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Valentina Assenova
University of Pennsylvania

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Keywords
music, piracy, copyrights

Disciplines
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Determinants of the Music Piracy Divide[1]

Valentina Assenova[2]
The Wharton School, University of Pennsylvania

Spring 2007

Abstract:

Why has physical piracy of music grown globally in recent years despite international efforts to reduce the problem? This research employs cross-country time series data analysis to examine physical music piracy rates across developed and developing economies. We provide 1999-2004 cross-country evidence from 70 countries that mean global music piracy rates grew over this period, and observe different mean rates for OECD and non-OECD countries. We examine the effect of per capita income, legal enforcement and technology on piracy rates in the developed and developing economies and choose a fixed-effects model. Our model indicates that variations in piracy of CDs and digital music on CD-Rs among all countries are largely due to growing Internet subscriptions. For non-OECD countries, the model suggests that the increase in Internet use coupled with poor copyrights enforcement has worsened piracy. For OECD countries, however, the growth in Internet subscriptions has not had a significant effect on piracy rates.

[1] A simplistic economic model of music piracy across countries is an inverted U-shaped curve, where piracy is very low in countries with low per capita incomes but begins to increase at a decreasing rate with increases in income, peaking in the middle income ranges, and decreases at an increasing rate with further increases in per capita income. Moreover, per capita income is closely tied to technology access. This model illustrates one of the reasons why music piracy is virtually non-existent in many African countries.

[2] Many thanks to Dr. Martin Asher and Vice Dean Dr. Barbara Khan for giving me the opportunity to do this research, to Prof. Kevin Werbach for his insight into the legal issues, to Dad for his support, and to my sister, Slavea, for inspiring this research.

1 Introduction

Piracy, generally defined as the illegal reproduction of copyrighted works for sale, presents a classic economic problem of market failure arising from asymmetric information between buy side and sell side agents and technological changes that digitized media and transformed it into a public good available over the Internet. This paper focuses on physical music piracy, which is defined as piracy on CDs and other recordable delivery devices. Despite this focus, we tackle a topic that has inspired one of a number of studies on the problems presented by free access to copyrighted digital media. The motivation of the research is the observation that music piracy of CDs and CD-Rs has grown over the past several years despite legal efforts by international copyrights and trade organizations to lessen it. We believe that implications of our findings are relevant to other digital media, including piracy of business and gaming software.

Although researchers have devoted considerable attention to illegal downloading over the Internet, the physical piracy of music is an equally compelling problem. Illegal sales of music on CDs and CD-Rs today account for a loss of over $4.5 billion dollars annually according to a recent report released by the International Federation of the Phonographic Industry (IFPI), the leading world music trade researcher.[3] China continues to make IFPI's list of the top ten pirate markets for music, with capacities for pirated CD production at about 19 times the legitimate domestic demand for CDs.[4] A large fraction of these pressed CDs are made for export and smuggled into Europe, Latin America, and North America, where CDs are resold for competitive prices similar to those of their legitimate counterparts. Moreover, the IFPI estimates that today, more than one in three discs sold word-wide is a pirated copy, and pirates outsell legitimate recordings in 30 countries. As these discs slip into the shadow economy, governments lose a fraction of their GDP and tax revenue, while local and international producers and artists are not compensated for their efforts.

The purpose of this research is to determine what factors have influenced the dynamics of physical music piracy since 1999 and its variation across countries, with hopes of making policy recommendations for developing economies. We use the year 1999 as a benchmark since it marked the introduction of the Napster file sharing model, which revolutionized the nature of the industry by making digital music available free of charge over the Internet. With this research, we hope to answer some fundamental questions, such as why piracy has grown overall in the past years. Specifically, where has piracy grown and why? Could this growth have been a factor of wider use of computers and growing Internet access? Is piracy a factor of income or the degree of legal enforcement in a particular country?

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[3] Commercial Piracy Report, IFPI 2006. The IFPI defines physical piracy as "the unauthorized duplication of an original recording for commercial gain without the consent of the rights owner." Pirated copies can be pressed in unlicensed plants (CDs), or burned in CD labs (CD-Rs), and are later sold on street markets or smuggled across boundaries for international sale.

[4] Commercial Piracy Reports, IFPI 2006, available at www.ifpi.org.

The paper is organized as follows. Section 2 introduces the theoretical background for this research and overviews existing scholarly work on this topic. Section 3 discusses the data and model selection used in this study, and presents the results. Section 4 concludes the paper by summarizing the findings and providing policy recommendations and suggestions for future research.

2 Theoretical Background

To our knowledge, there have only been two other studies that have examined the variation in music piracy rates across countries and time. We have also found two similar studies to this one, which focused on variations in software piracy across countries. Marron and Steel (1997), proposed that piracy levels vary with economic, institutional, and cultural factors. Using software piracy data, Morrison and Steel confirmed that piracy varied among high income and low income countries, specifically, that countries with higher per capita income had lower piracy rates.[5] They also discovered that countries with an individualist culture had much lower piracy rates than countries with a collectivist culture. Furthermore, piracy also varied based on institutional power for copyright enforcement.

Hui and Png (2002) explored the impact of price and the presence of music piracy on legitimate music sales. They developed and tested hypotheses from theoretical models of end-user and re-seller piracy on international panel data for 28 countries measuring 1992-1998 music CD sales. The study found empirical evidence that the demand for music CDs decreased with piracy. Hui and Png also discovered that the wide availability of pirated copies kept legitimate prices below market potential, such that overall losses including price effects may have amounted to 19% of legitimate revenue in 1998. After accounting for demand losses and price adjustments, the industry lost about 6.6% of its revenues to piracy. The results also indicated that price elasticity of demand of CDs was lower in the presence of piracy. Therefore, demand for legitimate copies was less likely to rise in response to decreases in price, because pirated copies were still cheaper to purchase.

Fischer and Andres (2005) further pursued the cross-country analysis of piracy in a study that used a sample of 71 countries to empirically analyze the relationship between income distribution and software piracy rates. They measured income inequality by the Gini coefficient and quintile shares and examined a variety of other factors influencing piracy rates variation. The study found that income inequality was negatively associated with piracy rates, in other words, as inequality increased, piracy levels decreased, and that the effect of income on piracy rates depended on a country's geographic region. Finally, the model predicted an inverted U-shaped relationship between piracy and per capita income, where piracy increased initially as income rose, and then decreased with further increases in income.

[5] Piracy rates are defined to be the estimated number of pirated copies produced and sold as a fraction of the sum of all copies produced (both legitimate and pirate)

In another study building on the concepts of individualism-collectivism (Marron and Steel, 1997), CD prices (Hui and Png, 2002), and income inequality (Fischer and Andres, 2005), Eyun-Jung Ki et al. (2006) used seven variables as determinants influencing music piracy rates across 71 countries. These included individualism-collectivism, the level of education, intellectual property protection, music CD price, music market size, income level, and income inequality. Of these variables, the study found that income level, income inequality, and market size had a significant impact on domestic piracy rates.

The underlying premise of most recent research has been that piracy over the past six years has adversely affected recording industry revenues, contributing to their persistent slump since 2001. The focus of most research has been the impact of piracy on CD sales, specifically digital piracy and the effects of peer-to-peer (P2P) file-sharing, stream-casting, and other forms of Internet piracy stemming from the Napster model of "free" digital music distribution. Following this trend, Peitz and Waelbroeck (2004) analyzed the role of music downloading on the downturn in CD sales. They used 2000-2001 cross-country data for 16 developed economies and controlled CD sales data for GDP, percent of adults downloading, broadband penetration, the ratio of Music Cassette sales to CD sales, and the number of CD sales per household. The study concluded that Internet piracy significantly accounted for the decline in CD sales in 2001.

For the purposes of data availability and consistency, this and other studies on music piracy use data from the International Federation of the Phonographic Industry (IFPI), the leading international music trade organization. The IFPI calculates domestic piracy rates as pirate units divided by legal units plus pirate units, and estimates pirate units from territory estimates (comprised of primary studies and seizures and enforcement) and optical media manufacturing research.[6] The Federation defines piracy as "the unauthorized duplication of an original recording for commercial gain without the consent of the rights owner."[7]

There are a number of factors that could influence variation in piracy rates across countries and time. Among them are: (1) relative prices of pirated and legitimate CDs, (2) specific taste for music, (3) market size in units and composition by demand for singles, CDs, and DVDs, (4) quality of the legitimate music available (perceived by the consumer), (5) substitution with other media forms of entertainment, e.g. movies, (6) the country-specific economic environment, relative personal income, and income distribution, (7) the country-specific legal environment and enforcement of intellectual property rights, and taxes and tariffs imposed on legitimate media, and (8) the technology available to tap into new distribution channels (e.g. peer-to-peer networks) and to make personal copies of optical discs (CD-R and DVD burners). However, many of these factors cannot be measured or quantified directly and accurately, which is a problem that any study of piracy and consumer preference faces.

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[6] "Commercial Piracy Measurement" slide show presented at the WIPO/OECD expert meeting October 18th 2005, available at http://www.oecd.org/dataoecd/43/14/35650193.pdf

[7] IFPI 2006.

Factor (1) is difficult to measure across countries since the real price of a CD and other legitimate copies includes different mark-ups, tariffs, VAT taxes, and retail overhead that vary considerably within and among countries, and average prices do not capture the reality of these price differences. Factor (2) could be observed through top music charts and other billboard information, but is difficult to measure accurately across countries and time, and measurements are lacking in many developing economies. Factor (4) is also subjective and difficult to measure. Factor (3) reflects the total legitimate demand for music, but it is closely related to the piracy rate and therefore we will eliminate it in our model. This study will not address factor (5) directly since it only affects what kinds of media are pirated and we assume that there is no significant substitution effect between music and movies and entertainment and business software that affects the overall piracy levels of recorded music.

The factors for which we have better measurements are the economic, legal, and technological variables that affect piracy. We assume that factors (6), (7), and (8), which reflect the economic, legal and technological environments, respectively, are encapsulated by three proxy variables: GDP per capita, the Corruption Perceptions Index (henceforth CPI), and Internet subscriptions per capita.

We note that the type of Internet access, dial-up or broadband, is important to our study of physical piracy. Physical piracy generally takes two forms: direct CD copying in pressing plants (located in countries with cheap labor and poor copyrights regulations), and direct or indirect copying by individuals.[8] For physical piracy to be possible on the individual scale, the person must have a CD decoder/copier/burner, and either access to the legitimate CDs or quick and cheap access to a musical "inventory" via the Internet.

Although broadband penetration is more likely to be strongly correlated with piracy than dial-up access, since file transfers of music are easier with broadband, we will use Internet access per capita as our technology variable since we do not have consistent data for all years and countries for broadband access. Also, data is lacking for CD burners for all countries during the time period under consideration, and therefore we exclude the effects of this factor on physical piracy.

This research builds on the previous findings by employing international panel time series data to examine variations in piracy rates across countries and time, particularly the discrepancies in piracy rates between developed and developing economies. We employ the Fischer and Andres (2005) measures for the level of economic development, namely GDP per capita, and the Eyun-Jung Ki et al. (2006) measure for demand, namely market size, in addition to new measures that account for the impact of technology and the legal environment on piracy levels. Specifically, we substitute Marron and Steel's (1997) concept of individualism-collectivism for a measure of corruption, a proxy for the

[8] By "direct" copy we mean, a one-for-one copy of an original CD, where all of the tracks are the same and in the same order. By contrast, an "indirect" copy, although it may contain all tracks from a given album accessed on the Internet, may also contain a different mix of original songs pulled from different albums. In practice, many of these "indirect" copies are under titles such as "Greatest Hits" or a selection of the Top 40 charts tracks.

effectiveness of the legal system, relevant to the enforcement of licensing and intellectual property rights regulations, and we add factors to account for technological differences between countries, like broadband and Internet users per 1000 people, as proxies for Internet piracy activity.

3 Data Description

We define our data as follows:

pr	Piracy rates, sales of pirated copies as percent of total pirate and legitimate
bb000	Broadband subscriptions per 1000 people
int000	Internet access per 1000 people
pc000	Personal computers per 1000 people
totunpc1	Total units of recorded music purchased per person per year
usdpc1	US $ value of recorded music purchases per person per year
gdppc	GDP per capita, PPP (year 2000 constant international $)
corp	Corruption Perceptions Index (CPI)

We selected the countries on the basis of the most complete and thorough data available for the time span we chose to study, 1999-2005. Appendix A gives a complete list of the countries included. We choose 1999 as our starting year since it was the year when Napster was created and other technological changes became important to the recording industry, including the more widespread use of computers, the Internet, and broadband.

All of the models are based on data of annual frequency for 1999-2004. Some values for given countries and years are missing from the original data sources, and some sources have data for 2005. Piracy rates data is available for 1999-2005, however all years in that span are not available for all countries. Sales data comes from the IFPI's Recording Industry World Sales reports for 1999-2004 and are given in market size and USD value.[9] The CPI is an index of corruption confidence (scaled from 1-10, 10 denoting full confidence and zero corruption), generated by Transparency International. Finally, we take our economic data for all countries except Taiwan, from the World Bank's World Development Indicators until the most current year available for gdppc, pc000, bb000, int000. The data for Taiwan is taken from government sources and estimates, and is adjusted by the author for consistency with the WDI data.

[9] All piracy rates and recording industry world sales data are used with the permission of the IFPI.

There are several potential problems with our data sample. First, we have missing values for some countries for particular years and for some variables, largely due to the number of countries included in the sample. However, we have tried to gather the most complete and thorough data available for the years and countries presented. Second, proxy data have disadvantages in that they may not accurately capture reality; however, we use proxies since direct, consistent measurements are not available and the proxies we use are generally accepted and come from leading sources. Furthermore, the IFPI and other research have recognized the potential inadequacy of the piracy rates measure (which estimates the pirated units purchased as a percent of all units purchased) in reflecting sales losses due to copyrights violations. Particularly, piracy levels for developed countries underestimate actual sales losses to copyright violations because online piracy may be contributing to low piracy levels estimates. It may be the case that physical piracy decreases with increases in online piracy, often proxied by broadband or Internet penetration in a given country, which implies a substitution effect between physical and online piracy. This is the main reason why we include measures for Internet penetration in our study.

Descriptive Statistics

Average global piracy rates have risen over the past five years and total nearly 40% in 2005 (see Figure 1). There are considerable differences in the trends of piracy rates between non-OECD (developing) countries and OECD (developed) countries.[10] OECD countries have exhibited declining average piracy rates since 2000 that have leveled off at about 10% on average, while non-OECD countries have exhibited growing average piracy rates at over 50% on average in 2005. Note that the average piracy rates for OECD and non-OECD countries are substantially different. These differences in our composition of data for the dependent variable indicate a heterogeneous sample with two subgroups.

Tables 1a-c give descriptive statistics for all countries, non-OECD countries and OECD countries, countries respectively. For all countries, the number of Internet users and personal computers per 1000 people has increased moderately over the past five years, growing from 117 and 157, respectively, in 1999 to 310 and 279, respectively, in 2004. In 2004 Internet users per 1000 people outnumber PCs because of the growing availability of Internet access to people who don't own PCs. At the same time, the base of broadband subscribers has been growing exponentially since 1999, and in 2004 the average number of subscribers per 1000 people was 71, up from around 6 in 2000. However, these increases are disproportional in OECD countries. Non-OECD countries average at about three times fewer Internet users per 1000 people than OECD countries, and about four times fewer personal computers per 1000 people.

Over the past five years, the average total units of recorded music purchased per person has fallen cumulatively by over 45 % of its 1999 value, from about 2 units per person on average in 1999 to less than one unit in 2004. Meanwhile, the average dollar spending on

[10] Organization for Economic Cooperation and Development, original members.

music purchases has also decreased from about $13.58 per person per year in 1999, to about $11.13 in 2002, (a decrease of about 18% of the 1999 value) and risen slightly since then to $12.32 in 2004 (a decrease of about 9% of the 1999 value). Decreases in the US dollar value, however, have not been adjusted to reflect inflation, and in real terms the value of music purchased may be much lower.

The average GDP per capita for all countries increased slightly from about $14,800 in 1999 to about $ 16,500 in 2004. The average GDP for the entire 1999-2004 period was about $15,700, including the biased value for 2005, and about $13,000 excluding the 2005 value. Meanwhile, the average corruption index has stayed at around 5.5 over the past six years – a value that indicates that the sample of countries we selected was composed proportionally of countries with high corruption (denoted by a low confidence index, specifically below 5) and countries with low corruption (denoted by a high confidence index, specifically above 5).

Figures 2a-c show co-behavioral plots of our dependent variable, piracy rates, and our leading independent variables: corruption, Internet access, and income per capita, respectively. The differences between non-OECD and OECD countries are evident in these plots. Non-OECD countries generally have higher piracy rates, lower Internet access, lower indexes of corruption confidence, and lower incomes per capita than OECD countries.

It is important to note that during the period under consideration, 1999-2004, OECD countries adopted broadband Internet access much more quickly and more widely than non-OECD (developing) countries. Moreover, many non-OECD countries were just beginning to adopt dial-up Internet technologies on a more massive scale beginning in 2000.

The type of Internet access available to individuals is a critical element to our discussion, since it influences the ability of an individual to pirate music. For example, broadband connectivity allows for faster file-transfer from peer-to-peer networks than dial-up. The consideration of broadband is important since physical piracy generally takes two forms: direct CD copying in pressing plants (located in countries with cheap labor and poor copyrights regulations), and direct or indirect copying by individuals. For physical piracy to be possible on the individual scale, the person must have a CD decoder/copier/burner, and either access to the legitimate CDs or quick and cheap access to a musical "inventory" via the Internet. One of the reasons why piracy rates of any kind are very low or non-existent in many African countries is because the necessary technology (fast Internet access and computers) for unauthorized copying is unavailable to many individuals.

Estimation Results

Cross-sectional time series data analysis is best suited for studying changes in piracy rates across countries and time for several reasons. First, this analysis reflects both cross-sectional differences (between countries), and time-series differences (within a given country for a set period of time). Panel data regression techniques allow us to examine these differences and to assess their impact on piracy rates independently. Second, panel data allows us to control for omitted variables that differ between cases but are constant over time, and for omitted variables that vary over time but are constant between cases. [11]

While it is possible to use ordinary least squares (OLS) regression techniques on panel data, they may not be optimal. OLS assumes a homogeneous sample of data, which is often not the case with real world data. Therefore, we examine several other models for panel data: the fixed effects, FE, the between effects, BE, and the random effects, RE, models, to select the optimal choice for our data.

The general form of a panel data model is:

$$y_{it} = \alpha + \beta_{it} x_{it} + u_{it}$$

where the error term $u_{it} \sim iid(0, \sigma^2)$ and i = 1,2,....., N individual-level observations, and t = 1,2,.....,T time series observations. We assume that y_{it} (the piracy rate) is a continuous rather than a discrete measure. The model reflects changes in the dependent variable y_{it} over countries (i) and time (t). Therefore, y_{it} is the piracy level for a specific country and year, and α and β_{it} are constants.

The fixed effects model is appropriate when y_{it} is heteroskedastic in x. The FE model fixes different averages of the dependent variable, pr, for each country or each time period, but assumes that the variance of the errors will not change across countries or time. In such a case, random effects estimation would give inconsistent estimates of the coefficient β_{it} in the model. The RE and BE models are appropriate when y_{it} is homoskedastic in x, that is, when the mean of the u_{it} error terms is zero.[12]

From our descriptive statistics, we observed different means for our dependent variable, piracy rates, for OECD and non-OECD countries, implying a heterogeneous sample of data. We also observed substantial correlation in some of our raw data and some non-normality and autocorrelation in the residuals. Therefore we eliminated some variables that were highly correlated and performed log transformations on other variables in this data. We transformed Internet per 1000 people into the log of Internet per capita, lnint, and GDP per capita into the log of gdppc, lngdppc. We also eliminated pc000 and bb000 as variables because they had less data available and were correlated with Internet subscriptions, and we removed totunpc1 and usdpc1 since they were correlated with piracy rates. We excluded dummy variables coding for individual countries and years

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[11] Available at http://dss.princeton.edu/online_help/analysis/panel.htm, accessed July 20, 2006.

[12] Available at http://economics.about.com, accessed July 20, 2006.

since they were not statistically significant. However, even after these transformations, there was some autocorrelation left in the residuals, which we chose to accept.

In all our model specifications, we included the independent variables, x_{it}, for each country and time period: the log of Internet subscriptions per capita with expected sign ambiguous, lnint, log of real income per capita with expected sign (-), lngdppc, the Corruption Perceptions Index (CPI) with expected sign (-), corp, and a dummy variable coding for "developed" OECD countries.[13] Note that real income per capita proxies the economic conditions in a given country for a given year, Internet access proxies the technological factors influencing piracy levels, and the corruption index proxies the legal environment that impacts copyrights and intellectual property legislation and efficacy.

First, we ran robust OLS regressions for all countries and then for OECD and non-OECD countries to conduct a preliminary analysis of the variables. Our best all-country OLS model chose three statistically significant variables: lngdppc, corp, and a dummy variable for "developed" (OECD) countries. Among these factors, the corruption coefficient was the most highly significant and with the expected negative sign, followed by the dummy variable for developed, also with a negative sign, and GDP per capita, also with a negative sign. Internet access was not significant in the all-country OLS model. The adjusted R-squared of this model was 0.577 with 364 observations (see Table 2a).

The significant difference in mean piracy rates between OECD and non-OECD countries prompted us to separate the sample. We ran OLS regressions for OECDs and non-OECDs and our findings were consistent with the all-country OLS, where the coefficients for corp and lngdppc were negative and significant across both groups. Our OLS results indicated that differences in legal enforcement and the standard of living were significant in explaining piracy variations. The coefficient of lnint exhibited a positive sign for non-OECD countries and a negative sign for OECD countries, but was insignificant in the OLS estimation.

To evaluate the appropriateness of the RE model for our data, we first ran the Breusch and Pagan Lagrangian multiplier test for $u_{it} = 0$, the essential assumption of the RE and BE models. The test strongly rejected the null hypothesis in the all-country and OECD/non-OECD regressions (Table 2a-c). Therefore the RE and BE models were inappropriate for our data.

We followed this analysis with a Hausman specification test to check whether our model was correctly specified. If a FE model is correctly specified, and if u_{it} is uncorrelated with x_{it}, the coefficients that are estimated by the fixed-effects estimator and the same coefficients that are estimated by the random-effects estimator should not be statistically different. That is, we would retain the null hypothesis of no systematic differences in the coefficients of the RE and the FE models. In our case, we retained the null hypothesis of no systematic differences in the coefficients (see Table 2a-c).

[13] The Corruption Perceptions Index measures are published annually by Transparency International and available at www.transparency.org

We proceeded to run an all-country FE model. The adjusted r-squared for the all-country FE model was .508. This model found *only* Internet access as significant across all countries. In other words, income per capita and legal enforcement were not significant factors in explaining differences in piracy rates across countries for 1999-2004. The Internet coefficient, 3.191, was highly significant and with a positive sign implying that a one percent increase in Internet access on average resulted in about a 3% increase in physical piracy across all countries during this period.

To examine the differences between developed and developing countries, we ran two more FE models for OECD and non-OECD countries. Dividing the sample by "developed" eliminated the significance of the income variable, since income per capita and a country's status as an OECD member are closely related. For non-OECDs, Internet and corruption were both significant variables. Moreover, the Internet coefficient was positive, implying an increase in piracy rates with increases in Internet subscriptions, while the corruption index coefficient was negative, implying a decrease in piracy rates with increases in the confidence index (less corruption perceived). Surprisingly, none of the variables were significant for OECD countries, and the sign of the Internet coefficient was negative, as in the OLS estimation. These differences in the sign of the Internet variable and in its significance may be due to the smaller sample in the OECD category, N=123, as compared to the non-OECD category, N=241. Although our results for the OECD countries have less explanatory power due to the relatively smaller sample size, the negative sign of the Internet coefficient could suggest that piracy rates have decreased as Internet subscriptions increased during 1999-2004. A larger sample of OECD countries would be needed, however, to confirm this finding.

Overall, we find that there are no significant temporal effects on piracy rates across time. Importantly, the all-country FE model, which we take to be the most valid all-country model, indicates that income and legal enforcement do not explain much of the variation in piracy across countries. We find that piracy rates variations among all countries are largely due to growing Internet access. For non-OECD countries, our results indicate that the increase in Internet access coupled with poor copyrights enforcement has worsened physical piracy. One explanation is that more individuals with access to the Internet are making home copies of downloaded music and selling it on the black market. In OECD countries, the growth in Internet subscriptions has not affected physical piracy rates. An explanation may be that people with access to the Internet purchase music online legally or download it illegally but are prevented from making pirated copies and selling them on the market because of the legal and economic conditions in OECD countries.

4 Conclusion

In this research, we tested several models for panel data, beginning with ordinary least-squares and proceeding with random effects, between effects, and fixed effects models to find an optimal choice for our data. The best fit for our data was the fixed-effects model with three variables: Internet access (a proxy for technology), GDP per capita (a proxy for the economic environment), and the corruption perceptions index (a proxy for legal enforcement).

As with other studies, we found the economic factors to be significant, since they were closely related to OECD membership. We also found our legal enforcement variables to be significant, but only for developing countries. The fixed-effects model for the entire sample of countries indicated that income per capita and corruption were insignificant in explaining piracy variations across countries during 1999-2004.

Most surprisingly, however, our findings suggest that growing access to the Internet has contributed significantly to rising piracy rates in developing countries, but has had no significant impact on piracy rates in developed countries. This finding is original since it suggests a relationship between access to the Internet and the growth of physical piracy in developing countries. This phenomenon is unique to developing countries and may be due to the nature of the piracy being measured and the specific economic and legal situations in developing countries. Continuing piracy may be a factor of differences in prices between original and pirated copies, and discrepancies in access to copying technology and the Internet. For example, with growing Internet access, more people are making home copies of downloaded music and making a business from selling them on the black market.

Further research might explore the nature of this relationship between Internet and physical piracy. For example, in developed economies, the decrease in piracy rates may be due to a substitution between Internet and physical piracy. It could be that as more people gain fast access to the Internet, they will either purchase music legally or download illegally with the same final result – a decrease in pirate copies of CDs and other physical formats. Growing legitimate sales over the Internet in recent years are potent evidence that market solutions to piracy are viable for countries where the computer and Internet per capita base is large enough and mechanisms for online transactions exist at a low per unit cost.

With the growth of technology, creating more business alternatives for developing countries will be essential to curbing the sales of pirated copies and creating a functioning market. Unfortunately, part of the problem for developing countries is poor technological infrastructure, which is why CDs are popular in the first place rather than free content providers like YouTube, which require hardware and Internet service. The lack of adequate access to technology may deter the development of market solutions. In the meantime, other non-market mechanisms may help alleviate the piracy problem in developing economies, such as sound copyrights enforcement, improved technological security of digital delivery formats, and monitoring of illegal market activity.

Table 1a. Descriptive Statistics for All Countries

Variable		Mean	Std. Dev.	Min	Max	Observations	
pr	overall	38.065	28.392	1.000	99.000	N	477
	between		27.336	1.000	99.000	n	69
	within		7.883	13.208	91.208	T-bar	6.91304
corp	overall	5.479	2.392	1.500	10.000	N	444
	between		2.333	1.860	9.771	n	69
	within		0.286	3.979	6.736	T-bar	6.43478
gdppc	overall	15738.820	9692.119	1858.000	36464.680	N	408
	between		9720.090	1944.667	34633.990	n	68
	within		893.992	10359.110	20346.110	T-bar	6
int000	overall	212.662	187.407	0.218	787.983	N	414
	between		170.170	0.350	639.279	n	69
	within		81.327	-49.713	511.372	T-bar	6
bb000	overall	28.815	48.237	0.000	247.939	N	303
	between		38.222	0.000	189.450	n	68
	within		27.902	-78.309	134.271	T-bar	4.45588
pc000	overall	217.414	204.749	1.000	1163.078	N	410
	between		190.098	6.333	679.011	n	69
	within		80.349	0.588	1090.291	T-bar	5.94203
usdpc1	overall	12.169	15.096	0.023	59.842	N	383
	between		15.018	0.082	55.296	n	65
	within		2.127	4.779	23.196	T-bar	5.89231
totunpc1	overall	1.254	2.129	0.017	28.033	N	385
	between		1.546	0.040	10.173	n	65
	within		1.468	-7.072	19.114	T-bar	5.92308

Sources: IFPI World Sales and Piracy Reports 1999-2005, World Bank WDI 1999-2004, Transparency International Corruption Perceptions Index 1999-2005.

Table 1b. Descriptive Statistics for non-OECD Countries

Variable		Mean	Std. Dev.	Min	Max	Observations	
pr	overall	49.90964	24.440	5	99	N	332
	between		23.317	9.833	99	n	48
	within		7.935	27.767	74.910	T-bar	6.91667
corp	overall	4.186254	1.672	1.50	9.4	N	291
	between		1.646	1.86	9.257	n	47
	within		0.283	3.220	5.443	T-bar	6.19149
gdppc	overall	10475.9	6541.219	1858	29087.00	N	277
	between		6497.056	1944.667	25870.08	n	46
	within		883.378	5096.181	15083.18	T-bar	6.02174
int000	overall	132.5013	137.367	0.218247	656.792	N	283
	between		118.272	0.349521	495.337	n	47
	within		71.532	-129.874	378.890	T-bar	6.02128
bb000	overall	16.10403	42.488	0	247.939	N	197
	between		36.310	0	189.4504	n	46
	within		18.108	-91.0204	97.25096	T-bar	4.28261
pc000	overall	128.6398	151.753	1	1163.078	N	279
	between		129.923	6.333333	561.1352	n	47
	within		84.179	-72.2273	1001.517	T-bar	5.93617
usdpc1	overall	3.315762	3.297	0.022695	16.23406	N	260
	between		3.180	0.081828	14.38941	n	44
	within		0.968	0.709687	8.530487	T-bar	5.90909
totunpc1	overall	0.500766	0.390	0.016791	2.044181	N	260
	between		0.363	0.03955	1.428033	n	44
	within		0.146	0.052799	1.194202	T-bar	5.90909

Sources: IFPI World Sales and Piracy Reports 1999-2005, World Bank WDI 1999-2004, Transparency International Corruption Perceptions Index 1999-2005.

Table 1c. Descriptive Statistics for OECD Countries

Variable		Mean	Std. Dev.	Min	Max	Observations	
pr	overall	10.94483	15.082	1	90	N	145
	between		13.151	1	50.286	n	21
	within		7.788	-13.912	64.088	T-bar	6.905
corp	overall	7.937255	1.433	4.2	10	N	153
	between		1.455	4.467	9.771	n	22
	within		0.293	6.437	8.737	T	6.955
gdppc	overall	26867.3	4409.057	16622.8	36464.68	N	131
	between		4381.181	18077.51	34633.99	n	22
	within		919.467	22217.92	29746.00	T	5.955
int000	overall	385.8341	162.596	68.915	787.983	N	131
	between		131.019	118.589	639.279	n	22
	within		99.564	186.775	684.544	T	5.955
bb000	overall	52.43943	49.558	0	189.449	N	106
	between		29.155	1.2	112.120	n	22
	within		40.337	-24.1517	157.895	T-bar	4.818
pc000	overall	406.4821	172.371	58.807	826.163	N	131
	between		159.467	77.047	679.011	n	22
	within		71.820	189.657	614.392	T	5.955
usdpc1	overall	30.88372	13.049	6.482	59.842	N	123
	between		12.698	7.966	55.296	n	21
	within		3.490	23.493	41.911	T-bar	5.857
totunpc1	overall	2.821976	3.171	0.645	28.033	N	125
	between		1.882	0.738	10.173	n	21
	within		2.574	-5.505	20.682	T-bar	5.952

Sources: IFPI World Sales and Piracy Reports 1999-2005, World Bank WDI 1999-2004, Transparency International Corruption Perceptions Index 1999-2005.

Table 2a. Regression Analysis for All Countries, Dependent Variable – Piracy Rate

	OLS	RE	FE
lnint	0.483	2.880	3.191
	(0.600)	(3.49)	(3.260)
lngdppc	-11.455	-14.088	-12.348
	(-3.980)	(-3.26)	(-1.450)
corp	-3.639	-3.444	-2.388
	(-5.060)	(-2.82)	(-1.440)
developed	-13.495	-14.945	
	(-4.870)	(-2.34)	
N	364	364	364
Adj. R^2	0.577	0.567	0.508
Breusch and Pagan Prob> chi2		0.0000*	
Hausman test Prob> chi2		0.4318	

Note: t-statistics reported in parentheses; t≥|2| indicates significance at the 5% level or greater. Constants not reported. * denotes statistically significant

Table 2b. Regression Analysis for non-OECD Countries, Dependent Variable – Piracy Rate

	OLS	RE	FE
lnint	0.527	2.886	3.024
	(0.640)	(3.36)	(3.06)
lngdppc	-10.987	-10.513	-8.005
	(-3.240)	(-2.08)	(-0.92)
corp	-3.634	-5.117	-5.164
	(-3.240)	(-3.19)	(-2.58)
N	241	241	241
Adj. R^2	0.256	0.238	0.227
Breusch and Pagan Prob> chi2		0.0000*	
Hausman test Prob> chi2		0.6944	

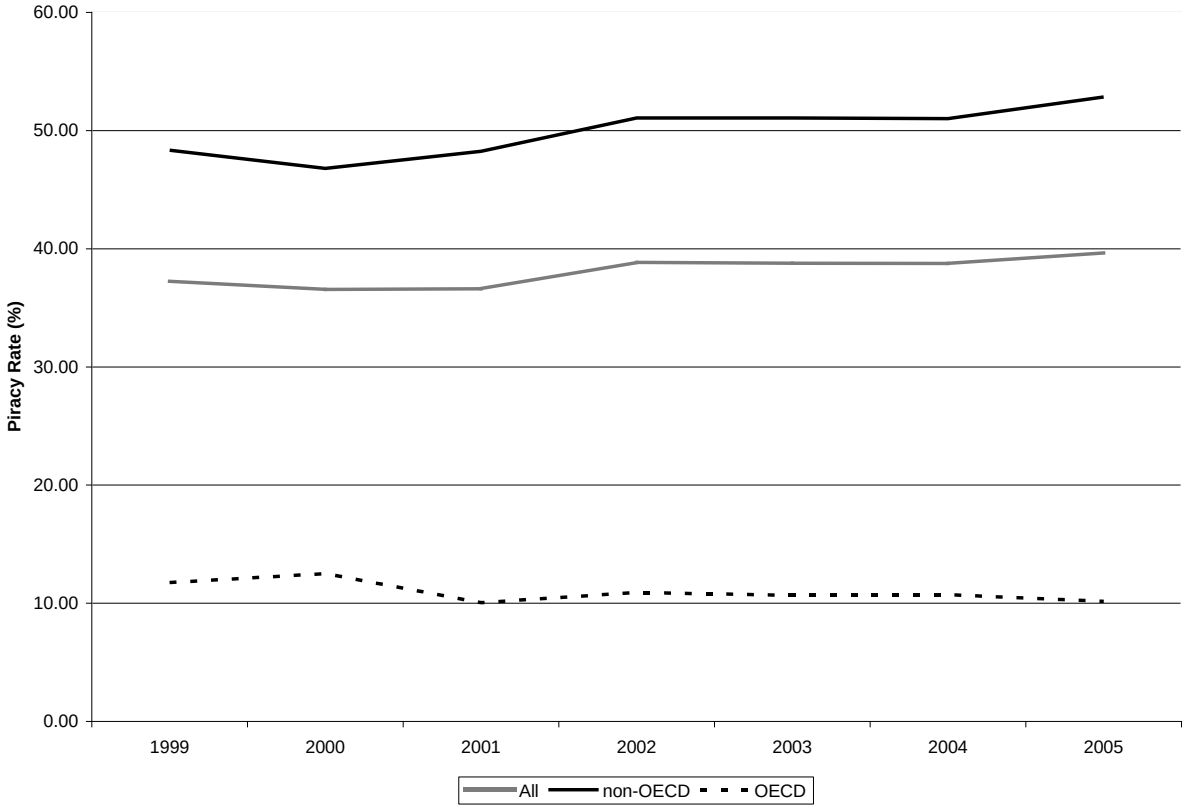
Note: t-statistics reported in parentheses; t≥|2| indicates significance at the 5% level or greater. Constants not reported. * denotes statistically significant

Table 2c. Regression Analysis for OECD Countries, Dependent Variable – Piracy Rate

	OLS	RE	FE
lnint	-0.360	1.906	-0.986
	(-0.170)	(0.62)	(-0.22)
lngdppc	-27.243	-27.910	6.212
	(-5.300)	(-1.84)	(0.16)
corp	-3.136	-2.091	3.583
	(-3.360)	(-1.26)	(1.12)
N	123	123	123
Adj. R^2	0.253	0.240	0.209
Breusch and Pagan Prob> chi2		0.0000*	
Hausman test Prob> chi2		0.1727	

Note: t-statistics reported in parentheses; t≥|2| indicates significance at the 5% level or greater. Constants not reported. * denotes statistically significant

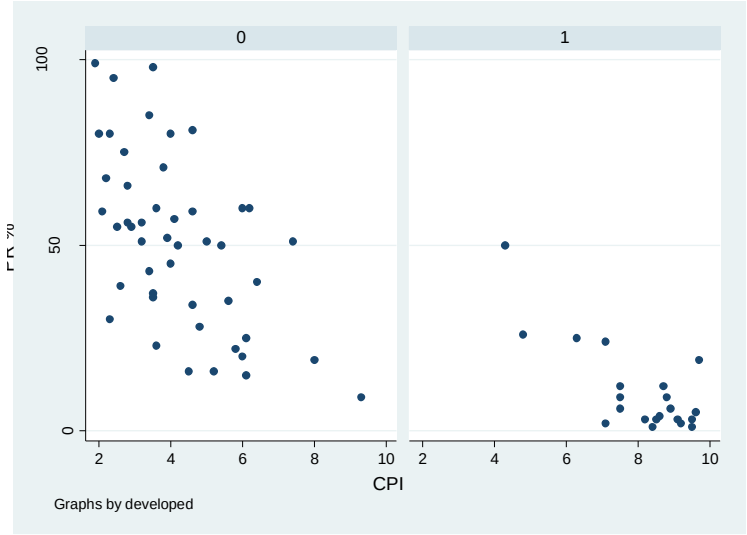
Fig. 1 Mean Piracy Rates, 1999-2005



Sources: IFPI, 2006.

Fig. 2a Corruption Perceptions Index (CPI) v. Piracy Rates, 2004

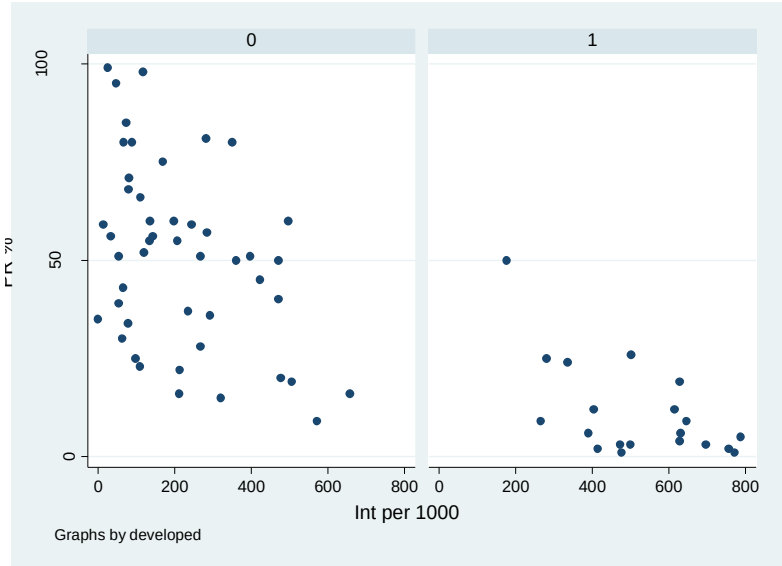
Non-OECD OECD



Sources: IFPI and Transparency International, 2004.

Fig. 2b Internet per 1000 People v. Piracy Rates, 2004

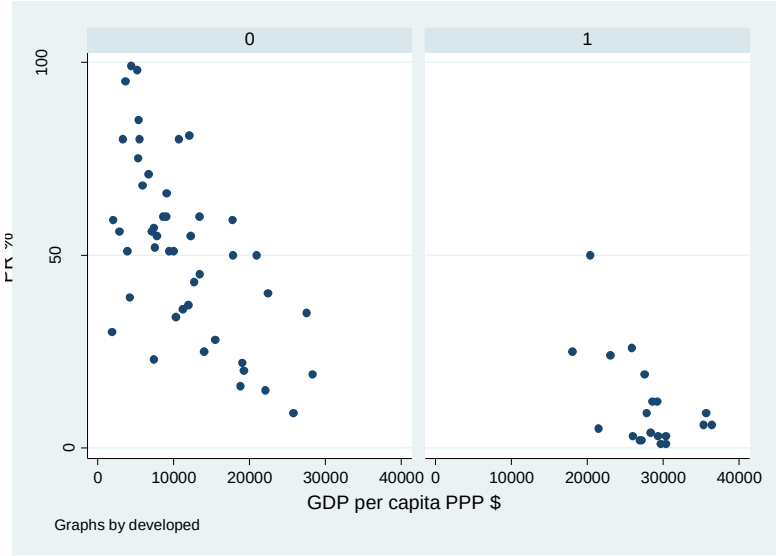
Non-OECD OECD



Sources: IFPI and World Bank, 2004.

Fig. 2c GDP per capita v. Piracy Rates, 2004

Non-OECD OECD



Sources: IFPI and World Bank, 2004.

Appendix A

Country list

Argentina
Australia*
Austria*
Bahrain
Belgium*
Brazil
Bulgaria
Canada*
Central America
Chile
China
Columbia
Croatia
Cyprus
Czech Republic
Denmark*
Ecuador
Egypt
Estonia
Finland*
France*
Germany*
Greece*
Hong Kong
Hungary
Iceland*
India
Indonesia
Ireland*
Israel
Italy*
Japan*
Korea, Rep. of
Kuwait
Latvia
Lebanon
Lithuania
Malaysia
Mexico
Netherlands*
New Zealand
Norway*
Oman
Pakistan
Paraguay
Peru
Philippines
Poland
Portugal*
Qatar
Romania
Russia
Saudi Arabia
Singapore
Slovak Republic
Slovenia
South Africa
Spain*
Sweden*
Switzerland*
Taiwan
Thailand
Turkey*
UAE
UK*
Ukraine
Uruguay
USA*
Venezuela
Zimbabwe

***** Original OECD members

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