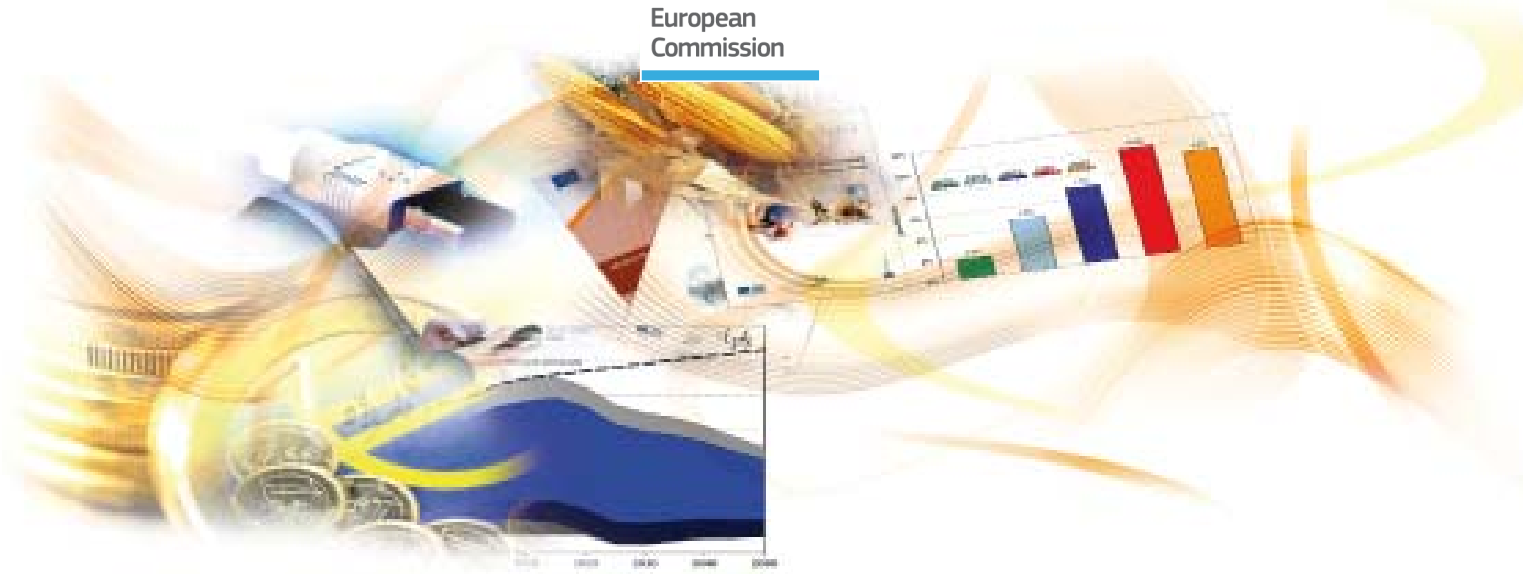




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Digital Music Consumption on the Internet: Evidence from Clickstream Data

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Abstract

The goal of this paper is to analyze the behavior of digital music consumers on the Internet. Using clickstream data on a panel of more than 16,000 European consumers, we estimate the effects of illegal downloading and legal streaming on the legal purchases of digital music. Our results suggest that Internet users do not view illegal downloading as a substitute to legal digital music. Although positive and significant, our estimated elasticities are essentially zero: a 10% increase in clicks on illegal downloading websites leads to a 0.2% increase in clicks on legal purchases websites. Online music streaming services are found to have a somewhat larger (but still small) effect on the purchases of digital sound recordings, suggesting complementarities between these two modes of music consumption. According to our results, a 10% increase in clicks on legal streaming websites lead to up to a 0.7% increase in clicks on legal digital purchases websites. We find important cross country difference in these effects.

Keywords: Digital Music, Copyright, Downloading, Streaming.

JEL classification: K42, L82, L86, Z1.

1 Introduction

The impact of music piracy on legal sales of music has been studied extensively in the empirical literature, focusing mainly on legal music sales in the form of physical CDs. Most studies find that piracy harms revenues, with estimated sales displacement rate far below one. That is, music consumers are found to substitute legal music consumption for illegal music consumption, but much of what is consumed illegally would not have been purchased if piracy was not available. There is a rather clear consensus on the negative effects of online piracy on the off-line physical sales of recorded music. Less attention has been paid, however, to the effect of online illegal music consumption on the online legal sales of digital music. Since the launch of the iTunes music store in 2003, the availability to purchase legal digital songs changed individuals' music consumption alternatives. Instead of having to buy a whole CD, the alternative to downloading any particular digital song illegally is now to purchase it in MP3 format. As emphasized in Waldfogel (2010), the appearance of file-sharing and downloading technology might have different effects on sales, depending on whether the legal option is a 12-song CD or à la carte songs. Consider an individual interested in a few songs of a given artist. While she may not consider buying the entire album (which also contains unknown songs) when offered the possibility to freely download these specific songs, she might nevertheless be willing to pay for them individually. The effect of downloading on individual songs and albums may therefore be different, and one can easily imagine a circumstance in which file-sharing would hurt album sales more than it hurts song sales.

The first contribution of this paper is to revisit the question of sales displacement in the digital era, adding evidence to a fundamental debate in the economics of copyright. Second, we analyze how online music streaming affects the purchases of digital music, a question that has received very little attention in the empirical literature thus far. Finally, a key contribution to this paper is the originality of its dataset, which helps us circumvent the inherent difficulties in studying illegal behavior such as file-sharing. Our approach relies on a novel dataset that enables us to follow a large sample of Internet users and their online behavior in five EU countries during 2011. For each of the individuals in our sample, we observe both information on demographic characteristics and on the webpages visited during the year. This allows us to identify specific visits on websites related to music consumption, both legal and illegal. Tracking individual online behavior also allows us to construct other variables reflective of otherwise unobserved characteristics, such as taste for music. All of these features, combined with the panel structure of our data, allows us to control for many forms of unobserved heterogeneity that would otherwise jeopardize the identification of a causal effect of illegal downloading (and legal online streaming) on the legal purchases of digital music.

Perhaps surprisingly, our results present no evidence of digital music sales displacement. While we find important cross country differences in the effects of downloading on music purchases, our findings suggest a rather small complementarity between these two music consumption channels. It seems that the majority of the music that is consumed illegally by the individuals in our sample would not have been purchased if illegal downloading websites were not available to them. The complementarity effect of online streaming is found to be somewhat larger, suggesting a stimulating effect of this activity on the sales of digital music.

Taken at face value, our findings indicate that digital music piracy does not displace legal music

purchases in digital format. This means that although there is trespassing of private property rights (copyrights), there is unlikely to be much harm done on digital music revenues. This result, however, must be interpreted in the context of a still evolving music industry. It is in particular important to note that music consumption in physical format has until recently accounted for the lion's share of total music revenues.¹ If piracy leads to substantial sales displacement of music in physical format, then its effect on the overall music industry revenues may well still be negative.

We cannot draw policy implications at the industry-wide level, as our analysis is only confined to the digital segment of the music industry. Nonetheless, digital music revenues to record companies are growing substantially. They increased more than 1000% during the period 2004-2010, and grew 8% globally in 2011 to an estimated US\$5.2 billion, reflecting the importance of digitization in the music industry (IFPI, 2011, 2012).² From that perspective, our findings suggest that digital music piracy should not be viewed as a growing concern for copyright holders in the digital era. In addition, our results indicate that new music consumption channels such as online streaming positively affect copyrights owners.

The remainder of the paper is organized as follows. Section 2 summarizes the underlying theory as well as the relevant literature on the subject. It presents the results of the main empirical studies on the effects of piracy on record sales. Section 3 presents the data and the different variables used in the estimation. Section 4 presents our empirical approach and the results of our estimations. Finally, section 5 discusses the results and concludes.

2 Theory and Related Literature

Economic theory does not provide a clear prediction for how illegal downloading should affect legal music consumption.³ The crucial point is to know whether illegal consumption (the downloading of an album or a song) would have been converted into legal consumption (the purchase of that same album or song) in the absence of illegal consumption channels. If the albums consumed through illegal channels are valued above their price by the consumer, then there is indeed sales displacement: the consumer would have bought the album had she not downloaded it. If, however, the consumer's valuation is below the album's price, then no sales displacement occurs: the consumer would not have bought the album had she not downloaded it. Given the heterogeneity of consumers, the willingness to pay will be above the market price for some and below the market price for others, leading to an average displacement rate between zero and one. Considering this simple static configuration, it follows that the availability of illegal music consumption channels unambiguously increases welfare.⁴ All instances of sales displacement will simply convert some of the producers' revenues into consumers surplus, while illegal consumption from low valuation indi-

¹In the case of the UK, it is indeed only in the first quarter of 2012 that sales from digital sales surpassed sales of traditional CDs and records for the first time, see <http://www.guardian.co.uk/media/2012/may/31/digital-music-spending-bpi><http://www.guardian.co.uk/media/2012/may/31/digital-music-spending-bpi>.

²This compares to growth of 5% in 2010 and represents the first time the year-on-year growth rate has increased since IFPI started measuring digital revenues in 2004 (IFPI, 2012).

³We will use the terms downloading and file sharing interchangeably to refer to illegal music consumption in the remainder of the text.

⁴Note that this leaves out the dynamic considerations of the issue.

viduals (individuals with valuations lower than the price) will increase consumer surplus without hurting revenues (Rob and Waldfogel, 2006; Waldfogel, 2010).

Illegal music consumption could also, in theory, stimulate legal music consumption. Since music is an experience good, file sharing can allow consumers to sample specific songs or albums which can inform them on what to buy. Similarly, the sampling of a specific song may stimulate individual demand for other songs by the same artist (Shapiro and Varian, 1999; Peitz and Waelbroeck, 2006; Belleflamme and Peitz, 2010).

Given all these considerations, the question of whether consumers' ability to illegally obtain free recorded music displaces legal music consumption remains an empirical one. An important and still growing amount of research has explored this question, using different data sources and different approaches. The reasons for the inherent difficulty in measuring the effect of illegal downloading on legal music sales are twofold. First, downloading is an illegal behavior, which renders its measurement difficult. It is therefore not easy to obtain data on unpaid consumption nor to link it to data on paid music consumption. Second, assuming that such data is available, identifying the causal effect of downloading on legal purchases is made difficult by the non-experimental nature of the data. The main challenge to overcome is the existence of unobserved heterogeneity that renders the downloading variable potentially endogenous.

Empirical researchers have pursued different types of strategies to come around these difficulties. A first set of papers uses time series data at the geographic level in order to compare the music sales levels in different locations over time. The main idea is then to ask whether places with higher levels of piracy (typically proxied by measures of Internet broadband penetration) present lower levels of sales. Some studies following this approach include Hui and Png (2003), Peitz and Waelbroeck (2004), Zentner (2009) and Liebowitz (2008), all of which find some displacement of physical music purchases by illegal downloads.

A second category of papers uses product level data (i.e. record data) to see whether records that are downloaded more are purchased more or less. Some researchers have used natural experiments to identify the causal effect of piracy on sales. Danaher et al. (2012) use the HADOPI graduated response law in France as an exogenous shock and compare iTunes music sales in France to sales in a set of other European countries. They find that HADOPI caused a 22.5% increase in song sales and a 25% in album sales relative to sales in the control group, which is consistent with Internet piracy displacing legal iTunes sales.

Often lacking such natural experiments, other researchers have used an instrumental variable approach to deal with the endogeneity of piracy. In a widely cited paper, Oberholzer-Gee and Strumpf (2007) construct a weekly panel of album sales and illegal downloads. They use the number of German secondary school students who are on holidays in specific weeks as instruments for downloads and find that file sharing has an effect on sales that is statistically indistinguishable from zero.

The third approach used in the empirical literature is to use individual-level (survey) data, asking whether consumers who engage in illegal music consumption engage in more or less paid consump-

tion.⁵ When using cross-sectional data, the presence of unobserved heterogeneity across individuals (in particular music taste) is an important obstacle to the identification of the causal effect of downloading on legal purchases. Using a survey administered to U.S. university students in 2003, Rob and Waldfogel (2006) rely on an instrumental variable approach with access to broadband as a source of exogenous variation in downloading. They find that each album download reduces purchases by about .2 in their sample. Zentner (2006) follows a similar approach using a cross-section of 15000 European individuals in 2001. Instrumenting for piracy using Internet connection speed as well as levels of Internet sophistication, he finds that people who self-report downloading music are also less likely to have recently purchased music.

As highlighted by Smith and Telang (2012), there are two main interpretation challenges that arise when using a survey-based approach. First, the conclusions are, inevitably, tied to the chosen sample. This is problematic if one believes that the sample is not representative of the overall population of interest. Although a study based on a sample of university students may still lead to insightful results, one cannot generalize them to a population other than the one of college students. Second, surveys can be affected by inaccurate recall or obfuscation from the respondents. In particular, individuals may voluntarily under- or over- represent their actual purchase or illicit behavior.

Although some specific papers fail to find evidence of sales displacement, the emerging consensus on the effect of piracy is that unpaid consumption depresses music sales. The displacement effects found are, however, typically less than 1, indicating that much of what is downloaded would not have been purchased in the absence of illegal consumption channels.

With the exception of Danaher et al. (2012), all of the above studies use data drawn from times in which the standard legal option offered by the music industry was a physical CD. Using two surveys of undergraduate college students, Waldfogel (2010) analyzes the effect of piracy when legal digital options are available. He finds, however, that the rate of sales displacement in both samples is similar to the one observed before legal digital options were available. More specifically, each additional downloaded song is found to reduce paid consumption by between a third and a sixth of a legally purchased song.

A number of recent studies show results that go in the opposite direction. Bastard et al. (2012) use survey data on a sample of 2000 French individuals. They find that while piracy has a negative effect on the probability to purchase music in CD format, it has a positive effect on the probability of downloading music legally. Hence legal music downloading and piracy are complements rather than substitutes in their sample. In a recent study, Hammond (2012) focuses on pre-release file sharing, in which file sharers download sound recordings that are not yet publicly available. Using instrumental variables to deal with the endogeneity of file sharing, he finds that the causal effect of file sharing of an album on its sales is essentially zero. Finally, DangNguyen et al. (2012) is, to our knowledge, the only empirical study that analyzes the effect of streaming on music purchases. Using survey data on French consumers, they find that consuming music as streams has no significant effect on CDs purchases but is a complement to buying music online. Our findings are in line with the results of this recent research.

⁵See also Rob and Waldfogel (2007) and Bai and Waldfogel (2012) for the case of movie piracy.

The limited number of studies analyzing the effect of piracy on sales in times when consumers are offered legal digital alternatives therefore offers rather mixed results, calling for further research on that specific question. While the literature on digital music is still scarce, some findings related to other digital media suggest that this is indeed a crucial question that needs to be tackled. For the case of television content, Danaher et al. (2010) find that the lack of availability of legal consumption channels is indeed causally associated with increasing piracy.⁶

3 Data and Variables

3.1 The Data

The original data on which we rely comes from Nielsen NetView, which is Nielsen’s Internet audience measurement service. It uses metered measurement of representative panels of Internet users to track usage across websites and digital applications. The service also reports demographic information on the Internet users. Nielsen initially aims at gathering a sample that is representative of the overall Internet audience at home for people aged at least 2 years old and with access to Internet in each country.

The Nielsen Clickstream Data provides a very rich set of information on both consumers’ demographic characteristics and online behavior. The sample that we have available contains information on 5000 individuals for each of the five largest European economies: France, Germany, Italy, Spain and the UK. First, we have access to information about the socioeconomic characteristics of each user. In particular, we observe gender, age, education, occupation, household income, household size, presence of children in the household and region of residence. Second, the original database contains all the clicks of each of the 25,000 Internet user for the period going from January 1st, 2011 to December 31st, 2011. For each of these clicks, we observe the URL of the webpage visited and the time at which it was visited, the duration of time that the webpage is viewed and a classification of the webpage according to its content. There is a total of 15 different categories, which contain a total of 83 subcategories.

The main task that needed to be carried out was the identification and classification of websites related to music consumption. By that we mean websites whose direct purpose is the listening of music. These can take several forms, which constitute our different categories of music consumption: music downloading, music streaming, music-video streaming, and radio. The downloading and streaming categories can further be divided into legal and illegal websites.⁷ We will restrict our analysis to the sample of individuals who consume music through legal purchases, illegal downloading or legal streaming, meaning that we leave out the individuals that never visited one of these specific music consumption websites during 2011. We consider individuals aged between 10 and 75. The focus of our study is to analyze the relationship between several channels of digital music consumption, and in particular on the causal effect of illegal downloading and legal streaming on

⁶Although they find that piracy depresses international box-office revenues, Danaher and Waldfogel (2012) obtain results consistent with Danaher et al. (2010) in the case of US box-office revenues. For another study related to movie piracy, see Peukert and Claussen (2012).

⁷The observations on illegal music streaming websites are quite scarce in our data set.

legal purchases of digital music. We therefore focus on individuals that are involved in either one of these three activities. After dropping individuals with missing values, we are left with a total of 16,290 individuals.⁸

3.1.1 Websites

We identified a total of 2,759 music consumption related websites in our database, which amounted to a total of 5,054,389 clicks during 2011. The classification of websites was done by going on the mostly visited ones and checking their purpose and origin. We decided to restrict our attention to the websites that had received more than 300 clicks during 2011, leaving us with a total number of 779 websites to check manually.⁹ Since the distribution of clicks is very concentrated on specific websites, our selection of websites covers 4,956,243 clicks, i.e. 98% of the total clicks.

It is important to note that we are only able to observe the number of clicks on a given website and that we do not have a precise description of the individual behavior for each click. Rather than measuring actual consumption or purchases, our data therefore gives a measure of the propensity to consume music. We believe, however, that this is still a good approximation to actual consumption. We see no specific reason for which an individual would go on a music-consumption website with other purposes than to consume music. While this is especially true for illegal downloading and legal streaming websites, the proportion of clicks that lead to a purchase for visits on legal purchasing websites could be expected to be lower due to simple browsing activity. Still, we believe that this (possibly) lower fraction of purchasing-clicks does not reflect any particular individual characteristic. In particular, we do not expect individuals to go window-shopping on legal purchasing websites in order to illegally download after their visit. First, information on specific albums, songs or artists can be found on other music-specific websites, so it is not clear why consumers should use legal purchasing websites for such purposes. Second, we believe information on songs' prices to be almost perfectly known to consumers before they go on legal purchasing websites, ruling out visits solely related to price information seeking.¹⁰

Our analysis is also affected by another related feature of the dataset. Many large retailers such as Amazon sell, among many other things, music in digital format. Our inability to observe precise consumer behavior within each website therefore prevents us from classifying any visit on websites such as Amazon in a music consumption category.¹¹ Last, visits on illegal peer-to-peer file sharing

⁸Missing values come mainly from the demographic variables, where some individuals failed to respond. Note that our panel can be constructed at pretty much any time dimension. We have constructed one version at the week level (52 observations per individual and one version at the month level (12 observations per individual). As expected the weekly version contains many more 0 values than the monthly version.

⁹Notice that the total number of visits (clicks) accounts for the overall database. Less than 300 clicks therefore means less than 1 visit a day among 25,000 individuals in 5 different countries, a rather small number.

¹⁰From a purely econometric point of view, our inability to distinguish between purchasing and non-purchasing clicks on legal purchasing websites is equivalent to a measurement error problem in the dependent variable. Since we do not expect the error component of our measure to be correlated with our measures of illegal downloading and legal streaming, the consistency of our estimates will not be affected.

¹¹Supposing that we could include the clicks corresponding to legal purchases of digital music on such websites, our final measure of legal purchases would be larger (or at least no lower) for each individual in the sample. In other words, our current measure of legal digital music purchases is lower than the true one. We should therefore expect to have a downwards bias on our estimates, i.e. a bias toward finding substitution between illegal downloading (legal streaming) and legal purchases.

websites do not allow us to differentiate between the file sharing of music files and other types of files such as movies or books. We believe, however, that this variable is still a very good proxy for the ability to obtain recorded music without paying.

3.1.2 Variables

Our econometric specification requires the construction of a set of variables that measure or proxy the determinants of legal digital music purchases. Aside from the type of individual socioeconomic characteristics mentioned above, we need variables related to the individual's online activity. First, we expect some other forms of entertainment to be related to the consumption of digital music. For each individual, we therefore consider the number of clicks on websites related to the following activities: online shopping, books & magazines, events, cinema and CDs purchase.¹² Second, we can use information on the visits to specific types of website as a proxy for individuals' taste for music. Individuals with a strong interest in music are indeed more likely to visit music-related websites such as radio and music-video websites. We also consider websites that are related to music but not to direct music consumption. These include websites related to music news, songs' lyrics or musical instruments. We finally also consider a variable that gives the total time spent online on all the websites of our dataset.

3.2 Descriptive Statistics

The following subsection presents some characteristics of the individuals in our sample. We then look at descriptive statistics on the online music consumption behavior for these individuals.

3.2.1 Music Users Characteristics

Table 1 presents some characteristics of the music users that constitute our final sample. Individuals are, not surprisingly, quite evenly distributed among the 5 different countries and in terms of gender. Almost half of the individuals in the sample have between 31 and 50 years of age, while more than 25% is less than 30 years old.¹³ More than 65% of the individuals is employed, with close to 8.5% being self employed, 8.5% are students, and 17% are out of the labor force.¹⁴ The unemployment rate in our sample is of 8.5%. Education level is decomposed into three categories: Primary, secondary and tertiary. Close to 27% of the sample has no more than a primary level of education, and more than a quarter has a secondary level of education. The remaining 47% has

¹²Books & magazines websites are sites that contain information, products, and/or services specifically on books and/or magazines. Events websites are sites that contain information and/or tickets sales specifically on physical events. Cinema websites are sites that contain information, products, and/or services specifically on movies, videos, and/or any other products and services associated with the movie industry. CDs purchase websites are sites that allow the purchase of CDs and LPs. These are rather specific websites that sell either collectibles or limited edition CDs. They are not websites from large retailers where one could find any type of CD. The latter type of website is included in the online shopping category. As already mentioned, we are unfortunately not able to identify the visits related to CDs from the ones related to other types of goods on these websites.

¹³The mean age in the sample is 39.7.

¹⁴These include children under 16, retired, homemakers, full-time carer (of someone in the household) or individuals out of the labor force for other reasons.

a tertiary education level. Total household income is divided into three categories.¹⁵ Twenty-two percent of the sample has a low household income; 62.3% has a medium family income; and the remaining 15.3% has a high household income. Half of the individuals in the sample form part of a less-than-two-people household, while 41% belong to a household of 3 to 4 people. The remaining 8.5% belongs to households of 5 or more individuals.

In terms of music consumption, almost 57% of the individuals have clicked at least once on a legal downloading website. Similarly, 57% of the sample has clicked at least once on a legal streaming website during 2011. Finally, close to 73% of the sample has clicked at least once on an illegal music website during 2011. Note that these different types of music consumers are not mutually exclusive. Figure 1 describes the distribution of music consumer types in the sample and reveals that only 40% of the music consumers belong to a single category. Twenty-six percent of the consumers actually belong to the 3 categories. More than half (60%) belong to at least two categories, and 53% of the sample consumes both legal and illegal digital music. Finally, note that 20% of the individuals in the sample have only clicked on illegal downloading websites.

3.2.2 Clicks

We now take a closer look at the behavior of the different types of individuals in our data. We can obtain a measure of music consumption intensity by looking at the number of times a consumer clicks on a given website or on a category of specific websites. Table 2 presents the mean number of monthly clicks on the different categories of websites (buying, streaming and illegal) as well as the mean number of active months for the individuals in our final sample.¹⁶

Several interesting patterns emerge when looking at individuals by country. In particular, Spain shows a much larger number of clicks on illegal downloading websites than the other remaining countries, and the second lowest number of monthly clicks on legal music websites. Italy and the UK also show larger number of visits on illegal websites, but Italy presents the lowest number of visits on legal webpages. Gender differences are also important in terms of illegal clicks, but not so much for legal (purchase and streaming) websites. Males show a much larger number of monthly clicks on illegal music websites. In terms of age, individuals between 16 and 40 also have an above average number of monthly visits on illegal music websites, with a rather low number of visits on legal pages. The same observation holds for students (and to a lesser extent for unemployed) when compared to individuals with other employment status. The mean number of clicks on illegal downloading websites is substantially lower for higher income categories.

The figures show that legal consumers (individuals that never clicked on an illegal music website during 2011) are, on average, active 2.5 months a year, while downloaders are active almost 6 months a year. Most interestingly, downloaders are also more active than legals both in terms of legal downloading (10% more clicks) and legal streaming (40% more clicks), as shown by their

¹⁵For France, Germany, Italy and Spain the income ranges are as follows. Low: Less than 18000 EUR a year. Medium: Between 18000 and 54000 EUR a year. Large: More than 54000 EUR a year. For the UK, the income ranges are as follows. Low: Less than 15000 GBP a year. Medium: Between 15000 and 50000 GBP a year. High: More than 50000 GBP a year.

¹⁶An active month is defined as a month in which the individual visited at least one of the three categories. Note that this definition does not take into account the intensity of clicks within an active month.

mean values of clicks. A positive relationship between legal and illegal consumption of digital music therefore emerges from this simple comparison of means. Comparing streamers and non-streamers (individuals that never clicked on a streaming music website during 2011) leads to similar conclusions. The figures show that streamers click more than twice as much on legal downloading websites, while their clicks on illegal downloading websites is 90% higher than for non-streamers. Again, this simple comparison of means shows a positive relationship between the different consumption channels and in particular between streaming and legal purchases. Table 3 presents cross correlations between the different music consumption channels and gives further evidence on this point. All these figures suggest, not surprisingly, that music taste is an important determinant of digital music consumption, regardless of its origin. In other words, one should expect people who like music to consume more of it, whether it is through legal downloading, illegal downloading, or streaming.

4 Research Question and Empirical Approach

The impact of music piracy on legal sales of music has been studied extensively in the empirical literature, focusing mainly on legal music sales in the form of physical CDs. While most studies find that piracy harms revenues, the estimated sales displacement rate is far below one. In other words, music consumers are found to substitute legal music consumption for illegal music consumption, but much of what is consumed illegally would not have been purchased if piracy was not available. Since the launch of the iTunes music store in 2003, the availability to purchase legal digital songs changed individuals' music consumption alternatives. Instead of having to buy a whole CD, the alternative to downloading any particular digital song illegally is now to purchase it in MP3 format. As emphasized in Waldfogel (2010), the appearance of file-sharing and downloading technology might have different effects on sales, depending on whether the legal option is a 12-song CD or à la carte songs. Consider an individual interested in a few songs of a given artist. While she may not consider buying the entire album (which also contains unknown songs) when offered the possibility to freely download these specific songs, she might nevertheless be willing to pay for them individually. The effect of downloading on individual songs and albums may therefore be different, and one can easily imagine a circumstance in which file-sharing would hurt album sales more than it hurts song sales.

Our goal is to answer two broad questions. First, as a descriptive exercise, we want to look at the determinants of music consumption in the form of purchasing, downloading and streaming. Our second objective is to see to what extent these different channels are related to each other. We revisit the sales displacement question and ask whether illegal music downloading is used as a substitute for legal digital music consumption. We are also interested in the effect that legal streaming may have on legal digital music consumption. As in the case of file-sharing, economic theory does not provide us with an unambiguous prediction for how music streaming should affect purchases of digital music. On the one hand, consumers may substitute legal downloads for streaming. On the other hand, consumers may well use streaming to sample new artists and/or songs. In particular, it may be the case that individuals assign a higher value to a song when they possess it, as opposed to simply having access to it. This would enhance the value of streaming services

as discovering tools, which would positively affect sales. Another part of the debate on streaming media is related to the concept of “windowing”, a strategy used by some artists requesting that an album be available first only on sales before being available on streaming platforms. Understanding whether consumers use these two channels as complements or substitutes is therefore crucial to understand how these types of strategies actually affect sales. To our knowledge, the only paper that has investigated this question empirically is DangNguyen et al. (2012).

4.1 Determinants of Music Consumption

Using the cross-sectional version of our data, we turn to standard regression analysis to look at the determinants of music consumption. Our objective is to describe how the number of clicks on purchasing, downloading and streaming websites vary across individuals in our sample. Table 4 presents the results of this exercise. Each column of the table represents the regression of the different dependent variables (the clicks on purchasing, downloading or streaming websites) on the same set of regressors.

Considering first demographic characteristics, some differences are worth noticing. Females use purchasing and downloading of music much less than males, while there’s no relevant difference for streaming. Legal purchases of digital music raise with household income, while downloads decrease with income. There appears to be no income differences for streaming. Downloading is decreasing in the education level, while streaming significantly increases with it. Education level does not affect purchases. The country differences are remarkable. In terms of purchases, Spaniards and Italians have 50% less clicks than Germans, British have 22% less clicks and French 13% less. The most striking differences appear when looking at the determinants of download. Compared to Germany, Spain show 230% more clicks on illegal downloading websites. Italy presents an important difference of 134% while the UK and France have 43% and 35% more clicks respectively. France stands out when it comes to streaming, with 150% more clicks than Germany. Spaniards have 20% more clicks than the German, while Italians have 25% less. The UK presents a small difference with Germany in terms of streaming, with only 9% more clicks. There are various possible explanations for these country differences. First, unobservable cultural characteristics could explain the use of different types of music consumption channels. Second, market forces, and in particular the limited access to legal digital purchasing websites, could influence the illegal downloading activity of consumers.¹⁷ Finally, cross-country differences in individual consumer choices may be driven by differences in specific, national copyright enforcement laws (e.g. HADOPI law in France). Age does not seem to affect purchases. Some important differences appear for downloading and streaming, however. Streaming seems to be mostly an activity of the really young, while downloading shows a reverse pattern.

The three types of music consumption are positively and significantly increasing in the variables that capture interest in music (visits on music related websites). This confirms that individuals who like music enjoy consuming more of it via the different channels available. The coefficients on the variables related to other online activities present some differences as well. The visits on

¹⁷For the case of television content, Danaher et al. (2010) present evidence that the lack of legal channels can positively affect the level of piracy.

book websites are positively correlated with purchasing and streaming, but not with downloading. Clicks on events websites are positively correlated with purchasing and streaming, but negatively with downloading and movies websites are positively correlated with all three channels of music consumption. This is also true for visits on types of websites related to instant messaging and personal webpages. Finally, clicks on global news and social network webpages significantly affect downloading and streaming, but not purchasing of digital music.

4.2 Displacement: Downloading, Streaming and Purchases

We now turn to the effect of illegal downloading and streaming on legal music purchases. In particular, the question we want to answer is how much does an instance of downloading (respectively streaming) depress or stimulate digital music purchases. Ideally, we would like to compare the legal purchases of an individual who has access to downloading (streaming) with the legal purchases of that same individual in the hypothetical case in which she has no access to downloading (streaming). This direct comparison is obviously impossible, as no individual can simultaneously be in these two scenarios. Since we only observe consumers when they have access to downloading and streaming, we have no way of knowing directly how they would have behaved had they had no access to those services.

One can start by asking whether individuals who download (stream) more also purchase more. The correlations already presented in table 3 showed the positive relationship between the different music consumption modes. The main problem of this simple approach is that individuals who like music like to consume more of it through the various channels available. This would give rise to a positive relationship between downloading (respectively streaming) and digital music purchases, regardless of whether a complementarity relationship exists. This prevents us from giving a causal interpretation to this positive relationship, as we have no way of knowing how an exogenous change in the availability of illegal downloading (respectively streaming) would affect legal purchases. The main obstacle therefore comes from individual unobserved characteristics, and in particular their taste in music. Several approaches can be used to circumvent this problem. One is to look for some measures of interest in music in order to partially control for unobserved individual heterogeneity. We use information on online behavior by considering the number of clicks on music-related websites such as radio and music-video websites. We also consider sites that are related to music, although not to direct music consumption. These include websites related to songs' lyrics, musical instruments or music news such as blogs. Note that, contrary to the indicators used in previous studies, these variables have several advantages. First, they are not the result of a subjective assessment from the individual. In many survey-based studies, music taste is measured by asking individuals about their music taste on a numerical scale (Rob and Waldfogel, 2006; Zentner, 2006; Waldfogel, 2010). Such a measure is plagued with several problems. Different people will assign different meanings to it (a strong taste in music may not have the same meaning for individual A than for individual B), making it an imperfect indicator of music interest. Also, category-based variables are less informative than variables that actually measure the strength of the factor of interest. Our measure of music taste avoids this types of problems. First, no self-assessment from the individual is needed as it is the result of directly observed behavior. Second, our data not only allows us to observe whether an individual visited

a given music-related website, it also gives us a measure of the number of times such visit was made. This gives us a better measure of the intensity of the factor we want to capture, namely the interest in music. We therefore believe our variables to be more reliable indicators of music interest than standard survey-based measures.

4.2.1 Cross-sectional approach

We start by looking at cross-sectional regressions of the following form:

$$P_i = X_i\beta + W_i\alpha + \delta D_i + \gamma S_i + \varepsilon_i, \quad (1)$$

where for individual i , P_i is the (log of the) number of clicks on legal purchase websites, D_i is the (log of the) number of clicks on illegal downloading websites, S_i is the (log of the) number of clicks on legal streaming websites, X_i is a vector including socioeconomic characteristics of the individual, and W_i includes a set of variables related to the individual's online activity on other types of websites. Unobserved characteristics affecting individual i 's clicks on legal purchase websites are included in ε_i , and α , β , γ and δ are parameters to be estimated. The unobserved heterogeneity problem in this specification comes from the fact that we expect ε_i to be correlated with D_i and S_i due to unobserved taste in music. Our measures of music interest in the form of visits to music-related websites is therefore included in W_i to solve that problem. The identifying assumption is therefore that, once controlling for music taste and other observable characteristics, the number of clicks on downloading and streaming websites is random.

Table 5 reports estimates of equation (1) using OLS. In this equation the unit of observation is an individual and X includes country dummies and individual socioeconomic characteristics. The specification in column 1 only controls for X and reports significant and positive estimated coefficients for both γ and δ . Column 2 includes our main measure of music interest, the number of visits to music-related websites. Controlling for this variable leads in a 20% drop in the effect of both downloading and streaming on purchases. Columns 3 to 5 include other measures of music consumption such as radio, illegal streaming and specific CD purchases.¹⁸ As expected, the introduction of such variables decreases the estimates of γ and δ . In particular, comparing columns 1 and 5, the estimated effect of clicks on illegal webpages drops by close to 40% when introducing the variable measuring the visits on other music websites. In turn, the estimated effect of the time spent on streaming websites drops by 35%. In column 6 we include more explanatory variables related to other forms of entertainment websites. All show positive and significant effects, except for websites related to movies and personal webpages. When we include the complete set of regressors (column 6), our coefficients of interest remain positive and highly significant. The estimates reveal positive elasticities of about 0.03 and 0.08 for the illegal music downloading websites and legal streaming websites respectively. Our results also show interesting

¹⁸CDs purchase websites are sites that allow the purchase of CDs and LPs. These are rather specific websites that sell either collectibles or limited edition CDs. They are not websites from large retailers where one could find any type of CD. The latter type of website is included in the online shopping category. As already mentioned, we are unfortunately not able to identify the visits related to CDs from the ones related to other types of goods on these websites.

country differences in terms of legal purchase of legal digital music. Individuals from Spain and Italy show around 50% less clicks than Germany, while the UK and France present around 20% less of such clicks.

Given that visits to legal music purchases websites is equal to zero for over fifty percent of the observations, we estimate again equation (1) using a Tobit model. Table 6 reports the unconditional marginal effects of the estimation. The estimate for δ drops by half while the estimate for γ diminishes in one third.

Our results suggest that illegal downloading and legal streaming have both a positive and significant effect on legal purchases of digital music. Although we have constructed measures of individuals' interest in music using online activity (visits on music related websites and other forms of music consumption), we cannot completely rule out the existence of other forms of unobserved heterogeneity we are not able to control for. Indeed, since we expect our results to bias away from finding a negative effect of downloading (respectively streaming) on purchases, finding a positive result may simply reflect the fact that our estimations are still contaminated by individual unobserved characteristics.

4.2.2 Longitudinal approach

The second approach that we use to further solve the problem of unobserved heterogeneity consists in exploiting the panel dimension of our data. Cross section regressions estimate the effect of illegal downloading (legal streaming) on legal purchases by comparing individuals with low levels of illegal downloading (legal streaming) and high levels of illegal downloading (legal streaming). The panel structure of the data allows us to take advantage of the variation in these variables within individuals and to control for other (time invariant) unobservable individual determinants of music consumption. We first consider the following regression equation

$$P_{it} = X_i\beta + W_{it}\alpha + \delta D_{it} + \gamma S_{it} + \xi_t + \varepsilon_{it}, \quad (2)$$

where the unit of observation is now an individual per month. Thus we regress the number of clicks on legal purchase websites made by individual i in each month on the number of that month's clicks on illegal downloading websites and legal streaming websites along with monthly time dummies ξ_t and our previous controls. Estimating (2) by pooled OLS allows us to take advantage of the within individual variation in P_{it} , D_{it} and S_{it} when estimating δ and γ .

Table 7 present the results of estimating (2) using pooled OLS. The estimates of δ and γ are reduced in about 15% compared to the cross sectional estimations. The estimates suggest elasticities of about 0.025 and 0.07 for the illegal music downloading websites and legal streaming websites respectively. The coefficients on the monthly time dummies present evidence of some seasonal effects. Taking July as a reference, it seems that visits on legal purchase websites are higher from December to March, and lower from August to November. No significant differences are noticed from April to June. The coefficients on the regressors related to online activity show estimates that are lower in magnitude as compared to the cross-sectional estimation.

We again estimate equation (2) using a Tobit model in order to take into account the fact that monthly visits to legal music purchases websites are 0 in our data. Table 8 reports the unconditional marginal effects of the estimation. The estimate for δ drops by half and the estimate for γ diminishes in two thirds. The elasticity of downloading clicks is therefore similar to the one found when using only cross-sectional variation, while the elasticity of streaming clicks is somewhat lower.

Our estimates in tables 1-8 might still be vulnerable to the concern that illegal downloading and streaming are endogenous. It may well be that some other form of unobserved heterogeneity is not completely captured in our measures of music interest. While people who visit many music-related websites have most certainly a high interest in music, it may be that some individuals with a high taste for music don't visit such webpages often and only click on websites that allow them to download, stream or purchase songs. The longitudinal structure of our data allows us to deal with this concern and to further control for fixed unobservable individual characteristics. We make the substitution $\varepsilon_{it} = \mu_i + \nu_{it}$, where μ_i is an individual-specific fixed effect and ν_{it} is an individual and month-specific error, and estimate the following equation

$$P_{it} = X_i\beta + W_{it}\alpha + \delta D_{it} + \gamma S_{it} + \xi_t + \mu_i + \nu_{it}. \quad (3)$$

Fixed-effects estimation allows to control for time invariant unobserved heterogeneity (such as interest in music) and identifies coefficient δ (respectively γ) from the relationship between variation in the tendency to click on legal purchase websites and variation in the tendency to click on illegal downloading websites (respectively streaming websites) for each individual. Only within individual variation is therefore used to identify our parameters of interest. Note that we are still controlling for time varying taste in music as our measures of music interest is actually time variant.

Table 9 presents the results of the estimation of equation (3). Including individual fixed effects we obtain coefficient estimates of 0.022 and 0.049 for our downloading and streaming variables, respectively.

The results presented in table 4 suggest that we could indeed expect country differences in the displacement rates estimated above. To check for this possibility, we expand equation (3) and estimate the following specification:

$$P_{it} = X_i\beta + W_{it}\alpha + \delta D_{it} + \sum_{c \in C} \delta_c D_{it} \text{Country}_{ic} + \gamma S_{it} + \sum_{c \in C} \gamma_c S_{it} \text{Country}_{ic} + \xi_t + \mu_i + \nu_{it}, \quad (4)$$

where Country_{ic} is a dummy variable equal to 1 if individual i is from country c and $C = \{ \text{Spain, Italy, France, UK} \}$. The parameter δ_c (γ_c) measures the difference between the effect of downloading (streaming) on purchases in country c compared to the effect of the same variable in Germany. Table 10 present the results of estimating equation (4) using fixed effects (within) estimation. Results show important differences across countries, but there is still no evidence of sales displacement.

5 Conclusion and Discussion

In the last decade, the music industry has faced many changes. In particular, it has seen its revenues decrease drastically, with industry representatives blaming most of it on piracy (IFPI, 2011). Nevertheless, the music industry seems to have embraced digitization and its many business opportunities. Indeed, digital music revenues have increased more than 1000% during the period 2004-2010, and growing 8% globally in 2011 to an estimated US\$5.2 billion (IFPI, 2011, 2012).¹⁹ While most empirical studies have indeed confirmed a significant negative impact of piracy on sales of physical music, the growing importance of the digital sector in total music industry revenue calls for a better understanding of the impact of both piracy and other music consumption channels on legal digital sales. In this paper, we revisit the question of music sales displacement in the digital era, and analyze in detail the effect of online music streaming on the legal purchases of digital music.

Conducting research on the revenue effects of illegal music consumption requires detailed data on the quantities of both legal and illegal music consumed by individuals. Relying on an original dataset, we are able to follow the clickstreams of more than 16,000 Internet users, and in particular their visits to legal and illegal music consumption websites.

After using several approaches to deal with the endogeneity of downloading and streaming, our results show no evidence of sales displacement. Overall, our different estimates show relatively stable, positive and low elasticities of legal purchases with respect to both illegal downloading and legal streaming. Across specifications, the estimates of δ suggest elasticities of about 0.02 between clicks on illegal downloading websites and legal purchases websites. If this estimate is given a causal interpretation, it means that clicks on legal purchase websites would have been 2% lower in the absence of illegal downloading websites. Specific country estimates show that for Spain and Italy the elasticity is zero, while it is close to 0.04 for France and the UK. All of these results suggest that the vast majority of the music that is consumed illegally by the individuals in our sample would not have been legally purchased if illegal downloading websites were not available to them.

Our results are in line with the findings of recent papers analyzing music piracy (Bastard et al., 2012; Hammond, 2012). Essentially these papers show that illegal music downloads have little or no effect on legal digital sales. These findings complement and do not contradict earlier research that found substantial amounts of sales displacement of legal physical music sales by illegal digital downloads.

Another contribution of our paper is the analysis of the effect of online music streaming on the legal purchases of digital music, a question that has received very little attention in the empirical literature thus far. On this particular question, our elasticity estimates show somewhat larger figures, ranging from 0.024 in our Tobit specification to 0.07 in the OLS case. Controlling for individual fixed effects leads to a 0.05 elasticity, suggesting complementarity between streaming services and purchases of legal digital music. Again, country differences show that this effect is

¹⁹This compares to growth of 5% in 2010 and represents the first time the year-on-year growth rate has increased since IFPI started measuring digital revenues in 2004 (IFPI, 2012).

larger for France and the UK (around 0.06) while it is smaller for Spain and Italy (around 0.035). Our results are in line with the results in (DangNguyen et al., 2012), the only study that has, to our knowledge, analyzed the question so far.

Taken at face value, our findings indicate that digital music piracy does not displace legal music purchases in digital format. This means that although there is trespassing of private property rights (copyrights), there is unlikely to be much harm done on digital music revenues. This result, however, must be interpreted in the context of a still evolving music industry. It is in particular important to note that music consumption in physical format has until recently accounted for the lion's share of total music revenues. If piracy leads to substantial sales displacement of music in physical format, then its effect on the overall music industry revenues may well still be negative.

We cannot draw policy implications at the industry-wide level, as our analysis is only confined to the digital segment of the music industry. Nonetheless, digital music revenues to record companies are growing substantially, reflecting the increasing importance of digitization in the music industry (IFPI, 2012). From that perspective, our findings suggest that digital music piracy should not be viewed as a growing concern for copyright holders in the digital era. In addition, our results indicate that new music consumption channels such as online streaming positively affect copyrights owners.

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6 Figures and Tables

Table 1: Individual characteristics: music users[†]

| | No. of individuals | % | Cumul. % |
|--------------------|--------------------|-------|----------|
| Country | | | |
| France | 3386 | 20.8 | 20.8 |
| Germany | 3091 | 19.0 | 39.8 |
| Italy | 3281 | 20.1 | 59.9 |
| Spain | 3664 | 22.5 | 82.4 |
| UK | 2868 | 17.6 | 100.0 |
| Total | 16290 | 100.0 | |
| Gender | | | |
| Female | 7892 | 48.4 | 48.4 |
| Male | 8398 | 51.6 | 100.0 |
| Total | 16290 | 100.0 | |
| Age Category | | | |
| 10-15 | 692 | 4.2 | 4.2 |
| 16-25 | 2062 | 12.7 | 16.9 |
| 26-30 | 1657 | 10.2 | 27.1 |
| 31-40 | 4278 | 26.3 | 53.3 |
| 41-50 | 3911 | 24.0 | 77.3 |
| 51-60 | 2338 | 14.4 | 91.7 |
| 61-75 | 1352 | 8.3 | 100.0 |
| Total | 16290 | 100.0 | |
| Employment | | | |
| Employed | 9371 | 57.5 | 57.5 |
| Out of Labor Force | 2775 | 17.0 | 74.6 |
| Self Employed | 1375 | 8.4 | 83.0 |
| Student | 1388 | 8.5 | 91.5 |
| Unemployed | 1381 | 8.5 | 100.0 |
| Total | 16290 | 100.0 | |
| Education | | | |
| Primary | 4359 | 26.8 | 26.8 |
| Secondary | 4233 | 26.0 | 52.7 |
| Tertiary | 7698 | 47.3 | 100.0 |
| Total | 16290 | 100.0 | |
| Household Income | | | |
| Low | 3649 | 22.4 | 22.4 |
| Medium | 10144 | 62.3 | 84.7 |
| High | 2497 | 15.3 | 100.0 |
| Total | 16290 | 100.0 | |
| Household size | | | |
| 1 - 2 | 8235 | 50.6 | 50.6 |
| 3 - 4 | 6662 | 40.9 | 91.4 |
| 5+ | 1393 | 8.6 | 100.0 |
| Total | 16290 | 100.0 | |

Continued on next page

Table 1: Individual characteristics: music users[†]

| | No. of individuals | % | Cumul. % |
|------------|--------------------|-------|----------|
| Buyer | | | |
| No | 7070 | 43.4 | 43.4 |
| Yes | 9220 | 56.6 | 100.0 |
| Total | 16290 | 100.0 | |
| Streamer | | | |
| No | 6978 | 42.8 | 42.8 |
| Yes | 9312 | 57.2 | 100.0 |
| Total | 16290 | 100.0 | |
| Downloader | | | |
| No | 4457 | 27.4 | 27.4 |
| Yes | 11833 | 72.6 | 100.0 |
| Total | 16290 | 100.0 | |

[†] The sample includes all music users, i.e. individuals that either buy, stream or download. Buyers are defined as individuals that clicked on at least one legal downloading website during 2011. Streamers are defined as individuals that clicked on at least one legal streaming website during 2011. Downloaders are defined as individuals that clicked on at least one illegal music website during 2011.

Table 2: Monthly Click Activity

| | Mean | | | | | N |
|-------------------------|---------------|--------|-----------|-------------|-------|---------|
| | Active Months | Buying | Streaming | Downloading | All | N |
| Country | | | | | | |
| France | 4.81 | 1.65 | 3.40 | 6.49 | 11.54 | 40,632 |
| Germany | 4.28 | 1.79 | 1.33 | 6.24 | 9.39 | 37,092 |
| Italy | 4.69 | 0.37 | 0.98 | 7.97 | 9.35 | 39,372 |
| Spain | 5.97 | 0.41 | 2.12 | 10.38 | 13.11 | 43,968 |
| UK | 4.46 | 1.23 | 2.51 | 7.99 | 11.75 | 34,416 |
| Gender | | | | | | |
| Female | 4.51 | 1.02 | 2.06 | 5.88 | 9.00 | 94,704 |
| Male | 5.24 | 1.12 | 2.09 | 9.76 | 13.03 | 100,776 |
| Age | | | | | | |
| 10-15 | 3.93 | 0.65 | 1.82 | 3.82 | 6.30 | 8,304 |
| 16-25 | 6.00 | 0.84 | 3.41 | 10.46 | 14.79 | 24,744 |
| 26-30 | 5.78 | 1.61 | 2.86 | 10.66 | 15.21 | 19,884 |
| 31-40 | 5.18 | 1.04 | 2.09 | 8.53 | 11.72 | 51,336 |
| 41-50 | 4.66 | 1.21 | 1.91 | 7.40 | 10.57 | 46,932 |
| 51-60 | 4.15 | 0.86 | 1.29 | 6.83 | 9.03 | 28,056 |
| 61-75 | 3.55 | 1.01 | 1.01 | 3.76 | 5.79 | 16,224 |
| Employment | | | | | | |
| Employed | 4.92 | 1.15 | 2.03 | 8.16 | 11.41 | 112,452 |
| Out of Labor Force | 4.04 | 0.89 | 1.71 | 5.22 | 7.84 | 33,300 |
| Self Employed | 4.68 | 1.01 | 1.24 | 6.70 | 9.02 | 16,500 |
| Student | 5.97 | 0.76 | 3.09 | 10.19 | 14.09 | 16,656 |
| Unemployed | 5.43 | 1.22 | 2.93 | 10.14 | 14.37 | 16,572 |
| Education | | | | | | |
| Primary | 4.61 | 1.40 | 2.00 | 7.28 | 10.73 | 52,308 |
| Secondary | 5.06 | 0.76 | 1.91 | 8.89 | 11.64 | 50,796 |
| Tertiary | 4.95 | 1.05 | 2.21 | 7.66 | 10.97 | 92,376 |
| Household Income | | | | | | |
| Low | 5.34 | 1.24 | 2.64 | 9.70 | 13.68 | 43,788 |
| Medium | 4.88 | 1.02 | 1.81 | 7.81 | 10.69 | 121,728 |
| High | 4.25 | 1.01 | 2.33 | 5.51 | 8.87 | 29,964 |
| Household size | | | | | | |
| 1 - 2 | 5.00 | 1.29 | 2.18 | 8.40 | 11.92 | 98,820 |
| 3 - 4 | 4.80 | 0.84 | 1.82 | 7.39 | 10.12 | 79,944 |
| 5+ | 4.61 | 0.84 | 2.66 | 7.16 | 10.68 | 16,716 |
| Children at home | | | | | | |
| No | 5.01 | 1.16 | 2.25 | 8.39 | 11.86 | 128,556 |
| Yes | 4.65 | 0.89 | 1.74 | 6.89 | 9.58 | 66,924 |
| Legal | | | | | | |
| Downloader | 5.79 | 1.10 | 2.26 | 10.85 | 14.28 | 141,996 |
| Non-Streamer | 3.51 | 0.66 | - | 5.20 | 5.88 | 83,736 |
| Streamer | 5.92 | 1.37 | 3.63 | 9.89 | 14.98 | 111,744 |
| Total | 4.88 | 1.07 | 2.07 | 7.88 | 11.08 | 195,480 |

[†] Buying, Streaming and Downloading clicks are defined as clicks on a legal downloading, streaming and illegal downloading websites, respectively. Streamers are defined as individuals that clicked on at least one legal streaming music website during 2011. Non streamers are defined as individuals that never clicked on legal streaming music website. Downloaders are defined as individuals that clicked on at least one illegal downloading music website during 2011. Legals are defined as individuals that never clicked on an illegal music websites. The figures in the table represent the mean number of monthly clicks.

Table 3: Cross-correlations of number of clicks

| Variables | Buying | Downloading |
|-------------|---------|-------------|
| Buying | 1 | |
| Downloading | 0.0559* | 1 |
| Streaming | 0.3634* | 0.0470* |

* Significant at the 1% level.

N = 16290

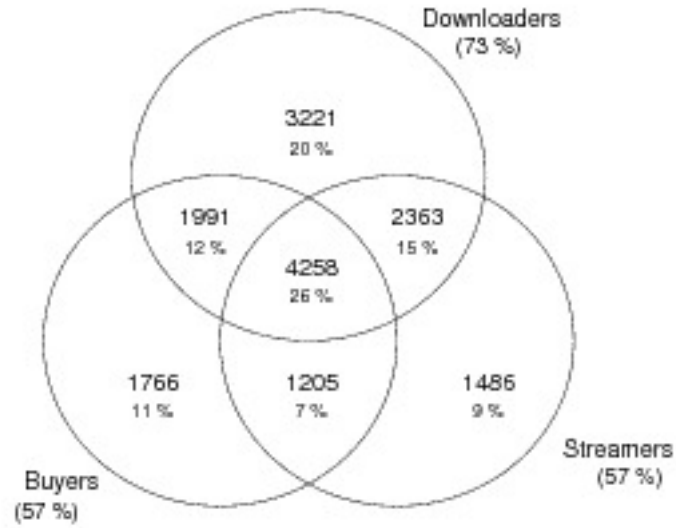


Figure 1: Composition of the sample by types of music consumer.

Table 4: Determinants of music consumption, †

| | Purchase | | Downloading | | Streaming | |
|------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| | (1) | (2) | (1) | (2) | (1) | (2) |
| | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. |
| Female | -0.071*** (0.02) | -0.103*** (0.02) | -0.587*** (0.03) | -0.463*** (0.03) | -0.017 (0.02) | 0.023 (0.02) |
| Household size | -0.039** (0.02) | -0.038** (0.02) | 0.009 (0.03) | -0.026 (0.03) | -0.004 (0.02) | -0.014 (0.02) |
| Medium Income | 0.092*** (0.02) | 0.072*** (0.02) | -0.082** (0.04) | -0.029 (0.04) | -0.018 (0.03) | -0.018 (0.03) |
| High Income | 0.163*** (0.03) | 0.131*** (0.03) | -0.297*** (0.05) | -0.168*** (0.05) | 0.023 (0.04) | 0.005 (0.04) |
| Education | 0.018 (0.01) | -0.002 (0.01) | -0.072*** (0.02) | -0.042** (0.02) | 0.101*** (0.01) | 0.082*** (0.01) |
| Children at home | -0.044* (0.03) | -0.046* (0.03) | 0.095** (0.04) | 0.042 (0.04) | -0.044 (0.03) | -0.039 (0.03) |
| Out of labor force | -0.004 (0.03) | 0.003 (0.03) | -0.030 (0.05) | -0.064 (0.05) | -0.069* (0.04) | -0.068* (0.04) |
| Student | 0.020 (0.04) | 0.009 (0.04) | 0.026 (0.07) | 0.004 (0.06) | 0.068 (0.05) | 0.030 (0.05) |
| Unemployed | -0.019 (0.04) | 0.001 (0.04) | 0.009 (0.06) | -0.034 (0.05) | 0.026 (0.04) | 0.025 (0.04) |
| Self Employed | -0.017 (0.03) | -0.003 (0.03) | -0.213*** (0.05) | -0.218*** (0.05) | -0.048 (0.04) | -0.052 (0.04) |
| Spain | -0.830*** (0.03) | -0.773*** (0.03) | 1.159*** (0.05) | 1.192*** (0.05) | 0.249*** (0.04) | 0.194*** (0.04) |
| France | -0.132*** (0.04) | -0.134*** (0.04) | 0.450*** (0.05) | 0.306*** (0.05) | 0.931*** (0.04) | 0.925*** (0.04) |
| Italy | -0.793*** (0.03) | -0.732*** (0.03) | 0.928*** (0.05) | 0.852*** (0.05) | -0.264*** (0.03) | -0.310*** (0.03) |
| UK | -0.290*** (0.04) | -0.255*** (0.04) | 0.140*** (0.05) | 0.361*** (0.05) | 0.017 (0.04) | 0.088** (0.04) |
| Age: 16-25 | 0.019 (0.06) | -0.019 (0.06) | 0.662*** (0.10) | 0.622*** (0.10) | -0.168** (0.08) | -0.159** (0.08) |
| Age: 26-30 | 0.107* (0.06) | 0.042 (0.06) | 0.444*** (0.10) | 0.525*** (0.10) | -0.291*** (0.08) | -0.234*** (0.08) |
| Age: 31-40 | 0.098* (0.06) | 0.041 (0.06) | 0.162* (0.09) | 0.416*** (0.09) | -0.313*** (0.07) | -0.209*** (0.07) |
| Age: 41-50 | 0.084 (0.06) | 0.039 (0.06) | -0.041 (0.09) | 0.273*** (0.09) | -0.384*** (0.07) | -0.274*** (0.07) |
| Age: 51-60 | 0.030 (0.06) | -0.004 (0.06) | -0.237** (0.09) | 0.181** (0.09) | -0.364*** (0.07) | -0.236*** (0.07) |
| Age: 61-75 | 0.002 (0.06) | -0.020 (0.06) | -0.668*** (0.09) | -0.049 (0.09) | -0.429*** (0.07) | -0.281*** (0.07) |
| Total online time | 0.130*** (0.01) | -0.002 (0.02) | 0.238*** (0.01) | -0.213*** (0.02) | 0.179*** (0.01) | 0.005 (0.02) |
| Total (log of) clicks on: | | | | | | |
| Other music websites | 0.170*** (0.01) | 0.145*** (0.01) | 0.146*** (0.01) | 0.079*** (0.01) | 0.195*** (0.01) | 0.158*** (0.01) |
| Radio & music video websites | 0.083*** (0.01) | 0.067*** (0.01) | 0.145*** (0.01) | 0.029*** (0.01) | 0.122*** (0.01) | 0.082*** (0.01) |
| Illegal Streaming websites | 0.112*** (0.02) | 0.098*** (0.02) | 0.479*** (0.03) | 0.365*** (0.03) | 0.254*** (0.03) | 0.230*** (0.03) |
| CD Purchase websites | 0.232*** (0.03) | 0.200*** (0.03) | 0.319*** (0.05) | 0.223*** (0.04) | 0.286*** (0.03) | 0.261*** (0.03) |
| Online store websites | | 0.053*** (0.01) | | 0.061*** (0.01) | | -0.015** (0.01) |

Continued on next page

Table 4: Determinants of music consumption, †

| | Purchase | | Downloading | | Streaming | |
|----------------------------|---------------------|--------------------|---------------------|---------------------|---------------------|---------------------|
| | (1) | (2) | (1) | (2) | (1) | (2) |
| | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. |
| Books websites | | 0.031*** (0.01) | | 0.005 (0.01) | | 0.045*** (0.01) |
| Events websites | | 0.044*** (0.01) | | -0.052*** (0.01) | | 0.040*** (0.01) |
| Movies websites | | 0.026*** (0.01) | | 0.336*** (0.01) | | 0.088*** (0.01) |
| Coupons websites | | 0.009 (0.01) | | 0.041*** (0.01) | | -0.022*** (0.01) |
| Instant messaging websites | | 0.017*** (0.01) | | 0.062*** (0.01) | | 0.043*** (0.01) |
| Personal webpage websites | | 0.019** (0.01) | | 0.270*** (0.01) | | 0.039*** (0.01) |
| Global news websites | | -0.004 (0.01) | | -0.112*** (0.01) | | 0.037*** (0.01) |
| Social Networks websites | | 0.005 (0.01) | | 0.027*** (0.01) | | 0.020*** (0.01) |
| Constant | -0.710*** (0.13) | 0.462*** (0.16) | -1.597*** (0.20) | 1.484*** (0.25) | -1.799*** (0.14) | -0.403** (0.18) |
| Adjusted-R ² | 0.185 | 0.198 | 0.237 | 0.329 | 0.225 | 0.243 |
| No. of Obs. | 16290 | 16290 | 16290 | 16290 | 16290 | 16290 |

† The dependent variable is the logarithm of the number of clicks on legal digital music purchase websites (first column), illegal digital music downloading websites (second column) and legal digital music streaming websites (third column). All regressors referring to clicks on a given type of website are in logarithm, all regressors referring to time spent on a given type of website are measures in hours. Robust standard errors are in parenthesis. The reference country is Germany.

* Significant at the 10% level.

**Significant at the 5% level.

***Significant at the 1% level.

Table 5: Ordinary Least Squares (OLS) Results, Cross-Section data †

| | (1) | (2) | (3) | (4) | (5) | (6) |
|------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. |
| Illegal download websites | 0.064*** (0.01) | 0.051*** (0.01) | 0.044*** (0.01) | 0.042*** (0.01) | 0.039*** (0.01) | 0.032*** (0.01) |
| Legal Streaming websites | 0.140*** (0.01) | 0.109*** (0.01) | 0.097*** (0.01) | 0.095*** (0.01) | 0.090*** (0.01) | 0.084*** (0.01) |
| Female | -0.044** (0.02) | -0.053*** (0.02) | -0.056*** (0.02) | -0.056*** (0.02) | -0.047** (0.02) | -0.087*** (0.02) |
| Household size | -0.030 (0.02) | -0.038** (0.02) | -0.038** (0.02) | -0.038** (0.02) | -0.039** (0.02) | -0.035* (0.02) |
| Medium Income | 0.101*** (0.02) | 0.093*** (0.02) | 0.095*** (0.02) | 0.096*** (0.02) | 0.096*** (0.02) | 0.074*** (0.02) |
| High Income | 0.175*** (0.03) | 0.164*** (0.03) | 0.172*** (0.03) | 0.174*** (0.03) | 0.173*** (0.03) | 0.134*** (0.03) |
| Education | 0.013 (0.01) | 0.007 (0.01) | 0.012 (0.01) | 0.012 (0.01) | 0.012 (0.01) | -0.008 (0.01) |
| Children at home | -0.050* (0.03) | -0.041 (0.03) | -0.046* (0.03) | -0.047* (0.03) | -0.044* (0.03) | -0.044* (0.03) |
| Out of labor force | -0.012 (0.03) | 0.003 (0.03) | 0.010 (0.03) | 0.010 (0.03) | 0.003 (0.03) | 0.011 (0.03) |
| Student | 0.030 (0.04) | 0.016 (0.04) | 0.009 (0.04) | 0.009 (0.04) | 0.013 (0.04) | 0.006 (0.04) |
| Unemployed | -0.036 (0.04) | -0.025 (0.04) | -0.022 (0.04) | -0.023 (0.04) | -0.021 (0.04) | -0.001 (0.04) |
| Self Employed | -0.007 (0.03) | -0.006 (0.03) | -0.004 (0.03) | -0.004 (0.03) | -0.004 (0.03) | 0.009 (0.03) |
| Spain | -0.922*** (0.03) | -0.867*** (0.03) | -0.885*** (0.03) | -0.911*** (0.03) | -0.897*** (0.03) | -0.828*** (0.03) |
| France | -0.283*** (0.04) | -0.218*** (0.04) | -0.246*** (0.04) | -0.244*** (0.04) | -0.234*** (0.04) | -0.221*** (0.04) |
| Italy | -0.823*** (0.03) | -0.774*** (0.03) | -0.809*** (0.03) | -0.811*** (0.03) | -0.805*** (0.03) | -0.734*** (0.03) |
| UK | -0.267*** (0.04) | -0.269*** (0.04) | -0.289*** (0.04) | -0.287*** (0.04) | -0.297*** (0.04) | -0.273*** (0.04) |
| Age: 16-25 | -0.002 (0.06) | 0.004 (0.06) | 0.015 (0.06) | 0.013 (0.06) | 0.009 (0.06) | -0.025 (0.06) |
| Age: 26-30 | 0.061 (0.06) | 0.096 (0.06) | 0.127** (0.06) | 0.124** (0.06) | 0.116* (0.06) | 0.045 (0.06) |
| Age: 31-40 | 0.038 (0.06) | 0.089 (0.06) | 0.137** (0.06) | 0.136** (0.06) | 0.119** (0.06) | 0.043 (0.06) |
| Age: 41-50 | 0.046 (0.06) | 0.095* (0.06) | 0.142** (0.06) | 0.139** (0.06) | 0.120** (0.06) | 0.050 (0.06) |
| Age: 51-60 | -0.033 (0.06) | 0.037 (0.06) | 0.096* (0.06) | 0.093 (0.06) | 0.072 (0.06) | 0.006 (0.06) |
| Age: 61-75 | -0.038 (0.06) | 0.024 (0.06) | 0.090 (0.06) | 0.087 (0.06) | 0.066 (0.06) | -0.003 (0.06) |
| Total online time | 0.193*** (0.01) | 0.144*** (0.01) | 0.107*** (0.01) | 0.106*** (0.01) | 0.104*** (0.01) | 0.006 (0.01) |
| Total (log of) clicks on: | | | | | | |
| Other music websites | | 0.174*** (0.01) | 0.156*** (0.01) | 0.156*** (0.01) | 0.147*** (0.01) | 0.129*** (0.01) |
| Radio & music video websites | | | 0.069*** (0.01) | 0.068*** (0.01) | 0.067*** (0.01) | 0.059*** (0.01) |
| Illegal Streaming websites | | | | 0.073*** (0.02) | 0.071*** (0.02) | 0.066*** (0.02) |
| CD Purchase websites | | | | | 0.194*** (0.03) | 0.171*** (0.03) |

Continued on next page

Table 5: Ordinary Least Squares (OLS) Results, Cross-Section data †

| | (1) | (2) | (3) | (4) | (5) | (6) |
|----------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|--------------------|
| | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. |
| Online store websites | | | | | | 0.052*** (0.01) |
| Books websites | | | | | | 0.026*** (0.01) |
| Events websites | | | | | | 0.042*** (0.01) |
| Movies websites | | | | | | 0.008 (0.01) |
| Coupons websites | | | | | | 0.010* (0.01) |
| Instant messaging websites | | | | | | 0.012** (0.01) |
| Personal webpage websites | | | | | | 0.007 (0.01) |
| Constant | -1.404*** (0.12) | -0.899*** (0.12) | -0.541*** (0.13) | -0.518*** (0.13) | -0.486*** (0.13) | 0.446*** (0.15) |
| Adjusted-R ² | 0.162 | 0.186 | 0.192 | 0.193 | 0.197 | 0.207 |
| No. of Obs. | 16290 | 16290 | 16290 | 16290 | 16290 | 16290 |

† The dependent variable is the logarithm of the number of clicks on legal digital music purchase websites. All regressors referring to clicks on a given type of website are in logarithm. Total time online is the logarithm of the total time spent online during the year, in seconds. Robust standard errors are in parenthesis. The reference country is Germany.

* Significant at the 10% level.

**Significant at the 5% level.

***Significant at the 1% level.

Table 6: Tobit Results, Unconditional Marginal Effects , Cross-Section data †

| | (1) | (2) | (3) | (4) | (5) | (6) |
|------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. |
| Illegal download websites | 0.047*** (0.01) | 0.035*** (0.00) | 0.028*** (0.01) | 0.025*** (0.01) | 0.022*** (0.01) | 0.015*** (0.01) |
| Legal Streaming websites | 0.111*** (0.01) | 0.081*** (0.01) | 0.069*** (0.01) | 0.067*** (0.01) | 0.063*** (0.01) | 0.056*** (0.01) |
| Female (d) | -0.050** (0.02) | -0.059*** (0.02) | -0.061*** (0.02) | -0.061*** (0.02) | -0.054*** (0.02) | -0.098*** (0.02) |
| Household size | -0.034* (0.02) | -0.042** (0.02) | -0.042** (0.02) | -0.041** (0.02) | -0.042** (0.02) | -0.037* (0.02) |
| Medium Income (d) | 0.114*** (0.02) | 0.105*** (0.02) | 0.107*** (0.02) | 0.108*** (0.02) | 0.108*** (0.02) | 0.084*** (0.02) |
| High Income (d) | 0.207*** (0.04) | 0.192*** (0.04) | 0.201*** (0.04) | 0.203*** (0.04) | 0.203*** (0.04) | 0.154*** (0.04) |
| Education | 0.026* (0.01) | 0.019 (0.01) | 0.025* (0.01) | 0.025* (0.01) | 0.025* (0.01) | 0.004 (0.01) |
| Children at home (d) | -0.057** (0.03) | -0.049* (0.03) | -0.054** (0.03) | -0.056** (0.03) | -0.053* (0.03) | -0.056** (0.03) |
| Out of labor force (d) | -0.013 (0.03) | 0.004 (0.03) | 0.012 (0.03) | 0.011 (0.03) | 0.006 (0.03) | 0.013 (0.03) |
| Student (d) | 0.039 (0.04) | 0.022 (0.04) | 0.015 (0.04) | 0.013 (0.04) | 0.017 (0.04) | 0.015 (0.04) |
| Unemployed (d) | -0.052 (0.04) | -0.040 (0.04) | -0.037 (0.04) | -0.039 (0.04) | -0.038 (0.04) | -0.014 (0.04) |
| Self Employed (d) | -0.012 (0.04) | -0.011 (0.03) | -0.009 (0.03) | -0.010 (0.03) | -0.011 (0.03) | 0.004 (0.03) |
| Spain (d) | -0.796*** (0.02) | -0.758*** (0.02) | -0.771*** (0.02) | -0.802*** (0.02) | -0.794*** (0.02) | -0.736*** (0.02) |
| France (d) | -0.224*** (0.03) | -0.166*** (0.03) | -0.195*** (0.03) | -0.191*** (0.03) | -0.184*** (0.03) | -0.173*** (0.03) |
| Italy (d) | -0.708*** (0.02) | -0.675*** (0.02) | -0.701*** (0.02) | -0.703*** (0.02) | -0.700*** (0.02) | -0.641*** (0.02) |
| UK (d) | -0.193*** (0.03) | -0.194*** (0.03) | -0.215*** (0.03) | -0.212*** (0.03) | -0.219*** (0.03) | -0.196*** (0.03) |
| Age: 16-25 (d) | -0.032 (0.07) | -0.021 (0.07) | -0.010 (0.07) | -0.012 (0.07) | -0.016 (0.07) | -0.061 (0.07) |
| Age: 26-30 (d) | 0.013 (0.07) | 0.051 (0.07) | 0.086 (0.07) | 0.082 (0.07) | 0.075 (0.07) | -0.013 (0.07) |
| Age: 31-40 (d) | -0.018 (0.06) | 0.037 (0.06) | 0.089 (0.06) | 0.086 (0.06) | 0.073 (0.06) | -0.016 (0.06) |
| Age: 41-50 (d) | -0.009 (0.06) | 0.043 (0.06) | 0.093 (0.06) | 0.090 (0.06) | 0.074 (0.06) | -0.006 (0.06) |
| Age: 51-60 (d) | -0.103* (0.06) | -0.034 (0.06) | 0.028 (0.06) | 0.022 (0.06) | 0.006 (0.06) | -0.067 (0.06) |
| Age: 61-75 (d) | -0.083 (0.06) | -0.023 (0.06) | 0.046 (0.07) | 0.041 (0.07) | 0.024 (0.06) | -0.049 (0.06) |
| Total online time | 0.237*** (0.01) | 0.188*** (0.01) | 0.147*** (0.01) | 0.146*** (0.01) | 0.145*** (0.01) | 0.032** (0.01) |
| Total (log of) clicks on: | | | | | | |
| Other music websites | | 0.161*** (0.01) | 0.142*** (0.01) | 0.141*** (0.01) | 0.135*** (0.01) | 0.115*** (0.01) |
| Radio & music video websites | | | 0.072*** (0.01) | 0.071*** (0.01) | 0.070*** (0.01) | 0.061*** (0.01) |
| Illegal Streaming websites | | | | 0.116*** (0.02) | 0.114*** (0.02) | 0.110*** (0.02) |
| CD Purchase websites | | | | | 0.140*** | 0.116*** |

Continued on next page

Table 6: Tobit Results, Unconditional Marginal Effects , Cross-Section data †

| | (1) | (2) | (3) | (4) | (5) | (6) |
|----------------------------|------------|------------|------------|------------|------------|------------|
| | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. |
| | | | | | (0.02) | (0.02) |
| Online store websites | | | | | | 0.069*** |
| | | | | | | (0.01) |
| Books websites | | | | | | 0.021*** |
| | | | | | | (0.01) |
| Events websites | | | | | | 0.045*** |
| | | | | | | (0.01) |
| Movies websites | | | | | | 0.015* |
| | | | | | | (0.01) |
| Coupons websites | | | | | | 0.006 |
| | | | | | | (0.01) |
| Instant messaging websites | | | | | | 0.014*** |
| | | | | | | (0.01) |
| Personal webpage websites | | | | | | 0.006 |
| | | | | | | (0.01) |
| No. of Obs. | 16290 | 16290 | 16290 | 16290 | 16290 | 16290 |

† The table presents unconditional marginal effects. The dependent variable is the logarithm of the number of clicks on legal digital music purchase websites. All regressors referring to clicks on a given type of website are in logarithm. Total time online is the logarithm of the total time spent online during the year, in seconds. (d)= dummy variable. Robust standard errors are in parenthesis. The reference country is Germany.

* Significant at the 10% level.

**Significant at the 5% level.

***Significant at the 1% level.

Table 7: Ordinary Least Squares (OLS) Results, monthly data †

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. |
| Illegal download websites | 0.045*** (0.00) | 0.033*** (0.00) | 0.031*** (0.00) | 0.031*** (0.00) | 0.030*** (0.00) | 0.026*** (0.00) |
| Legal Streaming websites | 0.105*** (0.01) | 0.078*** (0.01) | 0.075*** (0.01) | 0.075*** (0.01) | 0.074*** (0.01) | 0.071*** (0.01) |
| Female | -0.016*** (0.01) | -0.019*** (0.01) | -0.019*** (0.01) | -0.019*** (0.01) | -0.018*** (0.01) | -0.024*** (0.01) |
| Household size | -0.003 (0.01) | -0.004 (0.00) | -0.004 (0.00) | -0.004 (0.00) | -0.004 (0.00) | -0.003 (0.00) |
| Medium Income | 0.008 (0.01) | 0.007 (0.01) | 0.007 (0.01) | 0.007 (0.01) | 0.007 (0.01) | 0.007 (0.01) |
| High Income | 0.020** (0.01) | 0.019** (0.01) | 0.020** (0.01) | 0.020** (0.01) | 0.020** (0.01) | 0.020** (0.01) |
| Education | -0.000 (0.00) | -0.002 (0.00) | -0.001 (0.00) | -0.001 (0.00) | -0.001 (0.00) | -0.003 (0.00) |
| Children at home | -0.014** (0.01) | -0.010 (0.01) | -0.011 (0.01) | -0.011 (0.01) | -0.010 (0.01) | -0.009 (0.01) |
| Out of labor force | 0.005 (0.01) | 0.008 (0.01) | 0.008 (0.01) | 0.008 (0.01) | 0.006 (0.01) | 0.004 (0.01) |
| Student | 0.007 (0.01) | -0.004 (0.01) | -0.006 (0.01) | -0.006 (0.01) | -0.005 (0.01) | -0.008 (0.01) |
| Unemployed | -0.001 (0.01) | -0.001 (0.01) | -0.002 (0.01) | -0.002 (0.01) | -0.002 (0.01) | -0.003 (0.01) |
| Self Employed | 0.003 (0.01) | 0.002 (0.01) | 0.000 (0.01) | 0.000 (0.01) | -0.000 (0.01) | 0.001 (0.01) |
| January | 0.040*** (0.01) | 0.039*** (0.01) | 0.041*** (0.01) | 0.041*** (0.01) | 0.042*** (0.01) | 0.035*** (0.01) |
| February | 0.014*** (0.01) | 0.013** (0.01) | 0.014*** (0.01) | 0.015*** (0.01) | 0.015*** (0.01) | 0.012** (0.01) |
| March | 0.020*** (0.01) | 0.020*** (0.01) | 0.021*** (0.01) | 0.021*** (0.01) | 0.022*** (0.01) | 0.018*** (0.01) |
| April | 0.004 (0.01) | 0.006 (0.01) | 0.007 (0.01) | 0.007 (0.01) | 0.007 (0.01) | 0.006 (0.01) |
| May | -0.003 (0.01) | -0.003 (0.01) | -0.002 (0.01) | -0.002 (0.01) | -0.002 (0.01) | -0.003 (0.01) |
| June | 0.007 (0.01) | 0.007 (0.01) | 0.007 (0.01) | 0.007 (0.01) | 0.007 (0.01) | 0.006 (0.01) |
| August | -0.011** (0.00) | -0.008* (0.00) | -0.008* (0.00) | -0.008* (0.00) | -0.008* (0.00) | -0.009* (0.00) |
| September | -0.017*** (0.00) | -0.014*** (0.00) | -0.013*** (0.00) | -0.013*** (0.00) | -0.013*** (0.00) | -0.015*** (0.00) |
| October | 0.005 (0.01) | 0.007 (0.01) | 0.008 (0.01) | 0.008 (0.01) | 0.008 (0.01) | 0.003 (0.01) |
| November | -0.007 (0.01) | -0.008 (0.01) | -0.008 (0.01) | -0.008 (0.01) | -0.008 (0.01) | -0.014*** (0.01) |
| December | 0.019*** (0.01) | 0.019*** (0.01) | 0.019*** (0.01) | 0.019*** (0.01) | 0.019*** (0.01) | 0.012** (0.01) |
| Age: 16-25 | 0.015 (0.02) | 0.012 (0.01) | 0.011 (0.01) | 0.011 (0.01) | 0.010 (0.01) | 0.004 (0.01) |
| Age: 26-30 | 0.037** (0.02) | 0.048*** (0.02) | 0.051*** (0.02) | 0.051*** (0.02) | 0.049*** (0.02) | 0.036** (0.02) |
| Age: 31-40 | 0.020 (0.01) | 0.038*** (0.01) | 0.043*** (0.01) | 0.043*** (0.01) | 0.041*** (0.01) | 0.026** (0.01) |
| Age: 41-50 | 0.020 (0.01) | 0.038*** (0.01) | 0.042*** (0.01) | 0.042*** (0.01) | 0.039*** (0.01) | 0.026** (0.01) |
| Age: 51-60 | -0.001 (0.01) | 0.023* (0.01) | 0.030** (0.01) | 0.030** (0.01) | 0.027** (0.01) | 0.015 (0.01) |

Continued on next page

Table 7: Ordinary Least Squares (OLS) Results, monthly data [†]

| | (1) | (2) | (3) | (4) | (5) | (6) |
|------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. |
| Age: 61-75 | -0.002 (0.01) | 0.025* (0.01) | 0.034** (0.01) | 0.034** (0.01) | 0.030** (0.01) | 0.020 (0.01) |
| Total online time | 0.022*** (0.00) | 0.013*** (0.00) | 0.010*** (0.00) | 0.010*** (0.00) | 0.010*** (0.00) | 0.001 (0.00) |
| Total (log of) clicks on: | | | | | | |
| Other music websites | | 0.082*** (0.00) | 0.075*** (0.00) | 0.075*** (0.00) | 0.073*** (0.00) | 0.065*** (0.00) |
| Radio & music video websites | | | 0.026*** (0.00) | 0.026*** (0.00) | 0.026*** (0.00) | 0.021*** (0.00) |
| Illegal Streaming websites | | | | 0.007 (0.01) | 0.006 (0.01) | 0.004 (0.01) |
| CD Purchase websites | | | | | 0.174*** (0.04) | 0.166*** (0.04) |
| Online store websites | | | | | | 0.012*** (0.00) |
| Books websites | | | | | | 0.014*** (0.00) |
| Events websites | | | | | | 0.007*** (0.00) |
| Movies websites | | | | | | 0.005*** (0.00) |
| Coupons websites | | | | | | 0.004*** (0.00) |
| Instant messaging websites | | | | | | 0.006*** (0.00) |
| Personal webpage websites | | | | | | 0.004* (0.00) |
| Constant | -0.198*** (0.02) | -0.152*** (0.02) | -0.145*** (0.02) | -0.145*** (0.02) | -0.142*** (0.02) | -0.073*** (0.02) |
| Adjusted-R ² | 0.059 | 0.081 | 0.083 | 0.083 | 0.085 | 0.089 |
| No. of Obs. | 195478 | 195478 | 195478 | 195478 | 195478 | 195478 |

[†] The dependent variable is the logarithm of the number of clicks on legal digital music purchase websites. All regressors referring to clicks on a given type of website are in logarithm. Total time online is the logarithm of the total time spent online during the month, in seconds. Standard errors are in parenthesis and clustered at the individual level. All specifications include regional dummies. The reference month is July.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

Table 8: Tobit Results, Unconditional Marginal Effects monthly data †

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. |
| Illegal download websites | 0.024*** (0.00) | 0.018*** (0.00) | 0.017*** (0.00) | 0.017*** (0.00) | 0.017*** (0.00) | 0.014*** (0.00) |
| Legal Streaming websites | 0.040*** (0.00) | 0.027*** (0.00) | 0.025*** (0.00) | 0.025*** (0.00) | 0.025*** (0.00) | 0.024*** (0.00) |
| Female (d) | -0.014*** (0.00) | -0.016*** (0.00) | -0.016*** (0.00) | -0.016*** (0.00) | -0.015*** (0.00) | -0.019*** (0.00) |
| Household size | -0.001 (0.00) | -0.002 (0.00) | -0.002 (0.00) | -0.002 (0.00) | -0.002 (0.00) | -0.002 (0.00) |
| Medium Income (d) | 0.012*** (0.00) | 0.010** (0.00) | 0.010** (0.00) | 0.010** (0.00) | 0.010** (0.00) | 0.009** (0.00) |
| High Income (d) | 0.030*** (0.01) | 0.025*** (0.01) | 0.026*** (0.01) | 0.026*** (0.01) | 0.026*** (0.01) | 0.024*** (0.01) |
| Education | 0.005** (0.00) | 0.003 (0.00) | 0.004* (0.00) | 0.004* (0.00) | 0.004* (0.00) | 0.003 (0.00) |
| Children at home (d) | -0.010** (0.00) | -0.008* (0.00) | -0.009* (0.00) | -0.009* (0.00) | -0.009* (0.00) | -0.010** (0.00) |
| Out of labor force (d) | -0.003 (0.01) | 0.001 (0.01) | 0.001 (0.01) | 0.001 (0.01) | 0.001 (0.01) | -0.000 (0.01) |
| Student (d) | 0.007 (0.01) | -0.001 (0.01) | -0.002 (0.01) | -0.002 (0.01) | -0.002 (0.01) | -0.003 (0.01) |
| Unemployed (d) | -0.007 (0.01) | -0.006 (0.01) | -0.006 (0.01) | -0.006 (0.01) | -0.006 (0.01) | -0.006 (0.01) |
| Self Employed (d) | -0.005 (0.01) | -0.005 (0.01) | -0.006 (0.01) | -0.006 (0.01) | -0.006 (0.01) | -0.005 (0.01) |
| January (d) | 0.030*** (0.00) | 0.031*** (0.00) | 0.032*** (0.00) | 0.033*** (0.00) | 0.033*** (0.00) | 0.030*** (0.00) |
| February (d) | 0.010** (0.00) | 0.009** (0.00) | 0.011*** (0.00) | 0.011*** (0.00) | 0.011*** (0.00) | 0.010** (0.00) |
| March (d) | 0.013*** (0.00) | 0.013*** (0.00) | 0.015*** (0.00) | 0.015*** (0.00) | 0.015*** (0.00) | 0.014*** (0.00) |
| April (d) | 0.003 (0.00) | 0.004 (0.00) | 0.005 (0.00) | 0.005 (0.00) | 0.005 (0.00) | 0.005 (0.00) |
| May (d) | -0.004 (0.00) | -0.003 (0.00) | -0.002 (0.00) | -0.002 (0.00) | -0.002 (0.00) | -0.003 (0.00) |
| June (d) | 0.004 (0.00) | 0.004 (0.00) | 0.004 (0.00) | 0.004 (0.00) | 0.004 (0.00) | 0.004 (0.00) |
| August (d) | -0.012*** (0.00) | -0.010*** (0.00) | -0.010*** (0.00) | -0.009*** (0.00) | -0.010*** (0.00) | -0.010*** (0.00) |
| September (d) | -0.016*** (0.00) | -0.014*** (0.00) | -0.014*** (0.00) | -0.014*** (0.00) | -0.014*** (0.00) | -0.015*** (0.00) |
| October (d) | 0.005 (0.00) | 0.007* (0.00) | 0.008* (0.00) | 0.008** (0.00) | 0.008** (0.00) | 0.005 (0.00) |
| November (d) | -0.007* (0.00) | -0.007* (0.00) | -0.006 (0.00) | -0.006 (0.00) | -0.006 (0.00) | -0.010*** (0.00) |
| December (d) | 0.020*** (0.00) | 0.021*** (0.00) | 0.022*** (0.00) | 0.022*** (0.00) | 0.022*** (0.00) | 0.016*** (0.00) |
| Age: 16-25 (d) | -0.000 (0.01) | 0.003 (0.01) | 0.004 (0.01) | 0.004 (0.01) | 0.003 (0.01) | -0.000 (0.01) |
| Age: 26-30 (d) | 0.007 (0.01) | 0.020* (0.01) | 0.024* (0.01) | 0.024* (0.01) | 0.023* (0.01) | 0.016 (0.01) |
| Age: 31-40 (d) | -0.007 (0.01) | 0.010 (0.01) | 0.015 (0.01) | 0.015 (0.01) | 0.014 (0.01) | 0.008 (0.01) |
| Age: 41-50 (d) | -0.007 (0.01) | 0.009 (0.01) | 0.014 (0.01) | 0.014 (0.01) | 0.012 (0.01) | 0.008 (0.01) |
| Age: 51-60 (d) | -0.018* (0.01) | 0.001 (0.01) | 0.007 (0.01) | 0.006 (0.01) | 0.005 (0.01) | 0.002 (0.01) |

Continued on next page

Table 8: Tobit Results, Unconditional Marginal Effects monthly data †

| | (1) | (2) | (3) | (4) | (5) | (6) |
|------------------------------|----------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. |
| Age: 61-75 (d) | (0.01) -0.014 (0.01) | (0.01) 0.007 (0.01) | (0.01) 0.013 (0.01) | (0.01) 0.013 (0.01) | (0.01) 0.011 (0.01) | (0.01) 0.010 (0.01) |
| Total online time | 0.045*** (0.00) | 0.033*** (0.00) | 0.030*** (0.00) | 0.030*** (0.00) | 0.030*** (0.00) | 0.019*** (0.00) |
| Total (log of) clicks on: | | | | | | |
| Other music websites | | 0.041*** (0.00) | 0.038*** (0.00) | 0.038*** (0.00) | 0.037*** (0.00) | 0.034*** (0.00) |
| Radio & music video websites | | | 0.013*** (0.00) | 0.013*** (0.00) | 0.013*** (0.00) | 0.010*** (0.00) |
| Illegal Streaming websites | | | | 0.013** (0.01) | 0.013** (0.01) | 0.013** (0.01) |
| CD Purchase websites | | | | | 0.036*** (0.01) | 0.033*** (0.01) |
| Online store websites | | | | | | 0.009*** (0.00) |
| Books websites | | | | | | 0.005*** (0.00) |
| Events websites | | | | | | 0.001 (0.00) |
| Movies websites | | | | | | 0.007*** (0.00) |
| Coupons websites | | | | | | 0.001 (0.00) |
| Instant messaging websites | | | | | | 0.002 (0.00) |
| Personal webpage websites | | | | | | 0.000 (0.00) |
| Constant | | | | | | |
| sigma | | | | | | |
| Constant | | | | | | |
| No. of Obs. | 195478 | 195478 | 195478 | 195478 | 195478 | 195478 |

† The table presents unconditional marginal effects. The dependent variable is the logarithm of the number of clicks on legal digital music purchase websites. All regressors referring to clicks on a given type of website are in logarithm. Total time online is the logarithm of the total time spent online during the month, in seconds. (d)= dummy variable. Standard errors are in parenthesis and clustered at the individual level. All specifications include regional dummies. The reference month is July.

* Significant at the 10% level.

**Significant at the 5% level.

***Significant at the 1% level.

Table 9: Fixed Effects Estimation †

| | (1) | (2) | (3) | (4) | (5) | (6) |
|------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|--------------------|
| | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. |
| Illegal download websites | 0.036*** (0.00) | 0.029*** (0.00) | 0.027*** (0.00) | 0.027*** (0.00) | 0.027*** (0.00) | 0.022*** (0.00) |
| Legal Streaming websites | 0.067*** (0.00) | 0.055*** (0.00) | 0.052*** (0.00) | 0.052*** (0.00) | 0.051*** (0.00) | 0.049*** (0.00) |
| Total online time | 0.017*** (0.00) | 0.013*** (0.00) | 0.011*** (0.00) | 0.011*** (0.00) | 0.011*** (0.00) | 0.003*** (0.00) |
| Total (log of) clicks on: | | | | | | |
| Other music websites | | 0.061*** (0.00) | 0.057*** (0.00) | 0.057*** (0.00) | 0.056*** (0.00) | 0.051*** (0.00) |
| Radio & music video websites | | | 0.030*** (0.00) | 0.030*** (0.00) | 0.029*** (0.00) | 0.024*** (0.00) |
| Illegal Streaming websites | | | | 0.018** (0.01) | 0.017* (0.01) | 0.016* (0.01) |
| CD Purchase websites | | | | | 0.103*** (0.02) | 0.100*** (0.02) |
| Online store websites | | | | | | 0.008*** (0.00) |
| Books websites | | | | | | 0.008*** (0.00) |
| Events websites | | | | | | 0.003* (0.00) |
| Movies websites | | | | | | 0.010*** (0.00) |
| Coupons websites | | | | | | 0.007*** (0.00) |
| Instant messaging websites | | | | | | 0.011*** (0.00) |
| Personal webpage websites | | | | | | 0.003** (0.00) |
| Constant | -0.052*** (0.01) | -0.038*** (0.01) | -0.033*** (0.01) | -0.033*** (0.01) | -0.033*** (0.01) | -0.015** (0.01) |
| Adjusted-R ² | 0.018 | 0.029 | 0.031 | 0.031 | 0.032 | 0.034 |
| No. of Obs. | 195478 | 195478 | 195478 | 195478 | 195478 | 195478 |

† The dependent variable is the logarithm of the number of clicks on legal digital music purchase websites. All regressors referring to clicks on a given type of website are in logarithm. Total time online is the logarithm of the total time spent online during the month, in seconds. All specifications include monthly fixed effects. Standard errors are in parenthesis and clustered at the individual level.

* Significant at the 10% level.

**Significant at the 5% level.

***Significant at the 1% level.

Table 10: Fixed Effects Results, Interactions †

| | (1) | (2) | (3) | (4) | (5) | (6) |
|------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. | Coef./s.e. |
| Illegal download websites | 0.053*** (0.01) | 0.045*** (0.01) | 0.043*** (0.01) | 0.043*** (0.01) | 0.042*** (0.01) | 0.038*** (0.01) |
| Illegal download×Spain | -0.030*** (0.01) | -0.029*** (0.01) | -0.028*** (0.01) | -0.029*** (0.01) | -0.029*** (0.01) | -0.030*** (0.01) |
| Illegal download×France | 0.004 (0.01) | 0.007 (0.01) | 0.007 (0.01) | 0.007 (0.01) | 0.008 (0.01) | 0.007 (0.01) |
| Illegal download×Italy | -0.031*** (0.01) | -0.030*** (0.01) | -0.029*** (0.01) | -0.029*** (0.01) | -0.029*** (0.01) | -0.029*** (0.01) |
| Illegal download×UK | -0.012 (0.01) | -0.011 (0.01) | -0.011 (0.01) | -0.011 (0.01) | -0.012 (0.01) | -0.011 (0.01) |
| Legal Streaming websites | 0.081*** (0.01) | 0.068*** (0.01) | 0.066*** (0.01) | 0.066*** (0.01) | 0.066*** (0.01) | 0.062*** (0.01) |
| Legal streaming×Spain | -0.038*** (0.01) | -0.039*** (0.01) | -0.040*** (0.01) | -0.041*** (0.01) | -0.040*** (0.01) | -0.039*** (0.01) |
| Legal streaming×France | 0.004 (0.01) | 0.006 (0.01) | 0.005 (0.01) | 0.005 (0.01) | 0.005 (0.01) | 0.006 (0.01) |
| Legal streaming×Italy | -0.027* (0.01) | -0.027* (0.01) | -0.028** (0.01) | -0.029** (0.01) | -0.029** (0.01) | -0.029** (0.01) |
| Legal streaming×UK | -0.018 (0.01) | -0.017 (0.01) | -0.018 (0.01) | -0.018 (0.01) | -0.019 (0.01) | -0.018 (0.01) |
| Total online time | 0.017*** (0.00) | 0.013*** (0.00) | 0.011*** (0.00) | 0.011*** (0.00) | 0.011*** (0.00) | 0.003*** (0.00) |
| Total (log of) clicks on: | | | | | | |
| Other music websites | | 0.061*** (0.00) | 0.057*** (0.00) | 0.057*** (0.00) | 0.056*** (0.00) | 0.051*** (0.00) |
| Radio & music video websites | | | 0.030*** (0.00) | 0.029*** (0.00) | 0.029*** (0.00) | 0.024*** (0.00) |
| Illegal Streaming websites | | | | 0.026*** (0.01) | 0.026*** (0.01) | 0.024*** (0.01) |
| CD Purchase websites | | | | | 0.102*** (0.02) | 0.099*** (0.02) |
| Online store websites | | | | | | 0.008*** (0.00) |
| Books websites | | | | | | 0.009*** (0.00) |
| Events websites | | | | | | 0.003* (0.00) |
| Movies websites | | | | | | 0.010*** (0.00) |
| Coupons websites | | | | | | 0.007*** (0.00) |
| Instant messaging websites | | | | | | 0.011*** (0.00) |
| Personal webpage websites | | | | | | 0.003** (0.00) |
| Constant | -0.052*** (0.01) | -0.037*** (0.01) | -0.033*** (0.01) | -0.033*** (0.01) | -0.033*** (0.01) | -0.014** (0.01) |
| Adjusted-R ² | 0.019 | 0.030 | 0.032 | 0.032 | 0.033 | 0.035 |
| No. of Obs. | 195478 | 195478 | 195478 | 195478 | 195478 | 195478 |

† The dependent variable is the logarithm of the number of clicks on legal digital music purchase websites. All regressors referring to clicks on a given type of website are in logarithm. Total time online is the logarithm of the total time spent online during the month, in seconds. All specifications include monthly fixed effects. Standard errors are in parenthesis and clustered at the individual level.

* Significant at the 10% level.

**Significant at the 5% level.

**Significant at the 1% level.

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Abstract

This paper analyses the behaviour of digital music consumers on the Internet. Using clickstream data on a panel of more than 16,000 European consumers, we estimate the effects of illegal downloading and legal streaming on the legal purchases of digital music. Our results suggest that Internet users do not view illegal downloading as a substitute for legal digital music. Although positive and significant, our estimated elasticities are essentially zero: a 10% increase in clicks on illegal downloading websites leads to a 0.2% increase in clicks on legal purchase websites. Online music streaming services are found to have a somewhat larger (but still small) effect on the purchases of digital sound recordings, suggesting complementarities between these two modes of music consumption. According to our results, a 10% increase in clicks on legal streaming websites leads to up to a 0.7% increase in clicks on legal digital purchase websites. We find important cross country differences in these effects.

Key words: digital music, copyright, downloading, streaming.

JEL classification: K42, L82, L86, Z1

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