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ABSTRACT

Language, Internet and Platform Competition: the case of Search Engine*

The World Wide Web was originally a totally English-based medium due to its US origin. Although the presence of other languages has steadily risen, content in English is still dominant, which raises a natural question of how bilingualism of consumers of a home country affects production of web content in the home language and domestic welfare? In this paper, we address this question by studying how bilingualism affects competition between a foreign search engine and a domestic one within a small country and thereby production of home language content. We find that bilingualism unambiguously softens platform competition, which in turn can induce a reduction in home language content and in home country's welfare. In particular, it is possible that content in the foreign language crowds out so much content in the home language that consumers enjoy less content when they are bilingual than when they are monolingual.

JEL Classification: D21, D43, F12, F61, L13 and L86
Keywords: bilingualism, international trade, language, platform, search engine and two-sided market

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1 Introduction

During its early days, the World Wide Web was almost exclusively an English-based medium due to its origin in the U.S. 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, Prado and Blanco, 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 ratio of webpages over users is the highest for English among all languages: it is 1.42 for English while all other European languages have a ratio below 1 except for German which has a ratio of 1.16 (see Figure 4 in the Appendix). This dominance of English web content raises a natural question: how bilingualism of a given country (i.e., the ability of the country's population to speak English as well as its native language) affects the production of content in the home language and domestic welfare?

This question is important from an economic point of view because of the steadily growing share of international online trade in total trade and because linguistic barriers are the main source of frictions and trade costs in crossborder e-commerce.[1] The question is also important because of its implication on linguistic and cultural diversity. Actually, there is a wide concern about how globalization and the Internet affects linguistic and cultural diversity:[2] for instance, UNESCO (2008) organized a conference on "Globalization and Languages" to discuss the challenges and opportunities from globalization on linguistic diversity.[3] As a first step to address the issue, this paper considers a small open economy and studies how bilingualism affects competition between online platforms and thereby production of web content of the economy.

Interactions between consumers and content on the Web are mediated by platforms such as search engines, iTunes for music, Amazon for books etc. Although our model can be applied to other platforms as well, in this paper we focus on search engines. One way to see the importance of search engines is to look at the exponential growth of webpages. According to the official blog of Google, by 2000 the Google index reached one billion pages

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

[2] See for instance the book of David Crystal (2006) entitled "Language and the Internet".

[3] "Given current trends, experts estimate that within a few generations, more than 50 percent of the estimated 7,000 languages spoken in the world today may disappear. (UNESCO, 2008, p. 16)".

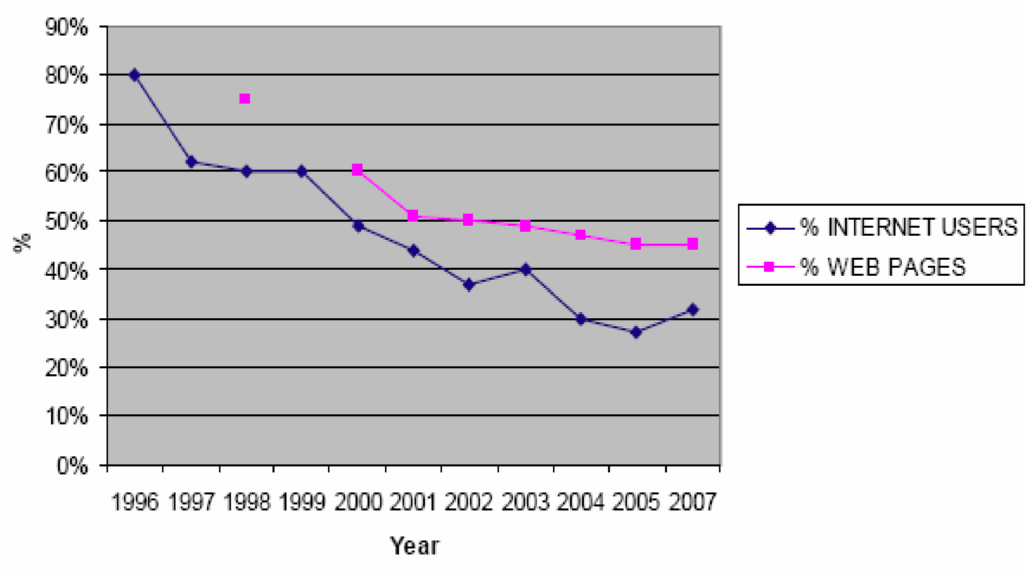

Figure 1: Evolution of percentages of English speaking Internet users and web pages (Pimienta, Prado and Blanco, 2009)

and by 2008 1 trillion unique URL.[4] Google's market shares in almost all national search services markets are astonishing (see the table in the appendix)[5]: whereas its market share estimates in the U.S. vary between 63% and 72% depending on the research institute that carried out the study, its market shares in Western European countries such as Belgium, Denmark, Finland, France, Germany, Netherlands, Portugal, Spain, U.K. are above 90%. What is equally surprising is that Google's market shares are below 40% in certain countries such as China, Czech Republic, Japan, South Korea, Russia, Taiwan where the leading search engine is either a domestic one or Yahoo.

In this paper, we consider competition between a foreign search engine and a domestic one in a home country[6] and study how search engine competition and production of content in the home language are affected by whether consumers of the home country are monolingual or bilingual. Does bilingualism increase the foreign search engine's market share in the home country? Does bilingualism make platform competition fiercer? How does bilingualism affect production of home language web content and domestic welfare?

[4] http://googleblog.blogspot.fr/2008/07/we-knew-web-was-big.html

[5] The market share represents the number of search queries done with Google over the total number of search queries in a given country.

[6] The model can be applied to competition between Google and Yahoo (or Bing) with a minor modification. See footnote 16.

In our model, there are two countries (Home country and Foreign country) each with its own language. The home language is used only by the Home country domestic content producers and consumers. Foreign content producers use the foreign language. Our focus is on the Home country's two-sided market where the competing home and foreign platforms bring together content producers and consumers and the latter can be either bilingual or monolingual. If consumers of the Home country are bilingual, they can consume foreign as well as domestic content.

We assume that the platforms (i.e. search engines) offer a search service of the same quality. The main difference between the two is that the home search engine offers access only to Home country's domestic content while the foreign one gives the domestic consumers access to both domestic and foreign content (i.e., the domestic engine can search only the Home country content while the foreign engine can search content of both countries). Since platforms offer no content translation and only bilingual domestic consumers can use foreign content, this difference between the platforms does not matter when consumers of the Home country are monolingual. However, the difference creates an advantage for the foreign platform when consumers are bilingual. At the same time, the foreign platform has a certain disadvantage since we assume that the offerings of the content producers (CPs) of the Home country have some overlap with the offerings of the CPs of the Foreign country. In other words, when consumers are bilingual, our assumptions imply: given that both platforms have the same mass of consumers, a domestic CP prefers joining the domestic platform to joining the foreign platform; given that both platforms have the same mass of domestic CPs, a consumer prefers the foreign platform to the domestic platform. The platforms levy (subscription) prices only on CPs and do not charge any price to consumers. In addition, we assume that consumers single-home and CPs multi-home.

Before analyzing the effect of bilingualism on platform competition, we consider a general model of platform competition in a closed economy and discover an important result: as one platform becomes more efficient (respectively, less efficient) in matching content producers and consumers, it strengthens (respectively, softens) platform competition. The intuition is based on a multiplier effect in a two-sided market. Suppose 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 terms of creating match value. This is why we obtain the result that as a platform becomes more (less) efficient, platform competition becomes stronger (weaker).

Our first result is that bilingualism can either increase or decrease the foreign platform's consumer market share in the Home country. On the one hand, having more foreign CPs on board helps the foreign platform to attract bilingual consumers. Bilingualism can even lead to a tipping equilibrium in which all consumers conduct search through the foreign platform. On the other hand, since domestic CPs are worried about competition from foreign CPs, the foreign platform has difficulty in attracting domestic CPs, which in turn makes it difficult to attract consumers. The equilibrium market share is determined by a trade-off between these two effects.

Our second result is that bilingualism softens platform competition. Access to foreign CPs comes with the cost of making exchanges between domestic CPs and consumers less valuable in the foreign platform. Because of the overlap between domestic content and foreign content, the ability to consume foreign content reduces the surplus that consumers in the foreign platform obtains from one additional domestic CP and the surplus domestic CPs subscribed to the foreign platform obtains from one additional consumer. In other words, it is as if bilingualism makes the foreign platform less efficient, which softens platform competition for the reasons explained earlier.

Our last result is that bilingualism can increase or decrease production of content in home language and hence domestic welfare. Regarding the effect of bilingualism on content production, there are two opposing forces. On the one hand, bilingualism can promote production of content in home language by increasing the mass of consumers using the foreign platform. A higher consumer concentration in one platform, all other things being equal, increases the home-language content production due to cross-side network externalities, typical in a two-sided market. On the other hand, bilingualism softens platform competition and thereby induces both platforms to extract a higher surplus from CPs, which can reduce production of content in the home language. In the extreme case in which bilingualism does not affect each platform's consumer market share, we find that content in the foreign language crowds out content in the home language so that the total effective mass of content[7] available in each platform gets reduced. This implies that bilingualism reduces domestic welfare if bilingualism does not affect consumer market share. Domestic welfare is reduced because each platform generates smaller surplus and, in addition, the foreign platform captures a larger share of the surplus. Bilingualism reduces world welfare if the reduction in surplus is greater than the saving in fixed cost, which results from the reduction of home language content in the foreign platform.

In general, we show that the welfare result depends on the relative weight of producer

[7] The effective mass of content in the foreign platform takes into account the overlap between domestic content and foreign content.

surplus over consumer surplus.[8] For most European and Latin American countries, the overlap is expected to be relatively large. Then, typically, bilingualism would increase consumer surplus at the cost of reducing producer surplus, which then decreases domestic welfare as long as the relative weight of producer surplus is large enough.

The paper is organized as follows. In section 1.1, we review the related literature. In section 2, we present our model of platform competition that includes international trade. In section 3, we consider the same model without international trade to study the multiplier in our two-sided model. In section 4, we analyze the case in which all consumers are monolingual. In section 5, we analyze the case in which all consumers are bilingual. In section 6, we compare the two cases in terms of prices, consumer market shares, mass of domestic CPs and welfare of the home country. Section 7 discusses the robustness of our results to relaxing the assumption of single-homing consumers, draws welfare implications on countries of different language families and suggests directions for future research.

1.1 Literature review

Our paper builds on the literature on two-sided markets (Rochet and Tirole, 2003, 2006, Caillaud and Jullien, 2001, 2003, Anderson and Coate, 2005, Armstrong 2006, Hagiu 2006, Weyl, 2010).[9] 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), 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.

In our model, language-related trade surplus differences are formalized in 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 the main feature of the models of bilingualism (Church and King, 1993 and Ortega and Tangeras,

[8] In section 6.3, we provide a theoretical foundation to why we can have a degree of freedom in terms of the relative weight of producer surplus over consumer surplus.

[9] 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).

2008).[10] However, our framework is different from the previous models of language or bilingualism in the two following 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's website share common language. Second, matches are mediated by platforms.

This paper is also related to the international economics literature which 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 (see 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 have been information sharing networks among internationally dispersed ethnic diasporas, sharing the same language and databases of business contacts, which can be viewed as a precursor of modern e-commerce platforms.[11] The importance of common language has also been emphasized in the literature which uses gravity models to show that immigrants promote trade with their country of origin (see Gould (1994), Head and Ries (1998), Wagner et al. (2002), and Rauch and Trindade (2002)). One likely reason for this impact of immigrants is their ability to speak their native language.

Despite the lack of official and comprehensive statistics on online international trade, a few notable empirical research papers studying the effects of e-commerce on trade have been published over the last few years. Freund and Weinhold (2004) was the first paper to provide empirical evidence consistent with a model in which the Internet reduces market-specific fixed costs of trade. In particular, using time-series and cross-section regression analysis on the data on bilateral trade from 1995 to 1999 and controlling for the standard determinants of trade growth, they find that a 10 percentage point increase in the growth of web hosts in a country leads to about a 0.2 percentage point increase in export growth. They also find that on average, the Internet contributed to about a 1 percentage point increase in annual export growth from 1997 to 1999. In a companion paper, Freund and Weinhold (2002) offer evidence that the Internet has even stronger impact on services

[10] 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.

[11] Rauch (1996, 1999) have analyzed the trade-facilitating role of these ethnic information-sharing networks using a search theory of trade in which such a network expands the number of possible export markets by increasing the number of draws a firm obtains when it searches for the best match. He showed 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.

trade. In particular, after controlling for GDP and exchange-rate movements, they find that a 10-percent increase in Internet penetration in a foreign country is associated with about a 1.7-percentage-point increase in export growth and a 1.1-percentage- point increase in import growth.

Several authors have analyzed cross-border e-commerce using different versions of the well-known gravity model of international trade 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). All papers based on the gravity model 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.

Blum and Goldfarb (2006) apply a gravity model to international internet click-stream data to analyze patterns of trade in non-tangible digital products and services which have negligible transportation costs. They find that distance negatively affects trade even in digital products and services that are free of transportation costs as long as their consumption is sensitive to cultural variables such as language (e.g., online music, games, and videos).

Unlike Blum and Goldfard (2006) which focused on trade in purely digital products, Hortaçsu et al. (2009) was the first paper to study international online trade in physical goods. It examines the importance of distance in these transactions using a sample of crossborder transactions from MercadoLibre, an online e-commerce platform covering twelve Latin American countries and two languages: Spanish and Portuguese. They conclude that distance still has an impact on trade, though less so in online than in offline transactions. They also provide evidence of a home-country bias in on-line trade patterns, i.e., the tendency of consumers to buy from domestic on-line merchants rather than foreign ones.

Lendl et al. (2012) use a dataset, which includes all crossborder transactions on eBay among 62 countries between 2004 and 2009, and estimate a gravity model of online trade with several explanatory variables, including shipping costs, common language, contiguity, quality of governance and legal environment, level of corruption, and colonial background. They find that most of these factors imply lower trade costs for eBay transactions than for their offline counterparts, with the notable exceptions of language and the level of corruption in the exporting country.

Martens and Turlea (2012) use a large-scale online consumer survey for 27 EU Member States to compare online trade patterns with offline trade patterns for similar goods. Using a standard gravity model they find evidence that while distance-related trade costs decline when moving from offline to online trade, trade costs associated with crossing language barriers increase.[12] They also estimate home bias in online trade in goods and compare it with estimates for offline trade available in economic literature. They find that home bias in online markets is considerably higher than in offline markets. Martens and Turlea (2012) conclude that strong home bias effect in online trade could be attributed to the high trade costs associated with crossing linguistic borders that considerably reduce the benefits of lower distance-related trade costs.

2 Model

There are two languages: home language (H) and foreign language (F). Home language is only spoken by consumers of the home country while foreign language is used abroad and by bilingual consumers of the home country. The home country is assumed to be small; the meaning of this assumption will be clarified later on. We view a search engine as an intermediary between consumers and content producers (hereafter CPs) and focus on the competition between two search engines within the home country, indexed by $i = 1$ or 2. In what follows, we present a simple stylized model.

2.1 Platforms, CPs and consumers

In the home country, there are a mass one of consumers and a continuum of CPs. We assume that CPs multi-home and consumers single-home. CPs will multi-home as long as this gives them a higher benefit than single-homing. We assume that each CP should incur a fixed cost to join a platform. There is a mass $F(k) = fk$ of CPs whose fixed cost of entry to platform i is below k, where f is a positive constant density. We assume that the total mass of CPs is large enough so that there are always CPs who decide not to join any platform.

[12] As Martens and Turlea (2012) suggest that a possible explanation for the greater importance of language barriers in online trade compared to offline trade has to do with the structure of trading environment. Traditional offline international trade is mostly carried out between businesses (Business-to-business or B2B), with well-established intermediaries such as wholesalers and import/export traders. Business-to-consumer (B2C) trade on the other hand puts final consumers directly in an exchange relationship with a wide range of anonymous potential suppliers, without any personal relationships. In an offline B2B trade environment with established long-term relationships, economies of scale may facilitate the amortization of translation costs, for instance by means of translated catalogues or hiring multilingual staff to deal with foreign clients. This is more difficult in a B2C online trading environment where consumers have direct exchanges with e-merchants. The small scale and short duration of these operations may make it more difficult to overcome linguistic barriers.

Regarding consumers, time constraint and habit formation can induce at least some fraction of consumers to single-home. In the case of search engine platforms, most platforms are portals providing a whole range of services designed to minimize a consumer's incentive to leave their portals. Hence, many consumers tend to form a habit such that their virtual life is centered around a portal. Therefore, for simplicity, we assume that all consumers single-home. In Section 7, we discuss the robustness of the results to relaxing this single-homing assumption.

We assume that consumers are uniformly distributed on a line between zero and one. Platform 1 (2) is located at the left (right) extreme point of the line. Platforms are horizontally differentiated for two different reasons. First, they differ in terms of the way they generate search results for a given query. For instance, they have different databases (i.e. indexed webpages), use different algorithms for search and different ways to display search results.[13] They also differ in terms of how much they rely on machines versus human forces. Second, they offer different services as portals.

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 p_i to CPs. Actually, Google's advertising fee is per click, which can be captured as a usage fee in our model. However, a usage fee makes it impossible to conduct analysis with closed-form solutions.[14] Therefore, for tractability, we consider subscription fees.

2.2 Language and exchanges

We consider that platform 1 is foreign and multilingual while platform 2 is domestic and monolingual. By monolingual we mean that it provides services to consumers and CPs only in domestic language.[15] Consumers of the home country are either bilingual or monolingual. Let $\alpha \in \{0, 1\}$ be the fraction of bilingual consumers in the Home country: $\alpha = 0$ (respectively, $\alpha = 1$) means that all the consumers of the home country are monolingual (respectively, bilingual). In addition, we assume that all CPs in the home country and only them have their websites in the home language.

[13] For instance, Naver (the dominant search engine in South Korea) has a multiple ranking model such that it displays search results according to different databases (called, collections) and each collection has its own ranking model.

[14] In section 3, we define the multiplier of our two-sided model of platform competition. Complexity arises because each usage fee directly enters into the multiplier, which affects the denominator of the pricing formula.

[15] Our model and analysis can be easily extended to the case in which both platforms are multilingual but differs in their coverage of foreign language content (such as Google versus Yahoo or Bing). See footnote 16.

Each consumer's location in the Hotelling line is uniformly distributed independently of whether he or she is bilingual or monolingual. A consumer derives utility from services (say organic search) and access to subscribed CPs. For simplicity we assume that the value of services u is the same for all platforms and all types of consumers (this is w.l.o.g., see footnote 17 below). We assume that u is large enough such that every consumer ends up using one of the two platforms.

Let n_i denote the measure of domestic CPs subscribed to platform i. We assume that a monolingual consumer "located" at distance d_i from platform i obtains the following utility upon joining it:

$$u + an_i - td_i$$

where $a > 0$ is the expected surplus per domestic CP on the platform and $t > 0$ is the transportation cost in the Hotelling model. A bilingual consumer obtains the same utility at the domestic platform 2 since it operates only in domestic language.

Let $n^F > 0$ be the measure of the foreign language CPs who are subscribed to platform 1 and offer products *relevant* to consumers of the home country. By "relevant", we mean that consumers of the home country have demand for the products and are able to obtain them at a negligible transaction cost if they are willing to. For instance, if content is paid for and cross-border on-line transaction is subject to heavy tariffs and/or non-tariff trade barriers, n^F is small even if the measure of foreign language CPs on board in platform 1 is large. Similarly, if the home country's economic and cultural background differs substantially from abroad, n^F is small.[16] The fact that we consider n^F an exogenous parameter is justified by our assumption that the home country is small relative to the foreign language one. The home country is so small that it cannot influence the presence of foreign language CPs on the foreign platform.

Only bilingual consumers of the home country can benefit from foreign language CPs of platform 1. Furthermore, we assume that platform 1 provides the option to use any single language or both languages. Basically, monolingual consumers can access only home language CPs whereas bilingual consumers can access CPs in any language. Actually, Google provides such options. We assume that the offerings of foreign language CPs have some overlap with the offerings of the domestic CPs: more precisely, given (n_1, n^F), there is an overlap of $2\gamma n_1 n^F > 0$. Since the overlapping offerings cannot be larger than the total offerings of the domestic CPs, we have $n_1 - 2\gamma n_1 n^F > 0$, which implies the following assumption.

[16] 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 $n^F = n_1^F - n_2^F > 0$.

A1: $1 > 2\gamma n^F$.

Hence, a bilingual consumer benefits from $n_1+n^F-2\gamma n_1 n^F$ CPs instead of n_1+n^F. We assume that when a content is offered both in domestic and foreign language, a consumer interacts with either content with the same probability. Therefore, $n_1 + n^F - 2\gamma n_1 n^F$ exchanges are divided between $n_1 - \gamma n_1 n^F$ in home language and $n^F - \gamma n_1 n^F$ in foreign language.

Finally we assume that a domestic CP attaches a value $b > 0$ to each consumer present on the same platform. Without loss of generality, we can normalize (a, b, f) to $a = b = f = 1$ (see the appendix). Hence, from now on, we consider the normalized model except for section 3 in which we study the multiplier in our model of two-sided market and section 6.3 in which we compare domestic welfare.

Let x_i denote platform i's share of consumers. Given that all consumers use one of the two platforms, x_i is equal to the measure of consumers using platform i. The next table summarizes our assumptions on the benefits of interactions between consumers and CPs:[17]

Table 1: surplus in each platform

	platform 1	platform 2
a monolingual consumer's surplus	$u + n_1$	$u + n_2$
a bilingual consumer's surplus	$u + (n_1 + n^F - 2\gamma n_1 n^F)$	$u + n_2$
a domestic CP's surplus	$x_1(1 - \alpha\gamma n^F)$	x_2

Note that when consumers are bilingual, the exchanges in foreign language makes the exchanges in home language within platform 1 less efficient in the following sense; the (expected) surplus that a domestic CP obtains from an additional consumer decreases from one to $(1 - \gamma n^F)$ and the (expected) surplus that a consumer obtains from an additional domestic CP decreases from one to $(1-2\gamma n^F)$. Actually, A1 guarantees that both the CP's marginal surplus and the consumer's marginal surplus are positive.

Qualitative interpretation of our assumptions is the following. In the case in which consumers are bilingual, if platforms have the same mass of consumers, a domestic CP prefers joining the domestic platform to joining the foreign platform; if both platforms have the same mass of domestic CPs, a bilingual consumer prefers the foreign platform to the domestic platform.

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

2.3 Timing and assumption

The timing of the game we consider is the following.

1. Each platform i chooses the subscription fee p_i for domestic CPs.

2. Domestic CPs make decisions to subscribe to platform 1 and/or platform 2 and each consumer forms the habit to use one of the two platforms.

In stage 2, we assume that for a consumer located at x, the cost of forming the habit to use platform 1 (2) is tx ($t(1-x)$).

We assume:

A2: $t > abf$.

A2 is a stability condition. Precisely, suppose that some consumers switch from platform 2 to platform 1. Then this will increase the mass of CPs subscribed to platform 1 while decreasing the mass of CPs subscribed to platform 2. This in turn induces extra consumers to switch from 2 to 1. 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. More precisely, A2 makes an increase in p_i induces a decrease in i's market share in consumers and which in turn makes i's profit a concave function of p_i. The role played by A2 becomes clearer in section 3 when we explain the multiplier.

3 Multiplier and spillover in a closed economy

Before we study the specific case of monolingual or bilingual consumers, it would be very useful to have a general understanding of what is going on in our model of platform competition in a two-sided market. In particular, understanding how the key parameters of the model affect the degree of platform competition through a "multiplier" (that we will identify in this section) is crucial to studying the effect of the change from monolingual consumers to bilingual consumers on the economy of the home country.

For this purpose, we consider a closed economy in which the surplus from the interaction between a consumer and a CP is platform-specific as represented by $a_i > 0$ for a consumer and $b_i > 0$ for a CP with $i = 1, 2$. In addition, we assume that consumer surplus from organic search is platform-specific as well and is represented by u_i. We maintain the normalization of $f = 1$.

Given (p_1, p_2), let x denote the location of the consumer who is indifferent between the two platforms. It is given by

$$u_1 + a_1 n_1 - tx = u_2 + a_2 n_2 - t(1-x), \quad (1)$$

which is equivalent to

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

CPs will join platform i so long as their resulting net surplus, $x_i b_i - p_i$, exceeds the fixed cost of joining the platform. Since the fixed cost of a CP who joins platform i is distributed with a constant density $f = 1$, the mass of CPs who join platforms 1 and 2 are determined by:

$$(xb_1 - p_1) - n_1 = 0; \tag{3}$$

$$[(1-x)b_2 - p_2] - n_2 = 0. \tag{4}$$

Given (p_1, p_2), we determine the allocation (x, n_1, n_2) from equations (2) to (4): we have

$$x = \frac{1}{2} + \frac{1}{2}\frac{[-2(a_1 p_1 - a_2 p_2) + 2(u_1 - u_2) + a_1 b_1 - a_2 b_2]}{A}, \tag{5}$$

where the denominator of the last term $A \equiv 2t - (a_1 b_1 + a_2 b_2) > 0$ is assumed to be positive from A2.[18] Let x_i denote the consumer market share of platform i. From (5), we have

$$\frac{dx_i}{dp_i} = -\frac{a_i}{A}. \tag{6}$$

$1/A$ represents *the multiplier* in our two-sided market. To explain (6), suppose that platform 1 reduces p_i by one unit. Then, from (3), n_1 increases by one unit and this in turn increases its consumer share by $a_1/2t$ from (2) (and decreases platform 2's consumer share by $a_1/2t$). This in turn increases n_1 by $a_1 b_1/2t$ and reduces n_2 by $a_1 b_2/2t$, which induces an additional increase in its consumer share by $a_1 \left(a_1 b_1 + a_2 b_2\right) / \left(2t\right)^2$ etc. At the end, the total increase in x is equal to a_1/A; actually, A2 is equivalent to $a_1/A > 0$.

Furthermore, we can also consider A as an *inverse measure of platform competition.* To see it, consider platform i's maximization of its profit given by

$$\pi_i = p_i n_i = p_i(x_i b_i - p_i). \tag{7}$$

From the first order condition, we obtain:

$$p_i = \frac{x_i b_i}{2 + \frac{a_i b_i}{A}}. \tag{8}$$

Therefore, all other things being equal, as A decreases, there is more competition between the two platforms and they charge a lower price.

Actually, we can define the "tax rate" on CPs in platform i as

$$\tau_i \equiv \frac{p_i}{x_i b_i} = \frac{1}{2 + \frac{a_i b_i}{A}}.$$

[18] $2t > a_1 b_1 + a_2 b_2$ is a generalization of A2 to when $a_1 b_1 \neq a_2 b_2$.

Basically, CPs' surplus in platform i is divided between CPs and the platform and τ_i (respectively, $1 - \tau_i$) represents the platform's share (respectively, the CPs' share). In any shared equilibrium in which each platform has a positive consumer market share, τ_i is constant and depends only on common factors (A, t) and platform specific factor $a_i b_i$. In particular, as A decreases, τ_i decreases: the stronger the competition between the two platforms, the smaller is the share captured by the platforms. What is interesting is that this inverse measure of the degree of competition decreases with each platform's effectiveness in terms of creating match value (a_i, b_i) such that if platform i becomes more efficient (i.e. a_i or b_i increases), it has a negative spillover on platform j since τ_j decreases. The converse is also true.

Proposition 1 *(measure of platform competition) Consider the model of platform competition in a closed economy in which the surplus from an exchange between a consumer and a CP depends on the identity of platform. Under generalized A2 (i.e. $A = 2t - (a_1 b_1 + a_2 b_2) > 0$), in any shared equilibrium,*

(i) the tax rate on CPs in platform i is given by

$$\tau_i = \frac{1}{2 + \frac{a_i b_i}{A}},$$

where A is an inverse measure of platform competition.

(ii) If platform i becomes more efficient (i.e. a_i or b_i increases), it strengthens platform competition and decreases τ_j: conversely, if platform i becomes less efficient (i.e. a_i or b_i decreases), it softens platform competition and increases τ_j.

4 Monolingual consumers

In this section, we study the case in which all consumers are monolingual. As a consequence, there is no international trade except for the "cross-border" provision to the Home country consumers of the search service by the Foreign platform. In this case, the two platforms are symmetric.

We first study the shared equilibrium in which each platform has a positive consumer market share. Since the analysis of this case is a particular case of section 3 with $a_1 = a_2 = 1$ and $b_1 = b_2 = 1$, we just write a few formulae.

Given (p_1, p_2), the consumer market share for platform 1 is given by

$$x_1 = \frac{1}{2} - \frac{1}{2}\frac{(p_1 - p_2)}{t - 1}. \tag{9}$$

From the first order conditions of profit maximization, we obtain:

$$p_i = \frac{x_i b}{2 - \frac{\partial x_i}{\partial p_i} b} \tag{10}$$

where

$$\frac{dx_i}{dp_i} = -\frac{1}{2}\frac{1}{t-1} < 0. \tag{11}$$

The second order derivative is $-2+2b\frac{dx_i}{dp_i} < 0$. Therefore, we have a unique equilibrium, which is symmetric ($x_1 = x_2 = 1/2$).

Under A2, we can show that there is no tipping equilibrium. Suppose that all consumers subscribe to platform 1 for instance. If platform 1 charges zero price, then platform 1 can attract mass one of CPs since a CP's surplus from subscribing to platform 1 is one. Hence, an upper bound on consumer's expected gross surplus from joining platform 1 is $u + 1$. Under A2, the consumer who is located at the opposite extreme point has an incentive to join platform 2 and obtain u rather than to join platform 1 and obtain $u+1-t$ since $t > 1$.

Summarizing, we have a unique equilibrium, which is symmetric. We use superscript M to denote equilibrium outcome when all consumers are monolingual:

Proposition 2 *(monolingual case) When all consumers are monolingual, under A2, we have a unique equilibrium, which involves two symmetric active platforms:*

$$x_i^M = x^M = 1/2,\ p_i^M = p^M = \frac{t-1}{4t-3}, n_i^M = n^M = \frac{2t-1}{8t-6}.$$

5 Bilingual consumers

We now study the case in which all consumers are bilingual. The model of bilingual consumers where each of a, b, f is normalized at one can be equivalently represented as the model of section 3 with the following parameter specifications:

$$a_1 = 1 - 2\gamma n^F, b_1 = 1 - \gamma n^F, u_1 = u + n^F, a_2 = b_2 = 1, u_2 = u.$$

We first define a very important parameter:

Definition 1 $\Gamma = a_2 b_2 - a_1 b_1 = 1 - (1-\gamma n^F)(1-2\gamma n^F)$.

We have $\Gamma = \gamma n^F \left(3 - 2\gamma n^F\right) \in [0, 1)$. Γ measures *the reduction in the efficiency of exchanges in home language within platform 1*, which is caused by exchanges in foreign language. More precisely, in the absence of the exchanges in foreign language, the efficiency of exchanges in home language within each platform can be measured by $a * b = 1$. Exchanges in foreign language reduce the (expected) surplus that a domestic CP obtains from having an additional consumer from one to $(1-\gamma n^F)$ and the (expected) surplus that a consumer obtains from having an additional domestic CP from one to $(1-2\gamma n^F)$. Therefore, the efficiency measure of exchanges in home language are reduced by Γ within platform 1. Note also $A = 2(t-1)+\Gamma$.

5.1 Shared equilibrium

As in the previous section, we first study a shared equilibrium. From (5), we have

$$x = \frac{1}{2} + \frac{-((1-2\gamma n^F)p_1 - p_2) + n^F - \Gamma/2}{A} \tag{12}$$

From (8), we have

$$p_1 = \frac{x_1(1-\gamma n^F)}{2 + \frac{(1-\gamma n^F)(1-2\gamma n^F)}{A}}; \tag{13}$$

$$p_2 = \frac{1-x_1}{2+\frac{1}{A}}, \tag{14}$$

where $p_1 > 0$ from A1.

Substituting the prices with the expressions of (13) and (14) in (12) gives

$$x_1^B = \frac{t-1+n^F+\frac{1}{2+\frac{1}{A}}}{A + \frac{1}{2+\frac{1}{A}} + \frac{1-\Gamma}{2+\frac{1-\Gamma}{A}}}, \tag{15}$$

where the superscript B in x^B represents the case in which all consumers are bilingual. $x^B > 0$ under A1.

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

$$n^F \leq t-1+\Gamma+\frac{1-\Gamma}{2+\frac{1-\Gamma}{2(t-1)+\Gamma}} \equiv \underline{n}^F. \tag{16}$$

5.2 Tipping equilibrium

Furthermore, we can have a cornering equilibrium. Under A2, there is no equilibrium in which platform 2 corners. However, there can be an equilibrium in which platform 1 corners.

For instance, we can study the monopoly tipping equilibrium. When $x_1 = 1$, the mass of CPs on platform 1 should satisfy the following equation:

$$(1 - \gamma n^F) - p_1 = n_1.$$

Platform 1's profit is

$$\Pi_1 = p_1((1 - \gamma n^F) - p_1).$$

Maximizing it leads to

$$p_1^T = \frac{(1 - \gamma n^F)}{2},$$

implying

$$n_1^T = \frac{(1 - \gamma n^F)}{2}.$$

where the superscript T means tipping. This is an equilibrium if platform 2 cannot attract consumers and therefore CPs by charging $p_2 = 0$. Hence, we have a cornering equilibrium with a monopoly price, if at price $(p_1, p_2 = 0)$, platform 2 doesn't sell or $x_1 > 1$ where x_1 is given by equation (12) :

$$\frac{t - 1 + n^F - \left(1 - 2\gamma n^F\right) p_1}{A} = \frac{t - 1 + n^F - \frac{1-\Gamma}{2}}{2\,(t-1) + \Gamma} > 1$$

or equivalently

$$n^F > \frac{2t - 1 + \Gamma}{2} \equiv \overline{n}^F. \tag{17}$$

We have $0 < \underline{n}^F < \overline{n}^F$. Summarizing, we have:

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

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

$$\begin{aligned} x_1^B &= \frac{t - 1 + n^F + \frac{1}{2+\frac{1}{A}}}{A + \frac{1}{2+\frac{1}{A}} + \frac{1-\Gamma}{2+\frac{1-\Gamma}{A}}},\ p_1^B = \frac{x_1^B(1-\gamma n^F)}{2 + \frac{1-\Gamma}{A}},\ p_2^B = \frac{1 - x_1^B}{2 + \frac{1}{A}} \\ n_1^B &= x_1^B(1 - \gamma n^F) - p_1^B,\ \ n_2^B = 1 - x_1^B - p_2^B, \end{aligned}$$

where $A \equiv 2(t-1) + \Gamma$.

(ii) If the condition $n^F > \overline{n}^F$ holds, the equilibrium is such that platform 1 corners the market and charges the monopoly price $p_1^T = \frac{(1-\gamma n^F)}{2}$.

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

6 Comparison

In this section, we compare the two cases: the monolingual case and the bilingual one in terms of market shares, tax rates, domestic content and domestic welfare for $a = b = f = 1$.

6.1 Market shares and tax rates in a shared equilibrium

In this subsection, we study how bilingualism affects the market shares and tax rates levied by the platforms in the home country.

Platform 1's consumer market share is given by:

$$x_1^B = \frac{1}{2} + \frac{n^F - \Gamma\left(\frac{1}{2} - \frac{1}{\left(2+\frac{1}{A}\right)\left(2+\frac{1-\Gamma}{A}\right)}\right)}{A + \frac{1}{2+\frac{1}{A}} + \frac{1-\Gamma}{2+\frac{1-\Gamma}{A}}}$$

When $n^F = 0$, $\Gamma = 0$ from Definition 1 and we obtain $x^B = 1/2$. Similarly when t becomes infinite, the term A becomes infinite and we have

$$\lim_{t\to\infty} x_1^B = \frac{1}{2}.$$

For the general case, the market share under bilingualism is higher for the foreign language platform (i.e. $x_1^B > 1/2$) if

$$n^F > \Gamma\left(\frac{1}{2} - \frac{1}{\left(2+\frac{1}{A}\right)\left(2+\frac{1-\Gamma}{A}\right)}\right). \quad (18)$$

This is clearly the case for a given n^F if γ is small (hence Γ is small). A sufficient condition to make $x^B > 1/2$ for $n^F > 0$ is $n^F > \Gamma/2$. On the contrary, a sufficient condition to make $x^B < 1/2$ is $n^F \leq \Gamma/4$. As Γ measures the reduction in the efficiency of exchanges in home language within platform 1 whereas n^F measures a consumer's gain from exchanges in foreign language within platform 1, it is intuitive that bilingualism decreases the market share of platform 1 if n^F is smaller than a certain fraction of Γ.

Alternatively, we can express platform 1's market share as follows:

$$x_1^B = cn^F + d,$$

where

$$c = \frac{1}{2(t-1)+\Gamma+\frac{1}{2+\frac{1}{2(t-1)+\Gamma}}+\frac{1-\Gamma}{2+\frac{1-\Gamma}{2(t-1)+\Gamma}}} > 0,$$

$$d = \frac{t-1+\frac{1}{2+\frac{1}{2(t-1)+\Gamma}}}{2(t-1)+\Gamma+\frac{1}{2+\frac{1}{2(t-1)+\Gamma}}+\frac{1-\Gamma}{2+\frac{1-\Gamma}{2(t-1)+\Gamma}}} > 0,$$

$$\frac{\partial c}{\partial \Gamma} < 0, \frac{\partial d}{\partial \Gamma} < 0.$$

Therefore, for any given $n^F > 0$, as Γ increases,[19] 1's market share decreases; for any given $\Gamma \in [0,1)$, as n^F increases, 1's market share increases.

Therefore, we have:

Proposition 4 *(market share) Suppose A1 and A2.*

(i) Bilingualism increases the consumer market share of the bilingual platform if $n^F \geq \Gamma(1+3\Gamma)/2(1+\Gamma)(1+2\Gamma)$ *but reduces it if* $n^F \leq \Gamma/4$*. For intermediate values, there exists* $\hat{t}$ *such that* $x_1^B > 1/2$ *if and only if* $t > \hat{t}$*.*

(ii) For any given $n^F > 0$*, as* Γ *increases, the consumer market share of the bilingual platform decreases; for any given* $\Gamma \in [0,1)$*, as* n^F *increases, the consumer market share of the bilingual platform increases.*

Proof. (i) Follows from the fact that the RHS of (18) decreases with t. ■

Figure 2 shows that for $t = 1,1$ and $\gamma = 1.9$, platform 1's market share (represented on the vertical ax) initially decreases and then increases as n^F (represented on the horizontal ax) increases.

We now compare the tax rate of each platform in shared equilibrium. Note first that bilingualism increases the inverse measure of platform competition by Γ: A increases from $2(t-1)$ to $2(t-1)+\Gamma$. This implies that tax rates are higher when consumers are bilingual than when they are monolingual. Let τ_i^M (respectively, τ_i^B) denote the tax rate of platform i when consumers are monolingual (respectively, when consumers are bilingual). We have:

Proposition 5 *(Competition-softening effect) Suppose A1 and A2. Bilingualism softens platform competition: it increases the inverse measure of platform competition by* Γ *and*

[19] This reasoning cannot be made for $n^F = 0$ since then $\Gamma = 0$ as well.

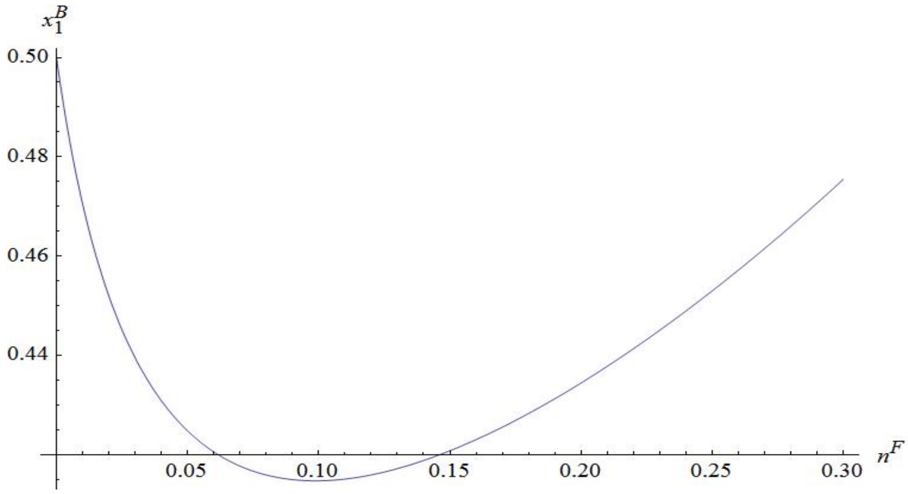

Figure 2: Platform 1's market share when consumers are bilingual (for $t = 1.1$, $\gamma = 1.9$)

thereby increases the tax rate of each platform. More precisely, in any shared equilibrium,[20] *we have:*

$$\tau_i^M = \frac{1}{2+\frac{1}{2(t-1)}} < \tau_2^B = \frac{1}{2+\frac{1}{2(t-1)+\Gamma}} < \tau_1^B = \frac{1}{2+\frac{1-\Gamma}{2(t-1)+\Gamma}} \text{ for } \gamma n^F > 0;$$
$$\tau_i^M = \tau_2^B = \tau_1^B \text{ for } \gamma n^F = 0.$$

Note that all the above tax rates are constant and do not depend on the exact market shares. Exchanges in foreign language come with the cost of making exchanges in home language less valuable in platform 1, which reduces the multiplier (i.e. $1/A$). When consumers are monolingual (i.e. $a_i = b_i = 1$ for $i = 1, 2$), the multiplier is

$$\frac{1}{2(t-1)}.$$

When consumers are bilingual, the multiplier is

$$\frac{1}{2(t-1)+\Gamma},$$

which is smaller than $1/2(t-1)$, which explains $\tau_i^M < \tau_i^B$ for $i = 1, 2$. A part from this multiplier effect, the fact that exchanges in foreign language make exchanges in home

[20]It is needless to say that in a cornering equilibrium, the tax rate of platform 1 is even higher than the rate in shared equilibrium (see section 6.2).

language less efficient within platform 1 has a direct effect of increasing the price charged by platform 1, which explains $\tau_2^B < \tau_1^B$. In real world, the exercise of market power of a search engine can be done through a high reservation price for keyword auctions.

6.2 Production of domestic content

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

Consider first the polar case in which bilingualism does not affect each platform's consumer market share (and hence $\gamma n^F > 0$). First, $x_1^M = x_1^B = 1/2$ implies $n_1^B - 2\gamma n_1^B n^F + n^F = n_2^B$. Furthermore, we know from proposition 5 that bilingualism softens competition, implying that $n_2^B < n_2^M = n_1^M$. Therefore, in this case, the amount of domestic content crowded out is more than the foreign content available such that bilingualism reduces the total effective amount of content available in each platform.

More generally, in a shared equilibrium, we have

$$n_1^B = x_1^B(1-\gamma n^F) - p_1^B = \left(cn^F + d\right)(1-\gamma n^F)\left(1 - \frac{1}{2 + \frac{1-\Gamma}{2(t-1)+\Gamma}}\right). \tag{19}$$

Note that since Γ strictly increases with γn^F for $\gamma n^F \in [0, 1/2)$, fixing Γ implies fixing γn^F. In other words, increasing n^F for given Γ implies reducing γ to keep γn^F constant. Therefore, for any given $\Gamma \in [0, 1)$, as n^F increases, content in the home language in the bilingual platform increases. For any given $n^F > 0$, as Γ increases, content in the home language in the bilingual platform decreases as $1-\gamma n^F$ and $(1-\Gamma)/(2(t-1)+\Gamma)$ decrease in Γ. For instance, for t large, x_1^B is close to 1/2. Then (19) implies that the gross surplus of domestic CPs in platform 1 is smaller under bilingualism than under monolingualism for $\gamma n^F > 0$. Furthermore, from Proposition 4, for $n^F \geq \Gamma/4$ and t large enough, $x_2^B < 1/2$ and hence the gross surplus of domestic CPs in platform 2 is smaller under bilingualism than under monolingualism as well. Therefore, in this case, bilingualism reduces domestic content in both platforms.

Consider now the monopoly tipping equilibrium (i.e. $n^F > \frac{2t-1+\Gamma}{2} \equiv \overline{n}^F$). First notice that the tax rate is given by:

$$\tau_1^T = \frac{1}{2} > \tau_i^M = \frac{1}{2 + \frac{1}{2(t-1)}}.$$

So CPs capture a smaller share of surplus under bilingualism. However the mass of consumers is also larger under bilingualism. We have $\left(1-\gamma n^F\right)/2 = n_1^T$ which is smaller than

n^M[21] if and only if

$$\gamma n^F > \frac{2t-2}{4t-3}.$$

Thus when there is little differentiation and large overlap between foreign language and domestic content, the price increase by the foreign platform more than offsets the increase in its consumer market share. As a result, bilingualism reduces content in the home language. On the contrary, if there is enough differentiation and little overlap, tipping increases the supply of domestic content. Summarizing, we have:

Proposition 6 *(content) Assume A1 and A2.*

(i) In a shared equilibrium (i.e. $n^F \leq \underline{n}^F$*)*

(a) For any given $\Gamma \in [0,1)$*, as* n^F *increases, home language content of the bilingual platform increases. For any given* $n^F > 0$*, as* Γ *increases, home language content of the bilingual platform decreases.*

(b) If bilingualism does not affect each platform's consumer market share, the amount of domestic content crowded out is more than the foreign content available such that bilingualism reduces the total effective amount of content available in each platform.

(c) Suppose $n^F \geq \Gamma/4$ *and* $\gamma n^F > 0$*. For t large enough, bilingualism reduces domestic content available in each platform,* $n_i^B < n^M$ *for* $i = 1, 2$*.*

(ii) In a monopoly tipping equilibrium (i.e. when $n^F > \overline{n}^F$*), bilingualism reduces domestic content available, i.e.* $n_1^T < n^M$ *if and only if*

$$\gamma n^F > \frac{2t-2}{4t-3}.$$

6.3 Domestic welfare

In this subsection, we study how bilingualism affects the social welfare of the home country. We first show that in order to compare welfare in the original model, we can restrict attention, w.l.o.g, to the weighted sum of the consumer surplus and producer surplus in the normalized model. And then, we perform welfare comparison for some special cases analytically and run simulations for a general case.

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

6.3.1 Welfare in the original model vs welfare in the normalized model

In the appendix, we show an interesting result about the link between domestic welfare in the original model with any (a, b, f) with $a > 0$, $b > 0$, $f > 0$ and domestic welfare in the normalized model with $a = b = f = 1$.

The domestic welfare in the original model when consumers are bilingual is defined as:

$$\begin{aligned} W(a, b, f, n^F, \gamma) &= \left\{ u + a\left(n_1 + n^F - 2\gamma n_1 n^F\right) x_1 + a n_2 x_2 - \frac{t}{2}\left[(x_1)^2 + (1 - x_1)^2\right] \right\} \\ &+ \left\{ n_2 p_2 + \frac{(n_1)^2 + (n_2)^2}{2f} \right\} \end{aligned}$$

where the term in the first bracket represents consumer surplus and the term in the second bracket represents producer surplus (i.e. the sum of the domestic platform's profit and the payoffs of domestic CPs); $\frac{(n_1)^2+(n_2)^2}{2f}$ takes into account both CPs' net surplus and their fixed cost. Note that the welfare when consumers are monolingual is simply a particular case of the welfare when consumers are bilingual with $n^F = 0$.

Define $CS(1, 1, 1, n^F, \gamma)$ and $\Pi(1, 1, 1, n^F, \gamma)$ as consumer surplus and producer surplus in the normalized model with $a = b = f = 1$.

$$\begin{aligned} W(1, 1, 1, n^F, \gamma) &= u + CS(1, 1, 1, n^F, \gamma) + \Pi(1, 1, 1, n^F, \gamma), \\ CS(1, 1, 1, n^F, \gamma) &= \left(n_1 + n^F - 2\gamma n_1 n^F\right) x_1 + n_2 x_2 - \frac{t}{2}\left[(x_1)^2 + (1 - x_1)^2\right], \\ \Pi(1, 1, 1, n^F, \gamma) &= n_2 p_2 + \frac{(n_1)^2 + (n_2)^2}{2}. \end{aligned}$$

Then, in the appendix, we show

$$W(a, b, f, n^F, \gamma) = u + bf\left\{aCS(1, 1, 1, n^F, \gamma) + b\Pi(1, 1, 1, n^F, \gamma)\right\}.$$

Therefore, comparing $W(a, b, f, n^F, \gamma)$ with $W(a, b, f, 0, \gamma)$ is equivalent to comparing $CS(1, 1, 1, n^F, \gamma)$ $+\frac{b}{a}\Pi(1, 1, 1, n^F, \gamma)$ with $CS(1, 1, 1, 0, \gamma) + \frac{b}{a}\Pi(1, 1, 1, 0, \gamma)$ where $b/a > 0$ is the relative weight of producer surplus in the domestic welfare. In other words, *in terms of the comparison, without loss of generality, we can restrict attention to the weighted sum of the consumer surplus and producer surplus in the normalized model.*

6.3.2 When $\gamma = 0$

When $\gamma = 0$, from proposition 3, in a shared equilibrium, we have:

$$\begin{aligned} x_1^B &= \frac{1}{2} + \beta n^F, x_2^B = \frac{1}{2} - \beta n^F; \\ n_1^B &= \left(\frac{1}{2} + \beta n^F\right)(1 - \lambda), n_2^B = \left(\frac{1}{2} - \beta n^F\right)(1 - \lambda), \end{aligned}$$

where

$$\beta = \frac{1}{2}\frac{1}{t-1+\frac{1}{2+\frac{1}{2(t-1)}}} > 0, 1-\lambda = 1-\frac{1}{2+\frac{1}{2(t-1)}} > 0.$$

In the monolingual case, we have

$$CS(1,1,1,0,0) = \frac{1}{2}(1-\lambda-\frac{t}{2}).$$

We assume $1-\lambda-\frac{t}{2} > 0$. It means that consumer surplus (net of the surplus from non-sponsored search) is positive in the monolingual case and it is satisfied if t is not too large. Then, we have

$$\begin{aligned} CS(1,1,1,n^F,0) &= (1-\lambda-\frac{t}{2})\left(\frac{1}{2}+2\beta n^F\right)^2 + (\frac{1}{2}+\beta n^F)n^F; \\ \frac{dCS(1,1,1,n^F,0)}{dn^F} &> 0; \frac{d^2CS(1,1,1,n^F,0)}{dn^{F2}} > 0. \end{aligned}$$

Hence, consumer surplus strictly increases with n^F; furthermore, it increases in a increasing way.

Regarding producer surplus, we have

$$\begin{aligned} \Pi(1,1,1,n^F,0) &= \left(\frac{1}{2}+\beta n^F\right)^2(1-\lambda)^2 + \left(\frac{1}{2}-\beta n^F\right)^2(1-\lambda); \\ \frac{d\Pi(1,1,1,n^F,0)}{dn^F} &\gtreqless 0 \text{ iff } n^F \gtreqless \overline{n}^F \equiv \frac{\lambda}{2\beta}; \frac{d^2\Pi(1,1,1,n^F,0)}{dn^{F2}} > 0. \end{aligned}$$

Actually, $n_1^B + n_2^B$ is constant and does not depend on n^F. Bilingualism increases platform 1's consumer market share and decreases that of platform 2, which in turn increases platform 1's CPs and decreases those of platform 2. This in turn increases CPs' total surplus because of economies of scale in the interactions between consumers and CPs; for given total number of consumers and CPs, having asymmetric market share generates a higher surplus from match between the two groups. However, bilingualism reduces platform 2's profit. Hence, the aggregate effect on producer surplus is ambiguous and we find that the marginal decrease in platform 2's profit dominates the marginal increase in CPs' surplus for any $n^F < \overline{n}^F$. Since $\Pi(1,1,1,n^F,0)$ is convex in n^F, this in turn suggests that there is another cutoff $\widehat{n}^F (> \overline{n}^F)$ such that bilingualism increases producer surplus if and only if $n^F > \widehat{n}^F$. Summarizing, we have:

Proposition 7 *(welfare when there is no content overlap) Suppose* $\gamma = 0$ *and* $1-\lambda-\frac{t}{2} > 0$. *When consumers are bilingual, in any shared equilibrium,*

(i) Consumer surplus and domestic CPs' surplus increasingly increases with n^F*;*

(ii) Domestic producer surplus including platform 2's surplus decreases with n^F up to $\overline{n}^F \equiv \frac{\lambda}{2\beta}$ and then increases with n^F. Hence, when bilingualism decreases producer surplus, there is a threshold weight of producer surplus such that bilingualism decreases (respectively, increases) domestic welfare for any weight (b/a) above the threshold (respectively, below the threshold).

6.3.3 When market share is not affected

Suppose $\gamma n^F > 0$ and consider the polar case in which bilingualism does not affect each platform's consumer market share. We know from Section 6.2 $n_1^B - 2\gamma n_1^B n^F + n^F = n_2^B < n_2^M = n_1^M$.

Consider first platform 2. The prices paid by CPs to platform 2 are pure transfer and do not affect domestic welfare. For given market share, maximizing domestic social welfare in platform 2 requires subsidizing CPs' subscriptions since CPs generates positive externalities to consumers. Therefore, an increase in the subscription price, which reduces the mass of CPs subscribed to platform 2, reduces domestic welfare generated by platform 2.

Consider now platform 1. Bilingualism reduces consumer surplus in platform 1 since the total "effective" mass of CPs ($n_1^B - 2\gamma n_1^B n^F + n^F$) is smaller than n_1^M. Domestic CPs suffer as well since they pay a higher subscription price whereas the expected number of transactions per CP decreases due to the competition from foreign CPs.

When we make world welfare comparison, the previous discussion shows that bilingualism reduces the surplus generated by each platform i from $(a+b)n_i^M/2 = n_i^M$ to $n_2^B = n_1^B - 2\gamma n_1^B n^F + n^F$. In platform 2, this reduction in surplus is larger than the saving in the fixed cost of entry from $\left(n_2^M\right)^2/2$ to $\left(n_2^B\right)^2/2$. However, in platform 1, the latter can be larger than the former. Therefore, bilingualism decreases world welfare if the reduction is total surplus is larger than the saving in the entry cost:

$$2n_1^M - \left(n_2^M\right)^2 - \left[2n_2^B - \left(n_2^B\right)^2\right] > \frac{1}{2}\left(\left(n_2^B\right)^2 - \left(n_1^B\right)^2\right).$$

Proposition 8 *(welfare when there is no change in the market share) Suppose that bilingualism does not affect each platform's consumer market share.*

(i) Bilingualism always reduces domestic welfare because

(a) the total surplus generated by each platform is smaller; and

(b) both consumers and domestic CPs get a smaller share of the reduced surplus in platform 1.

(ii) Bilingualism reduces world welfare if the reduction in the surplus generated by both platforms is larger than the saving in the entry cost of domestic CPs subscribing to platform 1.

6.3.4 General case

The previous polar cases show that bilingualism can increase or decrease a given domestic group's payoff. We here present simulations result for the general case. In general, for given t, there can be four regimes depending on the values of (n^F, γ):

- Regime I: $CS(1,1,1,n^F,\gamma) \geq CS(1,1,1,0,\gamma)$ and $\Pi(1,1,1,n^F,\gamma) \geq \Pi(1,1,1,0,\gamma)$
- Regime II: $CS(1,1,1,n^F,\gamma) \geq CS(1,1,1,0,\gamma)$ and $\Pi(1,1,1,n^F,\gamma) < \Pi(1,1,1,0,\gamma)$
- Regime III: $CS(1,1,1,n^F,\gamma) < CS(1,1,1,0,\gamma)$ and $\Pi(1,1,1,n^F,\gamma) \geq \Pi(1,1,1,0,\gamma)$
- Regime IV: $CS(1,1,1,n^F,\gamma) < CS(1,1,1,0,\gamma)$ and $\Pi(1,1,1,n^F,\gamma) < \Pi(1,1,1,0,\gamma)$

More generally, figure 3 shows all possible regimes on a plan of (n^F, γ) for given $t = 1.3$ in the shared equilibrium. γ belongs to $(0, 0.5)$ and is represented on the vertical axis and n^F belongs to (0,1) and is represented on the horizontal axis (hence A1 is satisfied and we also verify that there is always a shared equilibrium). Consider any given $n^F \in [0.35, 0.8]$. Then, for γ relatively small, bilingualism increases both consumer surplus and producer surplus. As γ increases, the conflict between the two groups emerges such that bilingualism increases consumer surplus but decreases producer surplus. As γ further increases and becomes relatively large, bilingualism decreases both consumer surplus and producer surplus. The regime III does not exist for the parameters considered.

In most western European countries and Latin American countries, we expect a high γ and a high n^F and hence these countries are likely to be in Regime II where bilingualism increases consumer surplus while decreasing producer surplus. As the weight of producer surplus in domestic welfare (i.e. as b/a) increases (respectively, decreases), bilingualism would decrease (respectively, increases) domestic welfare in these countries. On the contrary, in Asian countries, we expect a low γ and a low n^F. As long as γ is sufficiently smaller than n^F, bilingualism will increase consumer surplus and CP surplus.

7 Concluding remarks

Our main insight is based on the multiplier effect in our two-sided market and therefore should be robust to allowing for multi-homing on consumer side. As long as a positive fraction of consumers single-homes, the multiplier effect remains qualitatively the same: if some single-homing consumers switch from platform 1 to platform 2, it will increase content available in platform 2 and decrease content available in platform 1, which in turn induces

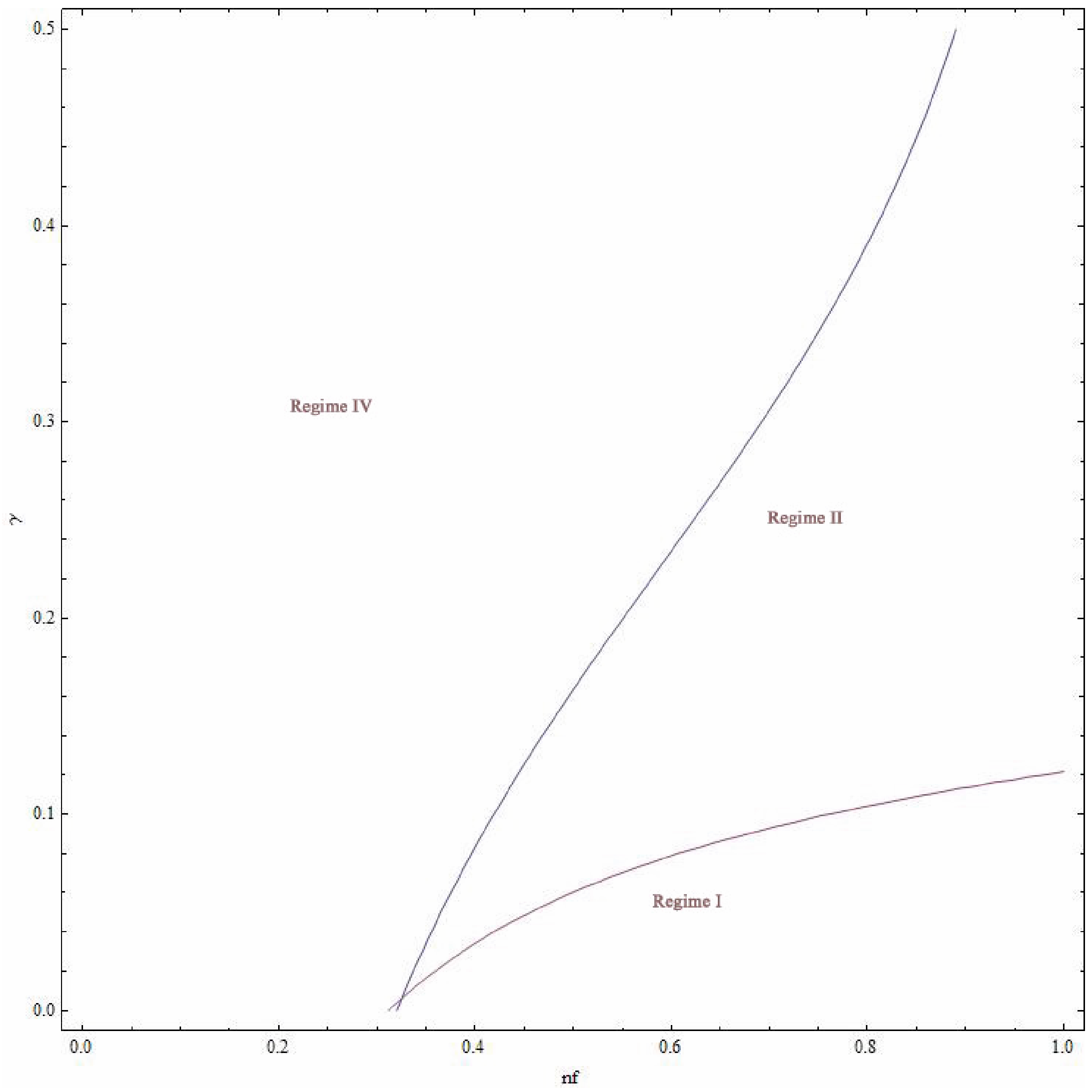

Figure 3: Contour of $CS(1,1,1,n^F,\gamma) = CS(1,1,1,0,\gamma)$ (the blue curve) and $\Pi(1,1,1,n^F,\gamma) = \Pi(1,1,1,0,\gamma)$ (the red curve) for $t = 1.3$

additional single-homing consumers to switch from platform 1 to 2 and so on. Then, we still have the result that as one platform becomes less efficient, it reduces the multiplier and thereby softens platform competition. In addition, we also have the result that a positive overlap between foreign content and domestic content has the effect of making the foreign platform less efficient in terms of marginal surplus generated by interactions between domestic consumers and domestic content. Combining the two results implies that bilingualism softens platform competition as long as a positive fraction of consumers single-homes.

In most western European countries and Latin American countries, Google's market share is above 90% and is larger than its market share in U.S.A. (see the last table in the appendix). Although we did not analyze what is going on outside of the small home country, our results can offer an explanation to this fact. Basically, a relatively large fraction of bilingual consumers in home country allows Google to leverage its market share in U.S.A. such that a tipping equilibrium (or a shared equilibrium close to tipping) can prevail in home countries. Our results show that this leverage typically increases consumer surplus at the cost of reducing surplus of domestic CPs. Therefore, when the relative weight of producer surplus over consumer surplus is large enough, bilingualism reduces domestic welfare in these countries. In particular, bilingualism can reduce the production of content in the home language when there is little differentiation of search service and a large overlap between content in English and content in the home language.

For our analysis, cultural factors should also matter 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. In particular, our results are consistent with the fact that Google's market share is often below its market share in U.S.A. in countries whose national languages are not based on Roman alphabet. In these countries, most consumers are monolingual and the overlap between English content and domestic content is smaller than in countries using Roman alphabet. Moreover it is more difficult to conduct the same query in several languages if alphabet are different. Hence there is little leverage of Google's market share from U.S.A. to home countries.

Our paper is a first step to economic research on languages and platforms in the Internet. There are many interesting issues for future research. One important benefit of bilingualism that we did not incorporate is that it can increase the number of consumers using the Internet in the beginning when little content is available in the home language. Therefore, at least in the early stage of the Internet, bilingualism promotes production of domestic web content by helping to reach a critical mass of users. It would be interesting to consider a dynamic model and to study the conditions under which the benefit of bilingualism eventually remains larger than its cost. Google offers translation service whose quality increases over time as its algorithm gets applied to larger and larger data. It would be interesting to analyze how the increase in the quality of translation service affects platform competition and domestic content production. Finally, it would be great to go beyond the small open economy, which requires to explicitly model platform competition both in the home country (i.e. the bilingual country) and in the foreign country (i.e. the monolingual country).

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9 Appendix

9.1 Normalization of the model to $a = b = f = 1$

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

$$x_i = \left[\frac{1}{2} + \frac{a(n_1 + n^F - 2\gamma n_1 n^F) - an_2}{2t}\right],$$
$$n_1 = \left(x_1(1 - \gamma n^F)b - p_1\right) f,$$
$$n_2 = (x_2 b - p_2) f.$$

We can normalize the original model as follows:

We do the following normalization:

$$\widetilde{x}_i = x_i, \widetilde{n}_i = \frac{n_i}{bf}, \widetilde{n}^F = \frac{n^F}{bf}, \widetilde{\gamma} = \gamma bf.\widetilde{p}_i = \frac{p_i}{b}, \widetilde{t} = \frac{t}{abf}, \widetilde{a} = \widetilde{b} = \widetilde{f} = 1.$$

Note that $\gamma n^F = \widetilde{\gamma}\widetilde{n}^F$. Then we have

$$\widetilde{x}_i = \left[\frac{1}{2} + \frac{(\widetilde{n}_1 + \widetilde{n}^F - 2\gamma \widetilde{n}_1 \widetilde{n}^F) - \widetilde{n}_2}{2\widetilde{t}}\right]$$
$$\widetilde{n}_1 = \left(\widetilde{x}_1(1 - \gamma n^F) - \widetilde{p}_1\right).$$
$$\widetilde{n}_2 = (\widetilde{x}_2 - \widetilde{p}_2).$$

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

$$W = u + a\left(n_1 + n^F - 2\gamma n_1 n^F\right) x_1 + an_2 x_2 - \frac{t}{2}\left[(x_1)^2 + (1 - x_1)^2\right]$$
$$+ n_2 p_2 + \frac{(n_1)^2 + (n_2)^2}{2f}$$

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

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

Note that A1 is the same both in the original model and in the normalized model. A2 becomes $t > 1$ in the normalized model.

9.2 Figures

	EN	SP	FR	IT	PO	RO	GE	CAT	Total
Speakers (millons)[3]	670	400	130	60	205	30	120	9	6607[4]
Speakers as % of world population	10.1%	6.1%	2.0%	0.9%	3.1%	0.5%	1.8%	0.1%	130%[5]
Internet users in a given language (millions)[6]	366	102	58	31	47	5	59	2	1154[7]
Internet users in % of speakers	54.6%	25.4%	44.9%	52.3%	23.1%	16.5%	49.1%	23.1%	17.5%[8]
Internet users in % of world population	5.5%	1.5%	0.9%	0.5%	0.7%	0.1%	0.9%	0.0%	17.5%
% internet users per language	32%	9%	5%	3%	4%	0%	5%	0.2%	130%
% web per language[9]	45.0%	3.8%	4.4%	2.7%	1.4%	0.3%	5.9%	0.1%	100%
Ling. productivity per language[10]	1.42	0.43	0.87	0.98	0.34	0.66	1.16	0.74	1
web pages per internet users in a given language	4.44	0.63	2.24	2.93	0.45	0.62	3.25	0.96	

Figure 4: Indicators for languages in the Internet (2007) (Pimienta, Prado and Blanco, 2009)

http://googlesystem.blogspot.com/2009/03/googles-market-share-in-your-country.html

Country	Market Share	Date	Research Institute
Argentina	89.00%	Jan-08	comScore
Australia	87.81%	Jun-08	Hitwise
Austria	88.00%	Jan-08	comScore
Belgium	96.00%	Mar-09	comScore?
Brazil	89.00%	Jan-08	comScore
Bulgaria	80.00%	Dec-07	multilingual search
Canada	78.00%	Jan-08	comScore
Chile	93.00%	Jan-08	comScore
China	26.60%	Oct-08	iResearch
Colombia	91.00%	Jan-08	comScore
Czech Republic	34.50%	Mar-09	
Denmark	92.00%	Jan-08	comScore
Estonia	53.37%	Jul-08	Gemius SA
Finland	92.00%	Jan-08	comScore
France	91.23%	Feb-09	AT Internet Institute
Germany	93.00%	Mar-08	
Hong Kong	26.00%	Jan-08	comScore
Hungary	96.00%	Aug-08	
Iceland	51.00%	Dec-07	
India	81.40%	Aug-09	comScore
Ireland	76.00%	Jan-08	comScore
Israel	80.00%	2007	
Italy	90.00%	Feb-09	
Japan	38.20%	Jan-09	Nielsen/NetRatings
Korea, South	3.00%	2009	
Latvia	97.95%	Jul-08	Gemius SA
Lithuania	98.18%	Aug-08	Gemius SA
Malaysia	51.00%	Jan-08	comScore
Mexico	88.00%	Jan-08	comScore
Netherlands	95.00%	Dec-08	
New Zealand	72.00%	Jan-08	comScore
Norway	81.00%	Jan-08	comScore
Poland	95.00%	Q4 2008	Gemius SA
Portugal	94.00%	Jan-08	comScore
Puerto Rico	57.00%	Jan-08	comScore
Romania	95.21%	Mar-09	statcounter.com
Russia	32.00%	Jan-08	Spylog
Singapore	57.00%	Jan-08	comScore
Slovakia	75.60%	Dec-07	
Spain	93.00%	Jan-08	comScore
Sweden	80.00%	Jan-08	comScore
Switzerland	93.00%	Jan-08	comScore
Taiwan	18.00%	Jan-08	comScore
Ukraine	72.42%	Feb-09	Bigmir-Interne
United Kingdom	90.39%	Dec-08	Hitwise
United States	63.30%	Feb-09	comScore
United States	72.11%	Feb-09	Hitwise
Venezuela	93.00%	Jan-08	comScore

Figure 5: Google's market share in each country