

**Peer-to-peer networks: Creative Destruction or just Plain  
Destruction?**

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The sales of music CDs have fallen dramatically in the last few years. A leading candidate among possible causes of this decline is the recent rise in file-sharing. The recording industry has tried to stem this decline by suing or threatening to sue individuals heavily engaged in file sharing. These law suits have attracted a good deal of publicity and discussion. A rather influential school of thought has formed in opposition to the corporate players in these industries, and these lawsuits have provided fodder for their critiques of traditional copyright.<sup>1</sup>

The motion picture industry has expressed concerns that its sales are likely to suffer a similar fate to that of the sound recording industry if nothing is done to stem the unrestricted use of file-sharing software. Owners of advertising-based mediums, such as television, are also concerned about their future viability if the advertising is stripped out of the programming and made available through file sharing networks, as is sometimes contemplated.

The very high profile of the music and movie industries has given the file-sharing issue a great deal of visibility. Although the revenues from these industries are only a small portion of GDP, these industries provide products that consume a large portion of our leisure time and tend to be recognized throughout the world.

At the center of the file-sharing debate is the empirical issue of whether or not file-sharing decreases sales.

Empirical work should always be informed by theory. In this paper I first explore some of the theoretical issues involved with file-sharing. I examine several theoretical factors that have been proposed to explain the behavior of file-sharers—substitution, sampling, network effects and indirect

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<sup>1</sup> These copyright critics, who are sometimes associated with the concept of the ‘creative commons,’ argue that copyright laws are being used by the sound recording, movie, and software industries so as to thwart competitive forces that would open up the market to new competition. This is the thesis of Laurence Lessig’s recent book *Free Culture* which views the current controversies as extensions of long-running debates regarding the power of cartels to monopolize access to creative works. In this view of the world, file-sharing is a wealth enhancing innovation, likely to democratize the entertainment industry by allowing artists to broadcast and distribute their works without intermediaries such as record companies. In this view, file-sharing systems should be promoted and if necessary, copyright law should be altered to allow file-sharing to proceed apace.

appropriability. One of the novelties of this analysis is the conclusion that sampling, the behavior most relied upon by those suggesting that file-sharing might have a benign impact on the industry, would actually have a negative impact. I conclude that of these factors, only network effects might have a positive impact on sales but suggest that this is unlikely to be an important factor. Thus economic theory would lead to an expectation that file-sharing should lead to a decline in sales relative to what they would have been in the absence of file-sharing.

I then turn to different methodologies that have been chosen in empirical examinations of this issue and I review these studies in some detail. I conclude that these studies tend to confirm what the theory predicts. Although some studies reach different conclusions, those studies appear to suffer from weak methodological choices or are based on questionable empirical specifications.

## **I. Background**

Sound recordings, movies, and television occupy the large bulk of our time spent on leisure activities, with the average American watching four hours of television and listening to three hours of music each day.<sup>2</sup> The advertising industry is primarily based around these industries, as is the consumer electronics industry, which would include all forms of stereo equipment, televisions, DVD players, VCRs, and so forth. Thus even beyond its share of GDP, its share of the collective consciousness and behavior of consumers is very large. It is also possible that its value to consumers might be much larger than that indicated by market revenues.<sup>3</sup>

The products of these entertainment industries have proven amenable to digitization, allowing them to be transferred over peer-to-peer file-sharing networks. Napster was the first well-known peer-to-peer file-sharing system, but others have followed in the wake of the preliminary injunction that

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<sup>2</sup> See Table No.909 “Media Usage and Consumer Spending: 1993 to 2003” in the 2000 US Statistical Abstract.

<sup>3</sup> Paul Romer conflates revenues and value in an otherwise thoughtful paper “When Should We Use Intellectual Property Rights?” *American Economic Review*, May, 2002, 213-216. He states: “The stakes in the battle over the music business are small enough to get lost in rounding error for world GDP of about \$30 trillion. However, this battle creates a “teachable moment” that could help frame policy in more important areas.” I would suggest that the interest in this topic reflects something more important than just a ‘teachable moment.’

effectively shut Napster down. Current replacements have surpassed Napster in popularity. Some Napster replacements are amazingly popular. As an example, Kazaa has been downloaded 350,000,000 times, Morpheus has been downloaded 125,000,000 times and iMesh has been downloaded 75,000,000 times from a single website.<sup>4</sup> It is estimated that file-sharing represents over one third of all material transferred over the Internet, and that music files are downloaded to the tune of .8 billion files per month.

In what follows I will focus on the sound recording industry because that is that market that has attracted the most attention. Since most computer users have enough bandwidth to download MP3 files and also have in place the requisite CD burners with which to allow the listening of this music in locations not tied to a computer, this is the arena where most file sharing is taking place. When bandwidth allows the downloading of high quality video files to take place in a matter of minutes, instead of the current length of hours, and when DVD burners become ubiquitous as are the CD writers, then movies, and to a lesser extent television, may become equally subject to file-sharing.

## **II. Economic Theory of File-Sharing's Impact**

One topic that has received too little attention in the recent literature is the theory underlying predicted impacts of file-sharing on the marketplace.<sup>5</sup>

One set of theories largely mirror the claims made in the Napster case by the opposing sides but there are additional theories as well. On the one hand, a downloaded file can substitute for the purchase of an original CD or single song. Substitution of a free alternative is easily understood to have a negative impact on sales. On the other hand, the claim has been made that users might merely use downloaded songs to become more familiar with potential music. Although this was originally referred

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<sup>4</sup> On the download.com website, as of mid May 2004.

<sup>5</sup> For discussions of the economics of copying and copyright see Watt (2004) or Varian (forthcoming).

to as the *exposure* effect,<sup>6</sup> it is currently called the *sampling* effect. Under this scenario users sample from available music and then purchase those songs and albums that are found to be most suitable to matching the tastes of the users. This sampling hypothesis is usually associated with a claim that sales will increase if consumers are allowed to become more familiar with the product before they purchase it, although, there has not been much analysis of this claim.

There is also a claim of potential network effects. As more downloaders listen to music, this theory goes, consumers derive greater value from their legitimate purchases. It is suggested that this might lead to an increase in the sales of CDs.

Finally, there is a possibility that sellers of original files can capture the value from later copiers indirectly in the price of originals, a concept known as indirect appropriability..

I examine each of these claims in turn.

### **A. Sampling**

Although it is often asserted that sampling would obviously be expected to have a positive impact on sales, the impacts of sampling are far more subtle. Indeed, a more complete analysis tends to lead one to expect that sampling would lead to a decrease in sales in this market.

The sampling story basically argues that file sharing allows consumers to experience music in a more complete manor prior to purchase than they would have been able to do were they to use the more traditional methods of learning about music: hearing it on the radio or at a friend's house. With file-sharing, listeners can become as familiar with the music as they wish, listening to it over and over again until they are sure they like it.

At that point, according to the sampling theory, the listeners go out and purchase the music through traditional outlets. A natural question is to ask why they would make a purchase when they

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<sup>6</sup> See Liebowitz 1981, 1985.

already have the item for free. There are several possible answers. First, they might be uncomfortable listening to music which they have not purchased. This discomfort might arise from a sense of honesty or a sense of wishing to support their favorite musicians. Alternatively, listeners might get to know three or four songs on an album which then allows them to feel comfortable buying the entire album and avoid the efforts involved with downloading another 6 songs.

Assuming that sampling occurs in the manner described above, what would be the likely economic impacts of sampling?

Assume that those engaged in sampling have no intention of listening to MP3 files after the sample period. Instead, they either purchase the music or throw it away. This is a pure analysis of sampling independent of any pirating motive.

I am not aware that any proponents of the sampling story have attempted to fill in the details of the pure impact of sampling.<sup>7</sup> Presumably, after sampling, consumers have more information about which CDs to purchase allowing them to purchase CDs that provide greater utility than they would have purchased without sampling. Although it is natural to think that consumers would be led to purchase more CDs if CDs can provide greater utility than they did without sampling this is not necessarily the case.

To see this it helps to think of a CD as a candy bar, following a line of reasoning developed by Jack Hirshleifer (1971).<sup>8</sup> Each individual consumer has particular tastes in music and some CDs are

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<sup>7</sup> The closest might be a paper by Gopal, Bhattacharjee, and Sanders (forthcoming). They attempt to analyze the theoretical impacts of file-sharing using a fairly typical model. Sampling plays an important role in their model but they do not analyze the impacts of sampling by itself. If the full cost of sampling were zero, consumers in their model would sample all music, in order to find the most highly valued music. Whether they would then purchase the preferred music depends on other costs, such as costs of punishment if caught pirating, the sound quality differentials between sampled and purchased music, and the revealed value of music. If sound quality was identical between original and copies and if there were no punishment if copying, consumers would completely pirate and purchase no music.

<sup>8</sup> By working with the underlying characteristic of the good we can avoid the heterogeneity problem brought about by the fact that CDs are not perfectly homogenous. This is done by assuming that CDs are differentiated by containing different quantities of the underlying music-listening service characteristic. This keeps the analysis simple. It also allows the analysis to treat the indirect valuation of copiers as altering the quantity of music services created by the original as an analog to increasing durability of a product. I provide this type of analysis in Liebowitz (1982a).

better than others as far as satisfying these tastes. Consumers, after all, do not derive utility from the CDs *per se* but derive enjoyment from listening to the music contained within the CD. The underlying demand can be thought of as the demand for music-listening services, which is met to differing degrees of success by various CDs. Those CDs that better satisfy the consumer can be thought of as providing more music-listening services within the fifty or so minutes of music contained within the CD. Since those CDs contain more of what the consumer wants, they can be analogized to providing consumers larger candy bars containing more of the candy which the consumer ultimately desires.

An equivalent analysis is to think of sampling as reducing the risk associated with the purchase of a CD. If consumers are not sure whether they will like the music on a CD they will consider it a somewhat risky purchase. Sampling has the possibility of reducing or removing this risk. What this means is that sampling allows consumers to achieve greater expected utility with a CD purchase than they would have achieved without sampling. At a given price of CDs, the cost of the expected satisfaction gained by consumers falls. Again, it is equivalent to putting more expected yummy music services in each CD.

It is natural to think that if candy bars remain constant in price while increasing in size, that the quantity of candy bars sold will increase. After all, each large candy bar provides more utility than a small candy bar. This is apparently the thinking of those claiming that sampling MP3s increases the sales of CDs.

The story, however, is not so simple.

First note that the price of candy is effectively lowered when the bar becomes bigger holding the price of the candy bar constant. If the demand *for candy* is elastic, then revenue in the market will increase when candy goes down in price, as it does when constant-price bars become larger. If revenues increase in this way, and the price of bar is unchanged, then more candy-bars are purchased. The inverse of this story will hold when the demand for candy is inelastic. Making candy bars larger

rotates the demand curve so that it is higher at small quantities but lower at large quantities—in other words, the demand curve becomes steeper. Satiation occurs at a smaller number of bars since each bar is bigger.

A simple analogy can be made to the introduction of cable television. Cable allowed viewers accustomed to having a choice of only a handful of broadcast signals to have a choice of dozens of channels. This should have increased the probability that viewers would find, in any half hour period, a program more to their liking than they were likely to have found with only the limited original choices. The analogy to the sampling hypothesis is very strong since allowing greater choice in a thirty minute television time slot is similar to providing information allowing greater choice in the selection of a CD.

Previous research examining the impact of increased viewer choice on total time viewing television tended to find that that providing more choice to consumers did *not* increase the time they spent viewing television.<sup>9</sup> Thus the claim that providing consumers the ability to fine-tune their product selections need not increase their consumption is seen to have real-world explanatory power.

Understood in this way, it becomes clear that better information about the product might lead to either an increase or a decrease in the number of units sold. Equivalently, it might lead to either an increase or a decrease in revenues. This was a conclusion I had reached in previous work (Liebowitz 2004). There is, however, some additional information in this market that helps to resolve this imprecision.

CDs are thought to have low variable costs of production and high fixed costs. It is common in theoretical models of markets like software or music to assume a zero marginal cost of production.

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<sup>9</sup> See Liebowitz (1982) who compares the link between viewing hours and cable penetration across different Canadian metropolitan areas and finds an insignificant but sometimes negative relationship. Also see Weimann (1996) who examines viewers in Israel after the introduction of a multi-channel cable system where previously there had been but a single public channel (a more extreme increase in choice than would normally be found). After a year, there was virtually no difference in changes in viewing between a group with cable and a control group that did not receive cable (the cable group increased its viewing by 16 minutes over the control group).

Although this is merely a theoretical convenience, since the variable costs are clearly not zero, variable costs do appear to be quite low in the case of sound recordings.

What are some of these variable costs? The cost of a blank CD is only a few cents and the pressing of CDs appears to be less than a dollar. Although the artists normally receive a royalty that is expressed as a function of sales, those payments are usually paid up-front as a non-refundable advance against future royalties, so for most units sold, marginal royalties to the performers are effectively zero. Promotional costs for CDs are also usually also taken out of up-front advances, removing another potential variable cost from the variable cost column. There is a variable payment made to the composers of songs that are included in the CD, however, with a statutory maximum payment of approximately seventy cents per CD.<sup>10</sup>

It seems reasonable to conclude, therefore, that variable costs are quite low relative to the wholesale price of CDs, which is in the vicinity of twelve dollars.<sup>11</sup>

This datum of low variable costs provides some important additional information about elasticity of demand facing each CD. Profit maximization, when marginal costs are zero, is equivalent to revenue maximization. The elasticity of demand must be one at the profit maximizing price chosen by sellers of CDs.

The elasticity of demand for CDs maps directly into the elasticity of demand for music-listening services. If the price elasticity of demand for CDs equals one, so too must the price elasticity of demand for music-listening services. After all, if the marginal revenue of another unit of music service is negative, so too must be the marginal revenue of the CD containing that unit.

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<sup>10</sup> This is a compulsory license which amounts to ninety cents for each CD. In the common case where the performer is the composer, however, it is typical for there to exist a “controlled composition” clause which pays less than (75% appears to be a typical rate) the statutory payment.

<sup>11</sup> If the composer is not the performer of the song, and if the song has not been recorded, this payment will be negotiated. After a song has been recorded by one performer, however, anyone can record the song if they purchase a ‘compulsory license’ which is the statutory payment described in the text

<sup>11</sup> According to statistics on the RIAA web page, the average price in 2003 was \$11.91.

Because there is competition between record titles, we should expect that the elasticity of demand for music-listening services (whether defined by musical genre or the entire industry) will be less than the elasticity of demand individual firms or individual record titles, for the same reasons that industries have lower elasticities than their constituent firms. This implies that the elasticity for the industry will be less than one.

It matters little, however, whether the price elasticity is less than one or equal to one. In either case revenues (and profits) fall when the price is lowered.<sup>12</sup> The effect of sampling (more music-listening services at a constant CD price) is to lower the price of music-listening services. The net effect should be to lower the revenues generated by music-listening services. With a price per CD that is independent of the sampling effect, this implies that the quantity of CDs will fall due to sampling. This analysis assumes, as does the candy bar problem, that the price of CDs is exogenous to the change in music-listening services created by CDs.

This is quite the opposite of the claim that is most frequently made for sampling.

### ***B. Substitution Effect***

The substitution effect is quite simple to analyze. The copy is treated as a substitute for the original. If the copy is identical or close in quality to the original, and if the cost of making the copy is low, the copy for a price of zero dominates the original at its positive price.

This is most appropriately modeled as a decrease in demand. The substitution effect can only work to reduce the price and quantity sold in the market.

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<sup>12</sup> Boldrin and Levine (2003) assume that elasticity is greater than one in order to generate their results, discussed below.

### **C. Network Effects**

Some products have network effects. These occur for a product when consumers' values of the product change depending on the number of other users there are of the product. Telephones and fax machine are two examples of products where the value of those products depends on the number of individuals using those products.

It has sometimes been claimed that network effects might be important to understand the impact of copying. Conner and Rumelt (1991), Takeyama (1994) and Shy and Thisse (1999) each examine models where the existence of unauthorized users creates additional value to the purchasers of legitimate copies and thus might increase the profits of the seller. These models are usually put forward in the context of software, although they might also be applied to file-sharing.<sup>13</sup>

There are several issues to be addressed in the context of possible network effects for sound recordings. The first is whether there are network effects at work. Contingent on network effects existing for sound recordings, a different issue is whether those network effects work merely to shift demand among different sound recordings or whether they work to alter the size of the market. A third issue is the nature of the impact of network effects—are they local or global—does the totality of usage matter, or just the number of individuals using the product who personally know one another?

The network effects story applied to file-sharing is relatively straightforward. File-sharing is likely to increase the number of music listeners since file-sharing provides access even to those who are unwilling to pay for it.<sup>14</sup> If there are more listeners to the music, even if the additional users were

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<sup>13</sup> It is unclear how strong network effects are for different categories of software. For some categories, such as personal finance software, network effects might be expected to be weak or nonexistent. In other cases, such as spreadsheets network effects are thought likely to be large. Although there have been attempts to measure the strength of network effects for spreadsheets, these attempts were marred by using Lotus 1-2-3 file compatibility as measure of network effects when such compatibility was also important for upgrading spreadsheet users wanting to remain compatible with their old work independent of any network effects.

<sup>14</sup> It is possible that listening to file-shared music might merely replace listening to the radio or listening to purchased music. File-sharing, however, does allow more precise choice of music than could be achieved by radio listening.

merely among the file-sharers, the value of music for non-file-sharing individuals might increase and the non-file-sharers would then purchase more music.

Before we accept this possibility of network effects, however, we need to understand possible mechanisms that might lead to network effects. The question is: do consumers derive value from other individuals listening to the same music they listen to? Unlike telephones, where network effects are obvious, or software, where the ability to transfer files might be important, the linkage of values between different music listeners is far less clear.

i. Local or Global Network Effects?

As normally modeled, network effects depend on the number of other users of the product. This would be a global network effect where only the total number of users counts, not the identity or locations of specific users. If you are in the habit of selling products over the telephone, network effects from telephones might well be global—you don't care who or where your customers are, as long as there are a lot of them.<sup>15</sup>

On the other hand, most potential network effects are likely to be local—you care mainly about calling certain individuals, you plan to transfer files with a few particular colleagues, you discuss movies and music with your friends. In these cases the total number of users of a product is largely irrelevant to you.

The first question is whether the activity of music-listening is subject to either local or global network effects to any important extent. This is a difficult question to answer. When a musical composition/performance becomes popular it might be due to some innate quality within the music, combined of course with some form of information, be it radio play, newspaper and magazine reviews, or word of mouth. On the other hand, it might be due some self-reinforcing network effect.

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<sup>15</sup> It is likely that for indirect network effects, where the price of some secondary item (such as repair service) is impacted by the number of users, that the identity of the users doesn't matter much and that the network effects are global. In the case of file-sharing, however, network effects, to the extent that there are network effects, would seem to be of the direct variety.

If network effects are global in nature then it isn't clear how file-sharing could impact sales since file-sharing doesn't usually show up in global measures of music popularity, which are normally based upon purchased CD sales or airplay.<sup>16</sup> If consumers care about the total universe of users they can only estimate the number of users from these publicly available statistics.

Local network effects, on the other hand, suggest that CD purchasers interact with friends who engage in file-sharing and then are influenced by their friends file-sharing musical tastes.

There is also the question of whether network effects, if they exist for musical works, have the impact mainly of shifting output from one musical composition to another or whether they have the impact of changing the overall size of the market. Normally, network effects are thought to increase the value of products as networks get larger. Products have some autarky value independent of network effects which can then be enhanced as the size of the network increases, as would be the case for computers and the Internet. In this instance network effects can only increase the value of products and the size of markets. It is possible, however, that network effects can lower utility below the autarky value—e.g., an unpopular restaurant that loses patrons who do not want to be seen as 'uncool'. In this latter case network effects need not increase the overall value or size of markets. If network effects work mainly to allocate utility from one CD to another depending on shifts in popularity, but do not increase the overall utility of CDs in general, then they can have a neutral or negative impact on overall sales.

## ii. The Nitty Gritty of Network Effects in Music

What might be the nature of network effects in music? Although it is almost certainly a common event that one person hears music at a friend's house and decides to buy it, that is not sufficient for a network effect to exist. Just hearing new music is merely a form of sampling. For it to be a network

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<sup>16</sup> Websites such as BigChampagne.com purport to measure popularity of downloads (although it is apparently uploads that they measure) and it is possible that such measures might become part of the public information about popularity.

effect, the value of the music once it has been heard must be higher because friends like it than would otherwise be the case. Music that is part of group activities, such as dancing, are good candidates for network effects since the value of one person likely depends on the enjoyment of other persons. Even so, music listened to as a part of group activities implies that one of the group members already has that music. Whether the other members are likely to purchase the music themselves to enhance group consumption would seem to be questionable. In the case of file-sharing, a network effect would exist when a person who doesn't file-share purchases music that his file-sharing friends can enjoy when they come over to visit. These do not appear to be powerful network effects, so as a practical matter, therefore, network effects from file-sharing would seem likely to be weak.

Although it is conceivable that network effects could play a role in the overall sale of CDs, and it is conceivable that file-sharing could increase overall usage sufficiently that CD sale might increase, it seems unlikely to be more than a minor impact.

The only test of network effects on record sales that I am aware of is indirect—looking at the impact of radio on record sales. Again, network effects from radio listening need to be separated from the sampling effects from radio, which is a more obvious impact

One might argue that radio play is more likely to exhibit global network effects. Global network effects are possible with radio since radio play is one form of communicating what 'everybody' is listening to. If individuals derive value from being part of the crowd, then there would be global network effects from radio play. Second, local network effects are also possible since groups can sit around listening to the radio and commenting on the songs. This might increase sales for those individuals wishing to make their friends happy in exactly the same manner as it might for file-sharing.

Undoubtedly, radio play influences the sales of records. Its main impact, however, seems to be to shift sales from one recording not receiving airplay to other recordings that do receive airplay. This conclusion is reached in Liebowitz (2004a) who examined two instances where radio broadcast did not

increase overall record sales. In the first instance, the introduction of radio in the US in the 1920s, the sale of sound recordings fell dramatically. In the second instance, the introduction of private radio stations in the UK during the last three decades of the twentieth century led to no increase in the sales of records. Although these results were not meant to be tests of network effects *per se*, they are certainly inconsistent with the possibility of strong network effects.

#### ***D. Indirect Appropriability***

The final impact of copying that might apply to file-sharing is indirect appropriability. This is a concept coined in Liebowitz (1985) and analyzed for the case of file sharing in Liebowitz (2002) which I summarize below. It has recently been brought up by Boldrin and Levine (2003) whose work was then critiqued by Klein and Murphy (2003). The basic idea is that originals from which copies are made might undergo an increase in demand as those making copies of originals capture some of the value from those receiving the copies and transfer this value into their demand for the originals that they purchase.

If, for example, everyone who purchased a CD made one cassette to play in their automobile, then the demand for the original CD would increase by the value of being able to make the tape and the sellers could capture some of this higher value by increasing the market price, as would happen when demand increased. This value is captured indirectly since there is no direct payment made for the copy.

In order for indirect appropriability to work, however, one of two conditions must hold. First, the variability in the number of copies made must be small, as in the example above. Or else the seller needs to be able to charge higher prices for those originals from which the most copies are made as in the real world example of photocopies. The most heavily photocopied copyright materials are journals, and most photocopying of journals takes place in libraries. Thus publishers of journals were/are able to charge higher prices to libraries than they charge to individual subscribers to take account of

photocopying and indirectly appropriate some of the value from copying. Support for this thesis came from empirical work revealing that such price discrimination was practically unheard of prior to the advent of the photocopier, and the most heavily copied journals were also those with the greatest price differential.

Contrary to the claims of Boldrin and Levine, indirect appropriability will not work for file-sharing, however. Because there is great variability in the copies made from each original, and sellers of originals cannot identify which originals are going to be used on file-sharing systems, the mechanisms that allow indirect appropriability to function will not work.

### **III. The Prima Facie Case against File-sharing**

Data on the sales of recorded music tend to be available on a yearly basis from organizations of record producers, such as the Recording Industry Association of America (RIAA) and the International Federation of the Phonographic Industry (IFPI). The United States is by far the largest single market.

Figure 1 represents the per capita sale of full-length albums sold in the United States since 1972.<sup>17</sup> The recent decline in sales is readily apparent. Clearly, there are yearly fluctuations in this series. These statistics indicate a somewhat smaller decline than usually suggested by the industry since I have stripped out the impact of ‘singles’ because their decline appears to be part of a much longer secular decline quite separate from file-sharing. Nevertheless, the current decline stands at thirty percent.

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<sup>17</sup> Data on quantities were reported beginning in 1973. For prior years only the industry revenues were reported. The data on revenues tend to be estimates based on the list price of recordings. I use full-length albums to avoid measurement problems as, for example, with singles, as they have been in a twenty year secular decline.