Peer-to-Peer File Sharing and Cultural Trade Protectionism*

Andres Hervas-Drane† Eli Noam‡

May 5, 2017

Abstract

We examine the Internet's impact on the cross-border distribution of cultural goods and assess its implications for cultural policy and cultural diversity. We present a stylized model of a two-country economy where governments are endowed with political preferences over the consumption of domestic content and enact import barriers and subsidies to protect it. We introduce peer-to-peer file sharing as a distinct distribution channel enabled by the Internet that provides access to all media products at a low cost. We report two main findings. First, the Internet renders legacy cultural policy inefficient, and the elimination of import barriers and the reduction of subsidized production can be desirable even when governments exhibit paternalistic preferences favoring the consumption of domestic content. And second, even though the Internet increases cultural diversity within countries, it can also reduce diversity across them.

Keywords: Media Industry, Digital Distribution, Cultural Policy, Cultural Diversity

JEL codes: F12, L16, L52, L82, L86

*We thank the editor and two anonymous referees for suggestions that helped to improve this paper. We also thank Fabrizio Germano for insightful discussions, as well as Pol Antràs, Ramon Casadesus-Masanell, Pablo Casas-Arce, Matthew Ellman, Avi Goldfarb, Gene Grossman, Massimo Motta, Morten Olsen, and seminar participants at the IESE SP-SP seminar, UPF seminar, Mannheim-ZEW ICT conference, Télécom ParisTech ICT conference, EARIE conference, the European University Institute media workshop, the Tilburg TILEC media workshop, Toulouse ICT conference, and TPRC conference. The authors are grateful for financial support from the Spanish Ministry of Economy and Competitiveness grants ECO2009-11307 and ECO2011-28965, the IESE Public-Private Sector Research Center, and the Columbia Institute for Tele-Information.

†Cass Business School, City, University of London (andres.hervas-drane@cass.city.ac.uk)

‡Columbia University (noam@columbia.edu)

1 Introduction

Online sharing of media content over file sharing networks has become pervasive during the last decade. A prime example of the cross-border impact of online sharing is American television series *Game of Thrones*. The series premiered in the US in 2011 and was broadcast in other countries with delays ranging from one day in the UK to over a year in Japan, and soon attracted an international following. With foreign audiences eager to watch every new episode, the number of online sharing downloads in subsequent years often surpassed the prime time television audience in the US.[1] In 2015, the Guinness World Records named the show the *most pirated television program*. In an attempt to circumvent unlicensed downloading the show is currently being broadcast simultaneously in 173 countries, keeping fans in many timezones awake until late in the night and featuring again in the 2016 Guinness World Records as the *largest TV drama simulcast.*

Online sharing has generated an active policy debate and a growing strand of academic literature, mostly focusing on sales displacement and the viability of traditional business models in the content industry. The long-term implications of online sharing for cultural policy and cultural diversity, in contrast, have received comparatively scarce attention. Domestic content is protected in most countries by cultural policies dating back to the 1920s and beyond. These policies encompass import barriers based on content quotas, which restrict commercial broadcasting of foreign content such as *Game of Thrones,* as well as subsidies supporting the production of domestic content. But these policies are under pressure from consumers empowered with online sharing to download foreign content from the comfort of their homes. If online sharing can be understood as a global distribution channel, what are the implications for traditional cultural policies and consumption patterns in the cultural sector? And what are the long-term implications for cultural diversity within and across nations? Because online sharing accounts for a significant portion of global content distribution and consumption, these are important policy questions.

We present a stylized model to evaluate the impact of online sharing on cultural policy and diversity. We consider a two-country economy and model the cultural sector by means of oligopolistic competition and variety-seeking consumers. We build our framework on the circular model of spatial competition developed by Salop (1979), and characterize cultural goods by the absence of marginal costs of production and the absence of export costs. We model cultural policy by endowing governments with political preferences over their population's consumption of domestic and foreign cultural content. If cultural goods portray national identity and values their consumption will generate public externalities, so we assume governments internalize these externalities when setting cultural policy. Governments can enforce content quotas to restrict the commercial distribution of foreign content and subsidize domestic producers to increase the number of domestic content varieties available to consumers. We introduce online sharing as a cross-border distribution channel that is broadly accessible and resilient to outside control. In our model, online sharing

[1] See 'Game of Thrones most pirated TV show of 2014,' BBC News, December 28th 2014.

allows consumers to access any media product at a low cost, and we assume such sharing cannot be blocked or severely penalized in democratic countries due to technical or political reasons.[2]

Our analysis explains why traditional cultural policies are no longer effective in the presence of online sharing. We show that online sharing exerts downward pressure on content prices and displaces demand from domestic content towards foreign content in countries that enforce content quotas. Both effects have implications for cultural policy. Quota enforcement becomes ineffective and inefficient. Ineffective because consumers can bypass commercial distribution restrictions through online sharing, and inefficient because consumers incur wasteful online sharing costs when doing so. As a result, subsidized production volumes that could be sustained under effective quota enforcement are no longer efficient; the supply of an increasing variety of content competing for consumer attention reduces the optimal volume of domestic production. Thus we show that the elimination of content quotas and the reduction of subsidized production can be desirable even when governments exhibit paternalistic preferences favoring the consumption of domestic content.

Based on these results we evaluate the implications of online sharing for cultural diversity in the world economy. We ask the following question: does online sharing increase or decrease cultural diversity in the long-term? In other words, does the Internet drive consumers in different countries to increasingly consume the same content, or does it drive them into separate content niches? To answer this question we use a fractionalization index and compare equilibrium consumption patterns with and without online sharing accounting for the optimal policy responses. We find that online sharing homogenizes consumption patterns across countries and thereby reduces cultural diversity. Our findings raise a question mark over the conventional wisdom that the Internet fosters cultural diversity; where domestic protectionism is entrenched, online sharing can be understood as an opening wedge for a global media distribution system.

Several simplifications are made to maintain tractability and derive these results. We focus on the case where producers face zero marginal costs to provide an analysis that is relevant to commercial digital distribution. The Salop model is well suited to this setting, unlike monopolistic competition models where equilibrium prices and profits collapse when marginal costs converge to zero. To ensure tractability, we adopt the maximum differentiation principle where producers locate their content varieties equidistantly along the perimeter of the Salop circle in each country. This is consistent with the fact that equidistance has been shown to be an equilibrium outcome of the location game. For our application, the assumption implies that producers can locate their product independently in each country, or in other words, content can be tailored to different national audiences at a negligible cost. For example, movie trailers and posters tend to vary across

[2]Even in North Korea, a country operating under conditions of cultural autarky where consumption of foreign content is severely punished, there are reports of growing demand for foreign content. Activists smuggle thousands of USB sticks into the country each year loaded with Hollywood movies, South Korean TV shows, and other material such as the Korean language version of Wikipedia. According to those involved in the trade, actors Arnold Schwarzenegger, Leonardo DiCaprio, Sylvester Stallone, as well as US television series Desperate Housewives and movies such as Spartacus or the Hunger Games are in high demand. See 'North Korea campaigners seek USB sticks,' BBC News, February 10th 2016.

countries, and it is not infrequent for audio dubbing or post-production editing to cater to specific markets.

Variety-seeking is the main driver of consumer demand in our model. In each country, the consumer population as a whole exhibits preference for variety, and benefits from consuming several content varieties rather than concentrating consumption on a single variety. The number of content varieties available to consumers within a country, or national diversity, will be a function of the number of producers supplying content. Thus we take the view that unique artistic talent is the fundamental driver of value creation. Consumers in our model exhibit no bias favoring domestic content, so the country of origin of consumers and that of producers do not factor into consumption utility. While these considerations are prone to affect consumption choices in the market, we do not incorporate them in our model. Instead, we focus on the simplest case of variety-seeking where preferences are identical across countries to formalize our argument.

1.1 Cultural policy and online sharing

Content quotas are the most widespread import barrier in the cultural sector and play an important role in our analysis. Content quotas emerged in the twentieth century with the expansion of cinema and later television, which led to a growth of exports from the US to Europe and reversed the historic direction of the flow of culture. This triggered a widespread adoption of trade restrictions, as shown in Table 1. Quotas have long been applied to cinema screens, TV channels, and radio airplay. They stipulate a minimum share of cinema screenings for domestic content (or a minimum share of broadcasting time over broadcasting channels), restricting the supply of foreign content and thereby blocking some foreign content varieties from being commercialized. This is in contrast to quantity-based quotas in other sectors of the economy, which restrict the number of units imported but not the number of varieties (e.g., import barriers in the automobile sector reduce the number of vehicles imported rather than their specific types).

Subsidies to sustain and promote the production of domestic cultural content are another important element of cultural policy in many countries. For example, the EU's MEDIA program and the Council of Europe's Eurimages cinema support fund actively subsidize European producers, as do many national and regional programs. In fact, government intervention in the cultural sector is so widespread that at the signing of the General Agreement on Trade in Services (GATS) in 1995, fewer than 30 countries would commit to free trade in the audiovisual sector, and among western democracies only the US and New Zealand liberalized the sector. The US has sought to countermand such trends in recent trade negotiations, requesting provisions to ban barriers on audiovisual electronic services.[3]

Several arguments have been proposed to explain the incentives for governments to increase

[3]See Bernier (2005) and Puppis (2008) for an overview of the evolution of trade agreements in the audiovisual sector and their implications for digital distribution.

Country	Initial quota	Domestic content quota
Australia	1927	Cinema: 15% of screenings Radio: 25% of airplay time
Brazil	1926	Cinema: 63 days of screening
Canada	1956	TV: 60% of broadcast time Radio: 35% of airplay time
China	1994	Cinema: 20 foreign films per year
France	1920	Cinema: 110 non-EU films per year TV: 60% of broadcast time Radio: 40% of airplay time
Malaysia	2005	Cinema: 14 days of screening TV: 70% of broadcast time
Mexico	1949	Cinema: 10% of screenings
Nigeria	n/a	Radio: 80% of airplay time
South Africa	1997	Radio: 25% of airplay time
South Korea	1967	Cinema: 73 days of screening TV: 80% of broadcast time
Spain	1955	Cinema: 73 days of screening TV: 51% of broadcast time

Table 1: Content quotas applied to cinema screens, television broadcasting and radio airplay in several countries. Source: Compiled by the authors.

exposure to domestic content. As pointed out by Noam (1991), these are rarely framed in economic terms. A central argument in the debate is that media content can portray national identity and values, so consumption of domestic content exhibits positive spill-overs for society and increases social cohesion. The European Union's audiovisual media services Directive 2010/13/EU, for instance, states that "audiovisual media services are as much cultural services as they are economic services. Their growing importance for societies, democracy [...], education and culture justifies the application of specific rules to these services." Nonetheless, countervailing factors suggest that the extreme case where no foreign content is consumed is unlikely to be desirable from a social perspective either. Exposure to foreign content can foster cultural openness, increase human capital, and facilitate trade. We build on this underlying tradeoff between the consumption of domestic and foreign content to model cultural policy.[4]

[4]Political preferences in our model can also be interpreted to originate from political economy tradeoffs. On the one hand, the dispensation of protectionism favoring domestic producers may allow governments to manufacture political consent domestically, providing leverage over the production of opinion-making content. On the other hand, strong cultural intervention can compromise international diplomacy and trade negotiations in other areas. The relative merit of public externalities vs. political economy factors in explaining incentives for cultural intervention

The advent of consumer online sharing presents novel challenges for cultural policy. The technology has evolved over several generations of Internet applications with newsgroups such as Usenet, centralized server-based exchanges on private or public hosting sites, and peer-to-peer file sharing (p2p) which emerged as the main driver of consumer online sharing in the last 15 years. As of 2015, file sharing accounted for 14% of total consumer Internet traffic, and the most popular file sharing application (BitTorrent) has been estimated to have over 266 million unique users per month with 90% of the content exchanged being copyrighted.[5] Despite its scale, online sharing has so far proven to be exceptionally resilient to both technical and legal attacks. This has mainly been due to technical workarounds implemented by p2p software developers, legal procedures requiring judicial oversight on a case by case basis, and public resistance.

1.2 Literature

Online sharing relates to the literature on private copying and its impact on copyright holders. Liebowitz (1985) observed that copying technologies increase the value of copyable originals, which can be beneficial to copyright holders. Besen and Kirby (1989) consider varying degrees of substitutability between originals and copies as well as the respective marginal costs of producing them. Bakos, Brynjolfsson and Lichtman (1999) examine the size of consumer sharing groups such as households or clubs when copies are perfect substitutes and copying costs fall to zero. Noam (2008) analyzes online sharing as a mechanism for creating a critical mass and as a step towards commercialization. This literature finds that private sharing can either harm or benefit copyright holders. For digital media content, online sharing exhibits high substitutability of originals and copies as well as large scale sharing, so we may expect it to harm copyright holders as is the case in our model.

Another literature strand has considered the implications of piracy for intellectual property protection, mostly in the context of software. Yoon (2001) and Banerjee (2003) analyze the extent to which government intervention to protect copyright holders is socially desirable. The optimal degree of government protection is shown to depend on the cost of producing the content and the cost incurred by producers to individually protect it in the market. Arai (2011) evaluates whether the revenues from piracy fines should be collected by producers or by government in order to maximize social welfare. This literature strand finds that some degree of government protection is generally desirable. Our focus in this paper is on cultural policy rather than copyright protection. To the extent that copyright protection is effective in increasing the cost of online sharing for consumers, our results suggest that it can complement cultural policies with the goal

remains a contentious issue, and for the purpose of our analysis it is sufficient to note that both interpretations are compatible with the model.

[5]For Internet traffic composition estimates, see 'Cisco Visual Networking Index: Forecast and Methodology, 2015-2020,' Cisco, June 2016. For BitTorrent userbase and content composition estimates see 'Sizing the piracy universe,' NetNames, September 2013 and 'Census of Files Available via BitTorrent,' Freedom to Tinker blog of the Center for Information Technology Policy at Princeton University, January 2010.

of fostering consumption of domestic content. However, we note that the effectiveness of penalties against unauthorized file sharing is yet unclear. For instance, McKenzie (2016) reports no effect of graduated response programs (which penalize repeat file sharing offenders) to raise box office revenues of new films.

Several contributions have examined the impact of online sharing in the music industry. Liebowitz (2006) and Oberholzer-Gee and Strumpf (2010) provide an overview of the literature analyzing the empirical evidence on sales displacement. There is evidence supporting sales displacement for commercially available content, though the estimated effects vary significantly across studies (a typical estimate is a rate of 20%). The decrease in music sales has not resulted in a decrease in production, however. Both Handke (2012) as well as Aguiar and Waldfogel (2016) report increased production of music since the advent of file sharing technology, and suggest that lower costs of production due to digitalization can contribute to explain the trend. Closer to the focus of our paper, Ferreira and Waldfogel (2013) provide an empirical analysis of popular music charts from 22 countries. They evaluate the impact of digitalization on music trade patterns and find that foreign content has decreased in the chart rankings of most countries over the last decade. It is worth noting that the dataset used in their study does not cover online sharing activity, so the findings are not inconsistent with the predictions of the model derived below. Preferences for music may also have a stronger domestic bias than those for other cultural goods, due to technical barriers to translation and the complementarity of live performances.

We are aware of two instances in the literature that have formally analyzed content quotas or online sharing in spatial competition models. Richardson (2006) examines a Hotelling model where the programming choices of broadcasters (their location choices) contribute to determine their advertising revenues, and shows that content quotas constraining programming can be socially preferable to advertising caps or the introduction of a publicly provided broadcaster. Peitz and Waelbroeck (2006) present a Salop model to analyze the impact of online sharing on a multiproduct monopolist. Online sharing enables consumers to sample products and identify their preferred varieties, which increases their willingness to pay for originals and in some cases allows the monopolist to profit from online sharing.

Several contributions in the trade literature have examined the broader implications of trade on culture. Francois and Ypersele (2002) show that in the presence of strong scale economies and variations in the valuations of consumers for different types of cultural goods, those enjoying more uniform valuations can drive others out of the marketplace. Rauch and Trindade (2009) evaluate trade dynamics when cultural goods differ in their style owing to distinct national traditions. They show that styles originating from large countries which enjoy larger network externalities can crowd out production of other styles in the long term, so targeted subsidies promoting national styles in small countries can increase world welfare. Bala and Long (2005) consider the dynamic effects of trade on cultural diversity based on price changes and the product preferences of consumers, and argue that smaller countries can lose their cultural identity when engaging in trade with larger

countries. Olivier, Thoenig and Verdier (2008) analyze a dynamic model where cultural identity is also a consumption externality that consumers derive utility from, and show that both social and product market integration between countries affects the evolution of cultural identity. The above contributions show that protectionist policies for cultural goods can be welfare-enhancing under certain assumptions. Our paper is complementary in the sense that we show that online sharing severely limits the effectiveness of such policies.

The next section presents the building blocks of our model and characterizes the benchmark cases of autarky and trade. Section 3 introduces political preferences for governments and characterizes cultural policy based on content quotas. In Section 4, we introduce online sharing and examine its short-term impact on cultural policy. We examine the long-term impact in Section 5 by endogenizing industry sizes and introducing subsidies. In Section 6 we evaluate the implications for cultural diversity across countries using a fractionalization index. We consider extensions to the model in Section 7 and conclude in Section 8.

2 Base model

We consider a world economy composed of two countries and a single media sector, such as the motion picture industry. We focus on the symmetric case where both countries exhibit equivalent consumer populations and industry sizes, which keeps the analysis simple given that our results do not hinge on the comparative size of countries.

There is a unit mass of consumers in each country and we define consumer preferences for media content over the unit length perimeter of a circle. The circle's perimeter provides a space understood to capture the spectrum of consumer taste for media content, where products will occupy distinct locations. It is useful to think of consumers in each country as located on a separate circle, given that the set of products available in each country will vary throughout our analysis. Consider the case of an individual consumer in country $k \in \{1, 2\}$ located at a specific point of the country's circle perimeter. The utility derived by the consumer from a product is given by utility u and *taste proximity*, a measure of the fit between the consumer's taste and the particular product. This is calculated as the distance that separates the location of the consumer and the product on the perimeter of the circle multiplied by taste parameter t. Thus a consumer's ideal product is located at the exact same location as the consumer (maximum taste proximity), and yields full utility u. More generally, the utility derived by consumer i when purchasing product j at price p_j, denoted by $u_{i,j}$, is given by

$$u_{i,j} = u - t\, d_{i,j} - p_j, \tag{1}$$

where $d_{i,j}$ is the distance separating the respective locations of the consumer and the product on the perimeter of the circle, and p_j is the price of the product. The outside utility of not consuming

is normalized to zero. Consumers have unit demand, and will either purchase a single product or stay out of the market. This captures the fact that media consumption is limited by the time constraints of consumers.

On the supply side, industry sizes are characterized by a pool of f producers in each country. Each producer supplies a unique differentiated content variety in the world economy and incurs zero marginal costs to distribute it to consumers. Similarly, there are no export costs when supplying foreign countries. We start our analysis by taking industry sizes as exogenous and assuming that producers face no fixed costs, and will relax these assumptions in Section 5.

When positioning their product on the perimeter of the circle in each country, producer profits will be determined by their proximity to neighboring varieties rather than by their absolute position. We assume the maximum differentiation principle where producers locate their content varieties equidistantly along the perimeter of the circle in each country.[6] When the set of content varieties supplied in both countries coincides, each variety can be interpreted to occupy the same position in both circles. When the set of content varieties supplied in both countries differs, producers fine-tune the location of their products in each country's circle in order to maintain equidistance with respect to neighboring varieties on its perimeter, so their position in both circles may differ.

To illustrate the mechanics of our model, we start by characterizing the benchmark cases of autarky and trade. Both cases can be solved by applying standard Salop model derivations. Consider the two-stage game where producers set prices for their content in each country in the first stage, and consumption decisions take place in the second stage. We restrict our analysis to market configurations where there is effective competition among producers, which requires that all consumers purchase in equilibrium. Without loss of generality, let $u = 1$, then a sufficient condition is $f > \frac{3}{2}t$.[7] We assume this to be the case throughout our analysis.

Consumer demand. We proceed by backwards induction, and start by characterizing the second stage purchasing decisions of consumers in country $k \in \{1, 2\}$ when there are n content varieties equidistantly located over the perimeter of the circle. Consider the demand for content variety j when priced at $p_{j,k}$ and surrounded by neighboring varieties $j-1$ and $j+1$ priced at $p_{j-1,k}$ and $p_{j+1,k}$. When all consumers purchase and producers compete for market share we can determine the demand for each content variety by comparing the utility that different varieties

[6] The maximum differentiation principle was first established by d'Aspremont, Gabszewicz, and Thisse (1979) in the Hotelling model. Economides (1989) shows that maximum differentiation is a perfect equilibrium outcome in the Salop model when firms choose where to locate their products and consumers exhibit quadratic transport costs. We have solved our model with quadratic transport costs by substituting $u_{i,j} = u - t\, d_{i,j}^2 - p_j$ in (1) and found that our qualitative results are unaffected, so we present the specification with linear transport costs for simplicity. The equidistance result also relies on the uniform distribution of consumers, which ensures that the location problem is symmetric for firms. See Noam (1987) for an analysis of content diversity in a Hotelling model where consumers are located following a normal distribution.

[7] The parameter constraint for this market configuration to hold can be derived by substituting $u = 1$ in (1) and equating $u_{i,j} = 0$ for the consumer "in the middle" who is strictly indifferent between the two neighboring varieties given equilibrium prices in (3).

deliver to consumers. Consider the consumer utility specification in (1). The consumer located at distance $\overline{x}$ from variety j over the perimeter of the circle who is indifferent between purchasing varieties j and $j+1$ will be given by

$$t\,(\overline{x}) + p_{j,k} = t\,(\frac{1}{n} - \overline{x}) + p_{j+1,k}.$$

A symmetric condition identifies the consumer who is indifferent between varieties j and $j-1$, located at distance $\underline{x}$ from variety j. Solving for $\overline{x}$ and $\underline{x}$, and given that total demand for content variety j is driven by all consumers between $\overline{x}$ and $\underline{x}$, that is $\overline{x} + \underline{x}$,

$$D_{j,k} = \frac{n(p_{j-1,k} + p_{j+1,k} - 2p_{j,k}) + 2\,t}{2\,t\,n}. \tag{2}$$

Content pricing. Consider next the first stage pricing problem of producers in country k. Given that marginal costs are zero each producer will choose its price $p_{j,k}$ to maximize revenues, which are given by $D_{j,k} \cdot p_{j,k}$. Solving for the optimal price and equating prices across producers for a symmetric pricing equilibrium yields

$$p(n) = \frac{t}{n}. \tag{3}$$

Lemma 1. *Under autarky, producers commercialize their content exclusively in their home country, $n_k^a = f$, and prices are given by $p_k^a = t/f$. Under free trade, producers commercialize their content in both countries, $n_k^{ft} = 2f$, and prices are given by $p_k^{ft} = t/n_k^{ft}$. Comparison of both regimes shows that free trade reduces prices and increases national diversity in each country, $p_k^{ft} < p_k^a$ and $n_k^{ft} > n_k^a$.*

Consumers purchase the content variety that is closest to their ideal location in equilibrium, and all producers quote the same price in each national market deriving equal market share and profits. Prices are entirely determined by markup due to the absence of marginal costs, and increase with consumer taste parameter t and decrease with industry size f, which jointly determine the intensity of competition. A higher taste parameter t softens competition because consumers incur higher disutility from consuming varieties distant from their ideal location. A larger industry size f intensifies competition because more content varieties are produced and therefore each variety has closer substitutes.

Producers are willing to export their content whenever possible because they incur no export costs in our model. Trade results in a higher number of content varieties being commercialized in each country compared to autarky, increasing national diversity. The availability of a larger number of content varieties increases consumer surplus, both by increasing the average taste proximity of consumers and products and by lowering prices due to more intense competition. This results in lower industry profits relative to autarky. The net impact on social welfare is positive, and thus free trade is desirable in the absence of political preferences such as those introduced in the

next section. It is worth stressing that consumers in our model care about their taste proximity to content and not about its country of origin, so domestic and foreign content varieties derive the same market share in each country. For the same reason, we refer to national diversity as a function of the number of content varieties consumed, irrespectively of their origin.[8]

3 Cultural policy

In this section we analyze import barriers in the form of content quotas keeping industry sizes fixed. We endogenize industry sizes and introduce production subsidies in Section 5. We will refer to the aggregate market share of domestic producers inside a country as the *domestic cultural share*, and denote it by $q_k \in [0,1]$. A content quota q_k (we denote domestic cultural shares and quotas indistinctively by q_k) is an import barrier that sets a domestic cultural share floor for domestic producers, or equivalently, a market share ceiling $1-q_k$ for foreign producers. If market conditions drive the total market share of domestic producers below q_k in their home country, a quota is enforced by restricting the number of content varieties supplied by foreign producers until domestic cultural share q_k is met. Enforcement implies that some foreign producers are excluded from the domestic market but others retain access. Because producers are homogeneous in our model, we sidestep selection mechanisms and assume that exclusion is applied randomly across foreign producers. Alternatively, enforcement can be interpreted as exclusion rotating across products over time, with foreign producers having similar access windows to the market.

We incorporate political preferences in our model to explain cultural policy. First, note that quota enforcement in a given country will restrict supply by foreign producers, which will increase domestic producer profits but reduce consumer surplus. The net effect on social welfare is negative, so governments must account for additional considerations if choosing to enforce content quotas. We adopt the view that governments maximize both social welfare and *cultural welfare* within their country. The latter is given by political preferences over cultural content consumption and is assumed to depend on the audience's exposure to domestic and foreign content, that is, on the domestic cultural share.

We define cultural welfare CW_k in each country as a function of the domestic cultural share q_k. To provide a rich characterization of cultural policy we let CW_k be inverse U-shaped in q_k, and consider the simplest specification that meets these properties:[9]

[8] If consumers exhibit domestic bias, for example by deriving higher utility $u > 1$ from domestic varieties than from foreign ones, producers would quote higher prices and obtain higher market shares in their domestic market than in the foreign one. Vogel (2008) considers a richer circular model with heterogeneous producers and shows that more efficient producers choose higher qualities and set higher prices, deriving higher market shares and profits than less efficient producers. Our model is simpler because consumers derive the same utility from all content varieties. Also note that if domestic bias were large such that producers always enjoy a substantial market share advantage in their domestic market, cultural policy interventions to increase their market shares and revenues such as those introduced in Section 3 would be rendered unnecessary.

[9] Our specification for CW_k ensures that the government's objective function G_k is concave in q_k. Note that

$$CW_k(q_k) = 2\,q^*\,q_k - q_k^2. \tag{4}$$

The specification implies that cultural welfare is maximized at $q^* \in [0,1]$ and the interpretation is as follows. On the one hand, low domestic cultural shares $q_k < q^*$ are not optimal due to the positive spill-overs that arise from the consumption of domestic content, which portrays national identity and values and contributes to social cohesion. On the other hand, high domestic cultural shares $q_k > q^*$ are suboptimal because consumption of foreign content is also desirable, as it fosters cultural openness, increases human capital, and facilitates trade. Governments will account for this tradeoff, and will set content quotas to maximize their country's sum of consumer surplus, industry profits, and cultural welfare: the objective function of the government in country k, denoted by G_k, will be given by $G_k = CS_k + \Pi_k + CW_k$.

We next characterize both the unilateral regime where governments set quotas independently as well as the multilateral regime where governments jointly set quotas to maximize world welfare.[10] We modify the timing of the game accordingly. In the first stage, governments set quotas q_k either unilaterally or multilaterally. In the second stage, producers price their content in each national market where it is commercialized. In the third stage, consumers observe content varieties and prices available in their country and consumption decisions take place. Note that our characterization of consumer demand in (2) and content prices in (3) carry over from the previous section, so we directly proceed to analyze cultural policy in the first stage of the game.

Cultural policy. Consider the impact of a quota q_k in country k given the presence of f producers in each country. Denote the industry share of country k in the world economy by $\bar{q}_k$, which in the case of two symmetric countries is given by $\bar{q}_k = 1/2$. When the quota in country k is below its industry share $q_k \leq \bar{q}_k$, the quota is met without enforcement and all producers commercialize their content. When $q_k > \bar{q}_k$, country k requires enforcement in order to meet the quota. The number of foreign producers allowed to commercialize their content in country k is restricted to ensure that $n_k = f/q_k$, where $(f/q_k) - f$ foreign producers are randomly selected to commercialize their content and the remaining are excluded. Therefore, we restrict our analysis to $q_k \in [\bar{q}_k, 1]$ given that quotas below the industry share of each country are equivalent to the binding case $q_k = \bar{q}_k$ where there is no enforcement, $n_k(\bar{q}_k) = 2f$.

We next characterize the objective function of governments. Consumer surplus in country k when $u = 1$ and n_k content varieties are available at prices $p(n_k)$ can be written as

simpler specifications for CW_k (for example functions that are increasing in q_k) tend to generate corner solutions with either maximum enforcement or no enforcement, due to the fact that social welfare is convex in quota enforcement q_k. In these cases, cultural welfare either overrides social welfare considerations or has no cultural policy impact. A rich characterization of cultural policy with an interior solution therefore requires an inverse U-shaped specification that captures the cultural downsides of high levels of enforcement.

[10] The multilateral regime is equivalent to the social planner's solution, and can be interpreted as the desirable outcome of trade agreements between governments where losers are compensated in other areas. For example, in the 2011 US-South Korea Free Trade Agreement, South Korea lowered import quotas on film and on broadcasting channels while the US lowered tariffs for textiles and electronics.

$$CS_k = 2\,n_k \int_0^{1/2n_k} 1 - t\,d_i - p(n_k)\,\mathrm{d}d_i. \tag{5}$$

Industry profits will depend on quotas in both countries. In each country, producers with market access obtain positive market shares and revenues, and producers excluded due to quota enforcement derive no revenues. The profits of producers based in country k given domestic and foreign quotas q_k and q_{-k} will be given by

$$\Pi_k = f[\frac{1}{n_k}\,p(n_k) + \frac{(f/q_{-k}) - f}{f}\,\frac{1}{n_{-k}}\,p(n_{-k})]. \tag{6}$$

Consider the problem of governments in the first stage under the unilateral regime. Each government unilaterally sets q_k to maximize $G_k = CS_k + \Pi_k + CW_k$ given q_{-k}. We can rewrite G_k as a function of quotas by plugging in prices $p(n)$ in (3) and substituting the number of varieties by $n_k = f/q_k$. Maximizing $G_k(q_k, q_{-k})$ with respect to q_k for each government and solving for q_k identifies optimal unilateral quotas, which we denote by $\hat{q}_k^u$ and are given by

$$\hat{q}_k^u = \frac{8f\,q^* - 5t}{8(f-t)}. \tag{7}$$

Recall that the solution is only well defined in the range $\hat{q}_k^u \in [\bar{q}, 1]$, where $q_k = \bar{q}$ implies no quota enforcement.

Consider next the problem of governments in the first stage under the multilateral regime. Governments jointly set q_1 and q_2 to maximize $G_1 + G_2$. Maximizing $G_1 + G_2$ with respect to q_1 and q_2 identifies optimal multilateral quotas, denoted by $\hat{q}_k^m$,

$$\hat{q}_k^m = q^* - \frac{t}{8f}, \tag{8}$$

where the solution is well defined in the range $\hat{q}_k^m \in [\bar{q}_k, 1]$. Note that it is always the case that $\hat{q}_k^m < 1$.

Proposition 1. *Content quotas under the unilateral (q_k^u) and multilateral (q_k^m) cultural policy regimes in each country are given by*

$$q_k^u = \begin{cases} \bar{q}_k & \text{if } \hat{q}_k^u \leq \bar{q}_k \text{(no enforcement)} \\ \hat{q}_k^u & \text{if } \hat{q}_k^u \in (\bar{q}_k, 1) \text{(enforcement)} \\ 1 & \text{if } \hat{q}_k^u \geq 1 \text{(cultural autarky)} \end{cases} \qquad q_k^m = \begin{cases} \bar{q}_k & \text{if } \hat{q}_k^m \leq \bar{q}_k \text{(no enforcement)} \\ \hat{q}_k^m & \text{otherwise (enforcement)} \end{cases}$$

where the number of content varieties commercialized in country k is given by $n_k = f/q_k$, and prices are given by $p_k = t/n_k$.

Compared to the free trade equilibrium, quota enforcement reduces national diversity and in-

creases prices. This reduces domestic consumer surplus but increases domestic industry profits as well as national cultural welfare.

The result provides a rationale for content quotas in the cultural sector. Governments enforce content quotas whenever domestic cultural shares under free trade conditions are low relative to the preferred domestic share q^*. Enforcement has several effects. On the one hand, enforcement increases consumption of domestic content varieties, which increases cultural welfare and domestic industry profits. On the other hand, it reduces national diversity and drives up prices, and therefore lowers consumer surplus. Governments account for these factors, so equilibrium quotas depend on the preferred domestic share q^* as well as on consumer taste parameter t and industry size f. Note that free trade is the special case of no enforcement in both countries, $q_k = \bar{q}_k$, and autarky is the special case of maximum enforcement where $q_k = 1$.

Equilibrium quotas differ in both regimes. In the unilateral regime, where governments set quotas independently, each government decides how close to set the level of enforcement to the preferred domestic cultural share q^*. In doing so, each government weighs the positive impact of enforcement on domestic producer profits against the negative impact on consumer surplus. When the preferred domestic cultural share is low ($q^* < \frac{5}{8}$), producer profit gains do not offset consumer surplus losses and governments choose to soften enforcement ($q_k^u < q^*$). When the preferred domestic cultural share is high ($q^* > \frac{5}{8}$) producer profit gains offset consumer surplus losses and governments are willing to engage in higher levels of enforcement ($q_k^u > q^*$).[11]

In the multilateral regime, where both governments jointly set quotas, the negative impact of enforcement on the foreign country is also internalized. Quota enforcement generates negative externalities across countries because it reduces the profits of foreign producers. As a result, multilateral quotas are always lower than unilateral quotas and below the preferred domestic cultural share in each country ($q_k^m < q^*$). The left panel in Figure 1 depicts equilibrium quotas under both regimes, and the right panel illustrates their effect on the number of content varieties commercialized.

In our above analysis, we have considered the simplest exclusion mechanism where commercial slots are randomly assigned to foreign producers. A richer model may consider the case where slots are auctioned. Our assumption that slots are assigned randomly allows us to ignore the question of how the revenues from such an auction may be used. For example, France levies a tax on cinema admissions and redirects the revenues to subsidize domestic production. Such mechanisms appropriate welfare from foreign producers, and would lead to higher equilibrium quotas in a unilateral regime. Furthermore, the selection mechanism has no impact in our model because producers are homogeneous. If producers were heterogeneous in the quality of their content, we

[11] The result follows from the fact that social welfare is convex in quota enforcement q_k with a minimum at $q_k = \frac{5}{8}$. On the one hand, consumer surplus decreases linearly with q_k as less content varieties are commercialized at higher prices. On the other hand, domestic producer profits increase quadratically with q_k as producers increase prices as well as gain market share from foreign producers. As a result, the impact of social welfare on the precise level of quota enforcement differs in the low and high q_k ranges.

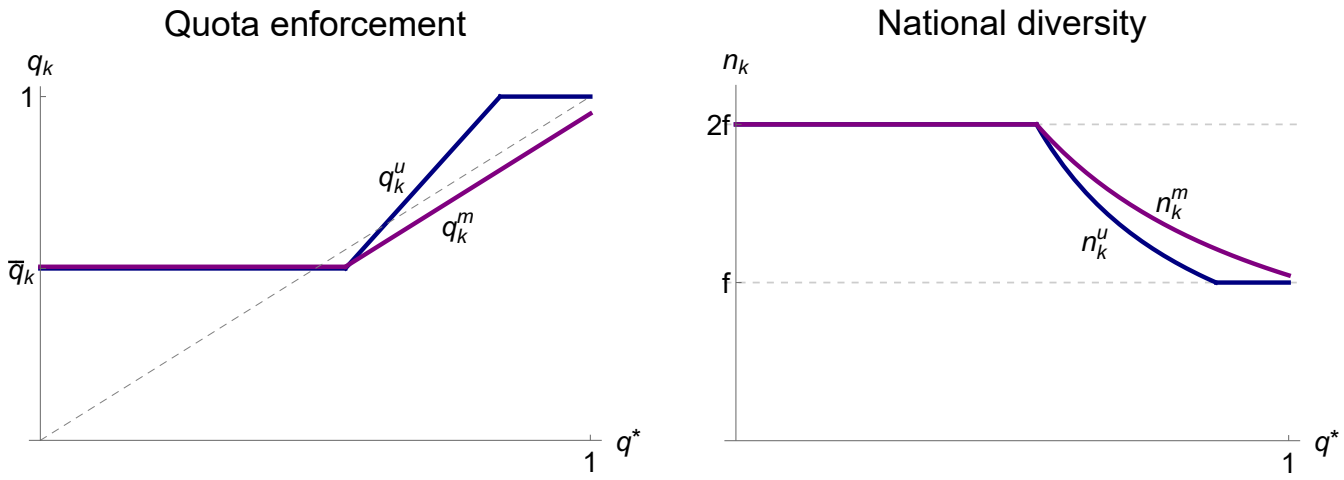

Figure 1: Equilibrium quotas under the unilateral and multilateral regimes (left) and national diversity under both regimes (right).

should expect an auction to select content varieties of higher quality for commercialization (such as *Game of Thrones* on television, for example). Foreign varieties would then derive higher average market shares than domestic varieties, which on average would be of lower quality, and the degree of enforcement required to meet a certain domestic cultural share target would also be higher than in our preceding analysis.[12]

4 The short-term effect of online sharing

We introduce online sharing into our model of the cultural sector. We model online sharing as an efficient distribution mechanism that scales beyond borders and enables consumers to access any content variety produced.[13] We keep industry sizes fixed to analyze the short-term impact of online sharing on consumption patterns and cultural policy, and in the next section, we endogenize industry sizes to evaluate the long-term impact.

Online sharing presents a non-negligible cost for consumers in the form of computing resources and bandwidth, and we denote this cost by o. We assume that $o < \bar{o}$ so that the cost of online

[12] We have also explored the case where countries are asymmetric. If industry sizes differ, it can be shown that the country with the smaller industry engages in a higher degree of quota enforcement. This follows from the fact that a lower industry share in the world economy results in a lower domestic cultural share in the absence of enforcement. As a result, the small industry government is more willing to engage in enforcement and may do so even when the large industry government does not. The asymmetry also implies that the small industry government needs to block a larger number of foreign content varieties than the large industry government to achieve the same domestic cultural share.

[13] We abstract from modeling the precise exchange mechanism that underlies online sharing and simply assume that it is self-sustainable and efficient. For a detailed analysis of the underlying mechanism and a characterization of its performance, see Casadesus-Masanell and Hervas-Drane (2009). File sharing networks are shown to be sustainable in the presence of selfish participants who care only about their own access to content, and the decentralized architecture of the networks implies that participants effectively share the costs incurred to enable the content exchange.

sharing for consumers is strictly lower than commercial distribution prices under free trade, where $\bar{o} = t/2f$. This captures the empirically relevant case where the efficiency of online sharing is a threat to commercial distribution, and maintains tractability by ensuring that equilibrium prices are symmetric across producers.[14] The timing of the game carries over from the previous section. In what follows, we consider the benchmark case where all consumers have access to online sharing, which is facilitated by the uptake of high-speed Internet access as well as the adoption of digital formats in commercial distribution. In Section 7 we relax this assumption and discuss the robustness of our findings when a part of the consumer population does not have access to online sharing.

Consumer demand with online sharing. We proceed to characterize consumer demand in the third stage independently of how it is served, either through commercial distribution or through online sharing. If content variety j is distributed commercially in country k at price $p_{j,k}$, consumers demanding the product in country k will compare price $p_{j,k}$ with online sharing cost o. If $p_{j,k} \leq o$, consumers will prefer to purchase the product through the commercial channel (assuming tie-breaking in favor of commercial distribution), and if $p_{j,k} > o$ they will prefer to obtain the product through online sharing. Let $\bar{p}_{j,k}$ identify the lowest effective price of content variety j in country k for consumers, $\bar{p}_{j,k} = min[p_{j,k}, o]$. If content variety j is not commercially distributed in country k due to quota enforcement, let $\bar{p}_{j,k} = o$. Following our earlier demand derivation in (2), the demand for content variety j in country k when n varieties are accessible to consumers will be given by

$$D^{os}_{j,k} = \frac{n(\bar{p}_{j-1,k} + \bar{p}_{j+1,k} - 2\,\bar{p}_{j,k}) + 2\,t}{2\,t\,n}.$$

Content pricing with online sharing. Consider the pricing problem of producer j in the second stage when commercializing its content in country k in the presence of online sharing. All content varieties produced are accessible to consumers, $n^{os}_k = 2f$, and neighboring varieties may be available through commercial distribution or only through online sharing (if under quota enforcement in country k). Clearly, producer j will quote a price $p_{j,k} \leq o$, as otherwise demand for variety j will be fully served through online sharing. Producer j chooses price $p^{os}_{j,k}$ to maximize revenues $D^{os}_{j,k} \cdot p^{os}_{j,k}$ under the restriction $p^{os}_{j,k} \leq o$, which given the effective price of neighboring varieties $\bar{p}_{j-1,k}$ and $\bar{p}_{j+1,k}$ yields

[14] Note that producers cannot compete against "free" in our model. If online sharing costs fall to zero for consumers, $o = 0$, producers obtain zero profits. However, online sharing presents non-negligible costs for consumers and should not be interpreted to be free. If the cost of online sharing for consumers is high, $o > \bar{o}$, then producers undercut online sharing when pricing their content and commercial distribution becomes comparatively more attractive. The characterization of equilibrium prices is complex because of the asymmetries that arise across producers and which in turn depend on the precise ordering of varieties across the perimeter of the circle. It should be clear, however, that demand increases for content varieties which are commercially available and decreases for those that are not. If the cost of online sharing is exceedingly high, $o \gg \bar{o}$, no consumers engage in online sharing.

$$p_{j,k}^{os} = \begin{cases} o & \text{if } \hat{p}_{j,k} \geq o \\ \hat{p}_{j,k} & \text{otherwise} \end{cases} \tag{9}$$

where

$$\hat{p}_{j,k} = \frac{\bar{p}_{j-1,k} + \bar{p}_{j+1,k}}{4} + \frac{t}{4f}.$$

Consider the implications of the optimal pricing strategy of producer j in country k. The optimal pricing strategy described by (9) implies price $p_{j,k}^{os} = o$ when both neighboring varieties $j-1$ and $j+1$ are effectively priced at o. To see this, note that $\hat{p}_{j,k} > o$ if $\bar{p}_{j-1,k} = \bar{p}_{j+1,k} = o$ because $o < \bar{o} = t/2f$. If neighboring variety $j-1$ (or variety $j+1$) is priced below o, then $\hat{p}_{j,k} > \bar{p}_{j-1,k}$ (respectively $\hat{p}_{j,k} > \bar{p}_{j+1,k}$). Therefore, in a symmetric pricing equilibrium, all producers match online share cost when pricing their content by setting $p_{j,k}^{os} = o$.

Cultural policy with online sharing. We next characterize the objective function of governments in the presence of online sharing, G_k^{os}. Consumer surplus and industry profits with online sharing can be derived from CS_k in (5) and Π_k in (6) by substituting the number of content varieties n_k with n_k^{os} and prices $p(n_k)$ with $p_{j,k}^{os} = o$. Cultural welfare with online sharing is given by CW_k in (4) accounting for the fact that quota enforcement is ineffective, so the domestic cultural share is given by the industry share. This obtains,

$$\begin{aligned} CS_k^{os} =& 2\, n_k^{os} \int_0^{1/2n_k^{os}} 1 - t\, d_i - o \, \mathrm{d}d_i \\ \Pi_k^{os} =& f[\frac{1}{n_k^{os}}\, o + \frac{(f/q_{-k}) - f}{f}\, \frac{1}{n_{-k}^{os}}\, o] \\ CW_k^{os} =& 2\, q^*\, \bar{q}_k - \bar{q}_k^2. \end{aligned} \tag{10}$$

Consider the problem of governments in the first stage. In the unilateral regime, each government sets quotas independently to maximize G_k^{os}. Inspection reveals that $G_k^{os}/\partial q_k = 0$, given that quota enforcement is ineffective. Therefore, any quota level constitutes a unilateral equilibrium. In the multilateral regime, governments jointly maximize $G_1^{os} + G_2^{os}$. Inspection reveals that $\partial(G_1^{os} + G_2^{os})/\partial q_k < 0$ for $q_k \geq \bar{q}_k$, so the multilateral equilibrium implies no quota enforcement.

Proposition 2. *The advent of online sharing ensures that all content varieties are consumed in each country and producers match online sharing cost when commercializing their content, $n_k^{os} = 2f$ and $p_k^{os} = o$. If governments cannot block or disproportionately penalize online sharing, $o < \bar{o}$, the multilateral response to online sharing implies the elimination of content quotas, $q_k^{os,m} = \bar{q}_k$. Legacy cultural policy is an inefficient status quo because governments lack the unilateral incentives to eliminate them, $q_k^{os,u} \in [\bar{q}_k, 1]$.*

Online sharing has two main effects on the cultural sector in the short-term: a content pricing

effect that exerts downward pressure on prices, and a demand displacement effect that increases foreign content consumption in countries that enforce quotas. The first effect drives producers to cut prices in order to match the cost of online sharing for consumers. This ensures commercial distribution remains competitive, so that consumers purchase content which is commercially distributed in their country instead of accessing it through online sharing. Moreover, note that producers match the cost of online sharing irrespectively of consumer's willingness to pay: even if producers could benefit from regional pricing by setting country-specific prices (for instance if consumers in both countries differ in their taste parameter t), online sharing would homogenize prices across countries.

The second effect arises under quota enforcement and is driven by consumers resorting to online sharing to access foreign content varieties that better match their taste but are not commercialized in their country. This displaces demand from domestic content (otherwise served by commercial distribution) to foreign content accessed through online sharing, rendering content quotas ineffective. The effect is consistent with the higher usage of online sharing reported for countries with limited commercial provision of streaming services and digital content catalogs. It is also consistent with the observation that US television series, which are frequently subject to quota restrictions or delayed broadcast on foreign television channels (as illustrated by the case of *Game of Thrones*), are among the most downloaded content over online sharing.

Our analysis reveals an important implication of online sharing for cultural policy. If such sharing cannot be blocked or disproportionately penalized, it provides a rationale for the elimination of content quotas even when cultural welfare is at stake in each country. The elimination of content quotas is desirable because online sharing renders them both ineffective and inefficient. Ineffective because consumers choose to bypass them, and inefficient because consumers incur wasteful online sharing costs when doing so. These costs represent a welfare loss borne by foreign producers who would otherwise sell their content to consumers. And precisely because the welfare loss is borne by foreign producers, Proposition 2 shows that countries lack unilateral incentives to eliminate content quotas. Legacy cultural policy is therefore a non-desirable status quo, and dismantling import barriers may require a cooperative approach among countries. Based on the assumption that such cooperation will prevail in the long-term, we next examine the implications of online sharing for industry sizes in the cultural sector.

5 The long-term effect of online sharing

This section endogenizes industry sizes and introduces production subsidies to evaluate the long-term effect of online sharing on the volume of production. We build on these results in the next section to analyze the impact of online sharing on cultural diversity in the world economy. To endogenize industry sizes, we introduce a fixed cost of production c for producers and incorporate entry decisions into the model. We consider both the case of competitive entry and the case of

subsidized entry. The former characterizes industry sizes based on the individual entry decisions of producers. The latter characterizes optimal industry sizes assuming governments intervene to sustain them by subsidizing producers or restricting entry if necessary.

We incorporate entry decisions into the timing of the game as follows. In the first stage, under competitive entry, potential entrants in both countries simultaneously choose whether to enter the sector or to stay out. Under subsidized entry, industry sizes are jointly chosen by governments to maximize world welfare.[15] In the second stage, governments set quotas. In the third stage producers price their content, and in the fourth stage consumption decisions take place. Note that in order to solve the game we need to make assumptions about how quotas are set in the second stage. When there is no online sharing, we assume for consistency that quotas are set unilaterally under competitive entry and multilaterally under subsidized entry. We focus on the empirically relevant case where cultural policy mandates enforcement, a sufficient condition in a two-country economy is $q^* > \frac{5}{8}$. In the presence of online sharing, following our results in the previous section, we assume that content quotas are eliminated.[16]

The focus of the exercise is to compare equilibrium industry sizes before and after online sharing within each regime, so we restrict our analysis to symmetric allocations where industry sizes coincide in both countries. Also note that we keep production cost c constant before and after online sharing. This ensures that we isolate the impact of online sharing from other technological shifts that may affect the production process.

Industry sizes with competitive entry. In the absence of online sharing, the solution to the second, third, and fourth stages of the game carries over from Proposition 1. Denote equilibrium industry sizes by f^c, and note that quotas will coincide across both countries in a symmetric entry equilibrium. Industry profits are given by Π_k in (6) and the solution is characterized by a zero profit condition for producers in each country, $\Pi_k(f^c)/f^c = c$. This ensures that f^c potential entrants choose to enter in each country and the remaining stay out. Substituting equilibrium varieties n_k and prices p_k from Proposition 1 in the zero profit condition and solving for f^c obtains the following implicit equation,

$$f^c = \sqrt{\frac{t \cdot q_k^u(f^c)}{c}}, \tag{11}$$

where quotas q_k^u are given by the unilateral solution in Proposition 1. We show in the Appendix that this equation identifies a unique solution for f^c.

[15] We do not solve the case where governments choose industry sizes unilaterally. We have analyzed the entry problem extensively, but unfortunately found this case to be intractable due to the complexity of government best-responses in the first stage. We nonetheless expect our qualitative results for the multilateral regime stated in Proposition 3 to also hold in the unilateral regime, given that the same quota mechanism is present in both cases.

[16] As noted in Proposition 2, content quotas are ineffective and inefficient in the presence of online sharing and therefore we do not expect them to remain enforced in the long-term. If quotas were nonetheless enforced, they would reduce producer revenues and drive consumers to incur wasteful online sharing costs, strengthening Proposition 3 by further reducing equilibrium industry sizes with online sharing, $f^{os,c}$ and $f^{os,m}$.

Consider next competitive entry in the presence of online sharing, to be denoted by $f^{os,c}$. The solution to the third and fourth stages of the game carries over from Proposition 2. Industry profits are given by Π_k^{os} in (10), and there is no quota enforcement in the second stage (quotas are eliminated), $q_k = \bar{q}_k$. Substituting equilibrium varieties n_k^{os} from Proposition 2 in the zero profit condition $\Pi_k^{os}(f^{os,c})/f^{os,c} = c$ identifies the following entry solution

$$f^{os,c} = \frac{o}{c}. \tag{12}$$

Industry sizes with subsidized entry. In the absence of online sharing, the solution to the second, third, and fourth stages of the game carries over from Proposition 1. Denote equilibrium industry sizes under subsidized entry by f^m. In the first stage, governments choose industry sizes to jointly maximize $G_1+G_2-(f_1+f_2)c$. Substituting $f_1 = f_2 = f$, plugging in content varieties n_k and prices p_k from Proposition 1, and solving for $\partial(G_1 + G_2 - 2\,f\,c)/\partial f = 0$ obtains the following implicit equation

$$f^m = \sqrt{\frac{t \cdot q_k^m(f^m)}{4c}}, \tag{13}$$

where quotas q_k^m are given by the multilateral solution in Proposition 1. We show in the Appendix that this equation identifies a unique maximum for f^m.

Consider next optimal industry sizes in the presence of online sharing, to be denoted by $f^{os,m}$. Governments jointly maximize $G_1^{os} + G_2^{os} - (f_1 + f_2)c$. Substituting $f_1 = f_2 = f$, plugging in content varieties n_k^{os} from Proposition 2, and solving for $\partial(G_1^{os} + G_2^{os} - 2\,f\,c)/\partial f = 0$ identifies two candidate solutions. It can be shown that only the following solution is a maximum,

$$f^{os,m} = \frac{t}{2\sqrt{2ct}}. \tag{14}$$

Inspection of the above entry solutions yields the following result.

Proposition 3. *Online sharing reduces industry sizes in the long-term both under competitive entry and under subsidized entry, $f^{os,c} < f^c$ and $f^{os,m} < f^m$. National diversity decreases under competitive entry if fixed costs are high, $n_k^{os}(f^{os,c}) < n_k(f^c)$ if $c > \frac{(5o-4q^*)o^2}{(2o-1)t}$, and otherwise increases. National diversity always increases under subsidized entry, $n_k^{os}(f^{os,m}) > n_k(f^m)$.*

Online sharing always reduces industry sizes in the long-term. Under competitive entry, the reduction is driven by the content pricing effect (lower prices) and the demand displacement effect (lower market shares) discussed in the previous section. Both of these effects reduce the revenues derived by producers. A countervailing effect is present in the long-term, given that the elimination of content quotas ensures that producers always derive revenues from foreign consumers. This third effect, however, is insufficient to offset the previous two. The left panel of Figure 2 illustrates why less producers are willing to enter the sector as a result: the revenues derived by each producer

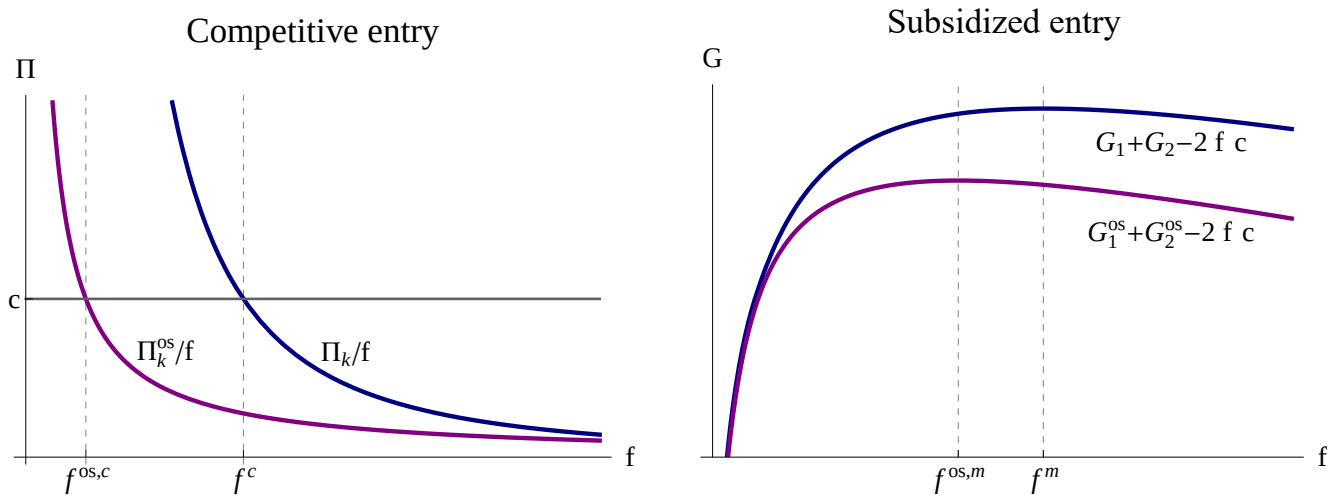

Figure 2: Equilibrium industry sizes under competitive entry (left) and subsidized entry (right).

(net of fixed costs) are lower with online sharing than without online sharing for any given industry size, $\Pi_k^{os}(f)/f < \Pi_k(f)/f$, and therefore the number of producers covering fixed production cost c in equilibrium is lower.

Online sharing also reduces industry sizes under subsidized entry. This result is independent of the shifts in producer revenues discussed above for the case of competitive entry, because governments redistribute surplus between consumers and producers in order to sustain optimal industry sizes under intervention. Instead, the result is driven by the lack of effective quota enforcement in the presence of online sharing. First, note that an optimal volume of production exists in the world economy, which results from the inherent tradeoff between consumer preferences for content variety and the costs of producing such variety. This tradeoff is affected by quota enforcement. Enforcement increases optimal industry sizes because it restricts the number of (foreign) content varieties supplied in each country. Online sharing, in turn, renders enforcement ineffective and thereby reduces optimal industry sizes. The right panel of Figure 2 plots the objective function of governments as a function of industry size both without online sharing (when quotas are enforced), $G_1 + G_2 - 2\,f\,c$, and with online sharing (when there is no enforcement), $G_1^{os} + G_2^{os} - 2\,f\,c$. Each curve represents the total welfare frontier, including both social welfare and cultural welfare. It can be readily verified that optimal industry sizes are always lower in the presence of online sharing.

Online sharing reduces industry sizes under both regimes, but this need not result in lower national diversity. Although the number of content varieties produced in the world economy is lower, improved consumer access to foreign varieties can result in a higher number of content varieties consumed in each country. Thus consumers may find that online sharing increases their available media choices. We find that this is always the case under subsidized entry, where online sharing increases national diversity. However, the effect can go in either direction under competitive entry. If production cost c is high, national diversity goes down. And conversely, if production cost c is low, national diversity goes up. Intuitively, improved access to foreign varieties only offsets

the decrease in production when the cost of production is low. In the next section, we explore the effect of online sharing on world diversity and show that it need not go in the same direction as that of national diversity.

The long-term impact of online sharing on social welfare can be shown to go in the same direction as its impact on national diversity under both regimes. Thus online sharing increases social welfare if (and only if) it increases national diversity. The long-term impact on cultural welfare is always negative, because online sharing drives domestic cultural shares down to free trade levels. Accounting for both effects, it can be shown that online sharing reduces total welfare in the world economy. The reduction in cultural welfare always offsets the potential increase in social welfare. As depicted in the right panel of Figure 2, online sharing shifts down the total welfare frontier in the world economy.

It is also of interest to compare the long-term outcome with online sharing to that of free trade. Both scenarios have in common the absence of import barriers, though it is important to stress that such barriers would not be eliminated if online sharing were not present (i.e., free trade is not an equilibrium outcome in our model given the political preferences of governments). Under competitive entry conditions, the fundamental difference with respect to free trade is that producers are forced to set lower prices with online sharing due its low cost for consumers, $o < \bar{o}$. This results in a lower volume of production than that predicted by the free trade equilibrium. Under subsidized entry, optimal industry sizes coincide in both cases due to the absence of import barriers. However, the subsidies required to sustain these industry sizes will always be higher in the presence of online sharing because of the lower revenues derived by producers in the marketplace. Note that this also applies to our main results discussed above. Online sharing reduces the optimal volume of production under subsidization, but it may well be the case that higher subsidies are required to sustain lower production targets given its impact on commercial revenues.

6 Diversity in the world economy

Our analysis has so far characterized the impact of online sharing on content diversity within countries. In this section we use a fractionalization index to examine its impact on diversity *across* countries. This family of indices measures the probability that individuals randomly picked from different populations share the same trait, and has been readily applied in the empirical literature on cultural diversity, see for instance Alesina et al. (2003). In our application, we will measure the probability that consumers randomly picked from different countries consume the same content. Based on our characterization of long-term outcomes in the previous section, we will compute the value of the index for the world economy with and without online sharing. If online sharing drives consumers in different countries to increasingly consume the same content, reducing the value of the index, then online sharing reduces world diversity. And conversely, if it drives consumers in different countries to consume different content, increasing the value of the index, then online

sharing increases world diversity.[17]

Denote by $s_{j,k}$ the market share of content variety j in country k when the total number of varieties produced is given by $2f$. We measure world diversity with the following fractionalization index FR,

$$FR = \frac{1}{2f}\sum(1 - s_{j,1} \cdot s_{j,2}).$$

The index is a direct extension of the Herfindahl concentration index to the case of two countries, subtracted from 1 to measure diversity or absence of concentration and normalized by the number of products. It obtains a minimum value of zero (no diversity) when consumption is concentrated on a single and common product across both countries. The value of the index increases when more products are consumed *or* when the set of products consumed differs across countries. To see the first effect, consider the case where the exact same mix of products is consumed in both countries, $s_{j,1} = s_{j,2} = \frac{1}{2f}$, so that $FR = 1 - (\frac{1}{2f})^2$. Clearly, FR is then increasing in f. To see the second effect, note that FR obtains the maximum value of 1 when there is no overlap among the set of products consumed in both countries, when $s_{j,1} \cdot s_{j,2} = 0$ for all products.

World diversity. We first characterize the fractionalization index in the absence of online sharing. Under quota enforcement in country k, the probability that any given content variety from the foreign country is commercialized is given by $(n_k - f_k)/f_{-k}$, and all commercialized varieties derive equal market shares. Therefore,

$$FR = \frac{1}{f_1 + f_2}[f_1(1 - \frac{1}{n_1} \cdot \frac{1}{n_2}\frac{n_2 - f_2}{f_1}) + f_2(1 - \frac{1}{n_2} \cdot \frac{1}{n_1}\frac{n_1 - f_1}{f_2})].$$

Denote the value of the index in the absence of online sharing by WD. Substituting n_k from Proposition 1, and equating $q_1 = q_2 = q$ and $f_1 = f_2 = f$ to account for symmetric equilibria obtains

$$WD = \frac{f^2 - (1-q)q}{f^2}.$$

Consider next the fractionalization index in the presence of online sharing. All content varieties produced are consumed in both countries and derive equal market shares in each of them,

$$FR = \frac{1}{f_1 + f_2}[(f_1 + f_2)(1 - \frac{1}{f_1 + f_2} \cdot \frac{1}{f_1 + f_2})].$$

We denote the value of the index in the presence of online sharing by WD^{os}. Equating $f_1 = f_2 = f^{os}$

[17] Note that this is the same criteria we have used to characterize diversity within countries. When the number of content varieties consumed within a country increases, the probability that randomly picked consumers within the country consume the same content decreases. Thus national diversity increases. And conversely, when the number of content varieties consumed decreases, so does national diversity. The effect can be formalized with a standard concentration index, though we have stated the results based on the number of varieties for simplicity given that all content varieties derive equal market shares in equilibrium.

to account for symmetric equilibria yields

$$WD^{os} = \frac{1}{1 - 4(f^{os})^2}.$$

Inspection of WD and WD^{os} accounting for the fact that $q \in [\frac{1}{2}, 1]$ and $f > f^{os}$ delivers the following result.

Proposition 4. *Online sharing reduces cultural diversity in the world economy,* $WD^{os} < WD$.

Online sharing reduces cultural diversity across countries in our model. This follows from the two mechanisms at play identified in our analysis: online sharing renders import barriers ineffective and also reduces the volume of production. The lack of effective import barriers (either due to consumers bypassing them or their formal dismantlement) homogenizes consumption patterns across countries. The reduction in the volume of production concentrates consumption within each country on a smaller number of content varieties. Both effects reduce cultural diversity in the world economy. Simply stated, our model predicts that online sharing increases the share of consumers in different countries consuming the same content.

The result is driven by the underlying preference structure in our model. In each country, the consumer population is variety-seeking and therefore willing to consume all content varieties produced in the world economy. When some content varieties are unavailable in some countries due to import barriers, a mechanism such as online sharing that eliminates these barriers ensures that consumption patterns converge across countries. It is worth noting that the reduction in the index does not require preferences to be identical across countries, as is the case in our model. It is sufficient that there is demand in each country for content varieties produced in the other, even if weaker than demand for domestic content. If this demand is served only in the presence of online sharing such that convergence in consumption patterns increases, then the cultural diversity index will decrease.

7 Extensions

Some of the simplifying assumptions present in our model merit additional discussion in light of recent trends observed in the cultural sector. On the one hand, content quotas in cinema, TV, and radio remain in place in many countries. On the other hand, streaming services such as Netflix or Spotify bypass these import barriers and continue to gain market share. We next enrich our model to explain and reconcile these trends. We consider the case where commercial distribution and online sharing are not perfect substitutes for all consumers and where additional distribution channels coexist.

Our base model assumes that online sharing is pervasive and all consumers access it at cost o. But some consumers may find it difficult to access online sharing because they are not digitally

savvy, their Internet connection is slow or their computing devices unsuitable, or they face the risk of high fines or reputational costs. To account for these factors in our model we let a share s of the population be composed of *e-savvy* consumers, who can access online sharing at cost o, and assume the remaining *e-unsavvy* consumers cannot access online sharing (or face an arbitrarily high cost of access).[18]

To explore the implications of streaming services we consider the case where two commercial distribution channels coexist. As in our preceding analysis, there is a traditional distribution channel accessible to all consumers and subject to content quotas where each producer prices their content. In addition, we introduce an online streaming service accessible only to e-savvy consumers that provides access to all content varieties for a fixed subscription price. The streaming service incurs zero marginal costs and the subscription price is set by producers, who share the revenues of the service according to the consumption of their content. Note that consumers have single-unit demand in our model, so the streaming service will not affect the volume of content consumed (that is, consumers will subscribe to access only their preferred content variety). The simplification ignores a relevant aspect of subscription services but is convenient given that our focus is to examine their impact on cultural policy and diversity.

In this setting, it can be shown that producers quote the same price in the traditional distribution channel as in our base model (as given in Proposition 1) and price the streaming service to match online sharing cost o. Both distribution channels coexist and serve different consumer segments, with traditional distribution servicing e-unsavvy consumers and the streaming service servicing e-savvy consumers. Producer profits are strictly higher than in the base model due to effective price discrimination, given that e-unsavvy consumers do not have access to the streaming service.[19]

Consider the implications for cultural policy and diversity. The government objective function in this extended model can be written as follows:

$$\begin{aligned} CS_k^e &= s\, CS_k^{os} + (1-s) CS_k \\ \Pi_k^e &= s\, o + (1-s)\Pi_k \\ CW_k^e &= s\, CW_k^{os} + (1-s) CW_k. \end{aligned} \tag{15}$$

Inspection reveals the following properties. Quota enforcement remains effective because it in-

[18] In this extended model, the number of content varieties available to e-savvy and e-unsavvy consumers will differ whenever some varieties are only accessible through online sharing. Our analysis in this section is based on the assumption that consumer demand for each segment is determined by the number of varieties available to that segment, i.e., the number of products present on the perimeter of the circle differs for e-savvy and e-unsavvy consumers within each country.

[19] Note that there is no online sharing in equilibrium because all e-savvy consumers purchase the streaming service. More generally, with a continuum of consumer types who differ in their online sharing cost, producer pricing may tolerate some degree of online sharing such that it coexists with commercial distribution in equilibrium. See Casadesus-Masanell and Hervas-Drane (2009) for a pricing analysis of this scenario with endogenous market coverage and online sharing performance.

creases the exposure of e-unsavvy consumers to domestic content. Governments therefore enforce quotas both in the unilateral and multilateral regimes, though this results in lower cultural welfare gains than in the base model because e-savvy consumers are unaffected by enforcement. The result provides a rationale for the persistence of content quotas in the presence of online sharing: there are benefits to enforcement for the population that lacks online sharing access. And conversely, there are no gains to enacting import barriers on streaming services because their customers will resort to online sharing for content that is commercially unavailable.

Industry sizes are higher than those predicted in our base model. Producer profits are higher, as noted above, given that e-unsavvy consumers are charged higher prices. This results in more producers entering the market under competitive entry, and optimal industry sizes in a subsidized regime are also higher due to the effects of quota enforcement. Cultural diversity is also reduced by online sharing in the extended model. The market shares of foreign content varieties increase in every country with online sharing, and streaming services satisfy most of the demand for these varieties.

Finally, we note that as the share of consumers with online access grows, $s \to 1$, the outcome converges to that of our base model. Import barriers and consumption patterns in the traditional distribution channel are unaffected by online sharing but represent a decreasing share of overall trade. In contrast, streaming services provide a growing share of the population with unrestricted access to a larger pool of content at lower prices, thereby delivering the benefits of online sharing to consumers.

8 Concluding remarks

Parallel distribution channels have improved consumer access to foreign media content in the past (e.g., gray imports, video rentals) but online sharing represents a distinct phenomenon given its immediacy, scale, and breadth of content. Our formal analysis has focused on the features of the technology most relevant to the cross-border flow of content, but other aspects will contribute to shape its impact. Some types of content are more prone to be exchanged over online sharing than others, or favor social consumption, or depend on real-time action. Online sharing will therefore not impact all content uniformly, and should generate a media environment that is different in terms of market characteristics and content composition.

We expect demand-side policies to play an important role in fostering consumption of domestic content going forward. Production subsidies may need to be reevaluated to account for lower commercial revenues and could be channeled to new types of producers and content providers. Governments could subsidize the consumption (rather than the production) of domestic content, and the proliferation of commercial streaming services enables such subsidies to be carefully targeted in order to increase their effectiveness. Sponsoring of content portals for domestic production could also prove effective, and public broadcasters have begun to serve as a natural platform to

develop such portals. The new media environment presents novel policy challenges but also novel policy avenues, and will require a re-thinking of goals, needs, and tools.

Appendix

We show that the implicit equations characterizing equilibrium entry f^c in (11) and f^m in (13) have unique and well-defined solutions. Recall that our analysis is based on the parameter range where $f > \frac{3}{2}t$ (which ensures the market is covered), $q^* > \frac{5}{8}$ (which ensures quotas are enforced in the second stage, so that $\hat{q}_k^u > \bar{q}_k$ and $\hat{q}_k^m > \bar{q}_k$), and $o < t/2f$ (which ensures symmetric pricing holds in the online sharing equilibrium, $p_k^{os} = o$). Consider first the case of competitive entry in the absence of online sharing,

$$f^c = \sqrt{\frac{t \cdot q_k^u(f^c)}{c}}.$$

Plugging $\hat{q}_k^u$ from (7) in the above implicit equation and rearranging obtains a polynomial equation, $P(f^c) = 0$, where the polynomial P is given by

$$P(f) = 8c\, f^3 - 8ct\, f^2 - 8q^* t\, f + 5t^2.$$

Note that P is a third degree polynomial, and therefore has three roots. Denote the three roots by f_I, f_{II}, and f_{III}. Evaluating the polynomial subject to the constraints $f > \frac{3}{2}t$ and $q^* > \frac{5}{8}$ reveals that $f_I < 0 < f_{II} < t < f_{III}$, and therefore f_{III} is the single candidate solution. Next, we apply the intermediate value theorem to establish that f_{III} is a real root. Inspection reveals that $P(f) < 0$ for $f \in (f_{II}, f_{III})$ and $P(f) > 0$ for $f > f_{III}$. Therefore, by continuity, it must be the case that f_{III} is a real root and we conclude that $f^c = f_{III}$.

Consider next the case of subsidized entry in the absence of online sharing, which is characterized by the following implicit equation

$$f^m = \sqrt{\frac{t \cdot q_k^m(f^m)}{4c}}.$$

Plugging $\hat{q}_k^m$ from (8) in the above implicit equation and rearranging obtains a polynomial equation $P'(f^m) = 0$ where

$$P'(f) = 32c\, f^3 - 8q^* t\, f + t^2.$$

Denote the three roots of P' by f'_I, f'_{II}, and f'_{III}. To identify which roots constitute a valid solution to the maximization problem of governments, we evaluate the second derivative of the objective function at each of the three roots. Inspection reveals that $\partial(G_1 + G_2 - 2\, f\, c)/\partial^2 f$ only obtains negative values at f'_{III}. Therefore, f'_I and f'_{II} cannot be welfare-maximizing and f'_{III} constitutes the single candidate solution. Next, we establish that f'_{III} is a real root. Inspection of $P'(f)$ subject to the constraints $f > \frac{3}{2}t$ and $q^* > \frac{5}{8}$ reveals that $P'(f) < 0$ for $f \in (f'_{II}, f'_{III})$ and $P'(f) > 0$ for $f > f'_{III}$, so continuity implies that f'_{III} must be a real root.

Inspection of entry solution $f^c = f_{III}$ characterized above as well as entry solution $f^{os,c}$ in (12)

subject to the constraints $f^{os,c} > \frac{3}{2}t$, as well as $q^* > \frac{5}{8}$, and $o < t/2f^{os,c}$ reveals that $f^{os,c} < f^c$. Moreover, inspection of entry solution $f^m = f'_{III}$ characterized above as well as entry solution $f^{os,m}$ in (14) subject to the constraints $f^{os,m} > \frac{3}{2}t$, as well as $q^* > \frac{5}{8}$, and $o < t/2f^{os,m}$ reveals that $f^{os,m} < f^m$. Finally, consider the number of content varieties consumed in each country, which is given by n_k in Proposition 1 in the absence of online sharing and by n_k^{os} in Proposition 2 in its presence. Given the preceding parameter constraints on f, t, q^*, and o, it can be shown that $n_k^{os}(f^{os,c}) < n_k(f^c)$ if and only if $c > \frac{(5o-4q^*)o^2}{(2o-1)t}$, and it is always the case that $n_k^{os}(f^{os,m}) > n_k(f^m)$.

References

[1] Aguiar, Luis and Joel Waldfogel (2016), 'Even the losers get lucky sometimes: New products and the evolution of music quality since Napster,' *Information Economics and Policy,* forthcoming.

[2] Alesina, Alberto, Arnaud Devleeschauwer, William Easterly, Sergio Kurlat, and Romain Wacziarg (2003), 'Fractionalization,' *Journal of Economic Growth* 8:2 155-194.

[3] Arai, Yasuhiro (2011), 'Civil and criminal penalties for copyright infringement,' *Information Economics and Policy* 23 270-280.

[4] Bakos, Yannis, Erik Brynjolfsson and Douglas Lichtman (1999), 'Shared Information Goods,' *Journal of Law and Economics* 42:1 117-155.

[5] Bala, Venkatesh and Ngo Van Long (2005), 'International trade and cultural diversity with preference selection,' *European Journal of Political Economy* 21 143-162.

[6] Banerjee, Dyuti S. (2003), 'Software piracy: a strategic analysis and policy instruments,' *International Journal of Industrial Organization* 21 97-127.

[7] Bernier, Ivan (2005), 'Trade and Culture' in *The World Trade Organization: Legal, Economic and Political Analysis*, Patrick F. J. Macrory, Arthur E. Appleton and Michael G. Plummer, eds, Springer Publishing.

[8] Besen, Stanley M. and Sheila Nataraj Kirby (1989), 'Private Copying, Appropriability, and Optimal Copying Royalties,' *Journal of Law and Economics* 32:2 255-280.

[9] Casadesus-Masanell, Ramon and Andres Hervas-Drane (2009), 'Peer-to-Peer File Sharing and the Market for Digital Information Goods,' *Journal of Economics and Management Strategy* 19:2 333-373.

[10] d'Aspremont, Claude, Jean Jaskold Gabszewicz, and Jacques-François Thisse (1979), 'On Hotelling's "Stability in competition"', *Econometrica* 47 5.

[11] Economides, Nicholas (1989), 'Symmetric equilibrium existence and optimality in differentiated product markets,' *Journal of Economic Theory*, 47:1 178-194.

[12] Ferreira, Fernando and Joel Waldfogel (2013), 'Pop Internationalism: Has Half a Century of World Music Trade Displaced Local Culture?' *The Economic Journal* 123 634-664.

[13] Francois, Patrick and Tanguy van Ypersele (2002), 'On the protection of cultural goods,' *Journal of International Economics* 56:2 359-369.

[14] Handke, Christian (2012), 'Digital copying and the supply of sound recordings,' *Information Economics and Policy* 24 15-29.

[15] Liebowitz, Stan J. (1985), 'Copying and Indirect Appropriability: Photocopying of Journals,' *Journal of Political Economy* 93:5 945-957.

[16] Liebowitz, Stan J. (2006), 'File-Sharing: Creative Destruction or just Plain Destruction?,' *Journal of Law and Economics* 49 1-28.

[17] McKenzie, Jordi (2016), 'Graduated response policies to digital piracy. Do they increase box office revenues of movies?' *Information Economics and Policy*, forthcoming.

[18] Noam, Eli (1987), 'A Public and Private-Choice Model of Broadcasting,' *Public Choice* 55 163-187.

[19] Noam, Eli (1991), *Television in Europe*, Oxford University Press.

[20] Noam, Eli (2008), 'The Economics of User Generated Content and Peer-to-Peer: The Commons as the Enabler of Commerce' in *Peer-to-Peer Video, The Economics, Policy, and Culture of Today's New Mass Medium*, Lorenzo Pupillo and Eli Noam, eds, Springer Publishing.

[21] Oberholzer-Gee, Felix and Koleman Strumpf (2010), 'File Sharing and Copyright,' *Innovation Policy and the Economy* 10 19-55, University of Chicago Press.

[22] Olivier, Jacques, Mathias Thoenig and Thierry Verdier (2008), 'Globalization and the Dynamics of Cultural Identity,' *Journal of International Economics* 76 356-370.

[23] Peitz, Martin and Patrick Waelbroeck (2006), 'Why the music industry may gain from free downloading – The role of sampling,' *International Journal of Industrial Organization* 24 907-913.

[24] Puppis, Manuel (2008), 'National Media Regulation in the Era of Free Trade: The Role of Global Media Governance,' *European Journal of Communication* 2008:23 405-424.

[25] Rauch, James E. and Vitor Trindade (2009), 'Neckties in the tropics: a model of international trade and cultural diversity,' *Canadian Journal of Economics* 42:3 809-843.

[26] Richardson, Martin (2006), 'Commercial broadcasting and local content: Cultural quotas, advertising and public stations,' *The Economic Journal* 116 605-625.

[27] Salop, Steven C. (1979), 'Monopolistic Competition with Outside Goods,' *Bell Journal of Economics*, 10:1 141-156.

[28] Vogel, Jonathan (2008), 'Spatial competition with heterogeneous firms,' *Journal of Political Economy* 116:3 423-466.

[29] Yoon, Kiho (2002), 'The optimal level of copyright protection,' *Information Economics and Policy* 14 327-348.