannot be known without direct experience, or when the search for information about the main attributes is more costly or difficult than experiencing the product directly. WRIGHT & LYNCH (1995) add to the literature by taking into consideration the fact that consumers are sometimes allowed to experience the product through free samples and, thus, define experience goods as goods whose qualities cannot be determined prior to consumption.

Of course, it could be argued that most goods in the economy correspond to the above definition and are, thus, experience goods. However, the problems brought about by experience goods are most likely to arise when the good is durable (NELSON, 1970). For a non-durable good, over-estimating the value of the good is not an important issue, since it is only related to one or a few episodes of consumption (for this reason, a fruit is, usually, not considered as an experience good). However, this becomes critical when the good is durable, since over-estimating the value of the good is, then, related to a, potentially large, number of episodes of consumption.

When one considers the goods that are supplied digitally, such as music, movies, software or books, it becomes obvious that most of them do indeed correspond to the above definition of experience goods. It is important, here, to differentiate the digital good from its content. While full information about the digital good, as a vector, is always available and unambiguous (e.g. the format used and its quality, such as MP3 128 kb/s), the information about the value of the content (e.g. how valuable the song embedded in the digital good is to the consumer) is often either unavailable or costly to retrieve. Regardless of the information the consumer may be able to obtain *ex-ante* on the attributes of the content, the "true" value of a digital good, which mostly relies on the value of the content, is often realised *ex-post*. Furthermore, the value of the content of some digital goods is so subjective that it is impossible for consumers to obtain full information on the attributes of the goods without experiencing them. This is typically the case of cultural goods such as music, movies, books, pictures, etc. In contrast, it may be possible for the consumers to obtain a sufficient amount of information on the main attributes of goods such as software, news, or technical reports, without experiencing them first. However, obtaining such information is likely to be much more costly than directly experiencing the product. Software suppliers often release demonstration versions of their products for this reason.

In addition, the value of digital goods is not necessarily fully revealed after the initial episode of consumption, and some digital goods, such as

music, software or video games, generally need to be experienced several times before their true value becomes known to the consumer.

However, in contrast to the two other properties of digital goods presented in the previous sections, it is important to note that the fact that digital goods are experience goods is not an intrinsic property of these goods, but is, instead related to their content. While all digital goods are, regardless of the content, public and durable, only a subset of these goods are experience goods. Yet, the content of digital goods, in general, is such that many of these goods are experience goods.

Furthermore, since the main characteristic of an experience good is that its value cannot be determined prior to consumption, this definition can be extended to the goods for which it is possible to obtain full information about their attributes but the value obtained from these attribute remains unknown or uncertain. In such a case, durability plays a crucial role. While all the information about a particular product may be available, the fact that its product is durable makes it uneasy (or even impossible) to accurately determine its present value, since it corresponds to the discounted sum of the value obtained during each future episode of consumption.

Therefore, all durable goods can be considered as experience goods, since the more a good is durable, the more it is likely to be regarded as an experience good by consumers. Since digital goods are infinitely durable, they can all be considered as experience goods, regardless of the nature of the content of the good itself.

Understanding this characteristic of (most) digital goods is essential because experience goods have important effects on the economy. First of all, these goods create difficulties for consumers when making consumption choices and, as such, they tend to reward reputation and create inertia. Another consequence is that experience goods typically have lower price elasticity. In regard to the market structure, the presence of experience goods is likely to lead to a strong market concentration (NELSON, 1970).

For firms, this characteristic of digital goods means that, depending on their ability to make consumers experience their products, they can either benefit from high switching costs or suffer from the switching costs of a more established competitor. For policy makers, the market concentration may lead to important market distortions and require public intervention (Microsoft Windows provides a good example of how an experience digital good can lead to market dominance).

However, even for firms that are talented (and/or lucky) enough to fall on the right side of the fence, the fact that digital goods are experience goods causes additional difficulties. As consumers are reluctant to purchase these goods before they are able to experience them and determine their value, firms have to supply consumers with samples of digital goods. If they do not do so, consumers may be encouraged to conduct their own sampling activity by pirating. This 'illegal sampling' is made possible by another characteristic of digital goods: their publicness. Once this has happened, consumers are unlikely to pay for a legitimate version, even after the good has been fully experienced, since original and pirated copies are identical.

Nonetheless, providing consumers with samples is not always an easy option. Indeed, firms need to ensure that consumers are only able to consume the sample a small number of times, as otherwise consumers' needs might be fulfilled by the sample, in which case they do not purchase the product. For some digital goods, it may be possible to offer, as a sample, a truncated/stripped down version of the digital good (as it is often the case with electronic books, films and software). Nevertheless, such a strategy may cause consumers to underestimate the value of the digital good, thereby reducing their willingness to pay. In addition, the value of some digital goods, such as music, is unlikely to be revealed by partial sampling, and may even require repeated experience.

Durability, plays, here as well, an important role. Indeed, if pirated digital goods were not durable, pirating for sampling motives could have a positive effect on demand. In such a case, consumers would pirate a digital good in order to experience it and when the pirated good would wear down, they probably would be inclined to purchase the original, since they would have discovered its true value. Interestingly enough, in such a case, the equal quality between the original and the copy of the digital goods would, most likely, not be an issue for producers.

■ The new age of piracy

Although it is true that piracy, in the form of copies of vinyl discs, audio and video tapes, photocopies of books, etc. has existed long before the advent of digital goods, the piracy of the pre-digital era was different and never reached the extent of digital piracy. The reason for this lies in the replicable nature of digital goods.

Indeed, pirating a non-digital information good necessarily leads to the creation of a substitute good of lower quality. Therefore, during the analogue era, a pirated version of an information good was, at best, a good substitute of the original. Furthermore, as copies of copies were made, additional loss of quality or information occurred and after a few rounds of copying, the resulting pirated good would be a very poor substitute to the original. Thus, piracy could not spread infinitely, since each additional copy further decreased the quality.

Successful piracy of an analogue good requires:

- an original or near original copy of the information good, otherwise the quality of the copy is too low;
- a direct copy between the original and the source: as each additional transfer to an alternate medium leads to a decrease in quality, it is not desirable to use any intermediate medium.

This explains why the analogue era piracy was intrinsically restricted, while digital piracy is not. Non-digital piracy requires a large number of originals spread in the population, while digital piracy only requires one original. Furthermore, since any transfer of an analogue good leads to an additional loss of quality, direct contact is required in order for the piracy to take place. Finally, even in the best conditions, analogue piracy only leads to the creation of a substitute of the original, thereby restricting the extent of piracy, since the demand for substitute is likely to be lower than the demand for originals.

The advent of digital technology has allowed piracy to develop to its full potential. First of all, any copy of a digital good is indistinguishable from the original. As a consequence, only one original needs to be sold for all consumers to be able to pirate: one original unit is sufficient to start a virtually infinite stream of absolutely identical copies. Secondly, since additional transfers of a digital good do not lead to any loss of quality, no direct contact between consumers is required for digital piracy to take place. As a result, even a rather isolated consumer is able to pirate the digital good through various intermediaries – such as phone lines (with modems), optical signals, wireless signals, etc. Finally, consumers are expected to be completely indifferent between the original and the copy as these are, due to the digital technology, perfect clones.

To this respect, GANTZ & ROCHESTER (2005) relate that, when asked the difference between taping a song from the radio and copying it onto a computer, EMI vice president Ted Cohen stated that the former intended to

create more demand "since the quality [obtained] was not of the level of something [the consumer] would want to keep", while downloading music from the internet is not serving the music industry as a marketing vehicle. Quite on the contrary, the identical quality between the original digital good and its copy is often seen as the principal cause of the recent decline in records sales.

Thus, what is new in the piracy of digital goods is not piracy itself, since this phenomenon is not new, but, rather, the fact that the technological constraints that had previously endogenously limited the extent of piracy, have disappeared with the advent of digital technology. Therefore, levels of digital piracy are expected to be extremely high, and this is indeed what recent figures show.

■ The value problem of digital goods

The characteristics of digital goods exposed in the previous sections have a common effect: they all tend to decrease the price consumers are willing to pay for digital goods. The publicness and durability of these goods are both expected to lead to a price equal to marginal cost (i.e. the replicating cost), while the fact that digital goods are experience goods makes (usually risk adverse) consumers reluctant to pay the actual value of the good.

In the case of digital goods, this pressure towards competitive price is an important issue for most of these goods are characterised by high (sunk) initial production costs that would not be recovered within a competitive environment. Thus, unless firms have a sufficient market power, they might not have enough incentives to produce new digital goods. From a social point of view, the issue of the production of digital goods is the traditional dilemma between underprovision and underutilisation (ARROW, 1962).

For firms producing digital goods, though, the previous sections have demonstrated that the nature of digital goods makes it difficult to recover initial investment. It is not one, but three important characteristics of digital goods that threaten their profits. In this respect, piracy might well be the "tree that hides the forest" of multiple issues related to the production of digital goods. Indeed, even assuming that it were possible to totally prevent piracy, the infinite durability of digital goods would still undermine the profits of the digital goods industry. Furthermore, since sampling is one of the important

motives of piracy, it could be expected that without piracy, consumers would be even more reluctant to pay for digital goods they have not experienced.

Furthermore, it is crucial for producers to understand how the different aspects of digital goods interact with each other. With regard to the public nature of a digital good, it is clear that it becomes stronger as time passes (more consumers owning an original or a copy means more potential sources). Producers would, thus, certainly want to concentrate most of their sales near the release date of the digital good. However, durability and the fact that digital goods are experience goods both lead, on the contrary, to consumers delaying their purchase.

Similarly, although renting is a good way of addressing the issues caused by both durability and (lack of) experience, the success of such a strategy can be undermined by the public aspect of digital goods. Indeed, consumers might subscribe to an online music service, download all the songs they need, remove the anti-copy protection and cancel their subscription, thereby leaving the provider with an immense amount of royalties to pay and no income (RAYNA, 2006a). How can renting be successful if consumers are able to retain the good without paying the rent?

In fact, it seems that the sharp decrease in reproduction and distribution costs producers have benefited from, because of digital technology, has been fully integrated by consumers, who are, thus, less inclined to pay a high price for digital goods. This phenomenon has certainly be exacerbated by the fact that consumers have taken an increasing part in the reproduction and diffusion of digital goods and are, now, an integral part of the production process (when a digital good is purchased online, the consumer bandwidth is used to distribute the good, the consumer processor is used to create the copy and the consumer hard drive to store the digital good). Regardless of the value perceived by consumers, how much is their willingness to pay for something that they may consider as having been essentially produced by them?

Although attempts have been made, with Digital Rights Management, to address all the issues caused by the nature of digital goods at once, these have been, so far unsuccessful (RAYNA & STRIUKOVA, 2008). In contrast, there are more and more examples of artists successfully using the nature of digital products to their advantage. Records are freely distributed and used to promote the purchase of tangible goods, such as concert tickets or

merchandising, which are not subject to the same issues⁷. Although such strategy cannot be universally applied to all digital goods, it shows that by understanding the nature of these goods and using it as a strength, instead of fighting against it, there may be some new and profitable ways to do business.

Conclusion

Digital economy is at the same time promising (for companies, but also, in terms of growth, for governments and policy makers) and extremely challenging, since it forces to rethink the way goods are produced, distributed and sold. To fully apprehend (I think this should be "comprehend") the potential of digital economy and anticipate the coming challenges, it is of the utmost importance to consider, and understand, the particular economic nature of digital goods.

As a matter of fact, digital goods are unlike any other good in the economy, in the sense that not only do they combine several particular characteristics, but also that these characteristics are, in their own way, extreme. Digital goods, like non-digital information goods, contain information, but also are themselves information. At the same time, digital goods are public, but unlike other public goods, their publicness varies and is a direct consequence of their non-rivalness. Furthermore, digital goods are infinitely durable, which is, in itself, rare, and are, due to this durability, experience goods.

For both entrepreneurs and policy makers, the challenge is that only one of these characteristics would be sufficient to drive the price of digital goods to an unsustainable level and create a market failure. Yet, with digital goods, three sources of market failure are combined. Although it is true that some firms are able to gain large amounts of profit within the digital economy, it is crucial to understand that the characteristics of digital goods presented in this article are only likely to become even stronger due to technological progress. Thus, the challenges created by digital goods will only become greater.

⁷ Income can also be derived from free downloads. When Radiohead offered their latest album online, letting downloaders free to choose how much to pay, the average price paid was \$6, much more than the typical amount of royalties gained per album sale.

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