Making Money by Giving It for Free: Radiohead's Pre-Release Strategy for In Rainbows

Faculty Research Working Paper Series

Marc Bourreau

Telecom ParisTech and CREST

Pinar Dogan

Harvard Kennedy School

Sounman Hong

Yonsei University

July 2014
RWP14-032

Making money by giving it for free:

Radiohead's pre-release strategy for In Rainbows*

Marc Bourreau†, Pınar Doğan‡, and Sounman Hong§

June 2014

Abstract

In 2007 a prominent British alternative-rock band, Radiohead, pre-released its album *In Rainbows* online, and asked their fans to "pick-their-own-price" (PYOP) for the digital download. The offer was available for three months, after which the band released and commercialized the album, both digitally and in CD. In this paper, we use weekly music sales data in the US between 2004-2012 to examine the effect of Radiohead's unorthodox strategy on the band's album sales. We find that Radiohead's PYOP offer had no effect on the subsequent CD sales. Interestingly, it yielded higher digital album sales compared to a traditional release. Our findings suggest the PYOP strategy generated higher sales revenues overall, even if one assumes no revenues were obtained directly from the PYOP channel. However, this "success story" does not readily apply to similar strategies adopted by other bands. We show that Nine Inch Nail's

*We thank Eric Avenel, Jorg Claussen, Sylvain Dejean, Ting Li, François Moreau, Martin Peitz, Thierry Pénard, Dani Rodrik, and Joel Waldfogel for useful remarks. We also thank participants at the 11th ZEW ICT Conference (Mannheim, 2013) and seminar participants at the University of Rennes and the Université of Paris-Sceaux for their comments. Pınar Doğan thanks the Blavatnik School of Government at University of Oxford for its hospitality during the final stages of writing this paper. Marc Bourreau acknowledges financial support by Agence Nationale de la Recherche under Grant No. ANR-08-CORD-018.

†Telecom ParisTech, Department of Economics and Social Sciences, and CREST-LEI, Paris. Email: marc.bourreau@telecom-paristech.fr.

‡John F. Kennedy School of Government, Harvard University, Cambridge, MA, and Visitor at the Institute for Advanced Study, Princeton, NJ (AY 2013-15). E-mail: pinar_dogan@hks.harvard.edu

§College of Social Sciences,Yonsei University, Seoul, Republic of Korea. E-mail: sounman_hong@yonsei.ac.kr.

free provision of its new album, *The Slip*, resulted in lower revenues from the album's digital sales.

Keywords: Pick-your-own-price; Music industry; Cannibalization; Market expansion.

JEL Codes: L82.

"The final acid test is come January, when the music has been available. Will there still be sufficient demand for a CD for us to feel that we've proved that making music available does not necessarily cannibalize CD sales?"

Bryce Edge (Radiohead's Manager), 11 October 2007[1]

1 Introduction

On September 30, 2007 when world-wide fans of Radiohead visited the band's web site to pre-order their new album *In Rainbows*, they were asked to name their own price for it. Along with the "pick your own price" (PYOP) offer for the digital download, the band offered a "deluxe box set" at a preset price.[2] The PYOP offer came to an end on December 10, 2007, and the album (in digital and physical forms) was released and commercialized subsequently, in January 2008.[3] Radiohead's strategy received considerable media coverage, and within six months it became a topic for a Harvard Business School Case Study.[4] The strategy also inspired other artists as well as information good providers.[5]

In Rainbows was downloaded in places as far-flung as North Korea and Afghanistan[6] and with very few listeners trying to buy for a penny.[7] This is in accordance with the literature on the PYOP models, which suggest that people do not necessarily free-ride when they are asked to pick and pay their own price.[8] It is argued that this is because in addition to the intrinsic value obtained from consuming a particular product, purchasers may obtain a warm glow from doing business with the given firm.[9] The number of people who downloaded In Rainbows through the band's web site, as

[1] "In Radiohead Price Plan, Some See a Movement," *New York Times*, October 11, 2007.

[2] One of the authors of this paper was puzzled with the PYOP offer. While her rational-economist-self dictated that she must pay the minimum service charge to download the digital album, her emotional-Radiohead-rabid-self revolted immediately, and she ended up preordering the deluxe CD at the preset price.

[3] Radiohead self-produced and self-released In Rainbows after their contract ended with EMI. See Morrow (2009) for a detailed account of the release strategy of In Rainbows.

[4] See Elberse and Bergman (2008).

[5] For example, British pop star Sir Cliff Richard followed the footsteps of Radiohead and announced that he would ask his fans to name their price for the digital download of his new album, Love, The Album. Also, shortly after Radiohead's offer, PASTE magazine asked its subscribers to pay what they like for a year's subscription of the magazine. See Fernandez and Nahata (2009) for examples of PYOP offers in the context of non-information goods such as restaurant services.

[6] See Pareles (2007b).

[7] See Morrow (2009), who quotes Murray Chalmers, a spokesperson for the band on this.

[8] See Fernandez and Nahata (2009), who set up a theoretical model of consumer behavior and show that when the product provides a positive value all consumers, free riding is never an equilibrium.

[9] See for example, Isaac et al. (2010); the warm glow may be obtained due to group identity, charitable support, and existence support. Existence support emerges due to customers desire for the continued existence of the firm (for example, due to valuation for future consumption possibilities).

well as the average price paid for it remains a mystery. However, according to the band's lead singer Thom Yorke, Radiohead has profited from the PYOP release strategy, making more money from digital downloads of In Rainbows than from digital downloads of all their other studio albums.[10]

In this paper we study whether the PYOP offer of In Rainbows hurt Radiohead's subsequent album sales, that is, whether this innovative strategy passed the final acid test, as put by the band's manager. The digital download of In Rainbows through the PYOP offer is a very close–if not a perfect–substitute to the digital album sold through the digital distribution channels (DDC) like iTunes, Amazon, etc., and therefore, the former might have reduced the sales of the latter. To the extent that there is some degree of substitution between the digital download and the CD of the same album, a cannibalization effect might have occurred also on the sales through the physical distribution channels (PDC) of In Rainbows.

At the same time, as Radiohead presumably received a much larger media coverage with this innovative strategy than what they would have received with a traditional release, the PYOP offer might have lead to higher sales for In Rainbows through all channels. In addition, the attention received by the PYOP offer might have generated positive spillovers to Radiohead's earlier albums. As Hendricks and Sorensen (2009) show in their seminal paper, a release of a new album can create a backward spillover effect, i.e., increase the artist's old album sales substantially, which may result from consumers discovering the artist upon hearing the new release. Although Radiohead is a well-established band, with six studio albums prior to In Rainbows, such spillovers might still exist, and might have been amplified with the additional media attention the PYOP strategy received. In short, while the PYOP offer might have cannibalized the sales of In Rainbows through the DDC and the PDC, at the same time it might have expanded the market both for In Rainbows and for Radiohead's earlier albums. Therefore, the net effect of the PYOP offer on Radiohead's album sales depends on the magnitude of these opposing forces.

Our paper is tangential to the literature on PYOP, as we are not studying consumers' behavior in picking a price (or the revenues directly generated with the PYOP offer),[11] but the effect of

[10] This may be partly due to the fact that the band did not receive much from the digital sales, as those revenues were captured by the recording company. See http://www.wired.com/entertainment/music/magazine/16-01/ff_yorke?currentPage=all. Similarly, Radiohead's publisher, Warner Chappell noted that "In Rainbows made more money before the album was physically released than the total sales for the band's previous album, Hail to the Thief." Subsequently in 2009, In Rainbows received the Grammy Award for Best Alternative Music Album.

[11] For a study with a focus on consumers' payment behavior facing PYOP offers, see Regner and Barria (2009), who analyze the payment behavior for the online music label Magnatune, where consumers were allowed to pay the price they picked, within a given range ($5-$18). See Gneezy et al. (2010) and (2012), for field experiments on PYOP strategies that analyze various behavioral concerns such as identity, self-image, and social responsibility.

the PYOP offer on the sales obtained through other legitimate channels.[12] Our paper is more closely related to the literature that studies the interaction between different channels through which a particular information good can be consumed, as with its PYOP offer for In Rainbows, Radiohead has effectively created an alternative (and temporary) channel of sales for its album. A relatively large set of studies has studied the effect of piracy on the sales through legitimate channels.[13] Focusing on the music industry, Waldfogel (2010a) looked at this relationship the other way around, and examined the effect of the introduction of legitimate and widely used digital channels (like iTunes) on unpaid consumption of music, as well as on the rate of displacement of paid by unpaid consumption. In a recent study on the music industry, Hammond (2013) analyzed data at the individual artist level, and found a negligible effect of pre-release file sharing (with the BitTorrent protocol) on music sales. Hammond argues that even though illegal file sharing may be harmful for the music industry as a whole, increased file sharing of an artist's music may allow that artist to gain a larger share of the industry revenues, and that such benefits are more likely to accrue to the established and popular artists.

We study the weekly music sales of Radiohead and a control group of similar artists between 2004-2012 in the US, using the empirical framework provided by Hendricks and Sorensen (2009). We find that Radiohead's PYOP offer had no effect on the subsequent CD sales. Interestingly, it yielded higher digital album sales compared to a traditional release. The increase in the sales of digital albums is mainly driven by the higher sales of the digital album of In Rainbows. This shows that the market expansion effect generated by the attention received by this innovative release strategy dominated any cannibalization effect. Our findings suggest the PYOP strategy generated higher sales revenues overall, even if one assumes no revenues were obtained directly from the PYOP channel. Our results are confirmed with the difference-in-differences method and also when we consider a control group that consists of artists that released albums of similar quality to In Rainbows.

Although our analysis shows that it is possible to "make money" by giving music for (almost) free, a question is whether our findings readily apply to similar pre-release strategies used by other artists. To test this, we conduct a similar analysis for *The Slip*, an album released by Nine Inch

[12] The effect of the PYOP offer on piracy of the digital album is another interesting research question, but is out of the scope of this paper. See Page and Garland (2008) for a study on piracy of In Rainbows during the PYOP offer.

[13] For a comprehensive survey on digital piracy, see Belleflamme and Peitz (2012). For a recent study on movie industry, see Ma et al. (2013) who analyze the data on all movies released within a three-year period (2006-2009) in the US, and show that pre-release movie piracy reduces the box office sales by 8% (compared to the counterfactual, where piracy happens on the first day of the legal release).

Nails (NIN) and provided for free in May 2008.[14] We show that although NIN's release strategy for The Slip had no effect on the band's overall CD sales compared to a conventional release, the offer created a negative effect on the digital album sales. This suggests that the market expansion effect generated by media attention, if any, was dominated by the cannibalization effect on the digital album sales of The Slip. Indeed, we find that the release strategy of The Slip did not receive much media attention, either online or offline.

The paper is organized as follows. We begin with a brief description of the pre-release strategy for In Rainbows and discuss the possible effects it may have generated on Radiohead's album sales. In Section 3 we present our empirical framework, followed by our findings in Section 4. We also check the robustness of our results by (i) using the difference-in-differences method, and (ii) considering a smaller "quality control group." In Section 5 we extend our analysis to NIN. Finally, we conclude.

2 The effect of the PYOP offer on Radiohead's total album sales

2.1 The PYOP offer for In Rainbows

In 2003, Radiohead fulfilled its 6-album contract with EMI, with the release of Hail-to-the-Thief. Upon completing their next studio album, In Rainbows, Radiohead pre-released it in digital form on October 10, 2007 from its web site. The price box was blank, and it was up to fans to decide how much to pay for the digital version of the album. The band had set an upper limit of £99.99, but no lower limit. One could set the price equal to zero and just pay a small service charge of £0.45 to download the album. At the same time, the band offered a "deluxe box set" version with a bonus CD, two vinyl albums, and artwork with a predetermined price of £40, to be shipped in December through Radiohead's own mail-order merchandising company, W.A.S.T.E. So many people responded to Radiohead's web site announcement that Radiohead's server crashed on October 1st.[15] The offer ended on December 10, 2007.[16] Soon after, In Rainbows was released as both digital and physical albums at a preset price (January 1, 2008). For the number of downloaders as well as the average price paid for the album, sources have come up with different numbers, none of

[14] Page and Garland (2008) provides a qualitative comparison of the In Rainbows PYOP offer and the free The Slip offer in terms of their costs and benefits to consumers.

[15] See Pareles (2007a).

[16] Radiohead did not announce an end-date for its offer from the outset. The band announced the closing date on December 5 from its web site. See http://www.radiohead.com/deadairspace/071211/WEb-Cam-ED-ON

which has been confirmed by the band or its representatives.[17] Claims about whether the strategy was (commercially) a great success or not cannot be verified[18] with open sources, as Radiohead did not release the official sales data of the In Rainbows PYOP operation to the public.

In this paper, we are interested in the effect of the PYOP offer on the sales through DDC and PDC,[19] and hence, the revenues generated directly through the PYOP offer are not our focus.[20] As we discuss below, the PYOP offer might have affected Radiohead's album sales through two opposing forces: cannibalization and market expansion. Before we describe how these two forces may have played out, we decompose the effect of the PYOP offer on Radiohead's total album sales: (1) its effect on sales of In Rainbows through DDC and PDC, and (2) its effect on sales of Radiohead's earlier albums.

2.2 The effect of the PYOP offer on In Rainbows sales

To study this effect, let us focus on consumers that have purchased In Rainbows (either through PYOP, DDC, or PDC), and define three distinct groups according to their possible consumption behavior in the absence of the PYOP offer, which is our counterfactual: (i) consumers that would have purchased the digital album otherwise, (ii) consumers that would have purchased the physical album (CD) otherwise, and (iii) consumers that would have not purchased the album (or would have obtained a pirated copy)[21] otherwise.

Within the first two groups, the consumers that end up purchasing the album only through the PYOP offer[22] represent the *cannibalization effect on the digital sales* and the *cannibalization effect on the CD sales*, respectively. To the extent that the digital album offered through the PYOP offer

[17] According to Gigwise.com, the downloadable version of the album sold 1.2 million copies, with an average price of £1, whereas an Internet research group, ComScore, claimed that 60 per cent of consumers who downloaded the album opted to pay nothing, with the average price being only £2.9. The former figure was cited as "exaggerated" by the band's co-manager Bryce Edge, and the latter was described as "wholly inaccurate." See Hardesty (2008).

[18] See for example, Chesbrough (2010), who claims that "[Any] revenue the band lost in the download experiment was more than compensated by greater publicity and sales of the commercial [release] and tickets for its world tour."

[19] See Appendix A for the total sales figures for all Radiohead albums decomposed for each channel as well as the ratio of digital album sales to physical album sales over time.

[20] We are also not interested in how the PYOP offer might have generated additional revenues from different sources, such as concerts and merchandise sales. See El Harbi et al. (2014), who provide a theoretical model and show that a PYOP release strategy can be profitable for a music artist, as it may generate higher revenues from live concerts.

[21] Since we are studying the effect of the PYOP offer on sales through the DDC and the PDC, for our purposes the consumers that would have obtained In Rainbows through piracy are not different than the group of consumers that would not have purchased it at all.

[22] Note that within both groups we can have consumers that purchase the album through multiple channels. For example, a consumer could first purchase the album through the PYOP offer, and consequently purchase it in the CD form. Such consumption decisions would not be considered as cannibalization.

is a closer substitute to the digital album offered through the DDC than the physical album offered with the PDC, one may expect a larger cannibalization effect on digital sales than on CD sales.

The size of the last group of consumers represents the *market expansion effect for In Rainbows*. Note that our data does not include PYOP sales, therefore we observe this effect on In Rainbows sales only through the DDC and the PDC.[23]

Due to the presence of two opposing forces, cannibalization and market expansion, the net effect of the PYOP offer on the Radiohead's album sales through the DDC and the PDC can be either negative or positive (or nil).

2.3 The effect of the PYOP offer on Radiohead's earlier albums sales

As Hendricks and Sorensen (2009) show, the introduction of a new album can increase the sales of the band's prior albums due to backward spillovers. The question we ask in this paper, however, is whether the change in total album sales is any different than what would have been obtained with a traditional release. That is, whether the PYOP offer (and not the release of In Rainbows) has generated a market expansion effect for the other albums. Similar to the market expansion effect for In Rainbows, the extensive media coverage might have served as "free advertising" for the band, and therefore increased the sales of their earlier albums. Therefore, if any, we can only expect a positive effect of PYOP on Radiohead's earlier albums.

One can also argue that the PYOP offer might have increased the sales of In Rainbows and Radiohead's earlier albums by facilitating sampling. Considering music as an experience good, Gopal et al. (2006) propose a theoretical model to show how piracy may generate a positive effect on artists' revenues by allowing consumers to sample music (whose value is unknown to the consumer ex-ante).[24] Note, however, that the sampling effect is likely to benefit more a new artist rather than an established band like Radiohead.

As we will discuss in greater detail, the market expansion effect on the sales through DDC and PDC may have been generated due to "free advertising" resulting from significant media coverage

[23] Note that the consumers that would have obtained a pirated copy in the absence of the PYOP offer are not likely to end up purchasing it through DDC or PDC in the presence of it. Furthermore, although we may expect some of those consumers to end up purchasing In Rainbows with the PYOP offer, their number is not likely to be large as the PYOP offers entails a small monetary cost (a 45 p fee) as well as a relatively large non-monetary cost (providing personal information including a valid credit card details). In any case, their consumption pattern is outside the focus of our research question.

[24] See also Peitz and Waelbroeck (2006) who show that the negative effect of free downloads on music sales may be offset by their positive effect due to sampling. Belleflamme and Peitz (2012) provide a more general framework and also argue that consumers can sample the digital goods, and observe the quality or suitability to their tastes before they purchase the good.

of the PYOP offer.

2.4 Two opposing forces: cannibalization and market expansion

Given that the PYOP offer may have increased or decreased the sales of In Rainbows, and that it could only have increased the sales of Radiohead's earlier albums (compared to a traditional release), the magnitudes of the opposing effects are likely to determine the sign of the overall effect.

Cannibalization of digital and physical sales In the context of information goods, several papers have studied how the introduction of a new sales channel can affect the sales through existing channels. Most of the studies focus on the cannibalization of physical sales by the introduction of a digital channel.[25] Some other studies have studied the effect of new channels on the consumption of the same content through the existing channels.[26]

The digital download of In Rainbows provided with the PYOP offer is a very close (if not perfect) substitute for the digital In Rainbows album sold through the conventional DDC. This suggests that, if any, the cannibalization effect is likely to be larger on the sales through the DDC than that of through the PDC.

Market expansion through "free advertising" Figure 1 shows the Google Trends[27] in the US for Radiohead, between 2004 and 2012. The horizontal axis represents time (from 2004 to 2012), whereas the vertical axis represents how often "Radiohead" is searched for relative to the total number of searches that used Google's search engine. Number 100 represents peak search interest, which happens upon the PYOP offer of In Rainbows. The closest peak happens when Radiohead releases its latest album King of Limbs, and is yet indexed as 47—half as many searches done in October 2007.

[25] See, for example, Biyalogorsky and Naik (2003), who show that the introduction of online storefronts for music did not significantly cannibalize physical record sales. Similarly, Danaher et al. (2010) show that the presence of the iTunes distribution channel has generated no statistical impact on DVD sales, but helped reducing piracy. See also Gentzkow (2007), who shows that online and offline newspapers are substitutes, and that online readership crowdouts print readership.

[26] For example, Waldfogel (2007) shows that Youtube viewing has only a small negative impact on television viewing.

[27] Google Trends is a public web facility of Google Inc., based on Google Search, that shows how often a particular search-term is entered relative to the total search-volume across various regions of the world, and in various languages (Wikipedia).

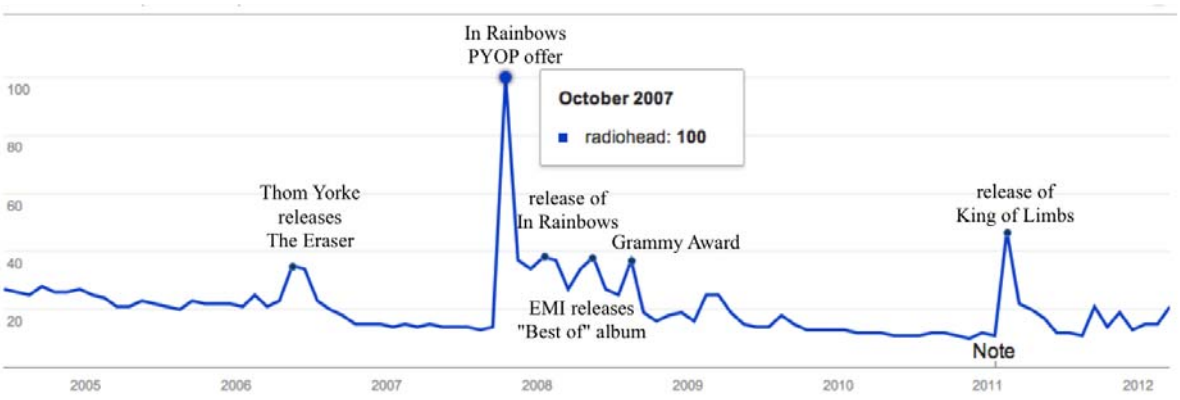


Figure 1: Google Trends in the US – Radiohead (June 2004 - March 2012)

Figure 2 shows the number of articles published in the US that contain Radiohead, over the same period time (searched via Factiva.com).

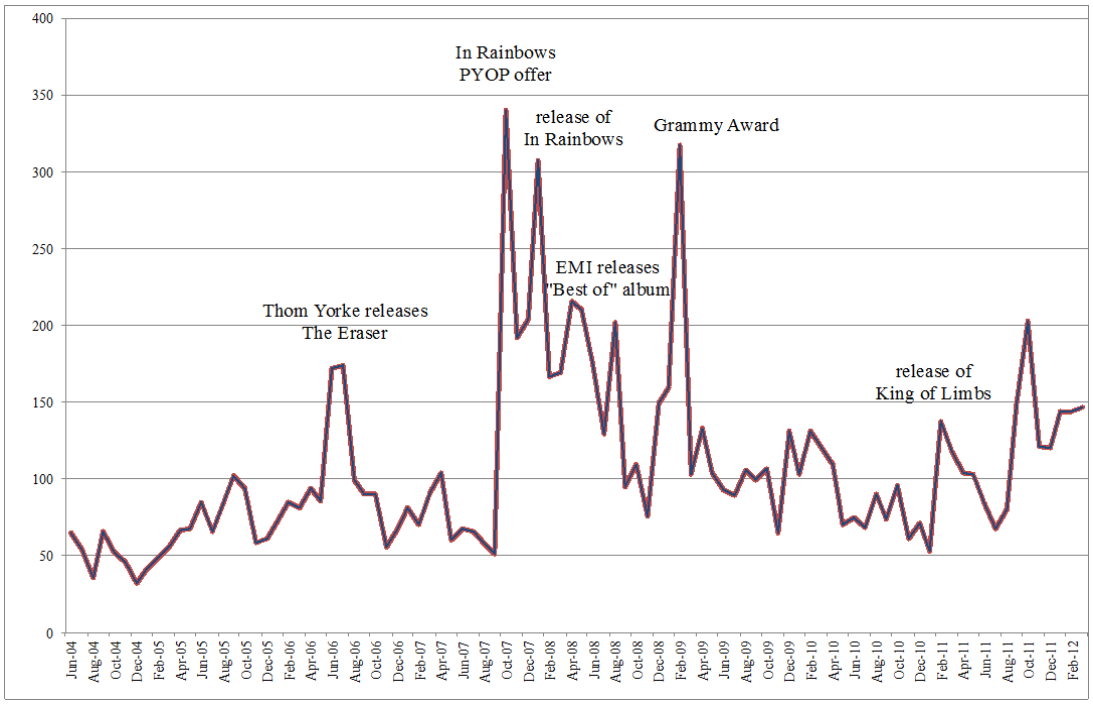


Figure 2: Radiohead in the US news; all Factiva sources (June 2004 - March 2012)

While the Google Trends figures reflect the demand for information about Radiohead, this figure shows the supply of information on Radiohead.[28] As it can be seen from the figure, the PYOP offer

[28]Note that the data for Figure 2 contain all the articles that mentioned Radiohead at least once, and they range

of In rainbows has received remarkable media attention. In October 2007, there were 340 articles that featured Radiohead, compared to 118 in March 2001 upon the release of the band's latest album King of Limbs.[29] The innovative pre-release strategy of In Rainbows might have helped resolve the information congestion problem, which is cited often in the advertising literature. In the information age, consumers are overwhelmed by high volumes of advertising from different sources. The consumers' limited attention span then leads to information congestion.[30]

3 The Empirical Framework

We are interested in testing whether Radiohead's PYOP offer for In Rainbows has generated an effect on the sales of Radiohead's (digital and physical) albums any different than a conventional release. We use weekly data for music album sales (both digital and physical) in the US for a period of 8 years. Our empirical approach is inspired by the framework provided by Hendricks and Sorensen (2009), who study the average spillover effect generated by a new album release in the music industry. We look at the sales of albums through DDC and PDC separately.

We show that the PYOP offer generated a positive impact on the digital albums, whereas its effect on physical CD sales is statistically insignificant. Furthermore, the increase in the sales through the DDC is mainly driven by the sales of In Rainbows, which suggests that by providing In Rainbows for "free," Radiohead increased the sales of In Rainbows through the DDC.

3.1 The Data

Our data is obtained from Nielsen SoundScan,[31] and contains weekly sales of music albums both in the digital and physical (CD) forms in the United States from 13 June 2004 to 01 April 2012.

The album sales are reported separately for 106 designated market areas (DMAs). DMAs correspond to major metropolitan areas, such as Boston, New York, Los Angeles or Chicago.

from articles that were exclusively written on the band to ones that incidentally mentioned it.

[29] The peak that appears after the release of King of Limbs (in October 2011) was mainly due the rumor that Radiohead would play at Zucotti Park in Lower Manhattan, where the protests for Occupy Wall Street has started.

[30] See for example, Anderson and de Palma (2013) who argue that to overcome information congestion, and increase the likelihood reach consumers, advertisers need to "shout to be heard," that is, send ads in larger quantities. See also Cabral and Natividad (2014) who show that in the movie industry, being number one in the box office in the opening weekend leads to higher subsequent demand for the movie due to increased consumer awareness.

[31] Nielsen SoundScan, a market research firm that tracks music sales data from cash registers for a panel of 14,000 retail stores, both offline and online. Digital stores (a total of 51) include all major digital platforms such as iTunes, Amazon, Google, E-music, Rhapsody, etc. (See http://en.wikipedia.org/wiki/Nielsen_SoundScan)

The Control Group

We have selected a control group of 22 artists, whose listener base is the closest to that of Radiohead. We used the data provided by Last.fm, and selected 50 artists that were listed top in terms of their similarity to Radiohead.[32] We excluded Thom Yorke and Jonny Greenwood (who are listed with "super similarity" and "very high similarity," respectively) as they are Radiohead band members.[33] We also excluded the artists that no longer existed or did not release any new album during our observation period (i.e., between June 2004 and March 2012) and also those that had less than 1 million listeners (roughly less than 28% of the number of Radiohead listeners) listed by Last.fm.

The control group consists of the following 22 artists, listed with the higher similarity ranking to the lower: Sigur Ros, Portishead, Muse, Arcade Fire, Beck, Interpol, Björk, Placebo, Coldplay, The National, Kasabian, Gorillaz, Massive Attack, Artic Monkeys, Oasis, The Strokes, The Flaming Lips, The Smashing Pumpkins, The Verve, R.E.M., Franz Ferdinand, and Sonic Youth.[34] Below is the sales of Radiohead and the control group decomposed according to the sales channel.

Table 1: Sales through physical and digital channels (June 2004 - March 2012)

	Sales through PDC	Sales through DDC
Radiohead	2,485,722	722,771
	77.5%	22.5%
Control group	27,097,985	8,177758
	76.8%	23.2%

3.2 The Regression Model

Our empirical framework is based on the model provided by Hendricks and Sorensen (2009). Similar to Hendricks and Sorensen, we consider a 39-week "treatment window" that includes 13 weeks before and 25 weeks after the release of the new album.

First, we use the following regression equation to estimate whether the pre-release PYOP strategy has created any different effect on the artist's album sales than a conventional release:

[32] For each artist, Last.fm provides a list of "similar" artists, which is automatically calculated based on Last.fm Audioscrobbler users' listening habits. If a lot of Audioscrobbler users listen to some artist X, but also to artists Y and Z, Y and Z will be stated as similar to X. In 2009, Last.fm claimed 30 million users for its Audioscrobbler.

[33] See: http://www.last.fm/music/Radiohead/+similar. These 50 artists were listed in descending order of similarity: super similarity, very high similarity, high similarity, medium similarity, and lower similarity. Note that the list changes (slightly) overtime. We have selected the list on January 2012.

[34] See Appendix B for more information on the control group.

$$\Delta \ln Sales_{ijt} = \alpha_i + \eta_j + \mu_t + \rho_t + \sum_{s=-13}^{25} \gamma_s C_{it}^s + \sum_{r=-13}^{25} \beta_r P_{it}^r + \epsilon_{ijt}. \quad (1)$$

This model estimates the impact of a new album release on the percentage rate of change (from week to week) in total album sales by a given artist. The dependent variable $\Delta \ln Sales_{ijt}$ is the first difference of the logarithm of album sales (either in the form of physical CDs or digital files) by artist i, at region (DMA) j, at time (week) t.[35] We include a number of different fixed effects in order to control for potential omitted variable bias: α_i represents an artist fixed effect, η_j a regional (Designated Market Area) fixed effect, μ_t and ρ_t are the monthly and yearly time fixed effects. We have two sets of indicator variables, P_{it}^r and C_{it}^s. The variable of our interest, P_{it}^r, is a set of indicators equal to one if the release of In Rainbows was r weeks away from period t. Similarly, C_{it}^s is a set of indicators equal to one if the release of artist i's new album was s weeks away from period t. The two sets of estimated coefficients in Equation (1), γ_s and β_r, measure how an artist's album sales have changed around the time when the artist has released a new album. The coefficients β_r's represents the impact of the pre-release of In Rainbows with the PYOP strategy on Radiohead's total album sales. The coefficients γ_s's represent the impact of the conventional release of a new album in the control group on the artist's total album sales.

Then, to test whether the impact generated by the PYOP pre-release strategy compared to a conventional release is statistically significant, we run the following regression:

$$\Delta \ln Sales_{ijt} = \alpha_i + \eta_j + \mu_t + \rho_t + \sum_{s=-13}^{25} \theta_s T_{it}^s + \sum_{r=-13}^{25} \widetilde{\beta}_r P_{it}^r + \epsilon_{ijt}, \quad (2)$$

$$T_{it}^s = \begin{cases} 0 & \text{if } P_{it}^s = C_{it}^s = 0 \\ 1 & \text{otherwise} \end{cases}.$$

T_{it}^s is a set of indicator variables equal to one if the release of any albums was s weeks away from period t.

The coefficients $\widetilde{\beta}_r$'s in Equation (2) measure the change in sales that add on top of (or subtract from) the general increase in album sales in response to a new album release. In other words, if the coefficients $\widetilde{\beta}_r$'s are statistically significant and positive, then "the sales effect" introduced by In Rainbows must be greater than "the sales effect" of a new album's traditional release by a

[35] As suggested by Hendricks and Sorensen (2009), using the first difference of log sales allows to control for a possible relation between sales and release times.

comparable artist, and this difference must be statistically significant. Since there is a time lag between the pre-release of In Rainbows with the PYOP strategy and the sales of the album, we adjust the time indictor t in calculating T_{it}^s by subtracting the number of weeks of the lag (i.e., 12 weeks).

Our estimation of Equations (1) and (2) builds upon two crucial assumptions. First, the control group we have selected is a valid counterfactual of the treatment group. Second, similar to Hendricks and Sorensen (2009), we assume that in any given period, our treatment indicators (C_{it}^r, P_{it}^s, and T_{it}^s) are not correlated with the idiosyncratic sales shocks in that period, so that Equations (1) and (2) yield unbiased and consistent estimates.

4 Estimation Results

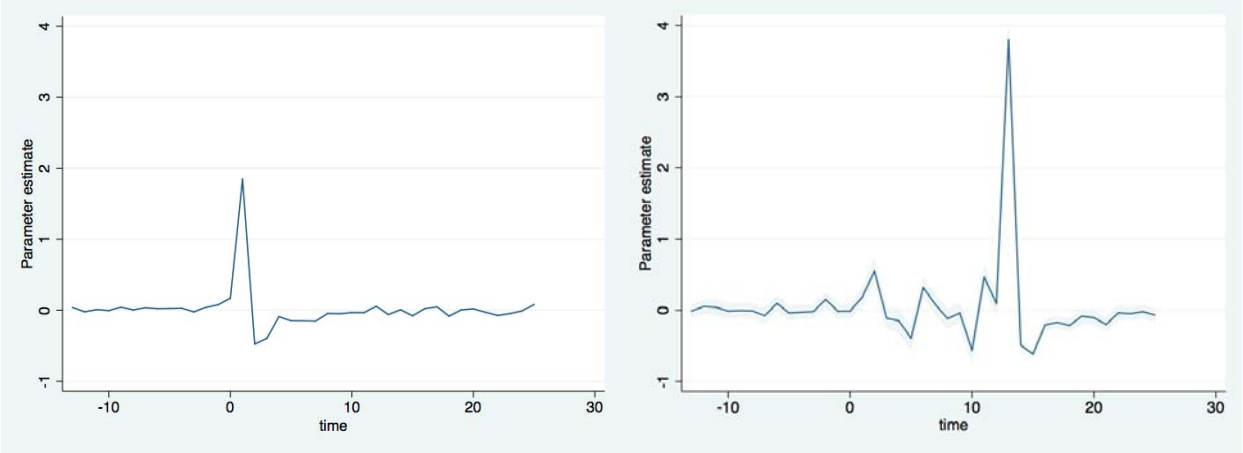
Due to the large number of estimated coefficients, we present our results graphically.

Figures 3 and 4 plot the estimated coefficients (i.e., the β_r's and γ_s's) from Equation (1), along with 95 percent confidence bands for digital and physical sales, respectively. The figures show that when an artist releases a new album, the total sales of the artist's albums rise. In the case of conventional album releases, the estimated coefficient at the "peak" is about 2 for digital album sales, as can be seen from Figure 3(a). This is translated as an increase in the digital album sales, which are about 7.4 times higher in the week of the release compared to the previous week. As shown in Figure 4(a), this observed "sales effect" for conventional releases is slightly greater for physical sales.

In the case of the PYOP pre-release strategy of In Rainbows, the coefficient in the "peak" is estimated to be about 3.7 for Radiohead's digital albums. This estimate suggests that Radiohead enjoyed an increase of about 40 times in its digital album sales compared to the week before.[36] Given that the increase in the change in the digital album sales are almost entirely driven by the sales of In Rainbows, this difference is remarkable, in particular because there are also unobserved sales of the digital album (through Radiohead's PYOP offer) during the 0-8 week window. The estimated change in the sales of Radiohead's albums through PDC, however, is not different than

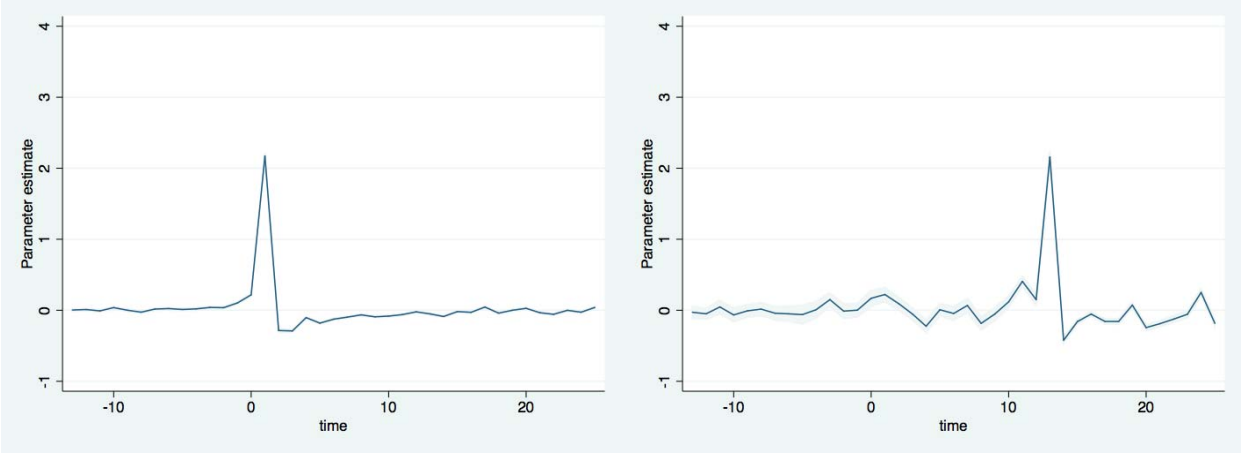
[36] Note that time "0" in 3(b) and 4(b) represents the pre-release of In Rainbows with the PYOP strategy in October 10, 2007. The PYOP offer was available during a 8-week window, followed by the release of the album (in both digital and physical form) on January 1, 2008 in the US. Therefore, during the window 0 to 12 weeks, there are no sales of In Rainbows, digital or otherwise.

the estimated change in the sales of the physical albums in the case of a conventional release.



3(a) Conventional release (γ_s) 3(b) With the PYOP offer (β_r)

Figure 3: Estimated changes in digital album sales with the release of a new album

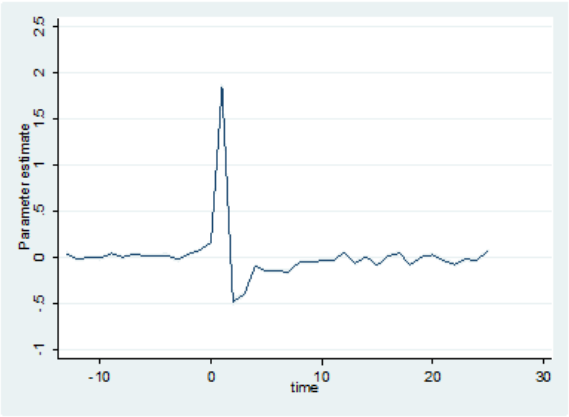


4(a) Conventional release (γ_s) 4(b) Pre-release with PYOP strategy (β_r)

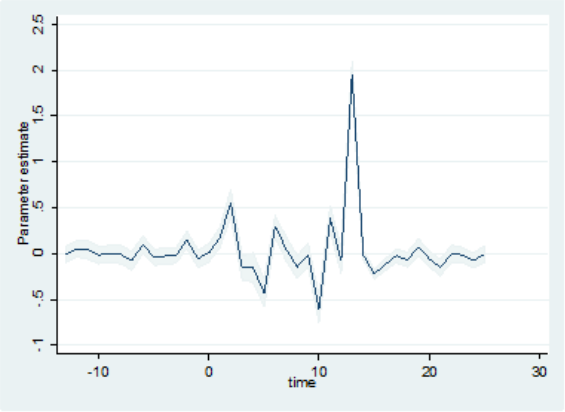
Figure 4: Estimated changes in CD album sales with the release of a new album

These findings are confirmed with the estimation results of Equation (2). Figures 5 and 6 show whether there is any statistical difference between the sales effect of the pre-release PYOP strategy of In Rainbow's and that of other albums by comparable artists. We see that the PYOP strategy had a minimal impact on the sales of the physical album. As far as digital sales are concerned, the pre-release PYOP strategy seems to have had a different impact than a conventional release strategy. The higher "jump" in album sales by Radiohead following the Radiohead's PYOP strategy

is statistically significant.

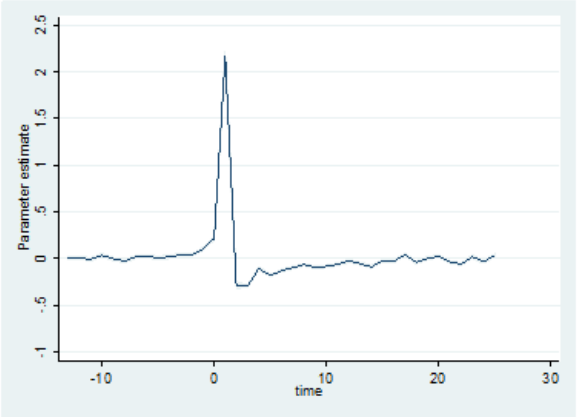


5(a) Common trend (θ_s)

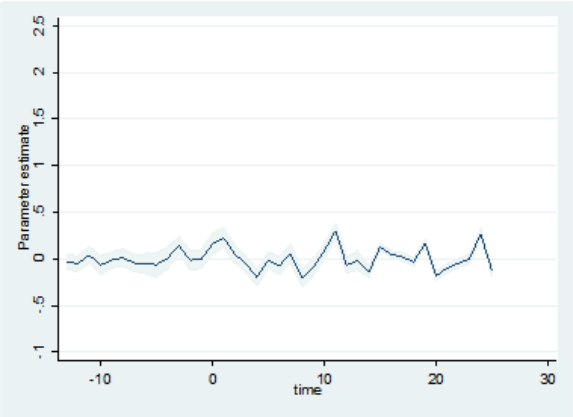


5(b) Additional trend with PYOP ($\widetilde{\beta}$)

Figure 5: The trend in the digital album sales following the release of a new album



6(a) Common trend (θ_s)



6(b) Additional trend with PYOP ($\widetilde{\beta}$)

Figure 6: The trend in the CD album sales following the release of a new album

Figure 7 shows the sales of In Rainbows and all Radiohead albums (including In Rainbows) through DDC and PDC from October 2007 to May 2008.[37] As the figures shows, the increase in the sales of Radiohead albums was mainly driven by the sales of In Rainbows and that there were no significant backward spillovers on the band's earlier albums. Since our analysis show that the PYOP release had no impact on the physical CD sales, this figure also suggests that the PYOP offer for digital In Rainbows has increased the sales of the same digital album provided through

[37] Note that since In Rainbows was released through DDC and PDC on January 2008, there are no sales of it prior to that.

the conventional channels.

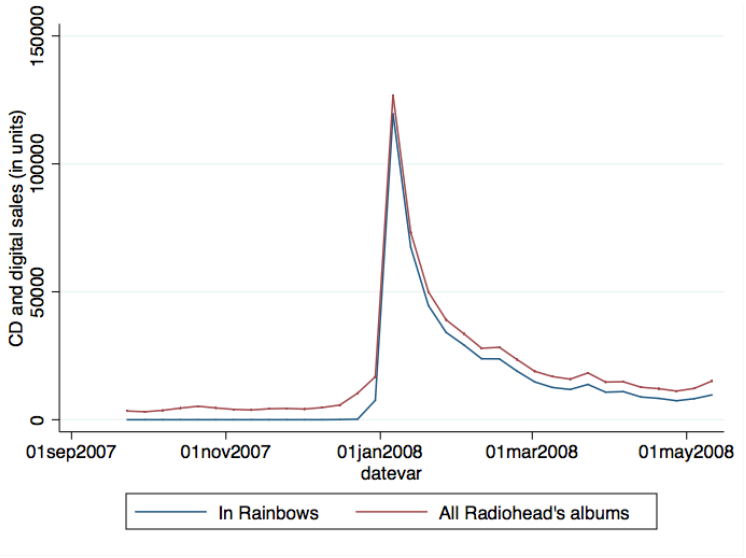


Figure 7: Sales of In Rainbows and all Radiohead (October 2007 - May 2008)

To sum up, our results indicate that the market expansion effect played a larger role for digital album sales than for CD sales. This is because the cannibalization effect of the PYOP offer (which has the opposite sign of the market expansion effect) is expected to be larger for the digital album sales due to a higher degree of substitution. Since we observe a positive impact of the PYOP offer on digital sales but none on CD sales, we can conclude that the market expansion effect for CD sales was not as prevalent as it was for digital sales. One possible explanation for this has to do with how the digital and CD markets are segmented. For example, age seems to be a determinant of consumers' choice of medium (digital or physical). Nielsen Soundscan and Billboard report (2012) points to the fact that consumers of 35 ages and over are most likely to be CD buyers, while consumers of 25 to 34 ages are most likely to be digital music buyers. It is possible that the "digital consumers" were more responsive to the media coverage of the innovative digital PYOP offer than the traditional CD consumers.

Robustness of the results

Difference-in-differences method We also performed a difference-in-differences (DID) estimation to test whether Radiohead's PYOP release strategy for *In Rainbows* had a different impact on the band's total album sales than a traditional album release. We obtain similar qualitative results than with our main analysis: the PYOP release strategy had a positive impact on Radiohead's

digital album sales; but it hardly had any effect on the band's CD sales.[38]

"Quality control group" To determine the control group, we selected artists that are similar to Radiohead, and we did not seek whether the albums produced by these artists were comparable to In Rainbows in terms of quality.[39] We also consider a subset of this control group ("quality control group"), which only contains the artists that have released at least one album of a similar quality to In Rainbows. To determine the quality of an album, we use a similar approach to the one adopted by Waldfogel (2012), and rely on critic-based data. Since our period of interest is rather recent, we use an annual listing of best albums (Pitchfork Top 50 Albums of the Year) along with three retrospective listings (Rolling Stones Best 100 Albums of the 2000's, Rolling Stones Best 500 Albums Ever (as of 2012), and Top 500 Albums on BestEverAlbums.com[40]). We also consider whether the album has received or was nominated for a Grammy Award (Album of the Year, Best Alternative Album, or Best Rock Album), and also take into account the consumer ratings provided by Amazon.com and i-Tunes. Our refinement criteria eliminates 10 of the 22 artists in our initial control group.[41] The empirical results with the "quality control group" are almost identical to those we obtained with the larger control group: the PYOP release of In Rainbows had a positive effect on the digital album sales, whereas the CD sales remained intact.

5 Does giving out music (almost) for free work for all?

> David Byrne: "And that works for you guys. You have an audience ready."
>
> Thom Yorke: "Well, yeah. (...) It's not supposed to be a model for anything else. It was simply a response to a situation. We're out of contract. We have our own studio. We have this new server. What the hell else would we do? This was the obvious thing. But it only works for us because of where we are."[42]

Since the PYOP offer has not been adopted by other similar artists, this is impossible to test for. However, Nine Inch Nail used a similar strategy to that of Radiohead and offered its digital

[38] See Appendix C for details.

[39] One could argue, for example, that the effects we find are due to the superior quality of In Rainbows and not to the PYOP release.

[40] BestEverAlbums.com uses 14,000 different greatest album charts to provide overall rankings for the best 1000 albums in history. We only mention those that are in Top 500.

[41] See Appendix D for our refinement criteria and the list of artists in the new control group.

[42] http://www.wired.com/entertainment/music/magazine/16-01/ff_yorke?currentPage=all

album for free. Although the release strategy used by Nine Inch Nails in 2008 is different than PYOP, the band gave the option to pay nothing to download the band's new album, The Slip.[43] We conduct a similar empirical analysis for the Nine Inch Nails' album releases and test whether the sales effects were any different than the conventional releases of the control group artists we define for Nine Inch Nails.

5.1 Where is Nine Inch Nail?

After their split with their record label, Interscope Records (part of Universal Music) in 2007, NIN released their new album, The Slip, with a similar strategy as Radiohead. The digital album was made available (with different DRM-free versions such as high quality MP3, lossless audio files) on May 5, 2008. In contrast to In Rainbows, the fans were not asked to name their own price—they could simply download the album for free.[44] The album was then released through conventional channels in July 2008. Different from the Radiohead's strategy for In Rainbows, the offer to download the album free did not end with its conventional release.[45] In June 2014, the digital album was still available for free download from the band's web site[46] (although, it was also sold at iTunes at $9.90).

To select the control group for NIN, we use the same criteria as the one we used for Radiohead.[47] The control group for NIN consists of: Marilyn Manson, A Perfect Circle, Tool, Queens of the Stone Age, Deftones, Korn, The Smashing Pumpkins, Massive Attack, Rob Zombie, and The Prodigy. Table 2 shows the sales of NIN and the control group decomposed according to the sales channel.

[43] Two months before releasing The Slip totally for free, Nine Inch Nails released another album, Ghosts I-IV, offering the first nine tracks (out of 36) for free. Since the latter album was available only partially for free, its release does not correspond to a PYOP offer.

[44] Those who downloaded the album had to provide a valid email adresss.

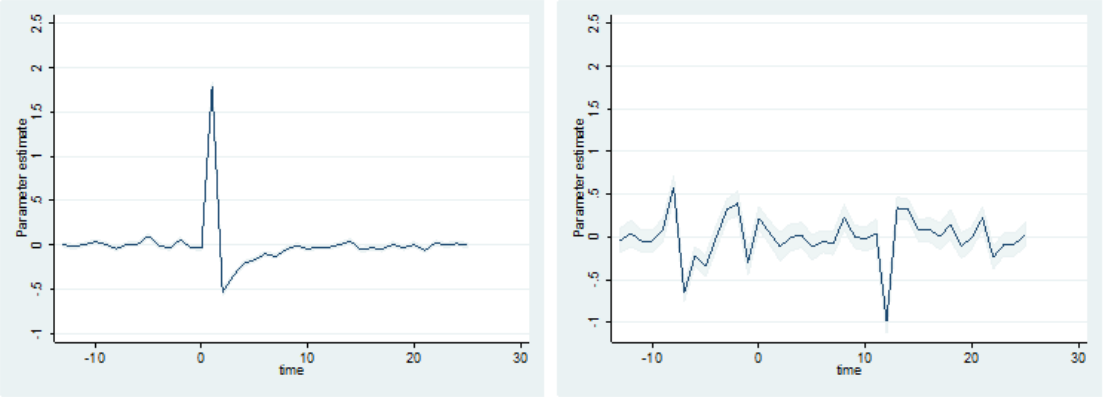
[45] NIN did not issue a statement on whether the offer was open-ended or not.

[46] See http://theslip.nin.com/.

[47] To take into account the difference in popularity between Radiohead and NIN, we included into NIN's control group all bands that had at least 28% of NIN's number of listeners on Last.fm, which corresponds to the same threshold ratio as for Radiohead's control group. See Table 7 in Appendix E for more information on the control group.

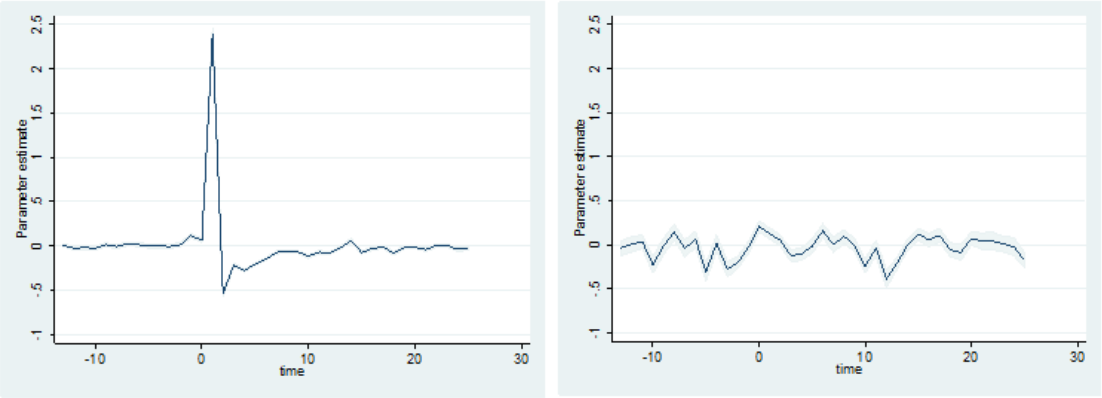
Table 2: Digital versus physical (CD) sales of music (in units)		
	Digital Sales	Physical Sales
Nine Inch Nail	368,282	2,775,334
	11.7%	88.3%
Control group	1,1790,684	18,097,039
	9.0%	91.0%
From June 13, 2004 to April 1, 2012		

Figure 8 shows that providing The Slip for free (in digital form) had a negative effect on NIN's digital album sales (compared to the conventional releases by the control group artists); the sharp drop in sales in Figure 8(b) is statistically significant. Figure 9 shows that there was no statistical difference between the effect of free digital release of The Slip on NIN's physical album sales and the effect of conventional releases on the physical album sales of the control group.



8(a) Common trend 8(b) Additional trend with the free release

Figure 8: The trend in the digital album sales following the release of a new album



9(a) Common trend

9(b) Additional trend with the free release

Figure 9: The trend in the CD album sales following the release of a new album

According to our findings, Radiohead's PYOP offer for (digital) In Rainbows and NIN's free provision of (digital) The Slip did not generate an effect on the bands' physical album sales any different than what they would have obtained with a conventional release. The impact on digital album sales of the respective bands was very different. By providing (digital) In Rainbows for "free," Radiohead increased its digital album sales (mainly driven by the sales of In Rainbows through DDC), whereas NIN's digital album sales were hurt by its provision of (digital) The Slip for free. Both Google Trends and Factiva searches with "Nine-Inch-Nails" (see Appendix E, Figures 12 and 13) show that the free release of The Slip did not generate a significant media attention compared to other events, including other album releases. This may explain why there was no market expansion effect (or it was sufficiently small and dominated by the cannibalization effect). Furthermore, a larger cannibalization effect for the The Slip may have taken place than that for In Rainbows (through DDC) as the offer for the former did not terminate upon its release through DDC, that is, at any given time, the consumers had the choice between buying the album through DDC and downloading it for free.

6 Conclusion

In this paper, we show that Radiohead's innovative pre-release strategy of In Rainbows benefited its album sales through digital distribution channels. The increase in Radiohead's digital album sales were mainly driven by the sales of In Rainbows, which suggests that the PYOP offer of In

Rainbows generated a market expansion effect (through extensive media attention) that dominated the cannibalization effect. Furthermore, the PYOP offer did not generate any effect on the physical CD sales. That is, market expansion and cannibalization effects have offset each other. Since we expect a smaller cannibalization effect on the CD albums (than on the digital albums), this suggests that the market expansion effect on physical CDs was also relatively small.

Radiohead's PYOP strategy for In Rainbows strategy proves to be a commercial success, at least for album sales. Even if one assumes that Radiohead has not obtained any revenues from the PYOP offer, the offer itself led to higher sales of the very same digital album.

Our analysis on the similar strategy adopted by NIN for its album The Slip show that by providing its digital album for free, NIN decreased its album sales through the digital distribution channels. In this case, market expansion effect seems to have been dominated by the cannibalization effect. Searches from both Google Trends and Factiva shows that the free release of NIN did not generate more attention than its other album releases, which may suggest a relatively small market expansion effect created by the offer. Furthermore, the free offer for The Slip did not end upon the release of the album through digital and physical distribution channels, which might have aggravated the cannibalization effect. Finally, similar to In Rainbows, the free release of the digital version of The Slip had no impact on the band's physical CD sales. That is, CD sales were not sensitive to the digital release strategies in these two examples.

References

Anderson, S. and A. de Palma, 2013, "Shouting to be Heard in Advertising," *Management Science*, 59(7), 1545-1556.

Biyalogorsky, E. and P. Naik, 2003, "Clicks and Mortar: The effect of on-line activities on off-line sales," *Marketing Letters*, 14(1), 21-32.

Belleflamme, P. and M. Peitz, 2012, "Digital Piracy: Theory," M. Peitz and J. Waldfogel, eds., *The Oxford Handbook of the Digital Economy*, Oxford University Press, 489-530.

Cabral, L. and G. Natividad, 2014, "Box-Office Demand: The Importance of Being #1," mimeo.

Chesbrough, H., 2010, "Business Model Innovation: Opportunities and Barriers," *Long Range Planning*, 43, 354-363.

Danaher, B., S. Dhanasobhon, M. D. Smith and R. Telang, 2010, "Converting Pirates without Cannibalizing Purchasers: The Impact of Digital Distribution on Physical Sales and Internet Piracy," *Marketing Science*, 29(6), 1138-1151.

Elberse, A. and J. Bergman, 2008, "Radiohead: Music at Your Own Price (A) and (B)," Harvard Business School, 9-508-110/111.

El Harbi, S., G. Grolleau and I. Bekir, 2014, "Substituting piracy with a pay-what-you-want option: does it make sense?" *European Journal of Law & Economics*, 37(2), 277-297.

Fernandez, J. M. and B. Nahata, 2009, "Pay What You Like?" Working Paper.

Garland, E., 2009, "The 'In Rainbows' Experiment: Did It Work?", http://www.npr.org/blogs/monitormix/2009/11/the_in_rainbows_experiment_did.html

Gentzkow, M., 2007, "Valuing New Goods in a Model with Complementarity: Online Newspapers," *American Economic Review*, 97(3), 713-744.

Gopal, R. D., S. Bhattacharjee and G. L. Sanders, 2006, "Do Artists Benefit from Online Music Sharing?" *The Journal of Business*, 79(3), 1503-1533.

Gneezy, A., U. Gneezy, L. D. Nelson and A. Brown, 2010, "Shared social responsibility: A field experiment in pay-what-you-want pricing and charitable giving," *Science*, 329, 325-327.

Gneezy, A., U. Gneezy, G. Riener and L. D. Nelson, 2012, "Pay-what-you-want, identity, and self-signaling in markets," *Proceedings of the National Academy of Sciences*, 109(19), 7236-7240.

Hammond, R. G., 2013, "Profit Leak? Pre-Release File Sharing and the Music Industry", *Southern Economic Journal*, forthcoming.

Hardesty, L., 2008, "The tipping jar: Radiohead is messing with the business of music," *Technology Review*, January/February 2008.

Hendricks, K. and A. Sorensen, A., 2009, "Information and the Skewness of Music Sales," *Journal of Political Economy*, 177(2), 324-369.

Isaac, R. M., J. P. Lightle and D. A. Norton, 2010, "The Pay-What-You-Like Business Model: Warm Glow Revenues and Endogenous Price Discrimination," working paper.

Kim, J.-Y., M. Natter and M. Spann, 2009, "Pay what you want: A new participative pricing mechanism," *Journal of Marketing*, 73, 44-58.

Leeds, J., 2007, "In Radiohead Price Plan, Some See a Movement," *The New York Times*, October 11, 2007.

Ma, L., A. L. Montgomery, P. V. Singh and M. D. Smith, 2013, "The Effect of Pre-Release Movie Piracy on Box-Office Revenue," *Information Systems Research*, forthcoming.

Morrow, G., 2009, "Radiohead's Managerial Creativity," *Convergence: The International Journal of Research into New Media Technologies*, 15(2), 161-176.

Page, W. and E. Garland, 2008, "In Rainbows, on Torrents," *Economic Insight*, Issue 10.

Pareles, J., 2007a, "Radiohead, Big Enough to Act Like a Baby Band," *The New York Times*, October 11, 2007.

Pareles, J., 2007b, "Pay What You Want for This Article," *The New York Times*, December 9, 2007.

Peitz, M. and P. Waelbroeck, 2006, "Why the music industry may gain from free downloading — The role of sampling," *International Journal of Industrial Organization*, 24(5), 907-913.

Regner, T. and J. A. Barria, 2009, "Do consumers pay voluntarily? The case of online music," *Journal of Economic Behavior & Organization*, 71, 395-406.

Shiller, B. and J. Waldfogel, 2011, "Music for a Song: An Empirical Look at Uniform Song Pricing and its Alternatives," *Journal of Industrial Economics*, 59(4), 630-660.

Varian, H. R., 2005, "Copying and Copyright," *The Journal of Economic Perspectives*, 19(2), 121-138.

Waldfogel, J., 2007, "Lost on the Web: Does Web Distribution Stimulate or Depress Television Viewing?" *Information Economics and Policy*, 21(2), 158-168.

Waldfogel, J., 2010a, "Music file sharing and sales displacement in the iTunes era," *Information Economics and Policy*, 22(4), 306–314.

Waldfogel, J., 2010b, "The four P's of digital distribution in the Internet Era: Piracy, Pricing, Pie-Splitting, and Pipe Control," *Review of Economic Research on Copyright Issues*, 7(2), 3-20.

Waldfogel, J., 2012, "Copyright Protection, Technological Change, and the Quality of New Products: Evidence from Recorded Music since Napster," *Journal of Law and Economics*, 55(4), 715-740.

Appendix

Appendix A: Sales through Physical and Digital Distribution Channels

Table 3: Sales of Radiohead Albums in the US

	Release	Sales (1993-2012)			Ratio
	(US)	PDC	DDC	Total	Digital/Total
Pablo Honey	April 1993	1,194,728	27,477	1,222,205	0.02
The Bends	April 1995	1,297,250	67,150	1,364,400	0.05
OK Computer	July 1997	2,192,560	94,898	2,287,458	0.04
Kid A	October 2000	1,277,525	61,240	1,338,765	0.05
Amnesiac	June 2001	930,390	27,650	958,040	0.03
Hail to the Thief	June 2003	1,027,701	28,697	1,056,398	0.03
In Rainbows	January 2008	596,138	233,211	829,349	0.28
King of Limbs	March 2011	193,422	90,591	284,013	0.32

Appendix B: Control Group for Radiohead

Table 4: Radiohead and the control group – Album sales and audiences

Artist	S.R.	Physical Sales	Digital Sales	DS/TS	Listeners	Alb04	Alb04-12
Radiohead		2,485,722	722,771	0.23	3,594,607	6	2
Sigur Ros	1	572,898	221,372	0.28	1,483,005	3	2
Portishead	2	375,571	157,441	0.30	1,584,999	2	1
Muse	3	2,004,407	652,493	0.25	3,039,987	3	2
Arcade Fire	4	1,073,319	797,902	0.43	1,734,044	0	3
Beck	5	1,885,113	365,220	0.16	2,158,016	7	3
Interpol	6	877,320	202,033	0.19	1,757,877	1	3
Björk	7	656,908	134,050	0.17	1,669,251	5	3
Placebo	8	219,908	54,392	0.20	2,142,056	4	2
Coldplay	9	7,917,734	2,601,404	0.25	3,881,893	2	3
The National	10	324,434	357,495	0.52	1,009,343	2	3
Kasabian	11	150,266	44,417	0.23	1,780,761	0	4
Gorillaz	12	2,963,338	459,315	0.13	2,588,968	1	3
Massive Attack	13	266,669	159,163	0.38	1,907,920	4	1
Artic Monkeys	14	545,424	231,946	0.30	2,230,738	0	4
Oasis	15	853,988	190,231	0.18	2,685,630	5	2
The Strokes	16	685,952	290,468	0.30	2,371,623	2	2
The Flaming Lips	17	771,418	198,002	0.20	1,309,429	10	3
The Smashing Pumpkins	18	1,353,668	301,779	0.18	2,121,075	6	2
The Verve	19	188,150	66,190	0.26	1,481,716	3	1
R.E.M.	20	1,616,597	425,637	0.21	2,156,128	12	3
Franz Ferdinand	21	1,312,873	170,786	0.12	2,470,687	1	2
Sonic Youth	22	482,030	96,022	0.17	1,214,194	13	2

Note: S.R.: Similarity Rank; DS: Digital Sales; TS: Total Sales; Alb04: Albums released prior to 2004; Alb04-12: Albums released between 2004-2012.

Source: Sales data: Nielsen SoundScan; SR, Listeners: Last.fm (as of Jan. 2012)

Appendix C: Difference-in-differences analysis

We compare the sales effect of *In Rainbows*'s PYOP release strategy to the sales effect of a traditional release with the difference-in-differences (DID) method. For the DID estimation, we define Radiohead's *In Rainbows* as the treatment group. The control group includes the albums of the artists that are similar to Radiohead. The treatment is the release of an album. Similar to our main analysis, we adopt a 39-week treatment window, beginning 13 weeks before the release of the new album and finishing 25 weeks afterwards. We then estimate the following model,

$$\ln Sales_{ijt} = \mu_0 + \alpha D_i + \theta T_{it} + \widetilde{\beta} D_i T_{it} + \epsilon_{it}, \tag{3}$$

where $D_i = 1$ if the artist is Radiohead, and $D_i = 0$ otherwise, and T_{it} is a post-treatment period indicator variable (i.e., $T_{it} = 1$ if at date t artist i has released an album in the last 25 weeks, and $T_{it} = 0$ otherwise). To capture only the differences between the treatment (*In Rainbows*'s PYOP release strategy) and the control group, we ignore the release of *The King of Limbs* for Radiohead when we build the T variable for the band.

Our coefficient of interest is the coefficient of interaction between D_i and T_{it}, that is, $\widetilde{\beta}$. The dependent variable $\ln Sales_{ijt}$ corresponds to the logarithm of either digital sales or CD sales of artist i, in MSA region j, and week t.

We ran equation (3) separately for digital and CD sales. The table below shows the estimation results, with and without time and region fixed effects. Column (1) shows the results for digital sales, without fixed effects. The coefficient of interest is the coefficient of $D_i \cdot T_{it}$ in column (1), which is significant and positive. It suggests that *In Rainbow*'s PYOP release strategy resulted in about 150 percent higher digital sales than a traditional release by a comparable artist. This estimated effect is quite robust and only slightly decreases to 122 percent when we control for time and region heterogeneities in column (2).

The results look different for CD sales—see columns (3) and (4). The estimated coefficient in column (3) is significant and positive. According to this estimation, *In Rainbow*'s PYOP release strategy resulted in about 28 percent higher CD sales than the traditional release of a comparable artist. The estimated coefficient becomes however insignificant when we include time and region fixed effects in column (4).

Table 5: Estimated coefficients for digital and physical sales

	Digital sales		CD sales	
	(1)	(2)	(3)	(4)
D	-0.304***	-0.408***	1.481***	1.387***
	(0.022)	(0.019)	(0.031)	(0.014)
T	0.728***	0.672***	1.135***	1.156***
	(0.006)	(0.004)	(0.007)	(0.006)
$D \cdot T$	1.498***	1.221***	0.281***	0.035
	(0.035)	(0.027)	(0.038)	(0.025)
Time fixed effects	No	Yes	No	Yes
Region fixed effects	No	Yes	No	Yes
N	199,493	199,493	199,457	199,457
R^2	0.072	0.506	0.112	0.421

Notes: (1) The dependent variable is log-transformed; (2) Standard errors in parentheses, *** $p < 0.01$.

Appendix D: "Quality Control Group" Selection

We select the artists that have released at least one album in our observation period that satisfies at least 3 of the 5 following criteria:

(i) Metacritic Metascore ≥ 80,

(ii) Metacritic User score ≥ 8.5,

(iii) Amazon ranking ≥ 4.0 *and* i-Tunes ranking ≥ 4.5 (as of May 2014),

(iv) Nominated or received a Grammy Award,

(v) Appeared at least on one of the following lists: "Rolling Stones Best 100 Albums of the 2000's," "Rolling Stones Best 500 Albums Ever" (as of 2012), "Pitchfork Top 50 Albums of the Year," "Top 500 Albums on BestEverAlbums.com."[48]

The albums that satisfy the selection criteria are marked with (*) in Table 6.

[48] BestEverAlbums.com uses 14,000 different greatest album charts to provide overall rankings for the best 1000 albums in history. We only mention those that are in Top 500.

Table 6: Radiohead and the albums of the "quality control group"

Artist	Album	M	U	A/iT	Grammy Award	Rolling S	Pfork	BEA
Radiohead	In Rainbows (2007)	88	9.2	yes	50^{th} BAA;nAY	30 ; 336	4	16
	The King of Limbs (2011)	80	7.8	no	54^{th} nBAA			274
Sigur Ros	Með suð í ... (2008)*	81	8.7	yes				464
Muse	The Resistance (2009)	72	8.2	no				332
Arcade Fire	Funeral (2004)*	90	9.4	yes	48^{th} nBAA	6 ;151	1	9
	Neon Bible (2007)*	87	8.8	yes	50^{th} nBAA	75	27	80
	The Suburbs (2010)*	87	8.8	yes	53^{rd} AY, BAA		11	39
Beck	Guero (2005)*	78	8.5	yes	48^{th} nBAA			
	The Information (2006)	73	8.5	yes				
	Modern Guilt (2008)	77	8.1	yes	50^{th} nBAA			
Interpol	Antics (2004)*	80	9.0	no			27	334
	Our Love to ...(2007)*	70	8.2	yes				
	Interpol (2010)	66	7.7	no				
Björk	Medúlla (2004)*	84	8.8	no	47^{th} nBAA		19	
	Volta (2007)	77	7.7	no	50^{th} nBAA			
	Biophilia (2011)	79	8.1	no	55^{th} nBAA			
Coldplay	X&Y (2005)	72	7.7	no	48^{th} nBRA			290
	Viva la Vida... (2008)*	72	8.1	no	50^{th} nAY	85		159
	Mylo Xyloto (2011)	65	7.1	no	55^{th} nBRA			
The National	Alligator (2005)*	82	9.3	yes				289
	Boxer (2007)*	86	9.0	yes			17	123
	High Violet (2010)*	85	8.8	yes			28	148
Gorillaz	Demon Days (2005)*	82	8.9	yes				154
	Plastic Beach (2010)	77	8.2	yes			35	405
	The Fall (2011)	67	6.1	no				

Table 6 continued

Artist	Album	M	U	A/iT	Grammy Award	Rolling S	Pfork	BEA
Arctic Monkeys	Whatever ... (2006)*	82	8.3	yes	49^{th} nBAA	41 ; 371		47
	Favourite Worst ... (2007)	75	8.3	yes				215
	Humbug (2009)	74	8.1	no				
	Suck It and See (2011)	76	7.8	no				
Franz Ferdinand	Franz Ferdinand (2004)*	87	8.5	yes	47^{th} nBAA	71		
	You Could Have... (2005)*	83	8.2	no	48^{th} nBAA		30	
	Tonight: Franz... (2009)	70	8.5	yes				
Sonic Youth	Rather Ripped (2006)*	82	8.7	yes				
	The Eternal (2009)	79	6.9	yes				

Notation **M:** Metacritic Metascore; **U:** Metacritic User score; **A/iT:** Amazon.com and i-Tunes criteria; **AY:** Grammy Album of the Year; **BAA:** Grammy Best Alternative Album; **BRA:** Grammy Best Rock Album (prefix **n** indicates that the album is nominated but did not receive the award); **Rolling S:** Rolling Stones listings (a single number indicates the rank in Best 100 Albums of the 2000's, second number indicates the rank in Best 500 Albums Ever); **Pfork:** Pitchfork Media Top 50 Albums of the Year listing (each number shows the albums ranking for the year in which the album is released); **BEA:** Top 500 Albums on BestEverAlbums.com

Figures 10 and 11 show our estimation results for digital and CD sales, respectively, with the "quality control group."

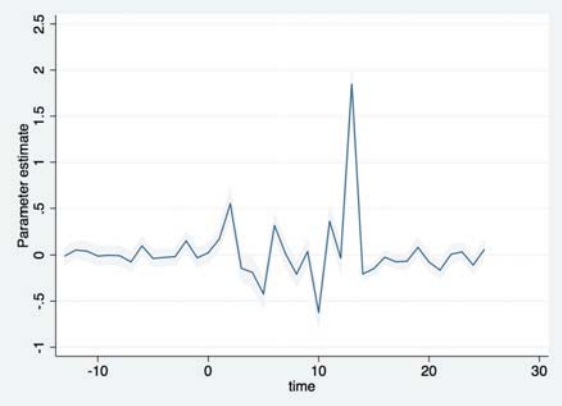


Figure 10: additional trend with PYOP ($\widetilde{\beta}$) in digital sales

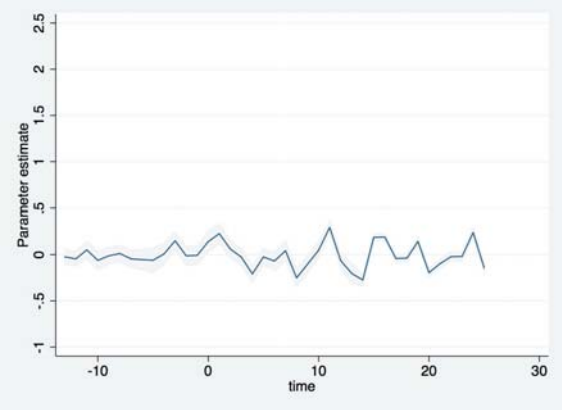


Figure 11: additional trend with PYOP ($\widetilde{\beta}$) in CD sales

Figures 10 and 11 are almost identical to Figures 5(b) and 6(b), respectively. The PYOP release generates higher digital sales than a traditional release, whereas it does not have any effect on CD sales.

Appendix E: Nine Inch Nails

Table 7: NIN and the control group

Artist	S.R.	Physical Sales	Digital Sales	DS/TS	Listeners	Alb-04	Alb04-12
Nine Inch Nails		2,775,334	368,282	0.12	1,666,578	4	4
Marilyn Manson	1	1,840,305	203,302	0.10	1,696,822	5	3
A Perfect Circle	2	1,388,073	175,083	0.11	1,293,013	2	1
Tool	3	3,384,856	4	0.00	1,380,539	3	1
Queens of the Stone Age	4	768,188	123,190	0.14	1,790,844	3	2
Deftones	5	1,074,869	193,858	0.15	1,300,162	4	2
Korn	6	5,265,918	421,104	0.07	2,008,589	6	4
The Smashing Pumpkins	7	1,353,668	301,779	0.18	2,121,075	6	2
Massive Attack	8	266,669	159,163	0.37	1,907,920	4	1
Rob Zombie	9	2,269,618	123,155	0.05	987,715	4	4
The Prodigy	10	452,875	90,046	0.17	1,641,688	3	3

Note: S.R.: Similarity Rank; DS: Digital Sales; TS: Total Sales; Alb04: Albums released prior to 2004; Alb04-12: Albums released between 2004-2012.

Source: Sales data: Nielsen SoundScan; SR, Listeners: Last.fm (as of Jan. 2012)

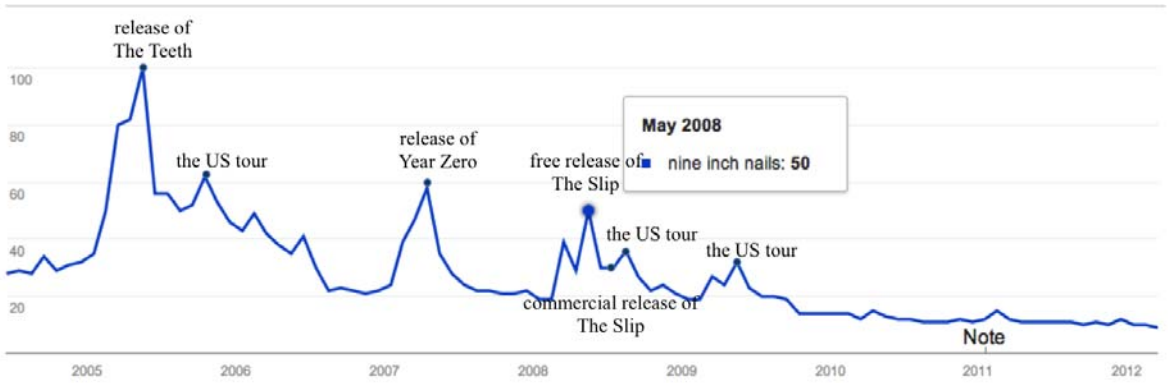


Figure 12: Google Trends in the US – Nine Inch Nails (June 2004 - March 2012)

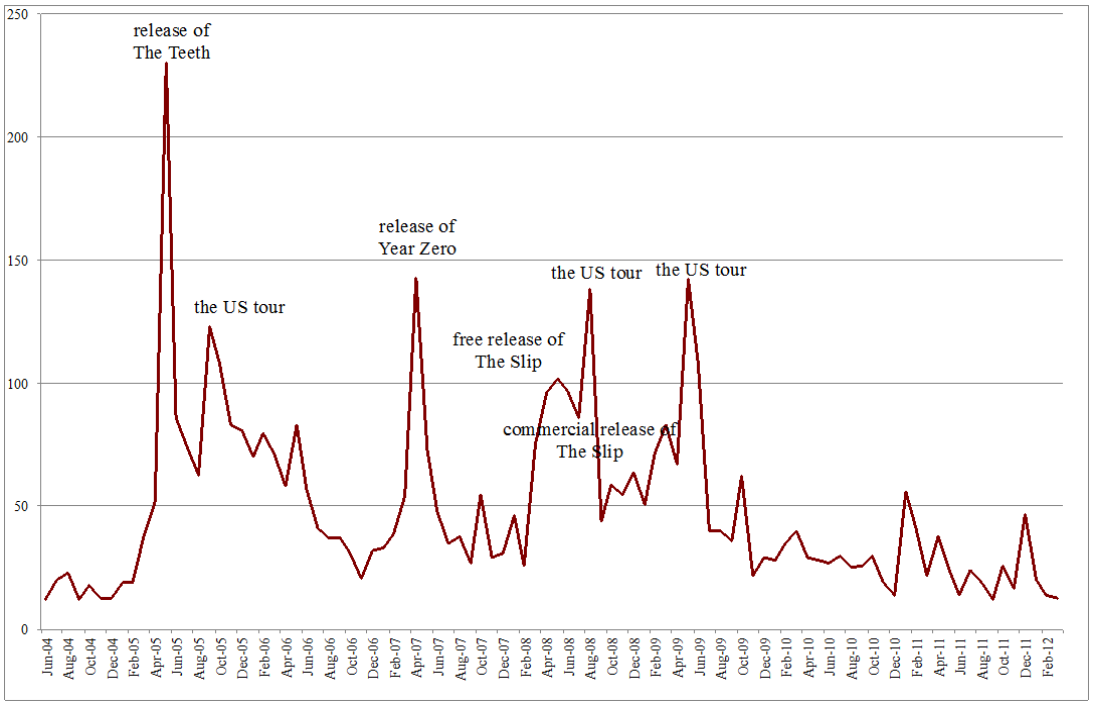


Figure 13: Nine Inch Nails in the US news; all Factiva sources (June 2004 - March 2012)