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Abstract

This study examines the impact of peer-to-peer (P2P) file-sharing on the Australian theatrical film industry. Using a large data set of torrent downloads observed on three popular P2P networks, we find evidence of a sales displacement effect on box office revenues. However, although statistically significant, the economic significance of this displacement appears relatively small. To establish causality, we make use of two precedent-setting Australian Federal Court case rulings, as well as observed levels of contemporaneous downloading in geographically separated markets within Australia. We observe that the release gap between the US and Australian markets is a key contributor to piracy early in a film's theatrical life; this finding provides a partial explanation for the industry's move toward coordinated worldwide releases.

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1 Introduction

Since the arrival of file-sharing technologies more than a decade ago, intellectual property protection has become an increasingly topical and important issue because digital technologies have provided consumers low-cost means with which to share copyrighted material. Indeed the global music, software, television and film industries claim to be facing the most significant single threat to their profits and very survival in history as a direct result of digital piracy. With the proliferation of BitTorrent and other file-sharing technologies, internet users can easily download content at close to zero cost given that they have a high-speed internet connection and sufficient download capacity. The increasing popularity of such services has created something of a revolution in the way many consumers access and consume content. As a result, content providers have waged an international 'war on piracy' in many countries, with high-profile legal cases against file-sharing services, individuals using file-sharing services, and internet service providers (ISPs).

Although it is extremely difficult to put a figure on the extent and costs of digital piracy, a recent annual industry survey by Business Software Alliance of 15,000 computer users across 33 countries found that more than 57% of respondents admitted to pirating software in 2012, up from 42% in 2011. Another recent study of piracy habits in the US found that 46% of adults have bought, copied, or downloaded unauthorised music, TV shows or films and that these practices correlate strongly with youth and moderately with higher incomes.[1] In Europe, a 2010 study by the International Chamber of Commerce found that internet pirates downloaded €10 billion worth of music, film and television and claimed that digital piracy could cost the content industries €240 billion in revenue and 1.2 million jobs by 2015.

The content industries would appear unambiguously of the opinion that piracy has only negative consequences for their stake-holders. However, many academics and industry observers have noted that piracy may have beneficial effects too if, for example, illegal downloading acts as a sample which precedes legal paid consumption, or if there are bandwagon effects in demand from shared word-of-mouth. Economic theory can predict either a positive or negative legal consumption effect from piracy.[2] Which effect is larger is an empirical issue. As Dejean (2009) and Waldfogel (2012) discuss in detail, three broad approaches have been pursued in the empirical literature investigating the effects of digital piracy on legal paid consumption. First, a number of studies have examined aggregate sales vis-à-vis internet usage, or computer ownership, as a proxy for downloading activity. These studies typically pursue either a cross-sectional approach (e.g. Peitz and Waelbroeck, 2004; Zentner, 2005; Walls, 2008), a time-series approach (e.g. Stevans and Sessions, 2005), or a combination thereof (e.g. Michel, 2006; Liebowitz, 2008). Second, some studies have utilised actual download information (e.g. Liebowtiz, 2006; Bhattacharjee *et al*, 2007; Oberholzer-Gee and Strumpf, 2007; De Vany and Walls, 2007). Third, others have based analyses on data obtained by surveying individuals on their consumption behaviour (e.g. Zentner, 2006; Rob and Waldfogel, 2006, 2007; Hennig-Thurau,

[1] Copy Culture in the US and Germany, The American Assembly, 2011.

[2] Peitz and Waelbroeck (2006) provide a useful survey on the theoretical contributions related to digital piracy.

Henning and Sattler, 2007; Waldfogel, 2010).

Conceptually, the best approach would appear to be the second one, where actual downloading activity is measured directly and related to legitimate sales. However, this approach is complicated by the inherent simultaneity between sales and downloads. A particularly impressive study employing data on actual downloads vis-à-vis sales is that of Oberholzer-Gee and Strumpf (2007). That study of the US recorded music industry used file-sharing data collected from OpenNap, a centralised peer-to-peer (P2P) network, providing a sample capturing 0.01% of the world's downloads, and contemporaneous album sales (retail and on-line) over a 17 week period in late 2002. To mitigate the endogeneity between sales and downloads, they considered the number of German school children on holiday under the assumption that German kids provided much of the supply of songs on file-sharing networks. However, they were unable to detect any displacement effect between download activity and music sales concluding that the observed decline in music sales is not the primary result of file-sharing.[3]

Our study similarly investigates digital piracy using actual download and sales data, but with specific application to the theatrical film industry. We employ an extensive data set of daily Australian state/territory level P2P torrent downloads and contemporaneous box office revenues. Our study is the first that we know of to consider digital piracy in the film industry using a large data set of actual downloading activity. Our empirical methodology is in many respects similar to the approach of Oberholzer-Gee and Strumpf; however, as discussed further below, there are a number of subtle and important differences. In particular, our identification strategy uses precedent-setting Australian Federal Court decisions in which Australia's second largest internet service provider (ISP), iiNet, was twice ruled to be non-complicit in digital piracy by failing to disconnect customers identified by copyright holders—represented by the the Australian Federation Against Copyright Theft (AFACT)—as having downloaded illegal content. In addition to the judgements of these court rulings, we also use the summed number of downloads in other geographic markets (*i.e.* states/territories) in our identification strategy—an approach similar to the use of (average) price in other markets often employed in the differentiated goods literature when estimating demand (*e.g.* Nevo, 2001).

Like Oberholzer-Gee and Strumpf, we find no evidence of a *contemporaneous* relationship between downloading and sales (i.e. box office revenues), but we do find evidence of a sales displacement effect when downloads are considered as a *dynamic stock* over one, two, three and four week windows. We also observe that both contemporaneous and dynamic stock downloads have a significant negative impact on first week box office. Given many films are subject to a release lag between the US and Australian markets, this suggests downloading activity post-US release but pre-Australian release decreases opening week revenues which are well-known to be particularly important in a film's life.[4] We find that

[3]Although appearing as the lead article in the *Journal of Political Economy*, and having been one of the most downloaded and cited papers in the journal since its publication, the findings have not been accepted without criticism. Notably, Liebowitz (2007, 2010) questions the data construction and instruments used in the econometric component of the research.

[4]This evidence is consistent with a recent study by Danaher and Waldfogel (2012) who find that, on average, international box office revenues are 7% lower when international releases are delayed relative to the US market in a study of seventeen countries pre and post BitTorrent technology.

the release delay between the US and Australian markets provides an opportunistic window for online pirates which is statistically related to decreased revenues at the box office. Although the present impact on box office revenues appears small, with the increasing use of file-sharing technology and increased speed of bandwith in Australia, this problem is likely to increase. The trend towards day-and-date releases seems the most sensible response given this increasing threat in the absence of legal solutions.

2 Australian Context and the iiNet Case

Australia provides an interesting context within which to study digital piracy—and in particular that related to theatrical films. Australians are well-known to be some of the most frequent cinema-goers worldwide. According to statistics compiled by Screen Australia, in 2010 Australia ranked third behind Iceland and Singapore in terms of annual admissions per capita, with the US ranking fourth.[5] It is widely known that Australians are also some of the most avid users of P2P file-sharing technologies for music, television and film.[6] Australia's attraction to file-sharing is often attributed to the relatively high prices faces by consumers as well as international release delays.[7] Two recent (2011) studies by Australian Content Industry Group (ACIG) and Australian Federation Against Copyright Theft (AFACT) estimate annual losses at A\$900m and A\$1.37b, respectively.[8] With the National Broadband Network (NBN) progressively rolled-out over the next decade, content industries fear that digital piracy will proliferate even further as consumers are able to access and download illegal content with increasing speed and ease.

Although Australian content providers have been lobbying the government to take a stand against piracy, thus far their efforts have largely been ignored with policy makers encouraging continued negotiations with ISPs to find a cooperative solution.[9] As a result of political inaction, some content owners have pursued direct legal action against individuals and, subsequently, ISPs in their war on piracy. The initial legal strategy pursued by some companies involved actions previously employed in the US (and other countries) by sending Australian ISPs 'cease and desist' notices outlining details of the customer's infringement and requesting they threaten the individual with disconnection of their internet service.[10] However, not all ISPs complied with such instruction and the failure to comply by Australia's second largest ISP, iiNet, resulted in a landmark court

[5] See `http://www.screenaustralia.com.au/research/statistics/acompadmitper.asp`.

[6] For example, the HBO hit *Game of Thrones* was most heavily downloaded by Australians (Ernesto, 2012). In relation to music downloads, a recent study by MusicMetric found that Australians download more songs per-capita than any other country and ranked sixth overall in terms of volume (Zuel, 2012).

[7] The disparity in prices for digital content has recently caught the attention of policy makers who have commenced an inquiry within the Australian House of Representatives about the issue.

[8] To put these figures in perspective, total Australian box office revenue in 2011 was A\$1.09b, a drop of 3% over 2010's record of A\$1.13b (Motion Pictures Distributors Association of Australia, 2012).

[9] The 'three-strikes' policy adopted in a number of countries (e.g. UK and France) was considered in Australia; however, to date, such a policy has found little support from policy makers.

[10] For example, the US television network CBS sent infringement notices to one Australian ISP, TPG, in relation to alleged offences by their subscribers warning them "1) Remove or disable access to the individual who has engaged in the conduct; and 2) Take appropriate action against the individual under your Abuse of Policy Terms of Service Agreement" (Britton, 2011).

case spanning more than four years.

In November 2008, a consortium of 34 record labels, pay-TV providers, film studios and other content providers filed the case against iiNet for failing to discipline its customers in relation to allegations of copyright infringement. The case of *Roadshow Films and others v iiNet* (or commonly *AFACT v iiNet*) was initially heard by the Federal Court of Australia and decided on 4 February 2010 with the trial judge ruling in favour of iiNet and awarding costs. In passing judgement, the trial judge noted that while iiNet users did infringe copyright, it was not the responsibility of iiNet to police its customers on the infringement of other parties' copyrights. The decision was subsequently appealed by AFACT to the full bench (Full Court) of the Federal Court on 24 February 2011 but was again dismissed by the presiding judges. The trial judges upheld the initial decision but for different reasons. They noted that although iiNet showed an indifferent attitude to the complainants' allegations, iiNet's inaction did not constitute authorisation for the act of copyright infringement. On further appeal, the case was heard by the High (Supreme) Court of Australia which again sided with iiNet in judgement passed on 20 April 2012. The Court unanimously dismissed AFACT's appeal and ordered AFACT to pay costs of approximately A$9m.[11] We make use of the first two rulings in our empirical exercise as detailed below.

3 Data and Descriptive Statistics

To investigate the impact of file-sharing on film revenues, we employ an extensive data set of Australian state/territory level daily box office revenues and P2P torrent downloads of 166 films released in Australian cinemas between January 2010 and August 2011. The films in our sample are typically large budget 'Hollywood-type' films which received a wide-release in the US theatrical market as well as an Australian theatrical release. Given the international nature of these films, *a priori* we would expect substantial interest in both cinematic consumption and illegal downloading allowing us to investigate potential displacement relationships between downloading activity and box office revenues. The torrent data were sourced from Peer Media Technology—a company which, among other services, measures digital piracy for companies in the entertainment, software and publishing industries. This service tracks downloads on three popular P2P networks: 1) BitTorrent, 2) eDonkey, and 3) Ares, where a download is defined as a unique instance of an IP address attempting to download an appropriately named file on a given day. The IP addresses are subsequently geo-located by another company, MaxMind, to provide state/territory level number of downloads per title per day in our particular context. Peer Media Technology estimates that their measurement provides approximately 55% of all downloads in the Australian context.

The torrent data of each film in our study span a longer period than the observed Australian theatrical life of the film, allowing us to track downloads which may have occurred both before and after the theatrical window. In particular, we observe downloads post US release, but pre-Australian release. Figure 1 reveals that the number of downloads spikes after the initial US release, presumably the result of increased availability and

[11] See `http://www.iinet.net.au/about/mediacentre/releases/index.html`

interest. But a significant number of downloads occurs prior to the Australian release and we hypothesize that this is related to release gaps between the two markets, and issue we shall discuss in more detail below. During the theatrical release window, we observe contemporaneous (daily) box office revenues and number of theatres for each film disaggregated to the state/territory level (Rentrak). In addition, we also observe US box office revenues, opening theatres and cinematic release dates, hence we observe the release gap between the US and Australian theatrical releases.[12]

In total we observe 295,304 torrent download data points and 64,328 daily box office revenue and theatre data points. We limit our attention to 20 weeks of box office revenues post Australian release which provides us 56,663 data points in the final estimation sample. Tables 1, 2 and 3 provide summary statistics for our data. Table 1 details aggregate level information for the 166 films observed. On average, each film earned nearly A$8.9m at the Australian box office and was released on 259 screens. The highest earning film, *Harry Potter and the Deathly Hallows Part 2*, made almost A$51m. The average number of downloads per title was almost 113,000, with an average file-size of 1.2GB. The most downloaded film, *Inception*, was downloaded more than 435,000 times. As noted above, all the films in our sample had a wide-release in the US market of at least 2,000 theatres (average of 3,125), and were generally large budget titles with an average (estimated) production budget of US$70m (data sourced from IMDb).

Table 2 provides further film-level summary statistics in relation to revenue and downloads. In terms of mean and median, there is some evidence that 'Action' films are popular with both cinema attendees and downloaders. However, while G (general admission) and PG (parental guidance) rated films are more popular with cinema goers; M (mature) and MA15+ (mature audiences 15 years and over) rated films are more popular with downloaders. Of all 166 films we observe, the correlation between total revenue and total downloads is moderately strong at 0.522. Figure 2 shows this relation with a simple linear regression which reveals a statistically significant positive relation.

Table 3 provides summary statistics for the disaggregated data used in estimation. Of the 56,663 data points, the average film's daily (state/territory level) revenue is A$25,148 and the average number of downloads is 95. These are simply weighted averages of the state/territory data contained in the body of the table. The state/territory summary data is consistent with respective sate/territory populations in terms of mean ranking.[13] However, the data for Northern Territory (NT) downloads are particularly low due to problems in primary data collection.[14] Aggregating all revenue and downloads across states/territories for all films observed on each of the 596 days in our sample, the average Australia-wide daily revenue was just under A$2.5m, with the highest recorded single day revenue of A$9.4m occurring on Wednesday July 13, 2011, coinciding with the release of *Harry Potter and the Deathly Hallows*. In terms of downloads, nation-wide the daily average was just over 31,000 with the highest single day number of downloads occurring

[12]All of the theatrical market data on films were obtained from Rentrak.

[13]In December 2011, New South Wales (NSW) and Victoria (VIC) were the largest states with populations of 7.25 million (approximately 32% of Australia's population) and 5.57 million (approximately 25%), respectively. Tasmania (TAS), Australian Capital Territory (ACT), and Northern Territory (NT) are the smallest in terms of population with 0.51 million, 0.37 million and 0.23 million, respectively.

[14]All estimates were re-calculated omitting this territory; there were no qualitative changes to results.

on Sunday June 12, 2011, where more than 61,700 downloads occurred. Our data also displays intra-week seasonality in relation to both revenue and downloads. Unsurprisingly Saturday, Sundays and Friday recorded highest average nation-wide revenues (downloads) at A\$4.0m (35,296), A\$3.3m (34,863), and A\$2.7 (28,424), respectively. We control for the intra-week seasonality in our model with the use of day-of-week dummy variables as discussed in the following section.

4 Econometric Model

Contemporaneous Downloads

The empirical model quantifies the sales displacement effect from illegal P2P torrent downloads on box office revenue. The approach is similar to Oberholzer-Gee and Strumpf (2007), with a number of important differences. First, our context is theatrical film revenues rather than music sales. This removes the complicated issue of transforming single downloads (sales) to a proxy for album downloads (sales). Second, the data are observed at daily, rather than weekly, levels. Also, data points are observed at the state/territory level, rather than national level. And third, our instruments for downloads in each market relies on judgements handed down in the Federal Court of Australia, as well as the contemporaneous downloading activity in the other state/territory geographical markets we observe. We discuss identification in more detail below.

Because films that are more popular at the box office are also more likely to be illegally downloaded, download activity should be treated as endogenous. We employ a two-step efficient generalized method of moments (GMM) estimation approach with robust standard errors (Hansen, 1982).[15] Our contemporaneous downloads model is defined in equations (1a) and (1b) which, respectively, represent the first stage and second stage of the GMM estimation

$$\begin{aligned} \ln D_{ist} &= \alpha_0 + \alpha_1 FC_t^1 + \alpha_2 FC_t^2 + \alpha_3 \ln D_{is't} + \alpha_4 \ln TH_{ist} \\ &\quad + \alpha_5 WK_{ist} + \alpha_d DW^d + \eta_s^D + v_i^D + \varepsilon_{ist} \qquad (1a) \\ \ln R_{ist} &= \beta_0 + \beta_1 \ln \widehat{D}_{ist} + \beta_2 \ln TH_{ist} + \beta_3 WK_{ist} + \beta_d DW^d + \eta_s^R + v_i^R + \mu_{ist} \qquad (1b) \end{aligned}$$

[15]Define the general form of equation (1) as $y = X\beta + u$, where the matrix of regressors, X, is of dimensions $N \times k$, and where N is the number of observations and k is the number of regressors. Also define the covariance matrix of u as $E[uu'|X] = \Omega$, which is of dimension $N \times N$. As some regressors (*i.e.* downloads) are endogenous, partition the regressors $\{x_1 x_2\}$ with the k_1 regressors x_1 endogenous and the $(k - k_1)$ remaining regressors x_2 assumed to be exogenous. The matrix of instrumental variables Z is $N \times l$, where the instruments are partitioned into $\{z_1 z_2\}$, where the l_1 instruments z_1 are excluded instruments and the remaining $(l - l_1)$ instrument $z_2 \equiv x_2$ are the included instruments (or exogenous regressors). The l instruments give a set of moment conditions, $E[zu] = 0$, with the sample analogue $\overline{g}(\beta) = (1/N)Z'u$. The intuition is to select a estimator for β which solves $\overline{g}(\hat{\beta}_{GMM}) = 0$. The GMM estimator chooses $\hat{\beta}$ that minimises the GMM objective function $J(\hat{\beta}) = N\overline{g}(\hat{\beta})'W\overline{g}(\hat{\beta})$, where W is an $l \times l$ weighting matrix. The optimal weighting matrix is that which produces the most efficient estimates. Following Hansen (1982), $W = S^{-1}$, where S is the covariance matrix of the moment conditions $S = E[Z'\Omega Z]$. For the heteroskedastic-consistent estimate of S, $\hat{S} = (1/N)\Sigma_{i=1}^{N} \hat{u}_i^2 Z_i' Z_i$ is used. The residuals come from a 2SLS regression which provides consistent estimates of β.

where R_{ist} and D_{ist} define revenue and downloads of film i in state s on date t, respectively. Our first instruments, FC_t^1 and FC_t^2 are dummy variables that takes the value 0 for dates prior to 4 February 2010 and 24 February 2011, respectively, and take the value 1 after these dates. Our second instrument, $D_{is't}$, represents the sum of downloads of film i in all other states/territories $s' \neq s$ on date t. TH_{ist} is the (time-variant) number of theatres showing film i in state s on date t. WK_{ist} is the week of the run of film i in state s on date t. DW^d represents a vector of dummy variables for day-of-week effects, η_s are state/territory fixed-effects, and v_i are film fixed-effects (with superscripts D and R denoting the first (downloads) and second (revenue) equations). Finally, ε_{ist} and μ_{ist} are first and second stage errors, respectively.

The logarithm transformation is applied to revenue and download data since both distributions are bounded below at zero and are skewed to the right. An additional benefit of the log-transformation is that the impact of downloads on revenues can be interpreted as an elasticity. Daily theatres, which are also transformed into logarithms, provide a time-variant measure of supply which allows demand to be realised on any given day. We would expect this variable to be positively related to revenues. The week-of-run variable captures the well-known typical decreasing relationship with time most films experience after they open. Given the left hand side revenue variable is in logarithmic form, the linearity of the week variable in fact would give rise to a convex relationship between revenue and time which is typically observed in box office (De Vany and Walls, 1997). Day-of-week dummy variables control for intra-week patterns in demand which typically reveal spikes on weekends and Tuesdays, which is a discount day for most cinemas in Australia (see De Roos and McKenzie, 2012). Finally, fixed-effects are also included for state/territory and film. As discussed further below, the inclusion of films fixed-effects goes some way to purging the simultaneity between revenue and downloads.

Identification

Identification in our model derives from the inclusion of two dummy variables for the Federal Court and Full Court of the Federal Court's decisions against AFACT on 4 February 2010 and 24 February 2011, respectively, as well as the sum of downloads observed across all other states/territories $s' \neq s$, which are contemporaneous to the number of downloads in state s on the particular day of observation.

Regarding the first instruments, it is possible that the decisions against AFACT could have either a positive or negative effect on downloading behaviour. On one hand, it could be argued that the media attention to the case sent a signal that the content industries were serious about pursuing legal recourse against those who infringed their copyrights—even though the judgements were against them. On the other hand, the negative outcomes might have signalled that individuals would not likely be punished by their ISPs and this increased downloading activity after the judgements.

Regarding the second instrument, the use of downloads in other geographic markets is similar in approach to the use of (average) price in other markets as an instrument for price in modelling demand in a focal market as common in the differentiated goods literature (e.g. Nevo, 2001). The intuition is that prices are correlated through common marginal cost shocks. Assuming the errors in demand are independent across market, this 'cost shifter' approach is valid.

While it it is obvious that the Federal Court's decisions are exogenous events which satisfy the statistical requirements to be valid instruments, it is less clear that the second instrument relating to the contemporaneous levels of downloads in other markets satisfies the same requirement. However, there are at least three strong arguments to support this instrument as valid in our context. Firstly, downloading activity in other states is almost certainly unlikely to affect theatre attendance (i.e. box office revenue) in the state of interest. Given the geographical locations of major cities and centres within Australian states, it would be a very small number of people who would potentially reside (and download) in one state but attend theatres in another state. Secondly, the number of downloaders present in a 'swarm' (i.e. the combined number of 'seeders' and 'peers' who possess a full copy or part copy of the file, respectively) plays an important role with downloading ability and speed. *Ceteris paribus*, the more active downloaders in a swarm, the higher the success rate and speed of download, or the lower the opportunity cost of downloading. Thirdly, any problems with downloading a particular title are likely to affect all downloaders regardless of their geographical location. For example, if a 'tracker' (i.e. the server which directs the torrent uploads and downloads) goes down, this will affect the number of downloads nation-wide assuming they are on the same P2P network.

Dynamic Stock of Downloads

Although the model described in (1) captures the potential sales displacement for film i, in market s, on date t; for a number of reasons it would seem more appropriate to consider the number of downloads over some window of time prior to, and including, date t for that particular film rather than only those downloads observed contemporaneously. For example, illegal downloaders may browse torrent sites for new titles and may initialise a download with the intent of viewing the download at a later time. In addition, downloading speeds (at least during the period of analysis in Australia) could be restrictively slow preventing instant playback necessitating files are downloaded in advance of actual consumption. Further, there is also the possibility that once a download has been completed, an individual may share the file with friends which would similarly contribute to potential future sales displacement effects. For these reason, we therefore consider it likely that downloading over some window of time affects future box office sales which would not be captured in our contemporaneous specification. We subsequently refer to this alternate approach as a *dynamic stock of downloads* in our empirical methodology and consider the modified model:

$$\begin{aligned} \ln D_{isT} &= \alpha_0 + \alpha_1 FC_t^1 + \alpha_2 FC_t^2 + \alpha_3 \ln D_{is'T} + \alpha_4 \ln TH_{ist} \qquad (2a) \\ &\quad + \alpha_5 WK_{ist} + \alpha_d DW^d + \eta_s^D + v_i^D + \varepsilon_{ist} \\ \ln R_{ist} &= \beta_0 + \beta_1 \ln \widehat{D}_{isT} + \beta_2 \ln TH_{ist} + \beta_3 WK_{ist} + \beta_d DW^d + \eta_s^R + v_i^R + \mu_{ist} \qquad (2b) \end{aligned}$$

where D_{isT} defines downloads of film i in state s over a period of T days, where $T \in \{7, 14, 21, 28\}$, prior to and including the date of observation. This specification would nest the contemporaneous model when $T = 1$. Essentially, the modification simply considers the dynamic stock of downloads over one, two, three or four weeks ($T = 7, 14, 21, 28$) prior to (and including) date t. Our instrument, $D_{is'T}$, is also similarly defined and now represents downloads of film i in all other states/territories $s' \neq s$ over T. All other variables remain as specified above.

5 Estimation Results

Contemporaneous Downloads

Table 4 provides regression results for the base model where downloads are treated contemporaneously to revenue on the date of observation. The first column reports robust OLS estimates without film fixed-effects. The coefficient on the key variable of interest, contemporaneous downloads (D_{ist}), is positive and significantly different from zero at 1%. The other estimated coefficients conform with a-priori expectations. Specifically, week-of-run (WK_{ist}) and contemporaneous theatres (TH_{ist}) reveal negative and positive signage, respectively. Again, both are statistically significant. Inclusion of film fixed-effects in the second column of Table 4 purges some of the endogeneity between revenue and downloads that exists because of unobservable shared tastes for more popular films. Notably, the estimated coefficient on contemporaneous downloads is reduced but is still significantly positive. The third and fourth columns represent the first and second stage GMM regressions defined in equations (1a) and (1b), respectively. The first stage estimates reveal a strong and significant positive relation with the excluded variables, FC_t^2 and $D_{is't}$, and a significant negative relation with FC_t^1. Using the Kleibergen-Paap (2006) LM test for under-identification, Cragg and Donald (1993) test for weak identification, and the Hansen J test for over-identification (as discussed by Hayashi, 2000) we find our instruments to be statistically validated.

The second stage results of the GMM estimation reveal a further decrease in the magnitude of the estimated coefficient on contemporaneous downloads. The positive relation between downloading activity and revenues is still apparent and significant, but the magnitude of the effect has been substantially reduced. This further supports that the excluded variables (instruments) are serving the model well by reducing the positive bias induced by the endogeneity of downloads. The other estimated coefficients in the second stage are similar in magnitude and signage to the robust OLS results of column 2.

Time-invariant and film-specific variables—such as budget, cast/director appeal, (pre-release) advertising, genre, classification rating, etc—are implicitly captured in our model by the inclusion of film fixed-effects. To examine the contributions of some of these variables, we extract individual film fixed-effects and consider them against the time-invariant film-specific variables observed in our data set. The correlation between budget and the extracted fixed-effects is 0.50 (compared to a correlation of 0.65 with total film revenues); and the correlation between (national) opening week screens and fixed-effects is 0.72 (compared to a correlation of 0.82 with total film revenues). In a basic OLS regression with fixed-effects as the dependent variable, estimated coefficients of both (log) budget and (log) opening screens are positive and significant at the 1% level of significance with an R^2=0.44. Both relationships still hold at 1% when controls are added for the categorical variables of sequel, genre, and classification rating with R^2=0.64. In comparison, a regression of (log) total revenue on the same set of covariates found similar explanatory evidence in terms of signage and significance with R^2=0.81. To the extent that the extracted fixed-effects correlate strongly with key variables, which have been shown as important attributes of overall film success, these findings validate the use of film fixed-effects as serving the model to capture the time-invariant determinants of demand for the films we observe.[16]

Dynamic Stock of Downloads

As discussed in Section 4, we consider it likely that individuals make theatre attendance decisions after a download decision. Under this assumption, it would be more appropriate to consider the number of downloads over some window of time prior to the actual date at which box office is observed. Tables 5 and 6 provide evidence when this window of time is considered at one, two, three and four weeks prior to (and including) the date of observation. Again we report the base models with and without film fixed-effects as well as the GMM estimates. In all four models, T=7,14,21,28, it is evident that the coefficient of (log) downloads reduces with the inclusion of fixed-effects and is further reduced with the two step GMM estimation approach (as also observed within the contemporaneous results reported in Table 4). However, unlike the contemporaneous case, the relationship between downloads and revenues is observed to be statistically negative implying a sales displacement effect. The (absolute) increasing magnitude of the download coefficient over the four models, T=7,14,21,28, is a simple manifestation of the increasing dynamic stock. The estimated coefficient suggests a sales displacement elasticity in the range 0.06-0.3. We discuss the economic interpretation of these results further below.

6 Discussion of Estimation Results

Instruments and Identification

Correct causal inference depends critically on the model being correctly specified. In modelling a potential sales displacement effect, the inherent difficulty lies in purging the simulataneity between downloads and revenues which manifests in a positive bias on the estimated coefficient in the absence of remedial measures. Fixed-effects provide a partial solution, but correct identification requires a strong instrumental variable. We argue that our instruments are particularly strong and satisfy both economic and statistical requirements. Intuitively, the decisions of the Federal and Full Court of the Federal Court provide an exogenous variable which would impact downloaders behaviours given the considerable media attention paid to each judgement. As argued above, however, it is not a-priori clear whether the rulings against AFACT would increase or decrease downloading behaviour. From the first stage results, the initial judgement appears to have decreased levels of downloading—perhaps the result of a signal sent that copyright holders were serious in their intent to pursue legal recourse (although obviously not achieving their desired

[16] A growing literature of empirical research has examined the correlates of financially successful films such as budgets, advertising and publicity expenditures, opening screens/theatres, marquee stars, critical reviews, awards, prequels/sequels, genre, rating, etc. See survey of McKenzie (2012) for examples.

outcome). The results relating to the second judgement, however, suggests an increase in downloading which might reflect a reduction in the perceived legal consequences of the activity.

Regarding the second class of instrument, the case was made that downloading activity in other states would be unlikely to affect box office sales in a focal state. The fact downloading is subject to consumption externalities implies that, with an increase in other downloaders, users face lower costs the more a particular file is being downloaded. In addition, costs are also increased for all users when faced with a common adverse shock—for example, a tracker going down. For these reasons, it is appropriated to assume that cost of downloading is inversely correlated with the number of number of downloaders actively downloading a particular title. We would therefore expect a positive correlation between downloads between states on a particular day which is observed.

The results of the first stage regressions reveal a particularly high R^2 which indicates high explanatory power of the (included and excluded) instruments. However, there may be concern that the correlation is too high in the sense that the first stage is just recovering the endogenous variable. This would certainly be true if there was a very high correlation between downloads in the focal market and other states. However, a simple regressions of $\log D_{isT}$ on $\log D_{is'T}$ for T=1,7,14,28 reveal R^2 in the range 0.22-0.34. In terms of simple correlations, the range is 0.47-0.58 between the endogenous (log) download variable and respective (log) downloads in other states. It is apparent that even though there is reasonably strong correlation between the endogenous variable and the instrument—the statistical requirement—it is far from simply recovering itself and the other instruments play an important role. As well, in terms of the statistical requirement that the instrument is uncorrelated with revenues, the condition appears to be well satisfied with simple correlation in the range -0.11 to 0.08. More formally, it was also observed that the statistical tests rejected under, weak and over identification.

Opening Week Revenues and Release Delay

One potential criticism of our model is that we are observing daily film revenues over the theatrical life of a film, which would typically be decreasing, whereas the dynamic stock variable may be increasing. Although we include a week-trend variable in both the first and second stage regressions, this potentially inverse relation may be driving the results. Indeed, the first stage regression results of Tables 4, 5 and 6 suggest that downloads are in fact positively related to the week of run variable WK_{ist}. To address this potential issue, we restrict the model described in equations (2a) and (2b) to only model revenues of films in their opening week of theatrical release. This means the variable WK_{ist} is now redundant as all films are observed in their first week of release. Table 7 provides results for the second stage regressions for the contemporaneous and dynamic models. In all cases the coefficient on the downloads variable is statistically less than zero implying that first week revenues are subject to a sales displacement effect. As illustrated graphically in Figure 1, the fact that many films are subject to a release delay between the US and Australian markets seems a logical explanation of the decreased first week sales when there is an opportunity for download prior to the opportunity for legal consumption.[17] In our sample of 166 films, the average release gap between the US and Australian markets was 28 days (median of 13 days). One film, *Thor*, was released in Australia two weeks prior to the US release, a further six films were released in Australian cinemas one week prior to the US release, and 50 films had a simultaneous release with the US release (opening within one day of the US release). The remainder of films had a positive release gap with the greatest gap being *Diary of a Wimpy Kid* which opened in Australia cinemas six months after its US release.

A simple regression of (log) downloads (observed within the first week) on observation date relative to the US release (controlling for day-of-week, state and film), retrieved a significant positive relation suggesting an increase in the number of first week downloads the more time elapsed since the US release, *ceteris paribus*. Given that illegal copies of films typically show up after the US release, this evidence is supportive of the release delay between the US and Australian markets providing opportunities for illegal consumption before the film is theatrically released in Australia. When release delays between the US and Australian markets are significant, the likelihood of high quality torrents files appearing on networks increases and increased levels of downloading would displace more sales.

Weekly Model

The model outlined in Section 4 was estimated with daily data. To examine whether this feature of our data has any bearing on results we also consider a model where revenue and downloads are considered at the week level, rather than daily. We do this both for the contemporaneous and dynamic stock models. The contemporaneous model is analogous to (1a) and (1b) but now the time subscript t represents a week, rather than a day, and is redefined t^W. The theatres variable, TH_ist, is redefined so it now represent the maximum number of theatres screening on any day of that week for the film of interest. Also, the day-of-week dummy variables are now redundant. The dynamic stock model is similarly redefined in terms of weeks as T^W, where T^W now represents the number of weeks included prior to week t^W. We consider the dynamic horizons T^W=1,2,3,4 implying that downloads are observed for one, two, three and four weeks prior to, and including, week t^W.

Results for the weekly model are reported in Table 8 which display second stage regression results for the contemporaneous and dynamic stock models. In the contemporaneous and T^W=1 model, a positive and significant relation between downloads is observed. However, in the T^W=2,3,4 models the relationship is negative implying a statistically significant sales displacement relationship. The magnitude of the estimated coefficients suggest a displacement elasticity of 0.15% for a 1% increase in downloads over the four weeks prior to, and also including, the week of observation. As discussed below, these results are quantitatively consistent with the (dynamic stock) daily model reported above.

[17]Even in the absence of a release gap, torrent sites sometimes feature leaked studio copies of titles which may have been intended for promotional reasons or award consideration. This means that it is possible for illegal downloading to occur prior to official international (as well as domestic Australian) release.

Forward Looking Dynamic Stock of Downloads

It has been argued that the dynamic stock approach to considering future sales displacement is more realistic than a contemporaneous approach. It might also be possible, however, that an individual forgoes cinema attendance today by making a decision to download the title at some point in the future. Obviously, this argument relies on the title being available for download and that the intention is actually carried out. To test whether downloaders forgo theatrical consumption prior to actually downloading the file, we consider a simple modification of our previously specified dynamic model (2) in which T is now forward looking. We denote this forward looking dynamic stock as T^F and consider the horizons T^F=7,14,21,28.

As Table 9 demonstrates, the estimated coefficients on the (log) downloads variable across all specifications (T^F=1,7,14,21,28) remains positive implying no displacement effect. Taken with the evidence of the (backward looking) dynamic stock model, this might suggest individuals who partake in downloading (and substitute it for paid cinematic consumption) are time impatient and seek out films on torrent sites early in their theatrical life—often prior to the official release if the film has already been released overseas as discussed above.[18] This observation is also consistent with the 'movie-maven' subculture among (particularly young and tech savvy) consumers who desire to see a film early and before the masses.

Sales Displacement Effects

Although we have detected a negative impact from file-sharing on box office sales in this study, the magnitudes are relatively small. The results do permit us to calculate some 'back-of-the-envelope' numbers concerning the potential cost of piracy. If we focus on the daily T=7,14,21,28 models, we observe sales displacement elasticities of 0.06, 0.16, 0.24 and 0.30, respectively. Given the median daily box office of films in our sample is A$3,593 (Table 3), this translates to a reduction in revenue of between A$2.19 and A$10.85, or between 0.19 and 0.84 people assuming an average ticket price of A$12.87 (Screen Australia reported average ticket price for 2011), for a 1% increase in downloading activity across these time horizons. Given that state/territory level median number of downloads over one, two, three and four weeks are 680, 1345, 1962 and 2485 (adjusting for Peer Media Technology's estimate of a 55% market coverage), this suggests that somewhere between 29 and 40 downloads displaces one purchased ticket each day depending upon which model is considered.

When considering the opening week and weekly models, we find similar levels of displacement for the weekly model but also find more serious levels of sales displacement for opening week revenues. Given the range of elasticities from Table 7, and the median opening week daily revenue of A$31,046, we estimate a 1% increase in downloads displaces between one and three paid admissions. With the range of the median number of downloads between 67 (contemporaneous model) and 725 (T=28), these levels imply

[18] In some sense the industry's practice of pre-release TV advertising may be contributing to this problem if consumer interest is aroused by trailers and the torrent file has already appeared on P2P networks.

that anywhere from 0.6 to 2.9 downloads displaces one paid admission—which appears relatively high—but in terms of economic significance, the overall potential effect is low because of the low levels of downloading actually taking place. In part this is reflective of the large number of films with simultaneous releases in the US and Australian market, but it is apparent that the longer a film's release is delayed between the two markets, the more likely the title is to appear on torrent sites which in turn increases the number of illegal downloads.

In terms of the weekly model's results of Table 8, and given the median weekly revenue of A$17,527, the estimated displacement for T=2,3 and 4 (weeks) suggest between six and eight downloads displaces one paid admission over a weekly time horizon. This finding is comparable to the daily model where it took between 29 and 40 downloads over the various windows considered to displace a sale on a given day. In the weekly model, we are observing approximately the same time frame for downloads but now a week for revenue/admissions. This explains why it now only takes five or six (i.e. daily finding divided by seven) to displace one paid admission in a week.

If, as many industry reports implicitly suggest, one download displaces one paid admission then the lost revenue of the median film in is in the order of A$1.3m (assuming median downloads of 100,000—see Table 4), or about 17.5%. The largest displacement result came from the opening week model in which our estimates suggest that as few as 0.6 downloads could displace one paid admission. However, the economic significance of this displacement is small because median downloads are relatively low for the opening week and associated windows we observe prior to the opening week.

7 Conclusion

This study has investigated digital piracy in the context of the Australian theatrical film industry. We find evidence of a sales displacement effect from illegal downloading on box office revenues. However, our estimates suggest (at least at present) the economic magnitude of this effect is small. One particular issue our study sheds light on is that piracy behaviour increases proportionally to the release gap between the US and Australian markets. Opening week revenues were shown to decline significantly because of downloads which occurred prior to the theatrical release. This finding is not unsurprising and provides partial explanation for the observed and growing trend of day-and-date world-wide releases—particularly for blockbuster titles.

Whether the theatrical film industry is likely to suffer revenue declines similar to those observed in the music industry is yet to be seen. Certainly there are key differences between the two industries which are important such as the relatively large size of film files relative to music files, as well as the extent to which a download provides a substitute with the social experience of cinematic consumption. Also, over the time-frame of our study, Australian broadband internet plans and speeds were often restrictive for downloading films but this will change dramatically in the very near future—especially with the roll-out of the National Broadband Network (NBN).

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Table 1: Film Summary Statistics

Variable	Obs	Mean	Median	Std. Dev.	Min	Max
Total revenue (AUD)	166	8,869,875	6,121,475	9,310,205	559	50,800,000
Total downloads	166	112,971	99,622	63,364	2,816	435,176
Filesize (MB)	166	1,200	1,320	408	637	3,470
Budget (USm)	166	70.3	50.0	56.4	1.5	260.0
Aus opening weekend screens	166	259	242	135	2	758
US opening weekend theatres	166	3,125	3,045	511	2,012	4,468

Table 2: Film Revenue and Download Summary Statistics — By Genre and Rating

		Revenue					Downloads				
	Obs	Mean	Median	Std. Dev.	Min	Max	Mean	Median	Std. Dev.	Min	Max
Genre											
Action	62	9,819,986	6,237,437	10,400,000	559	50,800,000	139,004	127,070	72,130	15,494	435,176
Comedy	43	7,619,477	5,790,803	7,234,506	3,081	32,500,000	98,960	81,704	52,423	14,941	212,375
Drama	25	5,651,684	5,077,956	3,565,573	401,302	12,500,000	98,020	90,102	51,136	38,173	244,313
Other	36	11,000,000	7,211,993	11,600,000	26,853	42,100,000	95,252	84,681	53,337	2,816	235,094
Rating											
G	10	12,600,000	10,700,000	11,300,000	1,921,982	42,100,000	93,946	90,442	56,215	39,033	235,094
PG	33	10,600,000	9,850,213	8,959,141	3,081	37,300,000	101,231	97,847	59,105	2,816	218,811
M	80	9,408,136	6,400,628	9,965,081	7,703	50,800,000	121,751	109,821	68,109	14,941	435,176
MA15+	41	5,874,578	3,870,168	7,055,600	5,780	32,500,000	113,080	98,110	57,553	15,494	244,313
R18+	2	1,279,820	1,279,820	1,809,148	559	2,559,081	48,319	48,319	24,139	31,250	65,388

Notes: All revenue amounts in Australian dollars.

Table 3: Estimation Sample Summary Statistics — By State

		Revenue					Downloads				
	Obs	Mean	Median	Std. Dev.	Min	Max	Mean	Median	Std. Dev.	Min	Max
State											
ACT	5,938	5,039	2,058	8,667	1	172,402	9.8	7.0	9.6	1	113
NSW	10,077	46,785	6,430	109,982	5	2,486,135	165.1	116.0	167.7	1	2,011
NT	654	3,235	1,571	5,010	16	57,125	1.1	1.0	0.4	1	5
QLD	9,258	31,436	6,774	66,907	5	1,195,300	117.9	80.0	121.4	1	1,271
SA	9,122	9,531	2,096	20,574	8	515,233	53.3	38.0	52.9	1	583
TAS	5,237	3,788	1,610	6,463	8	90,582	13.3	10.0	12.9	1	133
VIC	9,437	41,048	7,658	90,642	1	1,980,287	155.6	108.0	161.4	1	2,132
WA	6,940	19,634	5,530	37,772	5	608,630	78.5	59.0	75.4	1	1,160
All states	56,663	25,148	3,593	69,068	1	2,486,135	95.0	52.0	127.6	1	2,132

Notes: All revenue amounts in Australian dollars.

Table 4: Regression Results — Contemporaneous Downloads

log(Revenue)			GMM	
	OLS	OLS	1st stage	2nd stage
log(Dowloads)	0.150***	0.074***		0.032***
	(0.004)	(0.005)		(0.006)
Fed court decision dummy			-0.118***	
			(0.019)	
Full court decision dummy			0.030***	
			(0.008)	
log(Downloads other states)			0.958***	
			(0.003)	
log(Theatres)	1.416***	1.103***	0.031***	1.100***
	(0.005)	(0.006)	(0.002)	(0.006)
Week-of-run	-0.083***	-0.222***	0.016***	-0.224***
	(0.002)	(0.003)	(0.001)	(0.003)
Day-of-week dummies	Yes	Yes	Yes	Yes
State FEs	Yes	Yes	Yes	Yes
Film FEs	No	Yes	Yes	Yes
Under Identified			6967.1	
(P-Value)			(0.000)	
Weakly Identified			46643.1	
(P-Value)			(0.000)	
Over Identified			186.4	
(P-Value)			(0.000)	
N	56663	56663	56663	56663
R^2	0.846	0.891	0.942	0.891

Notes: Robust standard errors are in parentheses. *, ** and *** denote two tailed significance at 10%, 5% and 1%, respectively.

Table 5: Regression Results — Dynamic Stock of Downloads (T=7,14)

log(Revenue)	T=7				T=14			
			GMM				GMM	
	OLS	OLS	1st stage	2nd stage	OLS	OLS	1st stage	2nd stage
log(Dowloads$T$)	0.118***	-0.002		-0.061***	0.065***	-0.107***		-0.163***
	(0.004)	(0.006)		(0.006)	(0.004)	(0.006)		(0.006)
Fed court decision dummy			-0.107***				-0.112***	
			(0.013)				(0.012)	
Full court decision dummy			0.005***				0.043***	
			(0.005)				(0.005)	
log(Downloads other states$T$)			0.953***				0.943***	
			(0.003)				(0.003)	
log(Theatres)	1.424***	1.108***	0.032***	1.107***	1.437***	1.121***	0.038***	1.121***
	(0.005)	(0.006)	(0.002)	(0.006)	(0.005)	(0.006)	(0.001)	(0.006)
Week-of-run	-0.082***	-0.220***	0.017***	-0.221***	-0.079***	-0.211***	0.020***	-0.211***
	(0.002)	(0.003)	(0.001)	(0.003)	(0.002)	(0.003)	(0.001)	(0.003)
Day-of-week dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Film FEs	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Under Identified			7321.2				6623.3	
(P-Value)			(0.000)				(0.000)	
Weakly Identified			90291.7				110000.0	
(P-Value)			(0.000)				(0.000)	
Over Identified			230.1				278.6	
(P-Value)			(0.000)				(0.000)	
N	56663	56663	56663	56663	56663	56663	56663	56663
R^2	0.844	0.890	0.974	0.890	0.842	0.891	0.979	0.891

Notes: Robust standard errors are in parentheses. *, ** and *** denote two tailed significance at 10%, 5% and 1%, respectively.

Table 6: Regression Results — Dynamic Stock of Downloads (T=21,28)

log(Revenue)	T=21				T=28			
			GMM				GMM	
	OLS	OLS	1st stage	2nd stage	OLS	OLS	1st stage	2nd stage
log(Dowloads$T$)	0.022***	-0.195***		-0.244***	-0.005	-0.257***		-0.302***
	(0.004)	(0.006)		(0.006)	(0.004)	(0.006)		(0.006)
Fed court decision dummy			-0.116***				-0.112***	
			(0.012)				(0.012)	
Full court decision dummy			0.040***				0.034***	
			(0.005)				(0.005)	
log(Downloads other states$T$)			0.941***				0.940***	
			(0.003)				(0.003)	
log(Theatres)	1.448***	1.134***	0.042***	1.135***	1.455***	1.141***	0.042***	1.141***
	(0.005)	(0.006)	(0.001)	(0.006)	(0.005)	(0.006)	(0.001)	(0.006)
Week-of-run	-0.074***	-0.198***	0.022***	-0.197***	-0.070***	-0.186***	0.024***	-0.184***
	(0.002)	(0.003)	(0.001)	(0.003)	(0.002)	(0.003)	(0.001)	(0.003)
Day-of-week dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Film FEs	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Under Identified			6468.7				6443.4	
(P-Value)			(0.000)				(0.000)	
Weakly Identified			130000.0				140000.0	
(P-Value)			(0.000)				(0.000)	
Over Identified			311.9				323.6	
(P-Value)			(0.000)				(0.000)	
N	56663	56663	56663	56663	56663	56663	56663	56663
R^2	0.841	0.893	0.982	0.893	0.841	0.895	0.984	0.895

Notes: Robust standard errors are in parentheses. *, ** and *** denote two tailed significance at 10%, 5% and 1%, respectively.

Table 7: Regression Results — Opening Week Revenues

log(Revenue)	GMM 2nd stage				
	Contemp.	7 days	14 days	21 days	28 days
log(Dowloads$T$)	-0.048***	-0.125***	-0.114***	-0.106***	-0.103***
	(0.008)	(0.013)	(0.014)	(0.014)	(0.014)
log(Theatres)	0.986***	1.004***	1.002***	0.999***	0.997***
	(0.047)	(0.047)	(0.047)	(0.048)	(0.048)
Day-of-week dummies	Yes	Yes	Yes	Yes	Yes
State FEs	Yes	Yes	Yes	Yes	Yes
Film FEs	Yes	Yes	Yes	Yes	Yes
N	7429	7429	7429	7429	7429
R^2	0.954	0.954	0.954	0.954	0.954

Notes: Robust standard errors are in parentheses. *, ** and *** denote two tailed significance at 10%, 5% and 1%, respectively.

Table 8: Regression Results — Weekly Model

log(Revenue^W)	GMM 2nd stage				
	Contemp.	1 week	2 weeks	3 weeks	4 weeks
log(DowloadsT^W)	0.295***	0.047**	-0.073***	-0.128***	-0.150***
	(0.021)	(0.020)	(0.016)	(0.015)	(0.015)
log(Theatres$^{W(max)}$)	0.973***	1.004***	1.014***	1.015***	1.011***
	(0.014)	(0.015)	(0.015)	(0.015)	(0.015)
Week-of-run	-0.271***	-0.280***	-0.277***	-0.273***	-0.270***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
State FEs	Yes	Yes	Yes	Yes	Yes
Film FEs	Yes	Yes	Yes	Yes	Yes
N	9228	9228	9228	9228	9228
R^2	0.910	0.899	0.898	0.899	0.899

Notes: Robust standard errors are in parentheses. *, ** and *** denote two tailed significance at 10%, 5% and 1%, respectively.

Table 9: Regression Results — Forward Dynamic Stock Model

log(Revenue)	GMM 2nd stage				
	Contemp.	1 week	2 weeks	3 weeks	4 weeks
log(DowloadsT^F)	0.032***	0.100**	0.141***	0.168***	0.181***
	(0.006)	(0.008)	(0.009)	(0.009)	(0.009)
log(Theatres)	1.100***	1.101***	1.103***	1.103***	1.104***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Week-of-run	-0.224***	-0.223***	-0.221***	-0.221***	-0.220***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Day-of-week dummies	Yes	Yes	Yes	Yes	Yes
State FEs	Yes	Yes	Yes	Yes	Yes
Film FEs	Yes	Yes	Yes	Yes	Yes
N	56663	56663	56663	56663	56663
R^2	0.891	0.899	0.892	0.892	0.892

Notes: Robust standard errors are in parentheses. *, ** and *** denote two tailed significance at 10%, 5% and 1%, respectively.

Figure 1: Timing of Downloads

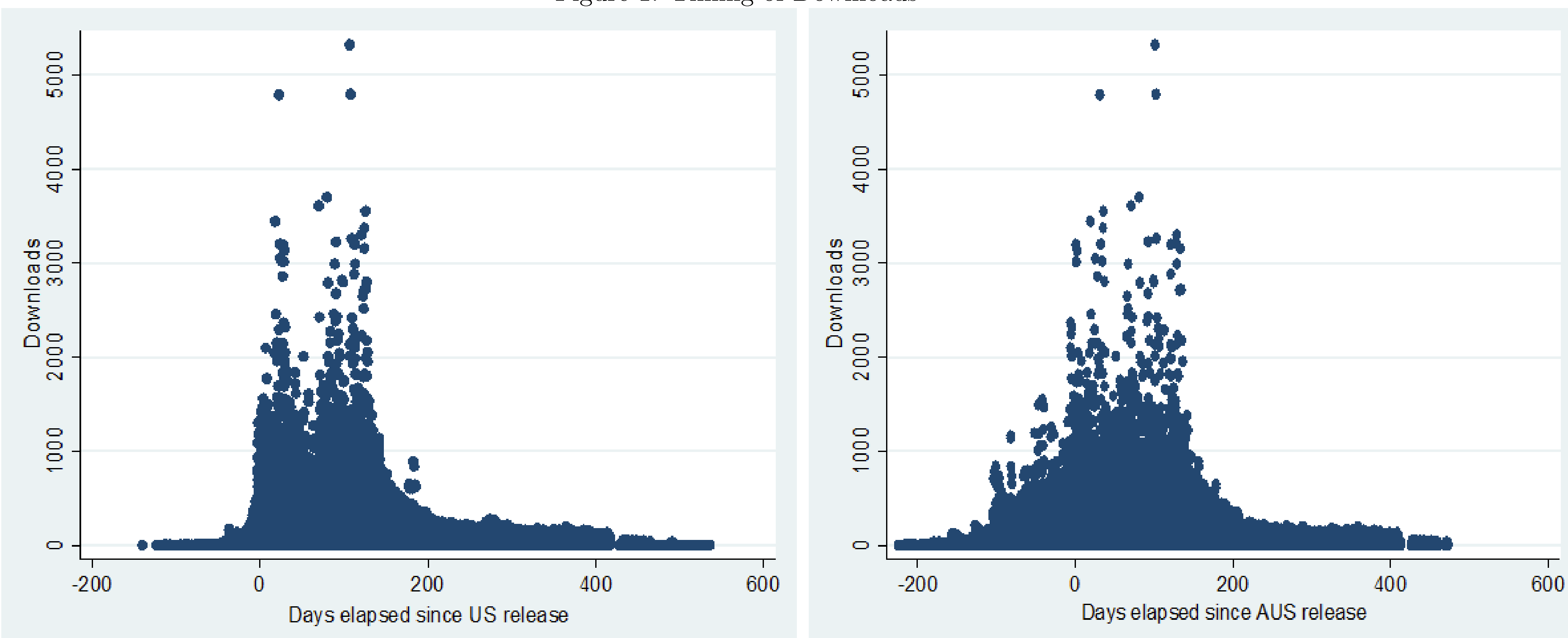

Figure 2: Total Revenues vs. Total Downloads (N=166)