A SIMPLE METHOD TO VALUE ANTI-PIRACY TECHNOLOGY IN THE RECORDED ENTERTAINMENT INDUSTRIES

[1]W. D. WALLS, [2]PATRICK J. HARVEY

[1]Economics Department, University of Calgary, Canada
[2]School of Accountancy, The Chinese University of Hong Kong
E-mail: [1]wdwalls@ucalgary.ca, [2]pjharvey@baf.cuhk.edu.hk

Abstract - This paper develops a methodologically sound framework for valuing anti-piracy technologies used in the recorded entertainment industries. The method is consistent with the `nobody knows" principle because it does not rely upon the calculation of a counterfactual `but for piracy' forecast. The developed method is applied in the context of the motion-picture industry to value digital watermarking technology; sample calculations are provided for theatrical box-office revenue, distributor revenue, and home video revenue.

Keywords - Counterfeiting, Piracy, Recorded Entertainment, Motion-Picture Industry, Nobody Knows, Valuation Method

I. INTRODUCTION

Piracy of recorded entertainment, particularly digital files for music and motion-pictures, is a known problem for copyright holders. This has led to technological solutions to protect content. In this paper, we examine piracy in the motion-picture industry and provide an example of a methodologically sound procedure for valuing anti-piracy technology that is accessible to practitioners.

Motion-picture piracy affects the theatrical movie market through both supply and demand margins. If pirate copies reduce revenue from theaters, then revenue per screen would decline leading theaters to drop the pirated film for a better prospect. A pirated film may even fail to meet the holdover amount required to extend the theatrical engagement for another week. As a result, other exhibitors would be less likely to exhibit a pirated film because of its low grosses. Through these mechanisms, piracy would accelerate the rate at which a movie's theatrical gross revenues decline and increase the rate at which it loses theaters through the weeks of its run.

On the demand side, if piracy accelerates the decline of a movie's theatrical gross, it will fall more rapidly in the highly competitive and closely followed contest for box-office rankings. When a movie declines in rank and revenue that event may be used as a signal by those potential viewers who key on rankings to choose among movies. (De Vany and Walls, 1997, provide a model of this dynamic demand process). To the extent that piracy accelerates a movie's box-office revenue decline its revenues in subsequent weeks are adversely affected. A rapid loss of revenue speeds the loss of theaters which, in turn, causes a further decline in revenue. If the pirated copies are poor or show an unfinished movie or work print that contributes to a poor assessment of the movie, then word-of-mouth transmission of this (biased) information would have a negative effect on theatrical grosses.

Anti-piracy technologies seek to reduce the supply of pirate copies. A recent study by the Digital Watermarking Alliance (2009) reports that digital serial numbers---a type of digital watermarking for prints of films---reduces digital filesharing by 25% to 52%. How does this reduction in filesharing activity translate into increased box-office revenue for films that utilize this technology?

There are three main approaches have been pursued in the empirical literature investigating the effects of digital piracy on paid consumption in the entertainment industries.

- A number of studies have examined aggregate sales and internet usage (or computer ownership, using those variables as a proxy for file sharing activity).
- Some studies have pursued an individual-level analysis by surveying individuals on their consumption behavior.
- Some studies have utilized actual internet download information.

Conceptually, the best approach would appear to be the third one, where actual downloading activity is modeled in such a way that potential sales effects can be identified. Nearly all empirical research on the revenue impact of filesharing has focused on the music industry. In the music industry, Liebowitz (2006, 2008) finds that file sharing accounts for at least all of the decline in US music sales. Liebowitz (2011) standardizes the metric of sales decline across most of the empirical studies of music sales and concludes that in most cases the entire decline in music sales can be attributed to file sharing. A recent journal article by De Vany and Walls (2007) is the only published research that quantifies the relationship between actual internet piracy and a film's box-office revenue.

A major weakness of counterfactual or ``but for piracy'' methods widely used to estimate damages is that those methods violate the ``nobody knows'' principle because they forecast what a movie would have earned in the absence piracy. The ``nobody

knows" principle states that even though we know a great deal about the factors that are associated with successful films in the past, this does not help us predict how successful a future film will be. Screenwriter William Goldman's (1983) famous statement that ``nobody knows anything" about how a movie will turn out at the box office has been verified and rigorously developed as the stable Paretian hypothesis by a variety of authors (De Vany and Walls, 2004; Walls 2004, 2005, 2010; McKenzie, 2003; Lee, 1999). Goldman's statement has been refined and restated by Richard Caves as the nobody knows principle: ``That is, producers and executives know a great deal about what has succeeded commercially in the past and constantly seek to extrapolate that knowledge to new projects. But their ability to predict at an early stage the commercial success of a new film project is almost nonexistent" (Caves, 2000, p. 371). In a highly-cited study, De Vany and Walls (1999) show that motion-picture revenue outcomes are characterized by extreme uncertainty---so extreme that forecasts of motion-picture box-office revenue have zero precision. It is possible of course to calculate naively a prediction of how much revenue a particular film will earn, but such a prediction is useless in practice because it has no precision.

The following section will set out how film piracy impacts box-office revenue. Section 3 quantifies how film attributes and box-office performance are related to film piracy. Sample calculations of the magnitude of losses due to film piracy are provided in Section 4. Conclusions are made in Section 5.

II. HOW MOVIE PIRACY AFFECTS BOX-OFFICE REVENUE

The model we employ, based on the published work of De Vany and Walls (2007), does not violate the ``nobody knows" principle of motion picture uncertainty. Piracy adversely affects the dynamics of demand and supply in the theatrical market. The immediate effect on the dynamics is to increase the rate at which revenue and the number of screens showing the movie decline. The longer-term effect is to alter the information dynamics in such a way that demand in later weeks is also reduced. Thus, a pirated movie will play off more rapidly and lose revenue at an accelerated rate during its run.

Table 1 displays the econometric estimates of De Vany and Walls (2007) relating a film's rate of revenue decline to the level of pirate supply. These estimates show that an additional unit of pirate supply (measured in site-days on a weekly frequency) accelerates mean revenue decline by about $443.82 per week and median revenue decline by about $437.91 per week. The similarity of the mean and median estimates is an indication that the robust to the particular method of calculation. These estimates allow us to provide a concrete way to transform changes in piracy into changes in box-office revenue by summing the revenue changes over the theatrical life of a motion picture.

Table 1: Revenue Decline and Pirate Download Supply

	least-squares	median regression
variable	estimate	estimate
constant	−4.35e+07	−4.15e+07
	(5428957)	(1.09e+07)
pirate supply	−443.8191	−437.9149
	(115.04)	(31.2635)
time	1.6e07	1.48e07
	(3266542)	(6508654)
time^2	−1422298	−1287740
	(427634)	(712499)
R^2	0.9954	0.9563

Note: Estimated standard errors are in parentheses.
Source: De Vany and Walls (2007), Table 4.

III. FILM ATTRIBUTES, BOX-OFFICE SUCCESS, AND PIRACY LEVELS

Piracy levels may be related to film-specific attributes such as the budget or the number of theater screens on which a film is being shown. If film piracy is systematically related to film attributes, this provides a valid way to quantify how piracy levels can be expected to vary across individual films. This is explicitly an ex ante analysis of movie piracy. BitTorrent reports the most downloaded films for the years 2008-2011, inclusive, on the website torrentfreak.com. The downloads reported refer to the BitTorrent site only, but these provide the only estimate publicly available of overall download activity. Data on budgets and the number of theater screens on which a film opened are reported on the website boxofficemojo.com.

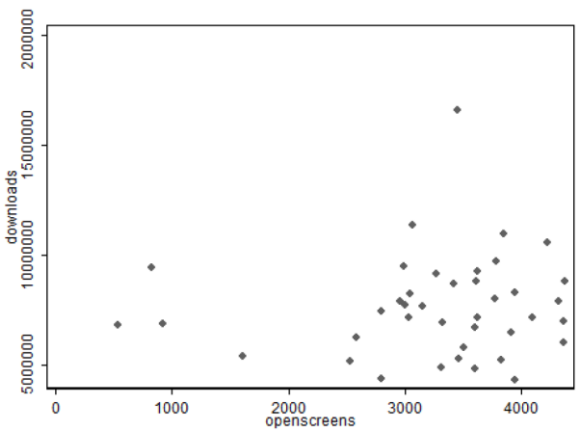

Figure 1: BitTorrent Downloads and Opening Screens

Figure 1 displays a scatterplot of the number of downloads and the number of theater screens on which a film opened for the forty films comprising the Top-10 most downloaded films in each year 2008-2011. About 80% of the films have downloads between 5 and 10 million; the outlier is Avatar with about 16.5 million downloads.

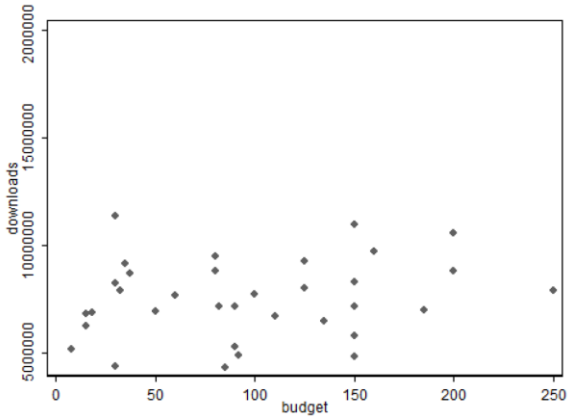

Figure 2: BitTorrent Downloads and Film Budgets

Figure 2 displays a scatterplot of downloads and a film's budget for the subset of films for which budget data were available. The scatterplot shows no relationship between downloads and budget. The finding that film piracy is not systematically related to film budgets or opening screens is entirely consistent with the nobody knows characteristic of film success. In the same way the De Vany and Walls (1999) find that motion-picture success is characterized by extreme uncertainty, we find here that motion-picture piracy is also highly uncertain. Ex Ante prediction of film piracy is at least as uncertain as the prediction of film success at the box office. For this reason, the unconditional average of film piracy is the best estimate for any film's level of piracy.

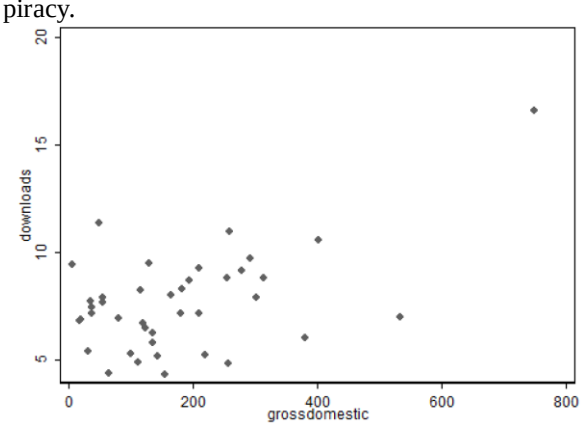

Figure 3: BitTorrent Downloads and Domestic Box-Office Gross

Levels of movie piracy may also be linked to box-office success. Figures 3 and 4 display scatterplots of BitTorrent downloads and domestic and worldwide box-office revenue, respectively, for the most downloaded films for the years 2008-2011. These figures show no strong pattern between piracy as measured by BitTorrent downloads and film success. The correlation between downloads and domestic box-office revenue is 0.5041; if the single outlying observation in Figure 3 is removed (Avatar) the correlation falls to 0.1914. The correlation between downloads and worldwide box-office revenue is 0.5703 and it falls to 0.1566 when the single outlying observation (Avatar) is removed from the sample.

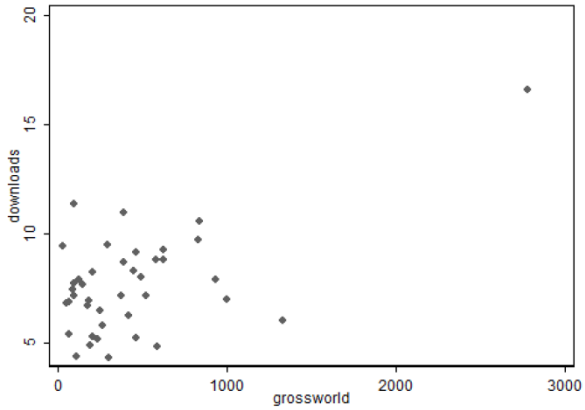

Figure 4: BitTorrent Downloads and Worldwide Box-Office Gross

It is apparent that ex ante prediction of film piracy is highly uncertain and it is not systematically related to film success or the film attributes. It follows that the unconditional average of film piracy is the best estimate for any individual film's level of piracy.

IV. A SAMPLE CALCULATION

The following sample calculation can be done for each film that used the anti-piracy technology. The use of anti-piracy technology increases the box-office revenue, a portion of which is returned to the distributor as the rental fee for exhibiting the film. The higher box-office revenue is associated with higher DVD sales revenue, a portion of which is returned to the distributor.

4.1 Box-Office Revenue

The use of anti-piracy technology reduces the revenue losses due to piracy. Because we do not have exact data on pirate supply, we take as a base case the level of pirate supply for a major motion-picture for which data are available. These data are described fully in the De Vany and Walls (2007) journal article.

Integrating the weekly median revenue decline over the pirate supply results in a revenue loss of $41.70 million. This is the baseline estimate of the revenue loss due to motion-picture piracy and it is not conditional on film attributes or film success at the box office. The Digital Watermarking Alliance (2009) estimates that digital watermarking for prints of films reduces digital filesharing by 25% to 52%. These estimates can be applied to the estimated revenue loss due to piracy: If the reduction in piracy due to the introduction of anti-piracy technology is taken to be 25%, this yields a revenue increase of about $10.4 million in US box-office revenue. If the reduction in piracy is taken to be 52%, this yields a revenue increase of about $21.7 million in US box-office revenue.

These estimates are entirely consistent with the ``nobody knows'' principle because there was no prediction of how the film would have performed in the absence of anti-piracy technology. The estimates are not conditioned on film attributes, nor are they conditioned on a film's box-office revenue. The estimates are based solely on published research that quantifies how pirate supply affects the rate of revenue decline. There is a distinct spatial clustering that characterizes the location of one-worker firms.

4.2 Distributor Revenue

A portion of the increase in box-office revenue would be kept by the cinemas exhibiting the film, with the remainder paid to the distributor as a rental fee. The exact rental fees are determined by the terms of the agreement between exhibitors and distributors. A marginal dollar of box-office revenue can generate rental payments as high as 90%. The average rental fee is about 50% of total box-office revenue. The additional revenue received by the distributor is the rental percentage applied to the additional revenue generated by a reduction in film piracy. For example, if the average rental rate of 50% were used, piracy-reduction technology that resulted in an expected increase in box-office revenue of $10.4 million would lead to an additional $5.2 million in revenue being returned to the distributor.

4.3 Home Video Revenue

Increased box-office revenue is associated with increased home video revenue. Within the period of the data set, DVD sales were becoming an increasingly important revenue window for the entertainment industry, especially the motion-picture industry. The Motion Picture Association of America (MPAA 2007) estimates that in 2007 the North American box-office gross was $9.6 billion, that international box-office gross was $17.1 billion, and that DVD sales to consumers were $16 billion; consumers spent an additional $7.5 billion on DVD rentals in 2007. DVD sales account for a large fraction of overall revenues and are second only to foreign box-office revenue in overall revenue generation. McKenzie (2010) finds that the relationship between box-office revenue and DVD sales revenue is positive and quadratic. McKenzie (2010, p.\ 171) states that, ``This observation is consistent with the observation that there is more kurtosis in the DVD revenue distribution but moreover, suggests that the popular films at the box office go onto achieve great success in the DVD market. In this sense, theatrical success leverages DVD success and seems to do so at an increasing rate." The precise estimated relationship between box-office revenue and DVD sales revenue is as follows:

$$\text{DVD Rev} = -14785.12 + 0.1112\,(\text{B-O Rev}) + 3.49e\text{-}9\,(\text{B-O Rev}\}\text{^}2$$

The expected increase in DVD sales revenue can be calculated directly from these regression results. For example, for a film with $100 million in box-office revenue the expected DVD revenue would be about $46 million. If the use of piracy-reduction technology increased box-office revenue by $10.4 million as set out in Section 4.1 above, the resulting DVD revenue would be about $54.8 million. The use of anti-piracy technology translates into about $8.8 million of additional DVD revenue.

CONCLUSIONS

This paper develops a methodologically sound framework for valuing anti-piracy technologies that is accessible to practitioners. The method is consistent with the `nobody knows'' principle because it does not rely upon the calculation of a counterfactual `but for piracy' forecast. The developed method was applied in the context of the motion-picture industry to value digital watermarking technology; sample calculations provided to demonstrate the impact of anti-piracy technology on theatrical box-office revenue, distributor revenue, and home video revenue.

REFERENCES

[1] Caves, R.E. (2000). Creative Industries: Contracts between Art and Commerce.Harvard University Press, Cambridge.
[2] De Vany, A.S. and Walls, W.D. (1997). The market for motion pictures: Rank, revenue and survival. Economic Inquiry, 35(4):783--797.
[3] De Vany, A.S. and Walls, W.D. (1999). Uncertainty in the movie industry: Does star power reduce the terror of the box office? Journal of Cultural Economics, 23(4):285--318.
[4] De Vany, A.S. and Walls, W.D. (2004). Motion picture profit, the stable Paretian hypothesis, and the curse of the superstar.
[5] Journal of Economic Dynamics and Control, 28(6):1035-1057.
[6] De Vany, A.S. and Walls, W.D. (2007). Estimating the effects of movie piracy on box-office revenue. Review of Industrial Organization}, 30(4):291--301.
[7] Digital Watermarking Alliance. (2009). Digital serial numbers and piracy deterrence: The deterrent effect of digital serial numbers on illegal file-sharing and downloading. Technical report. Available at http://www.digitalwatermarkingalliance.org/docs/papers/
[8] DWA_WhitePaper_PiracyDeterrence.pdf.
[9] Goldman, W. (1983). Adventures in the Screen Trade.Warner Books, New York.
[10] Lee, C. (1999). Competitive Dynamics and the Distribution of Box Office Revenues in Motion Pictures: The Stable-Paretian Hypothesis.Ph.d. dissertation, University of California at Irvine.
[11] Liebowitz, S.J. (2006). File sharing: Creative destruction or just plain destruction? Journal of Law and Economics, 49(1):1-28.
[12] Liebowitz, S.J. (2008). Research note--testing file sharing's impact on music album sales in cities. Management Science, 54(4):852--859.
[13] Liebowitz, S.J. (2011). The metric is the message: How much of the decline in sound recording sales is due to file-sharing? Working paper, School of Management, University of Texas---Dallas.

[14] McKenzie, J. (2003). Box Office Revenue Distributions, Paretian Tails, and Survival Analysis. Ph.d. dissertation, University of Sydney.

[15] McKenzie, J. (2010). How do theatrical box office revenues affect DVD sales? Australian empirical evidence. Journal of Cultural Economics, 34(3):159-180.

[16] Motion Picture Association of America. (2007). Entertainment Industry Market Statistics.

[17] Walls, W.D. (2005). Modeling movie success when `nobody knows anything': Conditional stable-distribution analysis of film returns. Journal of Cultural Economics, 29(3):177-190.

[18] Walls, W.D. (2010). General stable models of the rate of return to Hollywood films. Advances and Applications in Statistical Sciences, 2(1):19-36.

★★★