

Converting Pirates without Cannibalizing Purchasers:
The Impact of Digital Distribution on Physical Sales and Internet Piracy

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ABSTRACT

With the rise of Napster, BitTorrent, and other tools facilitating Internet piracy, rights holders have understandably become very concerned with the development of strategies to mitigate the impact of piracy on sales. These tools fall into three general categories: litigation, countermeasures, and competition. The literature has addressed the effectiveness of the first two anti-piracy strategies. In this paper we address the third strategy using NBC's decision to remove its content from Apple's iTunes store in December 2007 as a natural shock to the legitimate supply of digital content.

To address this question we collect two large datasets from Mininova and Amazon.com documenting the levels of piracy and DVD sales for both NBC and other major networks' content around this event. We then analyze this data in a difference-in-difference model and find that NBC's decision to remove its content from iTunes is causally associated with a 19.99% increase in the demand for NBC's pirated content. This is roughly equivalent to an increase of 92,612 downloads a day for NBC's content. Moreover, we see no change in demand for NBC's DVD content associated with this change.

Keywords: *Information goods, DVD sales, movie piracy, cannibalization, digital distribution.*

1. Introduction

Piracy is a large and growing concern in the media industries. The majority of the literature shows that the explosion of music piracy in the late 1990's negatively impacted CD sales (e.g., Hui and Png 2003, Blackburn 2007, Zentner 2006, and Rob and Waldfogel 2006). Evidence also shows that the subsequent growth of video piracy through the Bittorrent protocol or on Youtube.com can displace paid consumption of television or film (e.g., Rob and Waldfogel 2006, Danaher and Waldfogel 2007).¹

Not surprisingly, the RIAA, the MPAA, and nearly every major television network, film studio, or record label has referenced online piracy as a major concern. Media companies have made efforts to combat piracy through litigation, through countermeasures to degrade the performance of P2P file sharing networks, and through digital paid distribution. Other studies in the literature have addressed the effectiveness of the first two anti-piracy methods. In this study, we turn our attention to the effectiveness of the third method: competing with piracy through legitimate digital distribution.

In 2005, at least partly in response to the proliferation of piracy and file sharing, both NBC² and ABC³ began selling television episodes on the iTunes music store. CBS⁴ and Fox⁵ later followed suit, and most recently HBO⁶ (a paid cable channel) now offers some of its episodic content for sale on iTunes.

¹ See our literature review for more detail on this literature.

² See <http://www.apple.com/pr/library/2005/dec/06nbc.html>

³ See <http://www.apple.com/pr/library/2005/oct/12itunes.html>

⁴ See <http://www.apple.com/pr/library/2006/feb/07showtime.html>

⁵ See <http://www.apple.com/pr/library/2006/may/09fox.html>

⁶ See <http://www.apple.com/pr/library/2008/05/13itunes.html>

The networks have also begun streaming television episodes for free through their websites and through some third party websites. For example, in 2007 NBC and Fox launched a joint venture named Hulu.com⁷, where most of their television programming and several of their films are available for free streamed viewing with advertisements.

Moreover, digital consumption of television is not uncommon. NBC reported that they had 8.9 millions unique visitors who watched online television viewing on their website in September 2008.⁸ The number of over-the-air television viewers of the top show on NBC (Sunday Night football) was 17 million and the number of viewers of Heroes (the top episodic show on NBC) was 6.7 million (these numbers relate to the new shows only).⁹ ¹⁰ Nielsen numbers also show that the number of users watching TV at home was 282 million users per month while the number of users watching video on the Internet was 120 million users per month.¹¹

However, new digital distribution channels have raised two important questions for studios. The first question is: can digital distribution channels reduce the demand for “free” pirated copies of networks’ content? This concern was expressed by James Gianopulos, Co-Chairman of Twentieth Century Fox who, in commenting on threats from piracy, said “We can’t compete with free. That’s an economic paradigm that doesn’t work” (quoted in Thompson 2003).

The second question is: will digital distribution cannibalize physical channel sales such as over-the-air television viewing or sales of DVD box sets? In expressing this concern, Jeff Zucker, CEO of NBC Universal expressed the fear that digital distribution could “end up trading analog

⁷ See http://www.usatoday.com/money/media/2007-10-29-fox-nbc-hula_N.htm

⁸ See <http://tvbythenumbers.com/2008/10/01/nbccom-sees-increase-in-internet-video-viewing-of-tv-shows/5515>

⁹ See <http://tvbythenumbers.com/category/ratings/nielsen-weekly-top-broadcast-tv-show-ratings>

¹⁰ See <http://tvbythenumbers.com/2008/09/30/greys-anatomy-desperate-housewives-and-nfl-lead-among-18-49-year-old-viewers/5383>

¹¹ See

http://www.medialifemagazine.com/artman2/publish/Research_25/TV_s_new_best_friends_Web_and_mobile.asp

dollars for digital pennies.”¹² Even now, most networks only stream the most recent few episodes of television shows, for fear that making more available may cut into revenues from DVD box sets. This paper attempts to empirically address these two questions.

We do so through two quasi-experiments. The first occurred on December 1, 2007. During August of 2007, NBC expressed dissatisfaction with the Apple iTunes store’s pricing policy. While NBC (and other media companies) wanted more flexibility in pricing, Apple was enforcing a one-price-fits-all policy across nearly all episodes of television. When negotiations broke down, NBC announced that they would remove all of their content from iTunes on December 1, 2007, a significant move since they reportedly supplied 40% of all video content on the iTunes store.¹³ In response, Apple refused to offer NBC’s 2007 Fall season, and so on December 1 Apple removed all older NBC content from iTunes. In our analysis, we use this event as an exogenous shock to legal digital supply of all older seasons of NBC television.

The second experiment occurred on September 9, 2008, when NBC restored all of their content to the iTunes store. We use this experiment to verify our findings surrounding the first experiment.

Note that all of this content was generally available for sale on DVD, on iTunes (prior to December 1), and through piracy, and thus we study a market with a physical sales channel, a digital sales channel, and a piracy channel. In our analysis, we account for general time trends by observing changes in piracy or DVD sales one week before vs. one week after December 1 (and then September 9th) for NBC’s competitor networks such as ABC, CBS, and Fox (all of which

¹² New York Times, “Serving Up Television Without the TV Set,” Brian Stelter, March 10, 2008.

¹³ New York Times, “NBC Will Not Renew iTunes Contract,” Brooks Barnes, August 31, 2007.

continue to offer their content and thus received no shock on December 1 or September 9th). We then contrast this time trend with the change in piracy or DVD sales for NBC, arguing that any differences in piracy or DVD sales for NBC content after December 1 (or September 9th), over and above the difference for similar television networks, was caused by the removal or addition of NBC content to/from iTunes.

In summary, we find that the removal of NBC content from iTunes caused a 12% increase in piracy, which corresponds to 31 more pirated downloads per day per episode, or about 62,000 total additional pirated downloads per day. This number is twice as high as estimates for the daily number of downloads of these episodes on iTunes in the week prior to December 1, implying a spillover effect — once individuals start to pirate, they pirate more content than they would have originally purchased. We interpret this to mean that the non-financial “cost” of piracy – whether it be the cost to learn, the moral/stigma cost, or the fear of getting caught – must be largely fixed with relatively little variable component. Confirming the fixed cost story, we find that when NBC content was restored to the iTunes store on September 9, 2008, the average show experienced only a 4.5% decrease in daily pirated downloads – a decrease of 6.5 downloads per day. This implies a significant danger to content providers when their digital distribution service is interrupted, as viewers who pay the fixed cost and turn to piracy would have little reason to revert to legal purchases even when the digital distribution channel is reintroduced.

In contrast, we also find no change in the Amazon.com sales rank of NBC television season box sets in the two weeks surrounding December 1, 2007 or the two weeks surrounding September 9, 2008, implying that while customers who cannot purchase digitally may turn to piracy, they will not purchase DVD’s as a substitute.

The remainder of this paper proceeds as follows. In Section 2, we review the relevant literature. In Section 3, we give a general description of the digital market for media and present a theoretical model of the consumer's choice between piracy, digital channel purchase, and physical channel purchase. In Section 4, we discuss our data. In Section 5, we present our empirical models and results. Finally, in Section 6, we discuss the implication of our findings, limitation of our analysis, and areas for future research.

2. Literature Review

This paper fits into the literature on online piracy of information goods. There are a number of studies that examine the effect of online piracy on music CD sales as well as a few which study movie piracy or television piracy. The challenge in this literature is typically identification, as the correlation between physical sales and pirated downloads of each movie or song is typically driven by unobserved heterogeneity across goods. Zentner (2005), Hui and Png (2002), and Peitz and Waelbroeck (2004) use international panel data on music sales and pirated downloads and they all find some amount of displacement of CD sales by piracy. In contrast, Oberholzer and Strumpf (2004) ask whether albums sell less when they are pirated more and find little or no displacement. Rob and Waldfogel (2004) use survey data from a population of college students, asking whether individuals who pirate music purchase it less, including controls such as stated valuations of the albums in question or personal taste for music. They then also use a similar approach in 2006 to study the effect of movie piracy on paid consumption of movies such as theater attendance, DVD rental, and DVD purchase. In both studies they find displacement of paid consumption by piracy. Waldfogel and Danaher (2007) examine the impact of online piracy of Hollywood movies on the international box office and find evidence of displacement of ticket

sales by online piracy. Clearly the majority of studies (but not all) find a clear amount of substitution of unpaid consumption for paid consumption.

The more current question of interest is how to combat the negative effects of piracy. The primary tools used to combat piracy have been litigation, sabotaging of file sharing networks, and digital distribution. Bhattacharjee et al. (2006) examine the summer of 2003 legal threats of the RIAA against individual file sharers as a quasi-experiment and find that when the threat of litigation is higher, file sharing declines but availability of content is still substantial. Christine et al. (2005) study the impact of different poisoning strategies on the four popular peer-to-peer file sharing network and find that the injection of a few replicated decoys can lead to users' perception of content availability in the network. Mook (2005) reports that there is evidence showing that the MPAA and RIAA took action to sabotage the file sharing network. The impact of digital distribution, however, has gone largely unmeasured. There are few papers that attempt to measure the effect of free digital distribution on physical channel sales. Two notable exceptions are Waldfogel (2007) who finds only small displacement of authorized Youtube viewing of television content for actual over-the-air viewing¹⁴ and Deleersnyder et al. (2002) who find that when newspapers make their content available online it only has a small impact on physical newspaper sales (particularly when the online content is differentiated from the physical). However, to date we know of no studies that examine the effect of paid legal digital distribution on the original physical sales channel or on piracy, and this study is a first attempt to measure the degree to which paid digital distribution of television programming displaces piracy and/or cannibalizes DVD box set sales, if at all.

¹⁴ Waldfogel finds some evidence of complementarities as well.

3. Theory

3.1. Digital Distribution and Piracy

Theory does not clearly predict the effect of a digital sales channel on piracy or on consumption in a physical sales channel. iTunes purchases and pirated downloads are fairly close substitutes — both provide high quality, usually fast file downloads that can be viewed on a computer or, with some effort, a television or portable video device. Pirated files, of course, tend to be easier to share or use on a variety of devices (due to the Digital Rights Management incorporated into iTunes products) whereas iTunes downloads tend to have more consistent quality. Notably, the architecture of the Bittorrent protocol makes it such that files being downloaded by many users are obtained much more quickly and reliably than files being downloaded by only a few, and so piracy should be a better substitute for iTunes for popular shows than for shows which are only infrequently pirated. Thus, if the digital sales channel were removed, shows already popular on BitTorrent might be expected to experience a larger increase in piracy (since the time/reliability cost to get them is lower) than shows that were not widely pirated.

One might ask why anyone would purchase on iTunes if piracy is free. For this to occur, there must be some non-financial cost to piracy. We can think of several possible categories:

- i) There may be a cost to learn to use BitTorrent, which we would likely consider a fixed cost (especially since BitTorrent is easy to use once learned).

- ii) Individuals may experience moral qualms about pirating, which could be a fixed cost or a variable one.¹⁵
- iii) Individuals may fear being caught and punished, a cost which is also variable with respect to downloads.
- iv) It is possible that pirated downloads are viewed as less convenient as compared to iTunes consumption (either due to the relative ease of use of iTunes versus piracy sites or the variability in quality through piracy sites). This cost would also be variable with respect to the number of downloads.

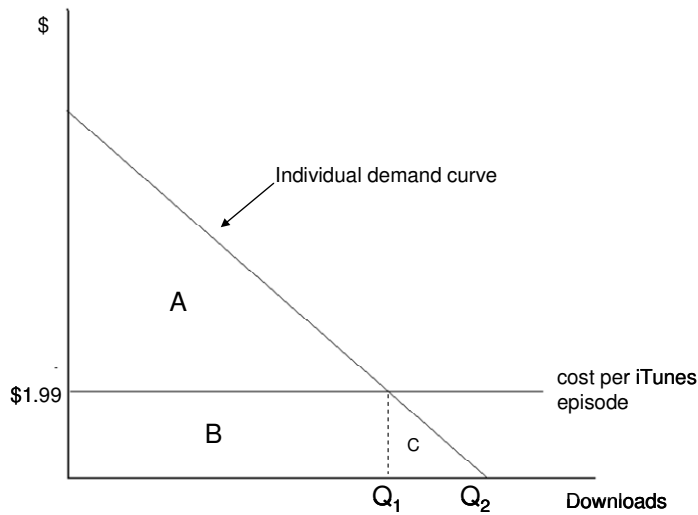
The nature of these costs tells us a lot about what we expect to happen to piracy when the digital distribution channel is removed (or introduced). Consider Figure 1 below.

Figure 1 represents an individual's demand curve for downloads of episodes of television. We assume a typical downward sloping demand curve for episodes — the intercept would be the most highly valued show download and each successive download has diminished returns. In this figure, we assume that the non-financial cost of pirated downloads is completely fixed, equal to some number F .¹⁶

¹⁵ Do individuals feel all of their compunction in the first illegal download, or does each successive illegal download come with additional “guilt”? It would be an interesting laboratory experiment to isolate the moral/stigma cost and determine its nature.

¹⁶ For simplicity, we also assume that there is no fixed cost to using iTunes, as it is a legal and less intimidating platform. Our analysis could easily be adapted to include a small fixed cost to using iTunes.

Figure 1

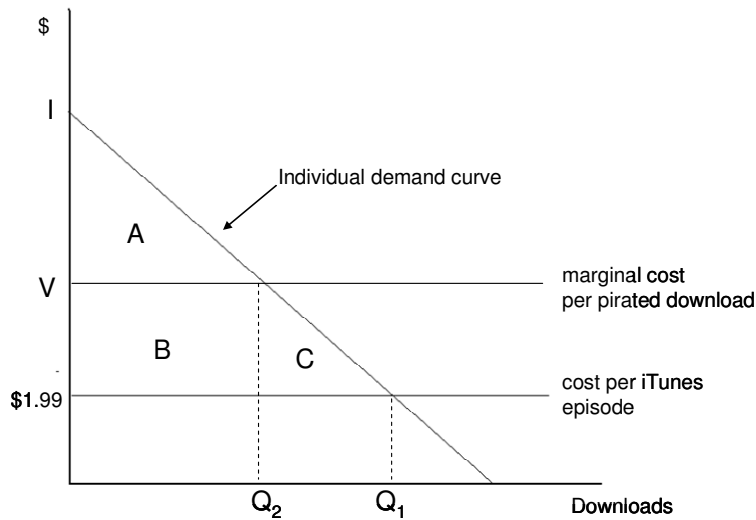


In this setup, if an individual chooses to download through iTunes, she will download Q_1 episodes and receive consumer surplus equal to area A. If the individual chooses to pirate, she will download Q_2 episodes (her satiation point for digital television) and receive consumer surplus equal to $A + B + C - F$. The consumer decides whether to pirate or purchase by comparing consumer surpluses and choosing the greater of the two. Thus, the individual will choose to download all episodes from iTunes if $B + C < F$ – in other words, if the additional surplus gained from piracy is less than the fixed cost (or the perceived fixed cost) of pirating.

This leads to some interesting predictions. For an individual who is using iTunes, if the content is removed from iTunes there are two possible outcomes. If $A + B + C < F$, then the individual will not turn to piracy and will no longer download the content (either no longer consuming it, or possibly purchasing the box set if that is a substitute). But if $A + B + C > F$, then the individual will download Q_2 episodes, and thus the increase in piracy will be greater than the original number of iTunes purchases.

Note that there are other ways to reach these outcomes as well and even an alternative outcome. Consider Figure 2, in which there is no fixed cost to piracy but instead a constant marginal cost equal to V .

Figure 2



Note first that if V , the constant marginal cost of each pirated download, were greater than I , the demand intercept, the individual would never pirate regardless of the availability of a legal download source (a result similar to that from Figure 1 when there is a very high fixed cost). However, if $\$1.99 < V < I$ as in the diagram¹⁷, then the individual will purchase Q_1 episodes from iTunes if they are available and receive surplus of $A + B + C$. If the legal purchase option is removed, then the individual will pirate Q_2 episodes and receive surplus equal to area A . Note that in this case, $Q_2 < Q_1$ so the increase in piracy is less than the original number of iTunes purchases before removal of the legal download alternative.

¹⁷ If $V < \$1.99$, then this is effectively equivalent to Figure 1 where we get the result that $Q_2 > Q_1$.

There are other possible structures for the non-financial cost of piracy, including a mix of fixed and variable costs as well as increasing or decreasing marginal cost.¹⁸ However, in even the simple examples diagrammed we have shown that when the digital purchase channel is removed, it is possible that an individual would either not turn to piracy, begin to pirate a number of episodes less than or equal the number of purchases she had been making on iTunes, or even begin pirating more than she had ever purchased. Given that the cost structure is likely heterogeneous across consumers, it is unclear what the effect of the addition or removal of the iTunes sales channel will have on levels of piracy.

However, as tests of whether digital distribution actually mitigates piracy, we predict several effects. First, if digital distribution mitigates piracy then when the digital distribution channel is removed for a single network, the average number of daily pirated downloads for shows owned by that network should increase above and beyond any change for other similar networks as viewers who cannot make digital purchases turn to piracy. Second, if digital distribution mitigates piracy then when a network's digital distribution channel is removed we may see the appearance of unique new torrents for shows of that network that were previously unavailable through piracy. The nature of the BitTorrent protocol is such that demand actually creates supply as users who are downloading an episodes are also forced to allow others to download from them the portions that they have already received. Thus, to remain viable a torrent for an episode often needs to generate a large enough "swarm" of downloaders. We predict that some shows which were unable to generate enough demand to remain available through piracy when they were available via digital distribution will become available through piracy once the digital distribution channel is removed.

¹⁸ In fact, it is possible to show that if the marginal cost is increasing then consumers might mix behaviors, pirating some episodes and purchasing others.

3.2. Digital Distribution and Physical Sales

The substitutability of iTunes purchases for DVD box sets is less clear than it was for piracy. DVD box sets may take longer to acquire and are often priced differently than the equivalent television content sold on iTunes. One might also speculate that DVD box sets appeal to a different market segment than the iTunes video store — less technologically savvy viewers, viewers who prefer to watch content on their televisions, or perhaps gift givers. Finally, DVD's often contain “bonus” extra content that is lacking in iTunes files or (some) pirated copies. Even if box sets and file downloads are substitutes for each other, it is possible that individuals who “go digital” will refuse to go back to the physical product (indeed, this would be consistent with a fixed cost associated with beginning to download/watch television online). However, it is still possible that some iTunes consumers would have otherwise purchased the box set, and this is clearly a fear of the networks as evidenced by Zucker's quote above. When deciding whether and how to have a digital distribution channel, networks must balance the potential benefits — new revenues from new consumers, regained revenues from pirates — against the potential costs — lost revenues from original channel sales.

In summary, iTunes customers may otherwise have been pirates, may otherwise have purchased the box set, or may otherwise not have viewed the content at all. We have shown that it is theoretically possible that the availability of content on iTunes could displace more pirated downloads than the number of episodes being purchased on iTunes. In this paper, we ask the following questions¹⁹:

¹⁹ As we discuss in detail in the data section, it is important to note that we are asking these questions in relation to older, off-season content for most of our analysis.

- i) What happens to the level of piracy of television content when that content is removed from iTunes?
- ii) What happens to DVD sales of television seasons when those seasons are removed from the iTunes store?

As well, we can provide some suggestive evidence as to the percentage of iTunes customers who would otherwise pirate content, the possibility that the decision of one network to make its content available or unavailable by digital distribution may affect piracy of other networks, and the shape of the non-financial cost curve associated with piracy.

4. Data

To answer these questions we need to collect data documenting levels of piracy for television content over time and changes in DVD sales over time. With respect to piracy data, following Smith and Telang (2008), we use the level of daily downloads at Mininova.org as our proxy for piracy activity on the programs in our sample. The website Mininova is a search engine for torrent trackers — the files that allow you to link to other computers to download a specific file. We selected Mininova as our proxy for piracy activity because, according to Alexa.com, it is the most popular torrent tracker site in our timeframe. Mininova is also useful for our study because it tracks the number of users who download each torrent and displays this information on their site. Our data include torrents of all television shows posted to Mininova from November 11, 2007 until the present. Our data include the name of the file, the date of the observation, the total cumulative downloads of this file to date (from which we infer the number of daily downloads), the number of days since the file first appeared for pirated download, and the size of the media

file.²⁰ We collect roughly 210,000 records per day from Mininova, yielding a dataset of over 68 million records for over 180,000 torrents.

For our analysis, we focus on piracy among television programming for NBC and its subsidiaries USA, Bravo, and the Sci-Fi Channel. We also analyze piracy for television programming from ABC, CBS, and Fox as a control. From the name of the torrent we were able to construct variables that indicate the name of the television series, the season, the episode number, and the network on which it aired. We removed all content from the 2007-2008 season from our data because the content being sold on iTunes prior to December 1 only included episodes prior to the 2007-2008 season.²¹

Torrent files and specific episodes do not necessarily have a one to one mapping. Some torrents may link to an entire season of a series, which would entail a larger file size and a longer download. We treat a download of this torrent as a download of each episode of that season for that show. More importantly, it is very common that there is more than one torrent for a given episode of a show — there may be 5 torrents on the Internet that contain, say, the fourth episode of the first season of *Heroes*. In our analysis, we add the downloads for each of these into a single number, essentially collapsing the download data from the torrent level to the episode level and allowing us to report results at the episode-level (a more meaningful reference point than the torrent-level for our purposes). Finally, we relegate our study to two periods corresponding to the quasi-experiments of interest. First, we examine levels of piracy and for the week before and the week after December 1, 2007, when NBC removed their content from

²⁰ On some days, when mininova did not provide the number of downloads of a particular show *i* on day *t*, we inferred it from the cumulative downloads on day *t*-1 and day *t*+1.

²¹ This is because, as noted below, starting in August 2008, Apple did not add any new NBC content to the iTunes store in response to NBC's announcement that it would remove all of its content in December.

the iTunes store. This leaves us about 5500 unique episodes of television to analyze, corresponding to about 75 unique television shows. We then study this exact same set of shows in the week before September 9, 2008 and the week after, when NBC returned their content to the iTunes store.

We also collected data from Amazon on DVD box sets for seasons of the same television shows present in our piracy data. We use DVD data from Amazon.com because Amazon.com is one of the largest Internet DVD retailers. Our data contains the daily sales rank at Amazon for the box set, as well as the series, season, network, and daily price at Amazon. We limit our Amazon study to box sets seasons of the same shows studied in our piracy data during the same two periods.

Prior work has shown that the relationship between sales rank and sales follows a Pareto distribution:

$$Quantity = \beta_1 Rank^{\beta_2} \quad (1)$$

Because we do not have direct supplier data as used by Brynjolfsson et al. 2003, we apply the experiment proposed by Chevalier and Goolsbee (2003) to parameterize this relationship. Specifically, we conducted an experiment on February 8, 2006, by ordering 7 copies of two DVD titles from different buyer accounts. We picked two DVD titles that had steady movement in ranks for six months, and tracked the movement of rank for 24 hours after we bought those items. The rank of one DVD title jumped from 60,521 to 2,875 and the rank of another title

jumped from 64,380 to 2,876. These changes yielded slope parameters (β_2) equal to -1.76 and -1.81 respectively. We use the average of the β_2 , which is -1.78, in our analysis.²²

We note at this point that our data collection strategy for both the piracy and DVD data overcomes a major problem with analyzing the before-after changes in digital distribution strategies adopted by firms. Specifically: new digital channels are typically announced on the day that they are available to the market. Thus, to analyze changes in pre- and post-announcement demand, one must typically have started gathering data prior to the announcement. In this way, we believe one contribution of our research is the development of a data collection system that allows us to data for all content available on two notable bellwethers for DVD sales and Internet piracy.

Our main strategy in this paper is to use the removal of NBC content from iTunes as a sort of quasi-experiment to determine the amount of displacement of both piracy and DVD sales caused by sales on the iTunes channel. The removal was announced in August of 2007, at which point Apple chose not to carry any new NBC content. According to sources at NBC, the removal of content began on November 30th 2007 and was completed by the end of December 1st – thus we use November 30th as the first day of our “post removal” period. We study this same set of shows in the two week period surrounding September 9, the date on which all of this content was restored to the iTunes store.

²² Using a different coefficient value (for example -1.81) would not effect our main findings.

5. Results

We begin by listing some very high level statistics on this data, shown in Table 1.

Table 1: Summary Statistics

	December 1, 2007	September 9, 2008
Piracy downloads		
Mean daily downloads per episode	342	233
Median daily downloads per episode	58	52
Number of unique episodes available	5,695	5,461
Number of unique series available	83	84
Mean number of days since episode first aired	3,075	3,286
Median number of days since episode first aired	1,498	1,768
Amazon.com sales		
Mean Amazon.com sales rank	34,254	37,363
Median Amazon.com sales rank	12,625	13,172

*Piracy data is at the episode level, while Amazon.com data is at the season box set level. The period of data for each column is the period extending one week before and one week after the listed date.

This table shows that the mean number of daily downloads per episode is 342 in the two weeks surrounding December 1, 2007 and 233 in the two weeks surrounding September 9, 2008. It is not surprising that the number is decreasing, as we study the same set of shows (all television seasons before the 2007-2008 season) for both periods and this content declines in popularity over time. The table also shows that the piracy data is right skewed, as the median daily downloads is well below the mean. The number of unique episodes available for piracy is 5,695 around December 1 but declines to 5,461 – this is by construction since we do not track any new content and some of the older seasons that we track disappear from the data as the number of downloaders reaches zero. The number of days since the episode first aired tells us that the mean episode is about 8 years old as of December 1, 2007 while the median is about 4 years old, and

of course these episodes age about another 9 months (270 days) by September 9, 2008. Finally, the mean Amazon.com sales rank of a box set season of television is 34,254 and is rising over time – as well, this data is right skewed. These summary statistics can not tell us anything about changes in piracy due to digital distribution, but they do reassuringly display all of the properties that we expected over time.

5.1. Piracy and Digital Distribution

The simplest possible analysis of the quasi-experiments is a comparison of means before and after the removal of NBC content from iTunes on December 1, and then again before and after the restoration on September 9. So to start, we ask if the average number of daily downloads of an NBC episode is greater in the two weeks after December 1 than in the two weeks before. Similarly we ask if the mean daily pirated downloads changes after September 9th, but we use a one week window before and after here in order to avoid interference from the start of the new season which mostly occurs about a week after September 9.²³ Table 2 displays the result of this comparison.

We first look at the December 1 data in Table 2. We see that the mean number of daily downloads for an NBC episode remains decreases slightly as does as does the number of daily downloads for non-NBC. One explanation for this result is that the removal of NBC content from iTunes had very little effect on piracy. However, an alternate explanation for this result (and one that we test below) is that the removal of content from iTunes leads new torrents to appear for less popular shows that were not available for piracy when they were available on iTunes. If this second explanation is true, it could lower the overall mean for NBC piracy after

²³ The new season is a factor in that a new season premiere of a show often has the effect of increasing piracy for past seasons of that show. Thus we are forced to shorten our window for the September 9 experiment in order to provide meaningful results.

November 30 — even while demand for pirated copies of individual episodes available before December 1 increased.

Table 2: Comparison of Piracy Means

	NBC	Non-NBC
December 1, 2007		
Mean daily downloads before December 1	258.1082	392.5414
Mean daily downloads on or after December 1	248.836	379.5577
Number of unique episodes before December 1	1,781	3,722
Number of unique episodes on or after December 1	1,910	3,711
Total download before December 1	6,411,666	20,300,000
Total download on or after December 1	6,620,531	19,600,000
September 9, 2008		
Mean daily downloads before September 9	134.6716	252.7205
Mean daily downloads on or after September 9	192.188	276.5529
Number of unique episodes before September 9	1,680	3,722
Number of unique episodes on or after September 9	1,590	3,781
Total download before September 9	3,140,004	13,100,000
Total download on or after September 9	4,709,568	16,300,000

Similarly, an alternative explanation for the lack of significant change in non-NBC piracy is that tracker files decline in popularity and are removed from the tracker site over time. If this were true, we would expect these episodes to have low download numbers prior to their disappearance, thus bringing down the mean for non-NBC piracy prior to December 1 but having no effect after December 1 as they are no longer observed.

Indeed, the second set of observations in Table 2 (rows three and four) is consistent with these potential explanations. While the number of unique non-NBC episodes available for piracy

decreases by 22 after December, the number of NBC episodes available increases by 271.²⁴ When we examine the data more closely, we discover that entire seasons of some less popular NBC content — seasons that were not available on Mininova before December 1 but were available on iTunes — become available on Mininova after December 1. These series include, for example, a number of seasons of *Saved by the Bell* and *Xena: Warrior Princess*. None of these seasons had new or updated box sets released, or new syndication deals during the time period of the study supporting the inference of causality with NBC's removal from iTunes. In short, it is striking that these entire seasons of older NBC television became available for piracy immediately after the removal of the iTunes channel (within a one week period) while no new non-NBC content becomes available. And thus our hypothesis that the removal of the digital distribution channel would give rise to the availability of new and unique torrents not previously available is confirmed.

One way to address this issue of newly available torrents affecting the means is simply to look at the total number of pirated downloads for each network before and after December 1. In rows five and six of Table 2, we do this and note that while the total number of downloads of all non-NBC episodes for the week after November 30 is approximately 700,000 less than the week before, NBC shows a an increase of about 200,000 in total pirated downloads after November 30 compared to before. Thus, the total aggregate piracy for NBC content increases after November 30 while the total piracy for non-NBC content decreases.

In contrast, we notice only small changes in piracy in the one week before and after window surrounding September 9, despite the restoration of NBC content to the iTunes store on this date.

²⁴ In fact, just as we see some non-NBC torrents expiring, we also see some non-NBC torrents expire (albeit less). So there are actually more than 271 new episodes of television being introduced after 12/1.

While these simple statistics tell a partial story, they fail to control for important episode-level heterogeneity or for the effect of the age of the torrents/content. Thus, a more sophisticated test of changes in piracy after the removal of iTunes is to run an OLS regression with fixed-effects for each of the episodes and test the significance of the coefficients. To this end we test the following model:

$$\ln Downloads_{it} = \beta_0 + \beta_1 NBC_i + \beta_2 After_t + \beta_3 NBC_i * After_t + \beta_4 * \ln(Age_{it}) + X_i + e \quad (2)$$

where $\ln Downloads_{it}$ is the natural log of daily downloads of a given episode i on day t . NBC_i is a dummy indicating if episode i comes from an NBC network, $After_t$ is a dummy variable equal to one if the observation is from November 30 (or September 9) or later and Age_{it} is the number of days between day t and the original airing of episode i . X_i is a vector of episode specific fixed effects. We use the log transformation on downloads as we have theoretically shown that the relationship between pirated downloads and the presence of a legal digital sales channel is not expected to be linear (since torrents that are already more highly downloaded will be more attractive to frustrated iTunes customers, and since the increase in piracy could be higher than the actual number of iTunes sales). However, to lend empirical support to this assumption, we also ran a Box-Cox test on the model, which essentially transforms the download data according to the following formula:

$$(Downloads^\theta - 1) / \theta \quad (3)$$

for all values such that $-1 \leq \theta \leq 1$.

The Box-Cox test finds the θ that produces the highest maximum likelihood score for the proposed model, and in this case the optimal θ was found to be .04. This indicates quite strongly

that a logarithmic transformation of downloads is the best fit for the model, as theoretically predicted.

We note that this model is equivalent to a difference in difference model and asks if the change in daily piracy of NBC content after its removal from iTunes is greater than the change for non-NBC content at the same time, since non-NBC content was not removed from iTunes. This allows us to control for a possible time trend in piracy, assuming that there is no reason to believe that the pre-existing time trend for non-NBC piracy should be different than for NBC piracy. The variable of interest is B_3 . If this variable is positive and significant then, under our assumptions, B_3 indicates the number of additional pirated downloads per NBC episode that was caused by the removal of NBC content from iTunes.

Table 3: OLS Regression

	(1) December 1 Experiment	(2) September 9 Experiment
Post Period	0.0731* (0.0048)	-0.0240* (0.0055)
Post Period * NBC	0.1268* (0.0075)	-0.0521* (0.0082)
Ln(No. of Days After Aired)	-1.2492* (0.1157)	4.3645* (0.2567)
Constant	13.5371* (0.5232)	-29.0799* (1.5804)
Observations	139,956	143,102
Number of TV episodes	5,346	5,036

Notes. Dependent variable is $\ln(\text{number of downloads})$. All models run with TV episode-level fixed effects with AR(1) disturbance. Standard errors are in the parentheses. * $p < 0.01$, ** $p < 0.05$, + $p < 0.1$.

The results using this model are given in Table 3. This regression shows a coefficient of 0.1268 on the interaction term for the December 1 experiment. In actuality, we can see from the post period coefficient that piracy on other networks increased by 7.31%, while on NBC it increased

by 19.99% (the sum of the post main effect plus the post*NBC interaction). Under our identifying assumption that ABC, CBS, and Fox piracy should experience trend as NBC piracy in the absence of the experiment, this indicates that the removal of NBC content from the iTunes store caused a 12.68% increase in piracy of that content.

While it may be a reasonable assumption that NBC piracy trends the same over time as ABC, CBS, and Fox piracy, it is also a testable one. We can examine this by running a different regression:

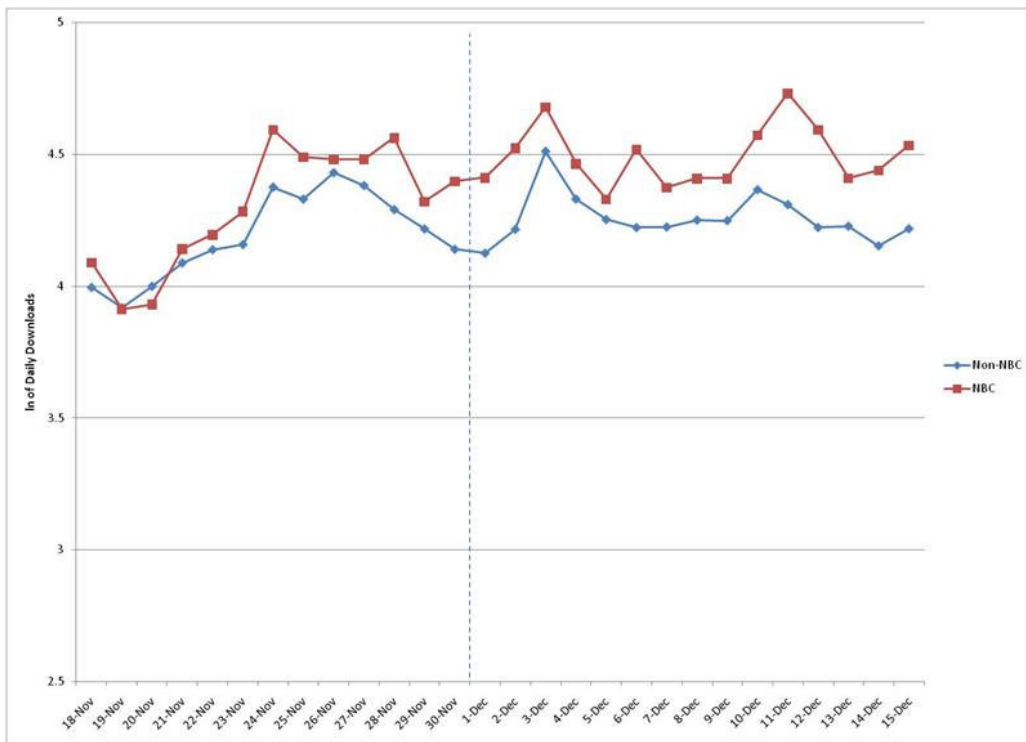
$$\ln Downloads_{it} = \beta_0 + \beta_1 Date_t + \beta_2 NBC_i * Date_t + X_i + e \quad (3)$$

$\ln Downloads_{it}$ is encoded as before. $Date_t$ is a vector of date fixed effects and X_i is a vector of episode specific fixed effects. The variable of interest is the interaction between the date fixed effects and the NBC dummy variable. To show that NBC has a similar time trend in piracy as other networks before the “treatment,” we would expect to each of the B_2 coefficients be jointly equal to zero for each of the dates prior to November 30. A positive B_2 after November 30 would indicate an increase in piracy due to the closing of the NBC iTunes channel.

Rather than list the 50 or so coefficients from this regression, we graph the date fixed effects and the incremental effect of being an NBC show on each of these dates in Figure 1. Specifically, in Figure 1 we calculate the non-NBC line by adding the constant term to each of the date fixed effects and we calculate the NBC line by adding the $NBC * Date$ interaction to each of these numbers. We draw a dashed vertical line in between November 30 and December 1 to indicate the date of the “experiment”. Examining the two lines, it does appear that there is a gap between NBC and non-NBC piracy prior to November 30 despite the presence of the episode fixed effects in the regression. However, a post-regression test that the coefficients for NBC piracy for each

date prior to November 30 are jointly equal to zero could not be rejected at the 95% level, indicating that the non-NBC piracy is a good control for NBC piracy. As well, a knowledgeable source we spoke to said that during the days leading up to December 1, Apple also removed all front-page and other promotional materials for NBC content from the iTunes site, which may cause the slight increase in NBC piracy over non-NBC piracy that one witnesses in the graph for the week leading up to November 30. For these reasons, we believe the most natural conclusion to draw from Figure 1 is that the results from the difference in difference model provide causal evidence of the effect of iTunes distribution on piracy.

Figure 1 – Predicted ln of Daily Downloads from OLS Regression (Includes episode fixed effects)



To get a better feel for the source of this increase in piracy, we look at some of the biggest drivers of the increase in downloads for NBC content. We find that the shows experiencing the highest increase in piracy are *Battlestar Galactica*, *Heroes*, and *30 Rock*. The first two are some of the most popular science fiction shows ever on television, presumably appealing to the same consumers known to make up the majority of pirates — young Internet savvy males.

There are a few ways to interpret the observed percentage change in piracy resulting from the removal of iTunes content. The first is to multiply the average increase in piracy per episode by the number of NBC episodes available by piracy prior to December 1 to determine the total increase in daily piracy attributable to the removal of the digital sales channel. The average NBC episode experienced 260 pirated downloads prior to December 1 and piracy increased this by 19.99%, resulting in an increase of 52 downloads per day per episode. Since there were about 1,781 NBC episodes available for piracy prior to December 1 and the average episode experienced an increase of 52 pirated downloads, we conclude that the removal of NBC content from iTunes caused a total increase of about 92,612 pirated downloads per day of NBC content.

Another way to look at the 52 download increase is to compare it to iTunes purchases of NBC episodes before the removal of the content. While we were not able to directly obtain data documenting the number of NBC downloads at iTunes, we were able to obtain summary data from an independent source that suggests the mean number of downloads for these shows on iTunes is about 16 downloads per episode per day. Thus, a single iTunes download appears to displace between 2 and 3 pirated downloads. This result, while shocking at first, was predicted by our model if the fixed cost of piracy were significant, and we discuss it in further detail in the final section of the paper.

Returning to table 3, we examine the coefficients for the September 9 experiment. In this experiment, we see a decrease of non-NBC piracy of 2.4% and a decrease of NBC piracy of 7.61% (the sum of the post main effect plus the post*NBC interaction). Under our identifying assumption that ABC, CBS, and Fox piracy should experience trend as NBC piracy in the absence of the experiment, this indicates that the returning of NBC content to the iTunes store is associated with 7.61% decrease in piracy of that content. This corresponds to about 7 less downloads per day, and so under the same assumption as the first model we state that the restoration of NBC content to the iTunes store decreased piracy of that content by only 7.61% - a much smaller number than the increase when the content was removed. This is also consistent with the notion of a fixed cost of piracy.

We also note that the results reported in this section are robust to a variety of alternative specifications, such as small alterations to the time frame of the data or including controls for the number of days since the torrents were initially uploaded.

5.2. Piracy and DVD Box Sets

To determine the degree to which the iTunes sales channel displaces purchases of DVD box sets, we employ similar tests to those above. Our dependent variable in this case is the log of Amazon.com sales rank, and thus a decrease in a DVD's rank indicates an increase in sales of that DVD. Table 4 compares means for NBC and non-NBC box sets before and after November 30 and then also before and after September 9.

Table 4: DVD Box Set Sales Rank at Amazon.com – Comparison of Means

	NBC	Non-NBC
Amazon.com sales rank before December 1	24,510	34,503
Amazon.com sales rank on or after December 1	26,840	42,193
Change	2,330	7,690
% Change	9.50%	22.30%
Amazon.com sales rank before September 9	31,354	39,483
Amazon.com sales rank on or after September 9	32,778	39,899
Change	1,424	416
% Change	4.50%	1.10%

We see from this table that the mean rank for non-NBC box sets increased by 22.3% after November 30, meaning that less television series box sets were sold in the week after than the week before. The increase in rank for NBC box sets was only 9.5%, which could indicate that the removal of NBC content from iTunes caused some additional purchases of DVD box sets. As well, when the content was restored to iTunes on September 9 NBC box sets had a slightly different change in sales rank than non-NBC box sets. However, as with our analysis for piracy, this comparison of means does not account for heterogeneity in the sets of DVD offerings on Amazon before and after December 1. Moreover, it does not account for changes in price that may occur during this time period (especially with the approaching holidays). Thus, we run a similar difference-in-difference model to the one ran for piracy, specified as follows:

$$\ln Rank_{it} = \beta_0 + \beta_1 \ln Amazonprice_{it} + \beta_2 After_t + \beta_3 NBC_i * After_t + X_i + e \quad (4)$$

We log transform the Amazon sales rank of box set i on day t as well as the daily Amazon price consistent with prior literature.²⁵ $After_t$ and NBC_i are the same as in the prior model and X_i is a vector of DVD specific fixed effects (a dummy variable for each box set). We present our results for this regression in Table 5.

²⁵ See Chevalier and Goolsbee (2003), Ghose et al. (2006), Smith and Telang (2004, 2007, and 2008).

Table 5: OLS Regression of Ln Sales Rank on Covariates (with DVD fixed effects)

	(1) December 1 Experiment	(2) September 9 Experiment
Log of Amazon Price	1.672** (0.410)	1.01** (0.063)
Post period	-0.005 (0.010)	0.04** (0.010)
Post * NBC	0.017 (0.019)	0.022 (0.018)
Constant	3.133** (0.134)	5.396** (0.205)

Notes. Dependent variable is $\ln(\text{rank})$. All models run with DVD-level fixed effects. Standard errors are in the parentheses. * $p < 0.01$, ** $p < 0.05$, + $p < 0.1$.

We note that raising price has the predicted effect of decreasing sales. The post period variable here indicates whether the date was after either the change in iTunes status – sales rank appears not to have been changing around the December 1 time frame but increasing slightly around the September 9 time frame. However, the insignificance of the post * NBC interaction term for either experiment is telling – NBC box sets experienced no changes in sales that was different from the change for non-NBC box sets. Thus, the removal of the digital sales channel did not seem to increase sales in the physical channel, nor did the restoration of the digital sales channel seem to decrease physical sales. We discuss this and our prior results below.

6. Discussion

The results presented above are the first test of which we are aware that quantifies the effect of a legal digital distribution channel on online piracy. As well, they offer decision makers at media firms some much needed evidence regarding the consumer’s short-term elasticity between purchasing digital media products versus physical media. In this final section, we discuss our results and their implications, as well as the limitations of the work as it stands and how they might be overcome by further research.

In this study, we first established that digital viewing of television, especially through the Internet, is an emerging trend that makes up a significant portion of all television viewing. Using the decision of NBC to remove all older seasons of television from the iTunes music store on December 1, we show that the removal of NBC's primary digital sales channel caused a 19.99% increase in piracy of that content over and above any change experienced by competitor networks ABC, CBS, and Fox over the same period. A 19.99% increase in piracy corresponds to about 52 more downloads per day per episode, or 92,612 total additional pirated downloads of all NBC content per day. Moreover, we obtained an estimate for the average daily downloads of similar content on iTunes in the two weeks prior to December 1, and this estimate indicates that the average episode received about 16 purchases per day. Thus, when the digital sales channel was removed piracy activity for that content increased by nearly twice the size of the actual digital sales figures before removal. We note that this is predicted in our theoretical model when there is a significant fixed cost to piracy but only a small (or no) variable cost. In other words, iTunes purchasers may avoid piracy because the fixed cost to learn to use BitTorrent (or the fixed moral/stigma cost of illegal behavior) makes piracy less attractive than iTunes. However, when the digital sales channel is not available, these individuals turn to piracy, pay the fixed cost and, likely discovering how easy BitTorrent is to use, begin to consume much more content through piracy than they ever purchased. Confirming this notion of a fixed cost, we show that when the same content was restored to the iTunes store it only experienced a 7.61% decrease in piracy.

Interestingly, this could even have a spillover effect for other networks that do have a digital sales channel, since once the fixed cost is paid for NBC it is likely paid for, say, ABC as well. Our data is consistent with this possibility.

Our results should sound an alarm to content providers, because if the fixed cost is sunk then it may be difficult to get pirates to return to legal options. This is an important result – it indicates that interruptions in the digital distribution channel – even short ones – may have lasting impacts as customers who turn to piracy are difficult to reclaim.

Digital distribution and DVD box sets present a different story, however. When NBC removed their archived seasons of television from iTunes, we saw no significant change in the Amazon.com sales rank for NBC content relative to the trend (likely seasonal) that we saw for non-NBC box sets. As well, when this content was restored we did not see any resulting decrease in box set sales. One possible interpretation of this is that digital television and DVD's are simply not substitutes in the short term e— once a consumer moves from physical to digital consumption they are unlikely to come back.

In addition to these implications, we note one other interesting potential direction for future research to come out of this study. In our theory section, we showed that the decision to purchase or pirate rests largely on the shape of the non-financial cost curve associated with piracy, which is technically free. While part of that cost may be related to learning or to the (sometimes) diminished quality of the pirated copies, these costs may approach zero in the future as pirates become more sophisticated in their methods but consumers become more technologically savvy and client software for piracy becomes even more user-friendly. We suspect that a large part of antipiracy efforts in the future may need to rely on the consumer's "moral" cost associated with piracy. In order to price competitively, digital distribution efforts would benefit from knowing more about the shape of this moral cost. We believe that user studies — whether in the laboratory or in the field — aimed at revealing the nature of the moral cost of piracy for different types of consumers to be a fertile area for future research.

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