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 the amount 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. On the one hand, bilingualism has the benefit of increasing cross-side network externalities by increasing consumer concentration on the foreign platform, which increases the amount of home language content. On the other hand, bilingualism exposes home language content to competition from foreign language content and softens platform competition, which reduces the amount of home language content. We find that bilingualism mostly increases consumer surplus but can reduce domestic producer surplus. The welfare effect of taxing the foreign platform is also analyzed.

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, the dominance of English content in the Internet continues to prevail: according to Web Technology Surveys, English is used by 59.4% 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 amount of home language content 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 amount 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 April 3,2020.

[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.

To further motivate the research questions raised in this paper and to provide an empirical illustration of the real-world context in which our theory framework is likely to be relevant, we analyze the quantitative relationship between the market share of English language content-distribution platforms and the English language proficiency of country populations around the world. More specifically, in this illustration, we rely on the monthly app engagement data (numbers of app downloads and active app users) generated by *Google Play Store* for Android-compatible e-reader platforms in 29 countries where English is not a native language of the majority of people. The data set is provided by a web analytics company called *SimilarWeb*. In the Appendix, we summarize the data set and discuss its limitations and a number of assumptions we had to make in this empirical illustration.

An e-reader platform is an Android app[6] which gives users both free and paid access to a variety of e-book titles to read on Android devices (such as a smartphone or a tablet computer).[7] There are three major e-reader platforms of the English-language origin which

[4]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]Certainly, there is also a large variety of e-reader apps designed for Apple iOS (iPhones and iPads) and Windows operating system devices, but SimilarWeb does not provide public access to world-wide user engagement data for Apple- and Windows-compatible apps and limits such access only to the U.S. data. However, if the U.S. data is any indication, the shares of the leading e-reader apps (in terms of downloads and active users) on Android devices is very similar to their shares on Apple and Windows devices. See https://www.similarweb.com/.

[7]Most of e-books these days are read on tablets and smartphones (iPhones, iPads, as well as

are not tied with the Android operating system and have affiliated on-line bookstores offering both English and non-English e-book titles: *Amazon Kindle*, *Rakuten Kobo Books* and *Scribd*. 24 of the 29 countries in the SimilarWeb's data set have at least one well-known domestic e-reader platform, which provides access to both free and paid titles in the domestic language.

To measure English language proficiency, we rely on the English Proficiency Index (EPI) provided by a global language training company EF Education First (see EF Education First, 2019). The EPI is based on the annual comprehensive English test data collected from non-native English speakers in 100 countries.

Consider bivariate correlation between the EPI and the individual market share of *Kindle* as well as the combined market share of *Kindle*, *Kobo* and *Scribd* (*KKS*), as shown in Table 1. Although not all of these relationships are statistically significant, their signs suggest that the foreign platform's market share increases with the proportion of bilingual consumers.[8]

Table 1: Correlations between the English Proficiency Index and English-language e-reader platforms' market shares in 28 countries.[9]

	Correlation	p value
Amazon Kindle's download share	0.182	0.173
KKS combined download share	0.263*	0.083
Amazon Kindle's active user share	0.287*	0.069
KKS active user share	0.361**	0.029

The table shows Pearson correlation coefficients (r).
*Significant at 0.1; ** Significant at 0.05.

Scatter plots in Figures 2-5 also provide some suggestive evidence of positive relationships between the English language proficiency (as measured by the EPI) and the download

Android or Windows based devices). Specialized e-reading devices (i.e., devices which are neither phones nor tablet computers and can serve only for reading e-books) are used by only about 7% of active e-books consumers and that share has recently been steadily declining. See https://www.statista.com/statistics/326906/worldwide-unit-sales-ereaders/

[8] We also examined correlations between the EPI and app download and active user shares of the leading native-language e-reader platforms of domestic origin and found that these correlations have negative (albeit insignificant) signs.

[9] SimilarWeb provides access (through a demo platform) to the e-reader app engagement data for 29 countries. But in our estimation of correlations between the EPI and English-language e-reader platforms' market shares, we excluded from that set the data on Japan as we view it as an outlier among countries with low English language proficiency. See more on this in the Appendix.

and active user market shares of *Kindle* and *KKS* even in the data set which includes the outlier country Japan.

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 a consumer of the home country is bilingual, she can consume foreign- as well as home-language 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.

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. In particular, we address the following questions. Does bilingualism increase the foreign platform's market share in the home country? Does bilingualism make platform competition fiercer? How does bilingualism affect the amount of home language content and the domestic welfare? 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 to domestic consumers only access to home country's domestic content while the foreign one gives them access to both domestic and foreign content.[10] 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 are monolingual. However, the difference creates an advantage for the foreign platform when some or all consumers are bilingual. At the same time, the foreign platform has a certain disadvantage because we assume that from the perspective of the bilingual consumers some offerings of the foreign country CPs may serve as direct substitutes for the offerings of the domestic country CPs. In other words, when consumers are bilingual, our assumptions imply that if the platforms have the same mass of

[10] 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 that the foreign platform has an advantage in providing access to foreign content. One way to capture this comparative advantage is illustrated below in this paper (see footnote 25 in subsection 2.2).

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 bilingual consumer prefers the foreign platform to the domestic platform. The platforms do not charge any price to consumers but charge subscription fees to CPs. In addition, we assume that consumers single-home (i.e., use only one platform) while CPs multi-home (i.e., may subscribe to one or two platforms).

In the paper, we analyze the case in which all consumers are bilingual and compare it with what happens when all consumers are monolingual. Our first result is that bilingualism increases the foreign platform's consumer market share. Although this result is expected, it is not trivial because of opposing effects. Having foreign content on board helps the foreign platform to attract bilingual consumers. However, as 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.[11]

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 a 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. This multiplier effect increases with each platform's efficiency in matching CPs with consumers. Therefore, when a platform becomes more efficient, the CPs' demand for platforms' matching services becomes more elastic and consequently platform competition becomes stronger. By contrast, platform competition becomes weaker when a 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. This reduction of the expected interaction surplus for each side has a similar effect on competition for domestic content as the reduction of matching efficiency of the foreign platform. Hence, it softens platform competition for the

[11] In our empirical illustration with the case of e-readers, some countries have no domestic platform allowing consumers to have access to e-books, which means that entire domestic demand is served by foreign platforms.

reasons explained above.

Combining the above two results generates nuanced predictions regarding the impact of bilingualism on the amount of home language content. 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 content can increase the amount of home language content per consumer as it increases consumer concentration in the foreign platform and thereby strengthens the cross-side network externalities. On the negative side, content substitution, together with the result that bilingualism softens platform competition, can lead to a reduction in the amount of home language content on the foreign platform. For instance, we find that due to the competition-softening effect, bilingualism always reduces the total mass of domestic content available in either platform.

We show that in general, the welfare effect of bilingualism depends on the weight of consumer surplus relative to domestic producer surplus (which includes domestic CPs' surplus and the domestic platform's profit). The difference between consumer surplus and domestic producer surplus can arise because consumers directly benefit from foreign content while domestic CPs may suffer from it because of substitution between domestic and foreign content. In addition, the profit of the domestic platform is always lower in the bilingual case than in the monolingual case. We find that bilingualism typically increases consumer surplus but reduces domestic producer surplus in the case of strong content substitution. In the latter case, bilingualism leads to lower domestic welfare if the relative weight of domestic producer surplus is large.

Finally, in light of the current debate about the taxation of large (mostly US based) platforms in OECD countries, we study the effect of a policy imposing a constant per-CP tax on the foreign platform. We find that taxing the foreign platform in general harms consumers and that a small tax reduces the total producer surplus. However, under certain conditions, a small tax can raise domestic welfare. For instance, when there is strong substitution between foreign content and domestic content, a small tax has almost no impact on consumer surplus but the tax revenue is larger than the loss in producer surplus. When we consider a large tax which significantly increases the market share of the domestic platform, we find that there is a trade-off between smaller consumer surplus and larger producer surplus. Hence, a large tax raises domestic welfare if the relative weight of producer surplus is large and the tax increases substantially the domestic platform's market share.

The paper is organized as follows. Section 1.1 reviews the related literature. Section 2 presents our baseline model. Section 3 analyzes the monolingual case and Section 4 analyzes

the bilingual case and compares it with the monolingual case in terms of the amount of domestic content. Section 5 performs welfare analysis and Section 6 analyzes taxing the foreign platform. Section 7 concludes. The Appendix gathers some proofs and extensions. The online appendix contains analysis of the mixed case in which bilingual consumers and monolingual consumers coexist.

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).[12] 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.[13]

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.[14] 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

[12] 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).

[13] 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.

[14] 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).

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 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.[15] 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).[16]

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, Lendl et al., 2012, and Martens and Turlea, 2012). 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.

While there is a substantial empirical literature studying online international trade, we are aware of only a few recent papers that consider formal models for analyzing the cross-border distribution of cultural goods, including audio and visual artwork and programming by means of radio, TV broadcasting and the Internet streaming. 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]

[15] 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.

[16] A somewhat broader literature emphasizes the importance of ethnic and linguistic commonalities between countries for facilitating their international trade (see Melitz, 2008, and Melitz and Toubal, 2014.) See Egger and Lassmann (2012) for a meta-analysis of the common language effect on trade.

[17] More generally, trade in cultural goods was analyzed in Francois and van Ypersele (2002), Bala and Long (2005), Janeba (2007), Olivier et al. (2008), Rauch and Trindade (2009), Disdier et al. (2010 a, b), Hanson and Xiang (2011), Ferreira and Waldfogel (2013), Maystre et al. (2014), and Hellmanzik and Schmitz (2015).

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.[18] Platform 1 is assumed to be foreign and has both domestic and foreign content while platform 2 is domestic and has only domestic content.[19] Let $\alpha \in [0, 1]$ be the proportion of bilingual consumers in the home country. The case of $\alpha = 0$ is called the monolingual case, that of $\alpha = 1$ the bilingual one and that of $\alpha \in (0, 1)$ the mixed one. We focus on the monolingual and the bilingual cases; the mixed case is analyzed in the online Appendix.[20]

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

[18] By ignoring the domestic market in the foreign country we focus on one of the two national markets. Thus, our paper is a first step toward studying a fully reciprocal model of international trade in content mediated by 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.

[19] Our analysis can also be extended to the case in which both platforms have domestic and foreign content but differ in their coverage of foreign language content. See footnote 25.

[20] In an interior equilibrium of the mixed case without substitution between foreign language and home language content, as α increases, the foreign platform's market share increases not only among bilingual consumers but also among monolingual consumers. Its share among monolingual consumers increases due to the indirect network effect: the increase in the proportion of bilingual consumers induces more domestic CPs to join the foreign platform, which, in turn, allows it to attract even more monolingual consumers. Therefore, as α increases, the amount of domestic content increases in the foreign platform while it decreases by the same amount in the domestic platform. However, the overall amount of domestic content available *per consumer* increases with α because of the two-sided externality between consumers and CPs. For this reason, we find that both the domestic consumer surplus and the domestic CPs' surplus increase with α and that the increase in CPs' surplus dominates the reduction in the domestic platform's profit if the amount of foreign content is large enough. In this case, a proactive policy promoting bilingualism is beneficial to consumers and domestic producers.

made available on a platform.[21] For any given pair of a consumer and a domestic CP that are active on platform i, we assume that the interaction between them generates a surplus of $a_i > 0$ to the consumer and a surplus of $b_i > 0$ to the CP. 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 platform i.

We view a_i as the increase in expected surplus per consumer 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. b_i is the expected profit of a domestic 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.

Following Armstrong (2006), we consider horizontally-differentiated platforms and assume that consumers are uniformly distributed on the Hotelling interval between zero and one. We assume that a consumer's location on the Hotelling line is independently distributed of the consumer's language skill. 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 values 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, that is they subscribe to only one platform.

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 in addition to charges per item sold (such as referral and closing fees).[22] In Jeon, Jullien and Klimenko (2018), we consider various alternative business models and show the robustness of our results to different assumptions about platforms' pricing structures.

CPs multi-home as long as this gives them a higher profit 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.[23] We assume that the highest cost/benefit ratio is large enough that there are

[21] Jeon, Jullien and Klimenko (2018) provides an extension of this model, in which the amount of home language content is endogenous.

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

[23] 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

always CPs who decide not to join any platform, which holds if b_i is not too large.[24]

Platform i chooses F_i to maximize its profit $\pi_i = F_i n_i$, where n_i is the mass of domestic CPs on platform i. 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

Monolingual 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 with respect to monolingual consumers, both platforms are equally efficient: 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 bilingual consumers. Given that platform 2 offers only home language content, the utility parameters are unchanged for this platform: $(u_2, a_2, b_2) = (u, a, b)$ regardless of whether consumers are bilingual or monolingual.

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.[25] We regard 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.[26]

We assume that there is some substitution between foreign language content and home language content for bilingual consumers. More precisely, we assume that among all pairs of home language and foreign language content producers, a fraction 2γ of them propose content which is very similar albeit conveyed in different languages. In that case a bilingual

small platforms even if they are available in the major platforms.

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

[25] 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 $n^f = n_1^f - n_2^f > 0$.

[26] 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.

consumer would interact with only one of the two CPs while a monolingual consumer would interact with the domestic CP.[27] As a consequence given n_1 amount of home language content and n^f amount of foreign language content, the total amount of content consumed by each bilingual consumer of platform 1 is $n_1 + n^f - 2\gamma n_1 n^f$ where $\gamma > 0$ is a parameter of substitution. As the total amount of content should increase in each element of (n_1, n^f), we introduce the following assumption.

Assumption A1: $1/2 > \gamma n^f$, $1 > 2\gamma bm$.

The first part of A1 is simply equivalent to $n_1 > 2\gamma n^f n_1$, which must hold obviously. The second part of A1 ensures that condition $n^f > 2\gamma n^f n_1$ holds in equilibrium. As for n^f, parameter γ should be higher if the home country's socioeconomic and cultural background is similar to that of the foreign country. For instance, if the foreign country is the U.S., we expect a high γ when the home country is located in western Europe or Latin America and a low γ when it is located in Asia.

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.[28] Therefore, among the total of $n_1 + n^f - 2\gamma n_1 n^f$ interactions mediated by platform 1, there are $n_1 - \gamma n_1 n^f$ in the home language and $n^f - \gamma n_1 n^f$ in the foreign language.

Given the values a and b per interaction, a bilingual consumer's total utility on platform 1 is $u + a(n_1 + n^f - 2\gamma n_1 n^f)$ and a domestic CP's surplus per consumer on platform 1 is $b(1 - \gamma n^f)$, 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.[29] For tractability of the model, we assume that neither a_i nor b_i depends on the supply of home language content on platform i.[30] Our model thus abstracts from price competition between domestic content producers that would make transaction surplus

[27] For instance, each consumer searching on the foreign platform may draw at random some content, which satisfies her needs. The search may be assumed to be such that it results with some positive probability in finding substantively the same content available in both domestic and foreign language. When this happens, the fully bilingual consumer may be equally likely to choose any one of the two language offerings of the same content.

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

[29] We should point out here that this representation is valid also if bilingual consumers obtain a utility $u^B \neq u$ at platform 1 provided that we redefine n^f as $\tilde{n}^f = \frac{u^B - u}{a} + n^f$ and adjust the value of γ to $\tilde{\gamma}\tilde{n}^f = \gamma n^f$.

[30] Jeon, Jullien and Klimenko (2018) analyzes a formal search model to show how to derive the values a_i and b_i.

endogenous. However our model can accommodate some form of non-price competition. In particular, substitution of home content by foreign content reduces the values a_i and b_i by a factor proportional to the volume of foreign content available on platform i. In addition, our model can be reinterpreted to accommodate substitution among offerings of home language CPs (see the Appendix).

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	$\left(u + an^f, a\left(1 - 2\gamma n^f\right), b(1 - \gamma n^f)\right)$	(u, a, b)

Hence, in platform 1, bilingualism increases the stand-alone utility by an^f and reduces the indirect network effect by a factor $2\gamma n^f$ for consumers and γn^f for domestic CPs.

From the specification of our model, we obtain the following demand systems. Platform 1's consumer market share in the monolingual case, denoted x_1^M, and the one in the bilingual case, denoted x_1^B, are given as follows:

$$x_1^M = \frac{1}{2} + \frac{a\left(n_1 - n_2\right)}{2t}, \tag{1}$$

$$x_1^B = \frac{1}{2} + \frac{a\left(n_1 + n^f - 2\gamma n_1 n^f - n_2\right)}{2t}, \tag{2}$$

where we use superscript M (B) to denote the monolingual (bilingual) case.

The domestic platform's consumer market share is then $x_2^M = 1 - x_1^M$ and $x_2^B = 1 - x_1^B$ respectively. Given the share α of bilingual consumers, the mass of CPs joining each platform is then

$$n_1 = mb\left[(1-\alpha)x_1^M + \alpha x_1^B(1 - \gamma n^f)\right] - mF_1, \tag{3}$$

$$n_2 = mb\left[(1-\alpha)x_2^M + \alpha x_2^B\right] - mF_2. \tag{4}$$

(2) and (3) show that for given allocation of domestic CPs, the presence of foreign content boosts bilingual consumers' participation to the foreign platform while for given allocation of consumers, it hinders domestic CPs' participation to the foreign platform for any $\alpha > 0$.

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 about each platform's consumer market share to decide whether to pay a fee or not.

3 Monolingual consumers

Consider the case in which all consumers are monolingual (i.e., $\alpha = 0$). 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.

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 $\varepsilon > 0$ (without affecting x_2). Then, from (3), the mass of subscribed CPs increases by $bm\varepsilon$ 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 (from (3)) n_1 by $ab^2(m)^2\varepsilon/2t$ and reduces (from (4)) 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. If it holds, the total increase in x_1 is equal to $[1 + \sigma^M]\varepsilon$ where

$$\sigma^M \equiv \frac{abm}{2t - 2abm} \tag{5}$$

is the positive multiplier in our two-sided market for the monolingual case. Note that an increase in (a, b, m) and a reduction in t strengthen the positive feedback in the two-sided market and thereby increase the multiplier.

In the monolingual case, the consumer market share of platform 1 is given by (1). From (3) and (4), the mass of CPs joining platform i $(= 1, 2)$ is given by

$$n_i^M = m\left(bx_i^M - F_i\right). \tag{6}$$

Using (1) and (6) and expressing x_i as a function of (F_1, F_2) yields

$$x_i^M = \frac{1}{2} - \sigma^M(\frac{F_i - F_j}{b}). \tag{7}$$

Platform i's profit is given by $\pi_i = F_i n_i$. Using (7) into (6), π_i is maximized at a price such that the platform's share in a CP's surplus is given as:

$$\frac{F_i}{bx_i^M} = \frac{1}{2+\sigma^M} \text{ for } i = 1, 2. \tag{8}$$

Condition (8) shows that in any shared equilibrium in which each platform has a positive consumer market share, a platform captures a share of the surplus generated by a CP subscribed to its platform that is constant and the same for both platforms. In particular, as σ^M increases, the platforms' share decreases. Therefore, we can consider σ^M a *measure of platform competition in the monolingual case*. The stronger is competition between the two platforms, the smaller is the share of the surplus captured by the platforms. This measure of platform competition increases with each element in (a, b, m) and decreases in t, which is very intuitive as an increase in (a, b, m) strengthens the positive feedback in the two-sided market.

Finally, from (6) and (8), the mass of CPs joining platform i is given by

$$n_i^M = mbx_i^M \frac{1+\sigma^M}{2+\sigma^M}, \text{ for } i = 1, 2, \tag{9}$$

where bx_i^M represents the total gross surplus that a CP obtains from joining platform i and $\frac{1+\sigma^M}{2+\sigma^M} = 1 - \frac{1}{2+\sigma^M}$ is a CP's share in the surplus.

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 surplus generated by a CP subscribed to its platform is given by

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

(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'. 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 (i.e., $\alpha = 1$) and contrast the bilingual case with the monolingual case. We assume $\gamma n^f > 0$ in order to study how substitution between foreign and home language content affects the market outcome. In the bilingual case, we study both the interior equilibrium where each platform is active and the cornering equilibrium where the foreign platform monopolizes the market.

4.1 Equilibrium of the bilingual case

We here study equilibrium of the bilingual case. We first define a parameter Γ which measures *the reduction in the efficiency of the exchanges in the home language within platform 1* due to the substitution between home language content and foreign language content:

Definition 1 $\Gamma \equiv 1 - (1 - \gamma n^f)(1 - 2\gamma n^f)$.

In the absence of the substitution between home language content and foreign language content, the efficiency of exchanges in the home language within each platform can be measured by ab. From Table 1, the substitution between home language content and foreign language content reduces the surplus that a domestic CP obtains from having an additional consumer from b to $b(1 - \gamma n^f)$ and the surplus that a consumer obtains from having an additional domestic CP from a to $a(1 - 2\gamma n^f)$. Therefore, the efficiency measure

of exchanges in the home language within platform 1 becomes $ab\,(1-\Gamma)$ and is reduced by $ab\Gamma$. Under Assumption A1 that $\gamma n^f \in [0, 1/2)$, we have $\Gamma \in [0, 1)$ and Γ strictly increases with γn^f.

Platform 1's share of bilingual consumers x_i^B is given by (2). From (3) and (4), the mass of CPs joining platform i is given by

$$n_1^B = mbx_1^B(1-\gamma n^f) - mF_1 \tag{10}$$

and

$$n_2^B = mb\left(1-x_1^B\right) - mF_2. \tag{11}$$

Expressing participation x_1^B as a function of F_1 and F_2 yields

$$x_1^B = c_1^B - \sigma^B\left(\frac{(1-2\gamma n^f)F_1 - F_2}{b}\right) \tag{12}$$

where

$$\sigma^B \equiv \frac{abm}{2t-(2-\Gamma)\,abm} \text{ and } c_1^B \equiv \frac{1}{2} + \sigma^B\left(\frac{n^f}{bm} - \frac{\Gamma}{2}\right) > \frac{1}{2}. \tag{13}$$

We call σ^B the multiplier in the bilingual case. To understand its meaning, consider a reduction in F_2 by $\varepsilon > 0$. This raises the CPs on platform 2 by $m\varepsilon$, which in turn increases x_2^B by $am\varepsilon/(2t)$, which reduces the CP participation on platform 1 by $am^2b(1-\gamma n^f)\varepsilon/(2t)$ and increases the CP on platform 2 by $am^2b\varepsilon/(2t)$. This in turn increases x_2^B by $a^2m^2b(2-\Gamma)\varepsilon/(2t)^2$ etc. Hence, the total increase in x_2^B is σ^B/b. Note also that $c_1^B > 1/2$ under Assumption A1.

Under bilingualism two types of equilibrium may exist: in a shared equilibrium, both platforms are active while in a tipping equilibrium, platforms 2 is not selling. We examine both types of equilibrium in turn.

Shared equilibrium

We first study the shared equilibrium in which both platforms are active. From (10), (11) and (12), by maximizing $\pi_i = F_i n_i$, we obtain the equilibrium price conditions:

$$\frac{F_1}{x_1^B(1-\gamma n^f)b} = \frac{1}{2+\sigma^B(1-\Gamma)} > \frac{F_2}{x_2^B b} = \frac{1}{2+\sigma^B}. \tag{14}$$

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:*

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

Proof. The proof is omitted as it follows from the discussion in the main text. ■

As a consequence, both platforms retain a higher share of CPs' surplus than in the monolingual case. As we previously explained, due to the substitution between home language content and foreign language content, exchanges in the foreign language come with the drawback 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 perceived efficiency for domestic CPs 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.[31]

Substituting the prices in (12) with the expressions from (14) gives the equilibrium market share of the foreign platform:

$$x_1^B = \frac{c_1^B + \frac{\sigma^B}{2+\sigma^B}}{1 + \frac{\sigma^B(1-\Gamma)}{2+\sigma^B(1-\Gamma)} + \frac{\sigma^B}{2+\sigma^B}} > 0. \tag{15}$$

Therefore, there is no equilibrium in which platform 2 corners the market. Notice also that holding Γ and σ_1^B constant, x_1^B increases linearly with the stock n^f of foreign content on the platform (as c_1^B does so).

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

$$n^f \leq bm\left[\frac{\Gamma}{2} + \frac{1}{2\sigma^B} + \frac{1-\Gamma}{2+\sigma^B(1-\Gamma)}\right]. \tag{16}$$

We show in the Appendix that for a given γ, this condition holds if the mass of foreign language is below a threshold $\underline{n}^f$ defined as

$$\underline{n}^f \equiv \max\left\{n^f \mid n^f \leq 1/(2\gamma) \text{ and } (16) \text{ holds}\right\}.$$

[31] 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 offerings of foreign and domestic CPs, the substitution among the offerings of domestic CPs, our main result will not be affected. Although adding such substitution reduces the multiplier both in the monolingual and the bilingual cases, the result that the presence of the substitution between domestic and foreign content offerings makes the multiplier in the bilingual case smaller than the one in the monolingual case remains intact (see the Appendix).

Notice that it is possible that $\underline{n}^f$ is equal to the maximal level $1/(2\gamma)$.

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 $x_1^B = 1$, the mass of CPs on platform 1 is $m\left((1-\gamma n^f)b - F_1\right)$ so that platform 1's profit, $\pi_1 = F_1 m((1-\gamma n^f)b - F_1)$, is maximized at price:

$$F_1^t = \frac{(1-\gamma n^f)b}{2},$$

implying domestic CP participation

$$n_1^t = \frac{(1-\gamma n^f)bm}{2}, \tag{17}$$

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 such a cornering equilibrium with a monopoly price, if at prices $(F_1^t, F_2 = 0)$, platform 2 does not sell, which is equivalent to the following condition:

$$n^f > bm\left(\frac{1}{2} + \frac{1}{2\sigma^B}\right). \tag{18}$$

We show in the Appendix that this holds if the mass of foreign CPs is above a threshold $\overline{n}^f$ defined as

$$\overline{n}^f \equiv \max\left\{n^f \mid n^f \leq 1/(2\gamma) \text{ and } n^f \leq bm\left(\frac{1}{2} + \frac{1}{2\sigma^B}\right)\right\}.$$

One can verify that $0 < \underline{n}^f < \overline{n}^f$ holds for $\Gamma \in [0,1)$ (provided $\underline{n}^f < 1/(2\gamma)$). As should be expected, for n^f between $\underline{n}^f$ and $\overline{n}^f$, the market tips 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 $n^f < \underline{n}^f$, then the equilibrium is a shared equilibrium and we have:

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

where the foreign platform's market share x_1^B is given by (15).

(ii) If $n^f > \overline{n}^f$, then the equilibrium is such that platform 1 corners the market and charges the monopoly price $F_1^t = \frac{(1-\gamma n^f)b}{2}$.

(iii) If $\underline{n}^f < n^f \leq \overline{n}^f$, then the equilibrium is such that platform 1 corners the market and charges a price below the monopoly price.[32]

Proof. See Appendix. ■

4.2 Comparison with the monolingual case: home language content

In this subsection, we compare the monolingual case and the bilingual one in terms of the amount of home language content available on the platforms. The amount of home language 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. We find that the foreign platform's market share is always higher in the bilingual case than in the monolingual case.

Proposition 4 *(consumer market share) Under Assumptions A1 and A2, bilingualism (i.e., $\alpha = 1$) increases the consumer market share of the foreign platform relative to the monolingual case: $x_1^B > 1/2 = x_1^M$*

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 home language content available in the Internet. We first find that bilingualism reduces the total amount of home language content measured by $n_1 + n_2$. Consider the shared equilibrium. Then for $\Gamma > 0$, the fact that $\sigma^B < \sigma^M$ implies

$$n_1^B + n_2^B < n_1^M + n_2^M.$$

[32] At $n^f = \underline{n}^f$, the equilibrium is cornered if $\underline{n}^f < 1/2\gamma$ and shared if $\underline{n}^f = 1/2\gamma$.

This result is due to the fact that bilingualism reduces platform competition and that competition from foreign CPs lowers the expected surplus of domestic CPs in the foreign platform. The same result holds in the tipping equilibrium as platform 1 charges a higher price than the price it charges in the shared equilibrium with $x_1^B \simeq 1$.[33]

We now examine the amount of content in each platform. Consider first the shared equilibrium. The fact that bilingualism softens competition together with the fact that bilingualism reduces the domestic platform's market share implies that bilingualism reduces the amount of home language 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 we find that bilingualism reduces the amount of home language 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 bilingualism than the mass in each platform under monolingualism. This can increase the mass 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 mass of CPs in the tipping equilibrium $n_1^t = bm\left(1 - \gamma n^f\right)/2$ is smaller than n^M if and only if the content substitution measured by γn^f is larger than a certain threshold:

$$\gamma n^f > \frac{2t - 2abm}{4t - 3abm}. \tag{19}$$

Since the right hand side of (19) 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 in the foreign platform. Summarizing, we have:

Proposition 5 *(home language content): Suppose Assumptions A1 and A2 and* $\gamma n^f > 0$.

[33] If the foreign platform is exogenously much more efficient at matching consumers and content providers, bilingualism is more likely to increase the aggregate supply of domestic content. Moreover, it is more likely that a monopoly tipping equilibrium emerges under bilingualism. As this equilibrium involves an additional distortion from the exercise of monopoly power, for high degree of substitution, the relationship between the total amount of domestic content under bilingualism and the efficiency level of the foreign platform may not be monotonic.

(i) Bilingualism (i.e., $\alpha = 1$) always reduces the total amount of home language content (i.e., $n_1^M + n_2^M > n_1^B + n_2^B$) and the amount of content available on the domestic platform (i.e., $n_2^M > n_2^B$) relative to the monolingual case.

(ii) In the shared equilibrium, bilingualism raises the amount of home language content available on the foreign platform relative to the monolingual case if γn^f is small and reduces it if γn^f is large. In the tipping equilibrium, bilingualism reduces the amount of content available on the foreign platform if and only if (19) holds.

Proof. See Appendix. ■

Thus, a key determinant of whether bilingualism increases or reduces the amount of home language content available on the foreign platform is the extent of substitution between foreign and home content measured by γn^f or Γ.

5 Welfare analysis

In this section, we study how bilingualism affects the welfare of the home country.[34] 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 the normalized model, we use the notation $\widetilde{n}^f = n^f/bm$ to denote the normalized quantity of foreign content. We then define $CS(\widetilde{n}^f, \gamma)$ as the consumer surplus (net of the stand-alone value u) in a model with $a = b = m = 1$ and foreign content $\widetilde{n}^f$. We similarly define $\Pi_d(\widetilde{n}^f, \gamma)$ as the normalized domestic producer surplus, which is the sum of the profit of the domestic platform and the profits of domestic CPs. Then, as shown in the Appendix, the domestic welfare in the original model can be written as

$$W = u + abm \left\{ CS(\widetilde{n}^f, \gamma) + \frac{b}{a} \Pi_d(\widetilde{n}^f, \gamma) \right\}. \tag{20}$$

Therefore, comparing bilingual welfare with monolingual welfare is equivalent to comparing $CS(\widetilde{n}^f, \gamma) + (b/a)\,\Pi_d(\widetilde{n}^f, \gamma)$ 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*

[34] A similar analysis would hold for world welfare. Under our small country assumption, bilingualism allows foreign CPs to sell content to domestic consumers. Therefore, bilingualism raises the joint profit of the foreign platform and the foreign CPs. Hence, world welfare increases whenever domestic welfare increases.

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.[35]

In what follows, our discussion is focused on the effect of bilingualism on consumer surplus and producer surplus in the normalized model. Assuming $a = b = m = 1$, the assumption A1 becomes $1 > 2\gamma n^f$ and $1 > 2\gamma$ while the assumption A2 becomes $t > 1$.

The consumer surplus is

$$CS(n^f, \gamma) \equiv \left(n_1 + n^f - 2\gamma n^f n_1\right) x_1 + n_2 x_2 - \frac{t}{2}\left[(x_1)^2 + (1 - x_1)^2\right], \tag{21}$$

while the domestic producer surplus is

$$\Pi_d(n^f, \gamma) = n_2 F_2 + \frac{(n_1)^2 + (n_2)^2}{2}. \tag{22}$$

Consider the case of no substitution between home language and foreign language content (i.e., $\gamma = \Gamma = 0$). First, if there is market sharing, 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 case of substitution between domestic and foreign content (i.e., $\gamma > 0$). Consider first the polar case in which γn^f is close to 1/2 (hence, $\Gamma \simeq 1$) still with market sharing. In this case, $n^f > 1/2$ from A1 and $t > n^f$ from (15) and $x_1^B < 1$. According to Proposition 5, domestic CP participation is lower on each platform under bilingualism than in the monolingual case. Hence domestic producer surplus is lower. Moreover, due

[35] Our model captures some important asymmetries between consumers and content producers in the way they benefit from online matches, which have implications for the relative weight of the producer surplus, b/a. First, the asymmetry between consumers and producers in terms of how they use "online platforms" is captured in our model by the assumption of single-homing consumers and multi-homing producers which is known as competitive bottleneck in the industrial organization literature. Under a competitive bottleneck, platforms tend to extract surplus from multi-homers and dissipate it to attract single-homers. This tends to increase b/a but in an endogenous way which is captured by our analysis to some extent. Second, the degree of competition among producers will surely affect b/a. The stronger is competition among producers, the lower will be b/a.

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 now the case in which bilingualism leads to the tipping equilibrium with the monopoly price. Then, we can show that bilingualism always increases consumer surplus because the increase in the total amount of content (including n^f) exceeds the increase in total transportation cost. CPs' surplus may increase or decrease depending on γn^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

$$\gamma n^f > 1 - \sqrt{2}\frac{2t-1}{4t-3}. \tag{23}$$

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 (23) 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 $\gamma = 0$, 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 $\gamma > 0$ is close to $1/(2n^f)$ (i.e., $\Gamma \simeq 1$), in a shared equilibrium, bilingualism reduces domestic producer surplus relative to the monolingual case while it increases consumer surplus if n^f is large enough.

(iii) When bilingualism leads to the tipping equilibrium with the monopoly price, it always increases consumer surplus relative to the monolingual case. It reduces domestic producer surplus if condition (23) holds.

Proof. See Appendix ■

6 Foreign platform taxation

Let us study how taxing the foreign platform affects domestic welfare in the bilingual case. We consider a fixed per-CP tax on the foreign platform such that the profit of the foreign platform is $\pi_1 = n_1(F_1 - \tau)$ and the tax revenue is $T = \tau n_1$. The profit function of the domestic platform is given as before $\pi_2 = n_2 F_2$. Without loss of generality, we consider the normalized model $a = b = m = 1$. From normalization we obtain the total domestic welfare

$$W = u + abm\left\{CS(\widetilde{n}^f, \gamma) + \frac{b}{a}\Pi_d(\widetilde{n}^f, \gamma) + \frac{b}{a}\tilde{T}\right\},$$

where $\tilde{T}$ is the revenue from the (normalized) tax in the normalized model.

The consumer demand for the foreign platform is:

$$x_1^B = \sigma^B\left[t + n^f - 1 - F_1(1 - 2\gamma n^f) + F_2\right]$$

where the multiplier is $\sigma^B \equiv 1/\left(2t - (2 - \Gamma)\right)$.

The new first-order condition for optimality of the price of platform i given a tax τ on the foreign platform is now

$$F_1 = \frac{x_1^B(1 - \gamma n^f)}{\sigma^B(1 - \Gamma) + 2} + \Lambda\tau \text{ and } F_2 = \frac{(1 - x_1^B)}{2 + \sigma^B}, \text{ where } \Lambda = \frac{\sigma^B(1 - \Gamma) + 1}{\sigma^B(1 - \Gamma) + 2}. \tag{24}$$

Λ is CPs' share in the surplus generated by CPs subscribed to platform 1 (see (14)). It is interesting to note that the pass-through rate is just equal to Λ. The fact that Λ increases with σ^B (hence decreases with t) and decreases with Γ plays an important role on the result we present later. (24) leads to the following equilibrium consumer market share of platform 1:

$$x_1^B = \frac{t + n^f - 1 + \frac{1}{2+\sigma^B} - \left(1 - 2\gamma n^f\right)\Lambda\tau}{\frac{1}{\sigma^B} + \frac{(1-\Gamma)}{2+\sigma^B(1-\Gamma)} + \frac{1}{2+\sigma^B}} \tag{25}$$

We see that the tax reduces the market share of the foreign platform among consumers, which is due to a price increase on the content side that induces a reduction of the participation of domestic content to the platform. Indeed the domestic CP participation to platform 1 is

$$n_1^B = \Lambda\left(x_1^B(1 - \gamma n^f) - \tau\right),$$

which is clearly decreasing with the tax. The larger price of the foreign platform together with larger participation of consumers to the domestic platform allows the latter to benefit from higher CP participation at higher price:

$$n_2^B = \frac{\sigma^B + 1}{\sigma^B + 2}(1 - x_1^B).$$

Thus without surprise a tax on the foreign platform hurts the activity of the foreign platform and raises all prices:

Lemma 1 *A tax on platform* 1 *has the following effects:* $\frac{dx_1^B}{d\tau} < 0$, $0 < \frac{dF_1}{d\tau} < 1$, $0 < \frac{dF_2}{d\tau} < 1$, $\frac{dn_1^B}{d\tau} < 0$ *and* $\frac{dn_2^B}{d\tau} > 0$.

Proof. See Appendix ■

Let us now analyze the welfare effect of a tax levied on the foreign platform. We provide in Appendix the detailed formulas for three cases of interest (no or large substitution, and almost tipping) and here describe only the effects. The effect of the tax on consumer surplus can be decomposed into three parts. The first part is the effect of the shift of participation from the foreign platform to the domestic platform (i.e., the reduction in x_1^B) on consumption surplus. This effect may be positive or negative as it reflects the change in relative attractiveness of the two platforms. The second effect is the change in transport costs which is positive because the allocation becomes more symmetric. Finally the tax raises the price of the platforms inducing a reduction of the supply of content which hurts consumers. Despite the existence of conflicting effects, in two among the three cases examined we find that a small tax reduces consumer surplus. However when there is a large substitution between home and foreign language, consumers are not affected by the supply of home language content on the foreign platform and therefore are indifferent to a marginal tax.

The domestic producer surplus is composed of two components: the domestic platform profit and the domestic CP surplus. Clearly the domestic platform benefits from the tax. The effect on domestic CP is not straightforward because their participation decreases on the foreign platform but increases on the domestic platform. However in all cases examined we find that the reduction of the domestic CP surplus on the foreign platform outweighs the benefits that the tax induces on the domestic platform. Thus the effect on domestic CP surplus is negative and of larger magnitude than the positive effect on the domestic platform.

It is also interesting to evaluate the gain in terms of tax revenues. For our decomposition of welfare, it would be meaningless to compare the reduction of consumer surplus with the revenue in the normalized model because it depends on the relative weight a/b. But it is interesting to see whether the tax revenue is larger or smaller than the effect on the domestic content producer surplus. In the next proposition we identify cases where the gain of revenue is large enough that a small tax raises total domestic welfare.

The next proposition formalizes this discussion.

Proposition 7 *Consider the bilingual case (i.e., $\alpha = 1$) and assume that platform 2 is active in equilibrium. Then a small tax on the foreign platform has the following effects:*

(i) If $\gamma = 0$ or x_1^B is close to 1, then it reduces consumer surplus and domestic producers surplus. The reduction of the domestic producer surplus is less than the tax revenue if σ^B is small.

(ii) If $1 \simeq 2\gamma n_F$, then it has no effect on consumer surplus and it reduces domestic producer surplus by an amount smaller than the tax revenue. Hence total domestic welfare increases.

Proof. See Appendix ■

The case $\gamma = 0$ is the case where the foreign platform's offering of foreign language content brings large value to both consumers and domestic content producers. It is thus not surprising that a tax on the foreign platform hurts welfare. The same holds when the market share of the foreign platform is large. However, if σ^B is small, which corresponds to high differentiation between platforms, the tax revenue offsets the loss of producer surplus. If in addition a/b is small so that consumer surplus is low, a small tax raises total welfare.

The case $1 \simeq 2\gamma n_F$ is interesting because in this case due to strong substitution, additional domestic CPs have almost no impact on the consumer surplus in the foreign platform. Therefore, consumers on platform 1 are not interested in having domestic content so that the tax has little effect on them although domestic CPs are able to sell on this platform. In this case the tax revenue is relatively large and the effect on domestic CPs is relatively small. Then a small tax is welfare improving. Hence, a small tax may be considered by the domestic tax authority if foreign content crowds out domestic content or if there is enough differentiation between the platforms and the weight given to consumer surplus is relatively small compared to domestic producer surplus and public funds.

While a small tax seems to improve welfare only if there is a strong substitution between home and foreign language content, this doesn't preclude a large tax to have a positive impact on welfare. To see that consider the case where $x_1^B \approx 1$ *(*but is interior) without tax. Then the foreign platform charges a large fee and the domestic producer surplus is close to $\frac{(n_1)^2}{2} \simeq \frac{1}{2}\left[\Lambda(1-\gamma n^f)\right]^2$. Now suppose that with a tax, the government succeeds in raising significantly the market share x_2^B of the domestic platform. Then the domestic producer surplus is larger than

$$n_2^B F_2 + \frac{(n_2^B)^2}{2} = \frac{1}{2}\frac{\left(\sigma^B+1\right)\left(\sigma^B+3\right)}{\left(\sigma^B+2\right)^2}\left(x_2^B\right)^2.$$

Thus the domestic producer surplus would increase if the tax induces a market share large

enough such that

$$x_2^B > \frac{\sigma^B + 2}{\sqrt{(\sigma^B + 1)(\sigma^B + 3)}} \frac{\sigma^B(1-\Gamma)+1}{\sigma^B(1-\Gamma)+2}(1-\gamma n^f),$$

where the right hand term is strictly less than 1. However we should point that in this case the tax will always hurt consumers, as stated below.

Proposition 8 *If the market almost tips to the foreign platform in the absence of tax, imposing a large tax may raise the domestic producers surplus if it raises sufficiently the domestic platform's market share but would reduce consumer surplus.*

Proof. We only need to prove the result on consumer surplus. Consumer surplus is

$$\begin{aligned} CS &= H\left(x_1^B\right) - \tau\Lambda(1-2\gamma n^f)x_1^B, \\ \text{where } H\left(x_1^B\right) &= \left[n^f + \Lambda(1-\Gamma)x_1^B\right]x_1^B + \frac{\sigma^B+1}{\sigma^B+2}(1-x_1^B)^2 - \frac{t}{2}\left[\left(x_1^B\right)^2 + \left(1-x_1^B\right)^2\right]. \end{aligned}$$

Suppose now that x_1^B is close to one. Then the slope of H at $x_1^B = 1$ is (using (25) and $\sigma^B \equiv 1/(2t-(2-\Gamma))$

$$H'(1) = (1-\Gamma)\Lambda > 0$$

Moreover it can be readily shown at an equilibrium where $x_1^B \simeq 1$,

$$H(1) = n^f + \Lambda(1-\Gamma) - \frac{t}{2} > H(0) = \frac{\sigma^B+1}{\sigma^B+2} - \frac{t}{2}.$$

Because the function H is quadratic in x_1^B, these two facts imply that whenever the foreign platform serves almost all the market, the consumer surplus is maximized when there is no tax, that is $H(1) > CS$ for any tax $\tau > 0$. ■

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 language 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. On the other hand, bilingualism can reduce the amount of home language content through two channels.

Substitution between foreign and domestic content reduces expected surplus for domestic CPs subscribing to the foreign platform. In addition, this substitution 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.

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

Although our paper focuses 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 amount of home language content 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. Our present model abstracts from competition among CPs on the platform to focus on competition between platforms. One interesting line for future research is thus to endogeneize price formation through content competition in order to understand the interaction between softening of platform competition and intensification of competition among CPs within the foreign platform induced by bilingualism. Another 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 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.

8 References

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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 $u + abm - t < u$.

9.2 Proof of Proposition 3

We have a shared equilibrium if

$$n^f < bm\left[\frac{\Gamma}{2} + \frac{1}{2\sigma^B} + \frac{1-\Gamma}{2+\sigma^B(1-\Gamma)}\right]$$

We then have

$$\begin{aligned}
&\frac{d}{dn^f} bm\left[\frac{\Gamma}{2} + \frac{1}{2\sigma^B} + \frac{1-\Gamma}{2+\sigma^B(1-\Gamma)}\right] \\
= \; & bm\left[\frac{1}{2} - \frac{1}{2+\sigma^B(1-\Gamma)} + \frac{\sigma^B(1-\Gamma)}{\left(2+\sigma^B(1-\Gamma)\right)^2} + \frac{1}{2} + \frac{(1-\Gamma)^2}{\left(2+\sigma^B(1-\Gamma)\right)^2}\left(\sigma^B\right)^2\right]\frac{d\Gamma}{dn^f} \\
= \; & bm2\left(\frac{\left(\frac{2t}{abm}-1\right)^2 + (1-\Gamma)^2}{\left(\frac{4t}{abm}-3+\Gamma\right)^2}\right)\gamma\left(3-4\gamma n^f\right) > 0
\end{aligned}$$

which is positive and decreasing in n^f. Hence $bm\left[\frac{\Gamma}{2}+\frac{1}{2\sigma^B}+\frac{1-\Gamma}{2+\sigma^B(1-\Gamma)}\right]$ is concave in n^f. This implies that the condition holds for n^f below some threshold $\underline{n}^f \leq \frac{1}{2\gamma}$.

For the case (ii) we have

$$\frac{d}{dn^f}bm\left(\frac{1}{2}+\frac{1}{2\sigma^B}\right)=bm\frac{1}{2}\gamma\left(3-4\gamma n^f\right).$$

As A1 implies $bm<\frac{1}{2\gamma(1-\gamma n^f)}$ we obtain

$$\frac{d}{dn^f}bm\left(\frac{1}{2}+\frac{1}{2\sigma^B}\right)<\frac{1}{2}\frac{\gamma\left(3-4\gamma n^f\right)}{2\gamma(1-\gamma n^f)}=\frac{\left(3-4\gamma n^f\right)}{4(1-\gamma n^f)}<1$$

Hence the condition $n^f > bm\left(\frac{1}{2}+\frac{1}{2\sigma^B}\right)$ holds if n^f is strictly above a threshold $\bar{n}^f$, which may be equal to the maximum level $1/2\gamma$.

Suppose $\underline{n}^f < n^f \leq \overline{n}^f$. Then, the optimal price for platform 1 is the highest price inducing market cornering for $F_2=0$, denoted by $F_1^* \in \left(\frac{(1-\gamma n^f)b}{2+\sigma^B(1-\Gamma)}, \frac{(1-\gamma n^f)b}{2}\right)$. Given $F_2=0$, reducing F_1 below F_1^* is not profitable because 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 either because this deviation makes platform 1 share the market with platform 2, which is suboptimal.

9.3 Proof of Proposition 4

From (15), we find that $x_1^B > 1/2$ if

$$n^f > bm\Gamma\left(\frac{1}{2}-\frac{1}{2+\sigma^B(1-\Gamma)}\frac{1}{2+\sigma^B}\right). \tag{26}$$

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

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

9.4 Proof of Proposition 5

The proof of (i) is omitted as it follows the discussion in the main text.

In the case of (ii), we only need to provide the proof for the result in the shared equilibrium. We have

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

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

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

which is bigger than 1 for λn^f small. When $\lambda n^f = 1/2$, we have $\Gamma = 1$ and

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

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

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

$$x_i = \frac{1}{2} + \frac{a(n_1 + n^f - 2\gamma n^f n_1) - an_2}{2t},$$

$$n_1 = m\left(x_1(1 - \gamma n^f)b - F_1\right),\ n_2 = m\left(x_2 b - F_2\right).$$

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

$$\widetilde{x}_i = \frac{1}{2} + \frac{(\widetilde{n}_1 + \widetilde{n}^f - 2\gamma n^f \widetilde{n}_1) - \widetilde{n}_2}{2\widetilde{t}}$$

$$\widetilde{n}_1 = \widetilde{x}_1(1 - \gamma n^f) - \widetilde{F}_1,\ n_2 = \widetilde{x}_2 - \widetilde{F}_2.$$

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

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

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

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

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 $1 > 2\gamma$ in the normalized model. A2 becomes $t > 1$ in the normalized model.

9.6 Proof of Proposition 6

Both (i) and (iii) follow from the discussion in the main text. In what follows, we prove (ii).

Consider consumer surplus. Under market sharing and $\gamma n^f = 1/2$, we have

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

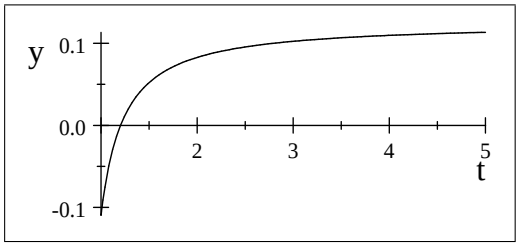
Using this condition, we find:

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

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 $\gamma n^f = 1/2$.

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

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

$$\geq \frac{(1-\Gamma)}{2} + \overline{n}^f - n^M - \frac{t}{4} > 0, \tag{27}$$

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:

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

When $\gamma n^f = 1/2$ 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 $x_1^B \in [0.5, 1]$.

9.7 Proof of Lemma 1

We have

$$\frac{dx_1^B}{d\tau} = -\frac{\frac{(1-2\gamma n^f)\left(\sigma^B(1-\Gamma)+1\right)}{2+\sigma^B(1-\Gamma)}}{\frac{1}{\sigma^B} + \frac{(1-\Gamma)}{2+\sigma^B(1-\Gamma)} + \frac{1}{2+\sigma^B}} < 0;$$

$$\begin{aligned}
\frac{dF_1}{d\tau} &= \frac{-\frac{\frac{(1-2\gamma n^f)\left(\sigma^B(1-\Gamma)+1\right)}{2+\sigma^B(1-\Gamma)}}{\frac{1}{\sigma^B}+\frac{(1-\Gamma)}{2+\sigma^B(1-\Gamma)}+\frac{1}{2+\sigma^B}}(1-\gamma n^f) + \sigma^B(1-\Gamma)+1}{\sigma^B(1-\Gamma)+2} \\
&= \frac{\frac{-\frac{(1-\Gamma)}{2+\sigma^B(1-\Gamma)}}{\frac{1}{\sigma^B}+\frac{(1-\Gamma)}{2+\sigma^B(1-\Gamma)}+\frac{1}{2+\sigma^B}} + 1}{\sigma^B(1-\Gamma)+2}\left(\sigma^B(1-\Gamma)+1\right) = \frac{\frac{1}{\sigma^B}+\frac{1}{2+\sigma^B}}{\frac{1}{\sigma^B}+\frac{(1-\Gamma)}{2+\sigma^B(1-\Gamma)}+\frac{1}{2+\sigma^B}}\frac{\sigma^B(1-\Gamma)+1}{\sigma^B(1-\Gamma)+2} < 1;
\end{aligned}$$

$$0 < \frac{dF_2}{d\tau} = \frac{(1-2\gamma n^f)}{\frac{2+\sigma^B}{\sigma^B} + \frac{(2+\sigma^B)(1-\Gamma)}{2+\sigma^B(1-\Gamma)} + 1}\frac{\sigma^B(1-\Gamma)+1}{\sigma^B(1-\Gamma)+2} < 1.$$

We also have

$$\frac{dn_1^B}{d\tau} = \Lambda((1-\gamma n^f)\frac{dx_1^B}{d\tau} - \tau) < 0;$$

$$\frac{dn_2^B}{d\tau} = -\frac{1+\sigma^B}{2+\sigma^B}\frac{dx_1^B}{d\tau} > 0.$$

9.8 Proof of Lemma 7

Consumer surplus is

$$\begin{aligned} CS &= (n_1^B + n^f - 2\gamma n_1^B n^f)x_1^B + n_2^B x_2^B - \frac{t}{2}\left[\left(x_1^B\right)^2 + \left(x_2^B\right)^2\right] \\ &= n^f x_1^B + \Lambda(1-\Gamma)\left(x_1^B\right)^2 + \frac{\sigma^B+1}{\sigma^B+2}(1-x_1^B)^2 - \frac{t}{2}\left[\left(x_1^B\right)^2 + \left(1-x_1^B\right)^2\right] - \Lambda\tau(1-2\gamma n^f)x_1^B. \end{aligned}$$

The domestic producer surplus is then

$$\begin{aligned} PS &= n_2^B F_2 + \frac{(n_1^B)^2 + (n_2^B)^2}{2} \\ &= \frac{\sigma^B+1}{\sigma^B+2}\frac{\sigma^B+3}{2(\sigma^B+2)}\left[(1-x_1^B)\right]^2 + \frac{1}{2}\Lambda^2\left[x_1^B(1-\gamma n^f) - \tau\right]^2 \end{aligned}$$

The tax revenue is

$$T = \tau n_1^B = \Lambda\tau\left(x_1^B(1-\gamma n^f) - \tau\right)$$

The derivative of the consumer surplus at zero tax is

$$\begin{aligned} \left.\frac{d\left(CS\right)}{d\tau}\right|_{\tau=0} &= \left[n^f + 2\Lambda(1-\Gamma)x_1^B - \frac{\sigma^B+1}{\sigma^B+2}2(1-x_1^B)\right]\frac{dx_1^B}{d\tau} - t(2x_1^B-1)\frac{dx_1^B}{d\tau} \\ &\quad -\Lambda(1-2\gamma n^f)x_1^B \end{aligned}$$

The derivative of the producer surplus at zero tax is

$$\begin{aligned} \left.\frac{d\left(PS\right)}{d\tau}\right|_{\tau=0} &= -\frac{\sigma^B+1}{\sigma^B+2}\frac{\sigma^B+3}{(\sigma^B+2)}(1-x_1^B)\frac{\partial x_1^B}{\partial\tau} + \left[\Lambda(1-\gamma n^f)\right]^2 x_1^B\frac{\partial x_1^B}{\partial\tau} \\ &\quad -\left[\Lambda\right]^2 x_1^B(1-\gamma n^f); \end{aligned}$$

and the marginal tax revenue at zero tax is

$$\left.\frac{dT}{d\tau}\right|_{\tau=0} = \Lambda x_1^B(1-\gamma n^f)$$

9.8.1 Case $\gamma = 0$

In this case $\Gamma = 0,\ \Lambda = \frac{\sigma^B+1}{\sigma^B+2}$ and

$$\frac{dx_1^B}{d\tau} = -\frac{\sigma^B\left(\sigma^B+1\right)}{2+3\sigma^B} < 0;$$

We have

$$\begin{aligned}
\left.\frac{d\left(PS\right)}{d\tau}\right|_{\tau=0} &= -\frac{\sigma^B+1}{\sigma^B+2}\frac{\sigma^B+3}{(\sigma^B+2)}(1-x_1^B)\frac{\partial x_1^B}{\partial\tau}+\left[\frac{\sigma^B+1}{\sigma^B+2}\right]^2 x_1^B(\frac{\partial x_1^B}{\partial\tau}-1)<0\\
&\Leftrightarrow\ -\frac{\sigma^B+3}{(\sigma^B+2)}(1-x_1^B)\frac{\partial x_1^B}{\partial\tau}+\frac{\sigma^B+1}{\sigma^B+2}x_1^B(\frac{\partial x_1^B}{\partial\tau}-1)<0\\
&\Leftrightarrow\ \frac{\sigma^B+3}{\sigma^B+2}(1-x_1^B)\frac{\sigma^B\left(\sigma^B+1\right)}{2+3\sigma^B}<\frac{\sigma^B+1}{\sigma^B+2}x_1^B(\frac{\sigma^B\left(\sigma^B+1\right)}{2+3\sigma^B}+1)\\
&\Leftrightarrow\ \frac{\sigma^B\left(\sigma^B+3\right)}{\sigma^B\left(\sigma^B+1\right)+2+3\sigma^B}<\frac{x_1^B}{1-x_1^B}
\end{aligned}$$

which holds because $x_1^B>1/2$ and the left-hand-side is less than 1.

Consumer surplus is changed by

$$\begin{aligned}
\left.\frac{d\left(CS\right)}{d\tau}\right|_{\tau=0} &= \left[n^f+2\frac{\sigma^B+1}{\sigma^B+2}x_1^B-\frac{\sigma^B+1}{\sigma^B+2}2(1-x_1^B)-t(2x_1^B-1)\right]\frac{dx_1^B}{d\tau}-\frac{\sigma^B+1}{\sigma^B+2}x_1^B\\
&= \left[n^f+\left(\frac{\sigma^B+1}{\sigma^B+2}2-t\right)\left(2x_1^B-1\right)\right]\frac{dx_1^B}{d\tau}-\frac{\sigma^B+1}{\sigma^B+2}x_1^B
\end{aligned}$$

We have

$$2x_1^B-1=\frac{\frac{1}{\sigma^B}+2n^f+\frac{2}{2+\sigma^B}}{\frac{1}{\sigma^B}+\frac{2}{2+\sigma^B}}-1=\frac{2n^f}{2+3\sigma^B}\sigma^B\left(2+\sigma^B\right).$$

Hence, using $t=1+\frac{1}{2\sigma^B}$, we have

$$\begin{aligned}
\left.\frac{d\left(CS\right)}{d\tau}\right|_{\tau=0} &= n^f\left[1+\left(\frac{2\sigma^B+2}{\sigma^B+2}-1-\frac{1}{2\sigma^B}\right)\frac{2\sigma^B\left(2+\sigma^B\right)}{2+3\sigma^B}\right]\frac{dx_1^B}{d\tau}-\frac{\sigma^B+1}{\sigma^B+2}x_1^B\\
&= n^f\left[\frac{2\sigma^B+2\left(\sigma^B\right)^2}{2+3\sigma^B}\right]\frac{dx_1^B}{d\tau}-\frac{\sigma^B+1}{\sigma^B+2}x_1^B<0.
\end{aligned}$$

The tax revenue is changed by

$$\left.\frac{dT}{d\tau}\right|_{\tau=0}=\frac{\sigma^B+1}{\sigma^B+2}x_1^B.$$

Therefore, we have

$$
\begin{aligned}
& \left.\frac{d\left(PS\right)}{d\tau}\right|_{\tau=0}+\left.\frac{dT}{d\tau}\right|_{\tau=0}>0\\
\Leftrightarrow\quad & -\frac{\sigma^{B}+3}{(\sigma^{B}+2)}(1-x_{1}^{B})\frac{\partial x_{1}^{B}}{\partial\tau}+\frac{\sigma^{B}+1}{\sigma^{B}+2}x_{1}^{B}(\frac{\partial x_{1}}{\partial\tau}-1)+x_{1}^{B}>0\\
\Leftrightarrow\quad & \frac{\sigma^{B}+3}{\sigma^{B}+2}(1-x_{1}^{B})\frac{\sigma^{B}\left(\sigma^{B}+1\right)}{2+3\sigma^{B}}>\frac{\sigma^{B}+1}{\sigma^{B}+2}x_{1}^{B}(\frac{\sigma^{B}\left(\sigma^{B}+1\right)}{2+3\sigma^{B}}+1)-x_{1}^{B}\\
\Leftrightarrow\quad & \sigma^{B}\left(\sigma^{B}+3\right)\left(\sigma^{B}+1\right)>\frac{x_{1}^{B}}{1-x_{1}^{B}}\left(\left(\sigma^{B}+1\right)\left(\sigma^{B}\left(\sigma^{B}+1\right)+2+3\sigma^{B}\right)-\left(\sigma^{B}+2\right)\left(2+3\sigma^{B}\right)\right)\\
\Leftrightarrow\quad & \sigma^{B}\left(\sigma^{B}+3\right)\left(\sigma^{B}+1\right)>\frac{x_{1}^{B}}{1-x_{1}^{B}}\left(\sigma^{B}\left(\sigma^{B}+1\right)^{2}-\left(2+3\sigma^{B}\right)\right)
\end{aligned}
$$

This holds for small σ^{B} such that $\sigma^{B}\left(\sigma^{B}+1\right)^{2}<2+3\sigma^{B}$.

9.8.2 Case of a large market share

If $x_{1}^{B}\simeq 1$ then

$$
\left.\frac{d\left(CS\right)}{d\tau}\right|_{\tau=0}\simeq\left[n^{f}+2\Lambda(1-\Gamma)-t\right]\frac{dx_{1}^{B}}{d\tau}-\Lambda(1-2\gamma n^{f})<0
$$

because

$$
\begin{aligned}
n^{f}+2\Lambda(1-\Gamma)-t & \simeq \frac{\Gamma}{2}+\frac{1}{2\sigma^{B}}+\frac{(1-\Gamma)}{2+\sigma^{B}(1-\Gamma)}+2\Lambda(1-\Gamma)-\left(\frac{1}{2\sigma^{B}}+1-\frac{\Gamma}{2}\right)\\
& = \frac{(1-\Gamma)}{2+\sigma^{B}(1-\Gamma)}+2\Lambda(1-\Gamma)-(1-\Gamma)=(1-\Gamma)\frac{1+\sigma^{B}(1-\Gamma)}{2+\sigma^{B}(1-\Gamma)}>0
\end{aligned}
$$

We also have

$$
\left.\frac{d\left(PS\right)}{d\tau}\right|_{\tau=0}\simeq\left[\Lambda(1-\gamma n^{f})\right]^{2}\frac{dx_{1}^{B}}{d\tau}-\left[\Lambda\right]^{2}(1-\gamma n^{f})<0
$$

and as $\left.\frac{dT}{d\tau}\right|_{\tau=0}=\Lambda(1-\gamma n^{f})$,

$$
\left.\frac{d\left(PS\right)}{d\tau}\right|_{\tau=0}+\left.\frac{dT}{d\tau}\right|_{\tau=0}=\Lambda(1-\gamma n^{f})\left(1+\Lambda(1-\gamma n^{f})\frac{dx_{1}^{B}}{d\tau}-\Lambda\right),
$$

which is positive if σ^{B} is small because then Λ is close to $1/2$ and $\frac{dx_{1}^{B}}{d\tau}$ is small.

9.8.3 Case $1=2\gamma n^{f}$

If $1=2\gamma n_{F}$, then we have $\frac{dx_{1}^{B}}{d\tau}=0$ and $\Lambda=1/2$. Hence,

$$
\left.\frac{d\left(CS\right)}{d\tau}\right|_{\tau=0}=0;
$$

$$\left.\frac{d\left(PS\right)}{d\tau}\right|_{\tau=0} = -\left[\frac{1}{2}\right]^2 \frac{x_1^B}{2} < 0;$$

and

$$\left.\frac{dT}{d\tau}\right|_{\tau=0} = \frac{1}{2}\frac{x_1^B}{2} > -\left.\frac{d\left(PS\right)}{d\tau}\right|_{\tau=0}.$$

9.9 Extension: substitution among domestic content

We here extend our model to include substitution among home language content in addition to the substitution between home language content and foreign content We provide an extension which shows that our original model can be reinterpreted to accommodate the substitution among home language content. A natural way to create competition among home language content is to introduce some installed base of home language content: at the outset, each platform is endowed with some mass of home language content. As we have a symmetric model but for the presence of foreign content in the foreign platform, we assume that each platform has $n^d > 0$ mass of home language content as installed base. Therefore, a consumer joining platform 2 expects to receive a surplus of $a(n_2 + n^d - 2\gamma^d n_2 n^d)$ whereas a domestic CP joining platform 2 expects to get a surplus of $b(1-\gamma^d n^d)\left[(1-\alpha)x_2^M + \alpha x_2^B\right]$ where $\gamma^d > 0$ is a parameter of substitution.

The location of the monolingual consumer who is indifferent between the two platforms is given by

$$a(n_1 + n^d - 2\gamma^d n_1 n^d) - tx_1 = a(n_2 + n^d - 2\gamma^d n_2 n^d) - t(1 - x_1),$$

which is equivalent to

$$x_1^M = \frac{1}{2} + \frac{a'\left(n_1 - n_2\right)}{2t}, \tag{28}$$

where $a' \equiv a(1 - 2\gamma^d n^d)$.

A bilingual consumer joining the foreign platform (i.e., platform 1) expects to get a surplus of

$$a(n_1 + n^d - 2\gamma^d n_1 n^d + n^f - 2\gamma^f \left(n_1 + n^d - 2\gamma^d n_1 n^d)n^f\right))$$

where the last term $2\left(2\gamma^d n_1 n^d\right)\gamma^f n^f$ represents the overlap between foreign content and the overlapping home language content between n_1 and n^d. For this subset of overlapping content, we allocate a half to foreign CPs and the remaining half equally between the installed base and the new domestic CPs.

The location of the bilingual consumer who is indifferent between the two platforms is given by

$$a(n_1+n^d-2\gamma^d n_1 n^d+n^f-2\gamma^f(n_1+n^d-2\gamma^d n_1 n^d)n^f)-tx_1 = a(n_2+n^d-2\gamma^d n_2 n^d)-t(1-x_1).$$

which is equivalent to

$$x_1^B = \frac{1}{2} + \frac{a'\left[(n_1-n_2)+n^f\left(\frac{1-2\gamma^f n^d}{1-2\gamma^d n^d}-2\gamma^f n_1\right)\right]}{2t}. \tag{29}$$

Therefore, for a share α of bilingual consumers, a domestic CP joining platform 1 expects to get a surplus of

$$\begin{aligned} & b(1-\gamma^d n^d)(1-\alpha)x_1^M + b\left[1-\gamma^d n^d-\gamma^f n^f(1-\gamma^d n^d)\right]\alpha x_1^B \\ = \;& b(1-\gamma^d n^d)\left[(1-\alpha)x_1^M+\alpha x_1^B(1-\gamma^f n^f)\right] \end{aligned}$$

The mass of CPs joining platform 1 is

$$n_1 = mb'\left[(1-\alpha)x_1^M+\alpha x_1^B(1-\gamma^f n^f)\right] - mF_1, \tag{30}$$

where $b' \equiv b(1-\gamma^d n^d)$. The mass of CPs joining platform 2 is

$$n_2 = mb'\left[(1-\alpha)(1-x_1^M)+\alpha(1-x_1^B)\right] - mF_2 \tag{31}$$

We now examine how the introduction of substitution among home language content modifies the multipliers. Note first that in the four equations (28)-(31) that determine $\left(x_1^M, x_1^B, n_1, n_2\right)$, the installed base n^d plays a role only through the term $\gamma^d n^d$. Therefore, the model we previously considered can be interpreted as a model with some positive installed base as long as $\gamma^d = 0$.

Consider first the monolingual case (i.e., $\alpha = 0$). Then, the current model with $\gamma^d n^d > 0$ is equivalent to the model we previously considered if we replace (a, b) with (a', b'). Therefore, the multiplier in the monolingual case becomes

$$\sigma^M(\gamma^d n^d > 0) = \frac{a'mb'}{2t-2a'mb'} = \frac{amb(1-\Gamma^d)}{2t-2amb(1-\Gamma^d)} < \frac{amb}{2t-2amb} = \sigma^M(\gamma^d n^d = 0)$$

where $(1-\Gamma^d) = (1-2\gamma^d n^d)(1-\gamma^d n^d)$. The substitution among home language content reduces the multiplier in the monolingual case.

Consider now the bilingual case (i.e., $\alpha = 1$). Then, after some manipulation, we find that platform 1's consumer share is determined as follows

$$x_1^B = \text{constant} + \sigma^B(\gamma^d n^d)\left(\frac{F_2-(1-2\gamma^f n^f)F_1}{b'}\right)$$

where

$$\begin{aligned}\sigma^B(\gamma^d n^d &> 0) = \frac{a'mb'}{2t - a'mb'\left[2-\Gamma\right]} = \frac{amb(1-\Gamma^d)}{2t - 2amb\left[2-\Gamma\right](1-\Gamma^d)} \\ &< \frac{amb}{2t - amb\left[2-\Gamma\right]} = \sigma^B(\gamma^d n^d = 0).\end{aligned}$$

Still, the multiplier in the bilingual case is obtained from the one in our previous model (with $\gamma^d n^d = 0$) by replacing (a, b) with (a', b'). The substitution among home language content reduces the multiplier in the bilingual case as well.

Therefore, this extension shows that we can include the substitution among home language content by considering a reduction in (a, b) in the original model and that the effects from the substitution between home language content and foreign content we identified in the original model should qualitatively remain intact in this extension.

9.10 Figures

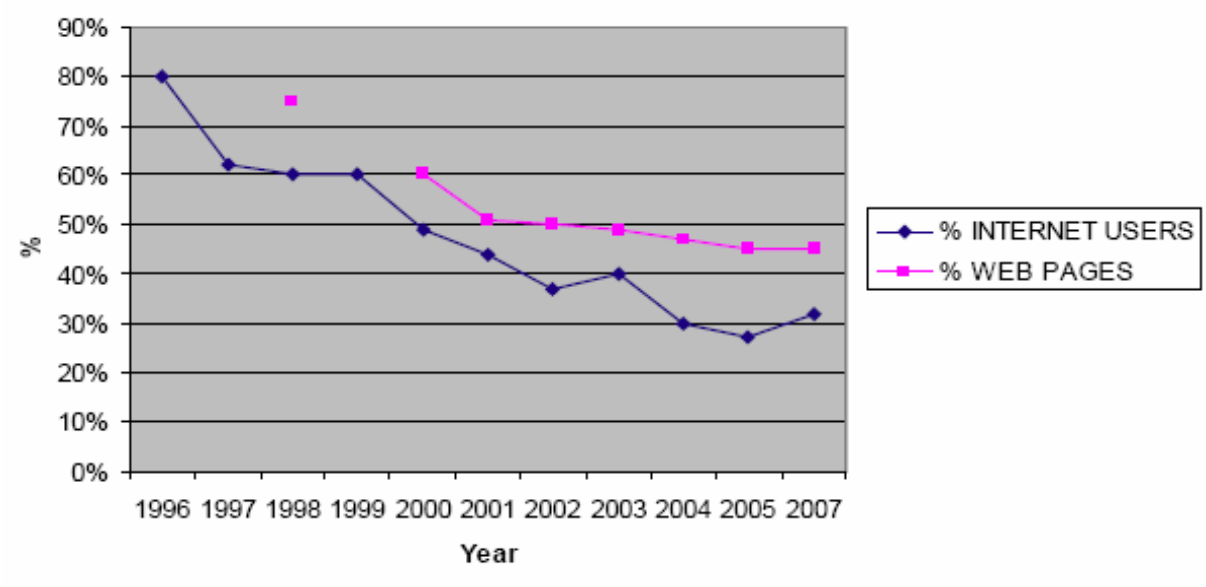


Figure 1. Evolution of percentages of English speaking Internet users and web pages (Pimienta, Prado and Blanco, 2009).

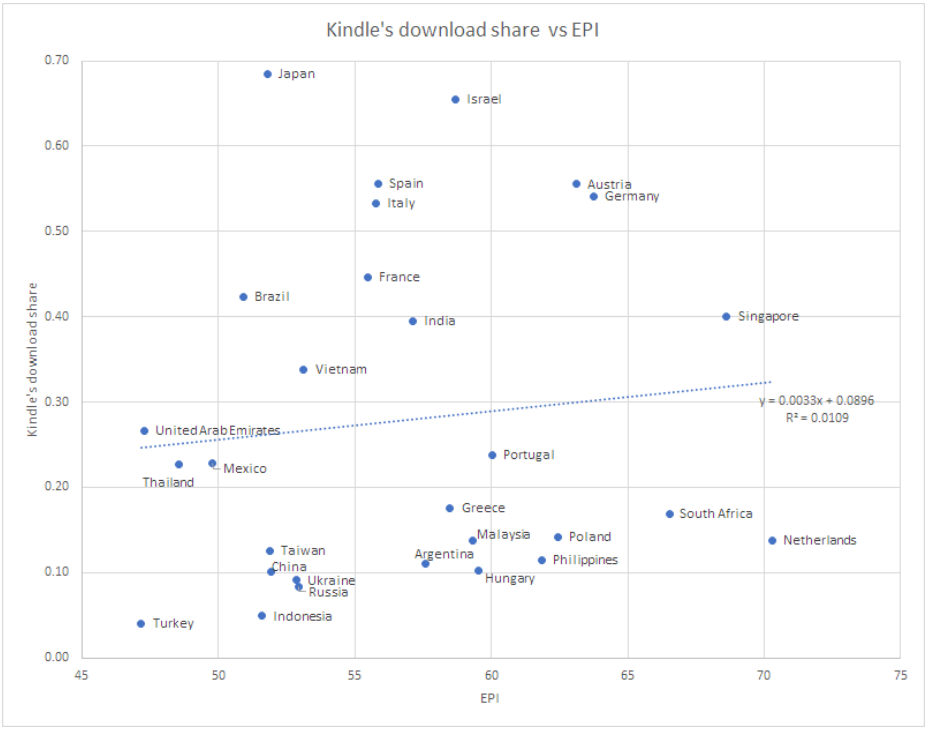


Figure 2. Amazon Kindle's download share vs EPI.

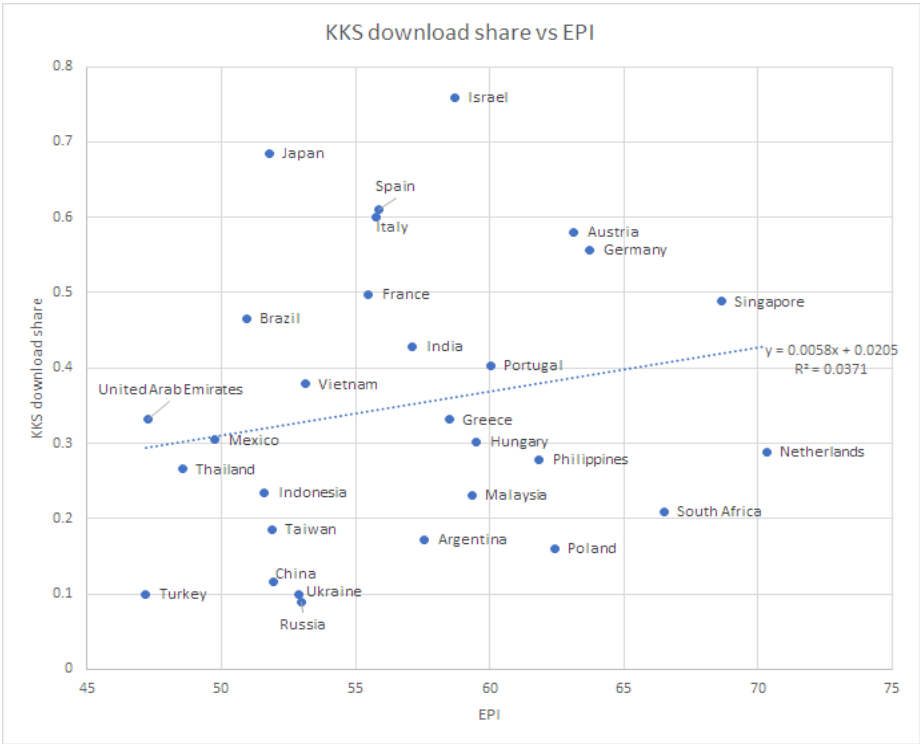


Figure 3. KKS download share vs EPI.

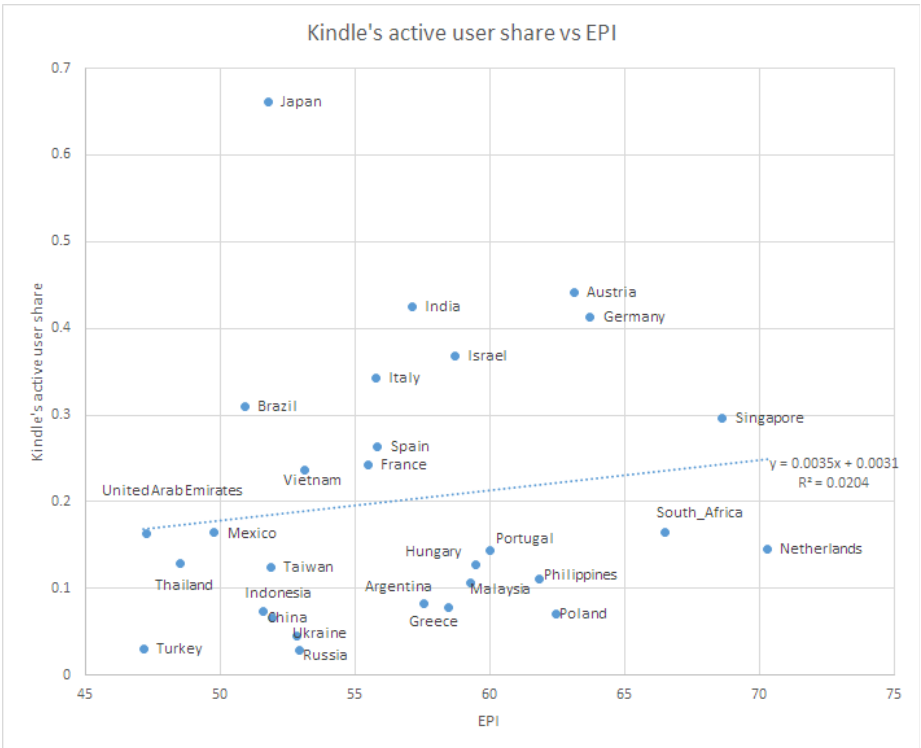


Figure 4. Amazon Kindle's active user share vs EPI.

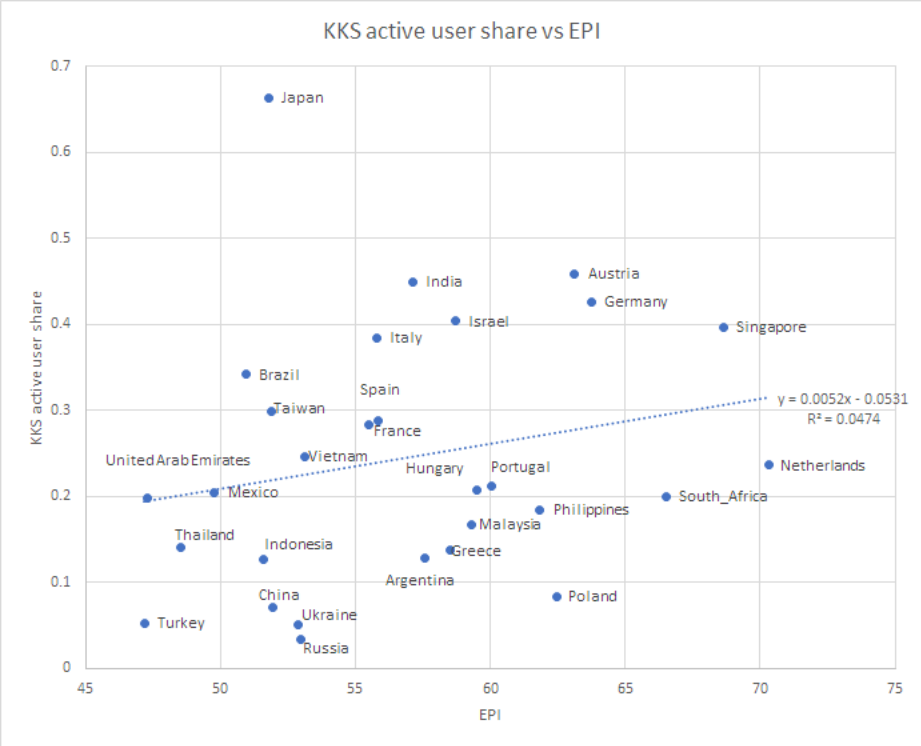


Figure 5. KKS active user share vs EPI.

9.11 Country data on platforms' download (active user) shares and the English Language Proficiency Index (EPI).

The SimilarWeb's data set (available through a free trial subscription on a demo platform) includes app download and active user numbers[36] in 29 countries only for the nearest three consecutive months (which, at the time of this writing, is 12/2019 through 02/2020), allowing only a cross-sectional correlation.

For each country, to calculate the download (active user) shares of individual e-reader platforms, we divide their download (active user) number by the total number of downloads (active users) of all e-reader apps, which provide both free and paid access to e-book titles and rank among the top 100 apps in the category Books and References in *Google Play Store*.

Note that worldwide, there are dozens of e-reader apps for Android devices, which can enable access only to a limited number of free e-books available on-line in various formats. For example, every country in the SimilarWeb's data set has at least one popular e-reader app which only allows free access to religious books (e.g., the Bible or the Koran). The download and active user numbers for these apps in many countries are much higher than for *Amazon Kindle*. To narrow down the e-reader market so that it best illustrates our model, we chose not to include in our study the apps that allow access to only a limited number of free e-books. There are 24 countries in the SimilarWeb's data set which have at least one well-known domestic e-reader platform providing access to both free *and* paid titles in the domestic language.

Also note that we do not include the *Google Play Books (GPB)* app download and active user data in our analysis of market shares of the major e-reader platforms of the English-language origin. On average 22% percent of the GPB app users in the countries in the SimilarWeb's sample rely on the GPB app version which was *preinstalled* on their Android devices. However, all GPB app versions (either preinstalled or downloaded and installed after users purchased their devices) are much better integrated with the Android operating system than any other e-reader app. Therefore, we interpret GPB as an app which is *tied with* the Google's Android operating system. Recent research on tying in two-sided markets has shown that the firm engaging in this strategy can inflate its market share relative to no tying (see Choi and Jeon, 2019). Since competing platforms in our model do not engage in tying, we choose to omit the GPB app from our empirical illustration of the relationship between e-reader platforms' market shares and the English language proficiency.

We should also note that although Google Play Store is officially blocked in China, a

[36] Users who opened the app at least once per month are considered active.

person using a Chinese smartphone can still download an app from a Google Play Store outside of China using a VPN (in Hong Kong, for example). SimilarWeb is able to track such users because the VPN can mask the user's location at the time of the download but not the country where the device is customarily used.

Finally, note that in our estimation of correlations between the EPI and English-language e-reader platforms' market shares, we used data for only 28 countries in the SimilarWeb's data set (which contains data for 29 countries) as we excluded from the set the data on Japan. We view Japan as an outlier among countries with low English language proficiency. Amazon, the Japan's leading e-book provider, entered Japan very early (in 2000) by leveraging its market share among Japanese customers buying foreign books from the U.S. on-line store Amazon.com as Japan was the second largest book market in the world. Moreover, Amazon has been number one e-commerce platform in Japan since it overtook its rival Rakuten in 2016.

Table A.1 The EPI, market shares of *Kindle* and the combined market shares of *Kindle*, *Kobo* and *Scribd* (*KKS*) in terms of app downloads and active users.

	2017 EF EPI	Kindle's download share**	KKS combined download share**	Kindle's active user share**	KKS combined active user share**	Domestic e-reader app***
Argentina	57.58	0.11	0.81	0.08	0.13	YES
Austria	63.13	0.56	0.30	0.44	0.46	YES
Brazil	50.93	0.42	0.52	0.31	0.34	YES
China	51.94	0.10	0.12	0.07	0.07	YES
France	55.49	0.45	0.42	0.24	0.28	YES
Germany	63.74	0.54	0.35	0.41	0.43	YES
Greece	58.49	0.18	0.67	0.08	0.14	NO
Hungary	59.51	0.10	0.70	0.13	0.21	NO
India	57.13	0.39	0.56	0.43	0.45	YES
Indonesia	51.58	0.05	0.77	0.07	0.13	NO
Israel	58.7*	0.66	0.19	0.37	0.40	YES
Italy	55.77	0.53	0.38	0.34	0.38	YES
Japan	51.8	0.68	0.29	0.66	0.66	YES
Malaysia	59.32	0.14	0.75	0.11	0.17	YES
Mexico	49.76	0.23	0.70	0.16	0.20	YES
Netherlands	70.31	0.14	0.70	0.15	0.24	YES
Philippines	61.84	0.11	0.72	0.11	0.18	NO
Poland	62.45	0.14	0.41	0.07	0.08	YES
Portugal	60.02	0.24	0.57	0.14	0.21	YES
Russia	52.96	0.08	0.25	0.03	0.03	YES
Singapore	68.63	0.40	0.51	0.30	0.40	YES
South_Africa	66.52	0.17	0.78	0.16	0.20	YES
Spain	55.85	0.56	0.35	0.26	0.29	YES
Taiwan	51.88	0.13	0.66	0.12	0.30	YES
Thailand	48.54	0.23	0.70	0.13	0.14	YES
Turkey	47.17	0.04	0.90	0.03	0.05	YES
Ukraine	52.86	0.09	0.45	0.04	0.05	YES
United Arab Emirates	47.27	0.27	0.67	0.16	0.20	NO
Vietnam	53.12	0.34	0.62	0.24	0.25	YES
Average	56.63	0.28	0.54	0.20	0.24	

* Educaton First does not provide the EPI for Israel but reports that countries' EPIs are strongly correlated with their average TOEFL iBT scores. Therefore, we estimated Israel's EPI using the country's average TOEFL iBT score for 2017 reported by the Educational Testing Service (see www.ets.org/toefl).

**App shares are based on the total app download and active user data for the period from 12/2019 through 02/2020.

*** Based on our own research as of January 19, 2020.

Sources: SimilarWeb Analytics, pro.similarweb.com; EF Education First, 2019.

10 Online appendix: the mixed case

This online appendix analyzes the mixed case where a share $\alpha \in (0,1)$ of consumers are bilingual and others are monolingual. We assume that a consumer's location on the Hotelling line is independently distributed of the consumer's language skill. We first study the simple case of no substitution between domestic content and foreign content and perform comparative static. We then characterize the interior equilibrium of the general case with substitution between domestic content and foreign content.

10.1 No substitution between domestic content and foreign content ($\gamma = 0$)

Suppose no substitution between foreign content and domestic content (i.e., $\gamma = 0$). We focus on an interior equilibrium where both platforms are active in both segments (monolingual and bilingual) of the consumer market.

In the mixed case, platform i's share of monolingual consumers x_i^M is given by (1) while platform 1's share of bilingual consumers x_1^B is given by (2). As there is no substitution between foreign and home language content (i.e., $\gamma = 0$), the mass of CPs joining platform i is given by

$$n_i = m\left(bx_i^A - F_i\right) \text{ for } i = 1, 2, \tag{32}$$

where $x_i^A \equiv (1-\alpha)x_i^M + \alpha x_i^B$ denotes platform i's overall (or average) consumer share for $i = 1, 2$. Expressing $\left(x_1^M, x_1^B\right)$ as a function of (F_1, F_2) yields

$$x_1^M = c_1^M - \frac{\sigma^M}{b}(F_1 - F_2), \tag{33}$$

$$x_1^B = c_1^B - \frac{\sigma^M}{b}(F_1 - F_2), \tag{34}$$

where

$$\frac{1}{2} < c_1^M \equiv \frac{1}{2} + 2\alpha\sigma^M \frac{an^f}{2t} < c_1^B \equiv \frac{1}{2} + \left(2\alpha\sigma^M + 1\right)\frac{an^f}{2t}.$$

c_1^M (c_1^B) denotes a constant in the demand for platform 1's service among monolingual consumers (bilingual consumers). Note that when $n^f = 0$, we have $c_1^M = c_1^B = 1/2$ because both platforms are completely symmetric. When $n^f > 0$, as bilingual consumers enjoy the foreign content whereas monolingual consumers do not, the foreign platform captures a larger market share among bilingual consumers than among monolingual consumers. Note that when the prices are equal, $F_1 = F_2$, the foreign platform's share among monolingual consumers is larger than the domestic platform's market share. This is due to the indirect

network effects: as its share of bilingual consumers increases, the foreign platform attracts more domestic CPs, which in turn increases its share of monolingual consumers. This can be also seen from the fact that c_1^M increases with the multiplier σ^M.

From (33) and (34), we find that the multiplier does not change with n^f and is given by σ^M in (5). This is because we assume that $\gamma = 0$. Therefore, platform i's profit $\pi_i = F_i n_i$ is maximized at a price such that its share of a CP's surplus is independent of α and n^f, as in (8):

$$\frac{F_i}{x_i^A b} = \frac{1}{2+\sigma^M} \text{ for } i = 1, 2. \tag{35}$$

Injecting (35) into (33) and (34) and solving for $\left(x_1^M, x_1^B\right)$ yields the equilibrium market shares:

$$x_1^M = \frac{c_1^M(\sigma^M+2) + \left[1 - 2\alpha(c_1^B - c_1^M)\right]\sigma^M}{3\sigma^M + 2}; \tag{36}$$

$$x_1^B = \frac{c_1^B(\sigma^M+2) + \left[1 + 2(1-\alpha)(c_1^B - c_1^M)\right]\sigma^M}{3\sigma^M + 2} \tag{37}$$

where $c_1^B > c_1^M > \frac{1}{2}$ implies $x_1^B > x_1^M$. With these consumer market shares, we can characterize the equilibrium as follows

Proposition 9 *(mixed case: equilibrium) Consider the setting with $\gamma = 0$, $n^f > 0$ and $\alpha \in (0,1)$. If n^f is small enough such that x_1^B in (37) is less than one, we have:*

(i) The equilibrium consumer market shares of platform 1, x_1^M and x_1^B, are given respectively by (36), (37). Moreover, we have $x_1^B > x_1^M$ and $x_1^A = (1-\alpha)x_i^M + \alpha x_i^B > 1/2$.

(ii) The equilibrium subscription fee F_i and the mass of CPs joining platform i are given by

$$F_i = \frac{x_i^A b}{\sigma^M + 2} \text{ and } n_i = mbx_i^A \frac{\sigma^M + 1}{\sigma^M + 2}, \text{ for } i = 1, 2. \tag{38}$$

Proof. (i) From (36) and (37), platform 1's overall consumer share x_1^A is given by

$$x_1^A = \frac{\left[(1-\alpha)c_1^M + \alpha c_1^B\right](\sigma^M+2) + \sigma^M}{3\sigma^M + 2} > \frac{\frac{1}{2}(\sigma^M+2) + \sigma^M}{3\sigma^M + 2} = \frac{1}{2}, \tag{39}$$

where the inequality follows from $c_1^B > \frac{1}{2}$ and $c_1^M > \frac{1}{2}$. The rest of the proof is omitted as it follows from the discussion in the main text.

(ii) Condition (38) follows from (32) and (35). ■

We now perform the comparative static analysis with respect to n^f and α. Consider first an increase in n^f. Note first that both c_1^B and c_1^M increase with n^f.

$$\frac{\partial c_1^B}{\partial n^f} = (1 + \frac{amb\alpha 2}{2t - amb2})\frac{a}{2t} > \frac{\partial c_1^M}{\partial n^f} = \frac{amb\alpha 2}{2t - amb2}\frac{a}{2t} > 0$$

As mentioned above the foreign platform's advantage relative to the domestic platform among bilingual consumers extends to monolingual consumers due to higher domestic CP participation in the foreign platform. An increase in n^f strengthens this advantage of the foreign platform among bilingual consumers as well as its advantage among monolingual consumers through the indirect network effects.

It is quite intuitive that an increase in the amount of foreign content available in the foreign platform increases the foreign platform's equilibrium market share among bilingual consumers. The effect of an increase in n^f on the foreign platform's share among monolingual consumers is less straightforward because the advantage of the foreign platform in terms of CPs participation is mitigated by the reduction of the subscription price of the domestic platform. But after some manipulation,[37] we find that an increase in n^f increases x_1^M as well as x_1^B.

Consider now an increase in the proportion α of bilingual consumers. We have

$$\frac{\partial c_1^B}{\partial \alpha} = \frac{\partial c_1^M}{\partial \alpha} = \frac{amb2}{2t - amb2}\frac{an^f}{2t} > 0.$$

An increase in the fraction of bilingual consumers raises the foreign platform's advantage relative to the domestic platform among bilingual consumers and indirectly among monolingual consumers. We also find that an increase in the share α of bilingual consumers raises each of x_1^M, x_1^B and x_1^A. This prediction is consistent with the empirical observation noted in the introduction that Amazon Kindle's app market share increases with the English proficiency of the population.

Finally, regrading the effect on domestic CPs participation n_i, condition (38) implies that there is no direct effect of n^f or α on n_i: indeed n_i is affected only through the change in x_i^A. An increase in x_1^A (and hence, a corresponding reduction in x_2^A) induces a proportionate increase in n_1 (respectively, reduction in n_2) such that the total participation of CPs $n_1 + n_2$ is constant:

$$n_1 + n_2 = mb\frac{\sigma^M + 1}{\sigma^M + 2}.$$

Summarizing these results, we have

Proposition 10 *(mixed case: comparative static) Consider the setting of $\gamma = 0$, $n^f > 0$ and $\alpha \in (0, 1)$. In the interior equilibrium, in which x_1^B in (37) is less than one, we have:*

(i) As n^f increases, x_1^M, x_1^B and x_1^A increase. As α increases, x_1^M, x_1^B and x_1^A increase.

(ii) Increasing n^f or α induces an increase in n_1 and an equal reduction in n_2.

[37] See the proposition below.

Proof. We have

$$\frac{\partial x_1^M}{\partial n^f} = \frac{2t - amb}{3\sigma^M + 2} \frac{2\alpha amb}{(2t - amb2)} \frac{a}{2t} > 0$$

and

$$\frac{\partial x_1^B}{\partial n^f} = \frac{(\sigma^M + 2)\frac{\partial c_1^B}{\partial n^f} + 2(1-\alpha)\sigma^M(\frac{\partial c_1^B}{\partial n^f} - \frac{\partial c_1^M}{\partial n^f})}{3\sigma^M + 2} > 0.$$

Moreover

$$\frac{\partial x_1^M}{\partial \alpha} = \frac{\partial x_1^B}{\partial \alpha} = \frac{2\sigma^M(\sigma^M + 1)}{3\sigma^M + 2} \frac{an^f}{2t} > 0;$$

$$\frac{\partial x_1^A}{\partial \alpha} = \frac{\left[(c_1^B - c_1^M) + \frac{\partial c_1^B}{\partial \alpha}\right](\sigma^M + 2)}{3\sigma^M + 2} > 0.$$

The point (ii) follows from condition (38) and the fact that the market is covered. ■

We now perform welfare analysis. Note that the intensity of competition is independent of α or n^f (i.e., $\sigma^M = \sigma^B$). We study how α changes the domestic welfare in the interior equilibrium characterized.

Regarding consumer surplus, we have:

$$CS = n^f \alpha x_1^B + n_1 x_1^A + n_2(1 - x_1^A) - \frac{t}{2}\left\{\alpha\left[(x_1^B)^2 + (1 - x_1^B)^2\right] + (1-\alpha)\left[(x_1^M)^2 + (1 - x_1^M)^2\right]\right\};$$

$$\frac{\partial CS}{\partial \alpha} = n^f x_1^B + n^f \alpha \frac{\partial x_1^B}{\partial \alpha} + 2(2x_1^A - 1)\left(\frac{\sigma^M + 1}{\sigma^M + 2}\frac{\partial x_1^A}{\partial \alpha} - \frac{t}{2}\frac{\partial x_1^B}{\partial \alpha}\right).$$

As we have $2x_1^A > 1$ and $\frac{\partial x_1^B}{\partial \alpha} > 0$, a sufficient condition for $\frac{\partial CS}{\partial \alpha} > 0$ is

$$\frac{\sigma^M + 1}{\sigma^M + 2}\frac{\partial x_1^A}{\partial \alpha} > \frac{t}{2}\frac{\partial x_1^B}{\partial \alpha},$$

which we verify to hold. Therefore, consumer surplus increases with α for two reasons. First, more bilingual consumers enjoy the foreign content. Second, the overall amount of domestic content *per consumer* increases with α because of economies of scale in the interactions between consumers and CPs. As α increases, both platform 1's consumer market share and its mass of domestic CPs increase while the reverse holds for platform 2. However, the total mass of domestic CPs, $n_1 + n_2$, remains constant. This implies that as α increases, on average, consumers get access to a larger amount of domestic content. This is very clear when x_1^A is close to 1, as in this case almost all consumers have access to twice the amount domestic content in the monolingual case.

Regarding producer surplus, we have

$$\Pi_d = \frac{\sigma^M + 1}{(\sigma^M + 2)^2}(1 - x_1^A)^2 + \frac{1}{2}\left[\frac{\sigma^M + 1}{\sigma^M + 2}\right]^2\left[(x_1^A)^2 + (1 - x_1^A)^2\right];$$

$$\frac{\partial \Pi_d}{\partial \alpha} = \frac{\sigma^M + 1}{(\sigma^M + 2)^2} \left[-2(1 - x_1^A) + (\sigma^M + 1)(2x_1^A - 1) \right] \frac{\partial x_1^A}{\partial \alpha}.$$

Therefore,

$$\frac{\partial \Pi_d}{\partial \alpha} \gtreqless 0 \text{ iff } x_1^A \gtreqless \frac{3 + \sigma^M}{4 + 2\sigma^M}.$$

As x_1^A increases with n^f, there is some threshold n^f such that below the threshold (above the threshold), the producer surplus decreases (increases) with α. A higher α reduces platform 2's profit but raises CPs' surplus because they also benefit from economies of scale in their interactions with consumers (just as consumers benefit from their interactions with CPs). Note that $1 > \frac{3+\sigma^M}{4+2\sigma^M} > 1/2$. Basically, when x_1^A is close to $1/2$, as α increases, the reduction in platform 2's profit dominates the increase in domestic CPs' surplus whereas the opposite holds when x_1^A is close to 1.

Summarizing, we have:

Proposition 11 *(domestic welfare) Consider the interior equilibrium in the case of* $\alpha \in (0, 1)$, $n^f > 0$ *and* $\gamma = 0$.

(i) As α *increases, consumer surplus increases.*

(ii) As α *increases, there is a threshold* n^f *such that producer surplus increases if and only if* n^f *is larger than the threshold.*

Proof. We omit the proof as the results follow from the discussions in the main text. ■

10.2 Substitution between domestic content and foreign content ($\gamma > 0$)

Consider now the case of substitution between domestic content and foreign content ($\gamma > 0$).

Inserting (3) and (4) into (1) and (2) , and expressing x_1^M as a function of (F_1, F_2) yields

$$x_1^M = c_1^M - \frac{\sigma_1^M}{b} F_1 + \frac{\sigma_2^M}{b} F_2 \tag{40}$$

where

$$
\begin{aligned}
c_1^M &= \frac{\left[\frac{1}{2}-\frac{amb}{2t}\right]\left[1+\frac{amb\alpha(2-\gamma n^f)}{2t-amb\alpha(2-\Gamma)}\right]+\frac{amb\alpha(2-\gamma n^f)}{2t-amb\alpha(2-\Gamma)}\frac{an^f}{2t}}{1-\frac{amb(1-\alpha)}{2t}\left[2+\frac{2amb\alpha(2-\gamma n^f)(1-\gamma n^f)}{2t-amb\alpha(2-\Gamma)}\right]} \\
\sigma_1^M &= \frac{\frac{amb}{2t}(1+\frac{amb\alpha(2-\gamma n^f)(1-2\gamma n^f)}{2t-amb\alpha(2-\Gamma)})}{1-\frac{amb(1-\alpha)}{2t}\left[2+\frac{2amb\alpha(2-\gamma n^f)(1-\gamma n^f)}{2t-amb\alpha(2-\Gamma)}\right]} \\
\sigma_2^M &= \frac{\frac{amb}{2t}(1+\frac{amb\alpha(2-\gamma n^f)}{2t-amb\alpha(2-\Gamma)})}{1-\frac{amb(1-\alpha)}{2t}\left[2+\frac{2amb\alpha(2-\gamma n^f)(1-\gamma n^f)}{2t-amb\alpha(2-\Gamma)}\right]}
\end{aligned}
$$

σ_1^M (σ_2^M) is a multiplier in the two-sided market associated with F_1 (F_2).

Similarly, expressing x_1^B as a function of (F_1, F_2) yields

$$x_1^B = c_1^B - \frac{\sigma^B}{b}F_1 + \frac{\sigma^B}{b}F_2 \tag{41}$$

where

$$
\begin{aligned}
c_1^B &= \frac{\left[\frac{1}{2}-\frac{amb}{2t}\right]\left[1+\frac{2amb(1-\alpha)(1-\gamma n^f)}{2t-amb(1-\alpha)2}\right]+\frac{an^f}{2t}}{1-\frac{amb\alpha}{2t}\left[(2-\Gamma)+\frac{2amb(1-\alpha)(1-\gamma n^f)(2-\gamma n^f)}{2t-2amb(1-\alpha)}\right]} \\
\sigma_1^B &= \frac{\frac{amb}{2t}(1-2\gamma n^f+\frac{2amb(1-\alpha)(1-\gamma n^f)}{2t-2amb(1-\alpha)})}{1-\frac{amb\alpha}{2t}\left[(2-\Gamma)+\frac{2amb(1-\alpha)(2-\gamma n^f)(1-\gamma n^f)}{2t-2amb(1-\alpha)}\right]} \\
\sigma_2^B &= \frac{\frac{amb}{2t}(1+\frac{2amb(1-\alpha)(1-\gamma n^f)}{2t-2amb(1-\alpha)})}{1-\frac{amb\alpha}{2t}\left[(2-\Gamma)+\frac{2amb(1-\alpha)(2-\gamma n^f)(1-\gamma n^f)}{2t-2amb(1-\alpha)}\right]}
\end{aligned}
$$

σ_1^B (σ_2^B) is a multiplier in the two-sided market associated with F_1 (F_2).

Regarding the multipliers, we have

Lemma 2 *When $\gamma n^f > 0$, under assumptions A1 and A2, each of the four multipliers strictly decreases with γn^f and we have*

$$\sigma_2^M > \sigma_1^M, \sigma_2^B > \sigma_1^B.$$

Proof. $\sigma_2^M > \sigma_1^M$ and $\sigma_2^B > \sigma_1^B$ are obvious. To save space, we below prove only that σ_1^M decreases with γn^f as the other results can be proved similarly. After some manipulation, we find

$$\sigma_1^M \frac{2t}{amb} = \frac{2t - amb\alpha 2\gamma n^f}{2t - amb\alpha(1+(1-\gamma n^f)(1-2\gamma n^f)) - amb(1-\alpha)\left[2 - \frac{amb\alpha(\gamma n^f)^2}{t}\right]}$$

Let f (g) represent the numerator (the denominator) of the R.H.S. We find

$$\begin{aligned} f'g - fg' &= -amb\alpha 2\left\{2t - amb\alpha(2-\Gamma) - amb(1-\alpha)(2 - \frac{amb\alpha(\gamma n^f)^2}{t})\right\} \\ &\quad + (2t - amb\alpha 2\gamma n^f) amb\alpha\left\{-3 + 4\gamma n^f - amb(1-\alpha)\frac{2\gamma n^f}{t}\right\} \\ &< -amb\alpha 2\left\{2t - amb\alpha 2 - amb(1-\alpha)2\right\} + (2t - amb\alpha 2\gamma n^f) amb\alpha\left\{-3 + 4\gamma n^f\right\} < 0 \end{aligned}$$

where the last inequality is obtained from $t > amb$ and $1 > 2\gamma n^f$. ■

When $\gamma n^f = 0$, all four multipliers have the same value equal to $\frac{amb}{2t-2amb} = \sigma^M$. Consider now $\gamma n^f > 0$. An increase in γn^f reduces all four multipliers because this weakens the positive feedback through the substitution effect experienced by domestic CPs and bilingual consumers in the foreign platform. More precisely, this substitution *directly* reduces the magnitude of changes in n_1 and x_1^B at each iteration of dynamic feedback process. But a smaller change in n_1 (respectively, in x_1^B) implies a smaller adjustment in x_1^M and x_1^B (respectively, in n_1 and n_2) in the next round of the feedback, which in turn reduces the feedback in the subsequent rounds. As the degree of substitution increases with γn^f, an increase in γn^f reduces all four multipliers and thereby weakens competition between the two platforms.

Since the substitution arises when bilingual consumers consume content in the foreign platform, we find that the multipliers are larger for platform 2 than for platform 1: $\sigma_2^M > \sigma_1^M, \sigma_2^B > \sigma_1^B$.

Each platform i maximizes $\pi_i = n_i F_i$ with respect to F_i. π_i is given by

$$\begin{aligned} \pi_1 &= n_1 F_1 \\ &= \left\{mb\left[(1-\alpha)\left(c_1^M - \frac{\sigma_1^M}{b}F_1 + \frac{\sigma_2^M}{b}F_2\right) + \alpha(1-\gamma n^f)\left(c_1^B - \frac{\sigma_1^B}{b}F_1 + \frac{\sigma_2^B}{b}F_2\right)\right] - mF_1\right\}F_1 \end{aligned}$$

and

$$\begin{aligned} \pi_2 &= n_2 F_2 \\ &= \left\{mb\left[(1-\alpha)\left(1 - c_1^M + \frac{\sigma_1^M}{b}F_1 - \frac{\sigma_2^M}{b}F_2\right) + \alpha\left(1 - c_1^B + \frac{\sigma_1^B}{b}F_1 - \frac{\sigma_2^B}{b}F_2\right)\right] - mF_2\right\}F_2 \end{aligned}$$

From the FOCs, we find

$$F_1 = \frac{(1-\alpha)x_1^M + \alpha x_1^B(1-\gamma n^f)}{(1-\alpha)\frac{\sigma_1^M}{b} + \alpha(1-\gamma n^f)\frac{\sigma_1^B}{b} + \frac{2}{b}}; \tag{42}$$

$$F_2 = \frac{(1-\alpha)(1-x_1^M) + \alpha(1-x_1^B)}{(1-\alpha)\frac{\sigma_2^M}{b} + \alpha\frac{\sigma_2^B}{b} + \frac{2}{b}}. \tag{43}$$

Inserting (42) and (43) into (40) and (41) and solving for $\left(x_1^M, x_1^B\right)$ yields

$$\begin{aligned} x_1^M &= \frac{c_1^M XY - \alpha(1-\gamma n^f)(c_1^B\frac{\sigma_1^M}{b} - c_1^M\frac{\sigma_1^B}{b})Y +}{D} \\ &\quad + \frac{\left[\alpha(c_1^M\frac{\sigma_2^B}{b} - c_1^B\frac{\sigma_2^M}{b}) + \frac{\sigma_2^m}{b}\right]X + \alpha(1-\gamma n^f)(\frac{\sigma_2^M}{b}\frac{\sigma_1^B}{b} - \frac{\sigma_1^M}{b}\frac{\sigma_2^B}{b})}{D}; \end{aligned} \tag{44}$$

$$\begin{aligned} x_1^B &= \frac{c_1^B XY + (1-\alpha)(c_1^B\frac{\sigma_1^M}{b} - c_1^M\frac{\sigma_1^B}{b})Y}{D} \\ &\quad + \frac{\left[(1-\alpha)(c_1^B\frac{\sigma_2^M}{b} - c_1^M\frac{\sigma_2^B}{b}) + \frac{\sigma_2^B}{b}\right]X + (1-\alpha)\left(\frac{\sigma_1^M}{b}\frac{\sigma_2^B}{b} - \frac{\sigma_2^M}{b}\frac{\sigma_1^B}{b}\right)}{D} \end{aligned} \tag{45}$$

where

$$X = (1-\alpha)\frac{\sigma_1^M}{b} + \alpha(1-\gamma n^f)\frac{\sigma_1^B}{b} + \frac{2}{b}, Y = (1-\alpha)\frac{\sigma_2^M}{b} + \alpha\frac{\sigma_2^B}{b} + \frac{2}{b}.$$

$$\begin{aligned} D &= XY + \left[(1-\alpha)\frac{\sigma_1^M}{b} + \alpha(1-\gamma n^f)\frac{\sigma_1^B}{b}\right]Y \\ &\quad + \left[(1-\alpha)\frac{\sigma_2^M}{b} + \alpha\frac{\sigma_2^B}{b}\right]X + (1-\alpha)\alpha\gamma n^f\left[\frac{\sigma_1^M}{b}\frac{\sigma_2^B}{b} - \frac{\sigma_2^M}{b}\frac{\sigma_1^B}{b}\right] \end{aligned}$$

Note that the denominator is the same in (44) and (45). In the case of the numerator, if we assume $\gamma n^f = 0$, the numerator of (45) can be obtained from the numerator of (44) by replacing α with $(1-\alpha)$ and the superscript M with B (and B with M).

The interior equilibrium exists whenever x_1^M in (44) and x_1^B in (45) satisfy $(x_1^M, x_1^B) \in (0,1)^2$. Then, x_1^M (respectively, x_1^B) is platform 1's share among monolingual consumers (respectively, among bilingual consumers). The equilibrium fees are obtained from (42), (43), (44), and (45).