Online Sharing and Cultural Globalization*

Andres Hervas-Drane† Eli Noam‡

March 15, 2011

Abstract

This paper considers consumer sharing of media content online, such as the exchange of music and film over file sharing networks, and its long-term implications for cross-border consumption. Policy makers have traditionally intervened in media markets to protect the production and consumption of domestic content, imposing trade barriers and other forms of cultural policies as a matter of public interest. We present a trade framework for the media sector and characterize the impact of subsidies and quotas, the two most common forms of intervention. We show that the advent of online sharing, with the Internet enabling consumers to access media content bypassing commercial distribution channels, reduces the volume of unsubsidized production and renders quotas and other forms of supply exclusion increasingly ineffective. This implies that online sharing homogenizes consumption patterns across countries and concentrates consumption on a lower number of product varieties, and should be recognized as a catalyst of cultural globalization.

Keywords: File Sharing, Entertainment Industry, Media Diversity, Globalization

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

*We thank Ramon Casadesus-Masanell for helpful comments and seminar participants at the IESE SP-SP lunch seminar.

†Universitat Pompeu Fabra and IESE SP-SP Center (andres.hervas@upf.edu)

‡Columbia University

1 The advent of online sharing

Shared experience is a core element of culture. The sharing of cultural content forms not only the basis of artistic and scientific production, but also acts as a vehicle for the transmission of cultural identity, character, and values. Over the last decade the sharing of cultural content has become pervasive online, as witnessed by the spectacular growth of peer-to-peer file sharing. Consumers have embraced the exchange of content online, enabled by advances in the digitalization of audio and video content paired with the widespread adoption of high-speed Internet access.

In wealthier countries, online sharing has become part of the public debate. The content industry has confronted the phenomenon, arguing that online sharing displaces sales and will hinder the incentives to produce content. A regulatory response to these new challenges has only recently begun to emerge. But an important element of this debate, the potential long-term effects of online sharing for cultural diversity, has so far received little attention in the literature. While online sharing is a relatively recent development, it already accounts for a significant and growing portion of global content distribution and consumption. How will online sharing affect consumption patterns across countries? Will audiences become ever more concentrated on a common subset of media products? Or will variety flourish? Since the answer to this question will shape new regulatory environments in most countries and the structure of the content industry for years to come, this is a matter of public interest.

In this paper we evaluate the implications of online sharing for cultural diversity, and do so by analyzing how it will affect the concentration of media consumption in the global market. If online sharing increases concentration, homogenizing consumption patterns across countries and driving consumers to increasingly consume the same products, we should expect online sharing to reduce cultural diversity in the global marketplace. If, on the contrary, online sharing reduces concentration by driving consumers in separate countries to consume different products, cultural diversity would increase.[1] Our analysis suggests that, due to the differential characteristics of online sharing with respect to the forms of offline sharing that it supersedes, it increases the concentration of media consumption. To the extent that media content contributes to shape society, as defendants of cultural policies have long claimed, online sharing should be recognized as a threat to local culture.

Our analysis proceeds as follows. In the next section, we start by tracing the recent emergence of online sharing and the technologies that facilitate it, with a focus on peer-to-peer file sharing. While unauthorized reproduction of content has long affected the industry, large-scale efforts of the past required considerable investments to produce and distribute copies in analog formats, and were generally executed by third-parties for profit. Online sharing, in contrast, has proven to be sustainable on a large scale by online consumer communities alone. We characterize the properties of online sharing with respect to the traditional forms of offline sharing analyzed in

[1] We formalize this notion and provide a measure of cultural globalization in Section 3.1.

the economics literature. We then review the cross-border benefits of online sharing for consumers when compared to commercial distribution, and argue that online sharing should be understood as a global distribution channel which is broadly accessible and extremely resilient to outside control.

In Section 3 we introduce a model of trade to formalize our argument. We consider a framework based on the circular model of spatial competition, with a variety-seeking population of consumers and production characterized by strong economies of scale. In the economy there are several countries, and firms may enter the global market to produce a unique product variety in one of the countries. We analyze the patterns of consumption and production that emerge under free trade, in the presence of subsidies, and in the presence of quotas. Both subsidies and quotas are the most common forms of intervention in the media sector and are present, to some extent, in most developed countries. Our model explains why subsidies and quotas help protect domestic production and consumption in the media sector. Subsidies do so by sustaining a minimum floor of domestic production. Quotas restrict supply of foreign content, biasing consumption patterns in favor of domestic content in each country.

We then introduce online sharing, modeled as a global distribution channel that allows consumers to access any given product. Consumers incur a cost to participate in online sharing, which can be understood as the opportunity cost of the time required to do so or the expected legal costs of being prosecuted in the process. We proceed to analyze the impact of online sharing on the global marketplace under the three trade regimes considered above. We find that online sharing reduces the volume of production that can be sustained in the economy, acting as a competitor to commercial distribution. Furthermore, online sharing renders quotas and other forms of supply exclusion ineffective, ensuring foreign content is accessible to consumers. Both effects imply that consumption becomes increasingly concentrated on a lower number of product varieties.

In Section 4 we review the regulatory implications of our findings and discuss extensions to the model. Because online sharing renders ineffective trade barriers based on supply exclusion such as quotas, we argue that cultural policies in the digital environment must evolve towards subsidization of domestic production and consumption. We also review the recent initiatives to punish online sharing of copyrighted content in several countries. We then briefly discuss two extensions of our model; enriching consumer preferences with a bias favoring domestic production and incorporating economies of scope into the production side. We conclude in Section 5. The Appendix includes all proofs developed in our formal analysis.

2 Understanding online sharing

Consumer online sharing has evolved over several generations of Internet applications. These include newsgroups (such as Usenet), centralized server-based exchanges on private or public hosting sites (RapidShare), and peer-to-peer file sharing, which has emerged as the main driver of consumer online sharing in the last decade. Peer-to-Peer (p2p) file sharing applications allow participants to

supply and demand digital content from one another, enabling content exchange to take place on a large scale and without intermediaries, as was previously required with newsgroups and hosting sites. Peer-to-Peer file sharing is enabled by the architecture of the Internet, which allows for data transmission between nodes connected to the network with negligible marginal costs and irrespective of geographical distance, and has become more attractive with the increase in bandwidth and computing resources available to end users. Peer-to-Peer networks increase scalability and robustness for a wide range of applications and are an active area of research.[2]

File sharing became mainstream in 1999 with the development of a music file sharing application called Napster, which allowed users to easily share songs online. Napster enjoyed an explosive user base growth but a short life, as it relied on proprietary central servers which were shut down under legal pressure from the music industry. But file sharing technology evolved quickly. Current generation applications are based on decentralized network architectures, offering no single point of attack, and facilitate the exchange of any type of content with much improved efficiency. The technology has matured to the point that it is relatively easy for the average Internet user to obtain content over p2p.[3] In a 2005 Pew Internet survey on 'The future of the Internet,' half of the experts consulted believed that file sharing would still be easy by 2015, and that forecast appears on track.

In the US and Western Europe, the two most successful p2p applications are currently BitTorrent and eMule, which together drive most of file sharing traffic. Big Champagne, a marketing research firm specializing in file sharing, estimated that over 200 million computers worldwide had p2p software installed as of 2008.[4] One of the largest BitTorrent hubs reported over 10 million simultaneous users that same year, suggesting that a non-trivial fraction is active online at any given instant.[5] It has been estimated that over 90% of the content exchanged is copyrighted.[6] And according to Cisco, file sharing accounted for almost 50% of consumer Internet traffic in 2008 (33% of all Internet traffic), and is forecasted to grow in volume at an average yearly rate of 25% up to 2013.[7]

Online sharing has proven exceptionally resilient to both technical and legal attacks. Since file sharing technology has important legal uses beside the unauthorized distribution of copyrighted content, attempts to restrict or block p2p traffic need to be selective. Copyright holders have long infiltrated file sharing networks with spoof content to discourage users, with little success. Attempts by ISPs to curb file sharing traffic have triggered arms races between network engineers

[2]Applications of p2p networks include: file sharing (Napster, BitTorrent and eMule), real-time video streaming (BBC, ABC), distributed computing (SETI@home, Folding@home), and voice over IP (Skype).

[3]Surveys have shown that 75% of teen music downloaders aged 12-17 agree that 'file-sharing is so easy to do, it's unrealistic to expect people not to do it.' See 'Teen Content Creators and Consumers,' Pew Internet, November 2 2005.

[4]See 'The State of Music Online: Ten Years After Napster,' Pew Internet, June 2009.

[5]See 'Pirate Bay has 10 million users,' The Inquirer, January 2008.

[6]See the 'Census of Files Available via BitTorrent,' January 29 2010 published on the Freedom to Tinker blog of the Center for Information Technology Policy at Princeton University.

[7]See 'Cisco Visual Networking Index: Forecast and Methodology, 2008-2013.'

and p2p application designers. Recent rounds of filtering attempts have resulted in updated file sharing protocols that encrypt traffic, difficulting its identification. Perhaps in advance of the next steps, researchers have already explored mechanisms to obfuscate p2p traffic patterns.[8] And in the US, network neutrality proponents have taken action against ISPs attempting to filter p2p traffic, with the FCC requesting Comcast to abandon the practice.[9]

Legal attacks against p2p have also failed to curb file sharing. Major legal cases against proprietary p2p applications Napster and Grokster have led to the successful development of open source p2p software initiatives. Copyright holders have sent warning letters and prosecuted file sharing users in several countries, with the media picking up on large damage claims, but these initiatives have failed to significantly reduce sharing traffic. Several European governments recently proposed to start punishing online copyright infringers with Internet disconnection and fines, but legal procedures requiring judicial oversight on a case by case basis and public resistance are perceived as blocks to their effective application.[10] These legal attacks have also seen the emergence of new political parties founded to defend the interests of file sharing users, such as the successful Piratpartiet in Sweden.[11]

2.1 Online sharing as a copying mechanism

Copyright holders have long argued that unauthorized reproduction of commercial content hinders their revenues. Unauthorized reproduction can take place on several scales, and a distinction should be made between organized piracy and private copying. Piracy is executed on a large scale for profit purposes, for example with the manufacturing of counterfeit CDs and DVDs. Piracy is subject to criminal law and actively pursued in most countries. Private copying, in contrast, has traditionally been small in scale and executed by consumers for personal consumption, for example with the domestic replication of content on personal recorders. In most countries, some forms of private copying enjoy fair use exemptions, and authorities will only ban copying devices designed exclusively for unfair uses.

The legal status of online sharing is subject to debate in many countries and is an active area of legislation. Despite its global scale, its widespread use by consumers for personal consumption and the absence of profit drivers render it more akin to private copying than piracy. The economics literature has in the past analyzed the impact of private copying, or private sharing, on copyright holders. We next review some of these contributions.

Liebowitz [9] observed that copying technologies, capable of producing valuable copies, also increase the value of copyable originals. If copyright owners can appropriate this increase in value

[8] See the SwarmScreen plugin designed by the Aqualab Project at Northwestern University, accessed at: http://aqualab.cs.northwestern.edu/projects/SwarmScreen.html

[9] See 'Comcast loses: FCC head slams company's P2P filtering,' Ars Technica, July 11 2008.

[10] We discuss the implications of these legal initiatives in the context of our model in Section 4.

[11] The Piratepartiet became the fifth most voted party in Sweden for the 2009 European Parliament elections, with 7,13% of votes.

by raising the price of originals, then private sharing may not be detrimental to their profits. Liebowitz reviewed the case of journal publishers with the advent of photocopying technology, and found that photocopying did not harm publishers.

Besen and Kirby [3] provide a theoretical analysis of the impact of copying technologies on a copyright holder, accounting for varying degrees of substitutability between originals and copies as well as the respective marginal costs of producing them. Takeyama [12] considers the implications of copying for the dynamic pricing strategies of a monopolist supplier. Both papers find that private sharing can either harm or benefit copyright holders. When the value of originals can be fully appropriated, copyright holders may be better off if producing copies is more efficient than producing originals, or if the consumers served by copies are distinct from those they prefer to target in the market.[12]

Bakos, Brynjolfsson and Lichtman [1] consider the case of digital information goods and the impact of private sharing when production and copying costs fall to zero. They examine the willingness to pay for originals when consumers form small sharing groups, such as households or clubs. They find that small-scale sharing tends to increase profitability when it reduces buyer diversity. On the contrary, when teams are very heterogeneous, profitability decreases.

In our view, there are two important differences between online sharing and the traditional forms of private sharing considered in this literature. First, online sharing exhibits improved efficiency as a copying mechanism than traditional analog formats, with lower marginal costs to produce copies and higher substitutability of originals and copies. And second, it exhibits improved scalability, since online distribution allows for a unique original to serve the full demand for copies. This significantly expands the size of the sharing groups formed by consumers, potentially reaching the whole consumer population. The literature suggests that both effects harm copyright holders.

The efficiency of online sharing, however, should not be overstated. The raise of online sharing has been paired with shrinking revenues in the music recording industry. With the declining sales of CDs over the last decade the industry has argued that it "cannot compete against free." But online sharing is not free for consumers, although it lowers replication costs with respect to traditional copying mechanisms. It presents non-negligible costs such as the investment of computing resources and bandwidth required to download content, a variable degree of congestion that delays the consumption of the content, and a positive risk of legal sanctions in several countries. The economics literature has reviewed the empirical evidence for the impact of file sharing on the sales of CDs, and Oberholzer-Gee and Strumpf [10] conclude in a recent literature review that file sharing explains at best 20% of the decline. This suggests there is scope to compete with online sharing despite its efficiency. Casadesus-Masanell and Hervas-Drane [4] apply economic modeling to this market and show that copyright holders can compete with online sharing by offering a

[12] Consider the market for productivity software such as Microsoft Office. A producer may profit from targeting firms for revenue and allowing consumers to copy the software, since consumers becoming more adept with the software increases its value for firms and also facilitates long-term pricing commitments by ruling out residential demand.

competitive online alternative and pricing accordingly.

The scalability of online sharing implies that access to a single original is sufficient to satisfy the demand of copies of the whole consumer population, since the distribution of copies is no longer bound to social networks or local communities. It is interesting to note that, in the limit, application of Liebowitz's indirect appropriability argument to this scenario requires copyright holders to extract consumers' surplus from new content on public release of an original. Theoretically, this may be implementable with fundraising release campaigns, although the nature of media content as an experience good is an important hurdle as consumers are uncertain of their valuation of new products. For established producers, however, reputation may help circumvent such difficulties.[13] Alternatively, a subscription revenue model that covered most of the consumer population and provided access to new content could be understood as a bundling solution, reducing uncertainty by aggregating the value across heterogeneous content.

2.2 Online sharing as a distribution channel

The improved scalability of online sharing cannot be understood in the context of traditional copying mechanisms. Perhaps the single most disruptive feature of online sharing is that it transparently scales beyond market borders, allowing consumers in different countries to seamlessly exchange content. To the extent that the Internet is global, online sharing endows consumers with access to content that would otherwise not be available to them through domestic commercial distribution channels. We next argue that online sharing should be understood as a global distribution channel.

Cultural policies are an important constraint for cross-border commercial distribution in the global market. Policy makers have long contended that domestic production and consumption of media content has important implications for public policy. Because media content can portray and influence perceptions of national identity, character, and cultural diversity, the sector has been considered more related to cultural policy than trade. For example, the European Union's audiovisual media services Directive 2010/13/EU 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."

Subsidies and quotas are the most extended forms of intervention in the media sector. Subsidies foster domestic cultural content by financing production in film, radio, and television. The European Union's MEDIA program, for instance, has an assigned budget of €755 million to subsidize European productions during the 2007-2013 period. Quotas protect domestic consumption by enforcing minimum market shares for domestic content, and have generally been applied to cinema

[13] Consider for instance the case of Prince, an established musician, who released a new album in 2007 bundled with a Sunday newspaper in the UK as part of a million dollar deal. Such a revenue model could nonetheless scale down to less established artists, with several web initiatives running auctions to propel and publish emerging artists. Also, reports point to growing fan subsidization of album recordings over the Internet.

screens as well as television and radio broadcasting. The EU directive states that "Member States shall ensure [...] that broadcasters reserve for European works a majority proportion of their transmission time." Bernier [2] documents that quotas in radio are set to 40% in France, and in television to 60% in France, and 51% in Spain. Outside Europe, television quotas are present in Canada, Australia, South Africa, Argentina, Brazil, Chile, Venezuela, Costa Rica, South Korea, and China.

Other factors beside cultural policies have also limited the commercial availability of media products for consumers. Analog broadcasting and physical distribution, limiting the number of broadcasting channels and shelf space, imply that titles have to be carefully selected to maximize demand. Differences across national markets due to localizing costs and taste idiosyncrasies affect the timing of releases across markets. But digital distribution is lifting several of these limitations, and the industry is adapting its business models accordingly. In recent years, large content catalogs have been licensed to new online distributors, and release windows have been shortened across different markets.

We conclude that cultural policies remain as the main cross-border constraint of commercial distribution. Therefore it is significant that online sharing may be the first global distribution channel for consumers, providing unrestricted access to content. It is this access to a global pool of content that sets online sharing apart from traditional copying mechanisms. With increasing Internet penetration and broadband speeds, we should expect consumers to continue to resort to online sharing wherever commercial distribution fails to deliver the full benefits of digital distribution.

3 Online sharing and trade in the media sector

To understand how online sharing will affect the concentration of media consumption, we next consider a formal model of trade. To simplify the approach, we focus on some key features of the content market. On the demand side we consider a consumer population characterized by heterogeneous preferences for content. The production of new varieties of content (or content-ideas) that meet the taste of unserved audiences can be understood as the essential value-generation process in the creative industries. To this end, we abstract from other factors that may play a role in the market, such as vertical differentiation of content in terms of quality or national differences in taste.

On the supply side, it has long been recognized that the media sector is characterized by strong economies of scale, driven by a combination of large fixed costs of production and very low marginal costs of distribution. This is perhaps best exemplified by the motion picture industry. Film production requires highly specialized human resources and costly infrastructure such as recording equipment, studio sets, and postproduction facilities. Once produced, however, the marginal costs of supplying a film to a larger audience (the costs directly attributable to reaching more spectators) are negligible in comparison. The presence of economies of scale implies that the

number of content varieties producers can supply will grow with the size of the audience they can reach.

To formalize our argument we build a trade framework based on the circular model of spatial competition developed by Salop [11]. We consider an economy with a single sector, such as the motion picture industry, and take consumers' willingness to pay for media products as exogenous.[14] The model is well suited to the analysis of trade policies in the media sector, which generally take the form of subsidies and quotas, and provides a tractable framework to analyze the impact of online sharing.

There are $K \geq 2$ countries with a unit mass of consumers each. Consumers in a given country are uniformly distributed over the perimeter of a circle with unit length, and firms also locate their media products on the circle's perimeter. The perimeter space can be understood as capturing the full spectrum of consumer taste for media content. The utility derived by a consumer from a product is given by utility u discounted by taste proximity, a measure of the fit between the consumers' taste and the particular product. The taste proximity discount is calculated as the square of the distance that separates the location of the consumer and the product on the perimeter of the circle, scaled by taste parameter t. Thus a consumers' ideal product is located at the exact same location as the consumer, incurs no taste proximity discount and yields full utility u. More generally, the utility of consumer i when purchasing product j is given by:

$$U_{i,j} = u - t\, d_{i,j}^2 - p_j$$

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. Consumers have unit demand, and will either purchase a single product or stay out of the market. The outside utility of not consuming is normalized to zero.

The uniform distribution of consumers over the circle implies that, all other factors equal, consumer welfare will increase with the supply of a larger number of product varieties (spread over the perimeter of the circle) as this will increase the average taste proximity of consumers and products. Thus the consumer population exhibits preferences for variety, and benefits from consuming several products varieties rather than concentrating consumption on a single variety.

Firms can enter the market and produce a single product variety in one of the countries. Firms incur a fixed cost C to enter the market and produce, and marginal costs are zero. Economies of scale are present because average costs are decreasing at all levels of output. We assume fixed costs are sufficiently low for firms to effectively compete for market share in equilibrium, $C \leq \overline{C}$.[15]

[14] A partial equilibrium approach implies that we are ignoring the impact of this sector of the economy on consumers' income. Foreign relocation of production, for instance, will not affect consumer expenditure on media products. The simplification is sensible if the media sector represents a small share of the economy. Cultural industries have been reported to generate a GDP share of 5 percent in in most developed countries, and the figure is lower for the content industries properly considered here. See Towse [13] pp. 171-172.

[15] The upper boundary on fixed costs $\overline{C}$ is derived in Proposition 4.

This ensures the market is covered and all consumers purchase. While other market configurations can arise with higher fixed costs, where competition among firms is constrained, we believe that effective competition better explains the global media market.

Throughout our analysis, we ignore product location choices by firms and directly assume maximum differentiation, where product varieties are located equidistantly along the perimeter of the circle. Economides [6] analyzes an extended model in which firm choose where to locate their products and shows that with quadratic transport costs, such as those present in our model, maximum product differentiation is a perfect equilibrium outcome. Ignoring the product location stage allows us to simplify our analysis and focus on the implications for trade.[16]

We proceed by analyzing the global market in the absence of online sharing first. We start by considering the case of free trade in Section 3.2. The global media market does not operate under a free trade regime, but it serves as a useful benchmark for our analysis. We next enrich our model by introducing cultural policies, and consider subsidies in Section 3.3 and quotas in Section 3.4. Although our model can accommodate both subsidies and quotas simultaneously, analyzing them separately simplifies our exposition and allows for an independent evaluation of their impact. Finally, we introduce online sharing in Section 3.5and evaluate its impact in all the previous cases. The specific timing of the game is discussed in each section. Games are solved by backwards induction, analyzing the last stage first and then moving back through the previous stages to characterize equilibria.

3.1 A cultural globalization index

It is useful to formalize the notion of cultural globalization before proceeding to the analysis. We propose an index of globalization G based on the concentration of media consumption across countries. Denote by $s_{j,k}$ the market share of product j in country k, then index G can be computed as

$$G = \sum_{j} \prod_{k} s_{j,k}. \tag{3.1}$$

The index obtains a maximum value of 1 when consumption is concentrated on a single product across all countries, and becomes lower when more products are consumed or the overlap in the products consumed across countries is reduced. The degree of globalization captured by the index can be understood as a measure of homogenization across countries. It does not account for other factors that may contribute to shape cultural identity, such as the origin of the media products

[16] Our maximum differentiation assumption also implies that firms can finetune the location of their products across different countries. In particular, in our analysis of quota enforcement in the absence of online sharing in Section 3.4, the exact mix of products supplied in each country will differ. Firms then have incentives to finetune the location of their product in each country to maintain equidistance with respect to neighboring products, and as a result of this finetuning the precise location of a product may vary across countries.

consumed. Geographical concentration in production will not affect its value.

Note that cultural policies such as subsidies and quotas are not are not incompatible with this notion of cultural globalization. If the goal of policy makers is to foster the consumption of domestic media content, they would not object to domestic producers monopolizing the global market. This would yield a high level of cultural globalization according to index G. Of course, policy markers can only legislate in their domestic market and have little or no control over foreign production and online sharing. It is the interplay of all these factors across countries that will determine the degree of cultural globalization in our model.

3.2 Free trade benchmark

We begin our formal analysis by considering a media sector operating under free trade in the absence of online sharing. Product varieties are commercialized in all countries and there are no trade restrictions or export costs.

The timing of the game is as follows. In the first stage, firms decide to enter or not the market and in which country to produce. In the second stage, firms set prices for their content in each country where it is commercially distributed. In the third stage, consumers observe product varieties and prices available in their country and consumption decisions take place. The following proposition characterizes equilibria under free trade.

Proposition 1. *Under free trade, the number of firms that enter the global market is characterized by* $F_{ft}^* = \sqrt[3]{\frac{tK}{C}}$*, and any allocation of such firms across countries constitutes an equilibrium. Independently of the location of firms, product varieties are consumed across all countries and enjoy equal market shares in each of them.*

Proof. All proofs are relegated to the Appendix.

As is well known in the circular model of spatial competition, firms compete in each country for consumers against those whose products surround it on the perimeter of the circle. Each firm faces a downward sloping demand curve in each country, and equilibrium is symmetric across firms and countries. All firms quote the same price p_{ft}^* for their product, obtaining equal revenues and market shares in each country. Firm revenues are decreasing in the number of firms present in the global market, as a higher number of product varieties intensifies competition among firms and drives down prices. A zero-profit condition determines the number of firms in equilibrium F_{ft}^*, and ensures no firms are willing to initiate or halter production.

Because our model is based on a partial equilibrium approach, it predicts the volume of production in the global market but not the allocation of firms across countries. The cultural policies analyzed in the next sections will constraint the location of firms in order to protect consumption of domestic content. Under free trade, however, any allocation of F_{ft}^* firms across countries is efficient and constitutes an equilibrium. Two corner cases can be identified. One is the symmetric

allocation where an equal number of firms produce in each country. In this case the media sector is of equivalent size in each country, producing an equal number of product varieties, and consumers in each country purchase and consume (on aggregate) a share $1/K$ of their media products from their own country and the remaining from foreign producers. The polar case is a tipping allocation, where all production is concentrated in one country. All consumers then purchase their media from the single producing country.

3.3 Subsidies

The simplest way to introduce subsidies in our model is to consider that countries directly subsidize the production of s domestic firms, with the announcement of s taking place before entry decisions by unsubsidized firms. We retain symmetry and assume that s is common across all countries. This simplifies our analysis and provides a level playing field where there is no basis for retaliation among countries to raise subsidies.[17]

Let $F_s = s\,K$ denote the total number of subsidized firms. The timing of the game follows that of our free entry analysis. In the first stage, having observed F_s, unsubsidized firms decide to enter or not the market and in which country to produce. In the second stage, both subsidized and unsubsidized firms set prices for their content in each country where it is commercially distributed. Consumption decisions take place in the third stage. The next proposition characterizes the impact of subsidies on the global market.

Proposition 2. *Subsidies ensure that at least s firms produce in each country and* $F_u^* = Max[F_{ft}^* - F_s, 0]$ *unsubsidized firms enter the global market. Any allocation of* F_u^* *unsubsidized firms across countries together with s subsidized firms in each country constitutes an equilibrium. All product varieties are consumed across all countries and enjoy equal market shares in each of them.*

Subsidies have two effects in our model. They ensure that subsidized firms are active and produce in each country, and they crowd out private investment by reducing the entry of unsubsidized firms. All firms, both subsidized and unsubsidized, quote prices to maximize revenues. This implies that the entry decisions of unsubsidized firms are characterized by the same conditions derived under free trade, and entry will occur as long as subsidies do not sustain or exceed the volume of production that would arise under free trade $F_s < F_{ft}^*$.

The analysis reveals that subsidies serve as an effective cultural policy tool by ensuring a certain volume of domestic content consumption. This precludes the tipping allocations identified in the free trade regime where content production becomes concentrated in a single country. The higher the level of subsidies across countries, the larger the proportion of production that is subsidized and

[17] Protectionist policies such as subsidies and quotas present a degree of strategic complementarity, implying that the best response of a given country to an increase in protectionism by another is often to retaliate with a similar policy. These strategic interactions are beyond the scope of our analysis, so we restrict our attention to the symmetric case where all countries engage in a common degree of protectionism.

the more symmetric the allocation of firms across countries in equilibrium. Once subsidies sustain an aggregate volume of production equivalent to that of free trade F^*_{ft}, the market share of domestic products is $1/K$ in all countries and their effectiveness is reduced. Additional subsidization can increase the number of domestic firms but cannot increase their market share.

3.4 Quotas

We model a quota as a requirement that a share q of product varieties supplied in a given country be produced domestically, by firms located in that country. A quota will be enforced if the share of domestic firms in the global market is below q, as it would otherwise not be met under free trade. Enforcement requires that the supply of products from foreign firms be restricted, so that domestic products represent a share q of supply in the country.[18] This implies that some foreign producers will be excluded from the domestic market but others will retain access. Given that all firms are ex-ante identical in our model, we assume that firms have an equal probability of being subject to import restriction in a given country when quotas are enforced. This is consistent with entry decisions taking place before quota enforcement, so that firms form an expectation of their probability of being excluded. The model can also be interpreted as exclusion rotating over products across time, with foreign firms having similar access windows to the market. We retain symmetry and consider the case in which all countries impose a common quota q.

We update the timing of the game as follows. In the first stage, firms decide to enter or not the market and in which country to produce. In the second stage, quotas are enforced if the shares of locally produced varieties in either country are below q. In the third stage, firms set prices for their content in each country where it is commercially distributed. Consumption decisions take place in the fourth stage. The following proposition characterizes the impact of quotas on the global market.

Proposition 3. *Quotas ensure that a share q of product varieties consumed in each country are produced domestically. If quotas are sufficiently low $q \leq 1/K$, any allocation of F^*_{ft}firms such that at least a share q of firms produce in each country constitutes an equilibrium. All product varieties are consumed across all countries and enjoy equal market shares in each of them. If quotas are higher $q > 1/K$, they are enforced in equilibrium by excluding foreign product varieties from commercial distribution. There are $f^*_q = \sqrt[3]{\frac{q^2 t}{C}}$ firms producing in each country, and they obtain a higher market share domestically than across foreign countries.*

Quotas amount to an exclusionary device that restricts supply. When quotas are low $q \leq 1/K$, the threat of supply exclusion ensures that firms allocate across countries in order to avoid enforcement, and a minimum share q of firms will produce in each country. When quotas are higher

[18]The results presented here assume that, in the limit, complete exclusion is feasible. That is, if there is no domestic production, no foreign product varieties are supplied in the domestic market.

$q > 1/K$, no allocation of firms can preclude enforcement. A symmetric allocation of firms will then minimize its impact, and production will be distributed evenly across countries. Enforcement implies that each country excludes some foreign product varieties from being commercialized, and this benefits firms in their domestic country, where they obtain an aggregate market share of q, but lowers their market shares and revenues in foreign countries. Firms anticipate this and entry decisions reflect their expectation of being excluded from foreign markets. The number of firms in equilibrium is larger than under free trade, because supply exclusion softens competition by reducing the number of product varieties commercialized in each country, and as a result prices are higher and the average taste proximity between buyers and products is reduced.

As a cultural policy tool, quotas do ensure a market share q for domestic content. When quotas are high, firms will locate production across countries to minimize the impact of supply exclusion and this provides strong incentives for a minimum floor of domestic production in all countries. Quotas do not require the investment of resources that subsidies do, and may be more effective to sustain high levels of domestic content consumption. But protecting domestic firms from foreign competition requires restricting supply, and this implies that consumer welfare is also reduced.

3.5 Online sharing

Based on our review of online sharing in Section 2, we next introduce a copying mechanism that is efficient and scales beyond borders. In particular, online sharing is a mechanism that (1) incurs and access cost c which is lower than market prices under free trade p^*_{ft}, and (2) allows consumers to access all content varieties produced. It is useful to define c as a proportion of free trade market prices, that is $c = \omega p^*_{ft}$. Consumers can now access content through two channels, commercial distribution and online sharing, and will face a choice when demanding product varieties that are available on both.

The next proposition summarizes the impact of online sharing on the three trade regimes we have considered in our analysis.

Proposition 4. *The advent of online sharing exerts downward pressure on firm revenues, reducing the volume of production in the global market. The equilibrium number of firms under free trade is reduced to $F^*_{os} = \omega F^*_{ft}$. Entry by unsubsidized firms in the presence of subsidies, and entry in the case of low quotas $q \leq 1/K$, is reduced in the same degree. Online sharing also renders ineffective supply restrictions in commercial distribution. In the presence of high quotas $q > 1/K$ this reduces firm entry in each country to $f^*_{os+q} = \omega\mu f^*_q$, where $\mu = K^{-\frac{5}{3}} q^{-\frac{5}{3}} < 1$. In all trade regimes, product varieties are consumed across all countries and enjoy equal market shares in each of them.*

Online sharing has two separate effects on firms. First, it exerts pressure on pricing, as it amounts to a parallel distribution channel with price c. Second, it intensifies competition in the presence of supply exclusion, when quotas are enforced, as it enables consumers to access product

varieties that would otherwise be unavailable in their country. Both effects reduce firm revenues and therefore reduce entry, decreasing the volume of production in the global market.

The first effect implies that firms must cut their prices down to c in the presence of online sharing. Under free trade, this will reduce firm entry in proportion to the cost advantage that online sharing offers with respect to market prices in its absence, $F^*_{os} = \omega F^*_{ft}$. Under subsidization, and as long as subsidies do not fully crowd out private investment in the absence of online sharing $F_{\text{S}} < F^*_{ft}$, it will reduce entry by unsubsidized firms down to $F^*_{os} - F_{\text{S}}$. This increases the market share of subsidized production in the global market, and implies that subsidies will play a larger role in defining the allocation of firms across countries. In the case of low quotas $q \leq 1/K$ where there is no supply exclusion, the volume of production will also decrease to F^*_{os}. Firms will allocate across countries to ensure that quota enforcement does not to arise.

Online sharing's impact on firm pricing is compounded by a second effect on product availability, which arises with the enforcement of higher quotas $q > 1/K$. Because consumers will access product varieties excluded in their country through online sharing, the second effect intensifies competition without expanding the revenue sources available to firms. This further reduces firm revenues, and the number of firms producing in each country with respect to the equilibrium without online sharing is reduced down to $f^*_{os+q} = \omega\mu f^*_q$, where $\mu = K^{-\frac{5}{3}} q^{-\frac{5}{3}} < 1$. Note that μ is decreasing in q and K, so the impact of this second effect is stronger the higher the level of quotas and the number of countries, which jointly determine the extent of supply exclusion present in the global market.

The only case in which online sharing has no impact on the volume of production is that of strong subsidization, when subsidies are sufficiently high to fully crowd out private investment in the absence of online sharing $F_s \geq F^*_{ft}$. Subsidized firms remain active because revenues continue to be positive, albeit lower. And online sharing will have no impact on the market if subsidies are even higher, such that competition among subsidized firms drives prices below c in the absence of online sharing.

Numerical simulations confirm that online sharing always increases cultural globalization index G 3.1.[19] The increase in the index is driven by the lower volume of production, as well as homogenization in the set of products consumed across countries in the case of high quotas. Both effects imply that online sharing increases the concentration of media consumption in the global economy.

[19] We are developing analytical results on the value of index G for all equilibria derived in our model. The properties of each equilibrium, as well as numerical simulations, suggest that the highest value of index G is obtained under online sharing. The second highest value is obtained under free trade, subsidies (as long as $F_s \leq F^*_{ft}$), and low quotas $q \leq 1/K$. The lowest value of the index is obtained under high quotas $q > 1/K$.

4 Discussion

Regulatory implications. Our findings suggest that subsidies are more effective as a cultural policy tool than quotas in the presence of online sharing. Quotas can no longer sustain high levels of domestic consumption, and their enforcement only reduces firm revenues in commercial distribution without increasing consumption of domestic content. Some analysts have suggested that supply restrictions could still be implemented on commercial digital distribution. For instance, Bernier [2] argues that regulation could be enacted on the provision of such services or control could be exerted over the hardware decoders required to access them, even for Internet content providers operating outside a country. Such initiatives have already been formally evaluated in some countries, as is the case of Canada.[20] However, in the presence of online sharing we should expect cultural policies based on supply exclusion to be phased out, not because they are unfeasible but because they are rendered ineffective.

Strong subsidization may remain as the main cultural policy tool. Domestic funding for production will need to be increased in many countries if they are to sustain current levels of domestic production and consumption. Innovative policies also have a role play. Digital distribution and on-demand access to content allow for direct subsidization of consumption, unlike the broadcasting environments that have largely preceded them. Such policies could subsidize consumption of domestic content, for instance by partially subsidizing its price. France has recently started to experiment with initiatives to subsidize digital music and attract the younger segment of consumers towards commercial distribution and away from online sharing.[21] Public initiatives to sponsor content portals for domestic production have also been considered in some countries, and public broadcasters could serve as a natural platform to develop them.

Regulatory initiatives to curb online sharing have also emerged in recent years. With a long tradition of cultural policy and a heavily protected domestic sector, European countries are at the forefront of this legal response. France, Sweden, Spain, the UK, as well as South Korea, have implemented rules to penalize file sharing users and online copyright infringement. In most cases, consumers engaging in online sharing risk facing fines and temporal Internet disconnection. This can be interpreted as rising the cost of accessing online sharing c in the context of our model, which reduces its impact on firm revenues and the volume of production. But its effectiveness to block access to content that is not commercially supplied domestically is unclear.[22]

The enactment of these initiatives has seen short-term falls in domestic file sharing traffic.

[20] See for instance the broadcasting review of Canada's regulator, Broadcasting Regulatory Policy CRTC 2009-329, June 4 2009, which evaluated (but postponed) a levy system on Canada's ISPs to fund Canadian Internet audio and video content. Perhaps for this reason, recent free trade agreements signed by the US with smaller countries contain provisions for the absence of trade obstacles in electronic services supplying cultural goods.

[21] See 'Le Music Subsidy,' New York Times Economix blog, October 14th 2010.

[22] In some cases, the new rules could actually foster the demand for foreign content. The *ley Sinde* in Spain does not punish end users, but instead focuses on the intermediaries facilitating the exchange of links to the content. Application of the law is expected to target sites hosted in Spain or specializing in domestic content, and could therefore result in an increase of c for domestic content rather than for foreign content.

But previous attempts to restrict online sharing have proven ineffective and unpopular, providing foundation for skepticism on their long-term effectiveness. It is worth noting that, even if they reduce online sharing activity, their overall effectiveness to limit its impact may be limited. Online sharing extends beyond the immediate content exchange taking place online, as digitalization has also facilitated offline sharing through other local channels such as private communities or physical distribution on digital media. Partial success in reducing online sharing activity would not preclude widespread access to commercial content in so far as some users, even a small subset of the current user base, still remain willing to engage in the exchange.

Domestic preference bias. Our model assumes that consumers care only about their taste proximity to products, with independence of their domestic or foreign origin. These preferences can be interpreted as those of a global audience which is homogeneous across countries. This simplifies the analysis by ensuring symmetric consumption patterns across products within each country. However, consumers may exhibit domestic bias and favor domestic products over foreign ones. In the global marketplace for content, heterogeneous cultural taste may be a significant barrier to trade for cultural goods.

Domestic bias can be incorporated in the model by considering consumers who derive higher utility from domestic products. For example, instead of deriving utility u from all content, consumers may derive a utility u_d from domestic content and utility u_f from foreign content, where $u_d > u_f$. In this setting, it can be shown that firms quote higher prices and obtain higher market shares in their domestic markets than in foreign ones. The analysis then becomes more complex because of the asymmetries that arise between firms and countries, but we expect the qualitative results of our base model to hold as long as the utility differential $u_d - u_f$ is not too large.

If domestic bias is strong in our model, cultural policies are unnecessary because domestic products obtain large market shares in their home country without intervention. However, it has been argued that domestic bias can justify cultural policies. Francois and Ypersele [8] show that, in some cases, preferences for local content are insufficient to guarantee domestic production under open trade regimes. The argument relies on the existence of different types of content, with some products exhibiting domestic bias and others not (e.g. auteur cinema and Hollywood blockbusters). This suggests that the precise assumptions on consumer preferences can play an important role when evaluating the impact of cultural policies. We believe that our base model specification without domestic bias contributes a neutral case for analysis.

Economies of scope in production. Our model presents economies of scale in production but does not incorporate economies of scope. The latter are present when there are competitive advantages to diversified output, such as concentrating production of several product varieties in the same location. Consider for example the case of film production. Economies of scope derive from the fact that most resources used in production are not specific to one product variety, or even a specific genre such as drama or fiction. Human resources and infrastructure can be allocated

across different product varieties, and as a result it is more profitable to produce them at a single production site rather than at several independent ones. The global relevance of production clusters such as Hollywood suggest that scope economies can play an important role in trade in the media sector.

We have analyzed specifications of our model that incorporate economies of scope. We find that, in general, this favors production tipping and concentrates firms in one or several countries (or production clusters). Firms in production clusters benefit from lower production costs, driving competitors in undersized clusters out of business. The number of clusters in the economy depends on how strong are the economies of scope and if they are exhausted or not by demand in the global market. The impact of cultural policies will then depend critically on the volume of domestic production they can support. Unfortunately, such models become intractable when incorporating quotas, and thus we have presented our analysis based on the more simple case that considers only economies of scale.

5 Concluding remarks

Factors beyond the scope of our formal analysis may contribute to shape the cultural impact of online sharing. Technological innovation could reduce it. If the industry can offer experiences that cannot be downloaded by online sharing users, such as three-dimensional cinematography, this will lessen its impact on commercial distribution. But media technology has trickled down to living rooms in the past, which suggests that vigorous and sustained innovation will be required. Media companies may explore innovative ways to exploit online sharing, if they cannot stop it. They could attempt to tap into complementary revenue streams tied to the consumption of content and monetize the online sharing audience. This could lead them to embrace online sharing, amplifying its impact. Our analysis has also focused on commercial content, which we expect will continue to constitute a large share of media consumption. But user generated content could play an important role in the new media environment.

We have argued that online sharing will homogenize media consumption patterns across countries and reduce the long-term volume of production in the industry. In our view, online sharing presents a formidable challenge to traditional cultural policies in the media sector. On-demand access to an ever greater pool of content may result in the striking fact that consumers wind up consuming content from less sources, and of increasingly foreign origin. As traditional trade barriers based on supply exclusion in a broadcasting world cease to be effective, and the competition for audiences becomes global, protected producers will be hard-pressed to maintain their market shares. Policy makers committed to their survival may become increasingly involved with their subsidization and challenged with the development of innovative policies. We expect new forms of subsidization to play an important role in this process. But the long-term effectiveness of this new generation of cultural policies to protect domestic production is yet uncertain.

Appendix

Proof of Proposition 1. Our analysis follows the solution of a standard Salop model but accounts for the presence of K markets, one in each country. We proceed by solving for a symmetric equilibrium.

Consider the third stage purchasing decision of consumers in country k when there are n product varieties commercially supplied in each country. We derive the demand of firm j in country k when quoting a price p_j^k, and surrounded by neighboring products $j+1$ and $j-1$ priced at p_{j+1}^k and p_{j-1}^k. In a market configuration where firms directly compete for market share, the market will be covered and all consumers will purchase, so we can determine the demand for each product by comparing the utility that different products deliver to consumers. The consumer located at $\overline{x}$ between products j and $j+1$ and which is indifferent between purchasing both products is given by

$$u - t\,(\overline{x})^2 - p_j^k = u - t\,(1/n^k - \overline{x})^2 - p_{j+1}^k.$$

A symmetric condition identifies consumer $\underline{x}$ which is indifferent between products j and $j-1$. Solving for $\overline{x}$ and $\underline{x}$, and given that total demand for product j is driven by all consumers between $\overline{x}$ and $\underline{x}$, that is $\overline{x} + \underline{x}$,

$$D_j^k = \frac{n^2(p_{j-1}^k + p_{j+1}^k - 2p_j^k) + 2t}{2t\,n}.$$

Consider next the pricing problem of firms in a given country in the second stage. Given that n products are located equidistantly over the perimeter of the circle and consumers are uniformly distributed, we solve for a symmetric equilibrium where all firms quote price p_{ft}. Given that marginal costs are zero, firms will choose price p_j^k in each country to maximize their local revenues, maximizing $D_j^k p_j^k$. Solving for a firm's optimal price in a given country and equating prices across firms for a symmetric equilibrium yields

$$p_{ft} = \frac{t}{n^2}. \tag{5.1}$$

Because the same number of firms are present in each country, in equilibrium all firms quote a common price p_{ft} in each country.

We can now turn to the first stage of the game and solve the entry decision of firms. The number of firms that enter the market will be determined by a zero-profit condition. Under free trade, firms commercialize their product in all countries and derive revenues from all of them, independently of the country they are based in. Firm profits are described by the revenues obtained in all countries given equilibrium prices p_{ft} and the fixed costs required to produce,

$$\pi_{ft} = K\frac{1}{n}\frac{t}{n^2} - C. \tag{5.2}$$

Since firm profits are independent of the location of firms under free trade, we can characterize the number of firms in equilibrium but cannot pin down their allocation across countries. Let F denote the total number of active firms. We can solve for F by equating $\pi_{ft} = 0$ and substituting $F = n$, given that under free trade all product varieties are commercialized in each country,

$$F^*_{ft} = \sqrt[3]{\frac{t\,K}{C}}. \tag{5.3}$$

Any allocation of F^*_{ft} firms across countries constitutes an equilibrium.

Proof of Proposition 2. We have characterized demand and equilibrium prices in a country where n product varieties are commercialized in Proposition 1. Those results carry over in the presence of subsidies, given that subsidized firms will also quote prices to maximize revenues. So the pricing problem of subsidized and unsubsidized firms is equivalent.

In order to understand the impact of subsidies, we need to analyze how it affects the entry decision of unsubsidized firms in the first stage. Note that s subsidized firms will be active in each country independently of the entry decisions of unsubsidized firms. This follows from the fact that subsidized firms will be willing to produce as long as this yields positive revenues, which is always the case.

We denote the total number of subsidized and unsubsidized firms by F_s and F_u respectively. The total number of product varieties commercialized in every country can then be written as $n = F_s + F_u$, with independence of the location of unsubsidized firms. The profits of unsubsidized firms are described by equation 5.2 as in our free trade analysis. Based on the entry solution F^*_{ft} 5.3 derived under free trade, and accounting for the fact that no unsubsidized firms will enter if it yields negative profits,

$$F^*_u = Max[F^*_{ft} - F_s, 0].$$

Any allocation of F^*_u unsubsidized firms across countries and s subsidized firms in each country constitutes an equilibrium.

Proof of Proposition 3. Demand and equilibrium prices in a country where n product varieties are commercialized has been characterized in Proposition 1, and the solution derived there holds for the third and fourth stages of the game considered here. In order to understand the impact of quotas we need to analyze how enforcement in the second stage affects the number of product varieties n commercialized in each country, and how this affects firm profits and the entry decision of firms in the first stage.

Because we are considering a symmetric setting, we restrict our attention to symmetric equi-

libria. Consider the second stage of the game when quotas may be enforced, and let f denote the number of firms producing in each country. Quotas will not be enforced whenever

$$\frac{f}{F} \geq q, \tag{5.4}$$

given that in this case the quota is met without enforcement. So no supply exclusion takes place, and all active firms commercialize their products in all countries $n = F$.

Quotas will be enforced whenever

$$\frac{f}{F} < q, \tag{5.5}$$

and enforcement will imply that some foreign firms will be excluded from supplying their products in each country. Let $\overline{f}$ denote the number of foreign firms that are allowed to commercialize their product in the each country enforcing a quota. Each country will restrict the number of foreign firms allowed to commercialize their product down to $\overline{f}$ in order to ensure the quota is met

$$\overline{f} = \frac{1-q}{q} f. \tag{5.6}$$

Thus $f(K-1) - \overline{f}$ foreign firms are randomly selected for exclusion, and the number of product varieties commercialized in country k will be given by

$$n = f + \overline{f}. \tag{5.7}$$

We next turn to the first stage of the game and solve the entry decision of firms. When there is no quota enforcement, firm profits will be characterized by equation 5.2 previously derived under free trade. Thus the equilibrium number of firms is also determined by F_{ft}^* as under free trade, but allocated across countries to satisfy equation 5.4 ensuring that no quota enforcement takes place. Inspection of the latter reveals that a non-quota-enforced equilibrium exists as long as $q \leq 1/K$.

When there is quota enforcement, the number of product varieties commercialized in each country will be lower than the total number of active firms. Optimal pricing strategies will still be given by p_{ft} 5.1 as a function of n, but firm revenues will differ from the previous case. Firms must anticipate that they may be excluded from foreign countries, and exclusion implies that they derive no revenues from the countries they are excluded from. So firm profits will no longer be characterized by the conditions derived under free trade. All firms face equal probabilities of exclusion from foreign markets, so firm profits under quota enforcement will be given by

$$\pi_q = \frac{1}{n}\frac{t}{n^2} + (K-1)\frac{\overline{f}}{f(K-1)}\frac{1}{n}\frac{t}{n^2} - C. \tag{5.8}$$

The number of firms in each country in a quota-enforced equilibrium f_q^* will be determined by a system of equations comprising a zero-profit condition on equation 5.8, and equations 5.7 and

5.6 to pin down f in each country. The unique real solution to this system is

$$f_q^* = \sqrt[3]{\frac{q^2 t}{C}}.$$

And the quota-enforced equilibrium can be supported as long as $q > 1/K$.

We next derive an upper boundary on fixed costs $\overline{C}^a$ that ensures a market configuration where firms directly compete for market share, as we have assumed in our analysis up to this point. When compared to the cases of free trade or subsidies, an equilibrium with quota enforcement exhibits the lowest number of product varieties commercialized in each country together with higher prices, so the condition that ensures firms price competitively in this scenario suffices to ensure it is also the case in the previous. When firms price competitively, all consumers must prefer to purchase rather than remain out of the market with an outside utility of zero. Consumers indifferent between neighboring products, characterized by $\overline{x}$ or $\underline{x}$, are the ones that derive the lowest utility from purchasing. So this market configuration holds if $U_{\overline{x},j} > 0$, or equivalently $U_{\underline{x},j} > 0$, which can be shown to reduce to $C \leq \overline{C}^a$ where $\overline{C}^a = \frac{8K^3 q^2 u^{\frac{3}{2}}}{5\sqrt{5t}}$.

Proof of Proposition 4. We start by characterizing consumer demand in the presence of online sharing. Consider country k where n product varieties are commercially distributed. In the presence of online sharing consumers can access all products F independently of the fact that they are commercially distributed in country k or not. We proceed by analyzing consumer demand of product j in country k independently of how this demand is served, either through commercial distribution by firm j or through online sharing.

If a given product variety j is distributed commercially at price p_j^k, consumers demanding the product will face a choice and compare price p_j^k with online sharing cost c. If $p_j^k \leq c$, consumers will prefer to purchase the product through the commercial channel (assuming tie-breaking in favor of commercial distribution), but if $c < p_j^k$ they will prefer to obtain the product through online sharing. Let $p_j^k = +\infty$ for products which are not commercially distributed in country k. Then the effective price of any given product variety j for consumers can be written as $Min[p_j^k, c]$.

Given that the market will be covered in equilibrium, we can characterize demand of product j by comparing the utility that neighboring products $j+1$ and $j-1$ from the full product space F deliver to consumers. The consumer located at $\overline{x}$ between products j and $j+1$ and which is indifferent between purchasing both products is given by

$$u - t\left(\overline{x}\right)^2 - Min[p_j^k, c] = u - t\left(1/F - \overline{x}\right)^2 - Min[p_{j+1}^k, c]$$

A symmetric condition identifies consumer $\underline{x}$ which is indifferent between products j and $j-1$. Solving for $\overline{x}$ and $\underline{x}$, and given that total demand for product j is driven by all consumers between $\overline{x}$ and $\underline{x}$, that is $\overline{x} + \underline{x}$,

$$D_j^k = \frac{F^2(Min[c, p_{j-1}^k] + Min[c, p_{j+1}^k] - 2\,Min[c, p_j^k]) + 2t}{2t\,F}. \tag{5.9}$$

We next turn to the pricing stage and consider the pricing problem of firms commercializing their product in country k. There are two separate cases to consider. When there is no supply exclusion due to quota enforcement, online sharing does not alter the subset of products available in country k. All products are distributed commercially and will be strategically priced by firms. But when there is supply exclusion, online sharing alters the subset of products available and some will only be available through online sharing. Their effective price is equal to online sharing cost c, and this will affect the pricing strategy of neighboring firms. We consider both cases separately.

Consider first the case in which there is no supply exclusion in country k. Given that marginal costs are zero, firms will quote prices to maximize revenues in each country. Clearly, if firm j quotes a price $p_j^k > c$ it obtains no demand in the presence of online sharing, so firm j will prefer to quote a price $p_j^k \leq c$. The optimal price implied by equation 5.9 if firms price in the range $p_j^k \leq c$ is given by p_{ft} 5.1. So the optimal price of firms in the presence of online sharing is

$$p_{os} = Min[p_{ft}, c].$$

Consider next the case in which there is supply exclusion in country k. To simplify the exposition, we will analyze only the case in which there is a lower number of firms than under free trade in the absence of online sharing $F < F_{ft}^*$, as the remaining case cannot arise in equilibrium.[23] We next argue that firms will price their products at $p_j^k = c$. To do so, we proceed by assuming that firm j's neighboring products are also priced at c in the case that they are commercially distributed in country k, that is $p_{j-1}^k = p_{j+1}^k = c$. The optimal price of firm j obtained by maximizing $D_j^k p_j^k$ when competing against two neighboring products effectively priced at c is

$$p_{os+q} = \frac{1}{2}(c + \frac{t}{F^2}).$$

Which implies that firm j's revenue is increasing in c, and that $p_{os} > c$ if $c < t/F^2$. This will always be the case, because the cost of online sharing is below market prices under free trade $c < p_{ft}^*$, and $p_{ft}^* < t/F^2$ whenever $F < F_{ft}^*$. Thus we conclude that firm j's revenue-maximizing price is $p_{os+q} = c$. The result implies that, in equilibrium, all commercially distributed product varieties are priced at c or available through online sharing at cost c, and firm revenues in countries where their product is commercially distributed are $D_j^k p_{os+q} = c/F$.

Having characterized firm prices in the presence of online sharing, we next analyze the entry

[23] To see why this is the relevant case, consider firm profits under free trade without online sharing. The presence of online sharing and quota enforcement implies that (1) firm pricing is constrained, and (2) the number of product varieties available to consumers in each country is the same as under free trade, but firms cannot derive revenues from commercializing their product in all countries. So firm profits, and therefore entry, must be lower than under free trade in the absence of online sharing. The remaining case which we are omitting from the analysis, $F > F_{ft}^*$, is also more complex because it implies asymmetric pricing across products.

decision of firms. Consider first the case of free trade. Firms commercialize their product in all countries, so there is no supply exclusion. Given prices p_{os} firm profits are described by,

$$\pi_{os} = K\frac{1}{F}Min[p_{ft}, c] - C. \tag{5.10}$$

The unique equilibrium is in the range $F < F^*_{ft}$ where prices $p_{os} = c$. Solving for the number of firms F that will enter the global market we obtain

$$F^*_{os} = \frac{c\,K}{C}.$$

Substituting $c = \omega p^*_{ft}$ in this expression, and then substituting for equilibrium prices p^*_{ft} under free trade characterized in Proposition 1 and rearranging,

$$F^*_{os} = \omega F^*_{ft}, \tag{5.11}$$

which characterizes entry under free trade in the presence of online sharing. It is immediate to verify that $F^*_{os} < F^*_{ft}$.

Next, we consider the case of subsidies. There is no supply exclusion, so firm pricing strategies are the same as in the above case of free trade. Following our previous analysis in Proposition 2 and based on the above result for F^*_{os} 5.11, entry of unsubsidized firms will be given by

$$F^*_u = Max[F^*_{os} - F_s, 0],$$

and any allocation of F^*_u unsubsidized firms across countries and s subsidized firms in each country constitutes an equilibrium.

Finally, we consider the impact of online sharing in the case of quotas. There are two separate cases to consider. When there is no quota enforcement, and therefore no supply exclusion, firm pricing strategies are the same as in the free trade regime above. As we established in Proposition 3, firm profits will be characterized by the same mechanisms as under free trade. Thus the number of firms in equilibrium will be given by F^*_{os} 5.11, but allocated across countries to satisfy equation 5.4 ensuring that no quota enforcement takes place, which again requires $q \leq 1/K$.

When there is quota enforcement and supply exclusion takes place, firms anticipate that they may be excluded from commercial distribution in foreign countries. Exclusion implies that they derive no revenues from the country enforcing the quota and that demand for their product in that country will be met by online sharing. Firm prices are given by $p^*_{os+q} = c$ as long as $F < F^*_{ft}$, and firm profits are then be given by,

$$\pi_{os+q} = \frac{1}{F}c + (K-1)\frac{\overline{f}}{f(K-1)}\frac{1}{F}c - C. \tag{5.12}$$

The number of firms in equilibrium will be determined by a system of equations comprising a

zero-profit condition on equation 5.12, and equation 5.6 to pin down the degree of exclusion $\overline{f}$ as a function of q. The unique solution to this system is

$$f^*_{os+q} = \frac{c}{q\,C\,K}.$$

Substituting $c = \omega p^*_{ft}$, and then substituting for equilibrium prices p^*_{ft} under free trade characterized in Proposition 1 and rearranging,

$$f^*_{os+q} = \omega\mu f^{k*},$$

where $\mu = K^{-\frac{5}{3}}q^{-\frac{5}{3}}$ and $\mu\epsilon(0,1)$. So f^*_{os+q} characterizes the number of firms in each country in a quota-enforced equilibrium with online sharing, which can be supported as long as $q > 1/K$. It is immediate to verify that $f^*_{os+q}K < F^*_{ft}$.

We next derive the upper boundary $\overline{C}^b$ on fixed costs that ensures a market configuration where firms directly compete for market share in the presence of online sharing. All equilibria characterized above exhibits the same product prices, but the quota-enforced equilibrium exhibits the lowest number of active firms. So a boundary on C derived for this case must suffice for the remaining. We require $U_{\overline{x},j} > 0$, or equivalently $U_{\underline{x},j} > 0$, which in the equilibrium with online sharing and quota enforcement can be shown to reduce to $C \leq \overline{C}^b$ where $\overline{C}^b = \frac{2}{q}\sqrt{\frac{c^2(u-c)}{t}}$.

We next formalize a single boundary $\overline{C}$ that ensures firms price competitively throughout our analysis. In addition to boundary $\overline{C}^b$ derived above, which depends on online sharing cost c, we derived boundary $\overline{C}^a$in Proposition 3. Either $\overline{C}^a < \overline{C}^b$or $\overline{C}^a > \overline{C}^b$ may hold for an online sharing cost in the range $c\epsilon(0, p^*_{ft})$, so we require $\overline{C} = Min[\overline{C}^a, \overline{C}^b]$.

References

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

[2] Bernier, Ivan (2003), 'Local Content Requirements For Film, Radio, and Television as a Means of Protecting Cultural Diversity: Theory and Reality,' accessed at Secrétariat à la diversité culturelle at Ministère de la Culture, des Communications et de la Condition féminine du Québec, http://www.diversite-culturelle.qc.ca/index.php?id=133&L=1

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

[4] 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.

[5] Dixit, Avinash K. and Joseph E. Stiglitz (1977), 'Monopolistic Competition and Optimum Product Diversity,' American Economic Review, 67:3 297-308.

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

[7] Ferreira, Fernando and Joel Waldfogel (2009), 'Pop Internationalism: Globalization of the Music Industry, 1960-2006,' Working Paper.

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

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

[10] Oberholzer-Gee, Felix and Koleman Strumpf (2009), 'File sharing and copyright,' Harvard Business School Working Paper 09-132.

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

[12] Takeyama, Lisa N. (1997), 'The Intertemporal Consequences of Unauthorized Reproduction of Intellectual Property,' Journal of Law and Economics, 4:2 511-22.

[13] Towse, Ruth (2003), 'A handbook of cultural economics,' Edward Elgar Publishing.