Piracy in Times of Covid

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Arianna Martinelli[*]   Julia Mazzei[*]   Alessandro Nuvolari[*]   Joost Poort[§]

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Abstract

The COVID-19 pandemic has deeply affected the patterns of consumption of cultural goods. Leveraging on novel data collected through a consumer survey in 14 countries (France, Germany, The Netherlands, Poland, Spain, Italy, Ireland, Sweden, United Kingdom, United States, Russia, Australia, Indonesia and Brazil) administered in January 2022 we aim to tackle two issues. First, we provide a descriptive picture of the changes in consumption of four cultural goods (movies, videos, games, and books), highlighting how the balance between legal and illegal consumption has changed during the COVID-19 pandemic. Second, we use the pandemic as a shock to both available income and individual demand to identify how these factors affect legal sales displacement.

[*] Institute of Economics and EMbeDS, Scuola Superiore Sant'Anna, Pisa (Italy).
[§] University of Amsterdam – Institute for Information Law (IViR)

1   Introduction and research questions

On April 20th, 2022 Netflix stocks plunged almost 38% following the announcement of a loss of 200,000 subscriptions to its platform. [1] Company executives blame the market saturation due to increasing competition of different platforms, the Russia-Ukrainian war and other macroeconomics conjunctures. The end of the acute COVID-19 pandemic might also play a role. As bluntly reported, the "pandemic streaming party is over"[2] indicating a stop in the surge in demand for online entertainment experienced during the COVID-19 crisis.

Consumers who wish to access digital cultural goods such as music, audio-visual content and e-books can often choose between both legal and illegal supply channels. There are indications that during the

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[1] See: https://fortune.com/2022/04/21/netflix-ceo-town-hall-grim-outlook-subscriber-exodus/ accessed on the 29th April 2022
[2] See: https://www.sciencetimes.com/articles/27840/20201023/pandemic-affected-netflix.htm accessed on the 29th April 2022

pandemic, both authorised and unauthorised consumption – commonly referred to as 'online piracy' – have sharply increased. MUSO data[3] suggests that film piracy increased by 41% in the USA, 43% in the UK, 50% in Spain, 62% in India and an astonishing 66% in Italy during the last week of March 2021, compared with the last week of February 2020 – just before many countries or regions experience a lockdown to combat the pandemic.

Using novel data collected through a consumer survey in 14 countries administered in January 2022 (see Section 2 for more details), the aim of this paper is twofold. First, we descriptively document the change in consumer behaviour during the COVID-19 pandemic, concerning both authorised and unauthorised consumption of cultural goods. We provide evidence regarding the consumption of four types of cultural goods – music, video, books, and games – through various legal and illegal channels. Our data allows us to depict how these changes have occurred across the respondent's country, age, and gender and to pin down how many consumers used illegal channels for the first time in this period. Moreover, we document for the first time the extent to which income reductions and changes in working conditions during the pandemic triggered the use of illegal channels.

Our second aim is to provide evidence about the existence and drivers of a displacement effect of online piracy on legal consumption of cultural goods, during the COVID-19 pandemic. To date, estimating displacement empirically has proven to be cumbersome. A substantial body of academic literature emerged on the effect of the unauthorised sharing of copyrighted works, but no general consensus was reached. Most of the earlier contributions focus on the music industry – e.g., Peitz and Waelbroeck (2004), Rob and Waldfogel (2006), Zentner (2006), Liebowitz (2006) and Oberholzer-Gee and Strumpf (2007). A smaller number of studies deal with the effect for films – e.g., Bounie, Bourreau and Waelbroeck (2006), Hennig-Thurau, Henning and Sattler (2007), Rob and Waldfogel (2007), Bai and Waldfogel (2012). In literature reviews (e.g., Handke, 2012; Smith and Telang, 2012; Watson, Zizzo and Fleming, 2015), it is observed that there are very few studies concerning other markets, such as games, books and software. Smith and Telang conclude that 'the vast majority of the literature … finds evidence that piracy harms media sales'. However, most of this evidence suggests a much smaller effect than a one-to-one displacement of sales by illegal copies, and quantitative estimates vary substantially.

As previous studies have highlighted (e.g. Quintais and Poort, 2018, Eijk, Poort and Rutten, 2010), this lack of unanimity may at least in part be due to the fact that there are several opposing channels through which online piracy may affect the purchase of legal content. On the one hand, illegal access may enhance cultural goods' legal demand through either a *sampling effect* (i. e., illegal consumers are introduced to new contents and genres, thus generating new legal demand) or a *network effect* (i.e. unauthorised consumption increases the popularity of cultural goods, boosting demand). Moreover, online piracy may raise the demand

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[3] https://www.muso.com/magazine/the-new-normal-what-the-coronavirus-means-for-digital-piracy accessed on the 24th March 2022

for *complementary products*, such as merchandise or live concerts. On the other hand, displacement may occur because of a *substitution effect*, namely, illegal consumption replaces legal purchases. More subtle negative effects on sales occur when sampling leads to fewer bad buys or deferred purchases at lower prices. Also, piracy may displace legal consumption via competition for people's time budget: if one watches a movie illegally, one cannot watch a movie legally at the same time. Finally, we may observe a *neutral effect* when pirate platforms meet the demand of consumers with insufficient willingness to pay, or of consumers looking for a work that is not on offer or is offered on a platform they do not know, or for a work in a specific technical quality or file type that is not legally available.

The strength of these different positive, negative and neutral interactions is likely to differ *between* content types. For instance, most people enjoy the same music many times, while they watch a film or read a book only once or twice. This implies that sampling will be more relevant for music than for audio-visual content and books. Also, the positive effect of piracy on the demand for related products such as live concerts and merchandize may be significant for music, while the time budget effect is less relevant, as music is often enjoyed while doing other things at the same time. All this suggests that net sales displacement is like to be higher for films, series and books than for music. The position of games in this spectrum is not obvious: it is likely that a fully functional game from an illegal source displaces demand for a legal version, but the gaming industry has more technical possibilities to ensure that an illegal version is not a perfect substitute – for instance, because it does not allow for periodic updates.

The strength of the different effects also varies *within* content types: the sampling effect is likely to be weaker for famous artists and blockbuster films from which consumers generally know what to expect. Moreover, popular and recent content is more likely to be on offer legally, whereas older and niche content may be unavailable or out of commerce. If so, consumption of such content from illegal sources cannot displace legal acquisition for that specific title. Watson, Zizzo and Fleming (2015) mention the long-tail distribution of pirated content, and the net displacement effect may be different further down this tail than in the head of the distribution. Indeed, some studies find indications that more popular musicians and albums (Blackburn, 2004; Mortimer et al., 2012) and blockbuster films (Peukert, Claussen and Kretschmer, 2017) suffer more from the substitution effect, whereas less-well-known productions may even benefit as the opposing sampling effect prevails. However, other studies find an opposite effect (Bhattacharjee, Gopal, Lertwachara, Marsden and Telang, 2007; Hammond, 2013).

Lastly, the relevance of the different interactions between piracy and legal sales has changed over time. In the early days of online piracy, music was legally available only on physical carriers, bundled in albums. Consumers who only wanted a specific song were not served unless it was released as a single. Likewise, audio-visual content was tied to DVDs locked with technical protection measures. This situation has changed dramatically, and nowadays most popular content is available not only on physical carriers but also as digital downloads and via streaming services. In addition, film trailers and music videos are generally

available for free via platforms such as YouTube. Moreover, Spotify offers a free ad-sponsored music streaming service and Netflix is planning to launch such a service for audio-visual content. [4] Such developments have reduced the incentive to turn to illegal sources for sampling or for specific technical formats that are not on offer via legal channels. It seems plausible that this has reduced piracy, and that is indeed what Aguiar and Waldfogel (2018) and Poort and Weda (2015) concluded for the illegal consumption of music concurrent with the rise of legal music streaming. The latter authors suggest that the net displacement rate of the remaining piracy may be higher as the positive sampling effect and the neutral effect of unmatched demand lose their relevance. Moreover, as many consumers lost interest in 'owning' content on CDs and DVDs, they became less likely to buy a physical carrier after sampling a digital file. On the other hand, by now the remaining pirates may be the ones with the lowest purchasing power or willingness to pay.

A related complexity is that both legal and illegal content supply have changed and diversified over time. To legally consume recorded music, for instance, one can buy a CD, rent it or borrow it from a library, purchase a digital file (e.g., on iTunes) or use a streaming service such as Spotify. There are also different technologies for illegal consumption. The market as a whole has shifted from physical carriers via downloads to streams. This implies that it can be misleading to interpret developments per channel in isolation: legal consumption via one channel cannibalises consumption via another. Put differently, a decrease in CD purchases may be due to legal downloads and streams as well as to online piracy. Ideally, one would estimate the effect of consumption via all illegal channels on all legal channels, making assumptions about how to add streams, downloads and physical carriers.

The recent COVID-19 pandemic provides an ideal setting to revisit these opposing forces and interactions. We can use the pandemic as a shock to both available income and individual demand to better identify how these factors affect legal sales. Restrictions adopted in most countries to fight the pandemic have drastically changed consumers' behaviours. Many have experienced changes in working conditions, with significant shifts from on-site to online working, while many social activities – including concerts, cinemas, clubs, large sports events – have been cancelled or did not allow the audience to attend: In our data, 52% of all respondents reported a significant change from on-site to online working or remote leaning. We hypothesise that more time spent at home due to online working or remote learning may have increased time available for cultural goods' consumption and, therefore, the overall demand for these contents through both legal and illegal channels. Moreover, consumers in specific sectors have experienced income reductions during the pandemic: In our data, 42% of respondents experienced an income reduction during

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the pandemic. We also hypothesise that a decrease in available income would affect the willingness to pay for legal content leading to more unauthorised consumption of cultural goods and to a displacement effect.

To test these hypotheses, we first rely on previous studies' methodology to empirically test the causal effect of illegal on legal consumption. Following the approach by Quintais and Poort (2018), we regress the volume consumed legally on the volume purchased illegally. Our data allows us to control for a variety of consumers' characteristics and demographics. We use an instrumental variable (IV) approach to resolve endogeneity issues. We instrument piracy consumption with the respondent's attitude toward a variety of illegal actions that might be considered acceptable as they do not inflict any direct or marginal damage to anyone (e.g. jaywalking, taking a flash photo in a museum and travelling on public transit without a ticket). The logic of this instrument is that, while such attitudes correlate (significantly) with online piracy, they do not affect cultural goods' legal consumption directly. To identify how income reduction and increasing demand moderate the displacement effect of online piracy, we augment the regression analysis mentioned above, interacting the volume of illegal consumption with both income and working conditions shocks.

2 Data collection and cleaning

For tackling our research questions, we use a novel dataset collected through a consumer survey administered by a specialised company[5] in January 2022. Our survey covers 14 countries around the world, which are: France, Germany, The Netherlands, Poland, Spain, Italy, Ireland, Sweden, United Kingdom, United States, Russia, Australia, Indonesia and Brazil. For nine of the countries in the data set (BRA, DEU, ESP, FRA, GBD, IND, NLD, POL, SWE), measurements for 2017 were available which made use of the same methodology, a very similar questionnaire and the same survey company (Poort, Quintais, et al., 2018). For six European countries out of these (DEU, ESP, FRA, GBD, POL, SWE), comparable measurements are also available for 2014 (Ende, Poort et al., 2015).

The final dataset includes 25,939 respondents, 7,095 of which are minors. Table 1 reports some key figures about the sample composition. By design, minors have been oversampled because this is a small age group of specific interest. Conversely, people over 50 are underrepresented in the panels of some countries and are hence under-sampled. To correct for this, respondents are weighted by gender and age, such that respondents in over-sampled categories are given smaller-than-unit weights and respondents in under-sampled categories are given larger-than-unit weights. Such weights have been calculated using data on the Internet using population share divided by the sample share per gender, age group and country.

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[5] The survey was carried out by Dynata (www.dynata.com).

Table 1: Sample composition by country, age, and gender

Country	Total	Adult	Minor	Male	Female	Gender Not binary or third gender	Prefer not to say
AUS	1871	1367	504	902	945	17	7
BRA	1905	1387	518	949	941	10	5
DEU	1819	1319	500	907	898	10	4
ESP	1814	1319	495	940	861	11	2
FRA	1851	1343	508	868	971	6	6
GBR	1879	1375	504	910	949	10	10
IND	1855	1338	517	966	812	75	2
IRL	1825	1318	507	955	853	8	9
IT	1899	1380	519	954	938	7	0
NLD	1840	1335	505	933	892	7	8
POL	1839	1342	497	917	909	9	4
RUS	1813	1299	514	865	939	6	3
SWE	1859	1357	502	952	878	17	12
USA	1870	1365	505	904	933	18	15
Total	25939	18844	7095	12922	12719	211	87

Consumption per type of content was calculated by combining the consumption from different reference periods (number of transactions such as purchases, downloads, or streaming in the past one, three or twelve months) and different measurement units (tracks versus albums versus hours of streaming, episodes versus seasons). This implies that assumptions had to be made to add these content-acquisition channels and to convert consumption of the past one, three and twelve months to annual totals. For comparability reasons, we clean and harmonise our data following the procedure adopted for Poort, Quintais, et al. (2018, Chapter 3 and Annex B).

Consumption in the past one, three and twelve months was combined to calculate annual figures. Since the survey was held in January 2022, this raises the question of how representative consumption in the winter is for the rest of the year. In previous exercises (Poort, Quintais, et al., 2018) seasonality was accounted for looking (when available) at sales during the previous year and calculating the share of sales that occurred over the quarter in which the survey was administered. Given COVID-19 impacted public live in many countries since the first quarter of 2020, it is meaningless to use the same approach as Q1 in 2021 is probably rather different from Q1 in 2022 (when our survey was carried out). For instance, in early 2021 movies theatres where closed and live performance not allowed in many countries in our sample. For these reasons we decided not to correct for seasonality for the reported volumes, hence, figures for the last 1 and 3 months are multiplied by 12 and 4, respectively, to arrive at annual figures. While this is a strong assumption, given the circumstances we think it is the most conservative approach. Furthermore, seasonality was not very strong for most consumption/content combinations in Poort, Quintais, et al. (2018) (a notable exception being live concerts) and only accounted for selected specific contents.

To convert different measurement units for some cultural goods, we apply the following rules:

▪ For music, 1 album is assumed to contain 10 tracks on average.

- For music, 1 hour of streaming is treated as equivalent to 0.1 albums or 1 track.
- For tv series, 1 season is assumed to consist of 10 episodes on average.

3 Piracy levels during the COVID-19 pandemic

In this section, we descriptively document the change in consumer behaviour during the COVID-19 pandemic, concerning both authorised and unauthorised consumption of music, audio-visual content, books and games. In our survey, we asked about the past use of legal channels (sales and rental of physical carriers, digital sales, streaming) and illegal channels (downloads and streams from unauthorised sources).

3.1 Pirates per legal user

A comprehensive metric to compare piracy levels between the various countries in our sample is the ratio between the share of the population using illegal channels over the past year, and the share using legal channels over the past year. This 'number of pirates per legal user' can be calculated for each content type separately and of all for content types combined. Figure 1 presents this metric for all four content types combined, in a scatter plot against the GNI per capita (For GNI per capita in PPP, the last available year was 2020.) The 2022 values are plotted in green, while measurements from 2017 are plotted in yellow and from 2014 in red. Arrows indicate the change for selected countries over time. While in Poland, Spain and France the relative number of pirates went down over this time span, a relevant increase can be observed in Germany, The Netherlands and the UK. The number of pirates per legal user in Sweden went down between 2014 and 2016 and went up between 2016 and 2022.

Figure 1: Percentage of pirates per legal user and per capita income - all content types
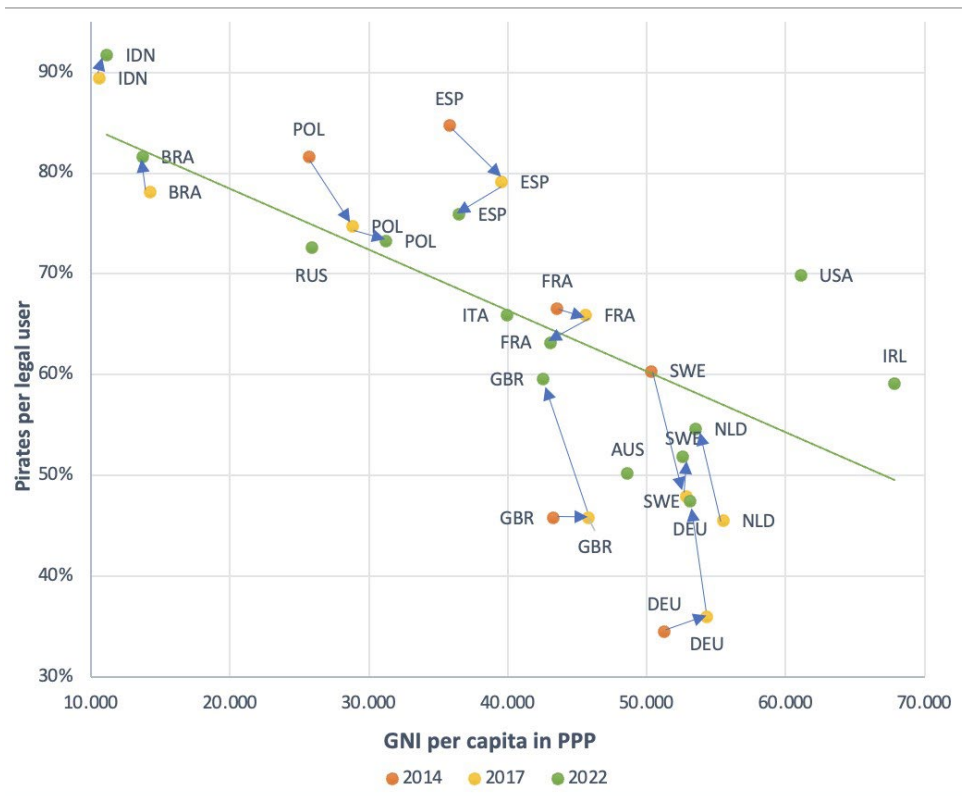
This graph warrants two observations:

1. In each of these three measurements, there is a negative correlation between the number of pirates per legal user and the per capita income.

2. Over time, countries tend to move towards the trend line.

This is confirmed in Table 2 and 3, comparing the development over time of the R^2 of the regression for the 6 countries for which data are available in all three measurements or the 9 countries for which data are available in the last three measurements.

Figure 2 gives the same graph for each of the content types in our survey. The main results (as well as the regression results) are very similar, even if for books, piracy levels are generally somewhat lower. This analysis suggests that as availability of (digital) content via legal channels has increased over the past decade, affordability or income is an increasingly important factor to explain piracy levels.

Figure 2: Percentage of pirates per legal user and per capita income - single content types
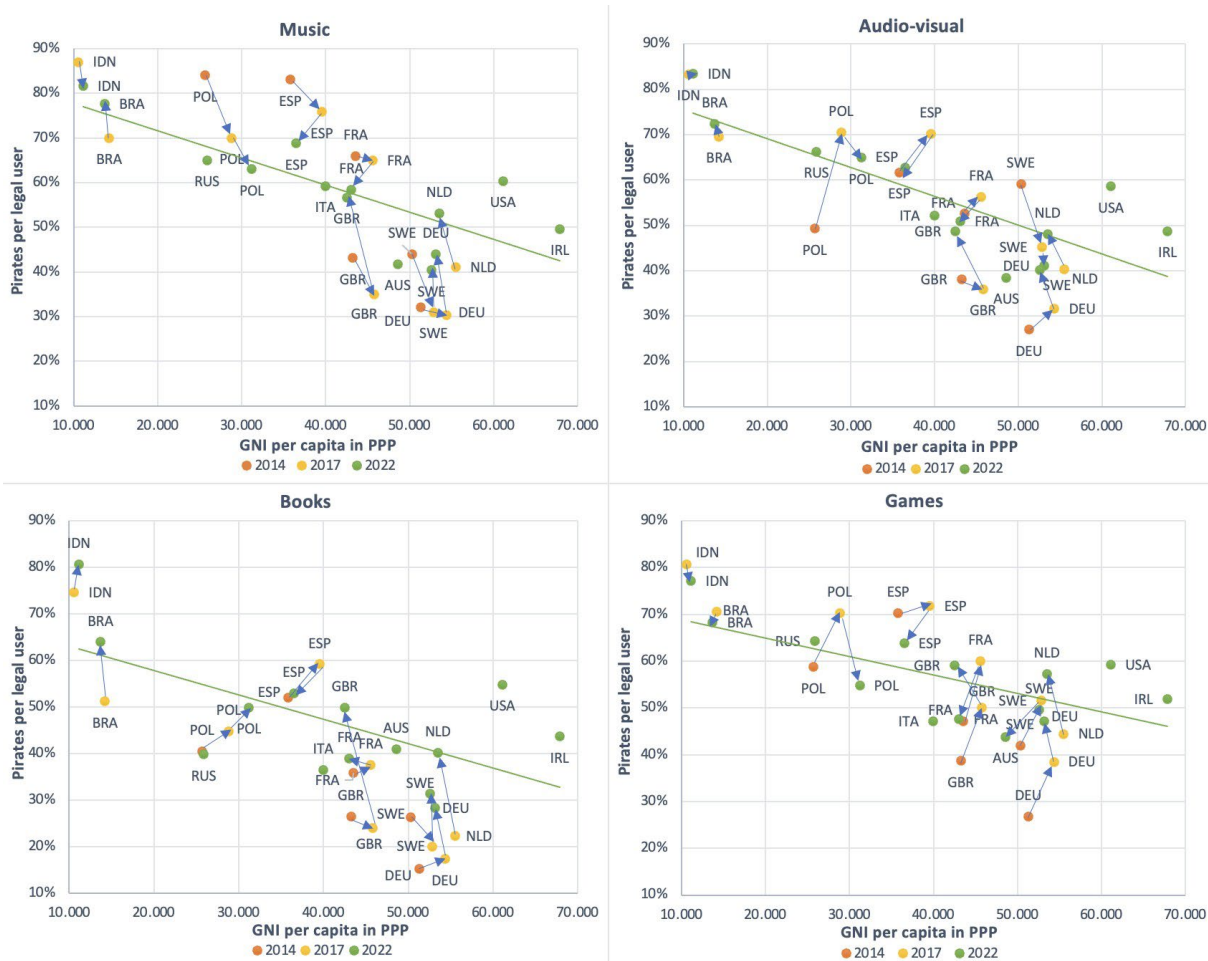

Table 2: Pirates per legal user on GNI per capita - OLS regression (6 countries 2014-2022)

	2014			
R_2	0,612			
	Coefficient	Standard error	Stat t	P-Value
Percentage of pirates	-38252,39	15229,47	-2,51	0,07
	2017			
R_2	0,680			
	Coefficient	Standard error	Stat t	P-Value
Percentage of pirates	-44355,35	15203,86	-2,92	0,04
	2022			
R_2	0,901			
	Coefficient	Standard error	Stat t	P-Value
Percentage of pirates	-72603,73	12050,23	-6,03	0,00

Table 3: Pirates per legal user on GNI per capita - OLS regression (9 countries, 2017-2022)

2017				
R_2	0,756			
	Coefficient	Standard error	Stat t	P-Value
Percentage of pirates	-77833,25	16710,47	-4,66	0,00
2022				
R_2	0,912			
	Coefficient	Standard error	Stat t	P-Value
Percentage of pirates	-103526,42	12168,62	-8,51	0,00

3.2 Individual changes in pirating behaviour

Next, we look at self-reported individual changes in pirating behaviour. First, Table 4 presents some basic characteristics of the respondents, separated in three groups: those who did not use any illegal channels in the past year to access music, those who has started using such channels before the pandemic (and are still using them) and those who started pirating music during the pandemic. The table shows that those who started pirating music during the pandemic are more often suffering income reductions and working or learning from home than the other groups. Table for the other content types are listed in the Appendix.

Table 4: Characteristics of non-pirates, pirates and new pirates (music)

	Share in sample	Minor	Male	With income reduction	With smart working/ learning
% of respondents: non-pirates	63%	20%	45%	32%	38%
pirates before the pandemic	30%	38%	57%	55%	72%
new pirates during the pandemic	7%	47%	62%	75%	88%

Figures 3 gives a first impression of behavioural changes in music and audio-visual piracy within the group of respondents that indicated to be using legal channels (by country). While the largest sub-group report no changes, substantial percentages started using illegal channels or report a slight or considerable increase. The latter groups are on average twice as large as the groups that report a slight or considerable decrease.
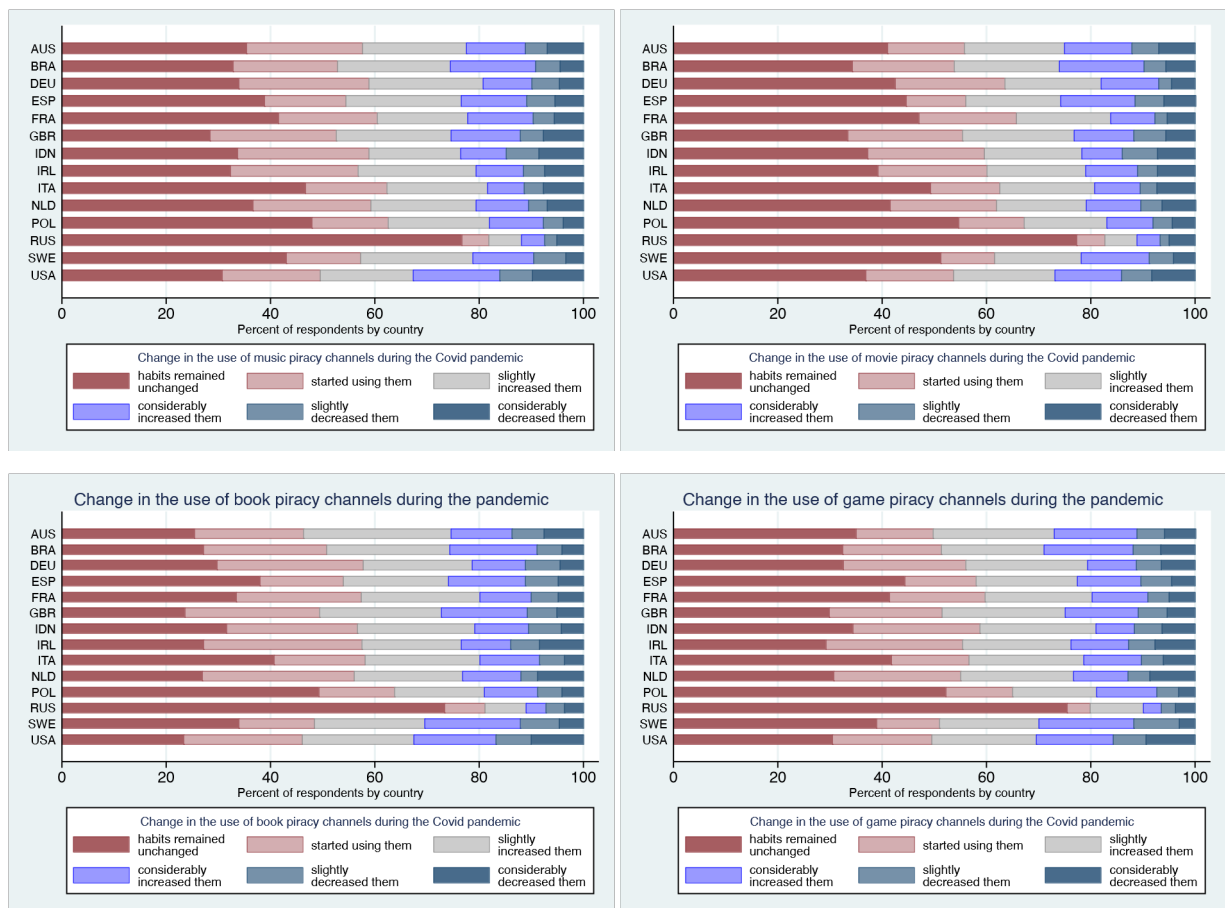
Figure 3: Change in the use piracy channels during the pandemic

In Table 5 and 6, we analyse those who started using those channels during the pandemic separately from those who have used such channels also before in more detail. Table 5 presents the outcomes of a probit model aimed at understanding who started pirating music during the pandemic, as opposes to non-pirates (tables for the other content types are very similar and are presented in the Appendix). The table shows that those who owned more of a list of technical devices that was presented in the survey were more likely than non-pirates to start using illegal channels to acquire music. More interestingly for the purpose of this paper, those who report an income reduction as a result of the pandemic and those who indicate a significant change from in-presence to *remote-learning* or *online-working* due to the pandemic are significantly more likely to have started using illegal channels for music, while the interaction effect between the two is statistically also significant. These outcomes suggest that income or affordability, as well as opportunities are important factors to explain piracy.

Table 5: Determinants of new pirate users during the pandemic - Music

	1	2	3	4
ownership device	0.208***	0.196***	0.183***	0.181***
	(0.012)	(0.013)	(0.013)	(0.013)
income reduction		0.636***	0.545***	0.348***
		(0.050)	(0.052)	(0.097)
smart working			0.495***	0.362***
			(0.059)	(0.079)
income reduction # smart working				0.279**
				(0.114)
Observations	16,755	16,755	16,755	16,755
Age FE	YES	YES	YES	YES
Gender FE	YES	YES	YES	YES
Education Level FE	YES	YES	YES	YES
Work Status FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES
Minor/Adult FE	YES	YES	YES	YES
Use of internet FE	YES	YES	YES	YES
Interest in music FE	YES	YES	YES	YES

Table 6 looks into the behavioural changes within the group of respondents who had been using illegal channels before the pandemic, using a generalized logistic regression. We use a generalized logistic regression because it relaxes the proportional odds assumption. The latter assumption is instead needed in an ordered logit model but is violated in our data. The results are consistent with those for the new pirates: these who mention the price as the primary reason for pirating, who own more devices, who suffered an income reduction during the pandemic or worked from home are more likely to have increased their pirating behaviour and less likely to have decreased it.

Table 6: Determinant of pirating behaviour changes during the pandemic - Music

	1-strongly decreased	2-slightly decreased	3-unchanged	4-slightly increase
price as reason	-0.201**	-0.308***	0.522***	0.194***
	(0.094)	(0.074)	(0.052)	(0.072)
ownership device	-0.0408**	-0.0456***	0.108***	0.0945***
	(0.020)	(0.016)	(0.012)	(0.017)
income reduction	-0.372***	-0.465***	0.552***	0.428***
	(0.096)	(0.075)	(0.053)	(0.073)
smart working	-0.336***	-0.368***	0.653***	0.521***
	(0.120)	(0.095)	(0.065)	(0.094)
interest in music	0.0107	0.00365	-0.0985***	0.0342
	(0.034)	(0.026)	(0.022)	(0.031)
Observations	7,784	7,785	7,786	7,787
Age FE	YES	YES	YES	YES
Gender FE	YES	YES	YES	YES
Education Level FE	YES	YES	YES	YES
Work Status FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES
Minor/Adult FE	YES	YES	YES	YES
Use of internet FE	YES	YES	YES	YES

Generalized logistic regression. Standard errors in parentheses.
Legend: *** $p<0.01$, ** $p<0.05$, * $p<0.1$

4 Sales displacement during the COVID-19 pandemic

Lastly, we turn to the question of sales displacement. As is well documented in preceding literature, regressing legal consumption on illegal consumption in an OLS suffers from endogeneity, due to unobserved individual characteristics affecting both legal and illegal consumption. The use of demographics and even the self-expressed interest in music, films and series, books or games cannot resolve this endogeneity issue entirely. This is illustrated in the OLS regression tables 7-10, which would suggest a positive effect of online piracy on legal consumption, which only slightly decreases after controlling for interest in the respective content type. Note that in the analysis in this section, we restricted the data sets on the 90th percentile of legal consumption levels. Beyond that threshold, self-reported consumption levels become very high and estimations become prone to reporting errors.

Table 7: Displacement effect for music - OLS regression

	1	2	3	4	5	6
illegal music	0.117***	0.120***	0.105***	0.0977***	0.103***	0.104***
	(0.023)	(0.022)	(0.022)	(0.023)	(0.023)	(0.023)
ownership devices				0.153	0.196*	0.205*
				(0.105)	(0.106)	(0.107)
income reduction=1					-1.390***	-1.317***
					(0.450)	(0.465)
smart working=1						-0.323
						(0.519)
Observations	9,869	9,869	9,869	9,869	9,869	9,869
R-squared	0.081	0.094	0.114	0.114	0.115	0.114
AGE FE	YES	YES	YES	YES	YES	YES
GENDER FE	YES	YES	YES	YES	YES	YES
EDUCATION FE	YES	YES	YES	YES	YES	YES
WORK STATUS FE	YES	YES	YES	YES	YES	YES
COUNTRY FE	YES	YES	YES	YES	YES	YES
MINOR FE	YES	YES	YES	YES	YES	YES
INTERNET USE	NO	YES	YES	YES	YES	YES
INTEREST MUSIC	NO	NO	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8: Displacement effect for movie - OLS regression

	1	2	3	4	5	6
illegal movie	1.039***	1.036***	0.991***	0.872***	0.872***	0.867***
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
ownership devices				1.839***	1.837***	1.783***
				(0.076)	(0.077)	(0.077)
income reduction=1					0.0831	-0.251
					(0.312)	(0.320)
smart working=1						1.570***
						(0.337)
Observations	21,732	21,732	21,732	21,732	21,732	21,732
R-squared	0.155	0.164	0.184	0.206	0.206	0.206
AGE FE	YES	YES	YES	YES	YES	YES
GENDER FE	YES	YES	YES	YES	YES	YES
EDUCATION FE	YES	YES	YES	YES	YES	YES
WORK STATUS FE	YES	YES	YES	YES	YES	YES
COUNTRY FE	YES	YES	YES	YES	YES	YES
MINOR FE	YES	YES	YES	YES	YES	YES
INTERNET USE	NO	YES	YES	YES	YES	YES
INTEREST MOVIE	NO	NO	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Displacement effect for book - OLS regression

	1	2	3	4	5	6
illegal book	1.978***	1.980***	1.901***	1.842***	1.868***	1.867***
	(0.073)	(0.073)	(0.072)	(0.074)	(0.074)	(0.074)
ownership device				0.622***	0.694***	0.689***
				(0.165)	(0.167)	(0.169)
income reduction=1					-2.301***	-2.334***
					(0.708)	(0.728)
smart working=1						0.156
						(0.813)
Observations	9,467	9,467	9,467	9,467	9,467	9,467
R-squared	0.095	0.096	0.128	0.129	0.130	0.130
AGE FE	YES	YES	YES	YES	YES	YES
GENDER FE	YES	YES	YES	YES	YES	YES
EDUCATION FE	YES	YES	YES	YES	YES	YES
WORK STATUS FE	YES	YES	YES	YES	YES	YES
COUNTRY FE	YES	YES	YES	YES	YES	YES
MINOR FE	YES	YES	YES	YES	YES	YES
INTERNET USE	NO	YES	YES	YES	YES	YES
INTEREST BOOK	NO	NO	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Displacement effect for games - OLS regression

	1	2	3	4	5	6
illegal game	0.652***	0.660***	0.635***	0.612***	0.615***	0.616***
	(0.021)	(0.021)	(0.021)	(0.021)	(0.022)	(0.022)
ownership device				0.758***	0.788***	0.801***
				(0.159)	(0.160)	(0.162)
income reduction=1					-0.913	-0.825
					(0.648)	(0.667)
smart working=1						-0.422
						(0.756)
Observations	9,656	9,656	9,656	9,656	9,656	9,656
R-squared	0.218	0.223	0.237	0.239	0.239	0.239
AGE FE	YES	YES	YES	YES	YES	YES
GENDER FE	YES	YES	YES	YES	YES	YES
EDUCATION FE	YES	YES	YES	YES	YES	YES
WORK STATUS FE	YES	YES	YES	YES	YES	YES
COUNTRY FE	YES	YES	YES	YES	YES	YES
MINOR FE	YES	YES	YES	YES	YES	YES
INTERNET USE	NO	YES	YES	YES	YES	YES
INTEREST GAME	NO	NO	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Several studies use a so-called instrumental variable (IV) approach to resolve this endogeneity issue. The aim in this approach is to look for variables that correlate with consumption from illegal sources but that affect consumption from legal sources only through the former. Earlier studies used instruments related to Internet availability and speed or individual Internet skills (e.g. Zentner, 2006; Oberholzer-Gee and Strumpf, 2007). That may have been a valid approach when content consumption via the Internet was almost synonymous with consumption from illegal sources, but today that can no longer be maintained. Currently, people need to have Internet access and Internet skills for the most important channels for legal consumption, making such variables unsuitable as instruments. The current study uses a different instrument related not to Internet aptitude or availability but to moral attitudes toward activities such as jaywalking, taking a flash photo in a museum and travelling on public transit without a ticket. This approach was also used in Ende, Poort et al. (2015) and Quintais and Poort (2018).

Tables 11-14 present the outcomes of these IV regressions per content type. The overall results differ substantially between these content types:

- For music (Table 11), the positive displacement effect of around +0.1 found in the OLS models changes downward to around -1.0, which would suggest a one-to-one displacement of legal consumption by illegal consumption. Model 5 shows that working or learning from home in itself has a positive impact on legal consumption, while model 6 shows that an income loss by itself has a neutral effect. However, model 7 and 8 show interaction effects of (instrumented) illegal consumption and income losses respectively working/learning from home. These models show that the displacement effect is larger for those suffering income losses and for those working or learning from home. For these not working from home, no statistically significant displacement effect is found. Model 9 shows that the displacement effects that are found can be attributed to adults rather than minors.

- For movies and TV-series (Table 12), the IV regression yields positive displacement effects, which become neutral after adding more control variables. As for music, model 5 shows that working or learning from home as well as in income reduction by itself increased legal consumption of audio-visual material. The latter may be due to the fact that respondents suffering an income loss had more time on their hands during the pandemic. Interaction effects between (instrumented) piracy and an income reduction working/learning from home are neutral, while model 9 indicates a positive displacement effect for minors and a negative displacement effect for adults.

- For books (Table 13), the displacement effect is neutral in the first three models, but becomes tentatively negative (at $p<0.05$ or $p<0.1$) after adding more controls, particularly working or leaning from home, which has a strong positive effect on book consumption via legal channels. Interaction effects indicate displacement effects occur only for suffering an income loss, but only for those working or learning from home and for adults. The other interactions are neutral.

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- For Games (Table 14), as for books, the displacement effect is neutral in the first three models, but becomes negative (at p<0.01) after adding more controls. Working or learning from home and – surprisingly – an income reduction by themselves affect legal game consumption positively. Interaction effects indicate displacement effects (of around -0.4~-0.5), regardless of respondents suffering an income loss or not, but only for those working or learning from home and only for adults.

Table 11: Displacement effect for music - IV regression

	1	2	3	4	5	6	7	8	9
illegal music	-0.707***	-0.631***	-0.666***	-1.019***	-1.066***	-1.034***			
	(0.136)	(0.134)	(0.140)	(0.199)	(0.213)	(0.216)			
ownership devices				1.278***	1.270***	1.285***	1.282***	1.320***	0.801
				(0.231)	(0.231)	(0.237)	(0.240)	(0.242)	(0.927)
smart working=1					1.379**			6.959***	
					(0.678)			(1.864)	
income reduction=1						0.240	2.651		
						(0.589)	(2.058)		
income reduction=0# illegal music							-0.760**		
							(0.316)		
income reduction=1# illegal music							-1.239***		
							(0.273)		
smart working=0# illegal music								-0.0347	
								(0.380)	
smart working=1# illegal music								-1.427***	
								(0.251)	
minor=0# illegal music									-1.172***
									(0.168)
minor=1# illegal music									1.442
									(4.080)
Observations	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869	9,869
AGE FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
GENDER FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
EDUCATION FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
WORK STATUS FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
COUNTRY FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
MINOR FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
INTERNET USE	NO	YES	YES	YES	YES	YES	YES	YES	YES
INTEREST MUSIC	NO	NO	YES	YES	YES	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 12: Displacement effect for movie - IV regression

	1	2	3	4	5	6	7	8	9
illegal movie	0.691***	0.732***	0.684***	-0.0596	-0.133	-0.120			
	(0.133)	(0.133)	(0.133)	(0.173)	(0.178)	(0.183)			
ownership devices				2.553***	2.506***	2.567***	2.572***	2.557***	2.393***
				(0.153)	(0.152)	(0.156)	(0.160)	(0.166)	(0.167)
smart working=1					2.414***			0.872	
					(0.379)			(0.924)	
income reduction=1						1.066***	0.750		
						(0.372)	(0.786)		
income reduction=0# illegal movie							-0.209		
							(0.325)		
income reduction=1# illegal movie							-0.0765		
							(0.177)		
smart working=0# illegal movie								-0.804	
								(0.493)	
smart working=1# illegal movie								-0.00114	
								(0.167)	
minor=0# illegal movie									-0.607***
									(0.169)
minor=1# illegal movie									1.406***
									(0.387)
Observations	21,732	21,732	21,732	21,732	21,732	21,732	21,732	21,732	21,732
AGE FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
GENDER FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
EDUCATION FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
WORK STATUS FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
COUNTRY FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
MINOR FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
INTERNET USE	NO	YES	YES	YES	YES	YES	YES	YES	YES
INTEREST MOVIE	NO	NO	YES	YES	YES	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 13: Displacement effect for book - IV regression

	1	2	3	4	5	6	7	8	9
illegal book	0.0925	0.108	0.0158	-0.928*	-1.060**	-0.990*			
	(0.359)	(0.363)	(0.367)	(0.482)	(0.510)	(0.533)			
ownership devices				1.927***	1.897***	1.934***	1.935***	1.901***	2.183***
				(0.285)	(0.283)	(0.290)	(0.291)	(0.283)	(0.383)
smart working=1					2.164**			2.587	
					(0.964)			(1.938)	
income reduction=1						0.590	1.042		
						(0.928)	(2.105)		
income reduction=0# illegal book							-0.863		
							(0.815)		
income reduction=1# illegal book							-1.074*		
							(0.606)		
smart working=0# illegal book								-0.879	
								(0.908)	
smart working=1# illegal book								-1.121**	
								(0.555)	
minor=0# illegal book									0.0575
									(0.426)
minor=1# illegal book									-7.850***
									(2.927)
Observations	9,467	9,467	9,467	9,467	9,467	9,467	9,467	9,467	9,467
AGE FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
GENDER FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
EDUCATION FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
WORK STATUS FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
COUNTRY FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
MINOR FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
INTERNET USE	NO	YES	YES	YES	YES	YES	YES	YES	YES
INTEREST BOOK	NO	NO	YES	YES	YES	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 14: Displacement effect for game - IV regression

	1	2	3	4	5	6	7	8	9
illegal game	-0.0671	-0.0301	-0.0879	-0.373***	-0.414***	-0.437***			
	(0.098)	(0.099)	(0.101)	(0.128)	(0.135)	(0.140)			
ownership devices				2.391***	2.340***	2.404***	2.405***	2.342***	2.342***
				(0.273)	(0.270)	(0.277)	(0.277)	(0.270)	(0.350)
smart working=1					2.844***			3.007	
					(0.932)			(2.397)	
income reduction=1						2.449***	1.071		
						(0.846)	(2.628)		
income reduction=0# illegal game							-0.545**		
							(0.256)		
income reduction=1# illegal game							-0.369**		
							(0.177)		
smart working=0# illegal game								-0.393	
								(0.313)	
smart working=1# illegal game								-0.419***	
								(0.154)	
minor=0# illegal game									-0.410***
									(0.103)
minor=1# illegal game									-0.183
									(0.574)
Observations	9,656	9,656	9,656	9,656	9,656	9,656	9,656	9,656	9,656
AGE FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
GENDER FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
EDUCATION FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
WORK STATUS FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
COUNTRY FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
MINOR FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
INTERNET USE	NO	YES	YES	YES	YES	YES	YES	YES	YES
INTEREST GAME	NO	NO	YES	YES	YES	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5 Conclusions and discussion

This paper aims at two main contributions. First, we provide worldwide evidence on changes in the consumption of cultural goods during the pandemic, focusing on the incidence of consumers starting to use illegal channels during the period. Second, we contribute to the literature on the relationship between legal and illegal consumption, providing fresh evidence on legal sales displacements and the role of demand and income as drivers of the phenomenon.

Our results show that the pandemic deeply affected the consumption of music, movies and TV-series, books and games, particularly so for these who reported a significant change from on-site to online working or remote leaning and those who suffered an income loss. While these disruptions also affected legal consumption positively, a significant share of the population started using illegal channels during the pandemic, and many who had used these channels before increased their pirating activities.

Affordability and opportunity turn out to be important drivers over piracy during the pandemic: those working or learning from home a significant amount of time have been more likely to start using pirate channels or increase their usage and the same holds for those suffering an income loss. The relevance of affordability is also underscored in an international comparison of the number of pirates per legal user: there is a striking and increasing correlation between this metric and the GNI per capita. One may hypothesize that this correlation has become stronger over time as a consequence of content markets becoming more globalised, and price setting less adapted to local income levels.

These observations are mirrored in the outcomes of the IV estimations of the displacement of legal by illegal consumption. For all content types except movies and TV-series, a significant negative effect was found, which was close to one for music and books. For audio-visual material, a positive effect was found. In most cases negative displacement effects could be attributed to adults, those working or learning from home and those suffering income losses. This underscores again that affordability and opportunity are highly relevant, not only for piracy in itself but also for displacement.

The relatively high displacement rates within these groups – in also in comparison with the findings in earlier literature – may have two further explanations. First, as was indicated in Section 1, the role of piracy has changed over time. With the increasing legal availability of content via different legal channels, most notably streaming channels for music and audio-visual material, as well as the emergence of ad-sponsored zero rated channels such as Spotify Free, the relevance of piracy for sampling content or accessing content which is not available legally (at all, on in the desired format) has decreased. The piracy that remains, is more likely to be price to substitution effects. Second, the displacement effect estimation may be somewhat

inflated in the context of flat rate subscriptions and time budget effects. While listening to music or reading a book via a piracy channel can displace consumption of such content from a legal channel, if only because one cannot listing to two songs or read two books at the same time, it does not necessarily displace *revenues* from legal sources as long as people do not cancel their subscriptions.

Acknowledgements

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Appendix

Table: Characteristics of non-pirates, pirates and new pirates - Movie

	Observations	Minor	Male	Income reduction	Smart working
% of respondents: non-pirates	52%	19%	45%	31%	36%
pirates before the pandemic	40%	35%	54%	50%	66%
new pirates during the pandemic	8%	45%	60%	73%	83%

Table: Characteristics of non-pirates, pirates and new pirates - Books

	Observations	Minor	Male	Income reduction	Smart working
% of respondents: non-pirates	72%	22%	48%	34%	42%
pirates before the pandemic	22%	40%	53%	59%	75%
new pirates during the pandemic	6%	44%	61%	77%	88%

Table: Characteristics of non-pirates, pirates and new pirates - Games

	Observations	Minor	Male	Income reduction	Smart working
% of respondents: non-pirates	66%	19%	44%	32%	39%
pirates before the pandemic	28%	44%	60%	57%	74%
new pirates during the pandemic	6%	46%	63%	76%	88%

Table: Determinants of new pirate users during the pandemic - Movies

	1	2	3	4
ownership device	0.221***	0.210***	0.197***	0.196***
	(0.012)	(0.012)	(0.012)	(0.012)
income reduction=1		0.519***	0.457***	0.305***
		(0.048)	(0.049)	(0.083)
smart working=1			0.339***	0.230***
			(0.054)	(0.071)
income reduction=1 # smart working=1				0.235**
				(0.102)
Observations	14,146	14,146	14,146	14,146
AGE FE	YES	YES	YES	YES
GENDER FE	YES	YES	YES	YES
EDUCATION FE	YES	YES	YES	YES
WORK STATUS FE	YES	YES	YES	YES
COUNTRY FE	YES	YES	YES	YES
MINOR FE	YES	YES	YES	YES
INTERNET USE	YES	YES	YES	YES
INTEREST MOVIE	YES	YES	YES	YES

Table: Determinants of new pirate users during the pandemic - Books

	1	2	3	4
ownership device	0.222***	0.209***	0.196***	0.194***
	(0.011)	(0.012)	(0.012)	(0.012)
income reduction=1		0.642***	0.566***	0.382***
		(0.046)	(0.047)	(0.089)
smart working=1			0.418***	0.294***
			(0.055)	(0.073)
income reduction=1 # smart working=1				0.258**
				(0.105)
Observations	19,310	19,310	19,310	19,310
AGE FE	YES	YES	YES	YES
GENDER FE	YES	YES	YES	YES
EDUCATION FE	YES	YES	YES	YES
WORK STATUS FE	YES	YES	YES	YES
COUNTRY FE	YES	YES	YES	YES
MINOR FE	YES	YES	YES	YES
INTERNET USE	YES	YES	YES	YES
INTEREST BOOK	YES	YES	YES	YES

Table: Determinants of new pirate users during the pandemic – Games

	1	2	3	4
ownership device	0.221***	0.208***	0.195***	0.193***
	(0.012)	(0.012)	(0.012)	(0.012)
income reduction=1		0.656***	0.575***	0.311***
		(0.047)	(0.048)	(0.091)
smart working=1			0.431***	0.258***
			(0.054)	(0.073)
income reduction=1 # smart working=1				0.370***
				(0.106)
Observations	17,752	17,752	17,752	17,752
AGE FE	YES	YES	YES	YES
GENDER FE	YES	YES	YES	YES
EDUCATION FE	YES	YES	YES	YES
WORK STATUS FE	YES	YES	YES	YES
COUNTRY FE	YES	YES	YES	YES
MINOR FE	YES	YES	YES	YES
INTERNET USE	YES	YES	YES	YES
INTEREST GAME	YES	YES	YES	YES