Direction des Études et Synthèses Économiques

G 2015 / 17

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Document de travail

Institut National de la Statistique et des Études Économiques

INSTITUT NATIONAL DE LA STATISTIQUE ET DES ÉTUDES ÉCONOMIQUES

Série des documents de travail
de la Direction des Études et Synthèses Économiques

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NOVEMBRE 2015

Les auteurs remercient Michael L. ANDERSON, Luc BEHAGHEL, Fabrice BERNIER, Sofia BORGES, Benoît DANARD, Hadrien DE NIJS, Benjamin E. HERMALIN, Przemyslaw JEZIORSKI, Claire LELARGE, Laurent LINNEMER, Deborah MREJEN, John MORGAN, Minjun PARK, Corinne PROST, Juliette STEHLÉ, Felix VARDY, Mauricio VARELA, Michael VISSER, Patrick WAELBROECK pour leurs apports. Ce travail a également bénéficié des commentaires des participants aux séminaires du D2E à l'Insee, du Crest, de Paris School of Economics, de Toulouse School of Economics, du congrès annuel de l'EEA à Toulouse, de la conférence annuelle de l'EARIE à Milan, de la 7e journée de la culture et de la communication, et de la 8e conférence sur l'économie des TIC à Telecom Paris Tech.

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Abstract

Using the French anti-piracy law known as Hadopi, we study the effects of online piracy on movie sales in theaters. Applying four estimation strategies at different levels of observations (country, town, consumer, and movie), we find that the introduction of the law is associated with a 9% increase in the market share of American movies but no expansion of the total market. We exclude supply side reactions by distributors as an explanation for this displacement effect that benefits American movies. The increase in the box office performance of American movies is primarily explained by the behavior of younger consumers.

Keywords: Anti-piracy law, Property rights, Online piracy, Business stealing, Demand expansion, Movie.

L'effet redistributif de la loi Hadopi sur la part de marché des films américains en salle

Résumé

Cette étude évalue la loi anti-piratage dite « Hadopi » pour étudier les effets du piratage sur les recettes des films en salle. À l'aide de quatre stratégies d'identification à différents niveaux d'observation (pays, villes, consommateurs, films), nous trouvons que l'introduction de la loi Hadopi est associée à une augmentation de la part de marché des films américains de 9 % mais sans augmentation de la demande totale pour les films en salle. L'analyse écarte les différentes réactions des distributeurs comme autres explications possibles à cet effet de substitution favorable aux films américains. La hausse des recettes des films américains est principalement expliquée par le comportement des jeunes consommateurs.

Mots-clés : Loi anti-piratage, droit de propriété, piratage sur Internet, redistribution des ventes, expansion de la demande, film.

Classification JEL : D12, K11, K42, L82

1 Introduction

Online piracy of cultural goods is a widespread phenomenon in developed countries and has important consequences for firms, consumers and public authorities (Oberholzer-Gee and Strumpf (2010), Waldfogel (2012a), Belleflamme and Peitz (2012)). According to Sandvine (2011), 19% (resp. 30%) of aggregate Internet traffic in North America (resp. Europe) was due to file sharing in 2011.[1] Society faces a major economic tradeoff between giving proper incentives to creators and allowing the public to benefit from the wider distribution of cultural goods with a marginal cost of nearly zero. Four countries (France, New Zealand, Sweden, and the United States) have recently enacted similar legislation to eliminate copyright infringement on the Internet.[2] The adoption and the implementation of these laws have been controversial and their intended effects highly discussed by policy makers.

This article intends to contribute new evidence to the debate by evaluating the effects of the French anti-piracy law (Hadopi) on the box office performance of movies. The Hadopi law was adopted at the end of 2009 and intended to reinforce Intellectual Property Rights for cultural goods.[3] This legislation is particularly intended to prevent Internet users from illegally downloading cultural goods on peer-to-peer file sharing services. Between September 2010 and December 2011, 824,576 warning emails and 68,341 registered letters were sent to users detected as infringers, which may have been a sufficiently substantial intervention to change individuals' behavior.

The market for movies in French theaters is well-suited to examining the effects of this anti-piracy law for several reasons. First, it is the first market to generate revenues for movies, and it conditions their success in subsequent markets (i.e., video and TV). Second, the market for movies in theaters is the main source of revenue for producers and distributors in France.[4] Third, foreign earnings represent a substantial share of the total gross of the U.S. motion picture industry (62.5% of total lifetime grosses of the top-10 most successful U.S. movies in 2013), and France is often among the yearly top 3 largest markets for U.S. exports.[5] Fourth, prices are fixed in this industry, i.e., there is no movie-by-movie pricing (Einav and

[1] Sandvine is a networking equipment company. Aggregate traffic is an average of downstream traffic and upstream traffic weighted by their sizes.

[2] The Copyright Alert System (CAS) has been implemented in the United States in February 2013. It is a graduated response system including six strikes that is very similar to the French Hadopi law. Unlike France, New Zealand, or Sweden, the CAS does not constitute a law but is the result of an agreement between right holders and Internet service providers.

[3] Hadopi is a "law promoting the distribution and protection of creative works on the Internet" see http://www.legifrance.gouv.fr: "LOI n° 2009-669 du 12 juin 2009 favorisant la diffusion et la protection de la création sur Internet"

[4] It represents 1,370 million euros and 207 million admissions in 2010 in France. DVD retail accounts for revenues equal to 1,200 million euros and 87 million transactions in 2010.

[5] The top-10 U.S. movies in the U.S. market in 2013 were The Hunger Games: Catching Fire, Iron Man 3,

Orbach (2007)). This prevents any finely tailored pricing reaction to the law, and we can measure sales by the number of tickets sold and not in monetary amounts. Fifth, data on both the demand (number of tickets sold) and the supply side (number of screens) of the industry are available, thus enabling us to distinguish supply-side from demand-side reactions to the law. Sixth, data on local geographic and consumer-level sales of movies are accessible, which allow us to perform a comprehensive analysis. Seventh, some evidence show that the supply of illegal copies only exists for U.S. films, but not for French ones, during their theatrical exhibition in France. This entails potential asymmetrical effects of online piracy that one could not study in other subsequent markets such as the video market, where both types of films are illegally available on the Internet.

We adopt four empirical strategies at different levels of observation to estimate two potential effects of Hadopi: (1) a demand expansion effect, using the total number of admissions as the outcome of interest, and (2) a redistributive effect among movies, using the market share of American movies as the outcome of interest. The four approaches are mutually reinforcing and complementary. Overall, these estimations indicate that the law is associated with an increase in the market share of American movies at the expense of other (domestic) movies without expanding the total market. Furthermore, we propose a simple model to derive the predictions that we use to understand the consumer behavior underlying the piracy effect and to approximate its impact on welfare in the short-term.

First, we conduct an investigation at the town level within France, using original data on the diffusion rate of broadband Internet, and movie sales. We find that towns with a higher level of online piracy (approximated by a higher penetration rate of broadband Internet) experienced a higher increase in American movie admissions after the introduction of the Hadopi law. There is no evidence of a significant market expansion effect associated with the law. These findings indicate that the Hadopi law had a pure redistributive effect between French and American movies. By examining the same movies across different towns, this approach excludes an important competing explanation: that American (resp. French) films could have experienced a positive (resp. negative) shock in France concomitant with but unrelated to the Hadopi law.

Second, we compare American movie sales to French movie sales within France. This approach shows that U.S. major film studios did not react to the Hadopi law by changing the quantity or the quality of the movies they export to France. Therefore, the effect of the law is very unlikely to be mainly driven by

Frozen, Despicable Me 2, Man of Steel, Gravity, Monsters University, The Hobbit: The Desolation of Smaug, Fast & Furious 6, Oz The Great and Powerful. Actually, this figure understates the true share that foreign markets represent, as some of those movies were yet to be released in some major foreign markets in 2013 (Source: www.boxofficemojo.com). The other largest markets for American films are Canada, Germany, Italy, Japan, and the United Kingdom/Ireland (Source: Motion Picture Association of America (MPAA)).

a supply reaction by the industry. This approach also confirms that the law is associated with an increase in the market share of American movies.

Third, we compare the performance of American movies across countries, using several relevant European countries as a control group for France. We find no supply reaction by American distributors in France, in terms of either the speed or quantity of exported films, compared with other countries. In addition, we again confirm that the sales of American movies substantially increased after the implementation of the Hadopi law.

Finally, using consumer-level data, we study movie sales from different groups of consumers. We find that sales to younger consumers, who are more likely to illegally download movies, have increased for American movies since the Hadopi law was passed, compared with French movies and older consumers.

The positive effect of the Hadopi law on American movies is consistent with the fact that American movies are much more subject to online piracy than are other movies when they are released in foreign theaters. American movies are often released in the United States earlier than in foreign markets (including France), and criminal networks that supply the online market with illegal copies are more organized and active on the American continent than in European countries, thereby allowing greater proliferation of their illegal copies on the Internet. During their theatrical exhibition in France, there is (almost) no illegal version of French films, but there are many illegal versions of American films. Consequently, when an anti-piracy law is enacted and makes it riskier to download films on the Internet, sales of American movies in theatres could increase.

The absence of a market expansion effect can be rationalized by consumers' tight budgets and time constraints that prevent any meaningful expansion of the market for movies in theaters. This reflects the idea of Heath and Soll (1996), recently refreshed by Hasting and Shapiro (2013), that individuals set budgets for categories of expenses and then track expenses relative to their budget, in an attempt to avoid diverging from their usual level of expenditures in a given categorie. Attending the movies is more time-consuming than watching pirated copies at home, because, for instance, of travel costs, waiting time, impossibility to stop watching a movie at any time and come back to it later on, and higher difficulty to stop watching a movie that one does not enjoy. Moreover, attending the movies is primarily a social practice that consumers would not reduce. According to the Centre National du Cinéma et de l'image animée (CNC), approximately 9% of individuals attended the movies alone during the period $2008 - 2011$.

Specifically, the underlying behavior would be as follows. Without an anti-piracy law, some people illegally consume American movies online and legally watch domestic (French) movies in theaters because illegal copies of American movies are easily available on the Internet during their theatrical exhibition, but

this is not the case for other (domestic) movies. When an anti-piracy law is implemented, they shift to legal consumption of American movies in theaters because it is now too risky to illegally obtain them online, and because they tend to prefer American films. Furthermore, as a side effect, they reduce their attendance for non-U.S. movies in theaters, due to budget and time constraints. As a result, the total industry profit remains unchanged but is redistributed: some sales of domestic (French) movies are displaced to American movies. However, consumers are not compensated for the loss of domestic films that they no longer watch. According to back-of-the-envelop calculation, this loss translates into a decrease in consumer welfare of approximately 73 to 94 million euros per year in the short-term.

The remainder of this article is organized as follows. Section 2 reviews the relevant literature. Section 3 provides some background on the online piracy of movies. Section 4 describes the data. Section 5 presents the results of the four complementary empirical approaches. Section 6 provides straightforward welfare implications and concludes.

2 Relevant literature

This article is related to the empirical literature on the effects of piracy on legal sales. This literature has been expanding rapidly, and only the most relevant articles to the current work are discussed in this section. Readers are referred to Waldfogel (2012a), Smith and Telang (2012), and Waldfogel (2012b) for more complete reviews and discussions of the literature. These findings also contribute to the general empirical literature on how the Internet affects the offline activity of individuals (Gentzkow (2007), Liebowitz and Zentner (2012), and Zentner et al. (2012)).

Three articles are closely connected to ours. Using a difference-in-differences approach across different countries with weekly aggregate iTunes sales, Danaher et al. (2014) find a positive effect of Hadopi on digital music sales in France. They also find evidence that this positive effect began before the law was passed, when Hadopi was much discussed in the media because of saliency. Adermon and Liang (2014) evaluate the effects of an anti-piracy law in Sweden, similar to the French Hadopi law, on music and movie sales. Applying difference-in-differences comparisons with Finland and Norway as control groups, they find that the Swedish law substantially decreased Internet traffic and increased music sales during the subsequent six months but had no significant effects on movie sales in theaters or on video. Finally, Bhattacharjee et al. (2006) study the effect of legal threats from the Recording Industry Association of America (RIAA) toward Internet users in 2003. Adopting an event study, they suggest that individuals have substantially decreased the number of files shared, although a wide variety of files remained available on the Internet after these actions.

Our article extends these three papers' contributions. First, we estimate the redistributive effects of an anti-piracy law by differentiating between different types of movies according to the difference in the level of online piracy, using the nationaly as a proxy. Then, comparing movie sales in towns with different levels of online piracy, we show that our results are not driven by shocks to the market for movies that are concomitant with but unrelated to the Hadopi law and, hence, that the estimated causal effect is much more convincing. Next, we cautiously investigate potential short-run supply-side reactions to the law in our international comparison analysis.[6] In addition, we devote careful attention to the choice of control group using the method developed by Hilger et al. (2011).

Our international approach also goes a step further and is conducted at the movie level. This enables us to control for movie characteristics and for competition, which are important determinants of box office performance. Furthermore, we deepen our understanding of the Hadopi effect using consumer-level data

[6]See Alcala and Gonzalez-Maestre (2010) for a similar theoretical argument.

to identify the type of consumers embedded in this effect. Finally, we estimate the welfare variation using a simple model and back-of-the-envelope calculations.

We find that anti-piracy laws are not associated with legal demand increase in theaters. This result is similar to that of Zentner (2010), who finds no statistically significant link between high-speed Internet penetration (a proxy for online piracy) and total box office revenues in a set of countries. It is also consistent with Bai and Waldfogel (2012) who find, using surveys on students, a small negative effect of online movie piracy on legal consumption in theaters. Regarding the recorded music market, Oberholzer-Gee and Strumpf (2007) also obtain an estimated effect of file sharing on sales that is not statistically distinguishable from zero. Peukert et al. (2013) and Danaher and Smith (2013) study the effects of the shutdown of Megaupload on movies' box office performance and digital sales, respectively. Danaher and Smith (2013) find a small increase in digital revenues (7%) but no effect on physical revenues. Peukert et al. (2013) show that only large blockbusters have taken advantage of the closing of Megaupload in theaters, which is consistent with the redistributive effect we find in this paper.

Our approach is also related to that of Liebowitz (2008), who compares the sales of music albums in cities with different levels of broadband Internet coverage rate as a proxy for file sharing. He finds that online piracy has a large negative impact on music sales over the period 1998-2003. In comparison, we additionally use an anti-piracy law as an exogenous shock to online piracy, consider several other empirical approaches to exclude other possible explanations for our result, and examine the motion picture industry during a recent period. In the context of the movie industry, several other empirical strategies find a displacement effect between illegal sharing and legal purchases, see De Vany and Walls (2007), Hennig-Thurau et al. (2007), Rob and Waldfogel (2007), Danaher et al. (2010), and Danaher and Waldfogel (2012). For papers on the recorded music industry, see Liebowitz (2006), Rob and Waldfogel (2006), Zentner (2006), and Bhattacharjee et al. (2007). They also demonstrate a negative effect of online piracy on album sales.

This paper is also linked to studies of the theoretical effect of file sharing on sales and industry profit. Overall, this literature shows that this effect is ambiguous; users could substitute illegal copies for legal consumption, which would increase the marginal cost of producing original units. However, file sharing could also increase profit under certain conditions (Conner and Rumelt (1991), Takeyama (1994), Takeyama (1997), Bakos et al. (1999), Varian (2000), Gopal et al. (2006), Peitz and Waelbroeck (2006), Rob and Waldfogel (2006), Jain (2008)). See for other recent papers in this literature Harbauch and Khemka (2010), Vernik et al. (2011), and Galbreth et al. (2012).

3 Description of online piracy of movies and of Hadopi

3.1 The origins of illegal copy of movies

The two major sources of illegal copies are camcording and video copies. According to the MPAA, camcording accounts for the highest share of newly released movies that are pirated. Camcording refers to thieves who use a digital recording device in a movie theater.[7] Illegal versions can also come from the video release of a movie through a DVD rip or Blu-ray rip. Approximately two or three weeks before a film's video release, DVD and Blu-ray copies are sent to distributors. Thereafter, it is very difficult to identify the origin of the leak, and video copies become easily available on illegal markets.

There are other sources of illegal copies that are less frequently used. Illegal copies of films are occasionally made from advance copies used for screening and marketing purposes called 'screeners'. Most of these can be traced through watermarking, which prevents most art theft, but pirates are able to circumvent this protection measure. Illegal copies can also be made from a stolen film print or digital file from a theater, film depot, courier service, or other industry-related facility for making or financing films.

Camcording and the theft of advance copies are very common practices in North America but not in France.[8] In addition, American movies are often released sooner in the U.S. than in France. In 2008, the median (mean) difference between the French theatrical release and the American one was 47 (59) days. Though is has decreased over time, this difference has remained largely positive. It was 47 (91) days in 2009, 40 (87) days in 2010, and 33 (57) days in 2011.

As a consequence, an illegal copy of an American movie is often available before its theatrical release in France, but this is not the case for most French movies. Thus, American movies in France are more exposed to piracy because of the supply of illegal copies on the Internet. Some casual empirical figures support these arguments. In October 2008, before the Hadopi law, the ALPA released a report on illegal downloading of movies in France.[9] Tables 1 and 2 draw on this report. They clearly illustrate that U.S. movies tend to be much more frequently illegally downloaded than French ones and are downloaded sooner (and in most cases before their release in France).

[7] Studio and theater owners have increased security and surveillance in theaters worldwide, and technologies such as Coded Anti-Piracy films or watermarking films are used to identify the source of illegal copies to prevent camcording.

[8] According to the ALPA, the main French association combating audiovisual piracy, there are almost no illegal copies coming from the theatrical exhibition of movies, and very few pirate teams specialized in camcording in France between 2007 and 2011. Other interviews with experts from the MPAA and from the Hadopi's government agency also confirm this, although it is difficult to obtain definitive figures.

[9] Le téléchargement illégal des oeuvres cinématographiques francophones, ALPA, 2008.

The difference in online piracy between U.S. and French films does not appear to come from the demand side. To illustrate this point, the total numbers of admissions in French theaters for the top-3 downloaded French movies are 20 400 000, 1 500 000, and 5 300 000 (from Bienvenue chez les Ch'tis, Persepolis, and La Môme, respectively), whereas for the top-3 downloaded U.S. movies, they are 1 200 000, 300 000, and 2 600 000 (from Jumper, Cleaner, and Iron Man, respectively). These figures show that the downloading of U.S. movies is relatively high while their demand in theaters (as measured by total admissions) is comparable to or lower than that for French movies.

Table 1: Top-10 downloaded French movies (June 2008)

title	number of daily downloadings	date of French release	date of first detected illegal downloading
Bienvenue chez les Ch'tis	9,800	27/02/2008	05/03/2008
Persepolis	3,500	27/06/2007	13/10/2007
La Môme	1,400	14/02/2007	15/10/2007
Disco	4,400	02/04/2008	10/04/2008
Survivre avec les loups	2,400	16/01/2008	25/01/2008
JCVD	2,400	04/06/2008	06/06/2008
15 an et demi	800	30/04/2008	08/05/2008
Chasseurs de Dragon	600	26/03/2008	07/04/2008
Sans arme, ni haine, ni violence	500	16/04/2008	28/04/2008
L'Homme sans âge	500	14/11/2007	26/11/2007

Source: ALPA statistics on counterfeit movies downloading on peer-to-peer networks, powered by Advertiso and THOMSON Image & beyond.

Table 2: Top-10 downloaded U.S. movies (June 2008)

title	number of daily downloadings	date of French release	date of first detected illegal downloading
Jumper	24,500	20/02/2008	18/02/2008
Cleaner	14,300	14/05/2008	22/05/2008
Iron Man	14,000	30/04/2008	05/05/2008
Cloverfield	13,800	06/02/2008	25/01/2008
Horton	13,000	02/04/2008	17/03/2008
Transformers	12,900	25/07/2007	13/10/2007
Juno	12,500	06/02/2008	20/12/2007
There will be blood	12,400	27/02/2008	11/01/2008
Bee movie	11,900	12/12/2007	25/11/2007
No country for old men	11,900	23/01/2008	28/11/2007

Source: ALPA statistics on counterfeit movies downloading on peer-to-peer networks, powered by Advertiso and THOMSON Image & beyond.

3.2 The Hadopi law

The French Hadopi law is a "law promoting the distribution and protection of creative works on the Internet". The law was presented to the National Assembly in March 2009, where it was at first supported and then rejected. The law was enacted in October 2009 after more than one year of debate at the Senate, the National Assembly and the Constitutional Council (Danaher et al. (2014)). Finally, the first emails

are sent by Hadopi in September 2010.[10] Hadopi is also the acronym for the government agency created to administer this law.

Hadopi was created for three official purposes: implementing a graduated response against online pirates, creating awareness/education among consumers regarding online piracy issues, and fostering legal online supply. Copyright holders, beneficiary owners or their representatives such as ALPA detect an infringement using peer-to-peer file sharing and inform the Hadopi authority, reporting the IP address of the infringer.[11] The Hadopi agency checks this report and sends the IP address to Internet service providers to identify the Internet access subscriber. Then, the Hadopi agency may initiate a graduated response in a 'three-strikes' procedure:

- 1st strike: an email message is sent to the incriminated Internet access subscriber as a warning (824,576 emails were sent between September 2010 and December 2011, and more than 4 million emails until 2015).
- 2nd strike: if, in the six months following the first strike, a repeat infringement is detected, a registered letter is sent to the infringer as a second warning, with similar content to the first email message (68,341 registered letters were sent over the same period, and more than 400,000 registered letters until 2015).
- 3rd strike: if, in the one year following the second strike, a repeat infringement is detected, a second registered letter is sent to the infringer, informing him or her that the facts of the case are now subject to legal proceedings. The infringer can be subjected to penalties such as a fine and a loss of Internet access for one month to one year, in which case the infringer is blacklisted from Internet service providers.[12]

The Hadopi law directly targets illegal peer-to-peer downloads. It may have deterred Internet users from downloading after receiving a warning from the Hadopi agency. The law may also have had an awareness and an educational effect on people who download illegally, who may in turn shift to legal con-

[10] Decree n° 2010-695 was published 26 July 2010; it was the last piece of legislation needed to implement the graduated response.

[11] The Hadopi agency is only empowered to initiate proceedings against illegal peer-to-peer file sharing. Technically, the Hadopi agency only tracks the 100 most popular and most downloaded movies in any given period. This list is not public and is regularly renewed.

[12] Since the law was approved in 2009, only one Internet user has been suspended (for 15 days) and was also fined EUR 600. The fine cannot exceed EUR 1500. However, the Hadopi agency has obtained 114 legal judgements within the framework of the graduated response. These figures appear low, but the graduated response is not designed to punish people and is mainly intended to educate people that they should not download illegally. Cutting off Internet access has been removed from the law in July 2013.

sumption. Conversely, infringers may have simply switched to streaming technologies or direct downloads, which are not monitored by Hadopi, but we provide evidence below showing that this was not the case.

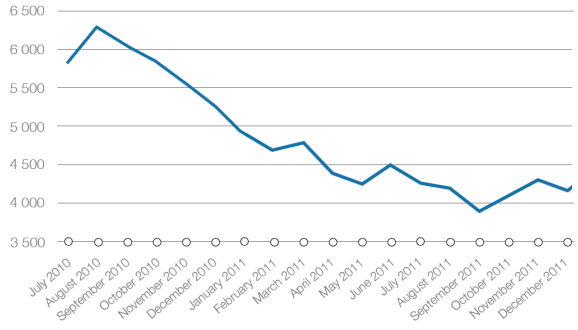
3.3 A business stealing effect is plausible

The law is likely to induce a business stealing effect for several reasons. First, many sources tend to show that there was a decline in peer-to-peer use from September 2010 to December 2011, when the graduated response started being implemented in France. Nielsen noted an important reduction of 50% in the audience levels of websites offering links (see graph 1(a)), whereas Peer Media also measured a drop of 43% in the illegal sharing of films on peer-to-peer networks in France during 2011 (see graph 1(b)).[13] This decline is consistent with the considerable number of messages sent by the Hadopi agency. Moreover, in a survey conducted in 2011 (Hadopi (2011)), 72% of warned Internet users reported that they had reduced or completely stopped their illegal usage following this warning. Finally, Mediametrie/NetRatings report no substantial increase in streaming and direct download services (see graph 4 in Appendix B), and Darmon et al. (2014) show using a survey of 2000 individuals conducted in 2012 that 78% of Internet users rightly believed that the Hadopi agency monitored illegal peer-to-peer downloads, but 68% (respectively 37% and 12%) of them also thought that the Hadopi monitored illegal direct downloads (respectively illegal streaming and illegal offline file sharing) while this is not the case. This body of evidence converges to show a decrease in online piracy that has mainly come from peer-to-peer channels and without important transfers to other piracy channels.

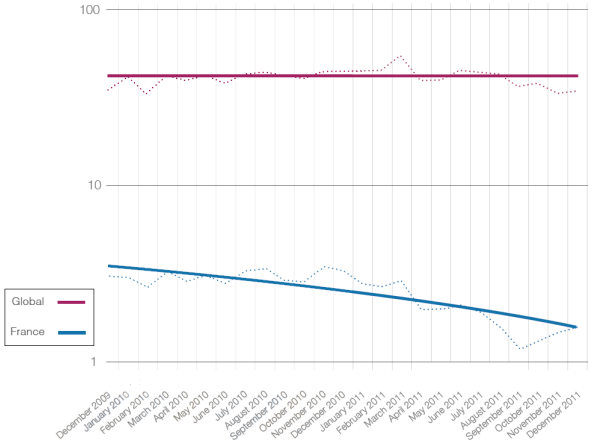
Data from the French national accounts on household consumption show that the share of consumption of movies in theaters in the shopping basket of the average French household has been stable since 1990 (see graph 6 in Appendix B). This supports the view that budget and time constraints might constitute important limitations to the expansion of the market for theatrical exhibition. Next, a survey conducted by *Observatoire de la satisfaction* shows that the distribution of audiences for American movies and French movies overlap significantly in terms of gender and age (see graphs 1(a), and 1(b) in Appendix B).[14] As a consequence, a large number of consumers are likely to enjoy watching both French and American movies. Finally, several pieces of evidence show that many French consumers tend to prefer American movies to French ones, which is a necessary condition to obtain a business stealing effect (the production budget, marketing expenditures, number of screens during the release week, and consumer ratings are significantly higher for American movies than for French ones; see Appendix B for more precise figures).

[13] Peer Media is an American company providing anti-piracy services targeted at peer-to-peer networks.
[14] *Observatoire de la satisfaction* is an independent research and polling institute specialized in the movie industry.

Figure 1: A clear decline in illegal downloading in France
(Sources: (a) IFPI / Nielsen, "Digital Music Report 2012", January 2012, total duplicated audience offering links to P2P files and applications, across approximately 40 P2P services, in thousand of unique visitors. (b) Peer Media Technologies, February 2012, sharing of internationally-observed films, change between December 2009 and December 2011, in millions of downloads initiated. Sample of 200 to 300 recent films in rotation.)



(a) The fall in audience levels of websites offering links to peer-to-peer files and applications



(b) The drop in illegal sharing of movies on peer-to-peer networks in France compared to the rest of the world

4 Data sources and descriptive statistics

In this paper, we conduct four empirical analyses by gathering many unique datasets that we describe in this section in the order in which the results are presented.

4.1 The town-level data

To implement a town-level approach, we use two sources of data, which we match through the Insee geographical codes for each town. These two sources are described below.

- Town-level Internet infrastructure and use data

The Internet data contain information on the infrastructure of high-speed Internet connections in France during the fourth quarter of 2011. They also contain the quarterly records of the number of households that have subscribed to high-speed Internet at every exchange point over the period 2008-2011. Using this dataset, we define the broadband coverage rate as the fraction of connections with download speeds higher than 512 kbit/s over the total number of connections available in a town and the broadband Internet use rate as the fraction of households that have subscribed to connections exceeding 512 kbit/s over the total number of connections for a given town. All details concerning the method to compute these indicators are available in Appendix C. Throughout this paper, high speed Internet is defined as Internet connections with download speeds that exceed 512 kbit/s. The Internet data come from Arcep, the French agency responsible for regulating telecommunications in France.

Table 3 presents the penetration of broadband in terms of coverage rate and use rate. By the end of 2008, the 68 towns in our dataset were well equipped with high-speed Internet infrastructure: 95% of these towns are supplied with at least 89.6% high-speed connections. This infrastructure equipment did not change during the period 2008-2011. The variation in the high-speed Internet use rate is more important than the variation in the coverage rate. The observation period also highlights the adoption of high-speed Internet by the households. The 5th percentile of the use rate was 46.7% in 2008, while it was 56.5% in 2011.

Table 3: Descriptive statistics for the local analysis: penetration of Internet

High speed Internet	Percentiles			
coverage and use	p05	p25	p75	p95
Coverage rate (%)	89.6	90.5	92.3	93.3
Use rate in 2008 (%)	46.7	49.6	53.9	59.2
Use rate in 2009 (%)	49.0	52.5	57.1	62.1
Use rate in 2010 (%)	53.5	56.5	60.6	64.6
Use rate in 2011 (%)	56.5	58.8	62.4	66.1

- Town-level movie sales data

The second dataset contains the box office performance of movies in the same 68 middle-size towns in France by movie theater, week, and movie, between February 2009 and August 2011.[15] The town level movie sales data come from *Médiamétrie*, a French audience measurement company.

Table 4 displays summary statistics about movie sales over the 68 towns.

Table 4: Descriptive statistics for the local analysis: average movie sales

	Before Hadopi		After Hadopi	
	Towns with Internet coverage rate under the median	Towns with Internet coverage rate above the median	Towns with Internet coverage rate under the median	Towns with Internet coverage rate above the median
U.S. movies admissions	19,952.3	23,437.1	25,124.3	32,949.3
	(18,007.6)	(25,286.9)	(19,047.2)	(28,627.0)
French movies admissions	13,730.3	16,945.5	14,841.6	19,874.0
	(11,235.4)	(16,515.8)	(12,193.8)	(18,249.9)

Standard errors in parentheses

4.2 The French movie sales data

This data set consists of all movies released on at least 100 screens in France between January 2006 and December 2011. The data include the number of admissions and the number of screens during the release week in theaters in France. The data also contain rich information on movie characteristics: genre, nationality, producers, distributors, average press reviews, and consumer reviews on Allocine.fr, age restriction, art house movie classification, and awards in two main film competitions (Cannes Festival and Oscars). Finally, the data include total marketing expenditures. Most of the data are provided by the CNC, the French public administrative organization under the authority of the Ministry of Culture and Communication, which is responsible for monitoring the French movie industry, and from websites. Marketing data come from TNS Sofres, which is a leading market research and market information group.

Table 5 provides the main descriptive statistics for French and American movies. French movies are released on fewer screens than are American ones. They are also less successful than American movies: the admissions per screen are 810 for French movies and 925 for American movies. This feature is consistent with higher consumer ratings for American movies (with an average of 3.15 on a scale of 5) than for French

[15] Agen, Albi, Amiens, Angers, Angoulème, Arras, Belfort, Blois, Boulogne sur Mer, Bourges, Brest, Brive la Gaillarde, Caen, Castres, Chalon sur Saone, Chalons en Champagne, Chambery, Charleville Mézières, Chartres, Cherbourg, Clermont Ferrand, Colmar, Créteil, Dijon, Dunkerque, Elbeuf, Epinal, Evreux, Haguenau, La Rochelle, Laval, Le Havre, Le Mans, Lorient, Maubeuge, Meaux, Metz, Montargis, Montauban, Montpellier, Mulhouse, Nancy, Nantes, Narbonne, Nevers, Nimes, Niort, Orléans, Pau, Périgueux, Poitiers, Reims, Rennes, Romans sur Isère, Rouen, Saint Brieuc, Saint Etienne, Saint Nazaire, Saint Omer, Salon de Provence, Strasbourg, Tarbes, Thionville, Tours, Troyes, Valenciennes, Vannes, Villefranche sur Saone.

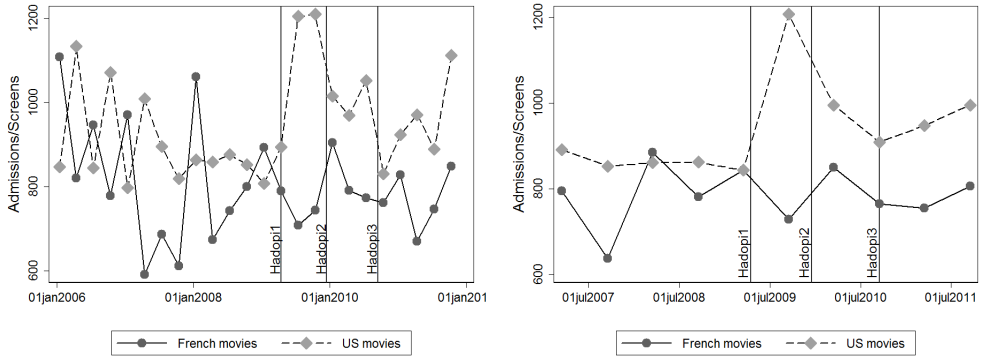
movies (with an average of 2.87). Finally, 32% of French films are classified as art-house whereas only 13% of American films are classified as art-house.

Table 5: Descriptive statistics

	U.S. movies		French movies	
	Mean	Std. Dev.	Mean	Std. Dev.
Number of obs.	575		456	
1st week admissions/screens	927	582	814	542
1st week admissions	386,582	452,890	303,546	415,199
1st week screens	363	195	326	162
Total admissions	984,314	1,310,327	898,626	1,667,620
Art and house	0.13	0.34	0.32	0.47
Average user rating	3.15	.48	2.87	0.58
Average Press rating	2.82	0.80	2.92	0.74

Figure 2 plots the ratio of admissions in the release week on the corresponding number of opening screens for French and American movies. Data are averaged by quarter. The media and national awareness of Hadopi began in the second quarter of 2009 (Danaher et al. (2014)), before the law was adopted. After this period, the ratio of American movies substantially increases and remains larger than the French counterpart in all subsequent quarters. This increase was sustained after the actual adoption of the law and the beginning of the enforcement of the graduated response. This graphical evidence suggest a positive association between Hadopi and U.S. movies' box office performance.

Figure 2: The increase in the performance of U.S. movies after the Hadopi law



(a) Admissions per screen between 2006 and 2011 (averaged by quarter)

(b) Admissions per screen between 2006 and 2011 (averaged by semester)

4.3 The international movie sales data

The data consist of weekly box office gross in 18 European countries during the period beginning in January 2007 and ending in December 2011. The data only include movie-level box office revenues for the top-10 or top-20 movies (depending on the country, but the criteria do not change over time for a given country) for a defined period (3-, 4-, or 5-day "weekends"). The data set contains the name of the movie, its distributor(s) in different countries, the release date in each country, and the number of opening screens and box office gross in U.S. dollars. The data were collected in September 2012 from ScreenDaily.com. In addition, we have annual information by country on GDP per capita and broadband penetration. Upon close inspection, the data are reliable and are provided in a common format across our period of interest for nine countries: Belgium, Finland, France, Germany, Italy, the Netherlands, Spain, Switzerland, and the United Kingdom. Movie revenues are converted into the number of tickets sold based on the current conversion rates and average ticket prices. Data cover 85% to 90% of the total number of admissions.

4.4 Consumer-level data

In France, a consumer has the option to subscribe to unlimited access movie cards issued by movie theater companies. This annual contract costs approximately 20 euros per month. The monthly fee is automatically debited to a bank account until cancellation. This card provides unlimited access to the movies exhibited in the theaters that accept the card. It includes all theaters that are part of the chain issuing the card and the independent theaters that have an agreement with that chain. The other option for a consumer to watch a movie in a theater is to pay approximately 10 euros per movie or to purchase a five-ticket pass for 40 euros. Note that students, unemployed persons, and seniors also have access to reduced-fare tickets.

We gathered unique sales data from three theaters in two medium-sized French cities that belong to the same chain and that all accepted the unlimited access card between 2008 and 2011.[16] These data contain the identity of the cardholder, the movie, the theater, and the date of each transaction and visit.

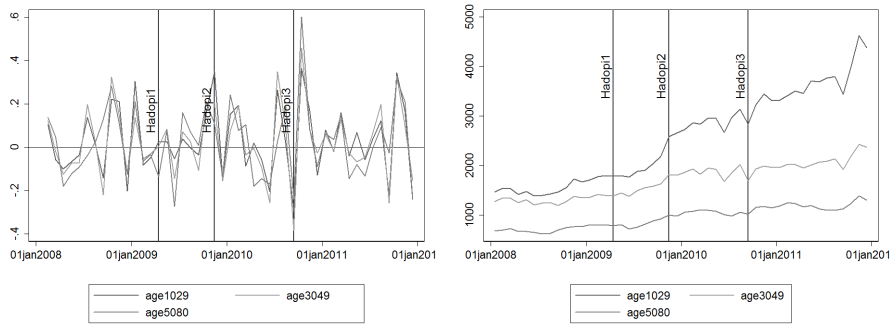
The combined market share of the three theaters accounts for between 80% and 90% of the market of the respective city. Another independent movie theater specialized in art-house movies is present in each city. We do not have sales data for those independent art-house movie theaters, but because the three movie theaters we use clearly dominate the local markets, we are confident that no competitive effect interferes with the subsequent analysis.

The unlimited access cards were introduced in 2003 and in 2006 in each city. The economic success of

[16] In the first town, there are two large theaters located in the inner city and in the suburbs. In the second town, there is one theater located in the inner city.

this program has been substantial. Graphs 3(a) and 3(b) display the monthly growth rate and the monthly number of consumers that have used their card at least once in the three theaters. No sharp change in the number of consumers with cards appears at the time that the Hadopi law was passed. Therefore, we assume that there was no sudden reaction by consumers who would have subscribed to the unlimited access card in response to the law. However, the choice of subscribing to this service remains endogenous. As the number of cardholders has increased consistently over time, the graphs also show that the number of cardholders has increased more quickly for younger consumers than for older consumers.

Figure 3: The number of consumers holding an unlimited access card is growing over time, in three theaters of two medium-size cities of France



(a) Monthly growth rate of the number of unique members consuming movies

(b) Monthly number of unique members consuming movies

Table 6 presents the percentage of U.S. films watched by consumers with card. This percentage is higher after the law was adopted. It is particularly the case for younger consumers, aged between 10 and 29, who generally download more than older consumers.

Table 6: Percentage of U.S. movies watched by consumers with unlimited access card

	Before Hadopi	After Hadopi
All consumers with card	51,2%	53,8%
Consumers aged between 10 and 29	58,2%	60,9%
Consumers aged between 30 and 49	52,4%	53,4%
Consumers aged between 50 and 80	37,9%	39,4%

5 Empirical strategies and results

In this section, we develop four empirical analyses to assess the effects of the anti-piracy law from different perspectives. We summarize the main results of each analysis in the form of their pros and cons in Table 7.

Throughout the study, we test whether the law had an effect using an indicator that equals one beginning in November 2009 (hereafter $Hadopi$), when the law was adopted, and zero otherwise. In addition, Danaher et al. (2014) argue that the Hadopi law began to have an effect on digital music sales in March 2009, when the law had yet to be enacted but was highly visible in the public debate. As a consequence, to test whether such an effect is also present for movie sales, we allow for heterogeneous effects of the Hadopi law in our estimations with respect to three periods of time:

- A first indicator for the period between April 2009 and October 2009 (hereafter $Hadopi1$), which corresponds to the period between the beginning of the debate among lawmakers and the adoption of the first version of the law.
- A second indicator for the period between November 2009 and August 2010 (hereafter $Hadopi2$), which is the period when the law was first adopted.
- A third indicator for the period between September 2010 and December 2011 (hereafter $Hadopi3$), which is the period during which the graduated response came into force.

5.1 Analysis 1: Town-level approach

5.1.1 Empirical strategy

To examine the effects of the Hadopi law on the market for movie theaters in France, we compare box office performance in towns with a high-level of piracy to that in towns with a low-level of online piracy. This empirical strategy allows us to purge the estimate of the law's effect from common shocks at the national level in France that would be concomitant with Hadopi. For instance, these coincident shocks could have been the release of unpredictably successful American movies or the release of poorly performing French movies.

We operationalize the level of online piracy before Hadopi in each town using broadband Internet use as a proxy, as in Liebowitz (2008) and Bhuller et al. (2013). Our empirical approach assumes that towns with high broadband Internet use experience more illegal downloads than towns with low broadband Internet use. As a result, towns with a higher level of Internet use should have been more affected by the Hadopi

Table 7: Recap of the advantages and limits of each empirical strategy

	Main effects identified	Advantages	Limits	Results
(1) Local comparisons: towns with high level vs. towns with low level of online piracy	Local market expansion effect and business stealing effect in towns with high level of online piracy compared to ones with low level of online piracy	- Main effects of the Hadopi law are captured Rules out simultaneous unrelated shocks specific to U.S. or to French movies	No conclusion at the national level: localized effect on middle-size towns	- No market expansion effect but business stealing effect - The market share of U.S. movies increases by 0.8% with a one percentage point increase of the broadband internet use rate
(2) National comparisons: U.S. movies vs. French movies in France	Relative business stealing effect of U.S. movies toward French movies	- Checks for supply reactions from U.S. film distributors compared to French film distributors - Controls for simultaneous unrelated shock symetric on all movies in France	- No conclusion on market expansion effect and pure business stealing effect - Does not check for simultaneous unrelated shocks specific to U.S. or to French movies	- Relative increase of U.S. films admissions by 10% relatively to French films - No reaction from the supply side of U.S. movies compared to French movies, except a decrease in the production budget, a decrease in user ratings, but an increase in the marketing expenditures
(3) International comparisons: France vs. other european countries	Market expansion effect in France and business stealing effect from U.S. movies in France, compared to other countries	- Main effects of the Hadopi law are captured - Checks for supply side reactions of film distributors of U.S. movies in France compared to other european countries	- Does not control for simultaneous unrelated shocks in France in general, or specific to U.S. or French movies - Does not check for supply side reactions of U.S. film distributors compared to French film distributors, in France	- No market expansion effect but business stealing effect: market share of U.S. movies increases by 8% - No change in the speed nor in the quantities of exports of U.S. films to France
(4) Consumer comparisons: consumers with high propensity vs. those with low propensity to download	Relative business stealing effect of U.S. movies toward French movies, between consumers belonging to different age groups	- Distinguishes what type of consumers are influenced by the new regulation - Provides an insight on the mechanism at work	- No conclusion on total market expansion effect - Very localized data collection	- Relative increase of U.S. films admissions compared to French films admissions - Increase by 20% for consumers aged 10-29 and by 10% for consumers aged 30-49, compared to consumers aged 50-80

law. Indeed, high-speed Internet facilitates and reduces time for downloading large files such as movies. A 1 Gb file takes 17 hours to download with a 128 kbit/s connection but only 4 hours with a 512 kbit/s connection and 1 hour with a 2000 kbit/s connection.

Weekly movie sales in a theater can be very erratic and depend on the presence of blockbusters. These volatile variations in sales are not linked to the Hadopi law but can hamper an accurate measurement of its effects. To compare a stable level of American movie sales with French movie sales by town before and after the Hadopi law, theater movie sales data are aggregated by town, by month and by nationality.[17] This aggregation mitigates the competitive effects between theaters in a town and smooths most of the erratic variation in movie sales in each town. We estimate the following equation:

$$Outcome_{ct} = \rho_c + \tau_t + \alpha Hadopi_t * Internet_c + x'_{ct}\beta + \epsilon_{ct} \quad (1)$$

where $Outcome_{ct}$ is an economic outcome (the logarithm of admissions to all movies and the market share of American movies) in geographic area (town) c during month t, $Hadopi_t$ equals one after the implementation of Hadopi, $Internet_c$ is the fraction of household connections subscribing to high-speed Internet over the total number of connections in town c during the first quarter of 2009, and x_{ct} is a set of time-varying covariates we describe below. The standard errors are clustered at the town level, as recommended by Bertrand et al. (2004), to take into account the autocorrelation between observations belonging to the same town.

The local broadband Internet use rate is potentially endogenous because it is a choice variable. For instance, households may have decided to change their subscription to broadband Internet to watch movies online rather than in the theater. We obtain exogenous variation in Internet use as in Bhuller et al. (2013) by exploiting the spatial variation of high speed Internet infrastructures. To instrument $Internet_{ct}$, we estimate the following first stage equation:

$$Internet_{ct} = \delta Infractructure_c + \omega_{ct} \quad (2)$$

where $Infrastructure_c$ is the fraction of connections with high speed Internet over the total number of connections in town c.

The infrastructure to access high-speed Internet was introduced in France with the installation of phone connections. The spatial variation in Internet infrastructure is linked to its progressive diffusion in France and is due to limited funding.

[17] Bi-national movies such as Harry Potter are considered American.

The timing of the diffusion of high-speed Internet is not correlated with the Hadopi law and does not vary substantially over the period $2008-2011$. The theoretical maximum download speed of an Internet connection depends on the infrastructure and is not the result of consumer choice. Internet service providers only advertise the maximum speeds they deliver in France as a whole. In principle, most consumers do not know the speed of their Internet connection before moving into their homes. However, any consumer can find this information using detailed maps available on the Internet. In remote areas, that some homes have poor Internet connections can be common knowledge. This feature might weaken the power of our instrument. A good feature of our instrument is that all Internet packages were unlimited over the period $2008-2011$, and hence, a consumer could not choose to restrict the speed of his or her Internet connection by paying less.

As Liebowitz (2008) notes, there are at least two limitations with using the broadband Internet use rate as a proxy for online piracy. First, the Internet use rate represents the number of users, not the intensity of Internet use. However, it seems reasonable to assume that the intensity of Internet use is strongly associated with the download speed allowed by the connection. Second, the Internet can influence movie admissions in theaters: it is a channel that convey media that can compete with movie theaters.[18] As a consequence, the α coefficient captures both the online piracy effect and the competing Internet effect. Nonetheless, our local-analysis begins in the middle of 2008, when the Internet was less of a new and growing form of alternative media. We believe that the competing effect of Internet has not experienced a drastic change coincidentally with the Hadopi law, and hence it may not be a substantial issue.

Unobservable town-level shocks and unobservable common time shocks that are correlated with movie performance are controlled for through town and through month fixed effects. We also control for a local time-varying indicator with x_{ct}, which contains factors influencing the box office performance of movies. That is, we control for the quality of all American and French movies available in town c during month t using the results of an ancillary estimation. We obtain these two movie quality indicators by estimating $\hat{\xi}_i$ using the following equation: $log(admissions_{icet}) = \gamma_t + \phi_c + \nu_e + \mu(t - r_i) + \xi_i + \zeta_{icet}$, where $log(admissions_{icet})$ is the logarithm of the admissions of movie i, in town c, in theater e, during week t, where γ_t is a week indicator, ϕ_c is a town indicator, ν_e is a movie theater establishment indicator, r_i is the release date of movie i, such that μ controls for the common decay effect of movie sales, and ξ_i is a movie indicator. $\hat{\xi}_i$ are then aggregated by month, town and nationality of movies, weighted by the number of movie theaters showing the movie i.

3D movies were introduced at essentially the same time as Hadopi with the release of Avatar near

[18] Another influence would be that the Internet can spread electronic word of mouth.

the end of 2009. This might have influenced the effect of the anti-piracy law because this technological innovation could have increased the demand for movies in theaters and 3D films were mainly American.[19] The effect of 3D films might also have been different across towns because the diffusion of digital projectors in France was progressive and due to limited funding. As a consequence, we additionally control for the number of movies played in 3D in town c during month t. In this way, we also partially control for the rapid conversion to digital projectors in France, as 3D movies require digital projectors to be exhibited in theaters.

5.1.2 Results

Table 8 and table 9 report the results with the market share of American movies and the log of total admissions as the outcomes of interest. Columns 1-2 control for town fixed effects and month fixed effects, columns 3-4 additionally control for the time-varying quality of American movies and French movies, columns 5-6 add the control for 3D screenings, and columns 7-8 contain all of the control variables and drop the 50% of towns with high-speed Internet infrastructure closest to the median as a robustness check to intensify the effect of Hadopi. The results indicate that American movies' market share increase by approximately 0.9 percentage point when the broadband Internet use rate increases by 1 percentage point, after the implementation of the anti-piracy law. The regressions also indicate no effect of the Hadopi law on the total number of admissions in France. These effects are robust to different specifications and do not appear before the actual implementation of the law. The results indicate that the Hadopi effect is most likely to be a pure business stealing effect that benefits U.S. movies at the expense of other (French) movies. However, the methodology requires supplementary analyses to exclude other competing explanations.

Table 8: DiD local analysis based on instrumentalized high speed Internet use: U.S. market share

	U.S. market share							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Hadopi × Internet	0.539		0.529*		0.569*		0.816**	
	(0.330)		(0.282)		(0.309)		(0.318)	
Hadopi1 × Internet		0.621		0.547		0.533		0.600
		(0.520)		(0.491)		(0.493)		(0.561)
Hadopi2 × Internet		0.840		0.766		0.780		0.979*
		(0.574)		(0.507)		(0.513)		(0.552)
Hadopi3 × Internet		0.915*		0.902**		0.959**		1.363***
		(0.505)		(0.432)		(0.463)		(0.456)
Town fixed effect	y	y	y	y	y	y	y	y
Month fixed effect	y	y	y	y	y	y	y	y
Quality of French films			y	y	y	y	y	y
Quality of U.S.			y	y	y	y	y	y
3D shows					y	y	y	y
Constant	0.541***	0.489***	0.394***	0.140	0.394***	0.0949	0.539***	0.544***
	(0.00562)	(0.00829)	(0.00733)	(0.247)	(0.00730)	(0.276)	(0.00812)	(0.00815)
Observations	2087	2087	2087	2087	2087	2087	990	990
R-squared	0.880	0.880	0.886	0.886	0.886	0.887	0.892	0.893

Standard errors clustered by town
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

[19] Avatar was followed by other 3D releases such as How to Train Your Dragon (2010), Alice in Wonderland (2010), and so forth.

Table 9: DiD local analysis based on instrumentalized high speed Internet use: Total admissions

	log(Total Admissions)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Hadopi × Internet	3.585		2.872		2.959		2.351	
	(2.599)		(2.112)		(2.158)		(2.145)	
Hadopi1 × Internet		1.680		1.081		1.048		-0.170
		(1.531)		(1.545)		(1.554)		(1.821)
Hadopi2 × Internet		4.315		3.154		3.185		1.969
		(3.084)		(2.496)		(2.521)		(2.526)
Hadopi3 × Internet		4.710		3.840		3.970		2.628
		(2.999)		(2.522)		(2.557)		(2.549)
Town fixed effect	y	y	y	y	y	y	y	y
Month fixed effect	y	y	y	y	y	y	y	y
Quality of French films			y	y	y	y	y	y
Quality of U.S.			y	y	y	y	y	y
3D shows					y	y	y	y
Constant	9.801***	9.447***	9.647***	7.183***	9.647***	9.059***	9.805***	9.804***
	(0.0253)	(0.0313)	(0.0436)	(1.448)	(0.0434)	(0.871)	(0.0339)	(0.0349)
Obervations	2087	2087	2087	2087	2087	2087	990	990
R-squared	0.941	0.941	0.942	0.942	0.942	0.942	0.934	0.934

Standard errors in parentheses
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.2 Analysis 2: American *vs* French movies in France

5.2.1 Empirical strategy

We check that our results are not driven by supply reactions by conducting an additional analysis at the French national level in a difference-in-differences setting. The "treatment" group comprises American movies, and the "control" group is composed of French movies. The baseline estimation is as follows:

$$Outcomes_{it} = \rho_t + \beta X_i + \gamma US_i + \alpha Hadopi_t \times US_i + \epsilon_{it} \tag{3}$$

for movie i during release week t, where US_i equals 1 if movie i is from the US and 0 otherwise, and where X_i is a set of movie variables including the production budget, the advertising expenditures, the number of screens on the release day, consumers' rating, press rating, fixed effects for genre, nationality, art-house movies, age restrictions, and distributors. We test four possible supply reactions to the Hadopi law: the log of the number of screens on which movies are released, the log of the production budget in dollars, the log of the total marketing expenditures, and the quality of movies measured by consumer ratings.

In addition, we also verify that the market share of U.S. movies has increased thanks to the anti-piracy law. We estimate equation 3 using the logarithm of admissions, and with the logarithm of the ratio between the number of admissions during the release week and the corresponding number of screens as dependent variables. This ratio is commonly used in the industry and enables re-scaling all movies, thus making comparisons more relevant and controlling for the main supply reaction. As discussed in Section 3, American movies are much more frequently pirated online than are French movies during their release

week, mainly because the pirates providing illegal digital copies are much more active in the U.S.. To the best of our knowledge, we are the first to exploit the difference in online piracy between U.S. movies and domestic movies, within a country, to estimate the effects of illegal file sharing on movie sales. This approach does not allow us to disentangle the market creation effect from the business stealing effect. It identifies relative business stealing by comparing American to French movies: American movies are directly impacted by the law, and French movies are indirectly impacted through the greater competition from American films following the law.

5.2.2 Results

We present the results of the supply reaction in table 10. They indicate that there was no change in the number of opening screens for U.S. movies during Hadopi implementation (columns 1 and 2), but there was a slight decrease in the production budget of American movies (columns 3 and 4), and a decrease in consumer ratings (column 5 and 6). We also observe a small increase in marketing expenditure during the third period of Hadopi (columns 7 and 8). Overall, these results exclude supply side reactions to the law as the main explanation for the increase in American movies' market share. They tend to indicate a decrease in American movie quality (the production budget and the consumer ratings) during the Hadopi effect, which actually reinforces the main result of an increase in demand for American movies. The increase in the marketing expenditure of American movies during the third period of Hadopi could have explained the rise in U.S. movies' market share, but we confirm the increase in U.S. movie sales relative to French ones, while controlling for advertising, in a robustness check presented below.[20] Then, this increase in advertising spending does not entail an increase in the number of screens, and hence, it might be linked to the legal reduction of the time to release a movie on video.[21] It could also partially come from a reaction on the part of distributors to the increased consumer demand for American films.

The results in table 11 confirm that Hadopi is associated with an increase in admissions for U.S. movies relative to French ones. They also indicate that Hadopi may have had an effect before its actual implementation during the period of legislative debate (April 2009 - October 2009). Finally, they also show that the Hadopi effect may have been temporary and ended in September 2010, the period during which the graduated response began to be enforced. However, this is the only analysis to exhibit such a

[20] In addition to this robustness check, we verify that the efficiency of advertising has not increased simultaneously with Hadopi implementation by estimating the following equation for U.S. movies: $log(Admissions_i t) = \rho_t + \delta log(AdSpending) + \beta log(AdSpending) \times Hadopi_t + \gamma X_{it}$, where X_{it} includes the usual control variables. It appears that β is not significantly different from zero.

[21] Simultaneous with the Hadopi law, the minimum period of time to release a movie on video after the theatrical release was reduced from six to four months.

Table 10: DiD French vs. American in France (first week), supply reaction: number of opening screens, production budgets, advertising expenditures, and consumer ratings

	(1) log(Screens)	(2) log(Screens)	(3) log(Budget)	(4) log(Budget)	(5) log(Ad)	(6) log(Ad)	(7) Consumer Ratings	(8) Consumer Ratings
Hadopi $\times U.S.$		-0.0187		-0.207*		0.140*		-0.257***
		(0.0506)		(0.108)		(0.0734)		(0.0771)
Hadopi1 $\times U.S.$	0.102		0.188		0.0646		-0.300*	
	(0.104)		(0.203)		(0.182)		(0.123)	
Hadopi2 $\times U.S.$	0.0517		-0.304*		0.0852		-0.312**	
	(0.0657)		(0.159)		(0.0930)		(0.109)	
Hadopi3 $\times U.S.$	-0.0440		-0.0663		0.208**		-0.303***	
	(0.0656)		(0.132)		(0.0811)		(0.0893)	
log(Budget)	0.248***	0.247***			0.0283	0.0303	-0.0104	-0.0102
	(0.0475)	(0.0484)			(0.0361)	(0.0355)	(0.0394)	(0.0392)
log(Ad)	0.310***	0.312***					0.0672*	0.0659*
	(0.0671)	(0.0672)					(0.0327)	(0.0331)
log(Screens)					0.886***	0.885***	-0.0281	-0.0363
					(0.0539)	(0.0545)	(0.0633)	(0.0632)
Consumer rating	-0.0142	-0.0183	0.0176	0.0117	0.0926**	0.0896*		
	(0.0324)	(0.0323)	(0.0771)	(0.0763)	(0.0456)	(0.0476)		
Press rating	0.0469**	0.0497**	0.0434	0.0427	-0.0164	-0.0169	0.377***	0.378***
	(0.0237)	(0.0239)	(0.0510)	(0.0507)	(0.0295)	(0.0298)	(0.0509)	(0.0513)
Genre fe	y	y	y	y	y	y	y	y
Nationality fe	y	y	y	y	y	y	y	y
Art and House fe	y	y	y	y	y	y	y	y
Age restriction fe	y	y	y	y	y	y	y	y
Month fe	y	y	y	y	y	y	y	y
Distributor fe	y	y	y	y	y	y	y	y
N	604	604	646	646	767	767	604	604
R^2	0.728	0.726	0.749	0.747	0.741	0.740	0.567	0.562

Robust standard errors
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

temporary effect beginning before the implementation of the law. We further implement several robustness tests to check these results.

Our first robustness check concerns extreme values. A few movies can capture nearly the entire audience, and the estimated Hadopi effects may simply be driven by few outstanding American (French) movies that coincidently performed well (poorly) during the Hadopi period. With a two-step procedure, we first estimate the main specifications and then re-estimate the same specifications having dropped the 20% of movies with the highest absolute residual values from the first estimate. The results are consistent with those obtained from the full sample; the main results are even reinforced with this procedure and are presented in Appendix D in table 16.

Thus far, we have assumed the effect of Hadopi to be the same for all American movies. However, the effect of the Hadopi law could be heterogeneous across American movies because online piracy is likely to affect more popular movies. Thus, as a second robustness check, we estimate the quantile treatment effect to determine the heterogeneous effect of the Hadopi law on movies box office performance.[22] Others

[22]We have extended this robustness check to the supply side variables. There is no noteworthy increase in the advertising expenditure for American movies during the Hadopi period into the right tail of the advertising expenditure distribution and not much into the rest of the distribution either. We also see no effect of the Hadopi law on the distribution of the number of opening screens, and of the production budget of American movies. Lastly, the decrease in consumer ratings for American movies during the Hadopi period seems to concern the whole distribution. All results can be obtained upon request, they are not presented for saving space.

advantages of quantile regression are its robustness to outliers and its robustness when the dependent variable has a highly non-normal distribution (see Koenker (2005)), which is important because outliers are not unusual in the movie industry: a few winners take all of the revenues. The results suggest that the positive effect of the Hadopi law on American movies' box office performance becomes larger as we move upward into the right tail of the distribution. In other words, the effect of Hadopi is stronger on the most successful movies, which are the most pirated ones (see table 17 in the Appendix). This finding confirms that online piracy reduces the superstar phenomenon (Rosen (1981) and Adler (1985)) as in Gopal et al. (2006). We find no negative effect of the Hadopi law in the left tail of the distribution, and hence, high-performing American movies do not benefit from the Hadopi law, to the detriment of less well performing American movies.

Table 11: DiD French vs. American movies in France (first week) : demand reaction

	(1) log(Admissions)	(2) log(Admissions)	(3) log(Admissions/Screens)	(4) log(Admissions/Screens)
Hadopi $\times U.S.$	0.110+		0.103	
	(0.0657)		(0.0680)	
Hadopi1 $\times U.S.$		0.265*		0.302*
		(0.123)		(0.126)
Hadopi2 $\times U.S.$		0.239**		0.257**
		(0.0905)		(0.0945)
Hadopi3 $\times U.S.$		0.0952		0.0798
		(0.0766)		(0.0800)
log(Screens)	1.393***	1.382***		
	(0.0759)	(0.0741)		
log(Ad)	0.101*	0.101*	0.231***	0.228***
	(0.0434)	(0.0418)	(0.0511)	(0.0491)
log(Budget)	-0.0292	-0.0265	0.0674	0.0675
	(0.0407)	(0.0400)	(0.0428)	(0.0414)
Consumer rating	0.198***	0.206***	0.192***	0.201***
	(0.0425)	(0.0425)	(0.0445)	(0.0442)
Press rating	0.120***	0.116***	0.132***	0.127***
	(0.0308)	(0.0306)	(0.0312)	(0.0310)
Genre fe	y	y	y	y
Nationality fe	y	y	y	y
Art and House fe	y	y	y	y
Age restriction fe	y	y	y	y
Month fe	y	y	y	y
Distributor fe	y	y	y	y
Constant	2.713***	2.764***	3.770***	3.793***
	(0.350)	(0.348)	(0.391)	(0.379)
N	767	767	767	767
R^2	0.801	0.803	0.444	0.452

Robust standard errors ; Consumer and Press ratings come from Allocine.fr
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.3 Analysis 3: International comparisons

5.3.1 Empirical strategy

A potential explanation for the better performance of American movies is that Hadopi triggered a supply-side reaction by U.S. majors. We began to rule out this explanation in the previous section by comparing the supply of American movies to the supply of French movies. However, it is possible that U.S. majors decided to open their movies on more screens in France, as a response to the law, relative to their strategy

in other European countries. To further assess the positive effects of the Hadopi law on American movies' box office performance, we compare some outcomes relative to the supply level of American movies between France and a control group composed of different European countries at the movie level.

The estimation equation is the following one :

$$Outcome_{ict} = \rho_c + \rho_t + \beta X_i + \alpha Hadopi_{ct} + \epsilon_{ict} \tag{4}$$

where X_i a set of movie variables that are defined as above and $Hadopi_{ct}$ is a post-Hadopi dummy variable that equals one only for France. Our dependent variables are the natural logarithm of the ratio between the number of admissions for movie i during first week t in country c, $Admissions_{ict}$, and the corresponding number of screens $Screens_{ict}$. We also directly test two possible supply reactions to the law: the quantity of U.S. movies exported to country c, measured by the log of the number of opening screens of exported movies, and the speed of exports, measured by the time lag in days between the date of release in the U.S. and the foreign release date (McCalman (2005)).

As a check of the main the effects of the Hadopi law on the demand, we compare France with other European countries with some aggregate outcomes of movie performance. To detect a total demand creation effect and a redistributive effect between American movies and domestic movies, we aggregate movie-level admissions data by country and by month. We use the following simple specification with data at the country $\times$ month level (see Adermon and Liang (2014) for a similar approach):

$$Outcome_{ct} = \rho_c + \rho_t + \alpha Hadopi_t \times France_c + \epsilon_{ct} \tag{5}$$

where c is a country index and t a time period index. $Hadopi_t$ is a post-Hadopi dummy variable equal to one after November 2009. Finally, ρ_c is a country fixed effect, ρ_t a quarterly fixed effect, and ϵ_{ct} an idiosyncratic error term. We study the effect on two aggregate outcomes: (1) the log of the total number of admissions and (2) the log of American movies market shares.

An important issue for the identification strategy is to have a convincing control group (Meyer (1995)). During the period 2008-2011, no measure similar to the French Hadopi law was implemented in Europe other than a 2009 Swedish law, and hence Sweden is always excluded from the control group (see Appendix E for a discussion). Then, to select the countries to be included in the control group, we use a methodology that ensures that the pre-treatment trends in the dependent variables of interest are similar to the trend in the treated country. We first visually check that there is no divergence in trends between France and a candidate control country. Then, we regress the variable of interest in France on this variable in the

candidate control country for the months preceding the beginning of the public debate on Hadopi (April 2009) to select the candidates that are significantly correlated with France, as proposed by Hilger et al. (2011). Details on the construction of the control group are available in Appendix E.

5.3.2 Results

The results from equation 4 are presented in Table 12. They indicate that American movies performed substantially better in France than in other countries after the implementation of Hadopi (columns 1 and 2). There is, however, no change in the speed of their exports (columns 3 and 4) or in the number of opening screens (columns 5 and 6), although we note that $Hadopi3$ is significantly negative in column 4. This decrease in the number of opening screens for American movies in France actually strengthens our main result. The time lag between the release in the US and in France increases during $Hadopi1$ but not during $Hadopi2$ or $Hadopi3$.[23] Overall, this analysis confirms that a supply reaction is not the main explanation for the positive effect of the Hadopi law on American movies.

Table 13 provides the estimation results from equation 5. They indicate no effect of the Hadopi law on the total number of admissions in France (columns 1 and 2). These regressions also indicate that American movies' market share increased by approximately 8% in France thanks to Hadopi relative to the control group (columns 3 and 4). This effect seems permanent and does not appear before the actual implementation of the law. This difference-in-differences strategy confirms that there is no demand creation following the law and that the mechanism at play is most likely a pure substitution effect to the benefit of American movies.

5.4 Analysis 4: Consumer-level approach

In this section, we provide some evidence to better understand the consumer behavior underlying the redistributive effect that benefits American movies.

Consumers who download more should be more sensitive to the anti-piracy law. For such consumers, we should observe a more important shift in their legal consumption of American movies in theatres. Using consumer-level data, our last approach provides additional evidence supporting this mechanism using the difference in characteristics (age) between consumers who have unlimited access card.

The benefit of this data collection approach is that it provides us with information on the type of consumers who purchase movies in theaters. Because we could only collect those data for two middle-size

[23]The Hadopi law has also reduced the legal delay between the release date of movies in theaters and the video release date from 6 to 4 months, which may explain this increase in the time lag in France.

Table 12: American movies across countries

	$log(\frac{Admissions}{Screens})$ (1)	$log(\frac{Admissions}{Screens})$ (2)	$log(Screens)$ (3)	$log(Screens)$ (4)	Lag (5)	Lag (6)
Hadopi × France	0.217***		-0.132***		0.292	
	(0.0419)		(0.0429)		(0.795)	
Hadopi1 × France		0.0599		-0.0977		2.143*
		(0.0682)		(0.0621)		(1.270)
Hadopi2 × France		0.224***		-0.0651		-0.106
		(0.0737)		(0.0677)		(1.459)
Hadopi3 × France		0.230***		-0.195***		1.129
		(0.0455)		(0.0492)		(0.879)
Log(Budget)	0.240***	0.240***	0.424***	0.425***	-1.444	-1.442
	(0.0314)	(0.0314)	(0.0307)	(0.0307)	(1.198)	(1.199)
Consumer rating	0.354***	0.354***	0.129***	0.128***	0.637	0.652
	(0.0528)	(0.0528)	(0.0453)	(0.0451)	(1.123)	(1.122)
Press rating	-0.0341	-0.0341	0.00939	0.00879	0.0194	0.0251
	(0.0337)	(0.0337)	(0.0321)	(0.0320)	(0.580)	(0.576)
Comp. age top 5	0.0370***	0.0371***	0.00786	0.00888	0.265	0.265
	(0.0123)	(0.0123)	(0.0172)	(0.0173)	(0.329)	(0.331)
Comp. perc. new screens	-1.025***	-1.025***	-0.896***	-0.894***	6.800	6.899
	(0.181)	(0.181)	(0.217)	(0.217)	(5.253)	(5.329)
Genre FE	y	y	y	y	y	y
Nationality FE	y	y	y	y	y	y
Art and House FE	y	y	y	y	y	y
Age restriction FE	y	y	y	y	y	y
Month FE	y	y	y	y	y	y
Constant	4.956***	4.947***	1.839***	1.829***	11.00***	10.63***
	(0.235)	(0.236)	(0.238)	(0.239)	(3.970)	(3.961)
Observations	3228	3228	1254	1254	1605	1605
R-squared	0.393	0.393	0.870	0.870	0.157	0.158

*Robust standard errors clustered by movie; Consumer and Press ratings come from Allocine.fr; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Control Group for log(Admissions/Screens): Belgium, Finland, Germany, the Netherlands, Spain, Switzerland, and United Kingdom; Control Group for log(Screens): Belgium, and the Netherlands; Control Group for Lag: Belgium, Italy, and United Kingdom.*

Table 13: DiD International comparison

	(1) log(Admissions)	(2) log(Admissions)	(3) log(U.S. market share)	(4) log(U.S. market share)
Hadopi × France	0.0833		0.0805***	
	(0.0529)		(0.0209)	
Hadopi1 × France		-0.0211		0.00190
		(0.0238)		(0.0339)
Hadopi2 × France		0.0821		0.0894***
		(0.0449)		(0.0153)
Hadopi3 × France		0.0770		0.0756**
		(0.0655)		(0.0239)
Country fe	y	y	y	y
Month fe	y	y	y	y
Constant	14.04***	14.04***	-0.252***	-0.251***
	(0.0356)	(0.0360)	(0.0340)	(0.0341)
Observations	420	420	420	420
R-squared	0.978	0.978	0.677	0.677

*Standard error are clustered by country allowing for observations to be correlated within a country. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Control Group for log(Admissions): Belgium, Germany, the Netherlands, Spain, Switzerland, and United Kingdom; Control Group for log(U.S. market share): Belgium, Germany, Italy, Spain, Switzerland, and United Kingdom.*

cities in France, the results in this section are not nationally representative. The effect in France as a whole could admittedly be different from that we describe hereafter.

5.4.1 Empirical strategy

Young consumers download illegally more often than old consumers (see Hadopi (2011)), and hence they are more likely to be affected by Hadopi. We use the information on the age of consumers with unlimited access cards to investigate which types of consumers were influenced by the anti-piracy law.[24]

This strategy exploits a difference in illegal downloading between young and older people. We implicitly assume that consumers with cards illegally download movies despite having unlimited access to movies in theaters. Such behavior might be due to a time constraint. Indeed, the opportunity cost of watching a movie in a theater is higher than that of watching a movie at home, even if the experience of consuming a movie on a computer or in a theater is clearly different. The costs of commuting and of waiting at the theater are the main components of this time cost. Further, it is easier to stop watching a movie that one does not enjoy at home than in a movie theater. Another explanation would be a preference for watching movies as soon as they are available, on the Internet, even if they will subsequently be available in movie theaters.

We aggregate individual transaction data from consumers with unlimited access cards by movie, week, theater and three different age groups: consumers between 10 and 29 years old, between 30 and 49 years old, and between 50 and 80 years old. The equation we estimate is as follows:

$$\begin{aligned} Sales_{ijta} =& \delta_i + \delta_j + \delta_t + \phi NumberCards_{jta} + \sum_{\tau=1}^{14} \beta_\tau \mathbb{1}_{\{t-r_i=\tau\}} + \sum_{a=1}^{2} \gamma_a Age_a + \sum_{a=1}^{2} \lambda_a USA_i * Age_a \\ &+ \sum_{a=1}^{2} \eta_a Hadopi_t * Age_a + \mu Hadopi_t * USA_i + \sum_{a=1}^{2} \beta_a Hadopi_t * USA_i * Age_a + \epsilon_{ijta} \end{aligned} \quad (6)$$

where the left-hand-side variable is the log of sales (number of admissions) from consumers with unlimited access cards belonging to age group a for movie i, during week t, in theater j.[25] Age_a is an indicator variable that equals one for sales associated with consumers who belong to age group a. $Numbercards_{jta}$ is the number of consumers belonging to age group a who have used an unlimited card at least once during month t at theater j. This variable accounts for the economic success of the loyalty

[24] We also tested for a difference between women and men, but no significant difference was found.

[25] When $a = 1$, this corresponds to people aged between 10 and 29, $a = 2$ being people aged between 30 and 49, and $a = 3$ matching people aged between 50 and 80.

program of the cinema chain and particularly the large increase in the number of young cardholders. The coefficients of interest are now β_1 and β_2. They measure the increase in the sales of American movies relative to other movies after the Hadopi law was passed from consumers with cards, separately for those aged between 10-29 years and between 30-49 years, in comparison to the increase by consumers with cards aged between 50-80 years. η_1 and η_2 are also interesting because they indicate whether the sales of French films among younger consumers increased after the law relative to consumption by older consumers. A detailed discussion of the interpretation of the β_a coefficients is provided in Appendix F.

5.4.2 Results

The columns 1 to 4 of Table 14 report the estimation results for equation (6). We observe an increase in American movies sales for younger consumers, relative to older ones, associated with Hadopi enforcement. The increase in the consumption of American movies is decreasing with age. Compared with consumers between 50 and 80 years of age, and compared with the sales of French movies, the increase in American movie sales after the anti-piracy law was passed is approximately 18% (statistically significant at the 1% level) for consumers between 10 and 29 years old and is twice the value of the increase for consumers between 30 and 49 years old, which is approximately 9%. This is consistent with illegal media consumption on the Internet decreasing with age (see Hadopi (2011)). The coefficients η_1 and η_2 are either negative or not significantly different from zero and indicate that sales of French movies to younger consumers decreased after the introduction of the Hadopi law. It confirms the substitution effect of the anti-piracy law to the benefit of American movies. Finally, this analysis reveals an effect beginning before the adoption of the law.

As a robustness check, we estimate equation (6) that controls for the increase in the number of consumers subscribed to the unlimited pass by age group. The results are presented in columns 5 to 8. The findings are similar: the coefficient β_1 is still positively significant and larger than β_2, which is also still positive. The main difference lies in the coefficients η_1 and η_2, which are more significantly negative than in columns 1 to 4. Taking into account the increase in the number of consumers subscribing to an unlimited card strengthens the redistributive effect that the increase in U.S. market share comes at the expense of French movies.

Table 14: Triple-differences on consumers with unlimited access card: a comparison between different age groups

	(1) stand. err. clustered by movie and by theater	(2) stand. err. clustered by movie	(3) stand. err. clustered by movie and by theater	(4) stand. err. clustered by movie	(5) stand. err. clustered by movie and by theater	(6) stand. err. clustered by movie	(7) stand. err. clustered by movie and by theater	(8) stand. err. clustered by movie
Hadopi × Age10-29	0.108+	0.108			-0.125*	-0.125		
	(0.0553)	(0.0799)			(0.0616)	(0.0854)		
Hadopi × Age30-49	-0.129***	-0.129**			-0.148***	-0.148**		
	(0.0330)	(0.0468)			(0.0335)	(0.0466)		
Hadopi × USA × Age10-29	0.189**	0.189*			0.192**	0.192*		
	(0.0674)	(0.0948)			(0.0668)	(0.0938)		
Hadopi × USA × Age30-49	0.0994*	0.0994			0.103*	0.103+		
	(0.0438)	(0.0619)			(0.0443)	(0.0616)		
Hadopi1 × Age10-29			-0.0569	-0.0569			-0.102	-0.102
			(0.0858)	(0.123)			(0.0861)	(0.123)
Hadopi1 × Age30-49			-0.0406	-0.0406			-0.0558	-0.0558
			(0.0495)	(0.0702)			(0.0505)	(0.0699)
Hadopi2 × Age10-29			0.0945	0.0945			-0.0694	-0.0694
			(0.0783)	(0.112)			(0.0797)	(0.113)
Hadopi2 × Age30-49			-0.0798+	-0.0798			-0.103*	-0.103
			(0.0464)	(0.0651)			(0.0471)	(0.0650)
Hadopi3 × Age10-29			0.0877	0.0877			-0.253**	-0.253*
			(0.0686)	(0.0994)			(0.0808)	(0.106)
Hadopi3 × Age30-49			-0.178***	-0.178**			-0.205***	-0.205***
			(0.0420)	(0.0595)			(0.0427)	(0.0590)
Hadopi1 × USA × Age10-29			0.292**	0.292*			0.289**	0.289*
			(0.104)	(0.143)			(0.104)	(0.143)
Hadopi1 × USA × Age30-49			0.188**	0.188*			0.182**	0.182+
			(0.0675)	(0.0942)			(0.0690)	(0.0939)
Hadopi2 × USA × Age10-29			0.202*	0.202			0.198*	0.198
			(0.0962)	(0.134)			(0.0945)	(0.133)
Hadopi2 × USA × Age30-49			0.133*	0.133			0.132*	0.132
			(0.0632)	(0.0896)			(0.0640)	(0.0892)
Hadopi3 × USA × Age10-29			0.323***	0.323**			0.337***	0.337**
			(0.0832)	(0.118)			(0.0826)	(0.116)
Hadopi3 × USA × Age30-49			0.178**	0.178*			0.182***	0.182*
			(0.0544)	(0.0767)			(0.0551)	(0.0762)
Number of unique members					y	y	y	y
N	21522	21522	21522	21522	21522	21522	21522	21522
R2	0.811	0.811	0.812	0.812	0.813	0.813	0.814	0.814

Standard errors in parentheses
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6 Welfare implications and conclusion

6.1 Welfare implications

The four empirical approaches all lead to the conclusion that the market share of American movie sales increased after the advent of the anti-piracy law. The estimated values of the coefficients are different, but they have similar implications after some adjustments are made to compute the total change in the number of admissions to U.S. films in France after the law. The implied effects are shown in Table 15. The number of admissions is different before and after the law, but we are only interested in the differences that are attributable to the law, and our estimation results show that there is no sizable demand creation caused by the law. Therefore, to compute the effects on the market share of American movie sales, we first assume that the total number of admissions was the same before the law.

Then, we note that the U.S. films' market share was equal to 48% after the Hadopi law was passed and that the total number of admissions over the post-Hadopi period was approximately 440 million.[26] Finally, we use the distribution of broadband Internet use presented in table 3 to compute the effect from the town-level approach and the consumer age distribution to compute the effect from the consumer-level approach.[27]

Table 15: Comparison of the results and variation in revenue and welfare

	Study 1: Town level approach	Study 2: American *vs* French movies in France	Study 3: International comparisons	Study 4: Consumer level approach
Estimated coefficient	Increase in the U.S. market share by 0.6 percentage point when the high speed Internet use rate increase by 1 percentage point	Increase in the number of admissions to U.S. films by 10%	Increase in the U.S. market share by 8%	Increase in the number of admissions to U.S. films for consumers aged 10-29 (resp. 30-49) by 20% (resp. 10%)
Rise in the market share of U.S. films	9%	10%	8%	10%
Rise in the number of admissions to U.S. films (in million)	17.1	19.2	15.4	20.0
Rise in the revenue to U.S. films $\equiv$ Decrease in the consumer welfare (in euros million)	107	121	97	126

With an increase in the U.S. market share of approximately 9%, the increase in U.S. film admissions after the law is between 15.4 and 20.0 million. It involves a decrease in admissions to French films of

[26] For instance, with a rise in the market share of US films equal to 12.3%, we obtain a rise in the number of admissions to US films equal to 22.9 million ($0.48 \times 440 - (0.48 \times 440/1.123) = 22.9$)

[27] The distribution of moviegoers' age in France is given by the CNC and is as follows: 42.8% are aged between 6 and 29, 25.8% are aged between 30 and 49, and 31.4% are aged 50 and over.

approximately the same amount. Given that the average ticket price was 6.3 euros in France during the post-Hadopi period, U.S. movies benefited from an increase in sales of between 97 and 126 million euros. On average, a distributor collects 38% of ticket revenue. As a consequence, the transfer in revenue from French movie distributors to U.S. distributors is between 37 and 48 million euros.

There is also a loss of consumers surplus associated with the law because according to our main mechanism behind the effects of the law, some consumers watch less non-U.S.movies legally in theaters. A back-of-the-envelop calculation consumer surplus loss is given by the quantity of non-U.S. (French) movies they stop watching legally times the price of a ticket in theaters. This amount also corresponds the transfer of sales between French and U.S. movies (97 and 126 million euros). Because the marginal cost to distribute movies is almost zero, the loss in consumer surplus is also a loss of welfare (See Appendix F for a more formal discussion).

This computation is very rough and only takes into account short run effects. For instance, we can only estimate the change in welfare for consumers involved in the business stealing effect, and we do not estimate the welfare variation for users who stopped downloading movies but who were not converted into legal consumers because of a lack of data.[28] Finally, our estimation of welfare loss says nothing about how consumers use their new free time. In particular, we do not consider subsequent substitution with DVDs or Blu-rays, as we have no detailed information on the video market.

6.2 Conclusion

In this paper, we have analyzed the effects of online piracy on movies' box office performance. We use the French anti-piracy law known as Hadopi as an exogenous shock to online piracy. Our four empirical analyses converge on the same conclusions. The Hadopi law clearly benefited American movies at the expense of French ones and created no additional demand for movies in theaters. These two effects are not driven by a supply reaction by distributors and producers.

Online piracy in a foreign country seems to distort the distribution of revenues between U.S. movies and domestic movies in favor of domestic movies. In that sense, implementing a regulation that deters illegal downloads re-establishes a 'fair' allocation of sales between U.S. and home movies according to their value to consumers. The French anti-piracy laws seem to be effective, at least partially and temporarily, in combatting file sharing. Indeed, our results are consistent with a decrease in the level of online piracy of cultural products. The long-term effect of these laws is more questionable, as the technologies associated with illegal sharing evolve quickly.

[28] Such an exercise would require at least some data on the downloads before and after the law.

The absence of demand creation also informs us of the partial inefficiency of the law concerning the users that download movies on the Internet but that never buy them. As they are not converted into legal consumers, this finding might indicate that the law does not reduce their level of online piracy because they know how to circumvent the graduated response. It could also mean that the law reduces the online piracy level of these users while they do not begin purchasing movies because their valuation of pirated products is too low: they would have not legally consumed movies without online piracy.

Finally, the effect of an anti-piracy law is likely to have larger effects on the video market than on the theatrical market, for at least two reasons. Firstly, the supply of illegal copies of movies during the video release is dramatically higher from this supply during the theatrical release. A video release triggers the supply of many illegal copies, including domestic and American movies. Secondly, legal videos are much more substitutable with their pirated versions. It would be interesting to carry out an evaluation of the Hadopi law's effect on the video market.

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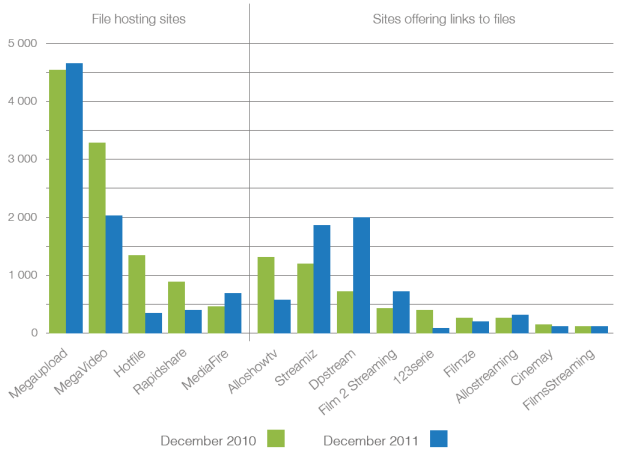
A A business stealing effect is plausible: additional proofs

The results of this paper indicate no demand creation associated with the Hadopi law, so that the increase in American market share mainly stems from cannibalization at the expense of other movies. The mechanism involves a decrease in illegal sharing of movies, a binding budget and time constraint, some consumers enjoying both U.S. and French movies, and a general preference for U.S. movies.

Many sources agree on a fall of peer-to-peer use throughout 2010 and 2011, when the graduated response was implemented in France. Mediametrie/NetRatings, a service providing measurement of online audience, reported no substantial transfer on streaming and direct download services (see graph 4).

Figure 4: The stability in usage patterns of streaming and direct download services in France.

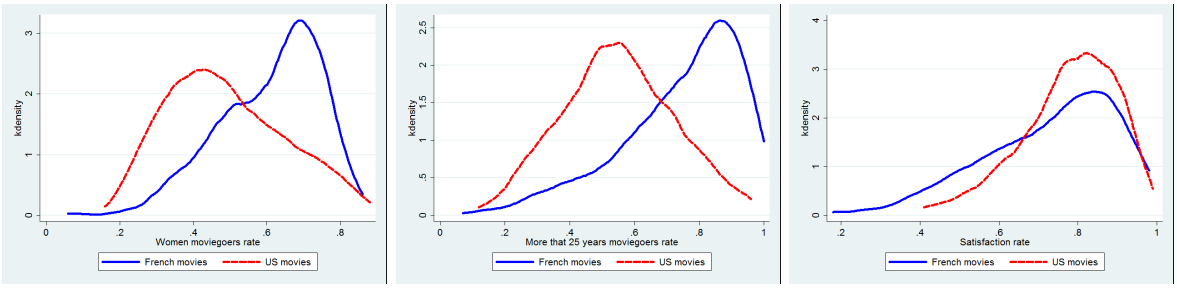


A survey conducted by *Observatoire de la satisfaction*, a company specialized in the French broadcasting market, shows that the American movies' audience distribution and the French movies' audience distribution overlap significantly in terms of gender, age, and satisfaction rate (see graphs 5(a), 5(b), and 5(c)). They use a sample of 598 movies widely released in France between January of 2006 and November of 2009. As a consequence, a fraction of movie audience is likely to enjoy both French and U.S. movies.

Data from the French national accounts on households consumption confirm that the share of consumption of movies in theaters in the shopping basket of the average French household has been steady since 1990, fluctuating between 0.11% and 0.14% of total budget (see graph 6). As a consequence, the budget and the time constraints might constitute important limitations to the expansion of the market of theatrical exhibition.

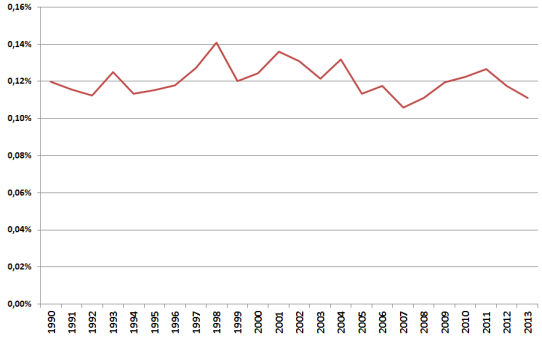
Consumers might prefer watching U.S. movies rather than French ones in theaters. Indeed, the average production budget is tremendously higher for U.S. movies ($63 millions) than for French ones ($9 millions).

Figure 5: The audiences of U.S. and French movies overlap



(a) Women prefer French movies (b) Elders prefer French movies (c) French movies are more disappointing

Figure 6: The share of consumption of movies in theaters over total consumption of household is stable.



This difference reflects for instance a more famous casting or better special effects associated. The audience may also anticipate that U.S. films are superior because marketing expenditures are also higher ($2 millions for U.S. movies against $1.1 millions for French ones). The observed ex post satisfaction of consumers is higher for U.S. movies. Indeed, the average user rating on www.allocine.fr, the major French content aggregator on movies (www.allocine.fr), is 3.1 for U.S. films when it is 2.8 for French films. Finally, during their release week, U.S. movies are played on 360 screens on average in France when French movies are played on 320 screens. Note that these figures correspond to the sample we use in section 5, that is biased toward big French movies. For instante, French movies are released on 180 screens on average in France, when considering all movies.

B Details on the Internet data set for study 1

In France, there are 33 millions local loops, also called connections, that can provide Internet to households, distributed over 15 000 Internet exchange points. Even if all exchange points can provide DSL technology, not all connections qualify for broadband Internet. The download speed of an Internet connection depends on three factors. Firstly, the length of an Internet line reduces its download speed, and homes located far away from an exchange point have lower download speed. Secondly, the diameter of the Internet cable also matters, where larger cables allow for faster connections. Last, and to a lesser extent, the technology embedded into an exchange point can affect the download speed.

A given town can be equipped with one Internet exchange point or with several exchange points if the town is big. Conversely, an Internet exchange point can equip different small towns. An Internet exchange point provides Internet access to users through Internet connections with different speed levels. The coverage rate of high speed Internet infrastructure is defined as the fraction of connections with download speeds higher than 512 kbit/s over the total number of connections delivered by an exchange point. For instance, an Internet exchange point can reach 30,000 households, with 27,000 connections with download speeds exceeding 512 kbit/s, and the remaining connections providing download speed inferior to 512 kbits/s. The coverage rate of this exchange point is 90%. For a given town, the average coverage rate is computed using the rates of all exchange points providing the connections to its inhabitants, weighted by the number of connections supplied by each exchange point. As an example, take a town provided by two exchange points. If the first exchange point can connect 30 000 households and has a high speed Internet coverage rate of 90% while the second one can connect 10 000 households and has a coverage rate of 80%, then the coverage rate of the town is 87.5%.

High speed Internet use rate is the fraction of households subscribed to connections exceeding 512 kbit/s over the total number of connections for an exchange point. The number of households signed up with broadband internet is collected for each exchange point on a quarterly basis by Arcep from Internet service providers. It is linearly interpolated to be used on a monthly basis. Continuing with the example above, with 20 000 households subscribed to broadband internet, the high speed internet use rate is 66.7%. The Internet use rate is aggretated for each town the same way as the Internet coverage rate.

C Robustness checks for study 2

Table 16: DiD French vs. American in France (first week): demand reaction, an additional robustness test

	(1) ln_entree1	(2) ln_entree1	(3) ln_entree_seance1	(4) ln_entree_seance1
Hadopi $\times U.S.$	0.157***		0.153**	
	(0.0475)		(0.0494)	
Hadopi1 $\times U.S.$		0.232**		0.317***
		(0.0788)		(0.0865)
Hadopi2 $\times U.S.$		0.303***		0.335***
		(0.0644)		(0.0657)
Hadopi3 $\times U.S.$		0.0993+		0.102+
		(0.0572)		(0.0588)
log(Screens)	y	y	n	n
log(Ad)	y	y	y	y
log(Budget)	y	y	y	y
Consumer rating	y	y	y	y
Press rating	y	y	y	y
Genre fe	y	y	y	y
Nationality fe	y	y	y	y
Art and House fe	y	y	y	y
Age restriction fe	y	y	y	y
Month fe	y	y	y	y
Distributor fe	y	y	y	y
N	615	615	615	615
R^2	0.915	0.919	0.703	0.713

Robust standard errors
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 17: DiD French vs. American in France (first week) : baseline results with quantile treatment effect

	(1) log(Admissions)	(2) log(Admissions)	(3) log(Admissions/Screens)	(4) log(Admissions/Screens)
q10				
Hadopi $\times U.S.$	-0.0308		0.00919	
	(0.120)		(0.117)	
Hadopi1 $\times U.S.$		0.185		0.0649
		(0.207)		(0.192)
Hadopi2 $\times U.S.$		0.101		0.0787
		(0.171)		(0.178)
Hadopi2 $\times U.S.$		0.0367		-0.00280
		(0.136)		(0.145)
q25				
Hadopi $\times U.S.$	0.0987		-0.0489	
	(0.106)		(0.102)	
Hadopi1 $\times U.S.$		0.205		0.198
		(0.177)		(0.171)
Hadopi2 $\times U.S.$		0.284+		0.175
		(0.155)		(0.154)
Hadopi3 $\times U.S.$		0.0616		-0.0526
		(0.119)		(0.124)
q50				
Hadopi $\times U.S.$	0.113		0.120	
	(0.105)		(0.0968)	
Hadopi1 $\times U.S.$		0.284		0.308+
		(0.180)		(0.183)
Hadopi2 $\times U.S.$		0.265*		0.331*
		(0.135)		(0.142)
Hadopi3 $\times U.S.$		0.0682		0.0402
		(0.115)		(0.118)
q75				
Hadopi $\times U.S.$	0.221*		0.244*	
	(0.104)		(0.103)	
Hadopi1 $\times U.S.$		0.196		0.267
		(0.206)		(0.216)
Hadopi2 $\times U.S.$		0.348**		0.341*
		(0.125)		(0.145)
Hadopi3 $\times U.S.$		0.138		0.138
		(0.119)		(0.128)
q90				
Hadopi $\times U.S.$	0.203+		0.228*	
	(0.111)		(0.115)	
Hadopi1 $\times U.S.$		0.253		0.496*
		(0.222)		(0.248)
Hadopi2 $\times U.S.$		0.279*		0.350*
		(0.138)		(0.169)
Hadopi3 $\times U.S.$		0.212		0.177
		(0.133)		(0.138)
N	767	767	817	767
R^2				

Bootstrapped standard errors in parentheses
+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
All regressions control for number of screens, marketing expediture, production budget, consumer and press rating, and include genre fe, nationality fe, art and house fe, age restriction fe, month fe, and distributor fe.

D Control group selection for study 3

During the period 2008-2011, no measure similar to the French Hadopi law has been implemented in Europe, besides Sweden in 2009. However, three waves of legislation in countries close to France may have stirred up the Internet users community, but we believe they did not have any significant impact on individuals because they have not been implemented. In Spain, in 2010, discussions were surrounding the Sinde Law, a provision designed to shut down websites in violation with copyright law. It was made law at the end of 2011. In Italy, in 2011, the regulation and competition authority for the communication industries, the AGCOM, expressed its intention to fight websites in violation with copyright law. The Spanish and the Italian measures are of quite a different nature compared to the Hadopi law. Finally in the United Kingdom, in 2010, the Digital Economy Act addressed online copyright infringement in a similar way to the graduated response of the Hadopi law. With this act, Internet subscribers who had downloaded illegal content using peer-to-peer file-sharing systems were supposed to receive notifications. This Act is in force although the procedure against infringers has not been implemented.

We then run the following estimation using observations in the pre-treatment period (i.e form January 2007 to March 2009) to select the relevant candidate to be included in the control group:

$$Outcome_{Fr,t} = \alpha + \beta_s Outcome_{ct} + \epsilon_{ct} \tag{7}$$

c is a country and t is a month, with $Outcome_{ct}$ being repetitively $Log(Admissions_{ct}/Screens_{ct})$ for US movies, $Log(Screens_{ct})$ for US movies, Lag_{ct} for US movies, $Log(Admissions_{ct})$ for all movies, and $Log(USmarketshare_{ct})$.

Table 18: $Log(Admissions_{ct}/Screens_{ct})$ (January 2007 - March 2009)

	(1) Belgium	(2) Finland	(3) Germany	(4) Italy	(5) Netherlands	(6) Spain	(7) Switzerland	(8) UK
Log(Admissions/Screens)	0.459***	0.381***	0.368***	0.223	0.395***	0.432*	0.409***	0.301***
	(0.128)	(0.116)	(0.0962)	(0.144)	(0.0795)	(0.245)	(0.141)	(0.0714)
Constant	3.672***	4.384***	4.397***	5.304***	4.246***	3.908**	4.170***	4.735***
	(0.855)	(0.724)	(0.619)	(0.939)	(0.522)	(1.605)	(0.897)	(0.497)
Observations	27	27	27	27	27	27	27	27
R-squared	0.329	0.464	0.396	0.109	0.372	0.301	0.365	0.437

Standard errors with Newey-West corrections allowing for observations within a country to be correlated up to 6 months. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Our preferred control group when the outcome of interest is the number of admissions over the number of screens of US movies is constituted by Belgium, Finland, Germany, the Netherlands, Spain, Switzerland,

and United Kingdom.

Table 19: $Log(Screens_{ct})$ (January 2007 - March 2009)

	(1) Belgium	(2) Finland	(3) Germany	(4) Italy	(5) Netherlands	(6) Spain	(7) Switzerland	(8) UK
Log(Screens)	0.304**	0.123	0.139	-0.168*	0.379*	-0.0672	0.0485	0.0674
	(0.109)	(0.120)	(0.144)	(0.0943)	(0.191)	(0.130)	(0.134)	(0.193)
Constant	6.262***	7.464***	6.946***	9.396***	5.696***	8.611***	7.802***	7.512***
	(0.661)	(0.610)	(1.168)	(0.756)	(1.202)	(1.043)	(0.742)	(1.608)
Observations	27	27	27	27	27	27	27	27
R-squared	0.132	0.020	0.024	0.041	0.090	0.003	0.004	0.003

Standard errors with Newey-West corrections allowing for observations within a country to be correlated up to 6 months. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Our preferred control group when the outcome of interest is the number of screens of US movies is constituted by Belgium, and the Netherlands.

Table 20: Lag_{ct} (January 2007 - March 2009)

	(1) Belgium	(2) Finland	(3) Germany	(4) Italy	(5) Netherlands	(6) Spain	(7) Switzerland	(8) UK
Lag	0.473***	0.456	-0.119	0.322***	-0.0420	-0.404***	-0.0671	0.405**
	(0.118)	(0.271)	(0.166)	(0.104)	(0.0395)	(0.0609)	(0.109)	(0.147)
Constant	2.565**	3.722**	8.031***	3.282**	7.322***	11.42***	7.443***	4.886***
	(1.241)	(1.694)	(1.960)	(1.468)	(0.804)	(0.820)	(0.761)	(1.058)
Observations	27	27	27	27	27	27	27	27
R-squared	0.172	0.080	0.011	0.141	0.004	0.207	0.004	0.113

Standard errors with Newey-West corrections allowing for observations within a country to be correlated up to 6 months. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Our preferred control group when the outcome of interest is the time lag of US movies is constituted by Belgium, Italy, and United Kingdom.

Our preferred control group when the outcome of interest is the number of admissions of all movies is constituted by Belgium, Germany, the Netherlands, Spain, Switzerland, and United Kingdom.

Our preferred control group when the outcome of interest is the number of admissions over the number of screens of all movies is constituted by Belgium, Germany, Italy, Spain, Switzerland, and United Kingdom.

Table 21: $Log(Admissions_{ct})$ (January 2007 - March 2009)

	(1) Belgium	(2) Finland	(3) Germany	(4) Italy	(5) Netherlands	(6) Spain	(7) Switzerland	(8) UK
Log(Admissions)	0.751***	0.0478	0.519***	0.0541	0.405***	0.351*	0.398***	0.321*
	(0.105)	(0.0759)	(0.0809)	(0.0449)	(0.132)	(0.174)	(0.116)	(0.176)
Constant	6.056***	15.87***	8.284***	15.64***	10.81***	10.99***	11.10***	11.34***
	(1.453)	(0.960)	(1.306)	(0.666)	(1.885)	(2.738)	(1.577)	(2.835)
Observations	27	27	27	27	27	27	27	27
R-squared	0.660	0.003	0.346	0.016	0.158	0.073	0.250	0.095

Standard errors with Newey-West corrections allowing for observations within a country to be correlated up to 6 months. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 22: $Log(Admissions_{ct}/Screens_{ct})$ (January 2007 - March 2009)

	(1) Belgium	(2) Finland	(3) Germany	(4) Italy	(5) Netherlands	(6) Spain	(7) Switzerland	(8) UK
Log(Admissions/Screens)	1.918***	0.347	1.581***	0.955***	0.389	0.819*	3.370***	2.134**
	(0.410)	(0.320)	(0.290)	(0.330)	(0.288)	(0.468)	(0.401)	(1.002)
Constant	-0.124*	-0.471***	-0.150***	-0.234**	-0.485***	-0.449***	0.0485	-0.406***
	(0.0680)	(0.153)	(0.0535)	(0.101)	(0.134)	(0.122)	(0.0583)	(0.136)
Observations	27	27	27	27	27	27	27	27
R-squared	0.684	0.072	0.535	0.298	0.041	0.062	0.614	0.109

Standard errors with Newey-West corrections allowing for observations within a country to be correlated up to 6 months. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Figure 7: Countries included in the control group for the Log(Admissions/Screens) of US movies.

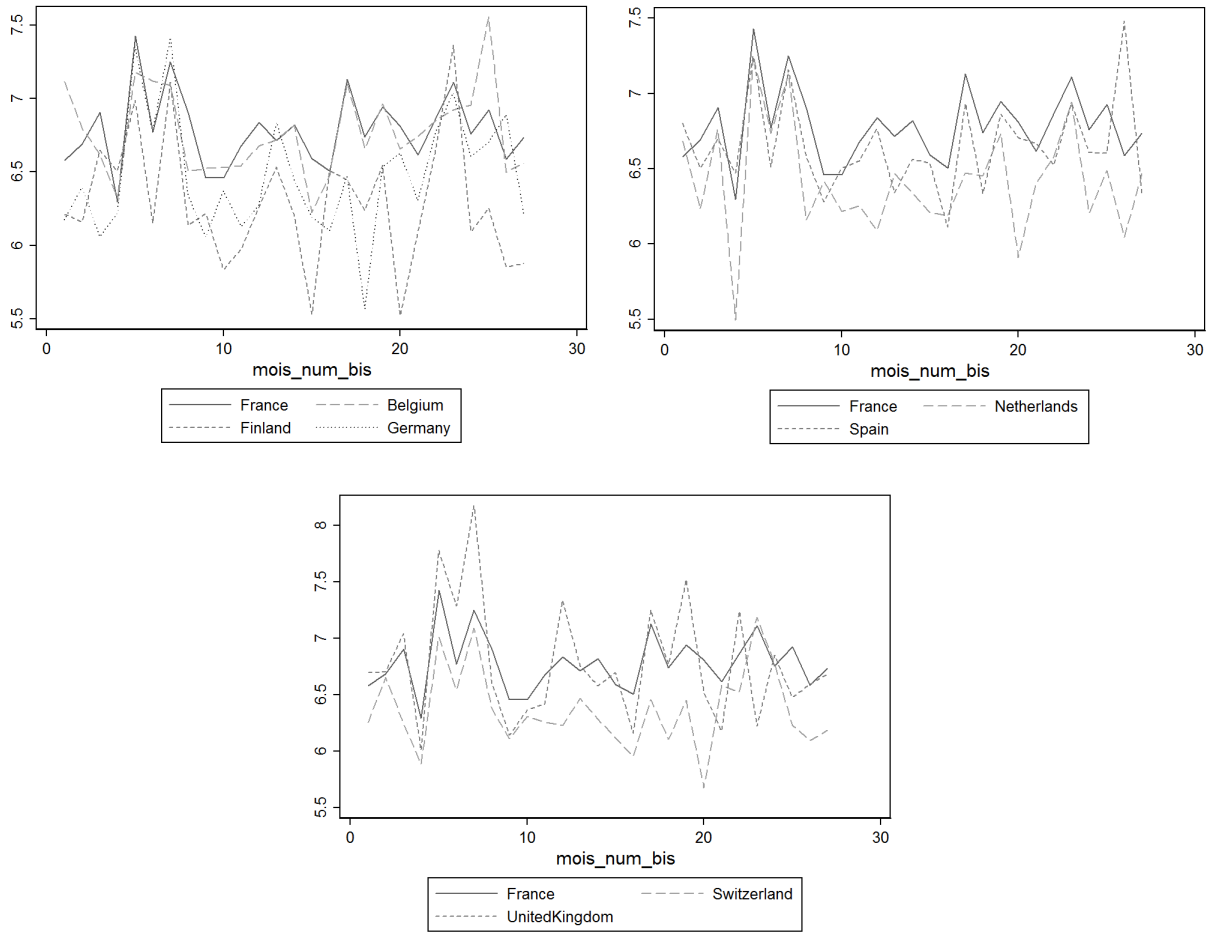


Figure 8: Countries not included in the control group for the Log(Admissions/Screens) of US movies.

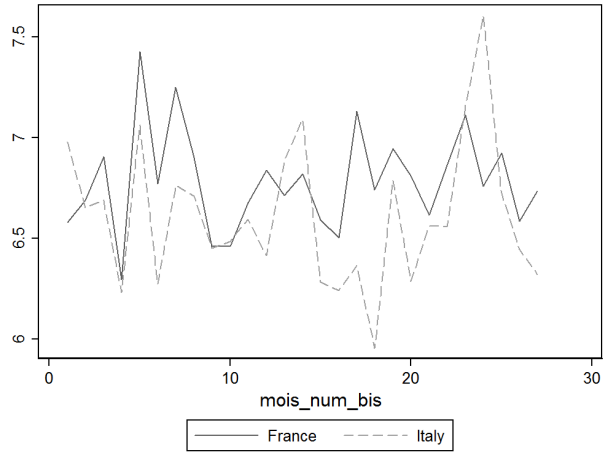


Figure 9: Countries included in the control group for the Log(Screens) of US movies.

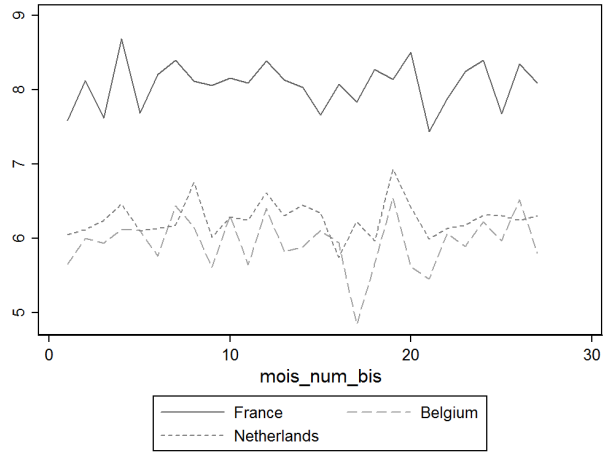


Figure 10: Countries not included in the control group for the Log(Screens) of US movies.

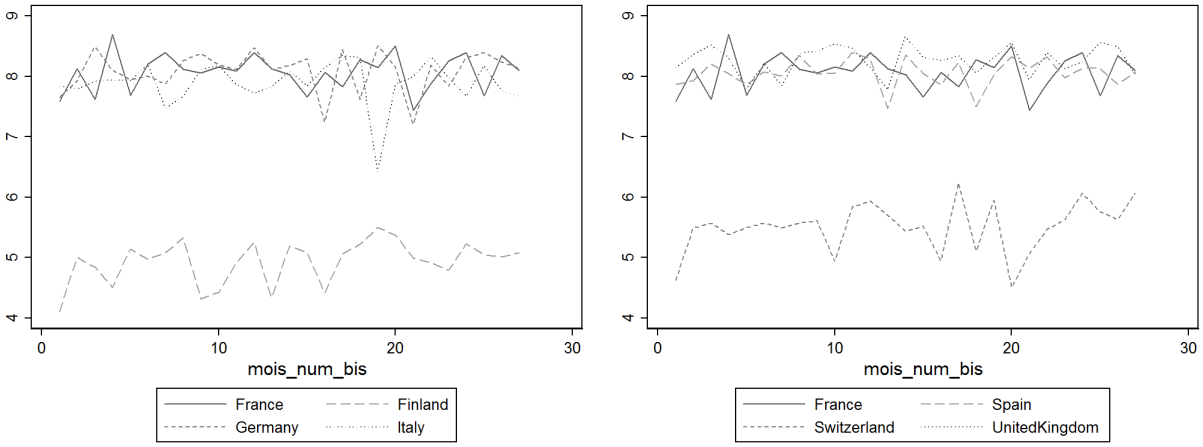


Figure 11: Countries included in the control group for the time Lag of US movies.

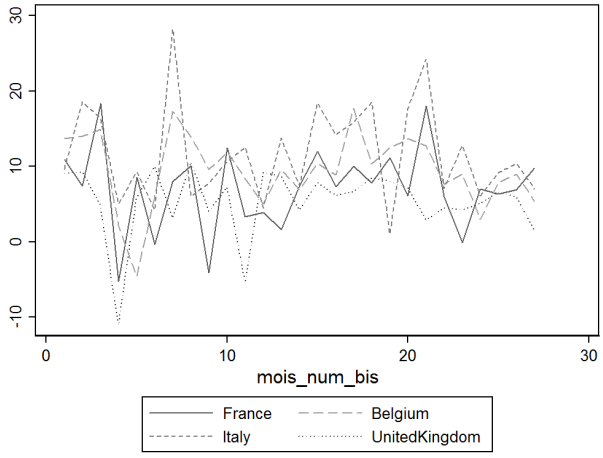


Figure 12: Countries not included in the control group for the time Lag of US movies.

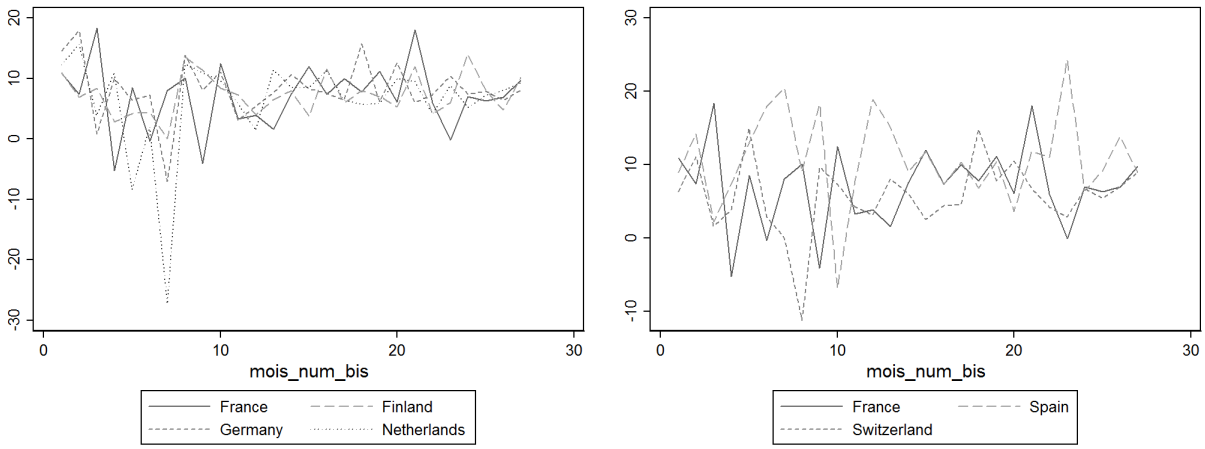


Figure 13: Countries included in the control group for the aggregate number of admissions of all movies.

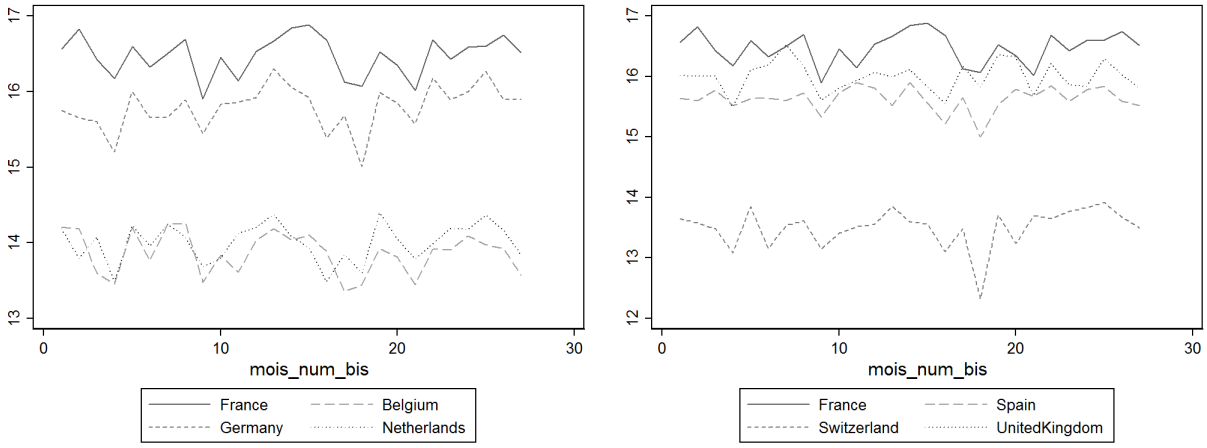


Figure 14: Countries not included in the control group for the aggregate number of admissions of all movies.

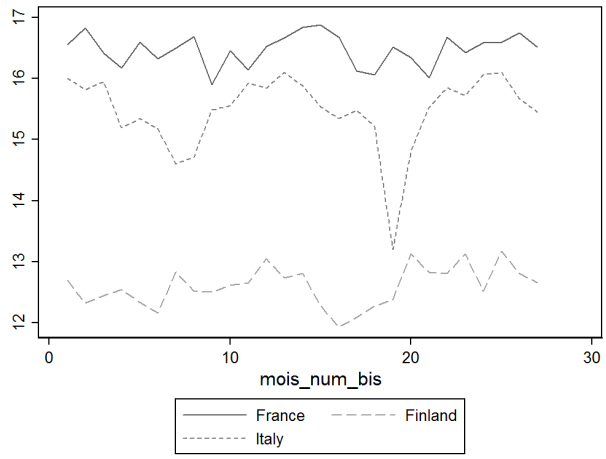


Figure 15: Countries included in the control group for the US market share.

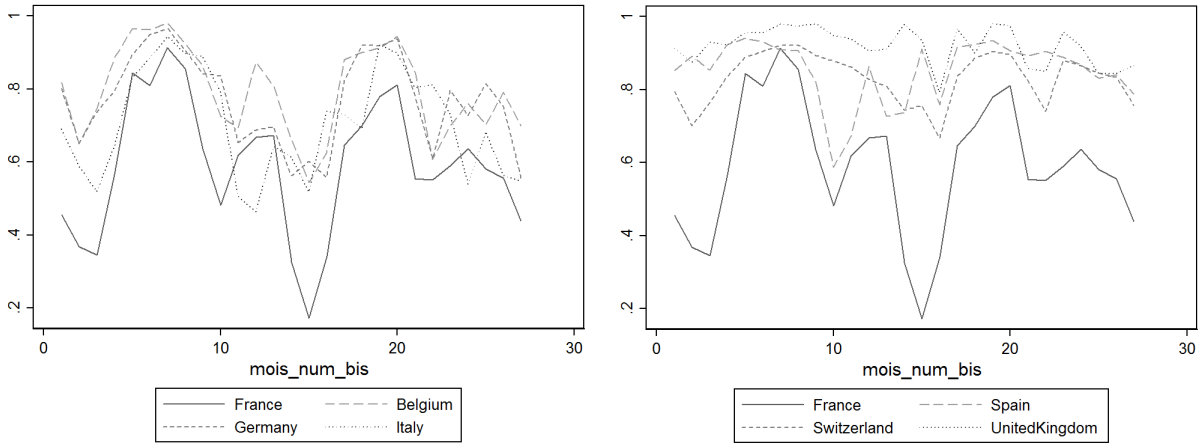
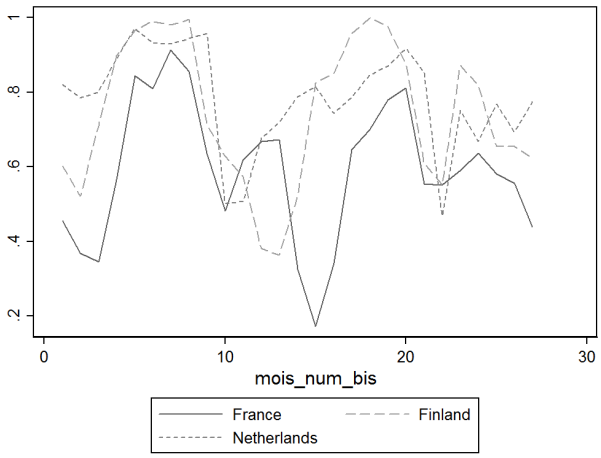


Figure 16: Countries not included in the control group for the US market share.



E Interpretation of β_a coefficients for study 4

A simplified version of equation (6) we estimate in Section 5 is the following one :

$$\begin{aligned} Y_{ijta} =& \gamma_i + \lambda_t + \delta_a + \alpha After_t * USA_i + \rho_1 After * Young1_{ta} + \rho_2 After * Young2_{ta} + \eta_1 USA * Young1_{ta} \\ &+ \eta_2 USA * Young2_{ta} + \beta_1 After * USA * Young1_{ita} + \beta_2 After * USA * Young2_{ita} + \epsilon_{ijta} \end{aligned}$$

Then, we define six differences:

$$\begin{aligned} (1)\ & E\left[Y_{ijta} | i = USA, a = Young1, t = After\right] - E\left[Y_{ijta} | i = USA, a = Young1, t = Before\right] \\ &= \gamma_{USA} + \lambda_{After} + \delta_{Young1} + \alpha + \rho_1 + \eta_1 + \beta_1 - \gamma_{USA} - \lambda_{Before} - \delta_{Young1} - \eta_1 \\ &= \lambda_{After} - \lambda_{Before} + \alpha + \rho_1 + \beta_1 \end{aligned}$$

$$\begin{aligned} (2)\ & E\left[Y_{ijta} | i = Fr, a = Young1, t = After\right] - E\left[Y_{ijta} | i = Fr, a = Young1, t = Before\right] \\ &= \gamma_{Fr} + \lambda_{After} + \delta_{Young1} + \rho_1 - \gamma_{Fr} - \lambda_{Before} - \delta_{Young1} \\ &= \lambda_{After} - \lambda_{Before} + \rho_1 \end{aligned}$$

$$\begin{aligned} (3)\ & E\left[Y_{ijta} | i = USA, a = Young2, t = After\right] - E\left[Y_{ijta} | i = USA, a = Young2, t = Before\right] \\ &= \gamma_{USA} + \lambda_{After} + \delta_{Young2} + \alpha + \rho_2 + \eta_2 + \beta_2 - \gamma_{USA} - \lambda_{Before} - \delta_{Young2} - \eta_2 \\ &= \lambda_{After} - \lambda_{Before} + \alpha + \rho_2 + \beta_2 \end{aligned}$$

$$\begin{aligned} (4)\ & E\left[Y_{ijta} | i = Fr, a = Young2, t = After\right] - E\left[Y_{ijta} | i = Fr, a = Young2, t = Before\right] \\ &= \gamma_{Fr} + \lambda_{After} + \delta_{Young2} + \rho_2 - \gamma_{Fr} - \lambda_{Before} - \delta_{Young2} \\ &= \lambda_{After} - \lambda_{Before} + \rho_2 \end{aligned}$$

$$
\begin{aligned}
(5)\ & E\left[Y_{ijta}|i=USA, a=Old, t=After\right] - E\left[Y_{ijta}|i=USA, a=Old, t=Before\right] \\
& = \gamma_{USA} + \lambda_{After} + \delta_{Old} + \alpha - \gamma_{USA} - \lambda_{Before} - \delta_{Old} \\
& = \lambda_{After} - \lambda_{Before} + \alpha
\end{aligned}
$$

$$
\begin{aligned}
(6)\ & E\left[Y_{ijta}|i=Fr, a=Old, t=After\right] - E\left[Y_{ijta}|i=Fr, a=Old, t=Before\right] \\
& = \gamma_{Fr} + \lambda_{After} + \delta_{Old} - \gamma_{Fr} - \lambda_{Before} - \delta_{Old} \\
& = \lambda_{After} - \lambda_{Before}
\end{aligned}
$$

With those six differences, we can give the interpretation of β_1, β_2, and $\beta_1 - \beta_2$ using difference-in-difference-in-differences:

$$\beta_1 = [(1) - (2)] - [(5) - (6)] \tag{8}$$

$$\beta_2 = [(3) - (4)] - [(5) - (6)] \tag{9}$$

$$\beta_1 - \beta_2 = [(1) - (2)] - [(3) - (4)] \tag{10}$$

As a result, β_1 (resp. β_2)can be interpreted as the difference in Y between consumers aged 10-29 (resp. 30-49) and consumers aged 50-80, between US movies and French movies, after and before the law is implemented. $\beta_1 - \beta_2$ can be interpreted as the same triple differences, but between people aged 10-29 and people aged 30-49.

F Theoretical framework

This section presents a stylized model of the consumer choice which provides several predictions that can be tested empirically. We over-simplify the user's choice to emphasize the mechanism involved in the effect of an anti-piracy law as there are already many general approaches in the theoretical literature about file sharing that are cited in the literature review. We note w_i (resp. u_j) the net utility of watching movie illegally online (resp. movie j legally in theaters)

We consider a market wherein individuals can choose to watch up to two movies, i and j. We assume that only a movie i can be illegally watched online, and that consumers face a budget/time constraint which prevent of fraction of consumers from watching both movies in theaters. Let us first consider the movie i. An option for a consumer is to buy a ticket to legally watch a movie i in a theater. Then she will get a utility u_i comprising the value of the movie, the price of the movie, and the time involved to watch it in a movie theater. Another option is to illegally download the movie on the Internet and watch it at home. In that case, the consumer gets a utility w_i that comprises the value of the movie and the transaction cost from illegally downloading the movie. The transaction cost from illegally downloading a movie comprises: the time to find and download an acceptable copy, the risk to catch a virus, the chance to be detected as an infringer and to be sentenced, the worse experience of watching a movie at home than in a movie theater (a movie theater allows the user from spending time with friends and benefiting from improved viewing equipments), and the extra value of the illegal consumption (like the absence of travel costs and waiting time, the possibility to stop watching a movie at any time and come back to it later on, and higher ease to stop watching a movie that one does not enjoy). A consumer always has the outside option not to watch a movie i with the utility u_0 that we normalize to zero. The consumer will simply choose the option that maximizes its utility. We note L_i the legal consumption of movie i, D_i the illegal consumption of movie i after downloading, and $\varnothing$ the behavior of consuming no movie. For example, the action L_i corresponds to the case where a consumer legally buys movie i. It happens if $u_i \geq w_i$ and if $u_i \geq 0$. The utility of downloading decreases once the anti-piracy law is introduced. The consumer can now obtain w_i' with $w_i' \leq w_i$.[29] The same reasoning applies for a movie j: we note L_j the legal consumption of movie j, and $\varnothing$ the behavior of consuming no movie (the movie j cannot be illegally downloaded).

There are six different behaviors before the law that can lead to eleven different possibilities when an anti-piracy law is enforced. The law has no effect on consumers who already legally consume both movies i and j, on individuals who either only legally watch a movie i or a movie j, and on persons who do not watch any movie. It can only affect users that illegally download. Some consumers illegally watch a movie i and legally purchase a movie j without the law. With the law, they can switch to the legal consumption of both movies if they are not constrained by time or by money. The main contribution of this model is that they may also stop from watching a movie j and switch to the legal consumption of a movie i if they are constrained and if they prefer i to j. Either, they may stop from watching a movie i and keep purchasing a movie j if they are constrained and if they prefer a movie j to a movie i, or if $u_i < 0$. We summarize this mechanism in table 23.

[29] Economic studies on criminal behavior indicate that individual's reaction to increased enforcement depends on the risk profile of the individual. Risk-seeking individuals may increase their illegal behavior when law enforcement increases (Ehrlich (1973), Heineke (1978)). Fortunately, most individuals are rather risk-adverse.

Table 23: Consumer behavior before and after the anti-piracy law

Before the law	After the law	Effect on the legal market
L_i,L_j	L_i,L_j	No effect
L_i, $\varnothing$	L_i, $\varnothing$	No effect
$\varnothing$, L_j	$\varnothing$, L_j	No effet
D_i,L_j	L_i,L_j	Market expansion effect (no revenue and no time constraints)
	L_i,$\varnothing$	Business stealing effect (revenue and time contraints)
	$\varnothing$, L_j	No effect
	D_i,L_j	No effect
D_i,$\varnothing$	L_i,$\varnothing$	Market expansion effect
	D_i,$\varnothing$	No effect
	$\varnothing$, $\varnothing$	No effect
$\varnothing$, $\varnothing$	$\varnothing$, $\varnothing$	No effect

L_i (resp. L_j) corresponds to the legal consumption of movie i (resp. j), D_i to the illegal consumption of movie i after downloading, and $\varnothing$ to the behavior of consuming no movie.

The law has no effect on individuals who already legally watch movies i and j, on consumers who only legally watch one of the two movies (either the movie i or the movie j), and on consumers who do not watch any movie, legally or illegally. Users download the movie i and purchase the movie j without the law if $w_i > u_i$ and $u_j > 0$.[30] With the law, they are converted into legal consumers of both movies if $u_i > w_i'$, if $u_j > 0$, and if they are not budget/time constrained. If they are budget constrained, then they switch to the legal consumption of the movie i and they stop watching the movie j if $u_i > w_i' + u_j$ (when $w_i' > 0$) or if $u_i > u_j$ (when $w_i' < 0$). Remark that whatever the sign of w_i', $u_i > u_j$ is a necessary condition for this situation to occur. They switch to the legal consumption of the movie j and stop watching the movie i if $u_j > 0$, $u_i < 0$, and $w_i' < 0$ when they are unconstrained, or if $u_j > 0$, $u_j > u_i$, and $w_i' < 0$ when they are constrained. They keep downloading the movie i and buying the movie j if they are unaffected by the law (that is if $w_i' > u_i$ and $u_j > 0$ or if $w_i' + u_j > u_i$). Lastly, for users that download the movie i without purchasing the movie j before the law, we have $w_i > u_i$, $w_i > 0$, and $u_j < 0$. When the law is introduced, they are converted into legal consumers of the movie i if $u_i > w_i'$ and $u_i > 0$, they keep downloading the movie i if $w_i' > u_i$ and $w_i' > 0$, and they stop from watching the movie i if $w_i' < 0$ and $u_i < 0$.

Individuals are heterogeneous in the three parameters that define them, u_i, u_j , and w_i. So the different cases of table 23 correspond to consumer groups with different preferences. Hence, it is an empirical question to determine which effect prevails to test the models. The size of the market expansion effect depends on the proportion of individuals who become legal consumers, i.e., the share of individuals who are persuaded enough by the law to stop downloading movies and who enjoy movies enough to buy them in theater. Similarly, the size of the business stealing effect depends on the proportion of individuals who are convinced by the law to stop downloading movies, who enjoy movies enough to legally buy, that

[30] Remark that this situation can happen even if $u_i > u_j$ and $u_i > w_i$, that is even if the consumer stricly prefer legally watching the movie i over watching the movie j and she strictly prefer legally watching the movie i over downloading the movie i.

are budget and time constrained, and that prefer the movie i to the movie j. In Section 3, we motivate why a movie i represents an U.S. movie and a movie j a French movie.

Using this model, it is possible to compute an approximation of the loss in consumer welfare in the market for movies in theaters. Without the anti-piracy law, the consumer's utility is given by $w_i + u_j$. With the law, it becomes u_i. The variation in utility induced by the law is simply given by $w_i + u_j - u_i$, with $w_i + u_j > u_i$ by construction. The utility of legal consumption primarily comprises the value of the movie minus the price. The utility of illegal consumption is mainly composed of the value of the movie minus the transaction cost of downloading it illegally. The difference in utility $u_j - u_i$ cancels out the price term because movies exhibit uniform prices (see Einav and Orbach (2007) for a discussion). The difference $w_i - u_i$ cancels out the value of the movie i. Then, assuming that the transaction cost is close to zero before the law, $w_i + u_j - u_i$ can be interpreted as the value of a movie j.[31] A lower bound of the value of a movie j is given by its price because its value is necessarily superior to its price. Finally, an estimation of the change in welfare is simply given by the variation in admissions to French films times the average ticket price. This loss in consumer welfare is estimated at between 97 and 126 million euros over the period between September 2010 and December 2011, that is, between 73 and 94 million euros per year in the short-term.

This approximation of the change in welfare is quite restrictive for several reasons. We can only estimate the change in welfare for consumers involved in the business stealing effect. We cannot estimate the welfare variation for users who stopper downloading movies but who were not converted into legal consumers because of a lack of data. Moreover, our estimation of welfare loss says nothing about how consumers fill their new free time. In particular, we do not consider subsequent substitution with DVDs or Blu-rays, as we have no information on the video market. Finally, this welfare loss is a short-term estimation. If, as aimed by the law, fighting against piracy fosters in the long term the production of high quality movies, a dynamic analysis of the welfare could have a different result. For instance, Giorcelli and Moser (2015) show that the adoption of copyright laws within Italy has increased the number and quality of new operas.

[31]The assumption that the transaction is close to zero seems plausible for the following reasons: the risk to be detected as an infringer before the law was close to zero, and, for a fraction of consumers, the extra value of watching illegally a movie at home might compensate the extra value of watching a movie in a well-equipped film theater.

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