Before the
UNITED STATES COPYRIGHT ROYALTY JUDGES
THE LIBRARY OF CONGRESS
Washington, D.C.

In the Matter of	)	
DETERMINATION OF ROYALTY RATES FOR DIGITAL PERFORMANCE IN SOUND RECORDINGS AND EPHEMERAL RECORDINGS (*WEB IV*)	)	**Docket No. 14-CRB-0001-WR (2016-2020)**

TESTIMONY OF BRETT DANAHER
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I. QUALIFICATIONS

1. My name is Brett Danaher. I hold my PhD in Applied Economics from the Wharton School at the University of Pennsylvania, and I am currently a tenure track professor of Economics at Wellesley College. My research has focused on the digitization of the media industries and the challenges and opportunities that this has presented to firms and governments. My work is largely empirical, and I have been published in four different top peer-review journals; I have also written book chapters for National Bureau of Economics Research volumes. I have consulted for and worked closely with a major music label and the International Federation of the Phonographic Industry ("IFPI"), the Motion Picture Association of America and several major motion picture studios, a television network, and several other firms involved with digital media or copyright protection. My C.V. is attached as Appendix A.

II. BACKGROUND AND SUMMARY

2. I understand that a primary objective of the Copyright Royalty Board ("CRB") in setting royalty rates for non-interactive webcasters is to identify the rate to which a willing buyer

and willing seller would agree. I understand that, in identifying the rates a willing buyer and willing sellers would negotiate, Congress has directed the CRB to consider "whether the use at issue might substitute for, promote, or otherwise affect the copyright owners' stream of revenues." But to date there is no clear evidence (at least of which I'm aware) of the degree to which consumption of music through webcasting services substitutes for other forms of music consumption, such as digital downloads via iTunes, Amazon Digital Music Store, or sales of CDs or other physical media. In fact, it is possible that webcasting is actually an economic complement to paid digital downloads (that is, a decline in the price of webcasting, which increases the use of webcasting, could cause an increase in other music purchases). There are several reasons to expect that this could be the case:

a) Webcasting may expose individuals to music they would not have otherwise heard, connecting consumers with products that they would be willing to buy but would not otherwise have been aware of.

b) Even if a consumer is aware of a song, a common problem with music and other "experience goods"[1] is that consumers cannot know the value of the good until they have experienced it and thus can't make an informed purchase decision. Webcasting allows sampling of music and thereby helps enable consumers to value the good.

c) In the case of non-interactive services like Pandora and iHeartRadio (but unlike interactive services like Spotify,[2] and Soundcloud), webcasting is very much an imperfect substitute for purchasing music. When music is purchased, or with interactive services, the consumer can listen to any song she owns at any time. On non-interactive webcasting services, despite some customization, songs and ordering are chosen by a DJ

[1] Experience goods are goods whose characteristics (and thus their appeal) are known to the consumer only after consumption. The principles of such goods, and market problems associated with them, were first documented in Nelson, P., 1970. "Information and Consumer Behavior," 78(2) *Journal of Political Economy*, pp. 311-329.

[2] Some interactive services like Spotify also offer a more radio-like, non-interactive service such as Spotify radio. An important difference with these services is that at any time, the user can stop the radio service and choose to listen to any song she desires, unlike on Pandora and iHeartRadio.

or an algorithm (and are not known to the user in advance) and the potential for instantly hearing the song one wants is unavailable.

3. There exists very little empirical research on the impact of webcasting services on music purchasing behavior. I summarize that literature in section V. To the extent the existing literature has addressed this question, it tends to treat all webcasting services as a whole despite these strong theoretical reasons to think that non-interactive webcasting services might have a different impact on purchasing behavior than would interactive services. I was asked by counsel for iHeartMedia to analyze webcasting's impact on the market for digital downloads from an economic perspective using available economic data.

4. Specifically, I analyze the effect that increased use of webcasting has on purchasing behavior. Based on a robust data set, my main conclusion is that use of non-interactive webcasting services has a significantly more positive (or less negative) impact on digital song purchases than interactive webcasting services. This difference is well-identified and statistically significant at the 95% confidence level.

5. Separately, I also find evidence that non-interactive webcasting has a net positive impact on digital purchasing (90% confidence) and that interactive webcasting has a net negative impact on digital purchasing (99% confidence), although these results on the absolute impact of these services on purchasing are less well-identified than the former conclusion regarding the relative impact of these services. Based on my sample, I find that adoption of non-interactive webcasting services causes individuals to purchase 6 more songs on average than they would have otherwise bought, whereas adoption of interactive webcasting services causes individuals to purchase 15 fewer songs on average than they would have otherwise bought. All of these results are consistent with economic theory. Thus, my findings support the conclusion that, although interactive webcasting services may substitute for other forms of music purchasing, non-

interactive webcasting services substitute significantly less, if at all, and are less likely to lead to a decline in the market for digital downloads. They may even increase the size of this market.

III. DATA

6. The data for this study were provided by an anonymous Internet consumer panel tracking company, hereafter referred to as Tracker.[3] Tracker data come from a large, demographically representative sample of users who allow a small program to run in the background on their computers that enables Tracker to monitor things like visits to websites plus duration there, time spent using webcasting services, digital music purchases, etc. The data we received from Tracker are a portion of their US sample. They contain observations for 15,000 web users in each of six months, from November 2013 to April 2014. The sample was selected to include a large number of users with varying degrees of webcasting usage as well as a small sample of users with no webcasting usage. No other selection criteria were used to choose the sample from Tracker's panel. Appendix B provides further detail regarding the Tracker data used in my analysis.

IV. REGRESSION ANALYSIS

7. To measure the impact of webcasting on music purchasing, one approach would be an econometric model that performs a regression analysis comparing (by individual) the number of songs purchased with the time spent on non-interactive and interactive webcasting services, respectively, controlling for other variables that are likely to affect such purchasing.

[3] I regularly use Tracker data in my academic research. In my experience working with media data, Tracker produces high quality, accurate data, and they are an industry leader in tracking computer use at the individual level. Their data are regularly purchased by major media firms. The trends I observe in the Tracker data also agree with what I know to be true about the music industry in terms of seasonal patterns and correlations between modes of usage, giving me further reason to trust the data. My contract with Tracker prohibits me from revealing their name.

This approach is susceptible to bias, [4] however, and I therefore needed to develop a more sophisticated methodology that more accurately captured the effect of webcasting services on music purchasing.

8. My analysis begins with the observation that non-interactive webcasting services like Pandora and interactive webcasting services like Spotify are growing in the U.S. Every month, there are individuals who begin using these services for the first time, having been previously unaware of these services or at least how much utility they would receive from using them. If some individuals are not using these services and then "discover" them – for example, through advice from a friend or an advertisement online – then their subsequent uptake of these services can be viewed as a "random shock" to their webcasting use caused by the discovery event, and for that reason, the change in their music purchasing behavior can be causally linked to webcasting.

9. This does not necessarily mean that they had never heard of the service before. Rather, the assumption is that they had never used the service and some random event, like a friend's advice, tipped them over to using the service. Of course, just because an individual is observed not using a site like Pandora for one month does not mean that she has never used it before and has not already "discovered" it. She may have been on vacation or simply not had a

[4] Specifically, the problem with this approach is that, even including controls for visits to music interest sites and demographics, it is likely that there are unobserved variables (based on a users' taste for music, for example) that would be correlated with both webcasting usage and digital purchasing behavior, and it is not obvious how to control for such variables. A possible improvement would be a panel method that specifically asks if an individual, in months where that individual uses webcasting services more, purchases more or less music (as compared to changes in other consumers). But again, if an individual's taste for music is changing over time, this model would still be biased toward finding positive impacts of both interactive and non-interactive webcasting services on purchasing behavior. Indeed, I have run these models and mostly found positive coefficients on all the variables of interest, but as they are biased in a positive direction they are not worth reporting. These models would also be biased by the measurement error in time spent on each of these services.

taste for music that month. However, what if an individual is observed not using a service for the first three consecutive months in the data? In a situation like this, it seems more reasonable to assume that this individual was not previously a user of the service and that most of the time, if we see the user start to use the service in the second three months, this represents a "discovery" event.

10. We can partly test whether these adoptions are really discovery events unrelated to changing music taste. I observed 15,000 individuals with varying degrees of non-interactive webcasting usage. Certainly I do observe in the data some individuals who are using non-interactive webcasting early on but who eventually stop. However, do they come back? In other words, if three or more months of non-usage followed by a month with usage indicates a discovery event (and not just changing taste in music), then I should rarely observe users who start using the service, leave it for three months, but come back.

11. Assume that if one uses a webcasting service for more than 15 minutes in a given month, one is considered a webcasting user for that month.[5] In the data, I observe 2,765 individuals who used a webcasting service in the first month but then did not use it in months two, three, or four. In other words, these individuals started as webcasting users but "left" the service. Of these individuals, only 131 of them are observed as webcasting users in months five or six. In other words, of those who leave the service for three months or more, only 5% of them are observed coming back in my data. This fact is consistent with the assumption that if a user is observed with no webcasting use in the first three months, she probably has not been a user before (at or at least not for a long time), and if I observe her using webcasting services after

[5] I choose 15 minutes as a cutoff because I sometimes observe an individual with a few moments on Pandora in a given month. It seems incorrect to believe that this indicates they really used the service in any meaningful manner. However, results are generally similar if I choose another cutoff like 10 or 30 minutes (no more than 10% come back).

that, it is reasonable to interpret that use as a random shock caused by "discovery" of the service (unrelated to tastes for music). If adoption of webcasting was largely driven by changing taste for music, I should see individuals regularly dropping out of webcasting usage and coming back. This does not appear to be the case.

12. I thus divide the dataset into two periods where period 1 refers to the first three months and period 2 refers to the second three months. I aggregate the data for each individual to the period level, summing up minutes listening to non-interactive and interactive services, music purchases, and control variables for the period. I then limit the sample to only individuals who have no non-interactive webcast usage in period 1 and who are observed purchasing a song at least once.[6] I can then compare the change in purchases in the second period (relative to the first period) for the people who "discover" and start using non-interactive webcast services in the second period to the change in purchases for a "control" group who do not discover these services in period 2.[7] Thus, the "control" group who never uses non-interactive services tells me the natural or seasonal trend for music purchasing behavior and sets a baseline, which I can then compare to the change in purchases of people who begin to use non-interactive services in period 2.[8] Importantly, and as shown in Appendix C, people who adopt webcasting services

[6] Individuals with no purchases in any period make up 90% of the data. If I included them, all the variance in the right hand variables would appear to have no impact, biasing all coefficients toward 0. But individuals who have 0 propensity to purchase are of little interest in this study, and so I drop these users for this model.

[7] In period 1, I consider an individual a non-user of webcasting only if they literally show 0 minutes of usage – this is to ensure that any subsequent usage is truly a new adoption. However, in period 2, I consider an individual a webcasting user if they use it for over 1 hour and a non-user otherwise. There are many individuals who show just a few minutes of webcasting use in a single month, but it seems unreasonable to call this an adoption and assume it could have any impact on purchasing. My results hold if I choose 90 minutes or 30 minutes as the cutoff to indicate an adoption of the service.

[8] This econometric approach to infer causality in the case of a new technology diffusing across the population has been used in prior, peer-reviewed and published literature. Waldfogel, J. and

during this period are statistically similar to the people who do not, eliminating the worry that this group is different and might have different seasonal trends in behavior.

13. The results of my analysis are presented in the table below. Appendix C contains additional information regarding the model used to perform this analysis.

Table 1: OLS Regression Results

	(i)	(ii)	(iii)
Period 2	-3.008	0.043	-2.184
	(2.53)	(1.00)	(3.05)
WebRadioUser * Period 2	5.952+		5.065
	(3.45)		(3.99)
Streaming User * Period 2		-15.309*	-10.147+
		(3.61)	(6.17)
Streaming Time	-0.197*		
	(0.07)		
Web Radio Time		0.708	
		(0.48)	
Music Site Visits	0.700+	0.862*	1.540**
	(0.42)	(0.27)	(0.70)
Constant	11.084*	11.106*	10.308*
	(1.24)	(0.85)	(1.42)
Observations	588	2028	486
Users	294	1014	243
Users who discover in period 2	154	78	
R-squared	0.524	0.553	0.517

Standard errors in parentheses
+ significant at 10%; ** significant at 5%; * significant at 1%

14. The results in column (i) demonstrate the following. The estimate on the "period 2" variable indicates that, for users in my dataset who never adopted non-interactive services, purchases were down by approximately 3 songs in the second period. However, if a

L. Chen, 2006. "Does Information Undermine Brand? Information Intermediary Use and Preference for Branded Web Retailers." *Journal of Industrial Economics*, Vol. 54, No. 4, pp. 425-449.

user discovered and began using non-interactive webcasting in period 2, then that user purchased approximately 3 more songs in period 2 than in period 1, which is an increase of approximately 6 songs over the control group. Thus, the results imply that adoption of non-interactive webcasting services, if seen as a random shock of discovery, caused individuals to buy 6 more songs than they would have otherwise bought. Although the restrictions to the sample to run this model bring the user base down to 294 users, the effect is statistically significant with 92% confidence.

15. In column (ii) the results for the interactive services adoption experiment are quite different. The coefficient for the treated users in the second period is negative and statistically significant with 99% confidence. It implies that when a user adopts interactive webcasting services in the second period, she purchases 15 fewer songs on average than if she had not adopted. Note that the coefficient for interactive services is negative while the coefficient for non-interactive services is actually positive.

16. One might ask whether the model truly teases out the causal impact of adopting webcasting services on purchasing behavior. Perhaps there are unobserved variables changing at the individual level driving both adoption of webcast services and the number of digital purchases? I believe this to be unlikely based on the fact that if these unobserved variables exist, they should be causing individuals to leave and come back to webcasting services regularly. But as pointed out earlier, when an individual uses webcasting services but then shows no use for three months, she is very rarely observed using them again (in the remaining two months of data). Still, I cannot completely rule out that these unobserved variables driving adoption could exist, and that they might not be random (thus adoption was not a discovery event), and that they cannot be fully controlled for by visits to music interest sites. This would bias the coefficients in the positive direction.

17. However, if such a bias exists, it should exist for both the interactive webcasting model and the non-interactive webcasting model as well. Thus, a comparison between the coefficients (a triple difference), would difference out the impact of these variables, assuming they have similar impacts on adoption of both services. In column (iii) of Table 1, I limited the sample to only those individuals who did not use any webcasting service – interactive or non-interactive – in period 1 and who also purchase at least 1 song. Thus, with this sample I am able to test both effects – adoption of non-interactive and interactive services – in the same model and compare the two effects using an F-test. The results show the following: the adoption of non-interactive services has a similar impact as in column (i), though with lower statistical significance due to reduced sample size. The adoption of interactive services in the more limited sample indicates a negative impact on purchases, though not as negative as in column (ii). Most importantly, a two-tailed f-test of the hypothesis that the two coefficients in column (iii) are actually equal was rejected at the 95% confidence level (p-value = .04). Thus, we can say with at least 95% confidence that non-interactive services have a greater promotional effect (or at least lower substitutional effect) on the digital download market than interactive webcast services. This is the strongest and most compelling result, as any remaining unobserved heterogeneity (from adoption decisions that are not random) should be similar for the two types of services, and thus differenced out of a comparison between the two coefficients.

18. In summary, in this original research I obtained six months of consumer level panel data to analyze the impact of non-interactive and interactive webcasting services on music purchasing. Using a standard econometric model, I found strong evidence that non-interactive webcasting services were more promotional (or, at a minimum, less substitutional) to digital downloads than interactive webcasting services, and that this difference was statistically

significant with 95% confidence. Viewing an adoption of a service (after three months of non-use) as a random discovery event (uncorrelated with changing taste for music), I also found that the adoption of non-interactive services has a positive impact on digital purchases (with 90% confidence) while the adoption of interactive services has a negative impact (with 99% confidence). Finding a more promotional/less substitutional effect for non-interactive services than interactive services is consistent with economic theory.

19. I believe that this represents the best available evidence to date on the impact of webcasting on purchasing behavior for digital downloads. It also is largely consistent with the limited prior literature on the topic, which I discuss in the next section.

V. RELATED LITERATURE

20. There is other literature related to the relationship between webcasting and purchasing behavior. Most of this literature either fails properly to analyze this relationship, or is consistent with my analysis here.

21. According to reports from the IFPI, digital downloads still account for about two-thirds of all digital music revenues in the world. Digital download revenues fell for the first time in 2013, by 2.1%.[9] At the same time, revenues from webcasting services are growing. Similar trends are observed in the United States. This has led to various claims that webcasting is the cause for the decline in digital downloads.[10] But these claims confuse correlation with causation, and I am not aware of any evidence that has shown empirically that the growth in webcasting is the cause of the decline in digital downloads. Moreover, as demonstrated in my analysis above, when discussing webcasting it is necessary to differentiate between non-

[9] http://www.ifpi.org/news/music-subscription-revenues-help-drive-growth-in-most-major-markets.

[10] See, for example, http://www.forbes.com/sites/zackomalleygreenburg/2013/07/26/so-long-mp3-reports-reveal-rapid-growth-for-streaming/.

interactive and interactive webcasting services, because they are capable of having – and, as I show, in fact do have – very different impacts on music purchasing behavior.

22. A few researchers have previously attempted to empirically estimate the impact of particular webcasting services on digital downloads, although none of these working papers have yet been published in peer-reviewed journals.

23. Researchers in France used a survey of 2000 representative French consumers to argue that use of streaming sites like Spotify and YouTube had a positive impact on digital downloads, though it is unclear to me that their instrumental variable methodology was appropriate, and I suspect their results were biased to be positive.[11]

24. Economists at the European Commission used Clickstream data to analyze the impact of streaming on sales, though they measured streaming through clicks on streaming sites and purchases through clicks on digital download websites.[12] They found a very small positive impact of streaming on purchasing, but nowhere does their paper mention what they consider as streaming sites, so I do not know if non-interactive webcast services were considered or if only sites like Spotify and Soundcloud were considered. My research adds to theirs by examining the differential effects of non-interactive versus interactive services, as well as using the "adoption event" as an exogenous shock to webcasting – something they did not do. Also, I measure actual digital downloads, not clicks on digital download sites.

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[11] The researchers used an instrumental variable that I believe would not satisfy the exclusion restriction required for IV regression to isolate a causal effect. DangNguyen, G., S. Dejean, and F. Moreau 2012. "Are Streaming and Other Music Consumption Modes Substitutes or Complements?" Working paper available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2025071.

[12] Aguiar, L, and B. Martins 2013. "Digital Music Consumption on the Internet: Evidence from Clickstream Data." Working paper available at http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=6084.

25. In what I believe to be the best methodological approach, two economists used the removal of all Warner Music's content from YouTube in January 2009 (and its restoration in October 2009) as natural shocks to the amount of music streaming and find that removal of Warner's content from YouTube led to an increase in digital downloads (compared to a control group made up of music from the other major labels).[13] This implies that streaming on YouTube has a negative impact on digital music purchasing, and I believe this result to be consistent with my results because YouTube is much closer to an interactive service than a non-interactive service. Unfortunately, their approach did not allow for them to test the impact of non-interactive services.

26. My research is the first of which I am aware to explicitly test the impact of non-interactive webcasting services on digital downloads and to compare this to interactive webcasting services. I believe this difference to be of significant importance to the Webcasting proceedings.

27. There is, however, one other related piece of research that I believe to have findings that are consistent with mine. Joel Waldfogel (of the University of Minnesota) has a distinguished record of research into the economics of digital media. In one of his papers, he finds that since the digitization of the music industry, sales have been less concentrated amongst the most popular albums and are more distributed into the "long tail."[14] Correspondingly, the percent of successful albums coming from the 3 (or 4, before Universal's acquisition of EMI)

[13] Hiller, R., and Kim, JH, 2014. "Online Music, Sales Displacement, and Internet Search: Evidence from YouTube." Working Paper available at http://faculty.fairfield.edu/rhiller/Research/OnlineMusicandSalesDisplacement.pdf.

[14] Waldfogel, J. 2012. "And the Bands Played on: Digital Disintermediation and the Quality of New Recorded Music." Working Paper available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2117372.

major music labels has declined as independent labels have found greater success. Waldfogel points out that music production has always been characterized by great uncertainty, and thus many released albums are unsuccessful and many unreleased albums would have been successful if they had been released. He presents evidence that non-interactive webcasting services have significantly diminished the cost of promoting an album, making it easier for small bands or labels to release and promote an album using these services, and some of these albums find great commercial success. He documents that web radio plays tracks from a number of albums that do not get play on traditional promotional channels like terrestrial radio (albums from the "long tail," for example), providing an avenue for consumers to connect with and discover this music. Combined with the fact that a larger number of commercially successful products are coming from independent labels and albums that are not getting airplay on traditional broadcast radio, the most logical conclusion is that non-interactive webcasting services are helping to increase competition in an industry that has long been characterized by significant concentration. As well, Waldfogel's results, while answering a different question than my research in this report, are consistent with my results. Non-interactive services are promoting digital downloads (or at least having a significantly less detrimental impact than interactive services), and part of this is through exposing consumers to songs and albums that they would otherwise never have been made aware of or had a chance to sample.

I declare under penalty of perjury that the foregoing is true and correct.

Brett Danaher

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10/6/14

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Last updated September 2014

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ACADEMIC POSITIONS:

Visiting Research Professor – Heinz School, Carnegie Mellon	Jan 2015-
Assistant Professor - Department of Economics, Wellesley College	2010-
Post-doctoral Fellow – Heinz School, Carnegie Mellon	2009-2010

EDUCATION:

Ph.D. Applied Economics	**Wharton School, University of Pennsylvania**	2010
B.S. Economics	**Haverford College**	2000

PUBLICATIONS:

"An Empirical Analysis of Digital Music Bundling Strategies" with Yan Huang, Mike Smith, and Rahul Telang (*forthcoming, Management Science*)

"Converting Pirates Without Cannibalizing Purchasers: The Effect of Digital Distribution on Internet Piracy and Physical Channel Sales" with Samita Dhanasobhon, Michael Smith, and Rahul Telang. *Marketing Science.* INFORMS, vol 29(6), pp. 1138-1151.

"Gone in 60 Seconds: The Impact of the Megaupload Shutdown on Movie Sales" with Mike Smith *International Journal of Industrial Organization.* Vol 33, March 2014, 1-8 Lead article.

"The Effect of Graduated Response Anti-Piracy Laws on Music Sales: Evidence from an Event Study in France" with Mike Smith, Rahul Telang, and Siwen Chen. *Journal of Industrial Economics*. Vol. 62(3), September 2014, pp 541-553.

"Piracy and Copyright Enforcement Mechanisms*"* with Mike Smith and Rahul Telang (*NBER Innovation Policy and the Economy, Vol 14*)

"Understanding Media Markets in the Digital Age: Economics and Methodology" with Mike Smith and Rahul Telang (*NBER Economics of Digitization*)

WORKING PAPERS:

"Reel Piracy: The Effect of Internet Movie Piracy on Box Office Sales" with Joel Waldfogel

"Three Strikes Revisited: The Impact of New Zealand's Graduated Response Anti-Piracy Law on Digital Music Sales"

WORK IN PROGRESS:

"Plague or Panacea: Is Digital Music Streaming a Complement or a Substitute for Sales?"

"Optimizing Movie Release Windows: Evidence from a Natural Experiment"

"The Impact of Piracy Website Blocking on Media Consumption and Welfare"

"Content, Exclusivity, and Value: How Intense is Competition Between Television Distributors?"

"Google as Your Conscience: Does Internet Search Affect Consumer Propensity for Illegal Behavior?"

FELLOWSHIPS AND AWARDS:

NerdScholar 40 Under 40 "Professors Who Inspire"	2014
IDEA Research Grant, Carnegie Mellon University	2014
NBER Economics of Digitization and Copyright Research Grant	2013
Post-doctoral Fellowship, Carnegie Mellon University	2009
Research Grant, Center for the Analysis of Property Rights and Innovation, UT Dallas	2009
Ackoff Fellowship, Wharton School, University of Pennsylvania	2008

TEACHING:

Wellesley College, 2010 – present
- Introduction to Statistics
- Introduction to Microeconomics
- The Information Economy
- Industrial Organization

Wharton School, University of Pennsylvania, 2007-2009
- Managerial Economics, MBA Program
- Managerial Economics, Executive MBA Program

PROFESSIONAL ACTIVITIES:

Presentations

European Commission Copyright Conference	Brussels, Belgium	2014
University of Minnesota – Carlson School	Minneapolis, MN	2014
Workshop on Information Systems and Economics	Milan, Italy	2013
UC San Diego Rady School of Management	La Jolla, CA	2013
Motion Picture Association of America	Sherman Oaks, CA	2013
Statistical Challenges in E-Commerce Research	Lisbon, Portugal	2013
University of Delaware Economics Seminar	Newark, DE	2013
NBER Economics of Digitization	Salt Lake City, UT	2013
International Industrial Organization Conference	Boston, MA	2013
SOBACO Speaker Series, U. of Minnesota	Minneapolis, MN	2013
Federal Trade Commission Microeconomics Conf.	Washington, DC	2012
Workshop on Information Systems and Economics	Orlando, FL	2012
Global Music Forum, Canada Music Week	Toronto, Canada	2012
Intellectual Property Series, Osgoode Law School	Toronto, Canada	2012
Workshop on Information Systems and Economics	Shanghai, China	2011
Statistical Challenges in E-Commerce Research	Rio de Janeiro, Brazil	2011
DO&IT Seminar Series, University of Maryland	College Park, MD	2010
DISOM Seminar Series, University of Washington	Seattle, WA	2010
Workshop on Information Systems and Economics	Tuscon, AZ	2009
Carnegie Mellon Applied Economic Seminar	Pittsburgh, PA	2009
Society for Economic Research on Copyright Issues	Berkeley, CA	2009
Workshop on Information Systems and Economics	Paris, France	2008
Web 2.0 Workshop hosted by the ZEW	Mannheim,Germany	2008

Research Institutes

Initiative for Digital Entertainment Analytics (*contributing faculty)* Carnegie Mellon University

Referee Service

Management Science, Journal of Economic Behavior and Organization, Economic Inquiry, International Review of Law and Economics, American Review of Law and Economics, Review of Industrial Organization, Marketing Science, Information Systems Research, Management Information Systems Quarterly

Discussant Service

NBER Economics of Digitization Summer Workshop	2014
Workshop on Information Systems and Economics	2013
International Industrial Organization Conference	2013
Statistical Challenges in E-commerce Research	2013
Workshop on Information Systems and Economics	2008

Memberships
International Industrial Organization Society
Society for Economic Research on Copyright Issues (SERCI)
American Economic Association

NON-ACADEMIC EXPERIENCE:

Consultant – Clearchannel Communications	San Antonio, TX	2013-
Consultant – Disney Studios / Verance	Los Angeles, CA	2012-
Consultant – IFPI	London, UK	2010-2012
Consultant – EMI Music	New York, NY	2009-2010
Analyst - Vanguard Group.	Malvern, PA	2000-2003

APPENDIX B: DATA

The Tracker data provides, for each individual consumer, the following variables for each of six months.

1. Number of tracks purchased on iTunes or the Amazon digital store
2. Number of visits to key non-interactive webcaster websites and time spent on those websites:[1]
    a. Pandora.com
    b. iHeartRadio.com
3. Number of visits to key interactive webcaster websites and time spent on those websites:
    a. Spotify.com
    b. Soundcloud.com
4. Time with Spotify.exe open and running resident on computer
5. Visits to a large group of "music interest sites" and time spent on said sites[2]
6. Demographic information:
    a. Gender
    b. Household income
    c. Age

The manner by which these variables are tracked affects the interpretation of any econometric models run using the data. Visits to websites are counted precisely. Time on websites is calculated as follows: a user is considered active on a website if the user interacts with the website (i.e. clicks on something) within 30 minutes. If a user closes the site, the time stops counting. If the user does not click on something within 30 minutes, the clock stops counting until the users interacts again. For example, if a user logs on to Pandora to listen to music for 90 minutes and interacts with the site (to change a track, click approval or disapproval, browse within Pandora, etc.) at least once every 30 minutes, this count as 90 minutes of web radio. If, however, a user starts a Pandora station and listens to it for 90 minutes but without interacting with Pandora at all, this will count as only 30 minutes of web radio. As a result, usage of webcasting may be understated for some users, except in cases where the total time is under 30 minutes (in such a case the user could not have listened for more than 30 minutes). This is true for time on non-interactive webcasting websites and time on interactive webcasting websites.

[1] There are, of course, non-interactive services other than Pandora or iHeartRadio (such as Apple's iRadio) and other non-interactive services than those we studied. However, after speaking with Tracker, we chose these particular services to study as they are the largest and they capture the vast majority of their respective markets.

[2] A list of these sites can be found in Appendix D. They are generally comprised of song lyrics sites, music blogs, and music magazine websites.

For one interactive service that I study, Spotify, the primary way that users access the service is not on Spotify.com (though they can do so there) but through an app they install on their computers. The Tracker data measure the amount of time this app is open, which does not necessarily correlate to the time that music is being played. For example, if a user opens the Spotify app and plays music for 30 minutes and then stops listening to music but leaves Spotify running for another 3 hours, the data report 3.5 hours of interactive streaming. Although this has the potential to overstate the amount of Spotify usage that occurs, it still provides a useful and reliable binary indication of whether a given individual is an active Spotify user – if one observes a user with 0 minutes of Spotify time and then a positive amount of usage, this indicates a change from no listening to some listening. Nonetheless, the end result is that non-interactive webcasting use is likely underestimated in the data (since it all occurs on websites) and interactive webcasting use may be underestimated (when it occurs on websites like Spotify.com or Soundcloud.com) or overestimated (when it occurs on Spotify.exe).

For the purposes of this report, I define the following variables:

Time on non-interactive webcasting services includes total time spent on Pandora or iHeartRadio.

Time on interactive webcasting services includes total time using Spotify (through the app or the website) or Soundcloud.

Digital song purchases includes total number of songs purchased at iTunes or Amazon's digital store (a download of a 14 song album counts as 14 songs).

Visits to music interest sites includes total visits to any of the 42 sites I've designated as indicative of an interest in music. These sites are listed in Appendix D.

Table A.1 summarizes the mean and standard deviation for each variable across individuals aggregated for all six months,[3] although the variable measuring minutes on applications or websites are likely biased as described above.

[3] In the very rare case of missing values in the data (less than 1-2% of observations) I assume a value of 0 as I believe they indicate a lack of any use of the site in question.

Table B.1: Descriptive Statistics for Variables

	Non-interactive webcast hours	Used non-interactive webcast?	Interactive webcast hours	Used interactive webcast?	Song Purchases	Purchased any songs?
Mean	2.4	0.62	7.4	0.12	2.6	0.10
Std. Dev.	3.6	0.48	51.5	0.32	15.0	0.30
Conditional Mean (on some use)	3.3		61.8		25.7	
Std. Dev.	4.1		137.5		40.1	

In the data, 62% of people used non-interactive webcasting services for at least 1 hour over the six-month period. The reason that this number is high is because we asked Tracker to include a large percent of users in our sample who actually use these services. Tracker reported to us that of their total US sample, only 14% of individuals used non-interactive webcasting services over an hour during the six-month period. In the sample we received, the average individual used non-interactive webcasting service for 2.4 hours over the six months according to the data, however, this is an underestimate of actual time on webcasting for the reasons previously described in tracking website usage. 12% of individuals used interactive webcasting services for at least 1 hour with the average user observed at 7.4 hours. Conditional on having used interactive services for at least an hour, the mean usage is actually 62 hours. Again these numbers likely include an overstatement of time using Spotify.exe and understatement of time using Spotify.com and Soundcloud.com. 10% of the sample purchased at least 1 song during the period, with the average number of songs purchased being 2.6. However, among users who do purchase at least one song, the average number of purchases was 26 songs over the six months. One implication from this is that there is a large percentage of people who are not using webcasting services (either interactive or non-interactive) on their computers or paying for digital downloads. While digital music products and services is a rapidly growing market, it is far from ubiquitous.

A few demographics are also useful.

Table B.2: Demographics of Sample

Age	Percent	Income	Percent
18-21	9%	Below 15K	10%
21-24	11%	15-25K	9%
25-29	9%	25-35K	10%
30-34	10%	35-40k	6%
35-39	8%	40-50k	13%
40-44	10%	50-60k	10%
45-49	12%	60-75k	20%
50-54	11%	75-100k	14%
55-59	7%	100K +	8%
60-64	4%	*Mean*	$55k
65-74	5%	*Median*	$59k
75+	3%		
Mean	*41*	**Gender**	**Percent**
Median	*42*	Male	53%
		Female	47%

53% of the sample is male. The mean and median age are both in the low 40's while the median income is around $55k and the mean is almost $60k. Again, these statistics reflect the fact that the sample was chosen to include a wide range of webcasting activity. However, it is clear that many different ages and incomes are represented in the sample.

APPENDIX C: DETAILED MODEL

My models focus on the adoption event as the source of the treatment effect of webcasting services. But these services have been around for a while, and one might worry that people who are adopting in my sample are a different group of people than the control group and thus might have differential trends for other reasons.

The following table shows the average demographics for individuals who count as adopters (after three months of non-use) of non-interactive webcast services versus those who are not identified as adopters.

Table C1: Demographics of Adopters vs. Non-Adopters

		Income (thousands)	Age	Male
Non Interactive Webcasting	Adopters	$59.4	41	53%
	Non-Adopters	$56.3	40	50%
Interactive Webcasting	Adopters	$59.1	41	53%
	Non-Adopters	$61.4	40	56%

Generally, for either service, those who are identified as adopters in the regression are demographically similar to those who did not adopt during this period.

Following my description of the econometric methodology in section IV, the actual model I ran is described as follows:

$$Downloads_{it} = \beta_0 + \beta_1 Period2_t + \beta_2 Period2_t * NonIntUser_i + \beta_3 InteractiveTime_{it} + \beta_3 MusicSites_{it} + \mu_i + \varepsilon_{it}$$

$Downloads_{it}$ represents individual i's number of songs download during period t. $Period2_t$ is a dummy variable equal to 1 if the observation is for the second period. $NonIntUser_i$ is a dummy equal to 1 if the user is observed using noninteractive webcasting services in period 2 (recall that we are limiting the sample to only individuals who did not use noninteractive services in period 1). $InteractiveTime_{it}$ is a control variable for the amount of time user i used interactive webcast services during period t. $MusicSites_{it}$ represents the number of visits of user i during period t to sites on the music interest site list and is intended as a measure of the user's interest in music during that period. μi represents a vector of user fixed effects.

In parallel, I can specify a similar model to determine the impact of adoption of interactive webcasting sites sites on purchasing.

$$Downloads_{it} = \beta_0 + \beta_1 Period2_t + \beta_2 Period2_t * IntUser_i + \beta_3 NonIntTime_{it} + \beta_3 MusicSites_{it} + \mu_i + \varepsilon_{it}$$

For this model, I only include individuals who were not observed using interactive webcasting services during period 1 so that any use in period 2 signifies new discovery and adoption. OLS results are reported in Table 1 in the body of the report. Column (i) reports estimates for the experiment with users who discover non-interactive webcasting services and column (ii) reports estimates for the experiment with users who discover interactive webcasting services. An advantage of this approach is that I only use a binary variable for adoption of the service in question, and I believe that the Tracker data can accurately measure whether a person is using a service or not even if the amount of time using it is measured inaccurately.

Column (iii) results are generated from the following model:

$$Downloads_{it} = \beta_0 + \beta_1 Period2_t + \beta_2 Period2_t * IntUser_i + \beta_3 Period2_t * IntUser_i + \beta_3 MusicSites_{it} + \mu_i + \varepsilon_{it}$$

Where only individuals who exhibit no use of interactive **or** non-interactive webcasting services in period 1 are considered. This limits the sample, but allows for a statistical comparison of the two coefficients to each other in the same model.

APPENDIX D: MUSIC INTEREST SITES

Below are the sites that I designated as indicative of music interest in the "music site visits" variable. They are comprised of music blogs, music magazines, lyrics sites, top 40 charts, and concert ticket sites.

1. www.rollingstone.com
2. hypem.com
3. pitchfork.com
4. allmusic.com
5. azlyrics.com
6. songlyrics.com
7. lyricsworld.com
8. spin.com
9. mojo4music.com
10. billboard.com
11. officialcharts.com
12. top40-charts.com
13. tinymixtapes.com
14. daytrotter.com
15. consequenceofsound.net
16. residentadvisor.net
17. stereogum.com
18. thelineofbestfit.com
19. youredm.com
20. popjustice.com
21. dancingastronaut.com
22. drownedinsound.com
23. fakeshoredrive.com
24. allhiphop.com
25. edmsauce.com
26. blog.largeheartedboy.com
27. rapradar.com
28. 2dopeboyz.com
29. factmag.com
30. hypetrak.com
31. indieshuffle.com
32. thewildhoneypie.com
33. lyrics.wikia.com
34. lyrics.com
35. music-new.com
36. digitalmusicnews.com
37. cmt.com
38. theboot.com
39. countryweekly.com
40. popcrush.com
41. songkick.com

42. livenation.com