

PIRACY OF INTELLECTUAL PROPERTY:
PAST, PRESENT, AND FUTURE

By

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July 2013

* I would like to thank Ying Wang for research assistance.

ABSTRACT

The last few decades have seen enormous growth in piracy of copyrighted goods and, in particular, an enormous growth in piracy of creative works that employ a digital format. In this paper I discuss classic theory related to the piracy issue, provide a brief history of the growth of piracy over the last few decades, and then discuss issues concerning the present situation. I conclude with speculation about the future of piracy, where one of my main points is that, at least for the developed world, there are important reasons for believing that piracy is likely to continue to grow.

I. INTRODUCTION

The ability to make illegal copies has long been a concern in the area of intellectual property and copyright. But the problems have become magnified in recent years as the march of progress has resulted in various types of creative works being stored in digital formats while at the same time the capability of making illegal copies of works stored in this way has widely diffused and the costs have fallen. The result has been substantial growth in digital piracy and reduced revenue flows to the copyright holders of various types of creative works. In this essay I describe this growth, discuss the current situation, and then speculate, hopefully in an informed way, about the possibility of future growth in piracy.

When I was a college student in the 1970s it was possible to make an illegal copy of a book or record and sell the copy which could hurt the profit of the copyright holder of the original work. But, although making an illegal copy was possible, there were important limits on the extent to which such copying could hurt the copyright holders. One important constraint was that, at least in terms of the copying technology available to the typical consumer like me, copies were relatively expensive to make and typically lower quality than the originals. For example, if I went to the university library at MIT in 1974 and made a copy of Samuelson's *Economics, 9th edition*, which was the textbook for my introductory economics course, the copy would have been quite expensive to make and the copy would have been considered a poor substitute for the book because it would not have been bound, it would not have been in color, etc.

So, although it was possible for me to make an illegal copy and sell it, there was little or no copying or trading of this sort. Of course, those with access to better technology could have reproduced the book at lower cost and higher quality, but the marketing and distribution required

to make this profitable would likely have drawn the attention of the authorities which would have led to heavy fines and possibly jail terms. So piracy was clearly an issue, but at least in terms of jurisdictions where copyright law was clearly enforced, the effects on the profit streams of the creators of the original works was likely quite limited.

Compare and contrast that situation to today's setting. It is still the case that textbook sellers who focus mostly on physical copies of books are not hurt substantially by illegal copying at least in terms jurisdictions that enforce copyright. But there are numerous other creative works that are marketed using digital formats where copying is frequently easy and copyright enforcement difficult. The result is that piracy has grown tremendously and there have been substantial effects on the profits of the creators of the affected original works.

An important issue concerning the piracy of copyrighted goods and, in particular, digital piracy is whether this growth is likely to continue or whether we have reached or are close to reaching something like an equilibrium level of piracy. At the moment the loss in revenue and profits of the creators of original works due to the piracy of copyrighted goods seems to have had a limited effect on the production of those works. For example, there is little evidence of a significant reduction in the creation of new music or books which are two of the types of original works where digital piracy has been significant. But if the revenue and profit streams to the creators of original works are substantially reduced even more, it is quite possible that there will be a significant effect on the level of investments in the creation of original works. So the potential for piracy to grow substantially in the future can be crucial for how these creative industries evolve over time.

There are a number of factors that come into play in terms of the prevalence of piracy and, in particular, digital piracy. These include: i) technology; ii) the law; and iii) user

preferences broadly defined. As discussed above, the main driver of the increase in digital piracy is changing technology which in many cases has decreased the cost of copying and which has also made the distribution of copies quite cheap. The details of copyright law and how it is enforced are also important for understanding the growth of digital piracy over time. And user preferences, broadly defined, must also be important since the frequency of illegal copying varies significantly across easily identifiable groups such as different age cohorts. This suggests that changes in preferences over time can also be an important driver of the prevalence of digital piracy.

A subtle issue that I discuss in detail in Section V concerns the fact that the prevalence of digital piracy seems to vary significantly with age. Specifically, digital piracy seems to be more common among younger individuals. The reason this is important is that the underlying cause of this correlation will serve to determine the extent to which digital piracy is likely to grow over time. If the correlation is due to an inherent aspect of age, then at least in terms of this correlation there is no clear prediction of future growth in piracy. But if the correlation is an inherent aspect of the cohorts themselves, then the evolution of user preferences over time suggests substantial future growth in digital piracy. In Section V I both discuss the issue in detail and discuss why it is likely that at least some of the correlation between piracy and age is due to a cohort effect.

The outline for the paper is as follows. Section II discusses theory concerning piracy, its welfare effects, and the role of copyright protection. Section III provides a brief history of piracy and, in particular, digital piracy over the last few decades. Section IV discusses factors correlated with the piracy decision and what we know about the consequences of piracy. Section V discusses how piracy is likely to evolve in the future. Section VI presents concluding remarks.

II. THEORY REVIEW

Before reviewing the history of piracy and digital piracy, I provide a brief review of why piracy matters. When a consumer makes an illegal copy of an original work, there is typically one less potential sale that the original producer can make. In the standard argument found, for example, in Novos and Waldman (1984), the result is less profits for the producers of original works which, in turn, translates into less investment in the production of original works.¹ In the literature this reduced investment in the production of original works is referred to as the underproduction loss.

Starting with Liebowitz (1985), there is an alternative argument referred to as indirect appropriability in which the effect of piracy on the underproduction loss is not so straightforward. This argument draws an analogy with durable goods production. In early models of durable goods production such as Swan (1972), the existence of secondhand markets does not reduce investments in quality and durability of original units because the new unit price should reflect expected prices a unit will sell for on the secondhand market in future periods. That is, if investments in quality and durability of new units improves used unit quality, then these investments should increase the prices a unit will eventually sell for on the secondhand market. In turn, if new unit consumers anticipate this, then new unit prices should reflect expected secondhand market prices and so the possibility units will eventually be sold on secondhand markets will not reduce investments in new unit quality and durability.

¹ Novos and Waldman (1984) builds on earlier analyses such as Arrow (1962) and Hirshleifer and Riley (1979) which describe a related underproduction loss that arises due to factors such as imitation rather than copying. See also Watt (2000), Varian (2005), and Peitz and Waelbroeck (2006) for surveys that focus on various aspects of the piracy issue.

The indirect appropriability argument basically substitutes the sale of copies for used unit sales in the above argument. That is, if buyers of new units can make and sell copies, then the willingness to pay of such buyers of new units should reflect the profits associated with making and selling copies. As a result, since the willingness to pay of new unit buyers is higher, new units sell for a higher price and thus the creators of new works are helped rather than hurt by the ability of new unit consumers to make copies. In his original paper in which this argument is first made, Liebowitz persuasively argues that libraries is an example of a market in which this argument is important.

Although some recent authors have built on this argument to claim that copyright protection is not needed to protect the profits of the producers of original content (see, for example, Boldrin and Levine (2002, 2004)), there are reasons to think that, although important in the case of libraries, it has limited applicability to the major markets such as music and e-books where digital piracy is important. First, as originally argued in Novos and Waldman (1984) (see also Besen and Kirby (1989)), competition between the new unit seller and consumers selling copies or competition just between such consumers will drive the copy price to be close to or equal to marginal cost which means there will be little if any indirect appropriability. Second, in the durable goods literature, papers such as Anderson and Ginsburgh (1994), Waldman (1996), and Hendel and Lizzeri (1999) show that imperfect substitutability between new and used units can cause complications not captured in Swan's argument discussed above with the result that secondhand market trade can hurt the profitability of new unit sellers. A similar argument concerning imperfect substitutability between new units and copies yields that the existence of

copies can constrain the price that can be charged for a new unit and this too limits the effects of indirect appropriability.²

This suggests that, as in the standard argument, piracy has the potential to reduce the revenues and profits of original goods producers in significant ways. And, in turn, the result can be reduced investments in the production of original works and reduced social welfare. As I discuss in the next section, there is little evidence so far that piracy has had a significant effect on investments in the affected industries. But this is not a guarantee that this theoretical possibility will not become an important factor in the future if piracy continues to rise.

Note that, although indirect appropriability is the main theoretical argument for how piracy can help or at least not substantially hurt the profit flows of original content producers, there are also other possibilities that could yield a similar result. One such possibility is that, if an original content producer sells multiple complementary goods, then piracy concerning one of the goods can potentially help the legal sale of one of the complementary goods. An example here would be a band whose music is pirated where the pirating leads to increased demand for the live concerts performed by the band.

A final issue worth mentioning here is the role of copyright protection. The role of copyright protection is to balance the underproduction loss that we have been discussing with the underutilization loss, where the underutilization loss refers to the loss due to individuals who consume the good in the first best but do not consume in the market equilibrium because the original goods producer sets a price for the good above marginal cost. This is the logic behind why copyright duration is typically limited. That is, preserving a monopoly for some amount of time after a good is created is necessary for there to be sufficient incentives for the producer to

² See Johnson and Waldman (2005) for a formal analysis that illustrates these points. See also Liebowitz (2005) for

invest, but after a long enough time the additional incentives for investment are outweighed by the societal costs due to consumers whose valuations for the product are above marginal cost but are not consuming the good.³

Another aspect of optimal copyright protection that can be understood in terms of this balancing is that copyright protection is typically limited in breadth, where the idea of fair use is an example of how copyright protection has limited breadth.⁴ As with limits on the duration of copyright protection, limits on the breadth of copyright protection can be understood at least partly as a balancing of losses due to underproduction with losses due to underutilization. That is, for uses where the reduction in the market value of the copyrighted good is small and the consumer consumes the good in the first best but not given copyright protection, it can be optimal to limit the applicability of copyright (see footnote 4 for a related discussion).

As will be discussed in more detail later, this perspective can be interpreted to suggest that the growth of digital piracy should result in changes in the laws relating to the breadth of copyright protection. The basic argument is that changes in technology have made copying and distribution easier. So holding the types of copying that are legal under the current laws fixed, these technological changes have likely resulted in individuals who previously could not have gotten access to a copy without purchasing a copy from the original producer now getting access to the good. If we assume that the laws optimally balanced the underproduction and underutilization losses prior to these technological changes, one might argue that given these

a related discussion.

³ See Akerlof et al. (2002) for a discussion along these lines. For alternative perspectives see Landes and Posner (2003), Liebowitz and Margolis (2005), and Adilov and Waldman (2013).

⁴ Fair use refers to uses of copyrighted material that does not require permission of the copyright holder. There are a number of factors that are typically considered in determining whether a particular use of copyrighted material qualifies under the fair use exception. These include whether the use is for educational purposes, the amount of the copyrighted material used, and the extent to which the use affects the market value of the original work.

changes balancing now requires changes in the law that will serve to increase the breadth of copyright protection.

III. A BRIEF HISTORY OF PIRACY AND DIGITAL PIRACY

Illegal copying or piracy has been an issue from a public policy perspective and in terms of the economics literature for many years. One clear illustration of its importance even decades ago is that the *Journal of Political Economy* published three papers on the topic over a short period of time in 1984 and 1985 – Novos and Waldman (1984), Johnson (1985), and Liebowitz (1985).⁵ But clearly, even though there was significant interest in the subject thirty years ago and even earlier, there is much more interest in the subject now both in public policy circles and in the economics literature. The question is, what has changed?

To understand what has changed, it is of interest to note the modeling strategy Novos and I employed in our 1984 paper. We assumed that copies were lower quality than original units and that the societal marginal cost of producing a copy exceeded the societal marginal cost of producing a unit sold by the creator of the original work. Both of these assumptions seemed reasonable at the time of the publication of that paper. Think, for example, of the music industry. In the early 1980s music sales were dominated by two audio formats – vinyl records and compact cassettes. Neither was easy to copy and, as a result, for most consumers a copy was inferior to an original unit and the cost, including the time cost of the individual making the

⁵ Based on my experience as the corresponding author on one of these papers, my sense is that this cluster of papers was due to a belief of George Stigler, who I believe was the editor for each of the papers, that the subject warranted additional attention in the economics literature. Given the extensive attention to the topic that has followed the publication of these three papers, I believe it is reasonable to conclude that Stigler was successful in creating interest on the topic. It is worth noting, however, that the literature on the topic goes back even much earlier. See, for example, Plant (1934).

copy, was above the original seller's cost of producing an additional unit since there were significant economies of scale in production.⁶

But this time period was also the beginning of a major transition. In the 1970s significant progress was made in the digital recording of music. Up to that point in time music was predominantly recorded using an analog format which in its simplest terms means that the audio signal was stored and played using a continuous electrical representation of the sound wave it was used to reproduce. A digital recording, in contrast, translates that soundwave to a binary series of zeros and ones. Since sound waves are basically continuous, a high enough quality analog recording should be superior to any digital recording in reproducing the exact sound. But a digital format has two advantages over analog. First, because it is continuous, copying an analog recording will typically introduce errors and errors will compound if a copy is made of a copy. In contrast, because it is just a string of zeros and ones, copying a digital recording will typically not introduce any errors. Second, as technology has progressed digital formats have been easier to adopt for mobile devices such as the iPod.

In the 1970s significant progress was made concerning the technology of digital recording by Sony and Philips. This eventually led in 1983 to CD players and discs being released in North America. The CD had the convenience of cassettes while at the same time producing music of similar or even possibly higher quality than vinyl records, where relative to vinyl records CDs had the advantage of being much less fragile (those familiar with vinyl records will remember how easy they were to scratch). As a result, CDs over time displaced cassettes and vinyl records in most uses.

⁶ One reason copy quality was typically lower was that an original unit frequently came packaged with complementary products, such as the album cover, which were also difficult to copy.

A specific market whose evolution illustrates the transition to digital technology is that of the portable music player. This market was revolutionized in the early 1980s with Sony's introduction of the Walkman which employed cassette tapes. Sony sold millions of these devices but its market dominance was relatively short lived. In 1983 Sony and Phillips partnered to market what became known as the Discman which employed CD technology. Initially its popularity was limited because of size and because the devices tended to skip when bumped or jarred. Technological improvements, however, relatively quickly made the devices smaller and eliminated the skipping problem. This eventually led by the late 1990s to market dominance of digital technology, where in the 2000s the best selling devices, particularly Apple's iPod, used MP3 technology which compresses the digital information significantly so less storage capacity is needed per song.

As I said above, prior to the move to digital technology copying was not easy and copies tended to be lower quality. And initially the move to digital technology did not significantly change the situation. At the beginning digital technology required specialized high capacity storage devices like CDs and DVDs and this limited the threat of copying. For example, a standard four minute song of CD quality uses about 40MB of space, while even by the late 1990s a typical home computer hard drive had about 1GB of capacity so a standard home computer could store no more than a few songs. Also, a standard internet connection at the time was quite slow in the sense that it would have taken more than two hours to download this type of four minute song.

But the situation changed as the technology progressed, where probably the most important change concerned progress in compression technology. This type of technology compresses the digital information so that less space is required for storage. In particular, MP3

technology, which was developed over a number of years and started to be heavily used in the second half of the 1990s, reduced the space needed to store digital recordings by a factor of 10. Once this technology started to diffuse piracy became much more feasible and posed a threat to the creators of original works significantly more serious than the illegal copying that was possible when earlier technologies were dominant. The reasons were that, related to earlier discussions, digital recordings could be copied with no errors and the development of the internet (and the higher download speeds which eventually became widespread) meant that the cost of distribution was also dramatically falling.

Starting in the late 1990s this move to digital recording and technological progress concerning compression technology, internet speed, and size of computer hard drives, led to dramatic growth in piracy through the development of peer to peer file sharing systems. In a peer to peer file sharing system the media to be copied is not actually housed on the system, but rather the system facilitates the sharing of files housed in one computer connected to the system with other computers connected to the system.

File sharing systems have been around since the 1970s but they began as systems used by a relatively small set of technologically savvy individuals rather than systems used by large groups. This changed with the introduction of Napster developed by Shawn Fanning which employed MP3 technology and allowed users to share digital music across computers. In Napster's design indexing and search were performed on Napster's servers, but the files remained on users' computers rather than on these servers. The system quickly became popular reaching over 26 million users early in 2001. However, Napster was sued by members of the Recording Industry Association of America (RIAA) and the courts ruled against Napster and held it liable for contributory infringement and vicarious infringement of the plaintiffs'

copyrights.⁷ The service was subsequently shut down when the presiding judge was dissatisfied with Napster's efforts to comply with an injunction that had been issued. Napster later agreed to a settlement of 26 million dollars and then eventually declared bankruptcy when its sale to Bertelsmann was blocked by the courts.

But this victory on the part of the members of the RIAA was short lived. Soon after Napster's demise various substitute file sharing systems appeared such as Morpheus and Grokster and later LimeWire and Pirate Bay. These systems have faced a series of legal cases including a case against Grokster that went to the US Supreme Court which Grokster eventually lost and which resulted in Grokster shutting down. However, despite all the court cases in which many of the rulings have favored the music and other content industries, content industries have not been successful in using this approach to make peer to peer file sharing systems unavailable.

There are a number of reasons for the lack of ultimate success of the content industries approach of suing the firms that support peer to peer file sharing. First, Napster had a central server used for indexing and it was ruled that Napster's behavior encouraged illegal sharing of copyrighted material. This made the legal issues relatively straightforward (I am being a little loose in my use of the term "relatively" here). Many more recent peer to peer file sharing systems are designed in ways that make the argument for illegality less straightforward. Second, since file sharing systems have a number of legitimate uses that do not involve the illegal sharing of copyrighted material, legal rulings cannot eliminate file sharing systems in general. In turn, since users frequently have the option of using a system in ways not officially encouraged by the host company, the result is that court rulings against companies that encourage illegal file

⁷ The finding of contributory infringement here means the courts concluded that Napster knew that its users were illegally distributing copyrighted material and that Napster provided support for such actions. The finding of vicarious infringement means that the courts concluded that Napster benefitted financially from its support of the illegal file sharing and that it had the ability to police the illegal activity.

sharing have limited ability to stop file sharing in general. Third, since the internet allows for sharing across national borders and the legal situation varies from country to country, court rulings in one country against firms that allow file sharing have limited ability to stop illegal copying even for individuals located within that country's borders.

In addition to suits against file sharing systems, content industry firms have also taken other actions to reduce the amount of unauthorized sharing of copyrighted material. In terms of other legal approaches, there are a few instances in which content owners brought legal action against internet service providers. These cases have been outside of the US (not surprising given precedents set by earlier US cases) and have in general been unsuccessful.

Another approach that was heavily used in the US up to 2008 was to bring legal action against individual file sharers. Initially the RIAA attempted to use a subpoena to get Verizon to identify file sharing customers. However, Verizon challenged the subpoena and won, so the RIAA was forced to name defendants based on IP addresses and no other information about the individual. In addition to being a costly process, this approach had the drawback of creating bad publicity for the RIAA because inevitably suits were brought against children, dead people, computer novices, etc.

The RIAA from one perspective was successful with this approach in that in most cases the parties reached a negotiated settlement in which the individual agreed to stop participating in illegal file sharing, while in a few cases the individual did not settle and in some of those cases the RIAA won large awards (although sometimes the award was reduced upon appeal). But the bottom line is that, even though the RIAA brought a large number of cases, there seemed to be

little effect on the overall level of file sharing and the RIAA eventually mostly abandoned this approach, likely because of bad publicity.

The other main approach to limit digital piracy taken by content providers is to attempt technological fixes, where the main idea here is to market the good in a fashion that makes piracy difficult. Probably the best known of these technological fixes is that of digital rights management (DRM).⁸ DRM refers to various types of technologies used to restrict the ability of a buyer of a legal copy of a creative work to make additional copies. It thus is a way to limit digital piracy by directly making illegal copying more difficult rather than by bringing a suit against one of the parties involved in the act of digital piracy.

A well known example of DRM is Apple's use of FairPlay which Apple used and continues to use with a number of its products. For example, FairPlay was employed by Apple for its iPod and iTunes store for a number of years. Basically, a song bought at the iTunes store was encrypted and the purchaser was limited in terms of the number of authorized devices that were given access to the key required to unencrypt the file so that the song could be listened to using the device. There were also limits on a buyer's ability to make copies of the song and the types of devices that could be used by the purchaser to listen to the song. These restrictions made it difficult to practice digital piracy with a song purchased from the iTunes Store at the time because an encrypted file could not be played on an unauthorized device.

Although DRM is still widely used such as in the case of ebooks, it is interesting to note that in the music industry DRM is not currently employed. The reason seems to be that DRM in music sales was not able to completely stop the pirating of digital music. The paradoxical result was that, since DRM restricted how legally purchased songs could be used but did not eliminate

the possibility of pirating, the use of DRM in music increased the attractiveness of a pirated copy over a legally purchased copy. So as a result it increased rather than decreased piracy. When this became evident the music publishers dropped the practice.

IV. PIRACY: INFLUENCES AND CONSEQUENCES

In the previous section I argued that piracy and, in particular, digital piracy has grown over time because of a number of factors, but mostly because of changing technology. In this section I discuss two issues. First, what are the factors correlated with the decision to practice piracy. Second, what do we know about the consequences of piracy. In the next section I then use these discussions to speculate about how piracy is likely to evolve in the future.

A) Factors correlated with the piracy decision

There are a number of studies that focus on factors that influence the piracy decision and these studies have considered a variety of factors. These factors include age, income and wealth, cultural influences, past behavior/habit formation, and the legal setting. In this subsection I discuss the main findings in this literature.

The first finding of interest is that the prevalence of piracy varies enormously. For example, that levels of piracy vary significantly can be seen by looking at cross country evidence. The Business Software Alliance and Software Publishers Association publishes estimates of software piracy and, in particular, software piracy by country. In a 1997 report they estimated that 45 percent of new software was pirated worldwide between 1994 and 1997, where the estimate varied from highs of 99 percent and 96 percent for Vietnam and China, respectively,

⁸ See Sundararajan (2004), Bergemann et al. (2005), Park and Scotchmer (2005), and Kim and Waldman (2013) for

to lows of 28 percent, 34 percent, and 36 percent for the United States, Australia, and the United Kingdom, respectively.

This cross-country variation has been investigated in a number of studies. Marron and Steel (2000) consider a number of factors that can explain why high-income countries tend to have lower piracy rates. Using a regression analysis where they control for multiple factors at once, they find three factors important for explaining the evidence. First, economic development which they measure using per capita income is negatively related to piracy rates. Second, culture matters. Countries characterized by cultures that emphasize sharing over individual ownership have higher piracy rates. Third, they find evidence that differences in intellectual property rights across countries is also important. They also find that other factors – such as average education levels and research and development levels – which are related to piracy using simple correlations are uncorrelated with piracy in their regression analysis that simultaneously controls for a number of factors.

Another study that looks at the determinants of software piracy rates across countries is Moores (2008). Similar to the Marron and Steel (2000) study just discussed, Moores finds that piracy is negatively related to wealth and that more individualistic/less collectivist cultures are also negatively related to piracy levels. Moores also points out that software piracy rates fell on average from 1994 to 2002 and goes on to investigate the driving forces of this fall. He argues that the fall is due to rising wealth levels across countries, but that the amount piracy falls in a country can be understood in terms of an interaction between the increase in wealth and cultural factors that either support or act to stop lower piracy levels.

There have also been a number of studies that focus on factors that influence the decision whether or not to pirate where the focus is at the individual rather than the country level.⁹ Likely because rates of piracy are particularly high on college campuses, many of these studies focus on factors related to college students' decisions concerning whether or not to practice piracy. There are a large number of studies on this topic. Starting with the studies that focus on college students, we again see that culture has a strong influence. For example, Swinyard, Rinne, and Kau (1990) analyzed software piracy among college students in Singapore and the US at the individual level and find that higher levels of software piracy among the students in Singapore are due to a great extent to cultural differences. Specifically, they argue that an important driver of the difference in piracy rates is that Asians tend to focus more on outcomes of behavior while Americans tend to focus more on rules concerning right and wrong in decision making.

Numerous other factors have been investigated including age, gender, family income, computer experience, habit formation, and attitudes toward piracy. The main results are that there is some evidence that piracy is higher for males, although the evidence suggests that whether or not there is a gender difference seems to depend on the nature of the piracy. There is mixed evidence concerning age, where some studies find that piracy increases with age while others find that it falls. But given the studies focus on college students where the range of ages is limited, these results may not be that informative of the importance of age for the piracy decision in the general population. Family income is in general negatively correlated with piracy, but the correlation tends to be weak. Finally, there is strong evidence that habit formation and personal attitude towards piracy matters, where the two seem to be linked in the

⁹ Papers in this literature include Swinyard, Rinne, and Kau (1990), Sims, Cheng, and Teegen (1996), Kini, Ramakrishna, and Vijayaraman (2004), Limayem, Khalifa, and Chin (2004), Al-Rafee and Cronan (2006), Goles et al. (2008), and Ramayah et al. (2009). See Liang and Yan (2005) and Marshall (2006) for surveys.

sense that experience with piracy is correlated with a more permissive attitude towards piracy. But the evidence is not fully clear cut concerning whether or not the correlation is capturing a causal relationship.

Although of significant interest, understanding the determinants of piracy in a college student setting only provides part of the picture. Although piracy may be more prevalent in the college student environment, it is certainly not confined to that environment. And understanding prevalence and factors that influence levels of piracy in the college environment may not give a clear picture of prevalence outside of the college setting and/or how various demographic and other factors influence levels of piracy outside of the college setting. So it is important to look beyond the college student setting to understand the determinants of piracy and how piracy rates are likely to evolve over time.

Unfortunately, studies on this topic are sparse. However, Mandel and Sussmuth (2010) is one interesting study along these lines. That study focuses on Germany and employs a sample that is not restricted to students but is rather representative of that part of the German working population that has high-speed internet access. In their empirical analysis they consider two related but distinct dependent variables. They consider a self-reported measure of the frequency of digital piracy and a measure of the amount of money saved through digital piracy.

I will focus first on the analysis of the self-reported frequency measure. Their main results here are that age, income, and student status are all significant predictors of the frequency of digital piracy. They find that younger individuals have a higher frequency of digital piracy, where their finding is not just that the youngest group has a higher frequency but rather that frequency drops with age throughout the whole range of ages in their sample. Consistent with earlier results in the student and cross-country studies, they find that income is negatively

correlated with frequency of digital piracy.¹⁰ And they also find that student status is positively correlated with frequency of digital piracy, although this effect disappears in regressions where income is controlled for.¹¹

As indicated, Mandel and Sussmuth also consider which factors are correlated with a measure of annual cost savings due to digital piracy. Here they find that age, income, and student status are all significant predictors as was the case in their analysis of their frequency measure, while gender is now an additional significant predictor. In terms of age, rather than the continuous falling effect found in their frequency analysis, they now find that the largest effect is for individuals between ages 21 and 25 which is their second youngest rather than youngest group. As for student status, they now find a significant positive correlation even after controlling for income. Finally, gender now matters in that males have significantly higher annual cost savings than females.

As will be discussed in more detail in Section V, these findings and, in particular, the finding concerning age can be interpreted to suggest that levels of digital piracy may continue to rise significantly for a number of years. The reason is that it is possible, maybe even likely, that the age effect is at least partly capturing a difference across cohorts and that as current young cohorts age the overall level of piracy will rise substantially.

B) Consequences of piracy of intellectual products

From a theoretical perspective, the consequences of the piracy of intellectual products is

¹⁰ To be precise, they do not control for income but rather they ask for self-assessed weights for different reasons for practicing piracy. I interpret a higher weight on “budget constraint” as indicating a lower income.

¹¹ They also find that being of German nationality is negatively correlated with their frequency measure, access to a DSL connection has a positive correlation, perceived degree of complexity of practicing digital piracy has a negative correlation, and perceived probability of being prosecuted for piracy also has a negative correlation.

likely to be reductions in the sale of new units and, depending on factors such as the importance of indirect appropriability, decreases in investment levels in the development of new intellectual products. There is substantially more research on the first issue than on the second. So I will start by discussing the research on the extent to which piracy displaces new unit sales and then briefly discuss what we know or don't know concerning how much this displacement affects investment levels.

There is an extensive literature on the extent to which piracy displaces new unit sales.¹² One of the most well known papers on the topic is Oberholzer-Gee and Strumpf (2007). That paper focuses on how album downloads affect US album sales, where they use the number of German secondary students on vacation in a particular week as an instrument for downloads and argue that this is a reasonable instrument because German users provide a significant proportion of the files downloaded by US users when they pirate music. Using this approach, they find that file sharing has no statistically significant impact on legal music purchases. However, the paper has been criticized on the grounds that the instrument is weak for various reasons (see Liebowitz (2010)) and because they do not allow a long enough time period for a download to affect legal sales (see Rob and Waldfogel (2006)).

Most of the other studies on the topic find that illegal downloads do reduce legal sales.¹³ A few of the more well known studies include Hui and Png (2003), the study of Rob and Waldfogel (2006) just mentioned, and Zentner (2006). Hui and Png look at cross-country cross sectional data from 1994-1998 and find strong effects on legal sales of piracy. Rob and Waldfogel survey piracy and legal purchasing behavior of students across four colleges in 2003

¹² See Smith and Telang (2012) for a survey.

¹³ There are a few other studies that find no effect of piracy on legal sales including Anderson and Frenz (2010) and Hammond (2012) but these papers have also been criticized based on problems with the statistical approach.

and find that a pirated download on average displaces .2 album sales. Zentner investigates a sample of 15,000 people in 2001 and 2002 and finds that pirating behavior has an effect on legal purchases a little larger than found by Rob and Waldfogel and more generally piracy reduced legal music sales by 7.8 percent. Overall, my sense of the evidence is that it strongly points to piracy having significant negative effects on legal sales.

The important subsequent question is to what extent have reductions in legal sales affected the supply of new products as standard theory suggests it should. This is a difficult problem to investigate since measuring supply in the relevant industries is not easy. But there have been a few analyses along these lines such as in Handke (2006), Oberholzer-Gee and Strumpf (2007), and Waldfogel (2010) and these studies have not found evidence of a significant supply response. So it seems that piracy is reducing profit streams for original content producers but, in contrast to the standard theoretical prediction, there has been little or no effect (so far) on the supply of new creative works in the relevant industries.

V. SPECULATION ABOUT THE FUTURE

As captured in the discussion in previous sections, there are a number of factors that determine the level of piracy in the economy including technology, culture, individual and national income, demographics, and the legal environment. I will discuss each of the major factors, where I will conjecture (hopefully, in an informed way) how each of these factors over time is likely to affect rates of piracy and indirectly the impact of piracy.

As discussed in Section III, the main driver of the increases in piracy in the economy is changes over time in technology which have both decreased the cost of copying and in many cases improved the quality of the copies. So an obvious candidate for further changes in the

rates of piracy is further changes in technology. My sense is that in many markets where digital piracy is possible it is unlikely that future changes in technology of copying, other than changes associated with internet speed which I discuss next, will be a major driver of future changes in piracy. The cost of making a copy, other than the time cost, is already very low in many cases of digital piracy and so further changes in technology in these cases not associated with internet speed cannot decrease the cost further in a meaningful way. Similarly, in many of these same cases the copy is basically a perfect duplicate of the original so technological changes cannot make a significant improvement on this dimension either. With both of these ideas in mind, it seems unlikely that further technological changes in how copies are made by themselves will lead to significant increases in piracy in markets characterized by digital piracy.

On the other hand, further diffusion of high speed internet and advances in internet technology that increase download speed will likely increase digital piracy. For example, Mandel and Sussmuth (2010) discussed earlier find evidence that download speed (in their data access to a DSL connection) matters in terms of frequency and extent of digital piracy. This seems quite plausible. One of the costs of digital piracy is the time cost of downloading. So higher speed connections should reduce the cost. In other words, as existing high speed technologies diffuse and there are further advances in technology that increase download speed the cost of digital piracy should fall and thus its frequency should rise.

Another way technological change could play a role is through further advances in 3D copying. Currently, the increase in piracy has been mostly due to the move towards digital products and the ease with which digital products can be copied. If a book was just sold as hard and soft cover versions, however, the problem of piracy would not be that different than it was 30 years ago since the cost to make a pirated copy of a book has not changed that much over the

years. But 3D copiers are becoming available and it is possible that technological advances in 3D copying could possibly substantially lower the cost. If that technological change comes about, then in the future the explosion in piracy might not be confined to digital products.

The last possibility concerning technology I will discuss is advances in technology, such as Digital Rights Management, employed to raise the cost of piracy and, in particular, digital piracy. In a sense this is a type of arms race between pirates and original content producers where one side tries to raise the cost of piracy and the other tries to lower it. In general, it is difficult in such a situation to make predictions concerning which side will be favored by future technological advances. Nevertheless, in the last few decades the major advances have favored the pirates and I would be surprised if subsequent advances clearly favored original content producers.

As discussed briefly earlier, cross-country studies of piracy find that piracy rates are clearly higher in countries with a more collectivist type culture than found in the US and Europe. I don't expect the US and Europe to move in that direction culturally, so I don't expect changes in piracy rates in the US and Europe as a result of cultural changes. On the other hand, market capitalism has been spreading around the world in recent years and so it would not be surprising if countries that have historically had more collectivist type cultures moved culturally towards the US and Europe. To the extent this occurs, one would expect resulting decreases in piracy rates in these countries.

Another important factor found in both individual and national studies is income. At the country level, as development advances across the globe I would expect the rise in incomes to decrease piracy rates in those countries that experience significant progress in national income. However, this effect may be small or even reversed to the extent the development is

accompanied by significant increases in the proportion of the population with internet access and, in particular, high-speed internet access. In terms of the US and Europe, one might argue that increases in income should also decrease piracy rates. But I think that is not so clear cut again because increases in income may lead to increases in internet and high-speed internet access. And also because, at least in the US, recent increases in income have been confined mostly to very high income groups and if this continues the increase in average incomes will likely have very little effect on piracy rates.

In Mandel and Sussman's (2010) study of the German working population, they found that a number of demographic variables were strongly correlated with the frequency and extent of internet piracy. For example, they found that both gender and age serve to determine the extent of piracy, where males pirated more and in general young individuals pirated more. Clearly, the idea that males pirate more should be of little importance for predicting future changes in rates of piracy since the proportion of the population that is male should be virtually constant over time. Further, one could make a similar argument concerning age but that argument misses an important possibility.

There are three distinct possibilities for why piracy rates might be correlated with age in the type of cross-sectional study of Mandel and Sussman (2010), where the implications for future changes in piracy are quite different across the possibilities. One possibility for such a result is that it is due to a true age effect while a second possibility is that it is due to a cohort effect. And of course a third possibility is that both age and cohort effects are important. By an age effect here I mean that as individuals age, on average, piracy falls, where if one compared different cohorts at the same age there would be no difference in the piracy rate. On the other

hand, a cohort effect means that as individuals age the piracy rate is unchanged, but the piracy rate varies across cohorts.

If age matters in the Mandel and Sussman (2010) cross-sectional study solely because of an age effect, then there is no reason from the standpoint of this finding to expect further increases in piracy in the future. In contrast, if the finding is due either partly or solely to a cohort effect, then there is a reason to predict further increases in piracy in the future. The reason is that as current younger cohorts with high piracy rates age the result would be increases in piracy rates for specific age groups and a subsequent increase in the overall piracy rate in the population. I did not find any direct evidence relevant for which of the three possibilities is the correct one. However, given the overall growth in piracy over time, it seems likely that holding age constant piracy rates are higher for later cohorts. That is, it is likely that in the cross-section age matters in terms of piracy rates at least partly due to a cohort effect and, in turn, this therefore represents another reason to expect future increases in piracy.¹⁴

The last major factor I will discuss in this section is the legal environment. First, as development progresses in less developed countries, more original content is likely to be produced in those countries and the likely result is that laws and enforcement levels will change in those countries to provide more protection for copyrighted goods. Second, in more developed countries such as the US and Europe theory would suggest that as piracy rates increase, achieving the efficient trade-off between the underproduction and underutilization losses would require both changes in the laws so that more protection is provided and higher levels of

¹⁴ To be more precise, my conjecture is that, because of increasing high speed internet access, the piracy rate for the youngest age groups have increased over time. In turn, because as found in a number of studies habit or past experience with piracy is an important predictor of current piracy, a higher piracy rate when a cohort is young will also translate into higher piracy rates as the cohort ages. That is, there is likely a cohort effect in piracy rates due to the combination of improving high speed internet access for later cohorts and habit being an important determinant of whether or not an individual chooses to practice piracy.

enforcement. However, it seems safe to say that the laws do not always match what is efficient and I am not confident in predicting that in the more developed world that increases in piracy will be accompanied by a strengthening of copyright protection.

Overall, I expect that in the future we will see rising piracy rates in more developed countries such as in the US and Europe and falling piracy rates in developing countries. The former is likely to occur because of technological diffusion, changes in the income distribution, and changes due to the aging of cohorts characterized by higher piracy rates. The latter is likely to occur because of income growth (although this factor may be muted by higher incomes leading to more high speed internet access), cultural changes, and changes in local laws. In turn, these changes in piracy rates should lead to revenue decreases for original content producers in the developed world and possible decreased investments in the creation of original content, while in the developing world the prediction is increased revenues and possible increased investments. However, the predictions concerning revenues and investment levels may be altered by the idea that these are global markets and so, for example, decreased piracy rates in the developing world can increase revenues and investment levels of original content producers in the more developed world.

VI. CONCLUSION

Piracy and, in particular, digital piracy has grown substantially over the last few decades. This growth is mainly attributable to technological changes that have made copying less costly and higher quality, while at the same time reducing the costs of distributing copies. Basic economic theory suggests that illegal copying of this sort should reduce investments in the creation of new works, but so far there is little evidence of any substantial reduction in

investments in new works in the most affected industries. But this does not mean that further increases in piracy would similarly have no substantial effect on such investments. So an important question is whether or not digital piracy is likely to continue to grow.

In this paper I have reviewed the history concerning the growth in piracy and also discussed and examined the factors that are likely to determine the extent of future growth. The main driver over the last few decades in the growth of piracy has been technological changes, so further technological changes constitute one important factor that can serve to determine the extent of such growth. Changing technology and diffusion of existing technology can continue to make copying and distribution cheaper and easier, or it can favor attempts by the producers of original works to produce and distribute their goods in ways that make illegal copying and distribution of illegal copies more costly. In the past technological progress has favored pirates rather than original producers and I think it is unlikely that future changes in technology will clearly favor original content producers. So, to the extent future technological changes and technology diffusion favor pirates or original content producers, my guess is that it more likely the pirates that will be helped.

Another important factor I discussed is demographics. One important fact concerning this factor is that the prevalence of digital piracy seems to vary significantly with age, where whether this is due to differences that arise as individuals age or differences across cohorts themselves that exist even after controlling for age is important for predicting the extent to which piracy is likely to grow. If the variation is primarily due to age, then the variation with age observed in the cross-section does not suggest further growth in piracy. But if the variation is primarily due to cohort differences after controlling for age, then we should expect future growth. There is no direct evidence on the topic but there are reasons to believe that cohort

effects are important for this correlation, so there is a prediction of future growth in piracy due to changing consumer preferences that favor piracy over acquiring access through more clearly legal means.

So overall, my analysis suggests the likelihood of at least moderate growth in the developed world in piracy rates in the future, where much of this growth will be due to the aging of cohorts characterized by higher a higher prevalence of piracy. Given the small effects that previous growth in piracy has had on investments in the creation of new works, if there is future growth but it is small, then my best guess is that there will be little effect on these investment levels. But if the growth is more substantial, then investment levels may be more significantly affected and the result would likely be pressure on legislators to better balance incentives for creation with access.

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