Don’t Play it Again Sam: Radio Play, Record Sales, and Property Rights

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Abstract:

This paper undertakes an econometric investigation of the impact of radio play on sales of sound recordings using a sample of American cities. The results indicate that radio play does not have the positive impact on record sales normally attributed to it and instead appears to have an economically important negative impact, implying that overall radio listening is more of a substitute for the purchase of sound recordings than it is a complement. This finding indicates that creating a set of property rights to allow this market to function properly is different than has been suggested by prior research. New technologies affecting radio broadcasts are likely to make this topic increasingly important in the coming years. This research also exposes a fallacy of composition in applying to an entire market a generally accepted positive relationship that holds for individual units.

It is well known that incomplete or missing property rights are likely to lead to wasteful exploitation of resources with their attendant deadweight losses. Coase (1960), of course, taught us that trying to ameliorate such problems through taxes and bounties was not a simple task.

When we think of instances of missing property rights we naturally gravitate toward the well known examples—air and water pollution, wild animals, traffic congestion—found in most economics textbooks. Our concern in this paper is with a case of incomplete property rights associated with a ubiquitous product that the average American uses for approximately three hours per day. That product is broadcast radio.

There are two aspects of the incomplete property rights surrounding the broadcast of recorded music although economists appear to have only been aware of one of them. The missing right recognized by economists is the inability of radio stations to charge owners of sound recordings for the broadcast of those recordings, an activity which is limited by statutes against 'payola'. Sound recording companies cannot legally pay radio stations to play particular sound recordings unless the stations accede to an onerous requirement of announcing the payment each and every time that sound recording is played. This restriction received extensive publicity in the 1950s when Congress held well-publicized hearings on this issue and this where the pejorative term payola, meant to describe payments from record companies to disk jockeys, was born.[1]

The missing property right that has not heretofore been recognized by economists is the inability of sound recording owners to restrict the broadcast of their sound recordings. Simply put, radio stations can broadcast sound recordings at will, with no permission required from the owners of the

[1] A reader interested in the tawdry details of payola can consult either Coase (1979) or Caves (2000). Coase provides detailed documentation about the lengthy history of the practice which existed well before the congressional hearings in the 1950s as well as details from the hearings. Caves covers much of the same information but also provides details of Dick Clark as a peerless payola pioneer that readers of a certain generation may find of interest.

sound recordings.[2] Yet the importance of music to these stations is readily revealed by the fact that radio stations are primarily described by the genre of sound recordings that they broadcast, whether it is Classic Rock, Hot Adult Contemporary, or Cool Jazz. There is virtually no economic analysis of this latter property right.

There have been, over the years, numerous news stories written about payola but only a handful of articles written by economists, among them Coase (1979), Sidak and Kronemyer (1987) and Caves (2000). These economists all lament the lack of property rights in this market, but their view of the missing property right is limited to the inability of record labels to directly pay radio stations, in an unfettered manner, for the possibly valuable promotional component of radio broadcast. These authors seem to have neglected the possibility that payments might also be made from radio stations to record companies for the possibly valuable exclusive right to broadcast certain songs that listeners wish to hear. A well-known analogy exists in the television broadcast market where broadcasters must legally acquire the rights to broadcast television programs owned by others and where broadcasters pay large sums for these rights.[3] The neglect of this possibility by previous economic writers may be due to the widely held belief that radio play is so beneficial to record sales that requiring radio stations to obtain permission to broadcast sound recordings would be irrelevant, in the same manner that a property right for goods that are not scarce would serve no useful role.

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[2] Owners of sound recordings in the United States do not have the legal ability to restrict the broadcasts of their sound recordings. In some countries owners of sound recordings have been provided a form of legal 'compensation' where radio stations must pay a fee for the use of sound recordings (with rates usually set by law or supervised by some quasi-judicial organization). Nevertheless, owners of sound recordings are not allowed to opt out of the system and engage in direct negotiations with radio stations, so there is no reason to believe that this system in any way approximates a market outcome. In contrast to the sound recording, radio stations in the US pay a "performance right" for the underlying musical compositions on the sound recordings broadcast by radio stations. The legal distinction is that performance rights payments go to composers and their publishers whereas the recording artist and record company do not receive any payments, although recording artists may be the composers and publishers may be owned by sound recording companies.

[3] The radio stations would need to acquire rights to broadcast particular sound recordings, the same way that television stations need permission to broadcast movies or television programs, and radio stations would be allowed to sell their possibly promotional services of broadcasting records on the radio to record companies.

Before we can write off the possibility that such a property right might in fact have a positive market value to radio stations in some circumstances, however, it would seem prudent to examine the impact of radio play on record sales. If radio play exerted a positive impact on overall record sales, consistent with assumptions, creating such a property right might well be superfluous. If radio play diminishes record sales, however, such a right may well be of value. Such a finding wouldn't rule out the possibility that payments might still go mainly from sound recording owners to radio stations, but it would make it far less likely.

While it seems likely that radio broadcasters can have a profound impact on the success of *individual* sound recordings, it does not appear, as Sidak and Kronemyer have commented, that anyone has empirically examined this proposition.[4] Even if radio broadcast does have the promotional impact on individual recordings normally assumed, it may not hold for the overall impact of radio broadcasts on the sound recording industry as a whole. As discussed below, there is a potentially important fallacy of composition in this market. To my knowledge there has been only a single examination of the impact of radio play on the overall market for sound recordings, Liebowitz (2004), which was a largely historical analysis.

The lack of a property right in the broadcast of sound recordings means we cannot discover the value of the right through direct observation. By way of analogy, we know through direct observation that television broadcasters place higher values on the right to broadcast movies than any possible positive value that movie owners might place on possible promotional impacts of television broadcasts (which, admittedly, seem likely to be negative for movie owners in terms of DVD sales).[5] It is easy to

[4] Sidak and Kronemyer state in their footnote 18: "There appears to be no published study confirming this complementary demand relationship, let alone estimating its empirical magnitude."

[5] Smith and Telang have examine the promotional impact of television broadcast on DVD sales and found it to be positive at the time of the broadcast and shortly afterward although they did not measure the impact on overall future sales. Nor do they examine the impact of television on the entire DVD market (there is ample evidence that the existence of television caused a dramatic decline in overall movie revenues, as found in Liebowitz 2004). Movie

observe that television stations pay positive prices for the rights to broadcast movies, and not vice-versa.[6] If there were a similar market for rights to broadcast music over radio we would know the impact of radio play by direct observation—we could examine whether and how much broadcasters might pay sound recording owners for broadcast rights. But there is no such market to turn to for such observation.

Is there a possibility that at a market based level the majority of the payments could go from radio stations to record companies for the right to broadcast recordings? The results below, where the overall impact of radio play on sound recordings is found to be negative, suggests that such a possibility is real. The currently known payments by sound recording owners to broadcasters might turn out to be similar to slotting fees paid by manufacturers which are common but do not overturn the fact that net monies flow from retailer to manufacturer and not the other way around.[7]

This issue will take on increasing importance in the near future due to a new generation of digital radio receivers—terrestrial, satellite, and Internet based—that are capable of making and storing copies of sound recordings. These receivers alter the typical "streaming" nature of radio, which has historically broadcast songs whose only trace remained in the memory of the listener. The new receivers allow users to automatically record digital songs, providing unlimited playback at the discretion of the user. This technology seems likely to exacerbate any negative impact on record sales from radio play, increasing (or making positive) the market price for the right to broadcast particular sound recordings.

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producers seem to believe that television broadcasts will cannibalize sales and it is hard to imagine that this belief is not correct.

[6] In contrast to record companies, movie owners are able to strictly control whether the station can broadcast the movie, when they can broadcast it, and for what price. Providing geographic exclusivity in these rights to single stations is common. Analyzing the historical reasons for this different set of rights granted to movie owners versus sound recording owners is beyond the scope of this paper, but several possibilities come to mind: 1) there was no copyright on sound recordings until 1971 so there was no right that could be sold and the current situation can be considered a form of grandfathering; 2) the belief that radio was beneficial to sound recording sales implied a zero or negative price; or 3) sound recording firms had less political power vis-à-vis radio broadcasters than did movie owners relative to television broadcasters and thus the sound recording owners were unable to secure for themselves the same set of rights as movie producers.

[7] For more information about slotting fees see Klein and Wright (2007).

There have already been several recent skirmishes between the sound recording and broadcast industries and we can expect more friction as these technologies mature.[8] This would seem, therefore, to be a propitious time to examine the nature of this interaction of radio on sound recordings.

I. A Brief History of Radio and Sound Recording

Radio and sound recordings have largely grown up together, with both industries reaching commercial viability early in the 20th century, although sound recordings came first. Thomas Edison is credited with creating the first sound recording in 1877 with a tinfoil recording process. Tinfoil was soon replaced with wax cylinders, leading to a long-forgotten standards battle between cylinders and disks (the disk system, known as the gramophone was developed by Emile Berliner). Just as VHS came later but nevertheless won its battle with Beta, disks came later but eventually won the day.

The first commercial American radio stations went on the air in late 1920. Numerous stations were borne in the next few years and by 1923 the number of stations was over 500, which remained the approximate number for the next fifteen years (Hazlett 1997).[9] In 1926 the penetration rate of radio was approximately 20%.[10] In those days both radio and sound recordings were more the provenance of the middle and upper classes than the lower class and the overall penetration rate of radio most likely severely underestimates the penetration rate of radio in sound recording households.

The market for sound recordings was surprisingly mature by the time of radio's entrance. For example, a magazine devoted to the sound recording industry (Talking Machine World) was established in 1905 and by 1920 monthly issues were averaging 200 pages.[11] Sound recording sales in 1921 were

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[8] I include satellite radio as a species of radio broadcast in this paragraph. An example of this friction can be found in the Washington Post, "Music Labels Sue XM Over Recording Device" Annys Shin, May 17, 2006; Page D01 at http://www.washingtonpost.com/wp-dyn/content/article/2006/05/16/AR2006051601826.html

[9] Reported in Figure 1 in Thomas Hazlett, "Physical Scarcity, Rent Seeking, and the First Amendment" *Columbia Law Review*, Vol. 97: 905-944. Hazlett's data are taken from Bureau of the Census.

[10] See Liebowitz (2004).

[11] See http://www.garlic.com/~tgracyk/tmw.htm.

more than $1.1 billion, measured in 2004 dollars, and the population was only slightly more than one third of the current population.[12] To put this value in perspective, constant dollar sales revenue per capita was actually slightly higher in 1920 than in 1950. An overview of the current music market that also touches on several of the issues raised in this paper can be found in Connolly and Krueger (2006).

Liebowitz (2004) examined the historical relationship between record sales and radio play for two periods: the introduction of radio in the US in the 1920s and the introduction of commercial radio in Britain in the latter decades of the 20th century. In the first instance record sales fell dramatically after the introduction of radio, and in the second case there was no evidence of a positive relationship between increased radio play of popular music and record sales. The current paper is an attempt to more directly and more precisely measure the current relationship between radio play and sound recordings.

II. The Possible Relationships between Radio and Sound Recordings

It is often claimed that radio has a beneficial impact on sound recording sales. While it is incontrovertible that radio can direct demand to particular songs that receive heavy airplay, the impact on individual songs is quite distinct from the impact on the entire industry, although this distinction has not been generally recognized.

The particular details of the overall impact of radio depend on two competing factors. On the one hand, radio allows users to experience new songs that they may not have previously heard. If this were the primary use of radio by listeners then radio could increase overall record sales. On the other hand, the time spent listening to radio is also capable of being a substitute for the time spent listening to prerecorded music. To the extent that broadcast radio is such a substitute, radio would be expected

[12] This number comes from correspondence with the Recording Industry Association of America (RIAA) as reported in Liebowitz (2004).

to harm overall record sales. Radio is capable of delivering both impacts and the relative strength of each would determine the overall impact.

A. What can we learn from statistics on music listening?

The bare statistics on time spent listening to various technological sources of music are informative in and of themselves. The average American spent five times as much time listening to radio per day than listening to traditional sound recordings in 2003, according to the US Statistical abstract.[13] These time-usage values seem incompatible with a hypothesis that radio is used primarily as a means to learn about new music for later purchase, since it would appear infeasible that consumers spend so much more time searching for new music then they spend in the ultimate act of music consumption. These statistics imply that radio is being used largely for its own consumption value.

Certainly, this line of thinking doesn't prove that time spent listening to radio is too long to be pure search, but it illustrates the great likelihood that much and probably most radio listening is a form of consuming music, and if so, radio is likely to be a substitute for the listening to and the purchasing of sound recordings. Understanding the nature of that substitution depends on understanding the nature of music consumption.

B. Music Consumption

Listening to music is a favorite activity for many individuals. The particular forms of consumption are varied, however, and include attending live performances, listening to CDs (or other sound recording mediums), or listening to radio and television broadcasts. Our focus is on the two major sources of music consumption—broadcast radio and sound recordings. These two music sources

[13] Radio (including satellite) is listed at 2.75 hours per day and sound recordings at .5 hours per day. See Table 1116 "Media Usage and Consumer Spending for 2003." The ratio was closer to 3:1 in 1999, before file-sharing began. Available at http://www.census.gov/compendia/statab/tables/06s1116.xls.

satisfy the music listening craving in different ways and each has certain advantages relative to the other.

Sound recordings provide the highest audio quality and also allow particular songs and performances to be ideally matched to an individual's tastes. Broadcast radio, besides suffering from lower audio quality and less perfectly matched music, also suffers from numerous minutes of advertising. Nevertheless, radio has some advantages over sound recordings—disk jockey patter (which many consumers apparently enjoy); broad playlists which allow the consumer to sit back and let someone else decide what to play (which is presumably more useful than a pure randomizer switch since otherwise radio would just use such a switch); and a much lower price since radio is free whereas the legal consumption of sound recordings requires that they be purchased.

These different characteristics provide different strengths for these two sources in catering to the music listening desires of consumers. We can think of two extremes in a continuum of music listening experiences. On the one hand, an individual might wish to listen to a specific recorded performance or set of performances, which we can refer to as "specific" music consumption. Alternatively, an individual might wish to listen to a random selection of performances from a large library of performances (most likely from a particular genre) which we can refer to as generic or nonspecific music consumption. The two types of listening, which are themselves somewhat substitutable, imply different behavior toward radio and sound recordings.

If specific music consumption is desired the individual will need to access the specific sound recordings of interest, either from his personal collection, those of acquaintances, or more general libraries. Once these sound recordings are in the individual's possession, he can easily and quickly listen to the songs in which he is most interested. Radio, by way of comparison, is not an efficient technology for accessing specific songs. Since a song is considered to be in heavy rotation if it is played twice a day, an individual would need to spend an inordinate amount of time listening to radio before even one desired song was played, to say nothing of a larger collection of songs (note that this is somewhat less true for satellite radio which sometimes has a station devoted to songs from but a single artist, e.g., the Elvis Presley or Bruce Springsteen stations on Sirius Satellite Radio).

Non-specific music consumption is another matter entirely. Radio is particularly good at catering to this desire, with its playlists and large libraries. Individuals can use their personal libraries to also provide a form of non-specific listening, perhaps by telling their CD or MP3 player to randomize the play of songs, or else choosing the music to listen to in a somewhat haphazard manner. Because sound recordings are not free, the music libraries of individuals are usually quite limited in comparison to that of radio stations. The disadvantages of radio are its lower audio quality and the fact that its collection of music is not as closely tailored to the tastes of individual listeners as their own libraries are likely to be. Nevertheless, the relative usage statistics reported above indicate that the disadvantages of radio are overwhelmed by its advantages for a great majority of individuals.

Note that radio and sound recording are substitutes for non-specific music consumption whereas specific music consumption should be dominated by the use of sound recordings. More importantly, radio broadcasts are clearly a substitute for sound recordings in the case of non-specific music consumption but may well be a complement for sound recordings in the specific music consumption category. This latter result is due to the fact that radio can provide information and therefore influence which specific sound recordings are purchased.

This dichotomy between the impact of radio in specific versus non-specific uses of radio broadcasts leads to the potential fallacy of composition. By focusing on the ability of radio to rearrange the position of songs in an individuals ranking of ‘favorites’ the analyst would only measure the positive impact of radio on sales of specific songs without capturing the true market impact.

Because radio and sound recordings compete for non-specific music uses, radio usage will have negative impacts on the sales of sound recordings for non-specific music uses, which appears to be by far the larger of the two uses. In the much smaller category of specific music use, radio will clearly influence the selection of sound recordings and may even increase the number of sound recordings sold. By focusing on the latter interaction of these music sources to the exclusion of the former interaction, previous discussion have ignored the potentially negative impact of radio on sound recording sales. We turn now to an empirical investigation of the overall relationship.

III. Data

In order to perform our analysis we need to merge three data sets together: Arbitron data on radio, Nielsen SoundScan data on record sales, and US Census data for market demographics.

The Arbitron radio data are based upon diaries filled out by respondents, similar to Nielsen television diaries. The data are produced several times a year and currently are found in digital form. We were provided access to their data for 1998 and 2003. Arbitron classifies stations by type and also aggregates groups of stations into approximately 275 (269 and 278 in 1998 and 2003 respectively) Metropolitan Survey Areas (known as Metro Areas) based on the areas in which they broadcast. Some rural residents are left out of the surveys. Arbitron data include information on the average time spent listening to radio in its Metro Areas as well as data on the share and genre of each radio station in an area, allowing a calculation to be performed separating the audiences for music radio and talk radio.[14]

Nielsen SoundScan sells data on record sales (full length albums) by geographic area, genre, and by year. Sales data come mainly from bar code scanners at retail outlets. Online sales are included in these numbers, with customer locations mapped to shipping addresses for physical units or credit card

[14] In 1998 the radio genres which we classified as 'talk' were: News, Religion, Sports and Talk. In 2003 the genres had multiplied and changed, and we classified as talk: All News, All Sports, Educational, News Talk Information, Spanish News/Talk, Sports, Talk/Personality, and Religious. Note that Gospel, although religious, is classified as music.

locations for digital downloads. As a factual matter, digital downloads played virtually no role in the analysis since they were a trivial component of the market even as late as 2003. Nielsen aggregates sales by Designated Market Areas (DMAs) of which there are 210 in the US and everyone in the United States is included in a DMA. We purchased data for the largest 100 largest DMAs which includes approximately 83% of the total population. As we will see below, smaller DMAs provide less reliable data.

The US Census, as part of it Current Population Survey (CPS) undertaken for the Bureau of Labor Statistics, conducts irregular surveys on Internet and Computer use. We use these Census surveys since we wish to control for the important impact of file-sharing on record sales. There was a survey in December of 1998 and another in October of 2003 and these are the two used in the analysis.[15] The surveys provide information on demographic variables such as average household income, age distribution by area, minority share of population, breakdown by gender, internet use, type of internet connection, as well as a host of other variables not used in the analysis. The geographic areas used in the Census are known as Metropolitan Statistical Areas (MSAs) and there are 241 of these areas in our data. As is the case with Arbitron Metro Areas, these MSAs do not include rural residents.[16] Census data are based on responses from individuals to survey questions. The size of the census survey sample (approximately 130,000 nationally) in small MSAs is sometimes insufficient to provide accurate estimates for various demographic data. We try to take account of this problem in the analysis. Arbitron Metro Areas normally correspond to Census MSAs although they are not identical to them.[17]

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[15] The control for file-sharing requires that the start date occur prior to file-sharing (1999) and that only one other year be used. For details see Liebowitz (2006).

[16] The Census Data also include PMSAs (primary metropolitan statistical areas) and CMSAs (consolidated metropolitan statistical areas) which are entire or parts of more heavily populated MSAs.

[17] Arbitron states: “Arbitron Metros generally correspond to the Metropolitan Statistical Areas (MSAs, PMSAs, CMSAs) defined by the U.S. Government’s Office of Management and Budget. They are subject to exceptions dictated by historical industry usage and other marketing considerations as determined by Arbitron.” See page 8.2 of Arbitron Radio Market Report Reference Guide, 2002.

Combining these data sets is not a trivial task. Since Nielsen DMAs are the largest areas and represent larger populations than Census MSAs or Arbitron Metro Areas (even when they all have the same name) we aggregated the MSAs and Metro Areas to match the Nielsen DMAs. This often required adding several MSAs (or Metro Areas) together to approximate the DMA. Arbitron provides a guide to link its Metro areas to the Nielsen DMAs, although the resulting matches are sometimes far from perfect. Matching the Census MSAs to the Nielsen DMAs was based upon examining Nielsen DMA maps (which show the counties belonging to a DMA) and determining which DMA an MSA belonged to based on the county containing the MSA.

The 'matched' Metro Areas and Census MSAs sometimes contained only a small portion of the DMA population, particularly for the DMAs with smaller populations and more rural characteristics. This is because rural households in DMAs are often excluded from Metro Areas and MSAs. For that reason we constructed a variable, "Coverage", which measures the portion of the DMA population replicated by the aggregated MSAs or Metro Areas.[18] When Coverage falls to a low level it is possible that the Census or Arbitron variables, based as they are on MSAs which make up only a small percentage of the DMA population, will not properly reflect the actual population characteristics in the DMA. In the analysis that follows the sample will sometimes be restricted to observations where the Coverage is greater than 60% or 75%, in order to eliminate the influence of potentially misleading measurements.

Although the data from Nielsen SoundScan cover 100 DMAs, one DMA could not be matched with any census MSAs and was dropped from the analysis. Further, missing data for radio listenership

[18] Coverage ratios were calculated for each DMA for both Arbitron and Census data and the lowest ratio for either Arbitron or Census data is used for each DMA. One difficulty in constructing these ratios was that Nielsen populations were based on individuals over the age of 2 whereas Arbitron populations were based on individuals over the age of 12. This required that we used Arbitron listed DMA populations when calculating the Arbitron coverage ratios.

removed another three or four DMAs, depending on year and whether radio was measured as total radio audience or music radio audience.

Table 1: 2003 Values							
Variable	Obs	Mean	Std. Dev.	Min	Max	pop weighted	Rural
College Degree	99	0.204	0.051	0.087	0.345	0.216	0.139
Coverage	99	0.683	0.206	0.203	0.977	0.828	
DMA Population (00,000)	99	23.505	27.275	6.308	194.212	54.835	
Household Income (000)	99	47.966	8.986	20.380	75.895	50.540	38.255
Males	99	0.480	0.023	0.400	0.520	0.482	0.484
Minority	95	0.220	0.138	0.024	0.665	0.269	0.293
Number Radio Stations	95	22.017	4.991	12.287	38.109	25.304	
Old (55+)	99	0.227	0.054	0.130	0.410	0.215	0.250
Share Internet	99	0.613	0.071	0.440	0.740	0.621	0.545
Radio Usage (hrs/day)	96	2.711	0.161	2.371	3.233	2.769	
Music Radio Usage	96	2.298	0.190	1.861	2.976	2.293	
Talk Radio Usage	95	0.417	0.138	0.190	0.750	0.476	
Record Sales per capita	99	2.321	0.440	1.499	3.879	2.445	1.837
Calculated Weights	99	651.593	545.538	17.108	2664.062		
Young (12-29)	99	0.303	0.044	0.200	0.410	0.306	0.288
98-2003							
Change in Variable	Obs	Mean	Std. Dev.	Min	Max		
College Degree	99	0.018	0.040	-0.114	0.208		
DMA Population (00000)	99	1.643	2.361	-0.559	13.845		
Household Income (000)	99	8.523	7.087	-6.660	26.901		
Males	99	0.001	0.035	-0.137	0.143		
Minority	93	0.019	0.054	-0.115	0.186		
Number Radio Stations	96	2.172	7.311	-11.404	65.000		
Old (55+)	99	0.011	0.047	-0.120	0.191		
Radio Usage	95	-0.294	0.104	-0.600	-0.050		
Music Radio Usage	95	-0.323	0.123	-0.623	-0.036		
Talk Radio Usage	95	0.029	0.092	-0.227	0.351		
Record Sales per capita	99	-0.577	0.695	-3.484	1.049		
Share Internet	99	0.310	0.058	0.120	0.466		
Young (12-29)	99	0.001	0.045	-0.110	0.140		

Table 1 presents summary statistics for 2003 and for the change from 1998 to 2003, allowing the reader to infer the 1998 statistics if desired. A person in the average DMA spent 2.3 hours per day listening to music radio and 2.71 hours a day listening to all radio. Sales of full length sound recording albums averaged 2.32 per person per year across DMAs, somewhat less than the average weighted by population. The combined coverage ratio in the average DMA was 68.3% and the DMA with the lowest values was about 20%, which would be a cause for concern if these observations were accorded much weight in the analyses. The national (weighted) coverage ratio was a more reassuring 82.8%, however. Small cities tend to have lower coverage ratios (the correlation between DMA size and coverage is .44).

As mentioned, the population of the top 100 DMAs represents about 83% of the national population. The MSA (Metro Area) population matched to the DMAs covers about 87% (79%) of the DMA population, so that in total our sample covers about 72% (66%) of the US population. How does the population left out of MSAs compare to the included population? Being more rural, the left out population would be expected to be poorer, have lower Internet usage, and lower education. This expectation is confirmed in the rightmost column of Table 1 where we see that left out individuals have lower Internet use, a smaller share of college degrees, lower incomes, and lower per capita record sales than the included population.

IV. Estimation

Our goal is to determine the impact of radio play on record sales. Our null hypothesis will be that radio increases record sales since that conclusion seems to have been accepted by almost everyone. All of our variables are measured as the per capita value in a city. The dependent variable will be record sales per capita. The key independent variable will be the average time spent listening to music radio. Demographic variables that are likely to influence record sales include income, Internet use, possession of college degree, relative size of age groups (over 55 and 12 through 29), and minority population (black and Hispanic).

We have data for 1998 and 2003. Having data for more than one year allows panel methods to be used and this will be our preferred methodology. The appendix present results from the single-year cross section regressions which provide similar results.

A. Radio Play and Record Sales

Table 2 presents results from running regressions using first differences. By taking first differences we control for underlying differences in the populations and circumstances of cities that do not change over this period and for which we do not have controls, in a manner identical to a fixed effects model.

The table includes regression results over the full 1998-2003 interval where all the variables are in first differences, except for the measurement of Internet usage which will be explained shortly. The dependent variable is the change in albums sold per capita. The various specifications in Table 2 differ from one another as we stratify the observations by coverage ratio and population in order to remove from the analysis observations likely to be less precisely measured.

The first column includes the full sample although these results are most vulnerable to poor measurements and are included more for the sake of completeness than for any information revealed. The second column weights each observation by a combination of population and coverage, so that larger cities are more heavily weighted and cities with greater coverage are more heavily weighted, with the weighting constructed to give approximately equal impact to population and coverage.[19] The purpose of this weighting was to reduce the impact of observations with likely mismeasurement due to low coverage or possible imprecision in the Census numbers due to the sample size being too small to provide reliable statistics. The weighting here is quite severe, with the variation from the highest to lowest weight on the order of over one hundred to one (as can be seen in Table 1). The next two

[19] The weighting was constructed taking the product of the squared coverage and the square root of the population.

columns eliminate observations (giving them a zero weight) when the coverage is less than either 60% or 75%. These cutoffs were chosen as fairly natural indicators of good if not great coverage and more demanding cutoffs would have lowered the number of observations further than deemed prudent, although we will explore the impact of choosing different cutoffs later in the paper. Columns 5 and 6 add in a cutoff for population as well as coverage.

Table 2: First Differences Regression on Change in Album Sales

Change in	Full Sample	Pop & Cov Wgt	Coverage >.6	Coverage >.75	Cov >.6; pop>.6M	Cov >.75; pop>.6M
Daily Per Capita Music Radio (Hours)	-0.0745	-0.7903	-0.7507	-1.1817	-0.6049	-0.7767
	(0.462)	**(0.076)**	(0.169)	(0.126)	**(0.067)**	**(0.056)**
Average Household Income (000s)	0.0087	0.0227	0.0299	0.0368	0.0148	0.0220
	(0.362)	**(0.025)**	**(0.047)**	**(0.086)**	(0.118)	**(0.034)**
2003 Internet Access	-1.5582	-2.7630	-3.4950	-4.5426	-2.7686	-2.5656
	(0.185)	**(0.012)**	**(0.043)**	**(0.062)**	**(0.003)**	**(0.014)**
BA Degree or above	3.1199	4.0142	6.2029	9.0215	-3.2295	0.3713
	(0.162)	(0.172)	**(0.081)**	**(0.080)**	(0.188)	(0.863)
Share 12-29	5.3332	5.2812	9.0277	8.2210	0.6868	0.8054
	(0.077)	**(0.094)**	**(0.022)**	(0.108)	(0.792)	(0.676)
Share Males	-0.8486	-2.4070	-4.6742	-4.9393	1.1555	-0.4517
	(0.721)	(0.329)	(0.159)	(0.196)	(0.452)	(0.774)
Share 55+	1.3197	1.1857	4.9417	1.0563	-0.5910	-1.2845
	(0.568)	(0.581)	(0.144)	(0.784)	(0.775)	(0.413)
Share Minority	-1.0790	-0.2796	0.4427	-0.9315	0.6420	-0.4186
	(0.475)	(0.844)	(0.806)	(0.700)	(0.675)	(0.744)
DMA Population (%)	-0.3810	-0.3324	-0.4518	0.0504	-0.8576	-0.4557
	(0.684)	(0.668)	(0.663)	(0.973)	(0.154)	(0.428)
Constant	0.2827	0.6820	0.9922	1.4393	1.0931	0.7715
	(0.719)	(0.308)	(0.342)	(0.326)	**(0.050)**	(0.145)
Observations	90	90	61	41	53	36
R-squared	0.14	0.20	0.33	0.37	0.25	0.36

Robust p values in parentheses; p value for music radio is for one tail test; bold is sig at 10% level; bold underlined at 5%, bold double underline 1%

Our primary interest is in the coefficients on music radio use. The coefficients are always negative and (excluding the full sample) imply that radio play causes a substantial decrease in the sales of CDs. The coefficients are generally at or near the border of statistical significance if we include 10% as a cutoff. The average coefficient (excluding the full sample) is -.82 but we will round this value down to -.75 in the illustrations below because when the impact of outliers is reduced the average coefficient falls to -.68.[20] This economic significance of these coefficients tells us that a one-hour increase in usage of music radio, which is somewhat less than one half of the average value, would lead to a decline of .75 sound recordings. Although the confidence intervals around these coefficients are wider than we might like, the implied impact of radio indicates an important economic impact of radio play on record sales since the yearly per capita purchases of sound recordings is about 2.7 over the five year interval. If this coefficient could be applied to the entire range of radio usage, and we will have more to say about this below, the decline in record sales would be very large relative to actual sales. These results are certainly strongly contrary to the normal expectation of a strongly positive impact of radio play on record sales.

Income is always positive, as expected, and usually significant. An increase in household income of $10,000 would lift sound recording sales by approximately .25 units. DMA population has no clear impact on sales.

The Internet variable requires some additional explanation. In the period from 1998 until 2003 file-sharing arose from nothing to become a very popular activity. Liebowitz (2006a) demonstrates that a correct specification for a regression measuring the impact of file-sharing, if file-sharing was zero in the beginning period, would be to use the *level* of Internet use in the later period in an otherwise first differenced regressions. As was the case in that paper, the Internet variable in Table 2 indicates a very strong negative impact of file sharing on record sales, which is consistent with most other studies of the subject (see for example, Liebowitz 2006, Rob and Waldfogel 2006, and Zentner 2006). The impact of file-sharing is less than this coefficient, however, because Internet usage itself can be something of a

[20] I used the built in RREG Stata routine to determine whether weakening the impact of influential observations would change the results. Although the coefficients were slightly lower, the average p values were slightly stronger (.08 versus .10). The RREG routine first eliminates observations with levels of Cook's D that are above 1 and then it iteratively lowers the weightings of observations with large absolute residuals, until a convergence threshold is reached.

substitute for listening to sound recordings as described in Liebowitz (2006a), which controls for this factor and concludes that file-sharing still has a large negative impact on record sales.

The share of the population with college degrees appears to have a positive impact on record sales until small cities are removed. It is also the case that when outliers are made less influential this variable loses its strength. The minority and age group variables do not have much consistency. The coefficient on share of individuals aged 12-29 appears to have a positive impact on record sales, but as was the case with the college variable, the result goes away when small cities are removed or when robustness checks (for outliers) are performed.

Table 3: Concise Regressors on Change in Album Sales

First Differences	Pop & Cov Wgt	cov>.6	cov>.75	cov >.6 pop>.6M	cov >.75 pop>.6 M	Avg
Daily Per Capita Music Radio (Hours)	-0.8091	-1.2560	-1.5237	-0.6347	-0.6931	-0.9833
	(0.065)	**(0.069)**	(0.101)	**(0.033)**	**(0.019)**	**(0.057)**
Average Household Income (000s)	0.0177	0.0194	0.0347	0.0084	0.0201	0.0200
	(0.033)	**(0.079)**	**(0.044)**	(0.320)	**(0.009)**	**(0.097)**
2003 Internet Access	-2.1177	-2.9273	-4.2516	-2.4070	-2.2478	-2.7903
	(0.026)	**(0.053)**	**(0.073)**	**(0.005)**	**(0.018)**	**(0.035)**
Observations	95	61	41	53	36	
R-squared	0.076	0.074	0.137	0.147	0.284	
Robust Regressions						
Daily Per Capita Music Radio (Hours)		-0.7562	-0.7493	-0.7066	-0.6614	-0.7184
		(0.019)	**(0.035)**	**(0.028)**	**(0.055)**	**(0.034)**
Average Household Income (000s)		0.0128	0.0146	0.0142	0.0187	0.0150
		(0.065)	**(0.079)**	**(0.047)**	**(0.024)**	**(0.054)**
2003 Internet Access		-1.9139	-1.7411	-2.1668	-2.0606	-1.9706
		(0.009)	**(0.043)**	**(0.003)**	**(0.015)**	**(0.018)**
Observations		61	41	53	36	
R-squared		0.163	0.169	0.205	0.232	

Robust p values in parentheses; p value for music radio is for one tail test; bold is sig at 10% level; bold underlined at 5%, bold double underline 1%; Constant term not shown.

Due to the relatively small number of observations it is important to try to maximize the efficiency of the estimates. To this end the regressions were rerun using only the variables that appear to actually have consistent and significant impacts—music radio use, Internet use, and income. The results are found in Table 3. The top half of that table provides the first differenced OLS regression coefficients. The general results are similar but generally stronger than in Table 2. The coefficient on music radio is somewhat larger, averaging -.98 with an average p value slightly below .06. The bottom half of the table provides the results from the robust regressions using Stata's RREG routine to weaken the impact of influential observations.[21] With these regressions the music radio coefficient is about the same as in Table 2 but the confidence interval is narrower.[22]

B. The Nature of the Substitution

We have found that, contrary to received wisdom, increases in time spent listening to music radio do not increase the purchase of sound recordings but instead appear to decrease the sale of sound recordings by an economically large amount. There are two possible explanations for a negative impact. One explanation might be that the time spent listening to radio is time that is taken away from other general entertainment activities and that listening to sound recordings is just one of these activities. The other explanation, which is the one that has been put forward in this paper, is that listening to *music* radio is a substitute for non-specific music listening that might otherwise have used sound recordings.

Fortunately, it is fairly easy to test between these two possibilities. Not only do we have a measure of time spent listening to music radio but we also have a measurement of the time spent listening to talk radio. If the former hypothesis were true, talk radio would have the same impact on record sales as does music radio since time would be the key element of substitution and an hour of talk radio takes as much time as an hour of music radio. If the latter hypothesis were true music radio would have a more powerfully negative impact on sound recording sales than would talk radio.

[21] Stata's RREG routine doesn't allow weighted regressions so the first column is blank.
[22] Although the robust regressions were not shown for Table 2, the average coefficient was .684 and the average p value was .079

Table 4 presents the partial (income and Internet coefficients are not shown) results of concise regressions which include both talk and music radio in regressions otherwise identical to Table 3. The coefficients on talk radio, although generally positive, have large confidence intervals. Certainly, talk radio does not appear to have the same impact or sign as music radio.

Table 4: Concise Regression with two types of Radio Station						
	Pop & Cov Wgt	cov>.6	cov>.75	cov >.6 pop>.6M	cov >.75 pop>.6 M	Avg
Daily Per Capita Music Radio (Hours)	-0.6238	-1.1435	-0.4070	-0.8487	-0.6004	-0.7247
	(0.126)	**(0.082)**	(0.364)	**<u>(0.017)</u>**	(0.113)	(0.140)
Daily Per Capita Talk Radio (Hours)	0.3996	0.2398	1.9753	-0.5094	0.1904	0.4591
	(0.598)	(0.842)	(0.212)	(0.319)	(0.735)	(0.541)
Observations	95	61	41	53	36	
R-squared	0.08	0.08	0.17	0.16	0.29	
Test for Equality of coefficients (p-val)	(0.182)	(0.266)	(0.120)	(0.437)	**<u>(0.036)</u>**	
Coefficients for Income and File-sharing Proxy not shown; Robust p values in parentheses; p value for music radio is for one tail test; bold is sig at 10% level; bold underlined at 5%, bold double underline 1%						

Because the confidence interval around talk radio is so wide we can only reject equivalence of the two coefficients for one regression specification; the other specifications have p-values ranging from .12 to .44 when the equivalence of the coefficients are tested. Nevertheless, the impact of talk radio certainly appears to be different than music radio and in a manner consistent with expectations. Our conclusion, therefore, is that music radio is a direct substitute for sound recordings independent of the time taken listening to radio. This is really not much of a surprise.

V. Further Checks

A. Outliers and Cutoffs

One possible issue is the impact of outliers. In all instances, beyond those mentioned in the text, the robust regression technique built into Stata were examined and the results were in close agreement with those presented in the text. The DfBetas for the radio coefficient were also examined and there is no evidence that the results presented are due to a small number of influential observations.

It is also possible that the cutoff points chosen may have inadvertently impacted the results relative to other possible cutoff values. Examining other cutoff values (based on the concise regression specification), as shown in Table 5, reveals that the cutoff values chosen did not lead to unusual results. [Note that as some cutoff values change the number of included observations may not change.] An examination of p-values, found in the bottom half of Table 5, also reveals that the chosen cutoff points in the main text do not provide unusual results.

Table 5: Music Radio Coefficients (and p-values) for Different Cutoff Values

Pop \ Cov	0.5	0.550	0.6	0.650	0.7	0.750	0.8	Average
none	-0.9572	-1.1719	-1.2560	-1.4040	-1.4725	-1.5237	-2.0500	-1.4050
400,000	-0.9289	-1.0739	-1.1722	-1.4040	-1.4725	-1.5237	-2.0500	-1.3750
500,000	-0.9517	-1.0974	-1.2012	-1.4414	-1.5140	-1.6070	-2.1453	-1.4226
600,000	-0.4671	-0.5597	-0.6347	-0.8320	-0.7323	-0.6931	-0.6219	-0.6487
700,000	-0.4632	-0.5597	-0.6347	-0.8320	-0.7323	-0.6931	-0.6219	-0.6481
800,000	-0.3684	-0.4496	-0.5162	-0.6963	-0.6993	-0.6296	-0.5314	-0.5558
Average	-0.6894	-0.8187	-0.9025	-1.1016	-1.1038	-1.1117	-1.3368	-1.00921
p values								
Pop \ Cov	0.5	0.550	0.6	0.650	0.7	0.750	0.8	Average
none	**(0.0945)**	**(0.0805)**	**(0.0690)**	**(0.0555)**	(0.1005)	(0.1005)	**(0.0615)**	**(0.0803)**
400,000	(0.1140)	(0.1020)	**(0.0860)**	**(0.0555)**	(0.1005)	(0.1005)	**(0.0615)**	**(0.0886)**
500,000	(0.1120)	(0.1020)	**(0.0855)**	**(0.0550)**	**(0.1000)**	**(0.0955)**	**(0.0590)**	**(0.0870)**
600,000	**(0.0700)**	**(0.0530)**	**(0.0325)**	**(0.0050)**	**(0.0265)**	**(0.0185)**	**(0.0635)**	**(0.0384)**
700,000	**(0.0735)**	**(0.0530)**	**(0.0325)**	**(0.0050)**	**(0.0265)**	**(0.0185)**	**(0.0635)**	**(0.0389)**
800,000	(0.1210)	**(0.0965)**	**(0.0645)**	**(0.0125)**	**(0.0260)**	**(0.0240)**	**(0.0915)**	**(0.0623)**
Average	**(0.0975)**	**(0.0812)**	**(0.0617)**	**(0.0314)**	**(0.0633)**	**(0.0596)**	**(0.0668)**	**(0.0659)**

B. Simultaneity

Finally, another potential problem with the estimation is the possibility of simultaneity. We have examined the role of radio broadcasts on the sales of sound recordings. The argument might be made that the sales of sound recordings have an impact on radio listening just as radio has an impact on sound recording sales. After all, they are substitutes for each other when individuals want to listen to non-specific music. Could the amount of time individuals spend listening to radio depend on the number of sound recordings that they purchase?

Although a linkage is clearly possible, there are reasons to doubt the importance of sound recording purchases on time spent listening to radio. First, the number of sound recordings available is the stock of owned recordings which is likely to be much larger than the flow of purchases, so the current flow might be at most only weakly related to the number of purchases unless the stock of older CDs depreciates rapidly over time. Second, for specific music consumption, sound recordings are the much preferred solution and radio will not be much of a substitute. Sound recording purchases intended mainly for specific listening (which might be the main use of sound recording purchases) should not, therefore, impact time spent listening to radio.

It is also useful to consider factors that might change the number of sound recordings purchased and the impact on radio listening. One very important factor during this period is file-sharing, and to this we should add instances of non-Internet based sharing, such as ripping borrowed CDs. Although we have a variable for internet based file-sharing, it might not pick up all of the impact of borrowed or pirated music. If it did not, individuals would decrease their purchase of sound recordings and at the same time likely decrease their listening to radio since they can now have a very large free library of music to which they can listen. In this case, a reduction in record sales would be associated with a decrease in radio listening, not an increase.

Nevertheless, we can perform a test to determine whether there is evidence of simultaneity or not. The test is a form of Hausman specification test in which we regress radio music listening on a set of exogenous variables, calculate the residuals, and then include those residuals in the regression on record sales. In this case the exogenous variables include all the demographic variables used in the above regressions plus, for the regression on radio music listening, changes in both the number of radio stations and time spent listening to talk radio, each of which should be independent of the possible music-radio / sound-recording tradeoff. Table 6 reports the coefficients on the variable consisting of the first stage residuals for our various combinations of cutoff, which are insignificant with all cutoff values.

Table 6: Coefficients of Residuals in Hausman Test					
	Pop & Cov Wgt	cov>.6	cov>.75	cov >.6 pop>.6M	cov >.75 pop>.6 M
coefficient	0.2619	0.1648	1.0382	-0.7221	0.2765
p value	(0.812)	(0.928)	(0.654)	(0.539)	(0.784)

The conclusion that would be drawn from this is that there is no simultaneity problem to worry about. Nevertheless, this test cannot be considered conclusive so we proceed to use instrumental variables in order to more fully expunge the possibility of simultaneity. We should keep in mind that because we have a fairly small sample size, instrumental variables, which provide biased and inefficient estimates, may not provide better estimates than OLS.

Equation (1) represents the equation that we have been estimating with OLS up to this point. Equation (2) represents a structural equation explaining music radio usage. The two new variables in this equation are the number of radio stations (Stations) and the amount of time that individuals spend listening to talk radio (RadioTalk).

(1) $\text{Albums} = a_0 + a_1\text{RadM} + a_2\text{Inc} + a_3\text{BA} + a_4\text{Yng} + a_5\text{Male} + a_6\text{Old} + a_7\text{Int} + a_8\text{Minority} + a_9\text{Pop}$

(2) $\text{RadM} = b_0 + b_1\text{Albums} + b_2\text{Stations} + b_3\text{RadioTalk}$

Listening to talk radio fulfills a very different taste than does listening to sound recordings and should not be a substitute for listening to sound recordings, at least no more than any other activity that takes up time. Further, we have already seen that the time spent listening to talk radio does not impact the number of albums sold. If talk radio is independent of album sales, it should be uncorrelated with the error term in the regression on Albums.

Our other instrument is the average number of stations in a DMA, which is a construct based on the average number of stations found in Arbitron metro areas weighted by the populations of the metro areas in a DMA and as such doesn't relate directly to any particular set of physical stations since a single station can appear in more than one metro area.[23] We expect this count of stations to be independent of record sales except through its impact on the radio music-use variable. The number of stations is determined in part by regulations since radio stations need government permission to broadcast. The number of stations is likely to impact the variety of programming and might allow listeners to find programming closer to their tastes, impacting the time spent listening to music radio, but there does not appear to be any other mechanism by which the number of stations would impact the sales of albums.

Our procedure will be to instrument for RadM in equation (1) with the fitted values of RadM from equation (3) that includes all the other exogenous variables that are found in equation (1) and the two instruments where X1…X8 is a vector representing variables 2-9 in equation (1).

$$(3)\ \text{RadM} = c_0 + \left| c_1 \ldots\ldots c_8 \right| \begin{vmatrix} X1 \\ . \\ . \\ X8 \end{vmatrix} + c_9\text{Stations} + c_{10}\text{RadioTalk}$$

The results of the second stage regression coefficients for radio music are found in Table 7. As a byproduct of using instrumental variables, the standard errors on radio music are larger than is the case for OLS which can explain why the coefficient is more variable than when using OLS and in one

[23] Not all stations in a metro area were counted. If a station was listed as having an audience rating (percentage of audience) of zero, it was excluded from the analysis. This is similar to Arbitron's listings which include stations only if they have a measurable presence, although they do not base it on ratings points but instead on audience size.

instance is even positive. Nevertheless, the average coefficient is about the same as before (-.826) which further supports the view that there is no evidence that the OLS estimates are impacted by simultaneity.

Table 7: Second stage IV estimates of change in sound recording sales					
	Pop & Cov Wgt	Coverage >.60	Coverage >.75	Cov >.6; pop>.6M	Cov >.75; pop>.6M
radio music change in hours*	-0.9375	-0.9658	-2.2727	0.4015	-0.6441
p values (one tail)	(0.177)	(0.256)	**(0.021)**	(0.301)	**(0.100)**
Sargan [non heteroskedastic-robust] Instrument validity; P-value	0.4303	0.4193	0.4112	0.7297	0.659
Hansen J Statistic on instrument validity [hetero robust Sargan]; P-val	0.2178	0.1278	0.1044	0.5537	0.4436
Heteroskedastic robust [quasi-Hausman] exogeneity test; Chi-sq p value for RadM	0.931	0.7223	0.5618	0.2698	0.9549
Anderson Canon Corr Underidentication LR test; p value	0.0000	0.0000	0.0001	0.0008	0.0004
Partial First Stage Results; Music Radio is dependent variable					
station count change	0.0025	0.0025	0.0023	0.0022	0.0024
	0.000	**0.000**	**(0.001)**	**(0.004)**	**(0.002)**
radtalkchg	-0.6657	-0.5962	-0.6768	-0.5600	-0.6778
	0.000	**0.000**	**0.000**	**0.000**	**0.000**
Observations	90	61	41	53	36
R-squared	0.537	0.486	0.642	0.476	0.626
Robust p values in parentheses; *=instrumented variable; bold is sig at 10% level; bold underlined at 5%, bold double underline 1%					

The Sargan test for instrumental validity implies that our instruments are likely to be valid and not related to the error term. The Hansen J Statistic, which differs from Sargan in that it is robust in the face of heteroskedasticity, provides a less sanguine answer to the same question although it too suggests, but more weakly, that the instruments are valid. A test similar to the simultaneity test reported in Table 6 but robust to heteroskedasticity leads to the same conclusion as before—there is no evidence that music radio is endogenous and thus no need for instrumental variables to begin with. Finally, the Anderson canonical correlation likelihood ratio test tells us that the instruments identify the equation. The bottom of Table 7 provides some coefficients and other results from the first stage regressions where it is easy to see that the two variables used as instruments are highly correlated with changes in music radio usage.

We conclude that simultaneity is not a problem for the OLS results.

C. Errors in Variables

Although we have taken steps in our estimation to eliminate or weaken any impact of measurement error, one might argue that such errors cannot have been completely eliminated. It is well known that under classical errors-in-variables circumstances (which assumes the measurement error term is not correlated with the true values of the variables) coefficients on all the rhs variables will be biased and inconsistent if any of the variables is mismeasured.

Of course, our interest is centered on the coefficient for music radio listening. If there were only one explanatory variable in the regression the nature of the bias due to the mismeasurement is much easier to determine since it would simply become the typical error-in-variables attenuation bias, where the coefficients are biased toward zero. For this reason the regressions were rerun leaving out the other rhs variables except music radio listening time. Table 8 shows that the results from these regressions are very similar to those obtained from the complete regression. Under standard EIV assumption we can conclude that measurement errors are likely to lower our estimates of the impact of music radio.

Table 8: Regression with Radio Music Use as Sole Independent Variable

	Pop & Cov Wgt	Coverage >.6	Coverage >.75	Cov >.6; pop>.6M	Cov >.75; pop>.6M	Average
Music Radio Sole	-0.7505	-1.0323	-1.1118	-0.3877	-0.4976	-0.7560
Variable	(0.113)	(0.143)	(0.200)	(0.157)	**(0.073)**	-0.1369
Observations	95	61	41	53	36	
R-squared	0.024	0.024	0.031	0.013	0.043	
In Full	-0.7903	-0.7507	-1.1817	-0.6049	-0.7767	-0.8209
Regression from	**(0.076)**	(0.169)	(0.126)	**(0.067)**	**(0.056)**	-0.0985

Robust p values in parentheses; p value for music radio is for one tail test; bold is sig at 10% level; bold underlined at 5%, bold double underline 1%

If the true coefficient were larger than the measured coefficient would not alter our analysis since it would merely strengthens the conclusions already drawn.

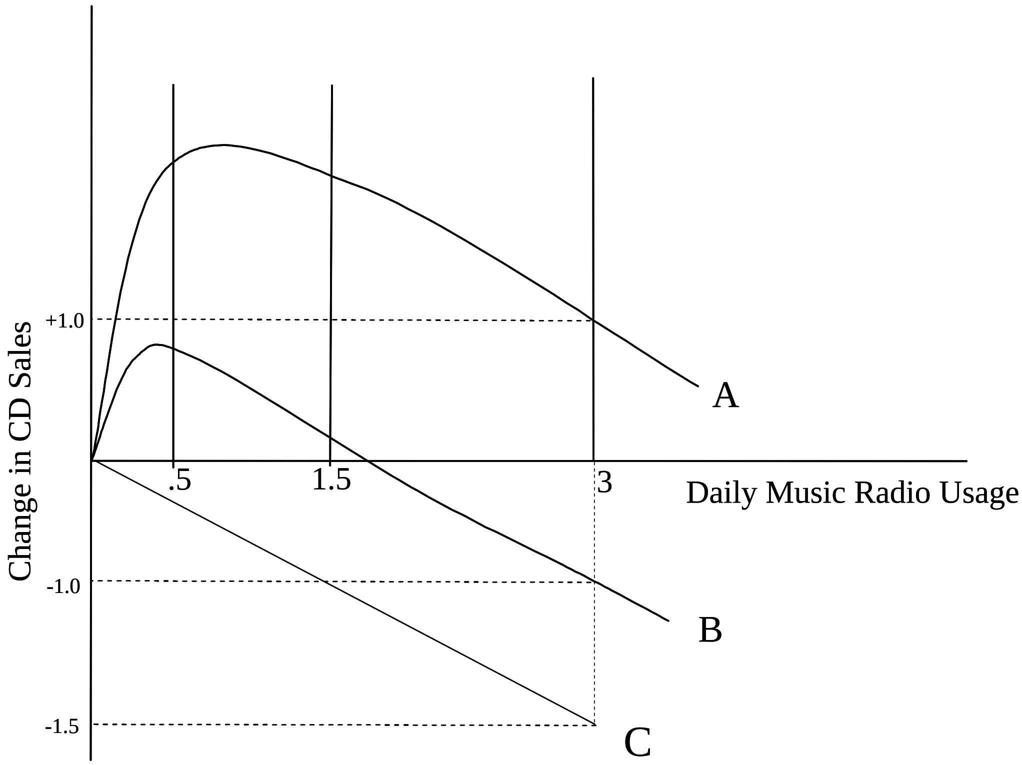
A solution often proposed for errors-in-variables is to use instrumental variables. Although we have performed such as examination above, there are difficulties with using it as a salve for the errors-in-variables problem beyond the difficulties mentioned for issues of simultaneity. Among those difficulties is the fact that most potential instruments (including the ones chosen) will suffer from the same errors-in-variable problems as the variables used in the OLS results unless instruments could be found that were based on DMA level data as opposed to constructed from the MSA level data, which we have not been able to do.

VI. Gauging the Overall Impact of Radio

We have found that radio use lowers sales of sound recordings. Because we have only a limited range of observations to work with the regression results that we have found could be compatible with other scenarios that might allow for overall positive impact of radio play on record sales. For example, radio at first might have a positive informational aspect on sales, which then turns negative when greater radio use becomes a substitute for listening to CDs. In this case the overall impact of radio could be positive or negative in spite of our negative findings. Assume, for the sake of example, that radio has a positive impact for approximately the first .5 hours of daily use and a negative impact thereafter. This is illustrated in Figure 1 for three possible cases, A, B, and C.

Correctly estimating the impact of music radio when all observations are between 1.5 and 3 will lead to a conclusion that music radio lowers record sales, which is correct within the bounds of the data. Attempting to extrapolate the impact of a factor, such as radio use, to levels that are outside the bounds of the sample can easily provide misleading results if the relationship looks like A or B, however. The negative relationship found in measured portion of A could obscure an overall positive impact that radio play might have on sound recordings since the large positive impact from the first half hour of music radio would be obscured.

Figure 1: Out of Sample Estimates can be Misleading



The bounds of music radio use in our 2003 sample (see Table 1) run from a low of 1.9 hours to a high of 3 hours, with an average of 2.3 hours. The 1998 values are just slightly higher. The range of changes in music radio use is .6 hours from 1998 to 2003. Within these ranges of observations the measured impact of radio play on the sales of sound recordings is negative. The average album consumption stood at 2.3 units per capita in 2003. If we were to assume that the relationship between music radio and CD purchases were linear throughout its range, as illustrated in case C, an increase in radio use from 0 to 2.3 hours per day could be expected to reduce album sales by more than one and a half albums, given a coefficients of -.75. This would be a very large negative impact of overall radio use. Yet the relationship represented by curve B would imply a loss of only 1 unit and the relationship represented by A would imply a gain of 1 unit, and either of these other two curves could also be consistent with the data at hand.

Is there any evidence for or against such a nonlinearity that might overturn the results found in generalizing these regression results? First, we ran quadratic specification of the amount of radio music use to see whether there was any evidence of nonlinearity within our data. There was not. We also split the data in half based upon music radio usage and ran separate regressions for each half. The cities with smaller music radio usage had a larger negative impact than the cities with greater music radio usage, contrary to what we would expect from the type of nonlinearity suggested by lines A or B. Still, the limitations on our data keep us from being able to say much more.

The historical approach used in Liebowitz (2004), however, can be used to throw some light on this possible nonlinearity. That paper examined the sales of sound recordings immediately before, during, and after the introduction of radio into the American market. If there was an initial positive promotional element in radio, and if it were large enough to overpower the later negative impacts, that positive impact should have clearly shown up in historical data which included the very first hours of music radio listening. As already mentioned, the sound recording market was already quite mature at that time, with per capita sales the equivalent of those in 1950. Yet, as that paper reported, there was no evidence of any but a negative impact of radio on sound records since sales fell significantly during the first few years of radio's growth in spite of a healthy and growing economy. The fact that record sales fell during the birth of radio would seem to imply that the net effect is negative, even at an initial stage.

That conclusion is echoed in Morton (2003):

> Record companies welcomed the subsequent transfer of electrical technology from radio and motion pictures to the phonograph industry, but hated the effect these two new forms of entertainment had on the record business. Radio was the biggest threat. On the eve of broadcasting's debut, between 1914 and 1921, record sales had doubled, largely because of sales of popular music. With the inauguration of network radio in the middle 1920s, the market for popular

> recordings collapsed, resulting in a number of companies leaving the field or changing ownership. (Page 26).

To be sure, this issue cannot be completely settled since one can argue the radio/sound-recording relationship in the early 1920s might have been very different than the current relationship. Nevertheless, the lack of any evidence in favor of the possibility of a net positive impact, when compared to the more substantial evidence of the negative impact of music radio, provides a prudent analyst with at least a tentative conclusion that radio has a net negative impact on sound recording sales. Further research is warranted.

VII. Discussion

Can this result be reconciled with the well-documented existence of payments to radio stations for the promotion of records? The existence of payola seems to have been taken as evidence that radio stations generate sufficient positive impact on record sales that the typical market clearing price for the right to broadcast sound recordings would be negative price for the rights to a sound recording. Does it provide evidence on whether a property right controlling the broadcasts of recordings would have economic value?

I think not. The overall negative impact of radio play found in the above regressions would be beyond the feasible control of record companies due to the current lack of broadcast property rights in sound recordings. Any record company that attempted to, let's say, pay radio stations to play fewer hours of sound recordings would only receive a portion of the benefits which would accrue to all sound recording companies. Nor would it make sense for a record company to pay radio stations to reduce the hours of broadcast of just that record company's songs since this would tend to decrease its market share and not have any salutary impact on overall record sales since those radio signals would still be broadcast for the same amount of time, allowing the same level of substitution of radio for sound recordings by consumers. Further, antitrust laws would prevent the entire industry from collectively trying to make such payments. Even if they could do so, entry problems would likely doom such an agreement since any station (talk radio, say) could then threaten to play more sound recordings (by changing formats) in order to generate payments not to.

It is also the case that payola is consistent with the possibility of an overall negative impact of radio play for the simple reason that payola doesn't impact the total quantity of radio broadcasts of sound recordings. Payola only impacts which particular songs are broadcast. There does not appear to be any evidence, for example, that record companies tried or can alter the share of music relative to talk on radio stations, or that they tried to convert talk radio stations into music radio stations.

Both Caves and Coase note that numerous attempts were made by record companies and before them, music publishers, to stop paying radio station personnel or well-known performers to play particular records or songs, beginning, according to Coase, with an episode in 1890. Some of these attempts, including the congressional hearings in the late 1950s, appear to be instances where established record companies were trying to reduce the airplay of a group of smaller upstart record companies who were heavy users of payola and who happened to specialize in that evil music otherwise known as rock-and-roll. Caves suggests that modern attempts to limit payola have largely been attempts by major record companies to restrict competition from smaller independents. There may well be truth to these claims of redistributional impacts from attempts to control payola. Nevertheless, if payola type activities benefited record companies in an overall sense the industry should not have wanted to eliminate the practice altogether.

The results of this paper are entirely consistent with a modified version of the conclusions of the economists who have argued for a market solution. Their focus on only part of the property rights problem have led them to conclude that payola should not be illegal, that it is payment for a useful service, and that the market should determine what the payments should be.

For example, Coase concludes (p 318):

> ..if the playing of a record by a radio station increases the sales of that record, it is both natural and desirable that there should be a charge for this. If this is not done by the station and payola is not allowed, it is inevitable that more resources will be employed in the production and distribution of records, without any gain to consumers, with the result that the real income of the community will tend to decline. In addition, the prohibition of payola may result in worse record programs, will tend to lessen competition, and will involve additional expenditures for regulation.

Caves states (p 292):

> The evidence supports a simple interpretation of the economics of payola in broadcasting. Promotional benefits to the label cannot be captured directly by the broadcaster, who lives by advertising revenue that generally will not reflect this benefit. Payola compensates for valuable promotion, and leaves us wondering why it is stigmatized as bribery rather than recognized as payment for services rendered.

We agree completely with this call for a fully functioning market. A complete market, however, would not merely allow payola to be legal. A fully functioning market would allow a complete set of property rights over the sound recording being broadcast, including the ability of record companies to restrict radio play and to provide geographically exclusive territories for the broadcast of songs.

VIII. Conclusions

The impact of music radio broadcast on the sales of sound recordings has received scant attention by researchers. The analysis above provides evidence that radio play is negatively related to the overall level of record sales and that the size of the negative impact is large. This implies that radio play is largely a displacement for the sales of sound recordings, a result that seems at odds with most conventional thinking.

The negative impact of radio on record sales only exists for music broadcasts and not for talk radio, which is consistent with a view that listening to music on the radio is a close substitute for listening to music on sound recordings. The measured negative impact of music radio on record sales is in the vicinity of 20% within the range of our observations. Extrapolating these results outside the bounds of our sample provides for a considerably larger impact, although such extrapolation is fraught with difficulties. Those difficulties are ameliorated somewhat by appealing to other evidence and other tests.

This finding is likely to become increasingly important in the near future as the transmission of music becomes increasingly digitized and the putative property rights (or lack of property rights) of the copyright owners come under greater scrutiny and political pressure. These results also provide some suggestions for public policy that is likely to become increasingly important in the next few years. As new broadcasting techniques (e.g., digital transmissions that allow high quality copies to be made automatically) make using the radio a closer substitute for the purchase of sound recordings, the above results should provide useful information in a discussion of whether the owners of sound recordings should be given the ability to exclude such usage.

On a methodological note, the apparent divergence between the impact of radio play on the sales of individual records versus its impact on sales for the entire industry indicates an important danger in trying to estimate the impact on an entire market by examining the impact on individual units, such as records. This potential fallacy of composition should be kept in mind whenever there are reasons to believe that the behavior of the whole may be different than the behavior of the individual parts (besides radio broadcasting, the example of file-sharing's impact on individual recordings vis-à-vis the entire recording industry come to mind). In these instances, the technology's impact on market shares can occur quite independent of the impact on overall market sales and it is important not to conflate share changes with overall market changes.

These problems highlight the difficulty of using any form of analysis to help regulators try to imitate markets. With a full property rights system in place, record companies could control how frequently their records were played and extract payments from radio broadcasters, or they might make payments to broadcasters as the case might be. A complete market solution would have a set of rights like the one between the television and movie industries. Record companies would be able to enter into whatever contracts they wished, including restricting the playing of songs to particular stations in particular localities. With this additional proviso, the market solution suggested by Coase, Caves, and Sidak and Kronemyer can be readily supported. In that case, the true value of the various rights could be determined where they are best determined—by direct observation in the market.

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IX. Appendix (available on request): Cross Section Results by Year

Because the simple cross section results are likely to be eclipsed in usefulness by the fixed effects results I do not included them in the main paper. Table x presents some of these results from for years 1998 and 2003. Our primary interest is in the coefficient on the time spent listening to music radio. As was the case in the text, we make the null hypothesis that radio play has a positive impact, in accordance with generally accepted beliefs, and for that reason use a one tailed test of significance.

Table x: Dependent Variable is Album Sales per Capita

	---------1998----------			---------2003----------		
	Pop&Cov	Coverage>.6	Coverage>.75	Pop&Cov	Coverage>.6	Coverage>.75
Daily Per Capita Music Radio (Hours)	-0.2684	-0.3407	-0.2231	-0.8985	-0.8684	-0.7406
	(0.162)	(0.164)	(0.300)	**<u>(0.004)</u>**	**<u>(0.012)</u>**	**(0.060)**
Average Household Income (000s)	0.0014	-0.0037	-0.0144	0.0038	-0.0035	0.0009
	(0.905)	(0.825)	(0.420)	(0.620)	(0.705)	(0.942)
Internet Access	2.8033	3.5014	3.7365	2.2326	3.2354	1.1920
	<u>(0.003)</u>	**<u>(0.004)</u>**	**<u>(0.008)</u>**	**<u>(0.013)</u>**	**<u>(0.005)</u>**	(0.325)
BA Degree or above	2.0535	1.3688	3.8211	1.4250	1.3102	3.1834
	(0.153)	(0.495)	**(0.076)**	(0.280)	(0.332)	(0.190)
Share 12-29	-1.4090	-1.8482	1.3650	-5.9985	-6.6625	-6.6705
	(0.319)	(0.354)	(0.481)	**<u>(0.004)</u>**	**<u>(0.001)</u>**	(0.117)
Share Males	-0.0535	-0.4676	0.6412	-2.5706	-5.7907	-6.3801
	(0.976)	(0.842)	(0.796)	(0.501)	(0.268)	(0.248)
Share 55+	-2.3272	-2.0592	-1.5963	-2.8457	-4.0333	-6.0944
	(0.063)	(0.224)	(0.397)	(0.165)	(0.115)	(0.118)
Share Minority	-0.1631	-0.1207	-0.0721	1.5137	1.4869	1.2157
	(0.705)	(0.831)	(0.902)	**<u>(0.002)</u>**	**<u>(0.011)</u>**	**(0.069)**
DMA Population	0.0025	0.0023	0.0019	-0.0003	-0.0006	-0.0018
	<u>(0.023)</u>	**(0.077)**	**(0.098)**	(0.776)	(0.661)	(0.195)
Constant	3.1779	3.7826	1.7483	5.9602	7.6909	8.9437
	<u>(0.032)</u>	**(0.080)**	(0.377)	**(0.086)**	**(0.088)**	(0.123)
Observations	94	62	42	92	66	47
R-squared	0.505	0.491	0.669	0.53	0.5	0.529

Robust p values in parentheses; p value for music radio is for one tail test; bold is sig at 10% level; bold underlined at 5%, bold double underline 1%

The measured relationship for each year is generally similar to that found with the fixed effects model. It appears strongly negative in 2003 although considerably less so in 1998. The music radio coefficients are inconsistent with the expectation that radio play is positive although the results for 1998 are sufficiently weak that we would have difficulty being able to say very much if we didn't have the superior fixed effects model to rely on.

Cities with populations having greater financial resources and media expertise would be expected to purchase more sound recording albums. Income, possession of the college degree and Internet Access all measure some dimension of this characteristic and are highly correlated with one another (~.6), although the Internet Access variable is related to file-sharing in 2003, as discussed in more detail in the main text. Although the coefficients on Internet use and college are generally consistent with this hypothesis, the income variable would be troubling. The results from the fixed effects model are very different and are far more reasonable than the results from the yearly regressions.

Demographic variables appear to play a larger role in the yearly regressions, although that might be due to the fact that the fixed effects pick up much of the demographic differences between cities. In the yearly regression an increased share of individuals over 55 appears to decrease record sales which would make sense since older individuals do not purchase many records according to RIAA surveys. Cities with larger shares of males and youthful individuals have lower record sales in 2003 but not in 1998, although file-sharing might be responsible for some of this since both groups are much more likely to engage in file sharing. Larger cities seem to be associated with greater record sales in 1998, but there is no impact in 2003. Minorities are associated with higher record sales in 2003, but there is no impact in 1998.

Of course, it is possible that none of these cross section results should be taken too seriously. It is generally understood that cross section results are often less reliable than similar panel data since panel data allow the control of fixed effects that might not be picked up in the cross section regressions. For example, there may be important differences between cities that we are not controlling for, such as the role of music in everyday life, technological and media knowledge, the importance of ethical or religious beliefs, immigration patterns, or family structure.