Language, Internet and Platform Competition*

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Abstract

The dominance of English language content on the Internet raises a question of how consumer bilingualism in a given country affects production of home language content and the country's welfare. We address this question by studying two-sided market competition between a foreign and a domestic content distribution platform in a small open economy. We find, on the one hand, that bilingualism has the benefit of increasing cross-side network externalities by increasing consumer concentration on the foreign platform, which in turn increases the amount of home language content. On the other hand, bilingualism softens platform competition and can even lead to the monopolization by the foreign platform. In this case, bilingualism would reduce the amount of home language content. We consider policy implications of bilingualism for promotion of home language content production.

Key words: Language, Bilingualism, Platforms, Two-sided Market, Content Producers, International Trade.

JEL codes: D43, F12, L13, L86

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1 Introduction

During its early days, the World Wide Web was by and large a medium based on English language. Although, with the globalization of the Internet, the presence of other languages has steadily risen, the dominance of English does not vanish. According to a UNESCO publication (Pimienta et al., 2009), the share of English web pages decreased from 75% in 1998 to 45% in 2007 and the share of English speaking users from 60% in 1998 to 32% in 2007 (see Figure 1). These shares are quite high relative to the share of English speakers in the world population, which is 10.1%. Furthermore, according to the most recent data, the dominance of English content in the Internet continues to prevail: according to Web Technology Surveys, English is used by 53% of all the websites whose content language is known.[1] This dominance of English raises a natural question: how bilingualism of a given country (i.e., the ability of the country's population to speak English as well as its native language) affects the production of content in the home language and the domestic welfare?

This question is important from an economic point of view because of the steadily growing share of international online trade (including trade in digital goods and services) in total trade and because linguistic barriers are the main source of frictions and trade costs in cross-border e-commerce.[2] The question is also important because of its implication for linguistic and cultural diversity.[3] As a first step to address these issues, this paper studies how bilingualism affects competition between online platforms and the production of home language content in a small open economy.

Interactions between consumers and content providers in the Internet are mediated by platforms such as iTunes, Google Play, and Amazon Kindle for music, ebooks, games and movies. These also include specialized vertical search engines such as Google Shopping and Kayak (and general search engines such as Google and Bing, to some extent), as well as online intermediaries for e-commerce such as eBay and Amazon Marketplace.

Our analytical framework is mainly motivated by online business-to-consumer (B-to-C) platforms which facilitate trade in digitized cultural goods such as books, songs, movies, and games consumption of which involves knowing the language in which these goods were

[1] The data are available at https://w3techs.com/technologies/overview/content_language/all and were accessed on August 21, 2018.

[2] Based on the consumer survey, Martens and Turlea (2012) estimate that the share of online trade in total cross-border trade in goods between the EU member states is in the range between 6 and 12 percent.

[3] There is a wide concern among experts and policy-makers about effects of the Internet on linguistic and cultural diversity. For instance, according to UNESCO's experts, given the current trend, more than 50 percent of the estimated 7,000 languages spoken in the world today may disappear within a few generations (see UNESCO, 2008, p. 16). See more on the effect of the Internet on the linguistic and cultural diversity in Crystal (2006).

created. There are many examples of competition between U.S.-based platforms and platforms originating outside of the U.S. For instance, the aforementioned Amazon competes against Tmall.com (owned by Alibaba Group), 360Buy.com, and Suning.com in China. In the more narrowly defined ebooks market, Amazon's Kindle faces competition from platforms such as Rakuten (Japan), Libri (Germany), Fnac (France), Cloudary (China), Kyobo (Korea). In streaming video on demand (SVOD), Netflix competes in France against French pay TV groups Canal Plus and Orange Cinema Series[4] and against several local players in China.[5] In streaming audio, the U.S.-based platforms Spotify and iTunes as well as France's platform Deezer compete against the major domestic online music distributor MelOn in the Korean market.

In this paper, we build on a well-known model of two-sided markets (Armstrong, 2006) to analyze platform competition in a small open economy (i.e., the home country) where the competing home and foreign platforms bring together content producers (CPs, hereafter) and consumers. While the home language is used only by domestic CPs and consumers in the home country, foreign CPs use the foreign language. If consumers of the home country are bilingual, they can consume foreign as well as domestic content. Our baseline model captures the business models of B-to-C online platforms which charge CPs for access to the platforms while providing free access to consumers. But in order to check the robustness of our analytical framework, we also consider a stylized model akin to SVOD platforms which acquire content from CPs and then sell access to this content (without advertising) to consumers (see the online Appendix).

Using this framework, we study how platform competition and the amount of content in the home language are affected by whether consumers of the home country are monolingual or bilingual.[6] In particular, we address the following questions. Does bilingualism increase

[4]Recently, the entry of Netflix in European countries has generated concerns regarding creation of European content. For instance, the French film producers' association complained that "Neflix is engaging in "fiscal dumping" by establishing its European base in Amsterdam and thus avoiding the French audiovisual taxes that national television channels and rival streaming services pay to subsidize French films." (The New York Times, "Europeans Bracing for Netflix", by Doreen Carvajal, September 12, 2014).

[5]The major SVOD players in China are iQIYI (an independent subsidiary of Baidu) and Tmall Box Office (or TBO) offered by the e-commerce giant Alibaba. There are also several smaller players such as LeTV, Sohu, and Yoku Tudou. See, http://www.forbes.com/sites/greatspeculations/2016/01/13/netflix-is-now-global-but-is-chinas-market-key-for-its-international-success

[6]The focus on the extreme cases of completely monolingual and completely bilingual consumers allows us to keep the model tractable and generate the main insights on the issue. In the future research, it would be interesting to study whether the equilibria in the intermediate cases, in which some fraction of consumers are monolingual and the rest are bilingual, would have (or not have) a "monotone" behaviour as the share of bilingual consumers varies.

the foreign platform's market share in the home country? Does bilingualism make platform competition fiercer? How does bilingualism affect online availability and production of home language content and the domestic welfare?[7] Although we mainly have in mind trade in cultural goods such as books, songs, and movies, consumption of which involves knowing the language in which these goods were created, our framework can be applied more generally to trade in all goods and services (physical or digital) involving information or labeling encoded in a certain language, which can be a barrier for cross-border transactions.

We assume that the two platforms offer a service of the same quality. The main difference between them is that the home platform offers the domestic consumers access only to home country's domestic content while the foreign one gives them access to both domestic and foreign content.[8] Since platforms are assumed to offer no content translation and only bilingual domestic consumers can use foreign content, this difference between the platforms does not matter when consumers of the home country are monolingual. However, the difference creates an advantage for the foreign platform when consumers are bilingual. At the same time, the foreign platform has a certain disadvantage since we assume that from the perspective of the bilingual consumers some offerings of the home country CPs may serve as direct substitutes for the offerings of the foreign country CPs. In other words, when consumers are bilingual, our assumptions imply: if the platforms have the same mass of consumers, a domestic CP prefers joining the domestic platform to joining the foreign platform; if both platforms have the same mass of domestic CPs, a consumer prefers the foreign platform to the domestic platform. The platforms do not charge any price to consumers[9] but charge subscription prices (and transaction fees in the framework considered in the on-line Appendix)) to CPs. In addition, we assume that consumers single-home while CPs multi-home.[10]

Our first result is that bilingualism increases the foreign platform's consumer market

[7]We distinguish the amount of content available in the platforms given the total amount of content produced from the content production itself.

[8]We make an extreme assumption that the domestic home-country platform (unlike foreign platform) is monolingual and can offer access only to content in the home-country language. In reality, of course, both home and foreign platforms are bilingual, but all we need for our results to go through is to assume that the foreign (home) platform has a comparative advantage in providing access to foreign (home) content. One way to capture this comparative advantage is illustrated below in this paper (see footnote 23 in subsection 2.2).

[9]In the online Appendix, we provide an exention in which we allow platforms to charge fees to both sides and provide a condition under which each platform finds it optimal to charge zero price on the consumer side when the non-negativity constraint on consumer access fee exists.

[10]We show that in equilibrium, no consumer has an incentive to multi-home (see Proposition 8 in Appendix).

share in the home country. Although this result is expected, it is not trivial as there are two opposing effects at work. Having foreign content on board helps the foreign platform to attract bilingual consumers. However, since domestic CPs prefer to avoid competition from foreign CPs, the foreign platform has difficulty in attracting domestic CPs, which, in turn, makes it harder to attract consumers. We show that the first effect dominates: bilingualism can even lead to a tipping equilibrium in which all domestic consumers access content through the foreign platform.

Our second result is that bilingualism softens platform competition, which implies that it allows each platform to extract more surplus from CPs. This result is based on the multiplier effect in our model of two-sided market. Suppose that some consumers switch from platform 2 to platform 1. This increases the number of CPs subscribed to platform 1 while decreasing the number of CPs subscribed to platform 2, which, in turn, induces additional consumers to switch from platform 2 to platform 1, and so on. Interestingly, this multiplier effect increases with each platform's efficiency in matching CPs with consumers. Therefore, when a platform becomes more efficient, the CPs' demands for platforms' matching services becomes more elastic and consequently platform competition becomes stronger. By contrast, platform competition becomes weaker when the platform becomes less efficient.

When consumers are bilingual, substitution between domestic content and foreign content reduces the value of exchanges between domestic CPs and consumers through the foreign platform. More precisely, the ability to consume foreign content reduces the marginal surplus that consumers using the foreign platform obtain from additional domestic CPs, as well as the marginal surplus that domestic CPs subscribed to the foreign platform obtain from additional consumers. It is as if bilingualism makes the foreign platform a less efficient matchmaker, which softens platform competition for the reasons explained earlier.

When we make the amount of home language content endogenous, we find, as our third result, that there is a positive feedback effect between production of home language content and platform competition, which was not previously identified in the economics literature. The more home language content is produced, the higher is the multiplier, which intensifies platform competition. This implies that the platforms charge lower fees to CPs, which further increases the amount of content produced and so on. However, when bilingualism leads to the tipping equilibrium in which the foreign platform charges the monopoly price to domestic CPs, it eliminates this positive feedback.

Combining the above three results generates nuanced predictions regarding the impact of bilingualism on the amount of home language content (in terms of its online availability and production). Conventional wisdom would suggest that substitution between foreign language content and home language content would negatively affect the latter. This would

be true in a 'one-sided' market. However, in a two-sided market, bilingual consumers' ability to consume foreign language content can increase the amount of home language content as it increases consumer concentration in the foreign platform and thereby strengthens the cross-side network externalities. On the negative side, bilingualism softens platform competition and can even lead to the monopolization by the foreign platform, which removes the positive feedback between content production and platform competition. In this case, bilingualism is likely to reduce the amount of home language content.

We show that in general, the welfare effect of bilingualism depends on the weight of producer surplus relative to consumer surplus. The difference between consumer surplus and producer surplus can arise because consumers directly benefit from foreign content while domestic CPs directly suffer from it because of substitution between domestic and foreign content. For most European and Latin American countries, both the relevant English language content and the degree of its substitutability with the home language content of these countries are expected to be relatively large. Therefore, in those countries unlike countries in Asia, bilingualism typically would increase consumer surplus at the cost of reducing producer surplus, which then decreases domestic welfare if the relative weight of producer surplus is large.

Our results also suggest that supporting a viable domestic platform and facilitating robust platform competition should be an integral part of the policy aimed at home language content promotion. This is because of the synergy between home language CPs and the domestic platform that arises from the positive feedback effect between home language content production and platform competition. Such a synergy suggests that it may be to the advantage of the home country to facilitate the distribution of the foreign content on the domestic platform. Such measures would reduce the likelihood of market monopolization by the foreign platform by giving the domestic platform a more level-playing field against the foreign platform as foreign CPs do not need to incur any fixed cost to make their content available for the distribution by the foreign platform among home country consumers as their content is already available on the platform for foreign consumers.

The paper is organized as follows. In Section 1.1, we review the related literature. In Section 2, we present our baseline model of platform competition with international trade. In Section 3 (4), we consider the monolingual (bilingual) case. In Section 5, we compare the two cases in terms of consumer market shares, the amount of home language content available on the Internet and the welfare of the home country. Section 6 studies the impact of bilingualism on the production of home language content. Section 7 concludes. The online Appendix provides three extensions to show the robustness of our results to alternative platform business models.

1.1 Literature review

Our paper builds on the literature on two-sided markets (Caillaud and Jullien, 2001, 2003, Rochet and Tirole, 2003, 2006, Anderson and Coate, 2005, Armstrong 2006, Hagiu 2006, Weyl, 2010).[11] Two-sided markets can be roughly defined as industries where platforms provide intermediation services between two (or several) kinds of users. Typical examples include dating agencies, payment cards (Rochet and Tirole, 2002), mass media (Anderson and Coate, 2005), operating systems (Parker and Van Alstyne, 2005), video games (Hagiu 2006), academic journals (Jeon and Rochet, 2010) etc. In such industries, it is vital for platforms to find a price structure that attracts sufficient numbers of users on each side of the market. Our paper has two novel aspects. First, it is the first paper that studies competition among platforms serving as intermediaries in international trade. Second, we examine how platform competition is affected by trade barriers that arise due to linguistic differences between buyers and sellers.[12]

In our model, the language-related trade surplus is formalized in a way that is similar to Lazear (1999) where individuals are randomly matched and a match generates a surplus only if the matched individuals share common language. This generates positive network externalities among individuals using a common language, which is a standard feature of several recent models of bilingualism.[13] However, our framework differs from the previous models of language or bilingualism in the following two dimensions. First, in our model, matches occur between two sides of a market: consumers and CPs. A surplus is created only if a matched pair of a consumer and a CP share common language. Second, matches are mediated by competing platforms.

This paper is also related to the international economics literature that emphasizes the role played by information networks in facilitating international trade. While the significance of traditional barriers to trade has been declining over time, barriers and frictions related to incomplete or asymmetric information with regard to trading opportunities in foreign markets remain substantial (Portes and Rey, 2005). Among the sources of these

[11] Our model in which we assume single-homing for consumers and multi-homing for CPs is similar to Anderson and Coate (2005), Armstrong and Wright (2007) and Hagiu (2009).

[12] Two empirical industrial organization papers (Gandal, 2006, and Viard and Economides, 2015) are related to our paper since they view the Internet as a two-sided market and study the impact of the online users' language heterogeneity on their demand for accessing foreign (mainly English language) digital content.

[13] For example, Church and King (1993) study each individual's choice to become bilingual and Ortega and Tangeras (2008) analyze the politically dominant group's choice between unilingual and bilingual education. An excellent overview of the literature on bilingualism and a novel economics analylsis of languages is provided in Ginsburgh and Weber (2011).

information-related costs of cross-border transactions are linguistic and cultural differences between the transacting parties. One of the traditional means of overcoming these sort of trade costs has been information networks of internationally dispersed ethnic diasporas, sharing the same language and databases of business contacts, which can be viewed as precursors of modern e-commerce platforms.[14] The importance of common language has also been emphasized in the literature which uses the gravity model of international trade to show that immigrants promote trade with their country of origin (see Gould, 1994, Head and Ries, 1998 and Wagner et al. 2002).[15]

Several authors have analyzed cross-border e-commerce using different versions of the gravity model which typically includes an explanatory variable capturing trade costs caused by language barriers (e.g., Blum and Glodfarb, 2006, Hortaçsu et al., 2009, Hanson and Xiang, 2011, Lendl et al., 2012, Martens and Turlea, 2012, and Ferreira and Waldfogel, 2013). Most of these papers confirm that as the importance of geographical distance-related trade costs decreases, other types of transaction costs become more prominent in online trade, in particular costs related to language barriers.[16]

While there is a substantial empirical literature studying online international trade, we are aware of only a few recent papers that construct relevant formal models for analyzing this phenomenon and the related trade and regulatory policies. And all these relevant theoretical studies are concerned not with online trade in digital content as such, but rather

[14] Rauch (1999) shows that trade networks based on family ties, colonial ties or a common language are important in explaining trade patterns, especially for differentiated goods that do not have reference prices.

[15] A somewhat broader literature emphasizes the importance of ethnic and linguistic commonalities between countries for facilitating their international trade. For example, Melitz (2008) argues that linguistic diversity of the country's population (e.g., bilingualism) promotes its foreign trade and considers the issue of the possible network externalities due to a common language. Melitz and Toubal (2014) constructed a common language index which summarizes evidence about influences of common official language, common native language, common spoken language and linguistic proximity and find that it has a strongly positive impact on trade in goods. See Egger and Lassmann (2012) for a meta-analysis of the common language effect on trade.

[16] Among the more prominent papers in this vein one can cite Blum and Goldfarb (2006) who find that distance negatively affects trade even in purely digital products and services that are free of transportation costs as long as their consumption is sensitive to cultural variables such as language (e.g., online music, games, and videos). Ferreira and Waldfogel (2013) study cross-border consumption of music using a data on popular music charts and conclude that despite recent advances in information and communication technologies, the effects of distance and language have remained fairly constant. Hanson and Xiang (2011) analyze data on US film exports using an econometric specification with some gravity explanatory variables. They find that average revenues per US film are negatively correlated with geographic distance and linguistic distance in a manner consistent with adjustment to these trade costs occurring along the intensive rather than the extensive margin.

with the cross-border distribution of cultural goods, including audio and visual artwork and programming by means of radio and TV broadcasting. For example, Richardson (2006) and Richardson and Wilkie (2015) analyze the effects of cultural and local music quotas in the context of commercial radio broadcasting of playlists, which mix domestic and foreign content. However, these papers employ models which are very different from ours and do not rely on two-sided markets interpretation of online intermediaries.[17]

2 Model

We build on a well-known analysis of two-sided markets (Armstrong, 2006) to analyze platform competition in a small open economy (the home country) and introduce common language as a necessary condition for an interaction between two sides (i.e., consumers and CPs). There are two languages: home language and foreign language. The home language is only spoken by consumers of the home country while the foreign language is used abroad and by bilingual consumers of the home country. We assume that all CPs in the home country have their content in the home language, and refer to them as domestic CPs. We view a platform as an intermediary between consumers and CPs and focus on the competition between two platforms, indexed by $i = 1$ or 2, within the home country. Platform 1 is assumed to be foreign and bilingual while platform 2 is domestic and monolingual. By monolingual we mean that it provides services to consumers and CPs only in the home language.[18] We then compare the situation where consumers of the home country are bilingual to the one in which they are monolingual.

[17] More generally, trade in cultural goods was analyzed in Francois and van Ypersele (2002) which developed the view that such goods are a source of externality due to increasing returns in their production. By contrast, in our model, an externality arises instead due to the indirect network effect at the intermediation level involving foreign language. More recent papers by Janeba (2007), Rauch and Trindade (2009), and Olivier et al. (2008) have considered models with consumers experiencing culture related externalities which may justify import restrictions (or subsidies) in cultural goods industries. Maystre et al. (2014) considered a model with monopolistic competition where trade liberalization simultaneously generates an increase in trade volume and a decrease in bilateral cultural distances which suggests that long-run and short-run welfare effects of trade policies in cultural goods industries may be quite different. Bala and Long (2005) construct a dynamic model which provides an explanation of why small countries sometimes insist on excluding cultural goods from trade agreements. While policy issues considered in these papers are related to our paper, they employ analytical frameworks which are very different from ours. Among the prominent empirical studies of trade in cultural goods, one can cite Disdier et al. (2010 a, b), Hellmanzik and Schmitz (2015), and Aguiar and Waldfogel (2018).

[18] Our analysis can also be extended to the case in which both platforms are bilingual but differ in their coverage of foreign language content. See footnote 23.

2.1 Platforms, CPs and consumers

The general structure of the model is the following. In the home country, there are a mass one of consumers and a mass m (> 0) of CPs whose content is already produced and can be made available on a platform. In Section 6, we make endogenous the amount of home language content produced.[19] For any given pair of a consumer and a domestic CP that interacts in platform i, we assume that the interaction generates a surplus of $a_i > 0$ to the consumer and a surplus of $b_i > 0$ to the CP. For tractability of the model, we assume that b_i does not depend on the supply of home language content on platform i. However, some foreign content may be substituted for home content so that the values a_i and b_i may depend on the foreign content available on the platform. In Appendix, we analyze a formal search model showing how to derive the values a_i and b_i.

We view a_i as the expected consumer surplus generated by an additional domestic CP in platform i, which is the product of the (additional) probability that the CP's content is matched to a consumer and the expected surplus conditional on the match. Similarly, b_i is the expected profit of a CP per consumer on platform i, which is the product of the probability of the match between a consumer and the CP and the expected profit conditional on the match. In the next subsection, we explain how bilingualism and foreign content affect a_i and b_i.

We consider horizontally-differentiated platforms and assume that consumers are uniformly distributed on the Hotelling interval between zero and one. Platform 1 (2) is located at zero (one). A consumer derives utility from a platform's basic service and from access to the CPs subscribed to the platform, net of the transportation cost. We assume that the value of basic services u_1 and u_2 are large enough such that every consumer ends up using one of the two platforms. Consumers single-home, i.e. subscribe to only one platform. We show in Appendix that there is no equilibrium in which consumers choose to multihome.

In terms of pricing, we assume that platforms do not charge any price to consumers while each platform $i = 1, 2$ charges a subscription fee F_i to CPs. For instance, in the case of Amazon, the platform charges professional sellers $ 39.99 for monthly subscription

[19] By ignoring the domestic market in the foreign country we focus on one of the two national markets. Our article is a first step to the next one in which we can study the fully reciprocal model of international trade in content mediated by two platforms competing in the two national markets. Empirically such a reciprocal digital trade environment was already investigated in Aguiar and Waldfogel (2018) who analyzed and compared theatrical versus Netflix distribution of films into 56 countries. They find that Netflix as a global distribution platform facilitates trade both from the USA to the rest of the world, as well as from smaller countries, such as Norway, to the USA. And while the US-origin repertoire has the highest reach measure through both Netflix and theatrical distribution channels, the US dominance over other repertoires is smaller in Netflix distribution.

in addition to charges per item sold (such as referral and closing fees).[20] In the online Appendix, we consider various alternative business models and show the robustness of our results to different assumptions about platforms' pricing structures.

Thus, if n_i domestic CPs join platform i, the utility of a consumer located at $x \in [0,1]$ is $u_1 + a_1 n_1 - tx$ if she joins platform 1, and $u_2 + a_2 n_2 - t(1-x)$ if she joins platform 2, leading to a market share of platform 1 given by:

$$x_1 = \frac{1}{2} + \frac{u_1 - u_2 + a_1 n_1 - a_2 n_2}{2t}. \tag{1}$$

CPs multi-home as long as this gives them a higher benefit than single-homing. In order to make its content available on a platform, a CP should incur a fixed cost that is uniformly distributed over the interval $[0, 1/f]$, where we *normalize* $f = 1$ for expositional simplicity.[21] We assume that the highest cost/benefit ratio is large enough that there are always CPs who decide not to join any platform, which holds if b is not too large.[22]

Given the fees and the consumer market shares, the masses of content producers joining platform 1 and 2 are respectively given by

$$n_1 = m(b_1 x_1 - F_1) \text{ and } n_2 = m(b_2(1 - x_1) - F_2). \tag{2}$$

The platform i then chooses subscription fee F_i to maximize profit

$$\pi_i = F_i n_i \tag{3}$$

given the system of demands (1) and (2). Bilingualism and foreign content affect the outcome of competition by changing the values of u_i, a_i and b_i.

2.2 Language and exchanges

In the monolingual case, consumers can access only home language CPs. We assume that the translation service is imperfect; hence the foreign platform does not provide translation services that would expand the supply to foreign content. We assume that the platforms

[20] See http://www.amazon.com/gp/help/customer/display.html?nodeId=200306550

[21] The cost of making content available in a platform is non-negligible and distinct from the cost of producing content (which can also be distributed through offline channels such as TV, radio, print and removable storage media.) For instance, Bresnahan et als. (2015) explain tipping out of small platforms for mobile apps in the US by decisions of owners of attractive applications not to make them available in small platforms even if they are available in the major platforms. The distinction between the cost of producing content and cost of making it available in a distribution platform is important in the model of home language content production which we will introduce in Section 6.

[22] A sufficient (but not necessary) condition is $b \leq 1$.

are equally efficient and therefore that the value of basic service as well as the values of interactions are the same for both platforms: $u_1 = u_2 = u$, $a_1 = a_2 = a$ and $b_1 = b_2 = b$.

Consider now the bilingual case. Given that platform 2 offers its service only in home language, the utility parameters are unchanged for this platform: $(u_2, a_2, b_2) = (u, a, b)$.

As for platform 1, let $n^F > 0$ be the measure of the foreign language content that is available on the platform and is *relevant* to consumers of the home country. By "relevant" we mean that consumers of the home country have demand for that content and are able to obtain it at a negligible transaction cost if they are willing to. For instance, if content is not free and cross-border online transactions are subject to heavy tariffs and/or non-tariff trade barriers, n^F is small even if the measure of foreign language CPs accessible through platform 1 is large. Similarly, if the home country's economic and cultural background differs substantially from that of the foreign country, n^F is small.[23] We consider n^F as an exogenous parameter, which is justified by our assumption that the home country is sufficiently small that it cannot influence the presence of foreign language content on the foreign platform.[24] In the end of Section 4, we examine the possibility that the platform may restrict access to foreign content and find that it has no incentive to impose such restriction.

We assume substitution between foreign language content and domestic content for bilingual consumers. More precisely, given n_1 amount of home language content and n^Famount of foreign language content, the total amount of content consumed by each bilingual consumer is $n_1 + n^F - 2\delta^F n_1$ where $\delta^F > 0$ is a parameter of substitution.[25] As an increase in n^F should increase the extent of content substitution, n^F and δ^F are related with each other but we treat them as distinct parameters in order to highlight their respective role in shaping the strategy of the foreign platform. In what follows, we introduce an assumption which guarantees that $\min\left\{n_1, n^F\right\} > 2\delta^F n_1$. We further assume that when some mutually substitutable content is offered both in the home and the foreign language, a bilingual consumer interacts with either content with the same probability. Therefore, among the total of $n_1 + n^F - 2\delta^F n_1$ interactions mediated by platform 1 there are $n_1 - \delta^F n_1$ in the home language and $n^F - \delta^F n_1$ in foreign language.[26]

[23] If platform 2 provides some access to foreign language content, we can define n_i^F as each platform's mass of "relevant" foreign language CPs and consider $n^F = n_1^F - n_2^F > 0$.

[24] Viard and Economides (2013) make a similar assumption that content creation by "large" countries is exogenous to adoption in "small" countries and find empirical support for it.

[25] Introducing substitution among the offerings of domestic CPs does not qualitatively affect our results. See the footnote right after Proposition 2.

[26] This tie-breaking assumption is for simplicity only and our results hold no matter the tie-breaking assumption as long as $\delta^F > 0$. See the footnote right after Proposition 2.

Given the values a and b per interaction, a bilingual consumer's utility on platform 1 is $u + a(n_1 + n^F - 2\delta^F n_1)$ and a domestic CP's surplus is $b(1 - \delta^F)x_1$, which translate into new values of u_1, a_1 and b_1 for the foreign platform. The next table summarizes our assumptions on the benefits of interactions between consumers and CPs.[27]

Table 1: surplus parameters (u_i, a_i, b_i) in each platform

	Platform 1	Platform 2
monolingual consumers	(u, a, b)	(u, a, b)
bilingual consumers	$\left(u + an^F, a\left(1 - 2\delta^F\right), b(1 - \delta^F)\right)$	(u, a, b)

Hence bilingualism increases the stand-alone utility by an^F and reduces the indirect network effect by a factor $2\delta^F$ for consumers and δ^F for domestic CPs. Since neither the total offerings of the domestic CPs nor the total offerings of the foreign CPs can be smaller than the mutually substitutable offerings, we make the following assumption:

Assumption A1: $1/2 > \delta^F$, $n^F > 2\delta^F(1 - \delta^F)bm$.

The first part of A1 is simply equivalent to $n_1 > 2\delta^F n_1$, which must hold obviously. The second part of A1 ensures that $n^F > 2\delta^F n_1$, relying on the fact that an upper bound of the measure of the domestic CPs that subscribe to platform 1 is $b\left(1 - \delta^F\right)m$ from the supply equation (2). This condition implies in particular that it is not possible to have too high degree of substitution with foreign content.

The timing of the game we consider is the following:

- Stage 1: Each platform i for $i = 1, 2$ simultaneously chooses the subscription fee F_i for domestic CPs.
- Stage 2: After observing (F_1, F_2), domestic CPs make decisions to subscribe to platform 1 and/or platform 2.
- Stage 3: After observing (n_1, n_2), each consumer decides which platform to use.

Notice that consumers observe the volume of content on each platform when deciding which to join. The CPs however need to form expectation of each platform's consumer market share to decide whether to pay a fee or not.

[27] We should point out here that this representation is valid also if bilingual consumers obtain a utility $u^B \neq u$ at platform 1 (due to bilingual service) provided that we redefine n^F as $\tilde{n}^F = \frac{u^B - u}{a} + n^F$.

3 Monolingual consumers

Consider the case in which all consumers are monolingual. As a consequence, there is no international trade except for the "cross-border" provision of the intermediation service by the foreign platform for the domestic consumers and CPs in the home country. We use superscript M to indicate the monolingual case.

Given symmetric parameters (u, a, b), the gross utility differential between platform 1 and platform 2 is $a(n_1 - n_2)$. At stage 2, one point increase in a platform's anticipated consumer market share raises its CP demand by mb. We assume the following stability condition, which is standard in the two-sided market literature:

Assumption A2: $t > abm$.

The reason for the assumption is the following. Suppose that an exogenous shock increases the mass of consumers on platform 1 by ε unit (without affecting x_2). Then, from (2), the mass of subscribed CPs increases by $bm\varepsilon$ units on platform 1. This induces (from (1)) a mass of $abm\varepsilon/2t$ extra consumers to switch from platform 2 to platform 1. This in turn increases n_1 by $ab^2(m)^2\varepsilon/2t$ and reduces n_2 by $ab^2(m)^2\varepsilon/2t$, which induces (from (1)) an additional increase in platform 1's consumer share by $(abm)^2\varepsilon/2t^2$ etc. If A2 is not satisfied, the mass of these extra consumers who switch later is larger than the mass of consumers who originally switched, which makes the system explode. When it holds, the total increase in x_1 is equal to $[1 + \sigma^M]\varepsilon$ where

$$\sigma^M \equiv \frac{abm}{2t - 2abm} \tag{4}$$

is the positive multiplier in our two-sided market for the monolingual case. Then, given (F_1, F_2), the allocation (x_i, n_i) is given by:

$$x_i = \frac{1}{2} + \sigma^M\left(\frac{F_j - F_i}{b}\right), \tag{5}$$

and $n_i = m(x_i b - F_i)$. Furthermore, we can also consider σ^M a *measure of platform competition in the monolingual case*. In fact, platform i's profit, $\pi_i = F_i n_i$, is maximized at prices such that the platform's share in the CPs' surplus is given as:

$$\frac{F_i}{x_i b} = \frac{1}{2 + \sigma^M} \text{ for } i = 1, 2. \tag{6}$$

Therefore, all other things being equal, as σ^M increases, there is more competition between the two platforms. (6) shows that in any shared equilibrium in which each platform has a positive consumer market share, the platform's share in the CPs' surplus is constant and

the same for both platforms. In particular, as the measure of the platform competition σ^M increases, the platform's share decreases: the stronger competition between the two platforms, the smaller is the share of the surplus captured by the platforms. This measure of the degree of platform competition increases with each element in (a, b, m) and decreases in t, which is very intuitive as an increase in any of (a, b, m) increases the elasticity of the CP's demand for the platform's service.

We have:

Proposition 1 *(monolingual case): Consider the case in which all consumers are monolingual. Under Assumption A2, we have a unique equilibrium, which involves two symmetric active platforms.*

(a) The share of platform i in the CPs' surplus is given by

$$\frac{F_i}{x_i b} = \frac{1}{2+\sigma^M} \text{ for } i = 1, 2.$$

(b) The equilibrium outcome is described by:

$$x_i^M = x^M = 1/2, \; F_i = F^M = \frac{b}{2}\frac{1}{2+\sigma^M}, \; n_i^M = n^M = \frac{mb}{2}\frac{1+\sigma^M}{2+\sigma^M} \text{ for } i = 1, 2.$$

Proof. See Appendix. ■

In reality, some foreign content can be translated into the home language. In the case of books, for instance, translated content is produced by domestic CPs who pay copyright fees and royalties to the foreign CPs owning the original content. Therefore, translated content becomes part of home language content. One way to include such a translation in our model is by assuming that the mass of home language content which is already produced and can be made available on a platform is increased from m to $m'(> m)$, where the difference $m' - m$ increases with n^F and decreases with the cost of translation. This will lead to the symmetric equilibrium described in Proposition 1 in which m is replaced by m'. In fact, the symmetric equilibrium with m' captures the best case scenario in terms of the domestic welfare since translated content may have lower quality than original content and may be a substitute for some of home language content. As our monolingual case (i.e., the symmetric equilibrium with m) captures the worst case scenario with the infinite cost of translation, if bilingualism leads to a reduction in home language content or the domestic welfare, the same conclusion will hold a fortiori when translation is taken into account in the monolingual case.

4 Bilingual consumers

In this section, we study the case in which all consumers are bilingual. We use superscript B to indicate the bilingual case.

We first define a very important parameter Γ which measures *the reduction in the efficiency of the exchanges in the home language within platform 1* due to the access to foreign language content:

Definition 1 $\Gamma \equiv 1 - (1 - \delta^F)(1 - 2\delta^F)$.

In the absence of the exchanges in the foreign language, the efficiency of exchanges in the home language within each platform can be measured by ab. From Table 1, exchanges in the foreign language reduce the surplus that a domestic CP obtains from having an additional consumer from b to $b(1-\delta^F)$ and the surplus that a consumer obtains from having an additional domestic CP from a to $a(1-2\delta^F)$. Therefore, the efficiency measure of exchanges in the home language within platform 1 becomes $ab\,(1-\Gamma)$ and is reduced by $ab\Gamma$.

Since $\Gamma = \delta^F\left(3 - 2\delta^F\right)$, under Assumption A1 that $\delta^F \in [0, 1/2)$, we have $\Gamma \in [0, 1)$ and Γ strictly increases with δ^F. As there is one-to-one relationship between δ^F and Γ, we use Γ when it is more convenient.

Shared equilibrium

We first study an equilibrium in which both platforms are active. At Stage 3, the gross utility differential between platform 1 and platform 2 is now $a\left(n_1 + n^F - 2\delta^F n_1 - n_2\right)$ while one point increase in anticipated market shares raises the CP demand by $mb(1-\delta^F)$ on platform 1 and by mb on platform 2. Following the same reasoning as in the monolingual case, the multiplier for the domestic platform 2 in the bilingual case is

$$\sigma^B \equiv \frac{abm}{2t - (2-\Gamma)\,abm} = \frac{\sigma^M}{1 + \Gamma\sigma^M}, \tag{7}$$

while for the foreign platform the multiplier is $\sigma^B(1-\Gamma)$. For expositional simplicity, in what follows, we simply call σ^B the multiplier in the bilingual case. Then, from (1), (2) and Table 1, we obtain the market share of the foreign platform:

$$x_1 = \frac{1}{2} + \sigma^B \frac{n^F}{mb} - \sigma^B \frac{\Gamma}{2} + \sigma^B \left(\frac{F_2 - (1-2\delta^F)F_1}{b} \right). \tag{8}$$

From (2) and (8), by maximizing $\pi_i = F_i n_i$, we obtain the equilibrium price conditions. Comparing the equilibrium prices leads to:

$$\frac{F_1}{x_1(1-\delta^F)b} = \frac{1}{2 + \sigma^B(1-\Gamma)} > \frac{F_2}{x_2 b} = \frac{1}{2+\sigma^B}. \tag{9}$$

The domestic platform's share in the surplus generated by domestic CPs takes the same form as in the monolingual case, but for the relevant multiplier σ^B. For $\Gamma > 0$, the share of a CP's surplus retained by the foreign platform is higher than what is retained by the domestic platform. The reason is that the perceived price elasticity is lower for the foreign platform, due to lower intensity of indirect network effects.

Moreover, we have:

Proposition 2 *(competition softening effect): Suppose that Assumptions A1 and A2 hold. Then, bilingualism softens platform competition:*

$$\sigma^B < \sigma^M \text{ for } \Gamma > 0 \text{ and } \sigma^B = \sigma^M \text{ for } \Gamma = 0.$$

As a consequence, both platforms retain a higher share of the CP's surplus than in the monolingual case. As we previously explained, exchanges in the foreign language come with the cost of making exchanges in the home language less valuable in platform 1. More precisely, the efficiency measure of exchanges in the home language within platform 1 is reduced by $ab\Gamma$. This change in platform 1's efficiency has spillover to the other platform since the multiplier in our two-sided market depends on the sum of the efficiency measures of each platform. In particular, bilingualism softens platform competition by reducing the multiplier compared with the monolingual case.[28]

Substituting the prices in (8) with the expressions from (9) gives the equilibrium market share of the foreign platform:

$$x_1^B = \frac{\frac{1}{2} + \sigma^B \left(\frac{n^F}{bm} - \frac{\Gamma}{2} \right) + \frac{\sigma^B}{2+\sigma^B}}{1 + \frac{\sigma^B(1-\Gamma)}{2+\sigma^B(1-\Gamma)} + \frac{\sigma^B}{2+\sigma^B}}. \tag{10}$$

$x_1^B > 0$ under A1 and A2 because $1 > \sigma^B\Gamma$ holds in (10). Notice that x_1^B linearly increases with n^F.

The existence of the shared equilibrium requires $x_1^B \leq 1$ so that platform 2 is active, which leads to the following condition:

[28] For this reason, Proposition 2 holds no matter the tie-breaking rule applied to mutually substitutable content. This is because bilingualism always strictly reduces a_1 and weakly reduces b_1. For a similar reason, if we assume, in addition to the substitution between foreign content and domestic content, the substitution among the offerings of purely domestic CPs, our main results will not be affected. Although adding such an assumption softens the multiplier effect both in the monolingual and the bilingual cases, the result that the presence of the substitution between the domestic and foreign content offerings makes the multiplier in the bilingual case smaller than the one in the monolingual case remain intact. We assume no substitution among domestic content for simplicity.

$$n^F \leq bm\left[\frac{\Gamma}{2}+\frac{1}{2\sigma^B}+\frac{1-\Gamma}{2+\sigma^B(1-\Gamma)}\right] \equiv \underline{n}^F. \tag{11}$$

Tipping equilibrium

We have seen above that there is no equilibrium in which platform 2 corners the market. However, there can be an equilibrium in which platform 2 is not active. When $x_1 = 1$, the mass of CPs on platform 1 is $m\left((1-\delta^F)b - F_1\right)$ so that platform 1's profit, $\pi_1 = F_1 m((1-\delta^F)b - F_1)$, is maximized at price:

$$F_1^T = \frac{(1-\delta^F)b}{2},$$

implying

$$n_1^T = \frac{(1-\delta^F)bm}{2}, \tag{12}$$

where the superscript T means tipping. This is an equilibrium if platform 2 cannot attract any consumers and therefore any CPs by charging $F_2 = 0$. Hence, we have a cornering equilibrium with a monopoly price, if at prices $\left(F_1^T, F_2 = 0\right)$, platform 2 does not sell, which is equivalent to the following condition:

$$n^F > bm\left(\frac{1}{2}+\frac{1}{2\sigma^B}\right) \equiv \overline{n}^F. \tag{13}$$

One can verify that $0 < \underline{n}^F < \overline{n}^F$ holds for $\Gamma \in [0,1)$. As should be expected, for n^F between $\underline{n}^F$ and $\overline{n}^F$, the market is tipping but the presence of platform 2 constrains the pricing of the foreign platform.

Summarizing, we have:

Proposition 3 *(bilingual case): Suppose that Assumptions A1 and A2 hold. When all consumers are bilingual, we have a unique equilibrium.*

(i) If the condition $n^F \leq \underline{n}^F$ holds, the equilibrium is a shared equilibrium. Then, we have:

$$\begin{aligned} F_1^B &= \frac{x_1^B(1-\delta^F)b}{2+\sigma^B(1-\Gamma)},\ F_2^B = \frac{\left(1-x_1^B\right)b}{2+\sigma^B} \\ n_1^B &= mbx_1^B(1-\delta^F)\left(\frac{1+\sigma^B(1-\Gamma)}{2+\sigma^B(1-\Gamma)}\right),\quad n_2^B = mb\left(1-x_1^B\right)\left(\frac{1+\sigma^B}{2+\sigma^B}\right), \end{aligned}$$

where the foreign platform's market share x_1^B is given by (10).

(ii) If the condition $n^F > \overline{n}^F$ holds, the equilibrium is such that platform 1 corners the market and charges the monopoly price $F_1^T = \frac{(1-\delta^F)b}{2}$.

(iii) For $\underline{n}^F < n^F < \overline{n}^F$, the equilibrium is such that platform 1 corners the market and charges a price below the monopoly price.

Proof. See Appendix. ■

Remark 1 *(endogenous n^F): We can make n^F and δ^F endogenous as follows. Suppose that some exogenous measure N^F of foreign content is already on board in the foreign platform for the distribution in the foreign country's market. Hence, there is no need to incur a fixed cost to make the foreign content available on the foreign platform for the distribution in the home country's market.*[29] *Consider now that platform* 1 *chooses the available content volume $n^F \leq N^F$ as well as the parameter of substitution δ^F. Clearly there is a link between the two, so the platform choice set is restricted. For any equilibrium,*[30] *the profit increases with n^F so that the foreign platform benefits from increasing foreign content volume as long as it does not raise the extent of substitution with domestic content. It may refrain from raising n^F if this implies greater content substitution. However, rather surprisingly, we can show that the foreign platform benefits from having some small substitution δ^F when t is small and n^F is not too large. In this case, since there is strong competition between the platforms, platform* 1 *would benefit from relaxing competition by creating content substitution and thereby reducing the two-sided multiplier.*

5 Comparison of the monolingual and the bilingual cases

In this section, we compare the monolingual case and the bilingual one in terms of the amount of home language content available on the platforms and the home country welfare.

5.1 Home language content available on the platforms

The amount of domestic content available on each platform depends on the consumer market shares, the amount crowded out by foreign content and the intensity of competition. Let us first examine the consumer market shares.

From the market share in (10), the foreign platform's market share is higher in the bilingual case than in the monolingual case (i.e., $x_1^B > 1/2$) if the volume of foreign content is large enough given the degree of substitution δ^F. We show below that this is always the case.

[29] Interestingly, this point is also emphasized in Hanson and Xiang (2011) who conclude that for motion picture trade global fixed export costs dominate bilateral (i.e., destination market-specific) fixed export costs. However, their data is on motion-picture distribution through theathrical releases rather than on-line.

[30] Here we consider a timing in which fixed payments from the foreign CPs to platform 1 were made before platform 1 chooses the fee for domestic CPs.

Proposition 4 *(market share): Suppose Assumptions A1 and A2 hold. Then bilingualism increases the consumer market share of the foreign platform.*

Proof. See Appendix. ■

Bilingualism has three effects in our model. First the foreign platform becomes more attractive to consumers who value the foreign content. Second, for given consumer market share, the foreign platform becomes less attractive to domestic CPs due to competition with substitute foreign content. Third, lower indirect network effects reduce the intensity of competition and raises more the prices on the foreign platform than on the domestic platform. The proposition shows that the first effect dominates the last two. However, the last two effects mitigate the increase of the foreign platform's market share.

We can now examine how bilingualism affects the amount of domestic content available in the Internet.

Consider first the shared equilibrium. We know from Proposition 2 that bilingualism softens competition, which reduces the volume of domestic content for given consumer market shares. This together with the fact that bilingualism reduces the domestic platform's market share implies that bilingualism reduces the amount of domestic content on this platform. Bilingualism increases the market share of the foreign platform, which will attract more domestic CPs unless the larger market share is offset by the price increase and the substitution with foreign content. Thus in the shared equilibrium, we expect bilingualism to reduce the volume of domestic content on the foreign platform when its consumer market share is not very large or when the degree of substitution between domestic and foreign content is high.

Consider now the monopoly tipping equilibrium. On the one hand, domestic CPs capture a smaller share of surplus in the bilingual case than in the monolingual case because of the monopoly power of the platform. On the other hand, the mass of consumers is twice larger in the foreign platform under the bilingual case than the mass in each platform under the monolingual case. This can increase the measure of CPs subscribed to the bilingual platform because of economies of scale in the interactions between consumers and CPs (i.e., due to the cross-side network externality in this two-sided market). We find again that the measure of CPs in the tipping equilibrium $n_1^T = bm\left(1-\delta^F\right)/2$ is smaller than n^M if and

only if the content substitution measured by δ^F is larger than a certain threshold:[31]

$$\delta^F > \frac{2t - 2abm}{4t - 3abm}. \tag{14}$$

Since the right hand side of (14) increases with t, when there is little differentiation of service offered by the platforms and a high degree of substitution between the foreign language and the home language content, the price increase by the foreign platform more than offsets the increase in its consumer market share. As a result, bilingualism reduces the amount of content in the home language. Summarizing, we have:

Proposition 5 *(content available in the Internet): Suppose Assumptions A1 and A2 hold.*

(i) In the shared equilibrium, bilingualism reduces the amount of content available on the domestic platform. Bilingualism raises the amount of domestic content available on the foreign platform if δ^F is small and reduces it if δ^F is large.

(ii) In the monopoly tipping equilibrium, bilingualism reduces the amount of domestic content available (i.e. $n_1^T < n^M$) if and only if (14) holds.

Proof. See Appendix. ■

Thus, a key determinant of whether bilingualism increases or reduces the amount of home language content available on the Internet is the extent of substitution between foreign and home content as measured by δ^F.

5.2 Domestic welfare

In this subsection, we study how bilingualism affects the welfare of the home country.[32] Before proceeding to welfare comparison, we show a result that facilitates it.

In the Appendix, we show that we can normalize the model, without loss of generality, by setting parameters $a = b = m = 1$ and scaling the amount of content by a factor $1/bm$. In

[31] Comparing n_1^T with n^M is appropriate as long as we assume that a CP's (platform-specific) fixed cost of entry is the same and does not depend on the identity of the platform. Even if fixed cost of entry is independently distributed across the platforms, the amount of content available to *each consumer* in equilibrium is given by n_1^T or n^M depending on whether consumers are bilingual or monolingual.

[32] A similar analysis would hold for world welfare. Under our small country assumption, bilingualism allows foreign CPs to sell content to domestic consumers. Remark 1 in Section 4 shows that the foreign platform has an incentive to provide access to foreign CPs. Therefore, bilingualism raises the joint profit of the foreign platform and the foreign CPs. Hence, world welfare increases whenever domestic welfare increases.

the normalized model, we use the notation $\widetilde{n}^F = n^F/bm$ to denote the normalized quantity of foreign content and define $CS(\widetilde{n}^F, \delta^F)$ as the consumer surplus (net of the stand-alone value u) and $\Pi_d(\widetilde{n}^F, \delta^F)$ as the domestic producer surplus, which is the sum of the profit of the domestic platform and and the profits of the domestic CPs. Then, as shown in the Appendix, the domestic welfare in the original model can be written

$$W = u + abm \left\{ CS(\widetilde{n}^F, \delta^F) + \frac{b}{a} \Pi_d(\widetilde{n}^F, \delta^F) \right\}. \tag{15}$$

Therefore, comparing bilingual welfare with monolingual welfare is equivalent to comparing $CS(\widetilde{n}^F, \delta^F) + (b/a)\,\Pi_d(\widetilde{n}^F, \delta^F)$ with $CS(0,0) + (b/a)\,\Pi_d(0,0)$ where $b/a > 0$ is the relative weight of the producer surplus in the domestic welfare. In other words, *in the welfare comparison, without loss of generality, we can restrict attention to the weighted sum of the consumer surplus and the producer surplus in the normalized model.*

From now on, we thus discuss the effect of bilingualism on consumer surplus and producer surplus in the normalized model. The consumer surplus is:

$$CS(n^F, \delta^F) \equiv \left(n_1 + n^F - 2\delta^F n_1\right) x_1 + n_2 x_2 - \frac{t}{2}\left[(x_1)^2 + (1 - x_1)^2\right],$$

while the domestic producer surplus is

$$\Pi_d(n^F, \delta^F) = n_2 F_2 + \frac{(n_1)^2 + (n_2)^2}{2}.$$

In what follows the welfare effect of bilingualism will result mostly from the combination of the positive effect of consumer concentration on the indirect network externality with the negative allocative effect of price inflation.

Consider first the case of market sharing with no content substitution $\delta^F = 0$. Then, the intensity of competition is unchanged ($\sigma^B = \sigma^M$) so that bilingualism improves the offer of platform 1 without affecting the price (per consumer) that each platform levies on domestic CPs. Platform 1's consumer market share and mass of CPs increase, while the reverse holds for platform 2. Overall consumers collectively benefit from platform 1's higher supply of content. Similarly bilingualism raises CPs' surplus because they benefit from economies of scale in the interactions with consumers. However, the aggregate effect on the domestic producer surplus is ambiguous since bilingualism reduces platform 2's profit. We find that there is a cutoff such that bilingualism increases the domestic producer surplus if and only if n^F is above the cutoff.

Consider now the polar case in which δ^F is large, close to 1/2, still with market sharing (recall that is requires $1/2 < n^F < 1/2 + 1/(2\sigma^B)$ by Assumption A1 and (11))). In this case,

domestic CP participation is lower on both platforms under bilingualism.[33] Hence domestic producer surplus is lower. Moreover, due to lower participation of CPs, the consumer surplus generated by platform 2 is also lower. But given that $n^F(>1/2) > n^M$, bilingualism increases the consumer surplus generated by platform 1. The overall effect on consumer surplus then depends on the amount of foreign content.

Consider finally the case in which n^F is so large (i.e., $n^F \geq \overline{n}^F$) that bilingualism leads to the tipping equilibrium with the monopoly price. Then, we can show that bilingualism increases consumer surplus since the increase in the total amount of content exceeds the increase in total transportation cost. CPs' surplus may increase or decrease depending on δ^F as the concentration of consumers in the foreign platform allows CPs to avoid duplication of fixed cost. A sufficient condition for bilingualism to reduce the producer surplus is that it reduces domestic CPs' surplus, which is given by

$$\left(n^M\right)^2 > \frac{\left(n_1^T\right)^2}{2},$$

which is equivalent to

$$\delta^F > 1 - \sqrt{2}\frac{2t-1}{4t-3}. \tag{16}$$

This condition is always satisfied if t is close to one: when there is little differentiation of service offered by the platforms, bilingualism always reduces producer surplus if it leads to the tipping equilibrium. Hence, if (16) holds, there is a conflict between the consumer surplus and the producer surplus effects and bilingualism reduces domestic welfare if b/a is large enough.

Summarizing, we have:

Proposition 6 *(domestic welfare): (i) When $\delta^F = 0$, in any shared equilibrium, bilingualism increases consumer surplus and domestic CPs' surplus. It increases domestic producer surplus if n^F is larger than a threshold.*

(ii) When δ^F is large, in any shared equilibrium, bilingualism reduces domestic producer surplus while it increases consumer surplus if n^F is large enough.

(iii) When bilingualism leads to the tipping equilibrium with the monopoly price, it increases consumer surplus. It reduces domestic producer surplus if condition (16) holds.

Proof. See Appendix ■

Remark 2 *(monopoly platform in the monolingual case): We can also perform welfare comparison of the bilingual case with an alternative scenario of the monolingual case.*

[33] This follows from $n_1^B = x_1^B/4 < n^M$ in the normalized model.

Namely, in the monolingual case, platform 1 does not enter the home country and hence platform 2 remains as the monopoly platform while, in the bilingual case, both platforms compete. Suppose that we do the comparison for a given location of platform 2. Then, in the monolingual case, by substituting $\delta^F = 0$ into (12), we find that the amount of home language content available on the monopoly platform 2 is $bm/2$, which is larger than n^M in the duopoly monolingual case. This is because the indirect network externality effect dominates the effect from monopoly price. This result together with the fact that the foreign platform's profit is not part of the domestic welfare implies that domestic welfare is higher in the monopoly monolingual case than in the duopoly monolingual case. Therefore, if bilingualism reduces welfare with respect to the duopoly case, it also reduces it with respect to the monopoly case.[34]

Simulation for the general case: domestic welfare

To gain more insights on welfare effects of bilingualism we solved the model numerically. Figure 2 shows the results of the simulation for the normalized model, i.e., under the assumption that $a = b = m = 1$. Given these parameter values, Assumption A2 implies $t > 1$, which we satisfy by setting $t = 1.1$. The horizontal axis in Figure 2 represents $n^F \in [0, 1]$ and the vertical axis represents $\delta^F \in [0, 1/2)$, where the latter range corresponds to the first part of Assumption A1. To account for the parameter values consistent with the second part of Assumption A1 (i.e., $n^F > 2\delta^F(1 - \delta^F)$) and the shared equilibrium outcome, we consider only the points located between the curves $n^F = 2\delta^F(1 - \delta^F)$ and $x_1^B = 1$. In general, for a given t, there can be four regimes depending on the values of $n^F$and δ^F:

- Regime I: $CS(n^F, \delta^F) \geq CS(0, 0)$ and $\Pi_d(n^F, \delta^F) \geq \Pi_d(0, 0)$
- Regime II: $CS(n^F, \delta^F) \geq CS(0, 0)$ and $\Pi_d(n^F, \delta^F) < \Pi_d(0, 0)$
- Regime III: $CS(n^F, \delta^F) < CS(0, 0)$ and $\Pi_d(n^F, \delta^F) \geq \Pi_d(0, 0)$
- Regime IV: $CS(n^F, \delta^F) < CS(0, 0)$ and $\Pi_d(n^F, \delta^F) < \Pi_d(0, 0)$

Figure 2 shows all possible regimes for $t = 1.1$ in the shared equilibrium. Then, for any given n^F and a relatively small δ^Fconsistent with the shared equilibrium (i.e., $x_1^B < 1$), bilingualism increases both the consumer surplus and the producer surplus. As δ^F increases,

[34]However, we also should take into account the effect on the production of home language content, which we analyze in the next section. Then, as the monopoly removes the positive feedback between content production and platform competition, this effect goes in favor of the duopoly. Therefore, the welfare comparison becomes ambiguous between the monopoly case and the duopoly case.

we enter into the region of the (n^F, δ^F) plane where bilingualism increases the consumer surplus but decreases the producer surplus. A further increase of δ^F brings us into the region where bilingualism decreases both the consumer surplus and the producer surplus. (Regime III does not exist for the parameters considered.)

In most western European countries and Latin American countries, we expect a high δ^F and a high n^F and hence these countries are likely to be in Regime II where bilingualism increases the consumer surplus while decreasing the producer surplus.[35] By contrast, in Asian countries such as China, Japan, Korea etc., we expect a low δ^F and a low n^F relative to European countries. Then, as long as δ^F is sufficiently smaller than n^F, bilingualism will increase the consumer surplus and the producer surplus.

6 Production of home language content

In the previous sections, we assumed that a certain amount of home language content had already been produced by a number of CPs by the time when the platforms choose the subscription fees they will charge to CPs. We here make this amount (i.e., the number of CPs) endogenous. To this end, we expand the timeline of the model by introducing Stage 0 before Stages 1-3, which were discussed in Section 2:

- Stage 0: Each content producer decides whether to produce content or not.

We assume that at Stage 0, a CP does not know the realization of the fixed cost of making its content available to each platform but knows the fixed cost of producing it. Let $G(\cdot)$ be the distribution of the fixed cost of production. Let π^{off} be the profit that each CP expects to earn with his or her content through off-line transactions. π^{off} is assumed to be a positive constant. Let π^{on} represent each CP's expected profit from online interactions with consumers via the two platforms. If π^{on} is a constant as well, the amount of content produced is equal to $G(\pi^{off} + \pi^{on})$. Below we study how bilingualism affects the production of home language content.

[35] If we take into account that countries for which translating/dubbing content is relatively costly (like Scandinavian countries or the Netherlands) have a relatively high degree of bilingualism, consumer surplus gain from bilingualism will be higher for these countries than for the rest of European countries when we allow for translating foreign content in the monolingual benchmark.

6.1 Monolingual case

Consider first the monolingual case. Recall that for a mass m of home language content produced, the multiplier in the monolingual case $\sigma^M(m)$, given by equation (4), increases with m. (In what follows, we use notation making explicit the dependency of σ^M on m: $\sigma^M(m)$). In other words, the intensity of platform competition increases with the amount of home language content produced. Then, each CP's expected profit from online interactions in the monolingual case is given by

$$\begin{aligned}\pi^{on,M}(m) &= \Pr\left[k \leq \frac{n^M}{m}\right] 2\left[bx^M - F^M - \frac{n^M}{2m}\right] \\ &= \left[\frac{b}{2}\frac{1+\sigma^M(m)}{2+\sigma^M(m)}\right]^2\end{aligned}$$

which increases with m. Therefore, the equilibrium amount of home language content produced at stage 0, denoted by m^M, is the fixed point of the following mapping

$$m \mapsto G(\pi^{off} + \pi^{on,M}(m)).$$

There must be at least one fixed point as $G(\pi^{off} + \pi^{on,M}(m))$ is strictly increasing with m, bounded from above and has a strictly positive value when $m = 0$. We assume that it is unique. The analysis shows that there is positive feedback between home language content production and platform competition: the more content is produced, the more intense is the platform competition, which lowers the fees charged by the platforms and hence increases the amount of content produced.

6.2 Bilingual case

In the bilingual case, the multiplier $\sigma^B(m)$ is defined in equation (7). In the shared equilibrium, each CP's expected profit from online interactions in the bilingual case is given by

$$\begin{aligned}\pi^{on,B}(m) &= \Pr\left[k \leq \frac{n_1^B}{m}\right]\left[b(1-\delta^F)x_1^B - F_1^B - \frac{n_1^B}{2m}\right] + \Pr\left[k \leq \frac{n_2^B}{m}\right]\left[bx_2^B - F_2^B - \frac{n_2^B}{2m}\right] \\ &= \frac{1}{2}\left\{\left[b(1-\delta^F)x_1^B(m)\frac{1+\sigma^B(m)(1-\Gamma)}{2+\sigma^B(m)(1-\Gamma)}\right]^2 + \left[bx_2^B(m)\frac{1+\sigma^B(m)}{2+\sigma^B(m)}\right]^2\right\}.\end{aligned}$$

Therefore, the equilibrium amount of domestic content produced at stage 0, denoted by m^B, is the fixed point of the following mapping

$$m \mapsto G(\pi^{off} + \pi^{on,B}(m)).$$

Such an equilibrium exists provided that n^F is not too large to satisfy the inequality presented in (11).

In the case of the tipping equilibrium with the monopoly price, each CP's expected profit from online interactions is given by

$$\begin{aligned}\pi^{on,T} &= \Pr\left[k \leq \frac{n_1^T}{m}\right]\left[b(1-\delta^F) - F_1^T - \frac{n_1^T}{2m}\right] \\ &= \frac{1}{2}\left(\frac{b(1-\delta^F)}{2}\right)^2.\end{aligned}$$

In this case, $\pi^{on,T}$ does not depend on m. Therefore, the equilibrium amount of home language content produced at stage 0 is $G(\pi^{off} + \pi^{on,T}) \equiv m^T$. In particular a tipping equilibrium exists if n^F is sufficiently large to satisfy the inequality given in (13).

6.3 Comparison

Consider first the scenario with no content substitution: $\delta^F = 0$. In the case of the market sharing equilibrium (i.e., when n^F is small), the presence of foreign content does not affect the intensity of competition and as argued in section 5.2 domestic CPs' profit is higher under bilingualism. Therefore, as long as bilingualism leads to the market sharing equilibrium, it raises the amount of home language content produced. By contrast, in the case of tipping with the monopoly price (i.e., when n^F is large but still with $\delta^F = 0$), the foreign platform pricing is not constrained by the domestic platform so that the price increase may discourage some production of content. In addition, the aforementioned positive feedback disappears as the profit of a domestic CP in the tipping equilibrium is independent of m. Therefore, we expect bilingualism to reduce home content production when m^M is large, which occurs if there is intense platform competition (t is small) or large values of interactions (ab is large).

Consider now the scenario with some content substitution, $\delta^F > 0$. For a given market share, increasing the degree of content substitution will decrease the production of home language content for two reasons. First, the domestic CPs have less interactions with consumers on the foreign platform. Second, they face higher prices of access to either of the two platforms. We thus expect the home content production to decline when the degree of substitution is high. We have:

Proposition 7 *(content production):*

(i) Suppose that δ^F is small.

(a) When market sharing occurs in the bilingual case, bilingualism increases the production of home language content.

(b) When tipping with the monopoly price occurs in the bilingual case, bilingualism reduces the home language content produced if the following condition holds

$$m^T = G(\pi^{off} + \frac{b^2}{8}) > \frac{t}{ab}\frac{4-2\sqrt{2}}{3-\sqrt{2}}.$$

(ii) Suppose that δ^F is large. Then bilingualism reduces the production of home language content when it leads to market sharing or to market tipping with the monopoly price.

Proof. See Appendix ■

Proposition 7 is similar to Proposition 5 in that bilingualism reduces (increases) the domestic production of content when there is a high (low) degree of substitution between foreign and domestic content. However, there is one major difference. Namely Proposition 7(i)(b) shows that even if there is no content substitution, bilingualism can reduce the production of domestic content if tipping occurs. This is quite in contrast with the result we have seen previously in Section 5.2: for given amount of domestic content produced, in the tipping equilibrium with $\delta^F = 0$, bilingualism increases the content available in the Internet. The reason for such a contrast is the interplay between content production and platform competition. As we already pointed out, the content production by new CPs intensifies competition between online intermediaries. The positive feedback effect that exists if the two platforms actively compete disappears when the market tips and the foreign platform acts as an unconstrained monopoly.

6.4 Discussion

The conclusion that under certain conditions, bilingualism may result in the reduction of the home language content available to the domestic consumers suggests that government interventions to support domestic cultural goods based on the home language may be warranted. With regards to cultural goods and services protection, there were several recent policy initiatives in the EU, Canada and Brazil which were inspired by the idea that an individual's decision to consume foreign cultural goods imposes a negative externality on other domestic consumers. In our model, such negative externalities among consumers occur as consumption of foreign content confers market power to the foreign platform, which then extracts a higher surplus from domestic content providers and thereby reduces production of home language content.

The ideas about market failures in the cultural goods production and trade have motivated several recent proposals by World Trade Organization (WTO) member states that

certain cultural and creative goods and services should either be given a special treatment within the international trade law or taken entirely outside of the WTO jurisdiction and transferred under the jurisdiction of the United Nations Educational, Scientific and Cultural Organization (UNESCO). The efforts of several country governments (most of all those of France, Canada and Brazil) to move matters of trade in audiovisual products outside of the jurisdiction of the WTO have culminated in 2007 in the Convention on the Protection and Promotion of the Diversity of Cultural Expressions under the auspices of the UNESCO. One of the provisions included in this Convention is that signatory parties have the right and the obligation to protect and promote their cultural expressions, even if this objective may only be attained by the adoption of restrictive trade policies.

The European Union's Creative Europe Programme is an example of the recent EU policy initiatives that were motivated by the idea that market failures in trade, production or consumption of cultural goods could be rectified by government policy interventions. The Programme has the budget of 1.46 billion for subsidizing the European cultural and creative sectors in the period of 2014-2020.[36]

Our results suggest that home language CPs and the domestic platform are complementary as without meaningful platform competition, the former is subject to the exercise of the monopoly power by the foreign platform.[37] Therefore, promoting a domestic platform that can compete against the foreign platform should be an imporant part of the policy intervention. Somewhat paradoxically, this may require removing barriers that make it difficult for the domestic platform to distribute foreign content. Such a measure would create a level-playing field for the domestic platform in its competition against the foreign platform as foreign CPs whose content is already accessible for consumers in the foreign country do not need to incur any fixed cost to make their content available on the foreign platform for home country consumers.

Our results also provide novel rationales for subsidizing production of home language content. First, content production in a two-sided market is suboptimal as content producers

[36]The general objectives of Creative Europe are: (a) to safeguard, develop and promote European cultural and linguistic diversity and to promote Europe's cultural heritage; (b) to strengthen the competitiveness of the European cultural and creative sectors, in particular of the audiovisual sector, with a view to promoting smart, sustainable and inclusive growth. See http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0221:0237:EN:PDF

[37]In 2014 the EU parliament voted a non-binding resolution urging the European Commission to consider breaking up Google (i.e., unbundling search engines from other commercial activities) as a remedy for its anticompetitive practices. In the context of these charges, some member of the European Parliament have accused Google of using its market power to divert traffic away from the European digital content providers and imposing unfavorable terms of access to its search platform for European artists, publishers, recording companies, and photographers (Gomez (2014)).

do not take into account positive externalities that they generate to the other side of the market, i.e., consumers. Second, the positive feedback effect between home language content production and platform competition provides an argument for subsidizing content production in the home language. Third, bilingual countries have additional reasons to subsidize content production as foreign content may crowd out home language content directly (through substitution) and indirectly (by softening platform competition). More generally, we contribute to the debate on protection of cultural goods by analyzing the production and distribution of cultural goods in relation to online content distribution platforms.[38]

7 Conclusion

In a small open economy producing home language content, bilingualism allows domestic consumers to enjoy foreign language content but may result in crowding-out of home language content when foreign content is a substitute to home language content. Analyzing bilingualism from the perspective of the two-sided online intermediation market generates the following novel insights. On the one hand, bilingualism has the benefit of increasing cross-side network externalities by raising concentration of consumers in the foreign platform, which can increase the amount of home language content produced and/or distributed online. On the other hand, bilingualism can reduce home language content production through two different channels. First, substitution between foreign content and home language content reduces the two-sided market multiplier, which softens platform competition and induces both the foreign and the domestic platforms to charge higher access fees to domestic CPs. Second, when bilingualism leads to a tipping equilibrium, the domestic platform is driven out of the market and the foreign platform can charge monopoly price to domestic CPs. This completely removes the positive feedback between home language content production and platform competition, which this paper has identified.

In our analysis, we neglected other potential benefits of bilingualism. More specifically, bilingualism may induce more foreign platforms to enter the home country[39] and may allow domestic CPs to create and export content in the foreign language. Another important

[38] In a similar context, Ji et al. (2016) study online advertising industry in relation to search engine platforms and find that a country with its own domestic search engine has more online advertising intensity (which is defined as online advertising spending over GDP) than a country without a domestic search engine.

[39] However, in contrast to the traditional manufacturing sector, competition in the Internet often leads to a winner-takes-all outcome. Therefore, if competition within the foreign country creates a single dominant firm in that country, then it is pretty likely that a single foreign platform enters the home country.

benefit of bilingualism that we did not capture in our model is that it can increase the number of consumers using the Internet early on when little content is available in the home language.[40]

Although our paper is focused on a hypothetical small open economy, our results provide insights into the prevalence of US-originated platforms outside of the US. The presence of a relatively large fraction of bilingual consumers in the home country allows a US platform to leverage its access to the US content so that a tipping equilibrium can prevail in the home country. Our results show that bilingualism can reduce the production of content in the home language when there is little differentiation between competing platforms in terms of the service they offer to consumers and a high degree of substitution between content in English and content in the home language. Our analysis also highlights the importance of cultural factors and characteristics of content as they affect the volume of relevant English content for a given country as well as the degree of substitution between content in the home language and content in English.

Our paper is a first step in the study of the economics of languages and platforms in the Internet. There are many interesting issues for future research. One potential extension is related to the presence of translation services (offered by platforms such as Google). The quality of such services has been increasing over time. Such an extension could be used to analyze how the increase in the quality of the translation service affects platform competition and domestic content production. Yet another promising avenue of future research is to extend the analysis beyond the small open economy and explicitly model platform competition both in the bilingual home country and in the monolingual foreign country.

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9 Appendix

9.1 Proof of Proposition 1

The proof is straightforward from the discussion in the main text. We here prove that there is no tipping equilibrium. Suppose that all consumers subscribe to platform 1. If platform 1 charges zero price, then platform 1 can attract a mass mb of CPs since a CP's gross profit from subscribing to platform 1 is b. Hence, an upper bound on a consumer's expected gross surplus from joining platform 1 is $u+abm$. Under A2, the consumer located at the opposite extreme point has an incentive to join platform 2 and obtain u rather than to join platform 1 and obtain $u + abm - t$ since $t > abm$.

9.2 Proof of Proposition 3

The cases (i) and (ii) are shown already. Suppose $\underline{n}^F < n^F < \overline{n}^F$. Then, the optimal price for platform 1 is the highest price inducing market cornering for $F_2 = 0$, denoted by $F_1^* \in \left(\frac{(1-\delta^F)b}{2+\sigma^B(1-\Gamma)}, \frac{(1-\delta^F)b}{2}\right)$. Given $F_2 = 0$, reducing F_1 below F_1^* is not profitable since this deviation still allows platform 1 to corner the market and in this case having F_1 closer to F_1^T increases its profit. Increasing the price above $F_1^*(n^F)$ is not profitable since this deviation makes platform 1 share the market with platform 2, which is suboptimal.

9.3 Proof of Proposition 4

From (10), we find that $x_1^B > 1/2$ if

$$n^F > bm\Gamma\left(\frac{1}{2} - \frac{1}{2+\sigma^B(1-\Gamma)}\frac{1}{2+\sigma^B}\right). \tag{17}$$

But using $\Gamma = \delta^F\left(3-2\delta^F\right)$ and Assumption A1, we have

$$bm\Gamma\left(\frac{1}{2} - \frac{1}{2+\sigma^B(1-\Gamma)}\frac{1}{2+\sigma^B}\right) < \frac{3-2\delta^F}{4\left(1-\delta^F\right)}n^F < n^F.$$

9.4 Proof of Proposition 5

We have

$$\begin{aligned}
\frac{n_1^B}{n^M} &= 2x_1^B(1-\delta^F)\left(\frac{1+\sigma^B(1-\Gamma)}{2+\sigma^B(1-\Gamma)}\right)\frac{2+\sigma^M}{1+\sigma^M}, \\
\frac{n_2^B}{n^M} &= 2\left(1-x_1^B\right)\left(\frac{1+\sigma^B}{2+\sigma^B}\right)\frac{2+\sigma^M}{1+\sigma^M}.
\end{aligned}$$

Given that $\sigma^M > \sigma^B$ and $x_1^B > 1/2$, the second ratio n_2^B/n^M is less then 1. Then

$$\frac{n_1^B}{n^M} = 2\frac{\frac{1}{2} + \sigma^B \frac{n^F}{bm} - \frac{\sigma^B \Gamma}{2} + \frac{\sigma^B}{2+\sigma^B}}{1 + \sigma^B \left(\frac{1-\Gamma}{2+\sigma^B(1-\Gamma)} + \frac{1}{2+\sigma^B}\right)}(1-\delta^F)\left(\frac{1+\sigma^B(1-\Gamma)}{2+\sigma^B(1-\Gamma)}\right)\frac{2+\sigma^M}{1+\sigma^M}$$

which is bigger than 1 for δ^F small. When $\delta^F = 1/2$ (which requires $bm/2 < n^F < bm\left(1/2 + 1/(2\sigma^B)\right)$ by Assumption A1 and (11)) we have $\Gamma = 1$ and

$$\frac{n_1^B}{n^M} = x_1^B \frac{1}{2}\frac{2+\sigma^M}{1+\sigma^M} < x_1^B < 1.$$

The proof of (ii) follows from the above discussion.

9.5 Normalization of the model to $a = b = m = 1$

Consider the original model with (a, b, m) in Section 2. Since the case of monolingual consumers is a particular case of bilingual consumers with $n^F = 0$, we consider the case of bilingual consumers. Then, (x_i, n_i) is determined by

$$x_i = \frac{1}{2} + \frac{a(n_1 + n^F - 2\delta^F n_1) - an_2}{2t},$$
$$n_1 = m\left(x_1(1-\delta^F)b - F_1\right),\ n_2 = m\left(x_2 b - F_2\right).$$

We can normalize the original model as follows:

$$\widetilde{x}_i = x_i, \widetilde{n}_i = \frac{n_i}{bm}, \widetilde{n}^F = \frac{n^F}{bm}, \widetilde{F}_i = \frac{F_i}{b}, \widetilde{t} = \frac{t}{abm}, \widetilde{a} = \widetilde{b} = \widetilde{m} = 1.$$

Then we have

$$\widetilde{x}_i = \frac{1}{2} + \frac{(\widetilde{n}_1 + \widetilde{n}^F - 2\delta^F \widetilde{n}_1) - \widetilde{n}_2}{2\widetilde{t}}$$
$$\widetilde{n}_1 = \widetilde{x}_1(1-\delta^F) - \widetilde{F}_1,\ n_2 = \widetilde{x}_2 - \widetilde{F}_2.$$

In the original model, the domestic welfare is given by:

$$\begin{aligned} W &= u + a\left(n_1 + n^F - 2\delta^F n_1\right)x_1 + an_2 x_2 - \frac{t}{2}\left[(x_1)^2 + (1-x_1)^2\right] \\ &\quad + n_2 F_2 + \frac{(n_1)^2 + (n_2)^2}{2m} \end{aligned}$$

where $\frac{(n_1)^2+(n_2)^2}{2}$ takes into account both CPs' net surplus and their fixed cost. This is equivalent to

$$\begin{aligned} W &= abm\left\{\frac{u}{abm} + (\widetilde{n}_1 + \widetilde{n}^F - 2\delta^F \widetilde{n}_1)\widetilde{x}_1 + \widetilde{n}_2(1-\widetilde{x}_1) - \frac{\widetilde{t}}{2}\left[(\widetilde{x}_1)^2 + (1-\widetilde{x}_1)^2\right]\right. \\ &\quad \left.\frac{b}{a}\left(n_2\widetilde{F}_2 + \frac{(\widetilde{n}_1)^2 + (\widetilde{n}_2)^2}{2}\right)\right\}. \end{aligned}$$

Note that the first part of A1 is the same both in the original model and in the normalized model and the second part of A1 becomes $\widetilde{n}^F > 2\delta^F\left(1-\delta^F\right)$ in the normalized model. A2 becomes $t > 1$ in the normalized model.

9.6 Proof of Proposition 6

Consider consumer surplus. The case $\delta^F = 0$ follows from the discussion above. Under market sharing and $\delta^F = 1/2$, we have

$$n^F - tx_1^B = n_2^B - t(1 - x_1^B).$$

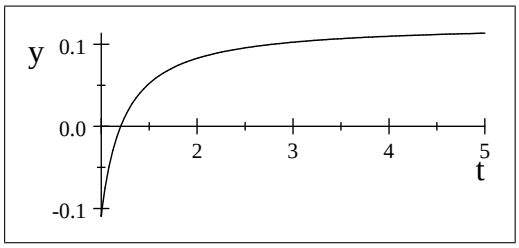
Using this condition, we find:

$$\begin{aligned} CS(n^F, \delta^F) - CS\,(0,0) &\equiv t\left(\left(x_1^B\right)^2 - \frac{1}{4}\right) + n_2^B - n^M \\ &= t\left(\left(x_1^B\right)^2 - \frac{1}{4}\right) + \left(1 - x_1^B\right)\left(\frac{1+\sigma^B}{2+\sigma^B}\right) - \frac{1}{2}\left(\frac{1+\sigma^M}{2+\sigma^M}\right), \end{aligned}$$

which is convex in x_1^B, increasing at $x_1^B = 1$. The value at $x_1^B = 1$ is $t\left(\frac{3}{4}\right) - \frac{1}{2}\left(\frac{1+\sigma^M}{2+\sigma^M}\right) > 0$ as $t > 1$. The value at $n^F = 1/2$ is

$$t\left(\left(\frac{\frac{1}{2} + \frac{\sigma^B}{2+\sigma^B}}{1 + \frac{\sigma^B}{2+\sigma^B}}\right)^2 - \frac{1}{4}\right) + \left(\frac{\frac{1}{2}}{1 + \frac{\sigma^B}{2+\sigma^B}}\right)\left(\frac{1+2\sigma^M}{2+3\sigma^M}\right) - \frac{1}{2}\left(\frac{1+\sigma^M}{2+\sigma^M}\right)$$

which is negative for small $t > 1$, as shown by the plot below:



CS gain for $n^F = 1/2$ and $\delta^F = 1/2$.

Hence, for small t, CS increases with bilingualism only for n^F large enough while for t large it increases for all n^F.

Let us turn to tipping at monopoly price. In the normalized model, we have

$$CS(n^F, \delta^F)\big|_{tipping} - CS(0,0) = \left[n_1^T(1-2\delta^F) + n^F - \frac{t}{2}\right] - \left[n^M - \frac{t}{4}\right] = \frac{(1-\Gamma)}{2} + n^F - n^M - \frac{t}{4}$$

$$\geq \frac{(1-\Gamma)}{2} + \overline{n}^F - n^M - \frac{t}{4} > 0, \tag{18}$$

where the first inequality is from $n^F \geq \overline{n}^F$.

Consider domestic producer surplus and a shared equilibrium. The change in the producer surplus is:

$$\left(1-x_1^B\right)^2 \frac{1+\sigma^B}{\left(2+\sigma^B\right)^2}+\frac{\left(x_1^B(1-\delta^F)\left(\frac{1+\sigma^B(1-\Gamma)}{2+\sigma^B(1-\Gamma)}\right)\right)^2+\left(\left(1-x_1^B\right)\left(\frac{1+\sigma^B}{2+\sigma^B}\right)\right)^2}{2}-n^M F^M-\left(n^M\right)^2$$

When $\delta^F = 0$, we have

$$\begin{aligned}&\left(\left(1-x_1^B\right)^2-\frac{1}{4}\right)\frac{1+\sigma^M}{\left(2+\sigma^M\right)^2}+\left(\frac{\left(x_1^B\right)^2+\left(1-x_1^B\right)^2}{2}-\frac{1}{4}\right)\left(\frac{1+\sigma^M}{2+\sigma^M}\right)^2\\ =\ &\frac{1+\sigma^M}{\left(2+\sigma^M\right)^2}\left(\left(1-x_1^B\right)^2-\frac{1}{4}+\left(\frac{\left(x_1^B\right)^2+\left(1-x_1^B\right)^2}{2}-\frac{1}{4}\right)\left(1+\sigma^M\right)\right)\end{aligned}$$

Which is convex in x_1^B and positive if x_1^B is above some threshold (smaller than 1), hence if n^F is above a threshold.

When $\delta^F = 1/2$ we have

$$\left(1-x_1^B\right)^2\frac{1+\sigma^B}{\left(2+\sigma^B\right)^2}-\frac{1}{4}\frac{1+\sigma^M}{\left(2+\sigma^M\right)^2}+\frac{\left(x_1^B/4\right)^2+\left(\left(1-x_1^B\right)\left(\frac{1+\sigma^B}{2+\sigma^B}\right)\right)^2}{2}-\frac{1}{4}\left(\frac{1+\sigma^M}{2+\sigma^M}\right)^2$$

which is negative for all $x_1^B \in [0.5, 1]$.

The tipping case follows from the discussion.

9.7 Proof of Proposition 7

Suppose $\delta^F = 0$. Then under market sharing

$$\pi^{on,B}(m)=\frac{1}{2}\left[b\frac{1+\sigma^M(m)}{2+\sigma^M(m)}\right]^2\left[(x_1^B)^2+(1-x_1^B)^2\right] > \pi^{on,M}(m)=\frac{1}{2}\left[b\frac{1+\sigma^M(m)}{2+\sigma^M(m)}\right]^2\frac{1}{2}.$$

Consider the case of tipping. Under our assumption that m^M is uniquely defined, if $G(\pi^{off}+\pi^{on,M}(m')) > m'$ holds for some m' then $m^M > m'$. Therefore, a necessary and sufficient condition for the bilingualism to reduce the amount of home language content is $\pi^{on,M}(m^T) > \pi^{on,T}$ which is equivalent to

$$m^T = G(\pi^{off}+\frac{b^2}{8}) > \frac{t}{ab}\frac{4-2\sqrt{2}}{3-\sqrt{2}}. \tag{19}$$

Suppose now that δ^F is large, close to 1/2. Then in the case of market sharing, we have $\Gamma \simeq 1$ and $\sigma^B(m) = \sigma^M(m) / \left(1 + \sigma^M(m)\right) < 1$. This yields

$$\pi^{on,B}(m) \simeq \frac{b^2}{2}\left\{\left[\frac{1}{4}x_1^B(m)\right]^2 + \left[\left(1 - x_1^B(m)\right)\frac{1+2\sigma^M(m)}{2+3\sigma^M(m)}\right]^2\right\} \tag{20}$$

$\pi^{on,B}(m)$ is convex in x_1^B and the values at 1/2 and 1 are respectively

$$\begin{aligned}\frac{b^2}{2}\left(\left(\frac{1}{8}\right)^2 + \left[\frac{1}{2}\frac{1+2\sigma^M(m)}{2+3\sigma^M(m)}\right]^2\right) &< \pi^{on,M}(m) = \frac{b^2}{4}\left[\frac{1+\sigma^M(m)}{2+\sigma^M(m)}\right]^2. \\ \frac{b^2}{2}\left(\frac{1}{4}\right)^2 &< \pi^{on,M}(m) = \frac{b^2}{4}\left[\frac{1+\sigma^M(m)}{2+\sigma^M(m)}\right]^2.\end{aligned}$$

Hence for all m we have $\pi^{on,B}(m) < \pi^{on,M}(m)$, implying the domestic production is lower under bilingualism.

Consider tipping with the monopoly price when δ^F is large. Then, we have

$$\pi^{on,T} \simeq \frac{b^2}{32} < \pi^{on,M}(m) = \frac{b^2}{4}\left[\frac{1+\sigma^M(m)}{2+\sigma^M(m)}\right]^2.$$

Thus bilingualism reduces the production of domestic content.

9.8 Endogenous pricing of content providers

We here determine (a, b) in an endogenous way. Once (a, b) is determined, (a_i, b_i) can be obtained from Table 1.

We assume that for each content, there is a probability λ that a consumer wants to consume it. Consuming a domestic content doesn't preclude consuming another domestic content. Let v represent the value that a given consumer obtains from a unit of content that he or she wants to consume. Let $F(\cdot)$ be its distribution, assumed to be the same for all desired contents. We assume that the hazard rate of $F(\cdot)$ is increasing such that the monopoly price p^m is uniquely defined. Assume that the platform matches consumers with desired contents but a given consumer discovers his/her valuation for a given content and its price only after incurring a search cost c such that $0 < c < E\left[v - p^m | v > p^m\right] \Pr\left[v > p^m\right]$.

If there is mutual substitution with a foreign content, a bilingual consumer consumes at most one unit of either one or another and v is perfectly correlated between the two substitute content units. The bilingual consumer is then matched with any of the two CPs with equal probability and learns v and this CP's price after incurring a costs c. She may then buy it or incur c a second time to learn the other CP's price. We assume "passive

beliefs" meaning that if consumers search some content and find a price they didn't expect, they do not revise their expectation about the other CP's price. Note that if both CPs charge the monopoly price, no consumer has an incentive to engage in the second search.

Then it is well known from Diamond (1971) that there is an equilibrium where all CPs charge p^m. Indeed if this is anticipated by consumers, no CP has an incentive to charge $p > p^m$ since this reduces the profit from those consumers who found its content after the first search. Moreover no CP has an incentive to charge $p < p^m$, because this cannot raise sales given that no consumer engages in the second search.

Hence, we have:

$$a = \lambda \left(E \left[v - p^m | v > p^m \right] \Pr \left[v > p^m \right] - c \right) \quad and \quad b = \lambda p^m \Pr \left[v > p^m \right].$$

9.9 Multihoming of consumers

In the paper, we assumed that consumers single-home. We can show that even if we allow them to multi-home, they have no such incentive. Note that we assume that the fixed cost of making a given content available to platform 1 is perfectly correlated with that of making it available in platform 2. Therefore, it is obvious that in the equilibrium of the monolingual case, no consumer has an incentive to multihome. We below prove that no consumer has an incentive to multihome in the bilingual case either.

Proposition 8 *In any equilibrium, no consumer has an incentive to multihome regardless of whether consumers are bilingual or monolingual.*

Proof. Consider the equilibrium of the bilingual case. Consider first $n_1^B \geq n_2^B$. Then no consumer using platform 1 wants to multihome as all content that he or she can find in platform 2 can be found in platform 1. It can be easily verified that no consumer using platform 2 wants to multihome either. In the equilibrium, the location of the consumer who is indifferent between platform 1 and platform 2 is given by

$$a \left[n_1^B + n^F - 2\delta^F n_1^B \right] - tx = a n_2^B - t(1-x).$$

If this consumer multihomes, he or she obtains $a \left[n_1^B + n^F - 2\delta^F n_1^B \right] - t < a n_2^B - t(1-x)$. As the marginal consumer has no incentive to multihome, no infra-marginal consumer has such incentive either.

Consider now $n_1^B < n_2^B$. In this case, a consumer obtains $a \left[n_2^B + n^F - 2\delta^F n_2^B \right] - t$ by multihoming. Therefore, the consumer who is indifferent between the two platforms has no incentive to multihome if the following condition holds:

$$a \left[n_2^B + n^F - 2\delta^F n_2^B \right] - t < a \left[n_1^B + n^F - 2\delta^F n_1^B \right] - tx$$

which is equivalent to

$$a(1-2\delta^F)(n_2^B - n_1^B) < t(1-x).$$

From Proposition 3(i), we have

$$\begin{aligned} a(1-2\delta^F)(n_2^B - n_1^B) &= abm(1-2\delta^F)\left\{(1-x)\left[1-\frac{1}{2+\sigma^B}\right] - x(1-\delta^F)\left[1-\frac{1}{2+\sigma^B(1-\Gamma)}\right]\right\} \\ &< abm(1-2\delta^F)(1-x)\left[1-\frac{1}{2+\sigma^B}\right] \\ &< t(1-x) \end{aligned}$$

where the last inequality comes from Assumption 2. ■

9.10 Figures

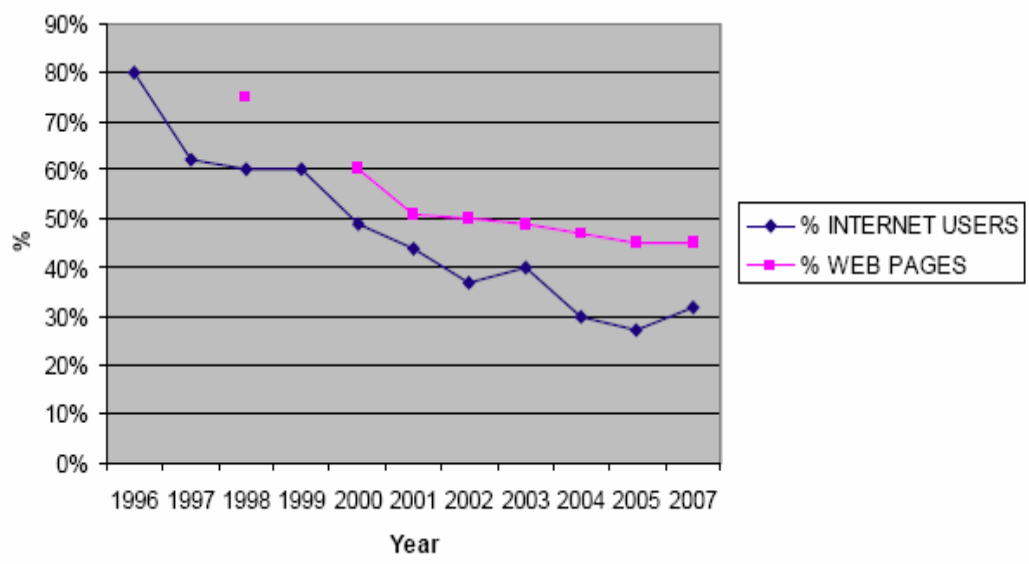


Figure 1. Evolution of percentages of English speaking Internet users and web pages (Pimienta, Prado and Blanco, 2009)

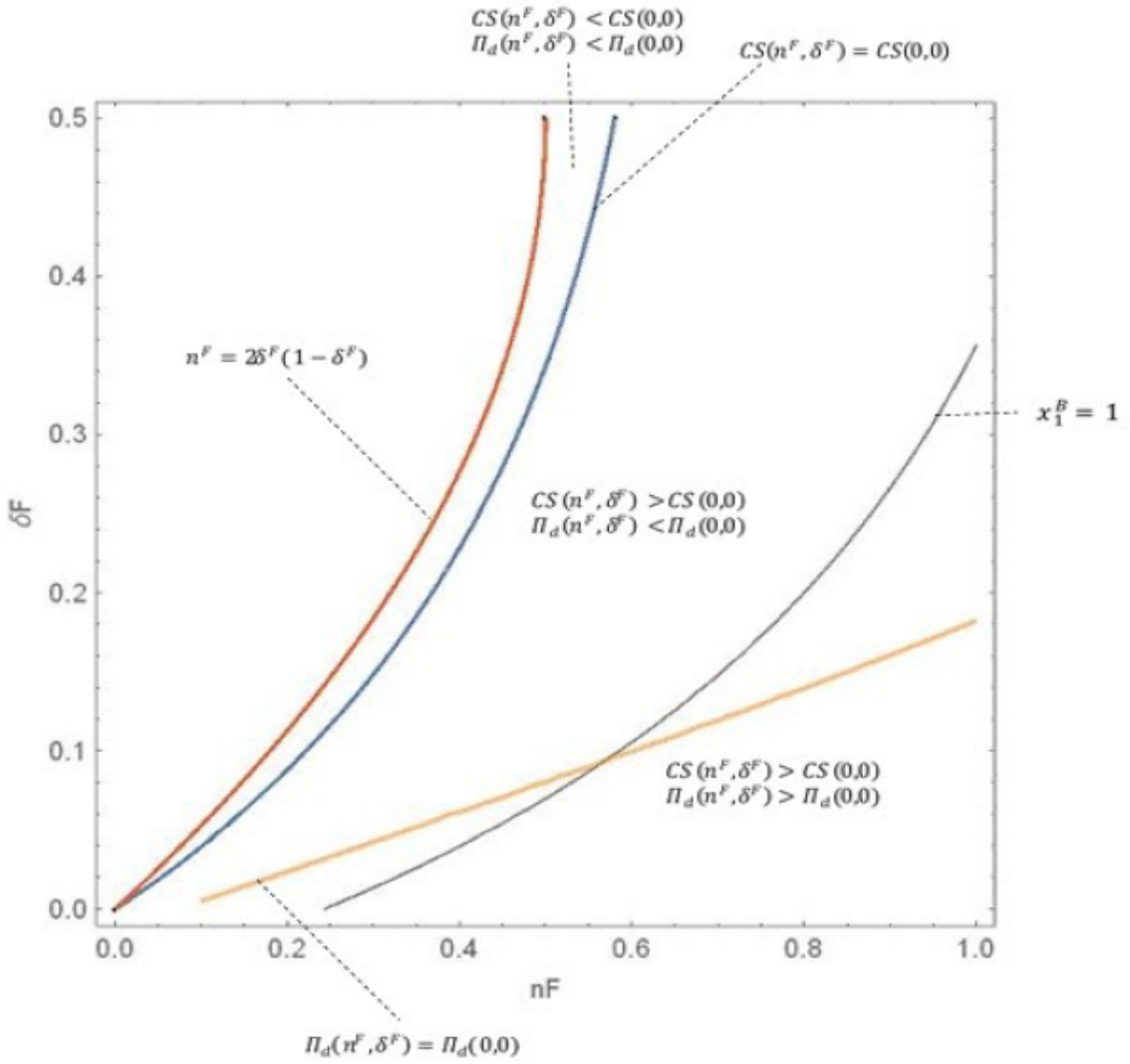


Figure 2. Contour of $CS(n^F, \delta^F) = CS(0,0)$ and $\Pi_d(n^F, \delta^F) = \Pi_d(0,0)$

10 Online appendix (not for publication): extensions

In the online appendix, we provide three extensions which show the robustness of our results. The most interesting among them is the first extension, which considers an alternative platform business model where each platform pays for content and charges consumers for the access to that content. The second extension considers the scenario in which the platforms charge access fees to both sides. The last considers the case in which the platforms can charge transaction fees.

10.1 Buy and resell

In this subsection, we consider an alternative platform business model in which each platform pays for content and charges consumers for the access to that content. There is no payment from consumers to CPs (i.e., $b = 0$). As the setting with only monolingual consumers is a special case of the setting with bilingual consumers where $\left(n^F, \delta^F\right) = (0, 0)$, we focus on the setting with bilingual consumers. Let P_i denote the payment from platform i to a domestic CP who makes its content available on the platform. We modify Assumption A1 as follows:

Assumption A1': $1/2 > \delta^F$, $n^F > 2\delta^F(1-\delta^F)am$.

The first part of A1' follows from the same assumption in A1. To explain the second part, suppose that platform 1 has cornered the consumer market share and chooses $P_1 = (1-\delta^F)a$ (i.e., it pays back to domestic CPs all the consumer surplus that they generate). This generates an upper bound of the number of CPs on board at platform 1, which is equal to $(1-\delta^F)am$. The second part of A1' ensures that the condition $n^F > 2\delta^F n_1$ holds at this upper bound.

We consider the following game:

- Stage 1: Each platform i for $i = 1, 2$ simultaneously chooses the price to domestic CPs for their content P_i and the access fee for consumers A_i
- Stage 2: After observing these prices, domestic CPs make decisions to subscribe to platform 1 and/or platform 2.
- Stage 3: After observing (n_1, n_2), each consumer decides which platform to use.

At Stage 3, given the supply of content (n_1, n_2) and the prices (A_1, A_2), platform 1's market share is determined by

$$x_1 = \frac{1}{2} + \frac{a(n_1 + n^F - 2\delta^F n_1 - n_2) - (A_1 - A_2)}{2t} \tag{21}$$

At Stage 2, the measure of home language content available on platform i is given by

$$n_i = mP_i.$$

Platform i's profit is

$$\Pi_i = A_i x_i - m\left(P_i\right)^2.$$

At a shared equilibrium, from the first-order conditions, we find

$$A_i^B = 2tx_i^B,\ P_1^B = \frac{a(1-2\delta^F)}{2}x_1^B,\ P_2^B = \frac{a}{2}\left(1-x_1^B\right); \tag{22}$$

$$x_1^B = \frac{1}{2} + \frac{2an^F - \frac{a^2m}{2}\left[1-(1-2\delta^F)^2\right]}{12t - a^2m\left[1+(1-2\delta^F)^2\right]}, \tag{23}$$

where we assume $12t > a^2m\left[1+(1-2\delta^F)^2\right]$, which ensures the existence of the equilibrium.[41] Under Assumption A1', we find $x_1^B > 1/2$, which is similar to the result in Proposition 4.[42]

In the monolingual case, it follows from (22) and (23) that there is a symmetric equilibrium where each platform chooses prices

$$A^M = t,\quad P^M = \frac{a}{4}.$$

Let us compare the monolingual case with the bilingual case when the latter leads to the shared equilibrium (including the limit of $x_1^B = 1$). The amount of home language content available on each platform is then

$$\begin{aligned} n^M &= n_1^M = n_2^M = m\frac{a}{4}; \\ n_1^B &= m\frac{a(1-2\delta^F)}{2}x_1^B,\ n_2^B = m\frac{a}{2}x_2^B, \end{aligned}$$

where $n_1^B > n_2^B$ for $x_1^B > \frac{1}{2(1-\delta^F)}$. We have $n^M > n_2^B$ from $x_1^B > 1/2$. $n^M > n_1^B$ holds if and only if the market does not become too concentrated in the bilingual case, i.e., $x_1^B < \frac{1}{2(1-2\delta^F)}$. Therefore when δ^F is small, bilingualism can increase the amount of domestic content available at the foreign platform, while it reduces it when δ^F is large, in particular when $\delta^F > 1/4$ (in which case $\frac{1}{2(1-2\delta^F)} > 1$).

Consumer surplus in the monolingual case is

$$CS^M = \frac{ma^2}{4} - \frac{5}{4}t.$$

Consumer surplus in the bilingual case is

$$\begin{aligned} CS^B &= an^F x_1^B - \left[1-(1-2\delta^F)^2\right]\left(x_1^B\right)^2\frac{a^2m}{2} \\ &\quad + \left[\left(x_1^B\right)^2 + (1-x_1^B)^2\right]\left(\frac{a^2m}{2} - \frac{5}{2}t\right). \end{aligned}$$

[41] A market sharing equilibrium exists if n^F satisfies the condition $an^F < 3t - \frac{a^2m}{2}(1-2\delta^F)^2$.

[42] Note that the foreign platform benefits from bilingualism only if $\left(2t - m\frac{a^2(1-2\delta^F)^2}{4}\right)\left(x_1^B\right)^2 > \left(2t - m\frac{a^2}{4}\right)\frac{1}{4}$, a necessary condition for the platform to offer foreign content. This holds for any $x_1^B \geq 1/2$.

Notice that the last term in CS^B is larger than CS^M. Hence we find that $CS^B > CS^M$ when δ^F is small. In this case, under bilingualism, access to foreign content combines with larger supply of domestic content on the foreign platform to raise consumer surplus.

As δ^F increases, the foreign platform reduces its supply of domestic content due to lower profitability. Combined with the price adjustment and the lower value at platform 2, this may reduce consumer surplus. For the case where δ^F is close to 1/2, domestic content is substituted by foreign content and, using condition (23), we find that the consumer surplus is lower under bilingualism if

$$2x_1^B + 5 < \frac{a^2 m}{t},$$

where the left hand side increases with $x_1^B \in (0.5, 1]$ from 6 to 7. This condition is compatible with our condition $12 > a^2 m/t$. Thus the consumer surplus decreases with bilingualism when there is little platform differentiation or when the value of content is large.

In summary, in the alternative business model where platforms generate revenue only through consumer access fees to content, we find that as foreign language content crowds out home language content, bilingualism can reduce home language content available on the Internet and can even reduce consumer surplus. Reduction in consumer surplus is more likely when the platforms are less differentiated and consumers enjoy greater benefit from content. These conclusions are consistent with the results we obtained in the baseline model in which the consumer access fee is zero and the platforms generate revenue by charging access fees to CPs.

10.2 When platforms charge access fees to both sides

We here provide the analysis for the case in which the platforms charge access fees to both sides. In addition to charging F_i to the CP side, platform i charges an access fee A_i to the consumer side. After describing the shared equilibrium for the bilingual case (as the monolingual case is a particular case of the bilingual case) without any restriction on the fees, we also consider the case when there is non-negativity constraint on A_i and derive the condition under which no platform has an incentive to deviate from the equilibrium described in Section 3 and Section 4 by charging a strictly positive fee to consumers.

We consider the following game:

- Stage 1: Each platform i for $i = 1, 2$ simultaneously chooses the access fee for domestic CPs F_i and the access fee for consumers A_i
- Stage 2: After observing (F_1, F_2, A_1, A_2), domestic CPs make decisions to subscribe to platform 1 and/or platform 2.

- Stage 3: After observing (n_1, n_2), each consumer decides which platform to use.

At Stage 3, the location of the indifferent consumer is given by

$$x_1 = \frac{1}{2} + \frac{a\left(n^F + n_1 - 2\delta^F n_1 - n_2\right) - (A_1 - A_2)}{2t}.$$

At Stage 2, the measure of CPs in each platform is given by

$$\begin{aligned} bx_1(1-\delta^F) - F_1 &= n_1/m; \\ bx_2 - F_2 &= n_2/m. \end{aligned}$$

Combining the three equations leads to

$$x_1 = \frac{1}{2} + \frac{\sigma^B}{b}\left[-(1-2\delta^F)F_1 + F_2 + \frac{n^F}{m} - \frac{\Gamma b}{2}\right] - \frac{\sigma^B}{abm}(A_1 - A_2).$$

Each platform's profit is

$$\begin{aligned} \Pi_1 &= F_1 n_1 + A_1 x_1 = F_1 m(bx_1(1-\delta^F) - F_1) + A_1 x_1; \\ \Pi_2 &= F_2 n_2 + A_2 x_2 = F_2 m(bx_2 - F_2) + A_2 x_2. \end{aligned}$$

From the FOCs, we can characterize the shared equilibrium as follows:

$$\begin{aligned} F_1^B &= \frac{b(1-\delta^F) - a(1-2\delta^F)}{2} x_1^B; \\ F_2^B &= \frac{b-a}{2} x_2^B; \\ A_1^B &= bm\left[\frac{a x_1^B}{\sigma^B} - F_1^B(1-\delta^F)\right]; \\ A_2^B &= bm\left[\frac{a x_2^B}{\sigma^B} - F_2^B\right] \\ x_1^B &= \frac{1}{2} + \frac{\frac{\sigma^B}{4ab}\left\{\left[b(1-\delta^F) - a(1-2\delta^F)\right]^2 - (b-a)^2 + \frac{4an^F}{m} - 2\Gamma ab\right\}}{3 - \frac{\sigma^B}{2ab}\left\{\left[b(1-\delta^F) - a(1-2\delta^F)\right]^2 + (b-a)^2\right\}}. \end{aligned}$$

In the monolingual case of $\gamma = n^F = 0$, we have:

$$x^M = x_i^M = \frac{1}{2}, F^B = F_i^B = \frac{b-a}{4}, A^B = A_i^B = bm\left[\frac{a}{2\sigma^M} - \frac{b-a}{4}\right] \text{ for } i = 1, 2.$$

We can also find the condition under which each platform finds $A_i \leq 0$ optimal. This means that if there is non-negativity constraint in consumer pricing, each platform finds $A_i = 0$ optimal, providing a rationale for our baseline model.

Consider an interior equilibrium of the bilingual case described in Proposition 3 and we study whether platform i has an incentive to deviate by charging $A_i > 0$. The first-order derivative of platform 1's profit with respect to A_1 at $A_1 = 0$ is given by

$$x_1^B - F_1^B mb(1-\delta^F)\frac{\sigma^B}{abm},$$

which is negative if

$$\frac{a}{b} < \frac{(1-\delta^F)^2\sigma^B}{2+\sigma^B(1-\Gamma)}.$$

Similarly, platform 2 has no such incentive if

$$\frac{a}{b} < \frac{\sigma^B}{2+\sigma^B}.$$

In the monolingual case, the condition is

$$\frac{a}{b} < \frac{\sigma^M}{2+\sigma^M}.$$

10.3 Transaction fees

We can extend our baseline model by introducing transaction fees in addition to subscription fees. Each platform i offers a tariff (F_i, p_i) on the CP side where F_i is a fixed subscription fee and p_i is a transaction fee. It is well-known from Armstrong (2006) that when platforms compete in two-part tariffs, there is a continuum of equilibria. This result still holds in our setting since a platform's best response depends only on the measure of CPs subscribing to its service but each platform has two instruments to induce subscription of a given measure of CPs. More precisely, given (F_j, p_j), there is a continuum of (F_i, p_i) that allows platform i to attract a given measure of CPs n_i and any such (F_i, p_i) generates the same profit to platform i.[43] However, different transaction fees (p_1, p_2) generate different level of platform competition and hence different equilibrium profits. For any $(p_1, p_2) \in [0, b]^2$, a reduction in p_i for $i = 1$ or 2 increases the multiplier of our two-sided market and hence intensifies competition. Therefore, the case of zero transaction fee that we previously analyzed is a polar case in which the platform competition is the strongest. We below study the other polar case of $p_1 = p_2 = b$ in which the platform competition is

[43] Let's consider the monolingual case and assume that the fixed cost of the marginal CP for platform i is c (i.e., $cm = n_i$). (The similar logic applies to the bilingual case as well.) For the marginal CP, the binding participation constraint means $c + F_i = (b - p_i)x_i(n_i)$. Therefore, the platform's profit is $[F_i + p_i x_i(n_i)] * n_i = [bx_i(cm) - c]\, cm$. Hence, the platform can use any combination of (F_i, p_i) satisfying $c + F_i = (b - p_i)x_i(n_i)$ and obtain the same profit.

the weakest and show that all of the previous results, except for the competition-softening effect of Proposition 2, obtain in this case as well. However, we conjecture that all of the previous results in the baseline model including the competition-softening effect should be obtained for any $(p_1, p_2) \in [0, b)^2$ and provide an argument for why $p_1 = p_2 = b$ is unlikely to be observed.

When platform i offers a tariff of $(F_i, p_i = b)$, the number of CPs subscribing to platform i uniquely depends on F_i and does not depend either on the rival platform's tariff or on each platform's consumer market share. In this sense, $(F_i, p_i = b)$ corresponds to the insulating tariff of White and Weyl (2013). (See White and Weyl (2013) for the analysis of platform competition in which each platform offers insulating tariffs to both sides.) In what follows, we assume for simplicity that the foreign platform charges zero fee for the transactions between domestic consumers and foreign CPs.

Since the monolingual case can be obtained from the bilingual case by setting $n^F = \delta^F = 0$, we study only the bilingual case. In what follows, we use '*tilda*' to represent the case of two-part tariff competition with $p_1 = p_2 = b$. When $p_1 = p_2 = b$, the measure of CPs subscribing to platform i is given by

$$n_i = -mF_i \text{ for } i = 1, 2. \tag{24}$$

Since each platform captures all CPs' surplus from transactions, F_i becomes a subscription subsidy and takes a negative sign. Inserting (24) into the condition for the location of the consumer indifferent between the two platforms (1) gives

$$x_1^B = \frac{1}{2} + \frac{am}{2t}(-F_1(1 - 2\delta^F) + \frac{n^F}{m} + F_2). \tag{25}$$

Since CPs' subscription decisions do not depend on consumer subscription decisions, the latter has no impact on the former. Hence, in contrast to the corresponding formula without transaction fee (8), there is no multiplier in (25) either in the monolingual case or in the bilingual one. Hence, bilingualism has no effect on the degree of platform competition.

Platform 2 maximizes $(F_2 + bx_2)\, n_2$ and from the first order condition we obtain

$$-\widetilde{F}_2 = \frac{\widetilde{x}_2 b}{2 - \frac{abm}{2t}}. \tag{26}$$

Platform 1 maximizes $\left(F_1 + x_1 b(1 - \delta^F)\right) n_1$ and from the first order condition we obtain

$$-\widetilde{F}_1 = \frac{\widetilde{x}_1 b(1 - \delta^F)}{2 - \frac{abm}{2t}(1 - \Gamma)}. \tag{27}$$

By inserting (26) and (27) into (25), we obtain the equilibrium market share of Platform 1

$$\widetilde{x}_1^B = \frac{1}{2} + \frac{\frac{abm}{4t}\left[\frac{(1-\Gamma)}{2-\frac{abm}{2t}(1-\Gamma)} + \frac{2n^F}{bm} - \frac{1}{2-\frac{abm}{2t}}\right]}{1 - \frac{abm}{2t}\left[\frac{(1-\Gamma)}{2-\frac{abm}{2t}(1-\Gamma)} + \frac{1}{2-\frac{abm}{2t}}\right]}, \tag{28}$$

which increases with n^F. The shared equilibrium exists (i.e., $x_1^B \leq 1$) if and if only the following condition holds:

$$n^F \leq bm\left[\frac{t}{abm} - \frac{(1-\Gamma)}{2-\frac{abm}{2t}(1-\Gamma)}\right] \equiv \widetilde{\underline{n}}^F. \tag{29}$$

Now we study the cornering (i.e., tipping) equilibrium in which platform 1 captures all consumers and charges a monopoly price on the CP side. Then, platform 1 maximizes $\left(F_1 + b(1-\delta^F)\right) n_1$ and from the first order condition, we obtain

$$-\widetilde{F}_1^T = \frac{b(1-\delta^F)}{2}. \tag{30}$$

This implies that the measure of domestic CPs is equal to

$$\widetilde{n}_1^T = \frac{mb(1-\delta^F)}{2}, \tag{31}$$

which is the same as in the case of no transaction fee. This cornering equilibrium exists if platform 2 cannot attract any consumer without making a loss on the CP side. This occurs exactly when the following condition holds:

$$n^F > \widetilde{\overline{n}}^F \equiv \frac{1}{2a}\left[2t - amb(1-\Gamma)\right].$$

Therefore, we obtain a result similar to Proposition 3.[44]

From (28), bilingualism increases the foreign platform's consumer market share if and only if the following condition holds.

$$\frac{(1-\Gamma)}{2-\frac{abm}{2t}(1-\Gamma)} + \frac{2n^F}{bm} > \frac{1}{2-\frac{abm}{2t}}, \tag{32}$$

[44]To obtain $n^F > \widetilde{\overline{n}}^F$, we can proceed as follows. Given platform 1's strategy, compute the highest profit that platform 2 can achieve by choosing a consumer marker share of $1-x$. Then, we should find a condition that makes this profit (weakly) negative for any $x \in [0,1]$. It turns out that it is sufficient that platform 2's profit is negative at $x = 1$, which gives $n^F > \widetilde{\overline{n}}^F$. Note also that $\widetilde{\overline{n}}^F$ is different from $\overline{n}^F$ since platform 1's strategy is not the same in both cases.

which is equivalent to

$$n^F > \frac{bm}{2}\left[\frac{1}{2-\frac{abm}{2t}} - \frac{(1-\Gamma)}{2-\frac{abm}{2t}(1-\Gamma)}\right] \equiv \widetilde{n}_1^F. \tag{33}$$

Under Assumption A1, we can show that the above inequality holds. Hence, bilingualism increases the foreign platform's consumer market share as in Proposition 4.

As bilingualism reduces the market share of the domestic platform, it reduces home language content available through the domestic platform. In an interior equilibrium, bilingualism increases home language content available in the foreign platform if

$$x_1^B > \frac{1}{2(1-\delta^F)}\frac{2-\frac{abm}{2t}(1-\Gamma)}{2-\frac{abm}{2t}}.$$

Therefore, if $\delta^F = 0$, bilingualism increases the home language content available in platform 1. If δ^F is close to 1/2, the R.H.S. of the above inequality is larger than one and hence bilingualism reduces the home language content available in platform 1. In the case of the tipping equilibrium with the monopoly price, we find that bilingualism reduces the amount of home language content if the following condition holds

$$\delta^F > \frac{2t-abm}{4t-abm}. \tag{34}$$

This condition is similar to (14) and hence we obtain a result similar to Proposition 5(ii).

Finally, we perform welfare comparison. We first note that the welfare normalization result in Section 5.2 is still valid in the case of competition with two-part tariff. Consider first $\delta^F = 0$. In the interior equilibrium, bilingualism improves the offer of platform 1 without affecting the intensity of platform competition. Hence, it increases consumer surplus for the same reasons explained in Section 5.2. Similarly, it increases the surplus of domestic CPs but decreases the surplus of the domestic platform. Hence, the analysis of the interior equilibrium for $\delta^F = 0$ is qualitatively the same as the one in the case of no transaction fee in Section 5.2.

Under market sharing and $\delta^F = 1/2$, we have from the proof of Proposition 6

$$\begin{aligned} CS(n^F, \delta^F) - CS(0,0) &\equiv t\left(\left(x_1^B\right)^2 - \frac{1}{4}\right) + n_2^B - n^M \\ &= t\left(\left(x_1^B\right)^2 - \frac{1}{4}\right) + \left(1 - x_1^B\right)\left(\frac{2t}{4t-1}\right) - \frac{1}{2}\left(\frac{2t}{4t-1}\right). \end{aligned}$$

At $x_1^B = 1$, $CS(n^F, \delta^F) - CS(0,0) = t3/4 - t/(4t-1)$ which is strictly positive as $t > 1$. Hence for n^F large enough, bilingualism increases consumer surplus.

Concerning domestic CPs' surplus, the change in the market sharing and $\delta^F = 1/2$ is

$$\frac{1}{2}\left(\frac{\frac{x_1^B}{2}}{2}\right)^2 - \frac{1}{2}\left(\frac{\frac{1}{2}}{2-\frac{1}{2t}}\right)^2 + \frac{1}{2}\left(\frac{(1-x_1^B)}{2-\frac{1}{2t}}\right)^2 - \frac{1}{2}\left(\frac{\frac{1}{2}}{2-\frac{1}{2t}}\right)^2,$$

which is negative for any $x_1^B \in (1/2, 1]$. As the bilingualism reduces the profit of the domestic platform, it reduces the producer surplus.

In the case of the tipping equilibrium with monopoly price, we get a result similar to Proposition 6(iii): it can be easily verified that bilingualism always increases consumer surplus (no matter the value of δ^F) and that it reduces the surplus of domestic CPs if the following condition holds:

$$\delta^F > 1 - \sqrt{2}\frac{2t}{4t-1}.$$

Therefore, we find that most of the results we obtained in the baseline model without transaction fee remain valid in the case of two-part tariff competition with the maximal transaction fee $p_1 = p_2 = b$. The only important result which does not hold when $p_1 = p_2 = b$ is the competition-softening effect of bilingualism. However, this effect will exist for any $p_1 = p_2 \in [0, b)$. In addition, we think that the outcome with $p_1 = p_2 = b$ is very unlikely to arise.[45] When $p_1 = p_2 = b$, the unique source of revenue for a CP is the entry subsidy from the platforms. For instance, suppose now that there are some CPs whose content is totally uninteresting to consumers who, as a result, do not spend time with this content. If, in addition, these CPs have low entry costs, then the high entry subsidy combined with $p_1 = p_2 = b$ will attract such CPs with totally uninteresting content who will not pay b since no transaction occurs.

[45] For instance, in the case of Amazon, the transaction fee consists of referral fee and closing fee. The upper bound of the referral fee is 15% of the price of the item sold and the closing fee is typically $1.35. See http://www.amazon.com/gp/help/customer/display.html?ie=UTF8&nodeId=1161240.