Price, Piracy, and Search:
Which Pirates Respond to Changes in the Legal Price?

ABSTRACT

Prior research suggests that high prices may motivate the decision to pirate entertainment goods. We analyze a natural experiment that decreased the tax rate, and hence also the net prices of eBooks, by 14% in Ireland while several other European countries were not affected. Using country-specific data on piracy visits, we find that this price decrease caused only a small and statistically insignificant decrease in total eBook piracy visits.

However, we further decompose piracy visits into those of direct pirates, who navigate directly to piracy sites, and indirect pirates, who search to find piracy sites. The 14% price decrease caused no change in direct piracy visits but caused a statistically significant 27% decrease in indirect piracy visits. These findings align with prior research suggesting that search can play an important role in piracy, but only for some pirates.

Our results demonstrate the potential of using price to mitigate piracy, but they also highlight the challenges firms face in competing with piracy for experienced pirates. We conclude by detailing both the policy and managerial implications of our work.

Keywords: digital piracy, pricing, information goods, natural experiment, generalized synthetic control

1. Introduction

Scholars in the Economics and Information Systems disciplines have dedicated significant attention to studying the effects of Internet-based media piracy on legal consumption of entertainment goods such as music, movies, television, and books. Empirical studies on this issue have largely reached consensus, as the vast majority of peer-reviewed papers demonstrate that piracy negatively affects legal consumption (Danaher et al. 2017; Liebowitz 2013). The US Chamber of Commerce estimates that video piracy alone costs content and distribution sectors in the United States between $29.2 and $71.0 billion each year, with up to a half million jobs lost as a result (Blackburn et al. 2019). Accordingly, recent academic work has focused more on how piracy's effect on legal revenues can be mitigated, including focuses on the availability, timeliness, and convenience of legal consumption channels.

One frequently proposed suggestion to influence the decision between legal and illegal consumption is to lower the legal price. This assertion goes as far back as the iTunes music store, when Steve Jobs stated "You'll never stop [piracy]. What you have to do is compete with it." (Goodell 2003). He went on later to argue that music companies should not be greedy in seeking prices higher than ninety-nine cents, as this would encourage piracy. Notably, even then the Chairman of EMI Music argued back, saying "I'm not persuaded of the fact that a lower price deters piracy. What I am persuaded of is that making music more convenient and better value is a deterrent to piracy."[1] James Giannopoulous, then President of 20th Century Fox Pictures, put it even more bluntly, saying "You can't compete with free. That's an economic paradigm that doesn't work." (Thompson 2003). Even today, media consumers cite prices being "too high" as a primary driver for pirating (Vuleta 2021).

[1] Mac Daily News (2005): https://tinyurl.com/356yueah

Prior research has provided evidence that higher prices contribute to piracy (e.g., Bhattacharjee et al. 2003; Cheng et al. 1997; Khouja et al. 2007), and Sinha et al. (2010) introduced the idea of "hardcore" pirates who may respond to differently to changes in pricing or useability of legal products than other pirates. Building on these and other prior studies, we test the effect of pricing on piracy using observed market data in the context of a natural experiment. In doing so, we further explore how search moderates the relationship between price and piracy, ultimately relating this to the concept of hardcore pirates.

Estimating the causal effect of legal price on piracy in a market setting is difficult due to the inherent endogeneity of price. Popular products will be priced higher and also pirated more heavily. We break this endogeneity by analyzing a natural experiment that shocked eBook prices in Ireland. Specifically, in November 2018, the European Union passed a directive that allowed member countries to tax eBooks more similarly to physical books and other media goods, rather than requiring the much higher tax rates associated with most non-exempt goods. A number of EU countries took advantage, lowering the tax rate on eBooks from the 20-25% range to the 5-10% range. In particular, Ireland, Belgium, and Portugal reduced their eBook VATs during the period for which we have data (i.e., January to August of 2019). We provide evidence that retailers in Ireland passed the 14% reduction directly to consumers in the form of eBook prices that were on average 14 % lower. In contrast, retailers in Belgium and Portugal did not reduce eBook prices despite reducing the VAT rate on eBooks during the period of time we study. Other countries in Europe did not lower the VAT rate during this period (though many did so later), thus constituting a potential control group.

We ask what happens to the number of visits to eBook-specific piracy sites in Ireland after the eBook VAT and consumer prices were reduced by 14%, relative to changes in this measure in

other EU countries that did not lower the VAT. We employ a synthetic control model and find that the shock to eBook prices in Ireland caused only a small and statistically insignificant decrease in total eBook piracy visits. However, we also break down eBook piracy visits into direct visits (people who navigate directly to piracy sites) and indirect visits (people who bounce to the piracy site from another site, most frequently a search engine). There is no statistically significant evidence of a change in direct eBook piracy site visits, which is consistent with the notion that these pirates have already sunk the fixed search and learning costs associated with piracy (Sivan et al. 2019) and thus neither notice nor care about the lowered legal prices. However, indirect pirates are less familiar with piracy and more likely to observe changes in legal options while searching for piracy websites. We find a statistically and economically significant 27% decrease in indirect piracy site visits caused by the lower eBook tax/prices. The magnitude of this decrease starts smaller and grows over time, reaching 35-45% in the final months of our study, a phenomenon that is consistent with prior literature on price salience and prior findings that search costs can play a key role in piracy.

Our research is important from both a managerial perspective and from an academic perspective. Managerially, if price can moderate the effect of indirect piracy on sales but not the effect of direct piracy, then price discrimination strategies that discount legal entertainment goods disproportionately for people who tend to engage in indirect piracy will improve profits. We discuss the feasibility of this in the final section of our study. From an academic perspective, prior research has analytically established the concept of heterogenous search costs across pirates (Gopal et al. 2006) and empirically demonstrated that these search costs impact piracy decisions (Sivan et al. 2016; Zhang 2018). We show using real world piracy data that consumers who navigate directly to piracy sites without searching do not change their behavior when the legal

price is reduced, and we provide evidence that this change in the legal price is neither salient nor relevant for these hardcore pirates. Meanwhile, consumers who have higher search costs still find the legal option relevant in their decisions and they are also more likely to discover the legal price while searching for piracy sites. Thus, these are the pirates most likely to be influenced by attempts to make the legal product more attractive.

2. Background and Framework

2.1. Mitigating the Effect of Piracy

Our work relates most generally to prior literature on piracy and legal consumption. Most early work in this literature focused on the effect of Internet piracy on legal sales, with the majority of papers finding a significant displacement effect (see Danaher et al. 2017 and Liebowitz 2013 for reviews of this literature). Other work asks how government policy can effectively combat piracy (e.g., Adermon and Liang 2014; Aguiar et al 2018; Danaher et al. 2014), with one study demonstrating that antipiracy policies are most effective when they substantially increase the search costs associated with piracy (Danaher et al. 2020).

Our study, however, is more closely related to a strain of research that asks what strategies firms can take to reduce piracy and mitigate its negative impact on legal consumption. Several studies demonstrate that convenient legal availability and access to content on digital channels can reduce piracy (Danaher et al. 2010; Lu et al. 2021), as can the timing of availability on these legal channels (Smith and Telang 2015). Usability of the legal option influences this decision as well, as Zhang (2018) found that the removal of digital rights management (DRM) protocols from music on iTunes caused an increase in paid legal music downloads on the store. Search costs of piracy options are also relevant, as Reimers (2016) founds that eBook sales increased by 14% when publishers enlisted an agent to send takedown notices to piracy websites that contained illegal

copies of their eBooks, and Sivan et al. (2019) found in an experiment that consumers chose the legal option more frequently when it was prioritized in search engine links.

2.2. Piracy and Legal Prices

A number of early analytical studies on piracy modeled the notion that firms could lower prices to combat piracy (Chellappa and Shivendu 2005; Sundararajan 2004), and that such lowered prices may affect consumer decisions (Khouja and Park 2007). Some analytical papers demonstrate that lower prices deter piracy (Geng and Lee 2013; Liu et al. 2011). Other survey-based studies found that higher legal prices encourage piracy (Bhattacharjee et al. 2003; Cheng et al. 1997). Ki et al. (2006) found a positive correlation between the average music CD price and piracy levels in a country. Cox and Collins (2014) analyzed a survey of over 6,000 individuals which included questions about attitudes and behaviors toward piracy. Respondents who were more likely to state that they could save money by pirating exhibited higher piracy rates in this survey. Ingram and Hinduja (2008) postulated that individuals rationalize piracy by telling themselves they would not "have to pirate" if the legal price were not so high, and Kukla-Gryz et al. (2021) found in a survey that a consumer's perception of the "unfairness" of the legal price correlates positively with the tendency to pirate.

Against this backdrop of research on the relationship between legal price and piracy, we test whether the deterring effect of reduced legal prices is observed in market data when a natural experiment shocks the legal price for some book readers but not others. However, synthesizing prior findings regarding the role of search costs in piracy and the presence of hardcore pirates, we also ask whether the effect of price on piracy is moderated by the type of pirate in question.

2.3. Price Salience and the Non-Financial Costs of Piracy

Although piracy is financially free, Gopal et al. (2006) note that pirates experience search/learning

costs to find and learn to use piracy sources. Danaher et al. (2010) provide evidence that a significant component of the cost of piracy is fixed rather than variable, Sivan et al. (2019) and Zhang (2018) empirically demonstrate that fixed search costs are quite relevant to the pirate or purchase decision. Reimers (2016) showed that taking down links to pirated eBooks increased book sales mostly by deterring "casual" pirates because it made their piracy search more difficult.

If fixed search and learning costs are a primary deterrent to piracy, then consumers who have already paid these costs may be the hardcore pirates described by Sinha et al. (2010) with willingness to pay (WTP) of zero for the legal good. For such pirates, whether an eBook costs $15 or is reduced to $10, the price of piracy is still $0. Such hardcore pirates would be unlikely to change behaviors in response to a modest reduction in eBook prices. Moreover, these hardcore pirates would be unlikely to even become aware of the lowered legal price in the market since they are navigating directly to piracy sites without searching.

Young (1980) outlines how consumers already participating in a particular market will observe and respond to changes in price, while non-participants in that market may lack awareness of changes in price. Further, both Blake et al. (2021) and Jessoe and Rapson (2014) empirically verify that price changes have diminished effects on behavior when they are less salient for consumers. Thus, pirates who have already sunk the fixed costs of piracy would be less likely to care about, or become aware of, changes in legal prices. As a result, they would be less responsive to such changes. Adding to this, experienced pirates may become anchored to the zero price of piracy that they repeatedly observe (Bassellier and Ramaprasad 2018), and thus again be less impacted by changes in the non-zero legal price.

In contrast, some consumers may be less experienced with piracy. These consumers have to search to find pirate sites with their desired content, and in doing so may also be exposed to the

legal price while searching for content. Because piracy still bears some cost for these searching pirates, when the lowered legal price becomes salient it may be preferable to searching and learning to use new pirate sites. Thus, we theorize that there are more and less experienced pirates, and that the less experienced pirates are the ones most likely to respond to changes in the legal price.

2.4. Direct and Indirect Piracy Visits

Though some prior studies have had access to piracy data, ours is the first of which we are aware to use data breaking down piracy visits into indirect visits mostly from searches vs. direct visits to piracy sites. Direct piracy visits are made by individuals who browsed straight to an eBook piracy site by typing it into the navigation bar, implying that most of these individuals are already quite piracy savvy and have paid the fixed search and learning costs for piracy. These could be referred to as hardcore pirates in that there is less incentive for them to consume legally and their awareness of changes in the legal channel may be limited. In contrast, indirect piracy visits are made by individuals who bounce from one website to a piracy site, with the first site usually being a search engine. These consumers are searching for where to acquire an eBook and thus still experience some degree of search costs associated with piracy. They may also see the legal price by chance when searching for piracy sites to acquire their desired media goods. A search for piracy will not always lead to discovery of the legal price, but will sometimes do so with probability between zero and one.

In Web Appendix A, we provide evidence that some typical searches for pirate sites return the legal price in top search results while other searches do not. This depends on a variety of factors including the exact terms in the search, the device on which the search was made, the book for which one is searching, and how much further a user navigates beyond the top displayed search results. Thus, the more a pirate searches, the probability that they will discover the legal price

increases. Once it is salient, it may affect their future behavior.

When such consumers finally discover the lower legal price, they may be incentivized to avoid the inconvenience of finding and learning to pirate an eBook. Given that the probability any given indirect pirate has been exposed to the lower legal price will increase over time, we might expect the proportion of indirect pirates for whom this price change is salient to likewise increase overtime. Thus, we might expect the total effect of a price reduction on all indirect pirates to increase over time as more individuals become aware of the price drop.

3. Background and Natural Experiment

The Value Added Tax (VAT) is a general consumption-based tax, payable on sales of products and services within the European Union (EU). According to EU's law, the *standard* VAT rate that applies to most non-exempt goods and services must be at least 15%, but member states choose their standard VAT subject to this constraint. The average VAT rate in the EU was 23% in 2021, with VAT rates ranging from 17% in Luxembourg to 27% in Hungary (Asen 2021). However, for specific "exempt" goods and services designated by the EU, member countries have the option to use *reduced* rates, which should typically be at least 5% (European Commission 2022).[2] Newspapers are an example of an exempt good.

The EU has historically allowed member states to tax printed books under the reduced VAT rates, but did not grant this exemption to eBooks, so EU members had to tax eBooks under their standard rates (Barbière 2015). On October 2nd, 2018, the EU's Economic and Financial Affairs Council (ECOFIN) agreed on a proposal to allow EU countries to apply reduced VAT rates to e-publications. The new directive -- Directive 2018/1713 -- was adopted on November 6th, 2018 (Council of the EU 2018).

[2] Under certain circumstances EU countries have been allowed to use special rates below 5% (and even zero) for a transitional period (European Commission 2022).

Starting in January 2019, several EU countries responded by reducing their VAT rates on eBooks. Some of the first countries to do so were Croatia, Ireland, and Portugal on January 1, 2019, followed by Belgium (April 1, 2019), Finland (July 1, 2019), and Sweden (July 1, 2019). (Asquith 2018). A decrease in the VAT on eBooks, however, only affects the consumer-facing price if the retailers (who pay the VAT to the government after a sale) choose to pass the decrease through instead of keeping it as profit. We emailed major eBook retailers in all six countries where the VAT was reduced during the time period of our data, asking them whether they reduced the price in eBooks in response to the VAT reduction. Only one retailer in Ireland emailed us back, confirming that they *"kept our VAT-exclusive price the same for all our ebooks, so the reduction (14%) was passed on to customers"*. However, we also gathered data on eBook prices at major eBook retailers in each country before and after the VAT reductions. In section 4.2 we provide strong evidence that Irish retailers did indeed reduce eBook prices by 14% on average as a direct result of the reduced VAT, while retailers in Portugal and Belgium did not pass on the savings to consumers. Thus, our study focuses on Ireland as the treated country and other European countries that did not lower the VAT (during our study) as a control group.[3] We also provide evidence around Belgium and Portugal as placebo tests, where the VAT was reduced but the consumer-facing price of eBooks did not change.

4. Data

4.1. Ebook Piracy Data

We obtained eBook piracy data from MUSO, a leading piracy-tracking company based in London. MUSO scans and catalogues piracy sites on a daily basis via algorithmically and manually analyzing DMCA copyright claims filed against different websites. As such, MUSO maintains a

[3] Importantly, exhaustive searches on LexisNexis and Factiva focused on news and blog reports in Ireland returned no new policies or events likely to impact piracy in Ireland during the window of our study.

database of over 100,000 piracy domains. Such a comprehensive database allows MUSO to track the number of daily visits from each country to websites associated with all major forms of piracy activity such as web downloads and public/private torrents across more than 200 countries and territories around the globe. MUSO's data has recently been used in academic studies (e.g., Lu et al. 2021) as well as government working paper series (e.g., Blackburn et al. 2019, EU IPO 2019).

MUSO's data further classifies piracy visits based on type of content illegally available on the domain: film, TV, music, software, and eBooks/publishing. MUSO uses a proprietary algorithm to attribute each visit to a piracy site to the type of content on the page that the visitor then viewed. Our interest is in the last category, eBooks/publishing. Moreover, MUSO distinguishes between direct visits to a piracy site (i.e., when a user types a specific domain in the address bar) and indirect visits (i.e., when a user bounces to a piracy site from a search result or a link). While visits to piracy sites may not correspond to pirated downloads on a 1-for-1 basis, they serve as a proxy for the total amount of piracy that occurs in each country on each day.

4.2. Ebook Prices and Sample Selection

We obtained piracy visits related to eBook content in 2018 and 2019 in all EU countries from MUSO. Because MUSO materially changed their tracking methodology in August 2019, we focus on the time period between January 2018 and July 2019. In order to focus on countries with high signal to noise ratios, we drop countries with populations below one million, where piracy visits experience relatively large random fluctuations from week to week.[4] This leaves us with 25 European countries in our data.

During the time period of our data, six of these countries reduced their e-publication VAT

[4] The average absolute week-to-week percent change in our outcome is nearly twice as large for countries below 1m in population as it is for countries above 1m. Thus, dropping these very small countries reduces the variance in our estimates. These small countries also have poor documentation regarding the timing of any VAT reduction. However, all results in this study hold in sign and significance with a higher population cutoff of 2m.

rates: Croatia, Ireland, Portugal (January 1st, 2019), Belgium (April 1st, 2019), Finland, and Sweden (July 1st, 2019). While one major retailer in Ireland informed us that they passed the VAT reduction to consumers in the form of lower prices, we need more systematic evidence as to which countries actually experienced lower consumer-facing eBook prices as a result of the VAT reductions. To obtain this, we turn to the Wayback Machine (WBM), which stores copies of many webpages on a number of different historical dates.

One of the leading (top five) eBook market retailers in Europe is Kobo.com (Mordor Intelligence 2023), which operates in 27 European countries including Ireland, Portugal, and Belgium. Kobo is estimated by Forbes (Cheng 2018) to have nearly 15% of the eBook market share in the US and a larger market share in European countries, an assessment echoed on Kobo's own website.[5] Unfortunately, WBM stores very few webpages at Kobo for individual books. However, WBM does frequently log the main page for Kobo in all three of these countries – for example, www.kobo.com/ie/en, the main Kobo page in Ireland, is logged several times per month. This main page includes many popular eBook titles and their associated prices. The titles change over time, and so the number of titles for which we can find both a pre-VAT reduction price and post-reduction price will decrease as we look further past the VAT shock. We recorded the prices of all titles available on Ireland's main Kobo page on December 27th, 2018 (just before the VAT reduction), and then found the prices of the same titles still available on Kobo's main Ireland page on Jan 15th, 2019 (two weeks after the reduction). We repeated this for Feb 13th, June 16th, and July 10th, the dates logged by WBM. We also check Nov 18th, 2018, to see if prices were changing for these titles before the VAT reduction. In Table 1 we report the number of titles jointly displayed on the main page on Dec 27th, 2018, and the date in question, as well as the within-title average

[5] https://www.kobo.com/news/kobos-bet-to-double-down-on-passionate-booklovers-pays-off-q1-ereader-sales-up-145-year-over-year

price change between Dec 27th and the date in question.[6]

Table 1 - Retail Price Change in Ireland in Response to VAT Reduction

	Before VAT Reduction		*After VAT Reduction*			
	18-Nov-18	27-Dec-18	15-Jan-19	13-Feb-19	16-Jun-19	10-Jul-19
Within-title avg price change compared to Dec 27	0%	*121 Titles*	-5%	-14%	-13%	-15%
# of Matching Titles	67		53	38	18	16

In Table 1, we see that 121 eBook titles were displayed on Kobo's main page in Ireland on Dec 27th, 2018, just before the VAT reduction. Of these titles, 67 of them were also on the main page on November 18th, over a month prior. The average change in price for those titles was 0%, implying that Kobo was not decreasing prices on the eBooks listed on this page prior to the VAT reduction. In contrast, on Feb 13th, 2019 (about 7 weeks after the VAT reduction), the average within-book price change was a price drop of 14%. This price drop remains consistent through July 2019, when our piracy data end. We note that the VAT reduction in Ireland was 14%, coinciding nearly perfectly with the reduction in price of the average book on the main Kobo page in Ireland. Although Kobo is just one retailer in Ireland, it is a dominant platform and other platforms would have had to have similarly lowered prices in response to the VAT in order remain competitive. Coupled with the statement from one of these smaller retailers, Oak Tree Press, that they indeed passed the VAT reductions through to consumers, we take this as evidence that the 14% VAT reduction in Ireland indeed led to a reduction in the retail price in Ireland.

One might ask whether there was a corresponding price reduction in the control group. We were able to find historical listings for the main page at Kobo for France, Germany, Cyprus, Slovakia, and Estonia, five of the countries within our control group. We found 486 titles available

[6] To avoid capturing idiosyncratically exaggerated percentage-wise changes in price of eBook titles, in this analysis and the following analyses in Belgium, Portugal, and control countries, we only focused on eBooks that were above 4 Euros on 27 Dec, 2018. Similar patterns emerge if we use a cutoff of 3 or 5 Euros.

on these pages on December 27th, 2018, and found 130 of these titles still available on February 13th, 2019. The average change in price of these titles in control group countries was less than a 1% decrease and in most countries the change was zero.

Finally, we do not include Sweden or Finland either in the control group or the treated group because their VAT tax reduction occurs just 4 weeks before our data end and thus they can have little impact on our results either way.[7] For Croatia, it appears the WBM did not archive any eBook retailer webpages prior to 2020 and thus we ignore this country because we cannot ascertain whether the VAT reduction led to a retail price reduction or not.

Belgium and Portugal are interesting cases. Portugal reduced the VAT in January 2019 while Belgium did so in April 2019. In Table 2, we replicate the process we used for the Irish main page of Kobo for each of Belgium and Portugal. We can see that although Portugal reduced the VAT on eBooks, there is no evidence of a corresponding retail price change. Two weeks after the VAT reduction, for the 66 books still on the main page (from the 129 that were there just before the VAT change), the average price change was 0. Six months later, for the books that we can still observe, there was still no change in price. In Belgium, we find similar results with only a very modest *increase* in price for the average eBook.[8]

Table 2 - Retail Price Changes in Portugal and Belgium After VAT Reduction

Portugal	*Before VAT Reduction*	*After VAT Reduction*	
	27-Dec-18	15-Jan-19	16-Jun-19
Within-title avg price change compared to Dec 27	N/A	0%	0%
# of Matching Titles	129	66	12

[7] On the WBM we do find evidence that retailers in Sweden and Finland reduced retail prices commensurately with the VAT reduction, which would imply that they are treated countries. Our models focus on Ireland as the sole treated country because we have only four weeks of post-treatment data for Sweden and Finland, but all of our results are robust to including these two countries as treated units and estimating a leads-lags version of our model.
[8] Fixed book pricing regulations in Belgium might have posed obstacles for publishers looking to decrease the prices of certain, but not all, eBooks. We thank an anonymous reviewer for bringing this issue to our attention.

Belgium	*Before VAT Reduction*	*After VAT Reduction*	
	27-Mar-19	10-Apr-19	16-Jun-19
Within-title avg price change compared to Mar 27	N/A	1%	2%
# of Matching Titles	140	59	20

In summary, of the six countries that reduced the eBook VAT during the period of our data, only for Ireland do we have sufficient data and clear evidence that the 14% VAT reduction led to an approximate 14% reduction in price. For Sweden and Finland, we do not have a long enough post period to conduct a meaningful analysis. For Croatia, we can find no historical pricing data for eBooks. For Belgium and Portugal, we find evidence that the VAT reduction did not cause a decrease in eBook prices, which allows us to use them as placebo tests in our analysis. (The VAT was reduced showing an "intent to treat", but there was no shock to the legal prices faced by consumers). Finally, for the control group of European countries that did not decrease their VATs, we have shown that within-book price changes were minimal, averaging near 0. Table 3 summarizes the status of different EU countries as used in our study.

We aggregate daily country-specific visit data to create a weekly measure of eBook piracy visits by country. We take the natural log of this outcome variable, both because piracy visits are right skewed and because we would a priori expect that EU country trends to be more similar on a relative basis (as opposed to a level basis) owing to large differences in country populations.

Table 3 – Selection of Countries

Country	**Assignment**	**Reason**
Ireland	Treatment	14% VAT reduction led to 14% price drop
Belgium, Portugal	Placebo	VAT reduction led to no change in price
Finland, Sweden	Dropped	Only 4 weeks of post-treatment data
Croatia	Dropped	Could not verify pricing
Poland	Dropped	VAT reduction announced during our study, then delayed until later
Austria, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Italy, Latvia, Lithania, Netherlands, Romania, Slovakia, Slovenia, Spain	Control	No VAT reduction during our period of study

4.3. Summary Statistics for Piracy Visit Data

Table 4 displays summary statistics for piracy visits across treated and control countries. In addition to aggregate piracy views, we consider two subsets of piracy views based on the source of traffic by which individuals accessed the piracy website, i.e., direct and indirect visits. We also present statistics for the control countries throughout the period of our data.

Table 4 yields several interesting insights. First, the magnitude of weekly piracy visits in the publication/eBook industry is enormous. Even if only a small portion of these visits are substitutes for legal purchase of eBooks, these numbers suggest that publishers in the EU are losing millions of dollars each week. Second, the median of piracy visits appears comparable across treated and control countries, though treated countries are more right-skewed. Third, approximately one-third of visits are indirect visits while two-thirds are direct visits.

Table 4 – Summary Statistics

	Weekly Direct Visits				*Weekly Indirect Visits*			
	Control		*Treated (Ireland)*		*Control*		*Treated (Ireland)*	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Min.	74,384	117,876	441,360	656,669	59,569	57,804	272,703	244,345
Median	1,213,710	1,371,404	616,594	698,614	588,775	545,587	310,442	273,963
Mean	2,922,704	3,497,389	577,417	704,359	1,323,280	1,341,955	311,192	273,763
Max	20,358,964	22,180,208	681,194	774,977	7,708,637	9,643,837	379,399	307,287
Obs.	918	558	51	31	918	558	51	31
Countries	18	18	1	1	18	18	1	1

We also obtain data on macroeconomic variables that might influence piracy consumption in a country. We utilize annually time-varying measures of population, GDP per employee, and broadband internet connectivity per 100 from the World Bank's World Development Indicators (WDI). These measures vary considerably across the EU countries in our data. For example, broadband penetration rate ranges from approximately 26% (Romania) to 46% (France).

5. Empirical Model and Results.

Our basic empirical approach is to use countries that have not yet experienced the VAT decrease as a counterfactual for Ireland, where the VAT decrease was implemented and caused a 14% decrease in the retail price of eBooks. We start with a difference-in-differences (DiD) model.

5.1. Difference-in-Differences Model

We specify our initial difference-in-differences model as follows:

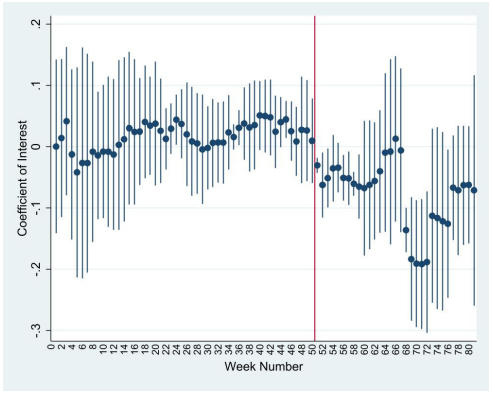
$$\ln (Piracy\_Visits)_{it} = \beta_1 week_t + \beta_2 week_t * treated_i + \sum \theta * Macro_{it} + \mu_i \quad (1)$$

where $Piracy\_Visits_{it}$ is the number of eBook piracy sites visits in country i during week t, $week_t$ indicates a vector of week fixed effects, $treated_i$ is a dummy variable equal to 1 for Ireland and 0 for all other countries, and μ_i is a vector of country fixed effects. $Macro_{it}$ is macroeconomic controls that vary within country over time including GDP per employee, population, and broadband connections per 100 capita. β_2 is then the coefficient of interest, indicating the degree to which Ireland's outcome variable changes week to week over and above the control group.

To trust that the parallel trends assumption is reasonable, one would want to observe that β_2 is jointly zero for all weeks prior to the week of treatment. We estimate (1) for each of our outcome variables – total, direct, and indirect piracy visits - and plot β_2 for each week along with its 95% confidence interval below in Figure 1.

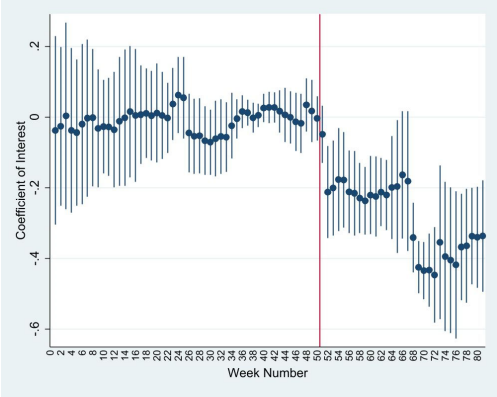
Figure 1 – Difference Between Ireland and Control Group Over Time

a. Total Visits



b. Direct Visits

c. Indirect Visits



While there may be some interesting post-treatment changes visible in these figures, there are two clear problems with this difference-in-differences analysis. First, in all three graphs we note potential violations of the parallel trend assumption during the pre-period. These pre-existing trends do not appear to be parametric or easily incorporated into the diff-in-diff model, thus is it unlikely that the assumptions required for causal inference in our model are satisfied. Second, although panel fixed effects estimation packages in R and Stata will estimate standard errors for the coefficient of interest, they are not valid in our case. Because we cluster standard errors at the country level and there is only one treated country, the asymptotics of clustered standard errors do not hold. These two problems – pre-existing differential trends and only a single treated cluster – are exactly the scenario for which the synthetic control method was developed (Abadie et al. 2010), and so we turn our analysis to that model.

5.2. Generalized Synthetic Control

Abadie et al. (2010) introduced the synthetic control method, in which a weighted combination of control units is used to create the counterfactual (i.e., the synthetic control). The synthetic control method assigns different weights to control units in a data-driven manner so that the resulting synthetic control for the treated unit approximates the actual treated unit on different features (e.g., outcome and other covariates) during the pretreatment period. The traditional synthetic control

approach does not produce conventional frequentist uncertainty estimates (e.g., standard errors). To overcome these limitations, Xu (2017) proposed the Generalized Synthetic Control (GSC) which, among other things, produces estimates of uncertainty. Moreover, GSC combines the synthetic control methodology with interactive fixed effects (IFE) model that incorporates unit-specific intercepts interacted with time-varying coefficients, which account for time-varying confounders.[9]

Following Xu (2017), we specify the following GSC model:

$$\ln\left(Piracy\_Visits\right)_{it} = \delta_{it}D_{it} + X'_{it}\beta + \lambda'_i f_t + \varepsilon_{it} \quad (2)$$

Piracy_Visits$_{it}$ represents the number of eBook piracy sites visits in country i during week t. D_{it} is the binary treatment indicator which equals 1 if treated country i (i.e., Ireland) has reduced its eBook VAT rate prior to week t. δ_{it} is the treatment effect on country i at week t. X_{it} is a vector of observed covariates that may relate to piracy visits in a country. In our case, we include the macro-economic variables discussed earlier: population, GDP per employee, and broadband penetration. λ_i and f_t are (r*1) vectors of latent factors and factor loadings, with r representing the optimal number of factors. This is chosen based on optimizing model performance (GSC selects r that minimizes MSPE). The factor component of the model takes a linear and additive form and covers a wide range of unobserved heterogeneities (Xu 2017). Finally, ε_{it} is the unobserved idiosyncratic shock for country i at week t, and has a mean of 0. We use the gsynth package in R and estimate a separate GSC model for each of overall, direct, and indirect eBook piracy visits.

Figure 2 plots the average difference between observed total, direct, and indirect piracy visits in Ireland and the estimated piracy visits in the corresponding synthetic control. Across all three plots, the pretreatment difference is close to 0, suggesting that the synthetic controls are performing

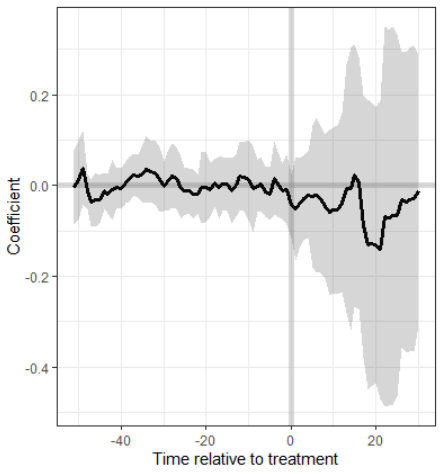
[9] For recent applications of the GSC method in the IS literature see He et al. (2020), Ramasubbu and Bardhan (2021), Wang et al. (2021), and Wang et al. (2022).

adequately in mimicking the treated units. As for posttreatment differences, visual inspection of the plots in Figure 2 suggests a small, insignificant decrease in total piracy visits and no change in direct piracy visits. However, there is a large decrease in indirect piracy visits, which appears to grow dynamically over time.

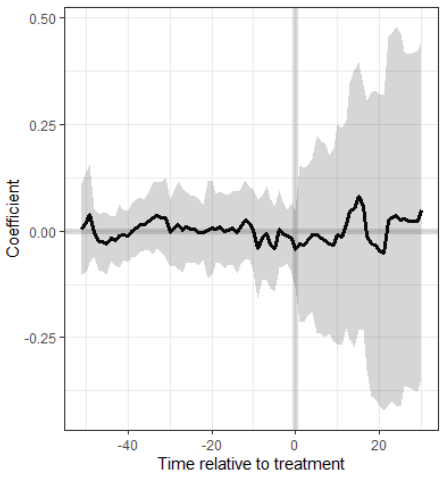
The main parameter of interest that summarizes the effect of treatment in GSC is the average treatment effect on the treated (ATT). Table 5 summarizes the ATT for each outcome variable. ATT is negative but statistically insignificant for overall visits (ATT=-0.049; p=0.675), while it is nearly 0 for direct visits (ATT=0.004; p=0.977). Indirect visits however decrease considerably (ATT=-0.319; p=0.047), and the effect is significant at 0.05 level. Notably, this coefficient represents the ATT across the entire posttreatment period, but it appears as if the effect grows dynamically over time as indirect pirates become aware of the lowered legal prices. If we drop Q1 and Q2 and run the model with only Q3 in the post-period, we observe an ATT of -0.499 with a p-value of <0.001, indicating a 39% decrease. In Web Appendix B, we further provide additional details regarding the GSC results for indirect piracy visits in Ireland.

Figure 2 – GSC Results (Estimated ATT)

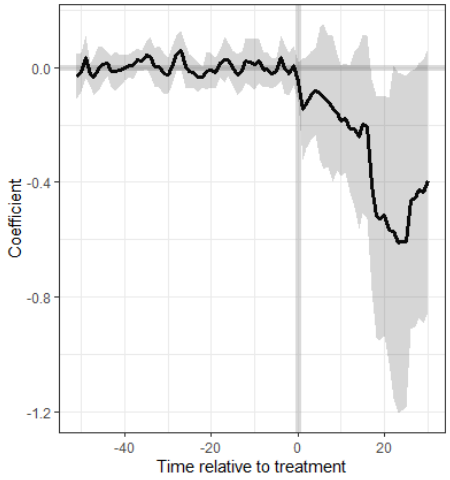
a. Total Visits



b. Direct Visits



c. Indirect Visits[10]



Thus, our generalized synthetic control model appears to perform well in simulating a control unit with similar pre-period trends to Ireland, and it demonstrates that indirect pirates reduced their piracy significantly in response to the price reduction in Ireland while direct pirates ignored the change in price. These findings are consistent with the hypotheses laid out in section 2.

Table 5 – Summary of GSC Results

	Total Visits	*Direct Visits*	*Indirect Visits*
ATT	-0.049	0.004	-0.319
Std. Err.	(0.119)	(0.148)	(0.161)
C.I. Lower	-0.283	-0.287	-0.636
C.I. Upper	0.183	0.295	-0.003
p-value	0.675	0.977	0.047

5.3. Placebo Tests

One might ask whether Ireland passed the VAT reduction in anticipation of some trend in eBook consumption. Fortunately, we have two countries that experienced an intent-to-treat without an actual treatment. In both Belgium and Portugal, the VAT on eBooks was reduced but our data from the WBM clearly demonstrate that the retailers did not pass this reduction on to consumers in the retail price. Thus, we can perform our analysis on these two countries to test whether an

[10] Standard errors are produced by 1000 bootstraps. Shaded areas represent the 95% confidence interval.

effect is observed in the absence of an actual price reduction. Because GSC allows for multiple treated units, we perform our placebo test using Belgium and Portugal as the treatment group, but results are similar if the model is applied to either country individually. Estimates of the ATT in this placebo test are provided in Table 6. The combined ATT in Portugal and Belgium – two countries whose legislators took advantage of the VAT reduction but where retailers did not pass the price decrease through to consumers – is close to 0 and statistically insignificant. This falsification exercise provides validation that our results for Ireland are likely to have a causal interpretation.

Table 6 – Summary of GSC Results for Placebo Test on Belgium and Portugal

	Direct Visits	*Indirect Visits*
ATT	0.063	0.071
Std. Err.	(0.082)	(0.111)
C.I. Lower	-0.098	-0.147
C.I. Upper	0.224	0.289
p-value	0.443	0.521

5.4. Changes in Legal eBook Consumption

A logical assumption might be that any reduction in eBook piracy visits caused by a decrease in the legal price of eBooks must be the result of potential pirates opting for a legal purchase instead. If so, then we would expect to see an increase in eBook sales in Ireland after the retail price dropped, relative to other countries in which the retail price remained unchanged. To this, we use data on legal eBook consumption from Statista's *Digital Market Outlook* reports. Unfortunately, Statista's reports provide only annual data on various metrics related to legal eBook consumption, and thus we cannot estimate a granular difference-in-difference model as we did with piracy. However, recall that Ireland's VAT change occurred in January 2019 and the retail price decrease was fully realized by February. Thus, it is reasonable to compare growth metrics in 2019 vs. 2018 for Ireland and for the control countries: a) revenue growth, b) growth in eBook penetration rate,

and c) growth in average revenue per user (ARPU). This analysis is summarized in Table 7.

Table 7 – Analysis on Legal eBook Consumption

	Revenue		*eBook Penetration*		*ARPU*	
	Control	Ireland	Control	Ireland	Control	Ireland
Growth Rate (2019 vs. 2018)	2.6%	5.5%	2.5%	1.4%	0.0%	2.8%

Note. Mean growth rate reported for the control countries.

In Table 7 we observe that the eBook revenue growth rate in Ireland more than double that of the control countries (5.5% in Ireland compared to 2.6% in the control), consistent with the idea that some piracy converted to legal purchases. The growth in eBook penetration – the size of the customer base - in Ireland was less than that of the control group, implying that the price drop did not convert any non-legal customers (most likely to be direct pirates) into paying consumers. However, the ARPU growth in Ireland was 2.8% while it was 0% in the control group, which suggests that individuals who were already legal consumers increased their spend on eBooks.

One potential explanation for this is that indirect pirates may be more likely to also sometimes be paying consumers, and thus the conversion of indirect pirates to the legal channel would increase ARPU more than increasing the size of the customer base. But even then, it seems unlikely that all indirect pirates were also legal eBook consumers.

A more compelling explanation starts with the fact that our model captures a local average treatment effect – i.e., the increase in the eBook purchases stemming from pirates who are enticed by a lower price. E-readers (e.g., Kindle, Kobo Reader, Nook) are the preferred mode of eBook consumption for most individuals. For example, in 2017, 67% of eBook readers in the UK used them for this purpose (Kunst 2019). These devices generally cost more than $100. Pirates who did not previously purchase any eBooks may have to cover the fixed cost of a device to go legal, and a 14% drop in the price of a book in which they are interested may not justify this. In contrast, indirect pirates who were also sometimes paying for eBooks have already sunk the cost of the

device and would be more likely to respond to a change in the price of eBooks.

The bottom line is that our empirical evidence points toward direct pirates being difficult to recover as paying customers, but indirect pirates being potentially swayed by changes in legal prices or other legal strategies, particularly if they have already sunk the cost of an eReader. Also, as we show in Web Appendix C, the reduction in eBook prices in Ireland also led to a 13% increase in consumers' searches for terms related to eBooks.

6. Discussion

Our research tests a prior finding from related research that lowered legal prices can deter piracy, but in the context of a natural experiment that shocked the legal price in one market but not others. The nature of our data also allows us to test a hypothesis that is based on several studies in Information Systems that demonstrate the importance of search in piracy. Specifically, we test whether pirates who search to download respond differently to the price change than pirates who do not.

We find that direct eBook piracy is not affected by the decrease in the price of eBooks that resulted from lowered tax rates. However, we find evidence that these price decreases reduced indirect eBook piracy visits by at least 27%, an effect that starts smaller and grows larger over time as indirect pirates become aware of the lower prices. Consistent with this, we do not find evidence that the size of the legal eBook customer base grew in Ireland when the VAT change caused a negative shock to eBook prices, but we do find evidence that the average revenue per existing customer increased more in Ireland than in unaffected countries.

Because pirates who navigate directly to piracy sites have already paid the fixed search and learning costs for piracy, the legal price is of little interest to them, nor are they likely to notice changes in this price since they do not search. Indeed, for these pirates, there seems to be some

truth to the adage “you cannot compete with free”.

However, pirates who use search engines and navigate to piracy sites through links are less likely to have sunk these fixed search and learning costs. For them, there is a comparison to be made between the non-financial cost of piracy and the comparatively simple (but pricier) legal option. Also, because they search, they are more likely to observe changes in the legal option, including its price. For these pirates, strategies that make legal content more appealing or convenient may persuade them to purchase, and in our study we find that they decrease their piracy when the legal price is decreased.

6.1. Managerial Implications

Because piracy visits are unlikely to map one-for-one with actual illegal downloads, we cannot interpret the 27% decrease in indirect visits as an elasticity. Pirates may make several site visits for each illegal eBook download. However, there are other insights to be gleaned from our results.

Because direct pirates do not appear to be influenced by an average 14% change in effective eBook price, but indirect pirates do, our results naturally imply a price discrimination policy based upon data on the proportion of piracy coming from direct visits vs. indirect visits. For example, MUSO’s data show considerable variation in the ratio of indirect-to-total eBook visits in the publishing industry across the EU countries. Some countries like Cyprus (41%) and Bulgaria (37%) have a higher ratio of indirect-to-total visits. Price reductions are more likely to be effective in converting pirates and thus optimizing profits in such countries. On the other hand, countries like Hungary (24%) and Slovenia (26%) have the lowest ratio of indirect-to-total eBook piracy visits in the EU. Decision makers should be cautious in using price reductions as a means to deter piracy here as the cross-price elasticity of demand with respect to piracy will be less elastic in these countries.

This is just one example. Entertainment firms frequently segment their audiences based on demographics, psychographics, behavior patterns on social media, etc. If copyright holders can obtain data about the indirect-to-total piracy visit ratio of certain segments, they can use this information to selectively target pirates for conversion. As a simple example, if we knew that males tend to make direct visits for eBook piracy, but females tend toward indirect visits, this would suggest that a coupon discount program targeting females (while retaining a higher price for males) might be an effective strategy for combatting piracy and optimizing profits.

Finally, though our study does not have direct evidence of this, the fact that direct pirates do not appear to take notice of the price decrease suggests that other strategies that make legal content more appealing may similarly hold little sway with direct pirates. This may explain why prior research on legal strategies such as digital distribution, streaming distribution, timing of legal availability, or useability/portability of the legal version have never yielded decreases in total piracy beyond 20-30%. Direct piracy (which in some countries can be up to 80% of eBook piracy) may be relatively impervious to many of these strategies. When these strategies do reduce piracy, it seems more likely that it is indirect pirates who are shifting consumption toward legal channels. Search, it appears, may play a key role in which pirates can be targeted for conversion.

6.2. Limitations and Future Research

Our findings come with several limitations. First, because of the change in the piracy tracking algorithm at MUSO, we were only able to observe the first seven months after the eBook price changes went into effect. Since the ATT appeared to be growing dynamically, it is possible that we understate the long-term effect of the price reductions on indirect piracy. Second, our data only allowed us to examine the effect of a 14% price reduction in Ireland. After our data end, additional countries reduced the VAT on eBooks and if retailers reduced the price in response then additional

data might allow us to determine whether there is heterogeneity in the effect of legal price across countries. Third, our research focused on the effect of legal price on piracy for only one type of good: eBooks. These findings may generalize to other media goods like film or television, but it is unclear if they will generalize to other pricing models. Though a la carte sales are still the primary form of distribution in eBooks, in film and television, the bundled strategy of monthly subscription services is becoming the dominant revenue channel. In music, bundling has already overtaken the market. It could be argued that pricing decisions by streaming platforms (e.g., Netflix, Spotify) could have a different relationship with digital piracy, as a change in subscription prices on these platforms affect consumers' access to millions of digital goods.

Our study opens a new question: if direct pirates are impervious to moderate reductions in the price of legal goods, are they lost to artists and companies who are trying to monetize their creative works? Future research might focus on whether there are levers other than price that content creators can shift to entice direct pirates back to legal channels or if nothing short of regulatory action can influence such piracy.

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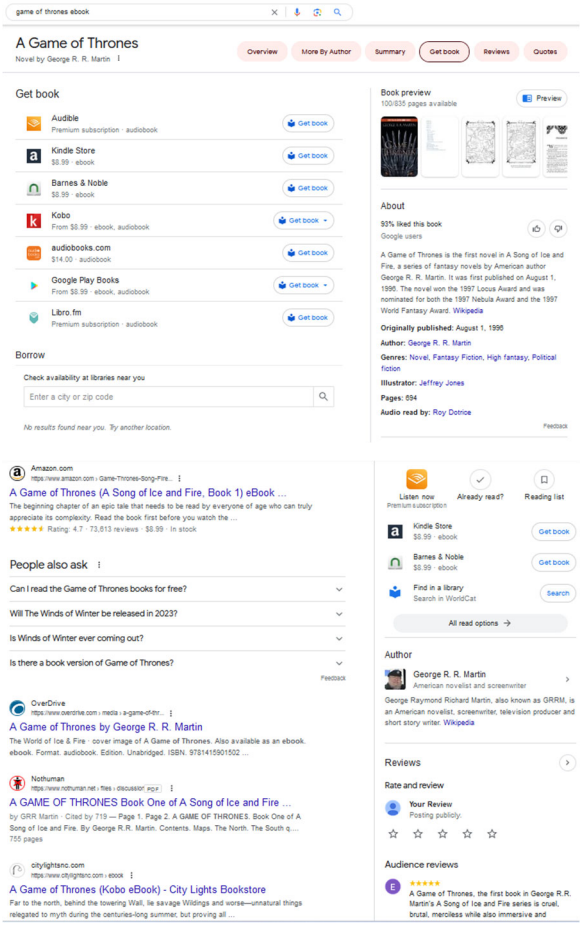
WEB APPENDIX

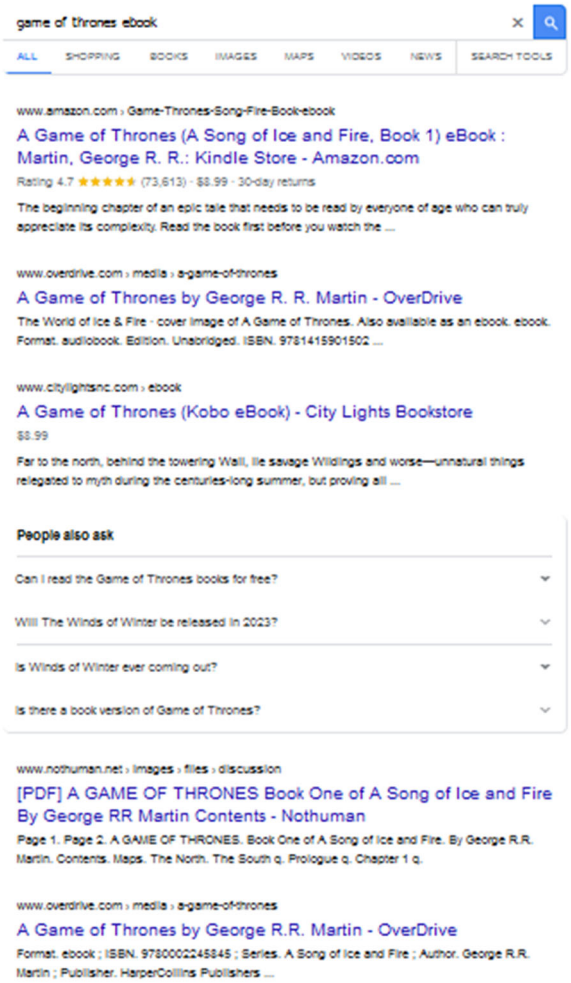
Web Appendix A. Price Salience for Indirect Pirates in Google Search Results

Exposure to and saliency of legal eBook prices while searching for illegal piracy sources can vary depending on several factors including the terms and device used to conduct said search. To demonstrate this fact, we emulate search results for a variety of eBook piracy related terms on both PC and tablet devices in Ireland using isearchfrom.com.

I. PC vs. Tablet

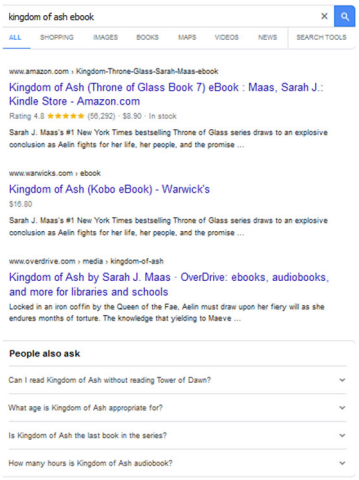
While the top five search results for "<book title> ebook" include both paid (legal) and free (illegal) sources, as well as legal price, legal sources and price are much more prominently displayed in the layout of results given a PC (left) than they are on a tablet (right) type device.

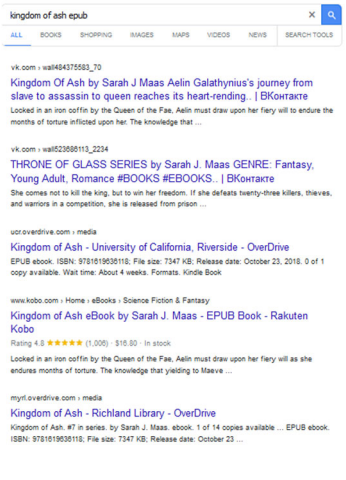


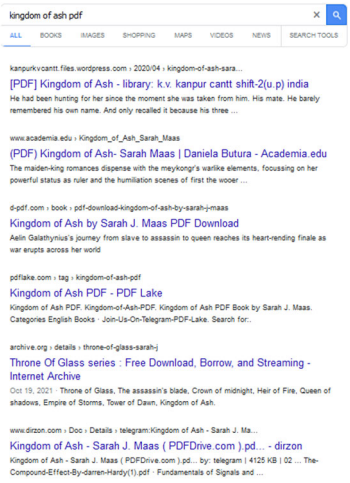


II. File type

One common technique when searching for pirated eBooks as discussed via online forums[11] is to search for specific file types instead of just titles. Depending on the file type and title, top results of such searches may or may not include both legal and illegal sources, which in turn may or may not display the legal purchase price on the search engine's results page.

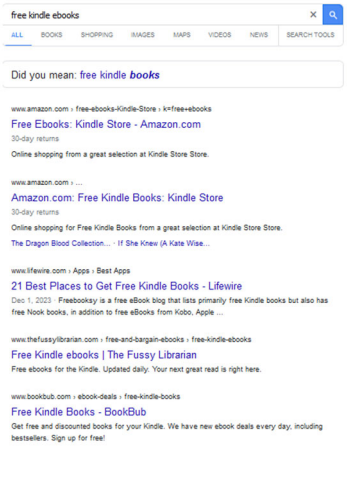


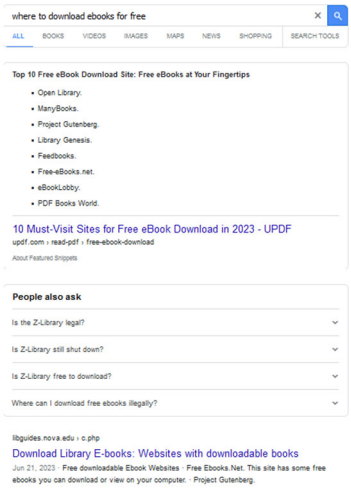


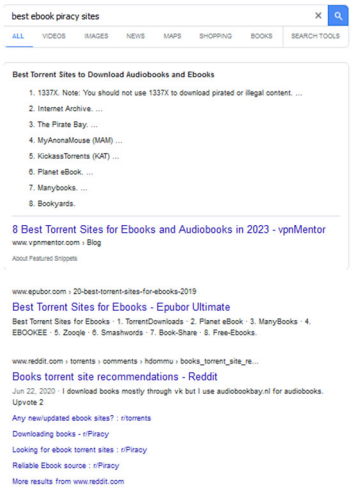


III. Generic search for eBook sources

When searching for free eBooks generically, the top results will not necessarily display legal sales prices on the search engine results page. However, the result may include references or direct links to mix of sites providing legal and illegal eBooks depending on how explicitly the intent to pirate is reflected in the search terms used.



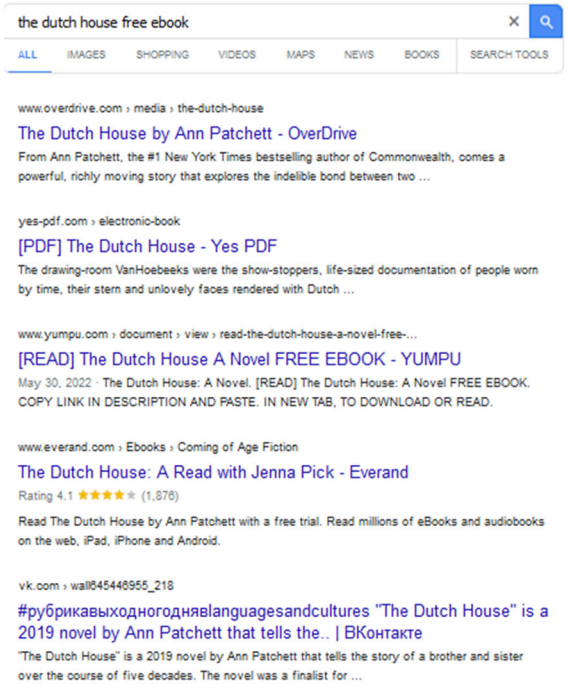


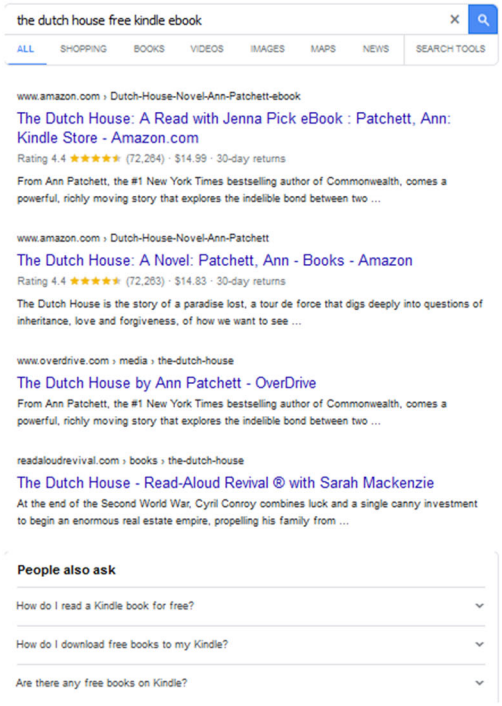


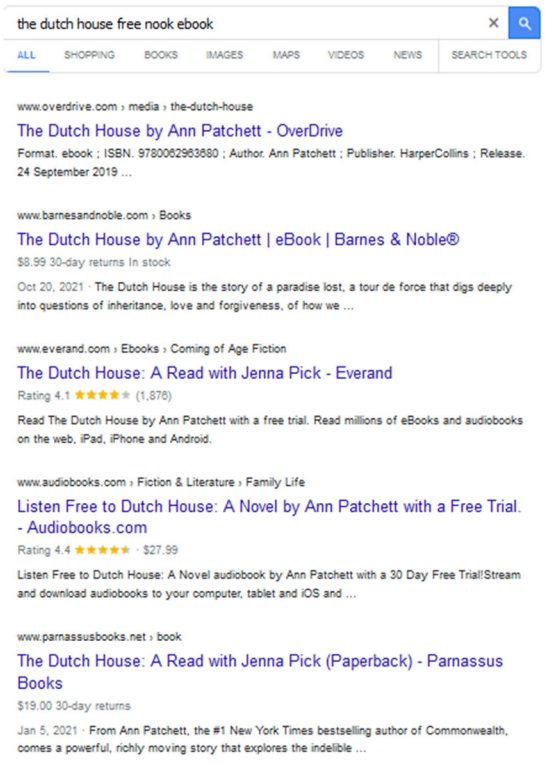
[11] https://www.reddit.com/r/Piracy/comments/oivbo2/yandex_ebook_search_terms/

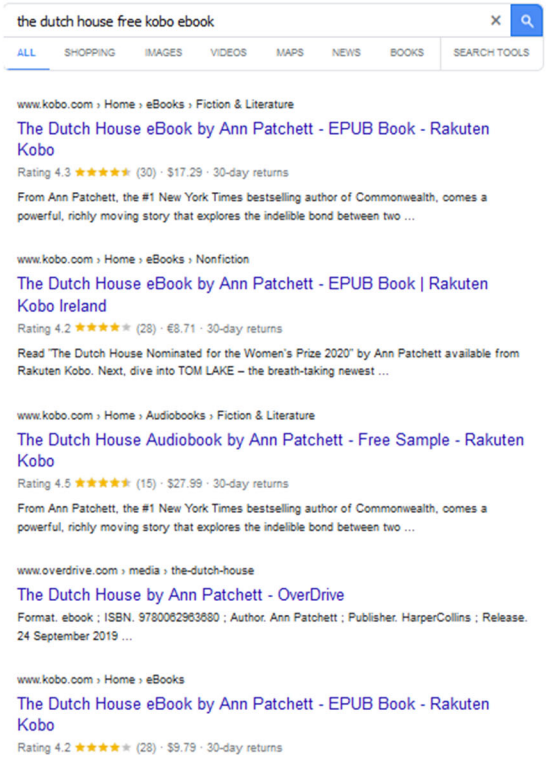
IV. eReader specific

In some cases, including the name of a specific eReader may return a different mix of legal and illegal sources including more or less prominent displays of the legal price on the search engine results page, even when words such as “free” are included in the search terms.

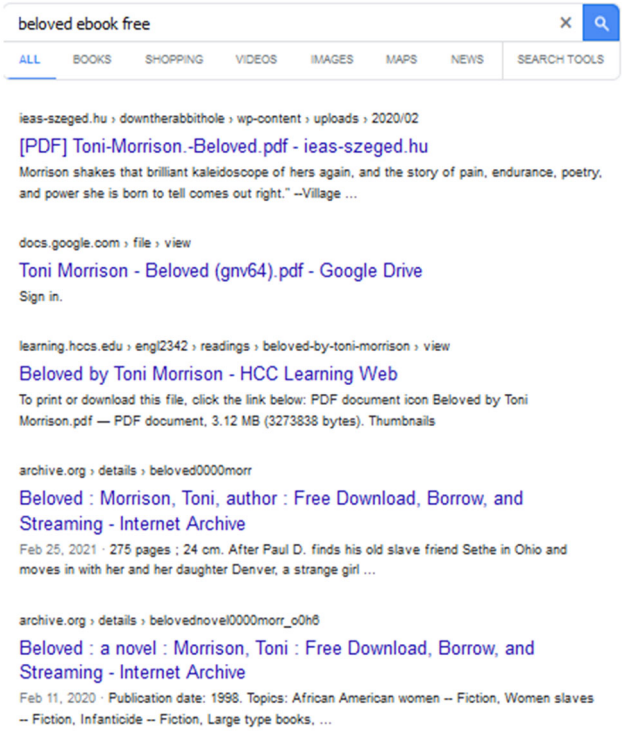


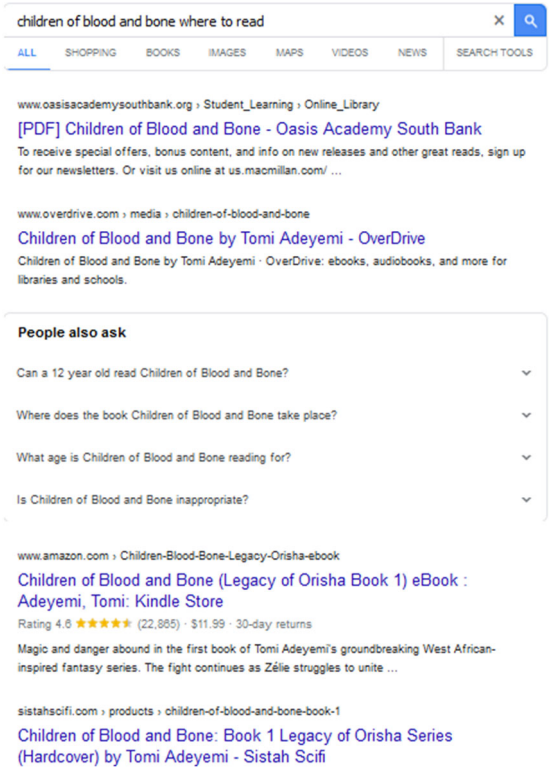


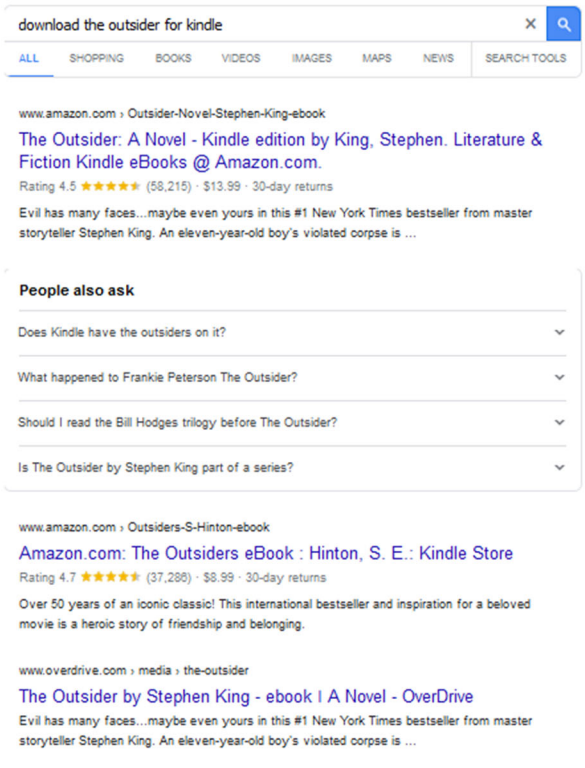


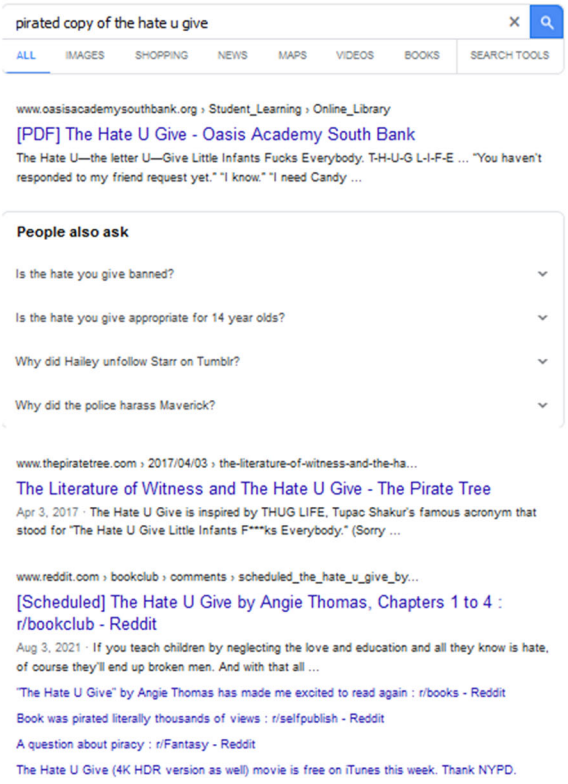


V. Miscellaneous search terms







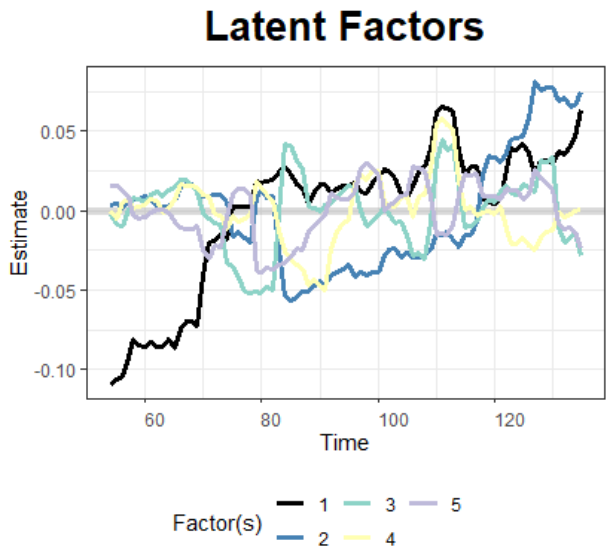


Web Appendix B. Generalized Synthetic Control Details

In this section, we provide additional details regarding the generalized synthetic control (GSC) results for indirect piracy visits in Ireland.

I. Latent factors:

The GSC model for indirect visits converged on a five-factor solution. The five latent factors are depicted in the figure below:



Below, we present estimated loadings for each of the five factors for each control country:

	Factor1	Factor2	Factor3	Factor4	Factor5
Austria	-0.163	-0.151	0.223	-0.437	0.167
Bulgaria	1.800	-0.256	-1.266	-1.338	-0.639
Cyprus	1.291	-0.148	0.341	-1.482	0.483
Czech Republic	0.133	0.212	-0.157	1.064	0.767
Denmark	-0.077	1.809	-1.532	0.706	-2.029
Estonia	0.216	1.870	0.000	0.104	0.405
France	1.649	-0.602	2.667	1.538	-1.093
Germany	0.246	1.935	0.983	-1.045	0.800
Greece	-1.210	-1.672	-0.116	-0.530	-0.246
Hungary	-1.499	0.173	-0.319	-0.871	-0.052
Italy	-0.884	-0.535	0.863	0.137	0.726
Latvia	-1.390	-0.873	0.225	-0.747	-0.154
Lithuania	-0.516	0.453	-0.685	1.569	1.592
Netherlands	-0.860	0.135	0.053	-0.172	-0.802
Romania	0.273	0.024	0.465	-0.221	1.696
Slovakia	0.856	-1.335	-1.829	1.729	0.755

Slovenia	1.060	-1.045	-0.603	-0.889	-0.660
Spain	-0.925	0.005	0.687	0.885	-1.717

II. Estimated Weight of each control country in constructing the synthetic Ireland:

	Weight
Austria	0.046
Bulgaria	0.108
Cyprus	0.319
Czech Republic	0.023
Denmark	-0.212
Estonia	0.278
France	-0.115
Germany	0.504
Greece	-0.277
Hungary	-0.035
Italy	-0.010
Latvia	-0.148
Lithuania	0.033
Netherlands	-0.142
Romania	0.297
Slovakia	-0.245
Slovenia	-0.061
Spain	-0.363

III. Estimated weekly treatment effects – including pre-treatment weeks:

Week	ATT	S.E.	CI.lower	CI.upper	*p*-value	# Treated Units
-51	-0.031	0.042	-0.114	0.052	0.461	0
-50	-0.017	0.037	-0.090	0.055	0.638	0
-49	0.036	0.038	-0.039	0.111	0.347	0
-48	-0.026	0.021	-0.066	0.015	0.221	0
-47	-0.032	0.035	-0.100	0.036	0.356	0
-46	-0.004	0.041	-0.084	0.075	0.912	0
-45	0.009	0.033	-0.056	0.073	0.795	0
-44	0.013	0.023	-0.032	0.058	0.581	0
-43	-0.014	0.027	-0.067	0.039	0.603	0
-42	-0.014	0.035	-0.082	0.054	0.685	0
-41	-0.012	0.028	-0.066	0.043	0.678	0
-40	-0.003	0.023	-0.047	0.042	0.906	0
-39	0.005	0.020	-0.034	0.045	0.785	0
-38	0.007	0.024	-0.040	0.055	0.766	0
-37	0.025	0.020	-0.015	0.065	0.217	0
-36	0.023	0.018	-0.011	0.058	0.188	0
-35	0.042	0.025	-0.007	0.090	0.094	0
-34	0.040	0.034	-0.027	0.107	0.242	0
-33	0.001	0.035	-0.069	0.070	0.986	0

-32	0.004	0.038	-0.071	0.078	0.926	0
-31	-0.022	0.039	-0.098	0.054	0.567	0
-30	-0.026	0.032	-0.090	0.037	0.420	0
-29	0.004	0.032	-0.059	0.068	0.894	0
-28	0.048	0.031	-0.014	0.109	0.130	0
-27	0.057	0.035	-0.012	0.126	0.103	0
-26	0.004	0.038	-0.071	0.079	0.921	0
-25	-0.012	0.032	-0.074	0.049	0.693	0
-24	-0.018	0.026	-0.069	0.033	0.498	0
-23	-0.034	0.027	-0.086	0.019	0.210	0
-22	-0.034	0.018	-0.069	0.002	0.063	0
-21	-0.012	0.034	-0.078	0.054	0.713	0
-20	-0.009	0.031	-0.070	0.053	0.784	0
-19	-0.019	0.028	-0.075	0.037	0.507	0
-18	0.015	0.026	-0.036	0.065	0.567	0
-17	0.025	0.042	-0.057	0.107	0.548	0
-16	0.028	0.031	-0.032	0.088	0.358	0
-15	-0.002	0.031	-0.063	0.059	0.946	0
-14	-0.025	0.036	-0.095	0.045	0.481	0
-13	-0.012	0.033	-0.077	0.054	0.725	0
-12	0.023	0.039	-0.054	0.100	0.555	0
-11	0.018	0.041	-0.062	0.099	0.654	0
-10	0.011	0.045	-0.077	0.099	0.807	0
-9	0.023	0.040	-0.055	0.102	0.563	0
-8	-0.009	0.032	-0.072	0.054	0.777	0
-7	-0.005	0.031	-0.065	0.055	0.862	0
-6	-0.021	0.027	-0.073	0.031	0.438	0
-5	-0.014	0.026	-0.066	0.037	0.580	0
-4	0.034	0.040	-0.044	0.113	0.390	0
-3	-0.003	0.045	-0.091	0.085	0.950	0
-2	-0.023	0.039	-0.100	0.054	0.555	0
-1	0.006	0.035	-0.063	0.075	0.858	0
0	-0.049	0.034	-0.115	0.018	0.152	0
1	-0.145	0.088	-0.318	0.028	0.100	1
2	-0.124	0.077	-0.274	0.027	0.107	1
3	-0.099	0.076	-0.248	0.050	0.193	1
4	-0.082	0.075	-0.228	0.064	0.270	1
5	-0.091	0.119	-0.324	0.142	0.443	1
6	-0.102	0.130	-0.356	0.153	0.435	1
7	-0.117	0.117	-0.347	0.113	0.320	1
8	-0.142	0.132	-0.401	0.116	0.281	1
9	-0.156	0.107	-0.366	0.053	0.143	1
10	-0.184	0.102	-0.384	0.016	0.071	1
11	-0.176	0.103	-0.377	0.025	0.086	1
12	-0.213	0.119	-0.446	0.020	0.074	1
13	-0.216	0.145	-0.500	0.069	0.138	1
14	-0.243	0.171	-0.578	0.093	0.156	1
15	-0.197	0.165	-0.520	0.125	0.230	1
16	-0.207	0.170	-0.540	0.125	0.222	1
17	-0.408	0.192	-0.785	-0.031	0.034	1
18	-0.519	0.218	-0.946	-0.093	0.017	1
19	-0.525	0.220	-0.957	-0.093	0.017	1
20	-0.515	0.219	-0.945	-0.086	0.019	1
21	-0.567	0.241	-1.040	-0.095	0.018	1
22	-0.571	0.300	-1.159	0.016	0.057	1
23	-0.610	0.307	-1.212	-0.009	0.047	1

24	-0.608	0.303	-1.202	-0.014	0.045	1
25	-0.607	0.298	-1.190	-0.023	0.042	1
26	-0.463	0.232	-0.917	-0.009	0.046	1
27	-0.455	0.231	-0.907	-0.002	0.049	1
28	-0.427	0.227	-0.873	0.018	0.060	1
29	-0.432	0.235	-0.893	0.029	0.066	1
30	-0.392	0.234	-0.852	0.067	0.094	1

IV. Coefficient estimates for the three macroeconomic covariates:

Variable	beta	S.E.	*p*-value
Broadband Internet Subscriptions (per 100 capita)	-0.008201	0.006808	0.2283
Population	0.000001	0.000001	0.0000
GDP Per Capita Employed	-0.000029	0.000008	0.0002

Web Appendix C. Changes in Search for eBooks in Legal Channels

In order to enhance our analysis in section 5.4, we have incorporated additional data from Google Ads (formerly known as Adwords). Unlike the annual data used in the section 5.4, this new dataset provides monthly search volume information, allowing for a more refined empirical analysis. We specifically focused on keywords and phrases that capture consumers' interest in and demand for eBooks through legal channels. We collected country-specific monthly search volumes for the following search terms from July 2016 to the end of 2019: "Kobo", "Apple books", "Google Play books", "Kindle books", "eBook", "eBooks.com", "Digital textbook". To create an aggregate measure of interest in legal eBooks, we summed the search volumes for all these keywords. We use Ireland as the treated country and all the 18 countries listed in Table 3 serve as controls. We run the following DiD analysis:

$$\ln\left(Search\_Volume\right)_{it} = \beta_1 Post_t + \beta_2 Post_t * treated_i + \sum \theta * Macro_{it} + \mu_i \qquad (3)$$

where $Search\_Volume_{it}$ is the aggregate volume of eBook searches in country i during month t, $Post_t$ is an indicator that takes a value of 1 after 2019 and 0 otherwise, $treated_i$ is a dummy variable equal to 1 for Ireland and 0 for other countries, and μ_i is a vector of country fixed effects. β_2 is the coefficient of interest, indicating the degree to which eBook-related searches changed in Ireland after the VAT rate reduction vis-à-vis control countries. The estimate for β_2 is .1291 ($p < .001$), indicating that the reduction in eBook prices in Ireland led to a 13% increase in consumers' interest in and search for eBooks.[12] The fact that various analyses using different data sources consistently support the effectiveness of the VAT rate reduction policy boosts our confidence in the policy's ability to bring about significant changes in consumer behavior.

[12] In this analysis, the pretreatment is relatively consistent across the pretreatment months which supports the appropriateness of the DiD analysis. Interestingly, when using GSC, the ATT remains the same (i.e., .1294), but it is not statistically significant ($p = .227$).