Language, Internet and Platform Competition: the case of Search Engine (Preliminary, Comments Welcome)*

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Abstract

Although transaction costs associated with on-line commerce are lower than the off-line transaction costs, language remains a key barrier to trade. This paper analyzes how on-line consumers' knowledge of a foreign language affects international competition between on-line platforms, such as internet search engines. More precisely, we consider search engines which provide interactions between two sides (consumers and merchants) of the market and analyze how the competition between a foreign platform and a domestic one in a home country is affected by whether consumers of the home country are monolingual or bilingual. We find some surprising results: (i) bilingualism can either increase or decrease the foreign platform's market share in the home country; (ii) bilingualism unambiguously softens platform competition; (iii) bilingualism can either increase or decrease the home country's welfare. We apply our results to address the question of to what extent Google's high market share in a given country is due to its own superior technology as opposed to the dominance of English.

Key words: Language. Bilingualism, Platform, Search Engine, Two-sided Market, International Trade.

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1 Introduction

The spectacular growth of e-commerce has created new famous players such as Google, Amazon.com, Ebay, Youtube, Facebook etc. Most of these firms are platforms that provide interactions among different individuals and/or companies: search engines mediate interactions between consumers and websites of merchants, online auction sites provide virtual market places where sellers and buyers meet, social networking sites provide social interactions among subscribers. Furthermore, all these virtual platforms are global players, which is a natural consequence of the fact that e-commerce faces much less friction than the trade environment in which the interaction between sellers and buyers is mediated by traditional means of communication. In particular, Google's market shares in search services in most countries in the world are astonishing (see the table in the appendix)[1]: whereas its market share in U.S. is 63% or 72% depending on the research institute that carried out the study, its market share in western European countries such as Belgium, Denmark, Finland, France, Germany, Netherlands, Portugal, Spain, U.K. are above 90%.[2] 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.

Even though on-line transactions face much less frictions than off-line ones, language remains as a key barrier to trade on Internet. This paper analyzes how language affects competition between on-line platforms that mediate interactions between consumers and merchants. More precisely, we analyze how competition between a foreign search engine and a domestic one in a home country is affected by whether consumers of the home country are monolingual or bilingual. Does bilingualism increase the foreign search engine's market

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

[2] One of the channels through which the Internet and the search engines are likely to impact international trade is the reduction of entry costs associated with imperfect information about a foreign market. The Internet has the potential to reduce these costs because suppliers can can advertise to numerous buyers at once and buyers can more easily find information about new products. Freund and Weinhold (2004) present empirical evidence which is 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) they offer evidence that the Internet has even stronger impact on services 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 in- crease in export growth and a 1.1-percentage- point increase in import growth.

share in the home country? Does bilingualism make platform competition fiercer? Does bilingualism increase domestic welfare? The answers to these questions generate insights useful to understand to what extent Google's market share in Western Europe (for instance) is due to its own superior technology as opposed to the prevalence of users who speak English.

In our model, there are two countries (Home country and Foreign Country) with different languages. We assume that all consumers of the Foreign country are monolingual while all consumers in the Home country are either monolingual or bilingual. We assume that the two search engines, a domestic one and a foreign one, offer search service of the same quality. The domestic platform (i.e. search engine) offers access to domestic content only while the foreign one gives access to both domestic and foreign content. Since only bilingual consumers can trade with foreign merchants, this difference does not matter when consumers of the Home country are monolingual. However, the difference creates an advantage to the foreign platform when consumers are bilingual. This advantage comes with a disadvantage since we assume that the offerings of the merchants of the Home country have some overlap with the offerings of the merchants of the Foreign country. In other words, our assumptions imply: given that both platforms have the same mass of domestic consumers, a domestic merchant prefers joining the domestic platform to joining the foreign platform; given that both platforms have the same mass of domestic merchants, a monolingual consumer is indifferent between the two but a bilingual consumer prefers the foreign platform to the domestic platform. The platforms levy (subscription) prices only on merchants and do not charge any price on consumers. In addition, we assume that consumers single-home and merchants 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), 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 merchants subscribed to platform 1 while decreasing merchants subscribed to platform 2, which in turn induces additional consumers to switch from platform 2 to platform 1, and so on. This multiplier effect depends on each platform's efficiency in terms of creating match value and increases with the efficiency of each platform. 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 merchants on board help the foreign platform to attract bilingual consumers. Actually, bilingualism can lead to a tipping equilibrium in which all domestic consumers conduct search through the foreign platform which charges a monopoly price on domestic merchants. On the other hand, since domestic merchants are worried about competition from foreign merchants, the foreign platform has difficulty in attracting domestic merchants, which in turn makes it difficult to attract consumers. The equilibrium market share is determined by a (complex) trade-off between these two effects.

Our second result is that bilingualism softens platform competition in the Home country. Access to foreign merchants comes with the cost of making the trade between a domestic merchant and a domestic consumer less valuable in the foreign platform. First, the international trade reduces the marginal surplus that a domestic consumer in the foreign platform obtains from one additional domestic merchant because of the substitution effect. Second, the same effect reduces the surplus a domestic merchant in the foreign platform obtains from a domestic consumer. In other words, it is as if bilingualism makes the foreign platform less efficient, which softens platform competition for the reasons explained earlier.

The last result is that bilingualism can either increase or decrease the welfare of the Home country. To explain why it can reduce the domestic welfare, suppose that bilingualism does not affect consumer market share: each platform has an equal share. Then, the fact that bilingualism softens competition implies that both platforms charge higher prices on merchants and hence each platform attracts less domestic merchants than when consumers are monolingual. In addition, the fact that the market share is equal means that each platform has the same "effective" mass of merchants.[3] Therefore, bilingualism reduces domestic welfare for the two following reasons. First, bilingualism decreases the total pie generated by the domestic platform. Second, in the foreign platform, consumers suffer from bilingualism because the total effective mass of merchants is smaller and domestic merchants suffer as well because they face a higher price and competition from foreign merchants.

In general, we show that the welfare result depends on the relative weight of producer surplus over consumer surplus.[4] Even if there is no overlap between the offerings of domestic merchants and those of foreign merchants, bilingualism can decrease domestic platform's profit more than it increases merchants' surplus. In this case, surprisingly, bilingualism decreases domestic welfare as long as the relative weight of producer surplus is large enough.

[3] The effective mass of merchants in the Foreign platform takes into account the overlap between domestic merchants and foreign merchants in their offerings.

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

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

Our paper builds on the literature on two-sided markets (see for example Rochet and Tirole, 2002, 2003, 2006, Caillaud and Jullien, 2003, Anderson and Coate, 2005, Armstrong 2006, Hagiu 2006, 2009, Armstrong and Wright 2007, Jeon and Rochet 2010). Two-sided markets can be roughly defined as industries where platforms provide intermediation services between two (or several) kinds of users. Typical examples are payment cards, software, Internet, academic journals and media. 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. Our model in which we assume single-homing for consumers and multi-homing for merchants is similar to Armstrong and Wright (2007) and Hagiu (2009).

This paper is also related to the international economics literature which emphasizes the important 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). Incomplete information in the international market creates difficulty in matching agents with productive opportunities and interferes with the ability of prices to allocate scarce resources across countries. 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 Internet search engines. 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.[5] [6]

In our model, language-related trade costs differences are formalized in way that is similar to Lazear (1999)[7] where individuals are randomly matched and a match generates a (constant) surplus only if the matched individuals share common language. However, our framework is different from the previous models analyzing the effects of linguistic and cultural differences on trade in the two following dimensions. First, in our model, matches occur between two sides of a market: consumers and merchants. A surplus is created only if a matched pair of a consumer and a merchant's website share common language. Second, matches are mediated by search engines.

The paper is organized as follows. 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 of platform competition. In section 4, we analyze the case in which all domestic consumers are monolingual. In section 5, we analyze the case in which all domestic consumers are bilingual. In section 6, we compare the two cases in terms of prices, consumer market shares, mass of domestic merchants and welfare of the home country. Section 7 concludes and draws implications on Google's market shares in the world.

2 Model

There are two countries: home country (H) and foreign country (F). We focus on the competition between two search engines within the home country. The home country is assumed to be small relative to the foreign country; the meaning of this assumption will be clarified later on. We view a search engine as an intermediary between different groups (for instance, consumers and merchants) in a two-sided market. Although we focus on the direct trade between consumers and merchants, with some minor modifications, our

[5] 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.

[6] More recently, Rauch and Watson (2002) analyzed the supply of 'network intermediation' in the context where agents with networks of foreign contacts either can use their networks themselves in support of production or can make their networks available for others to use and thereby can become network intermediaries. One of their welfare conclusions is that intermediaries may have inadequate incentives to invest in expanding their networks, suggesting a rationale for some real-world policies that encourage intermediaries to maintain large networks.

[7] Church and King (1993) also present a model similar to that of Lazear.

model can be applied to the situation in which search engines mediate interactions between consumers and websites which provide information for free and are sponsored by advertising (of merchants). In what follows, we present a simple stylized model.

2.1 Platforms, merchants and consumers

In the home country, there are a mass one of consumers and a continuum of merchants. In the model, we assume that merchants multi-home and consumers single-home. Merchants are only interested in profits that they can make by selling their products and therefore they will multi-home as long as this gives them a higher profit than single-homing. We assume that each merchant should incur a fixed cost per platform. There is a mass M of merchants whose fixed cost of entry is distributed over $[0, M/f]$ with a constant density $f > 0$ where $M(> 1)$ is large enough such that in no equilibrium all M merchants incur the fixed cost.

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.

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,[8] use different algorithms for search and different ways to display search results.[9] 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 merchants. 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.[10] Therefore,

[8] Search on world wide web is carried on the information copied and stocked in the data center of each search engine.

[9] 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.

[10] In section 3, we define the multiplier of our two-sided model of platform competition. Complexity

for tractability, we consider subscription fees.

2.2 Language and trade

We consider that platform 1 is a foreign one operating in both countries while platform 2 is a domestic one operating only in the home country.[11] The two countries have different languages and 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). Each consumer's location in the Hotelling line is uniformly distributed independently of whether he is bilingual or monolingual. All consumers in the foreign country are assumed to be monolingual.

Let n_i denote the measure of domestic merchants subscribed to platform i. Let $n^F > 0$ be the measure of the merchants from the foreign country 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 purchase them at a negligible transaction cost if they are willing to. For instance, if cross-border online transaction is subject to heavy tariffs and/or non-tariff trade barriers, n^F is small even if the measure of foreign merchants on board in platform 1 is large. Similarly, if the two countries have very different economic and cultural background, n^F is small. Platform 2 is assumed to operate only in the home country and hence has no foreign merchant subscribed. This is without loss of generality since if each platform i has n_i^F mass of "relevant" foreign merchants, then we can consider $n^F = n_1^F - n_2^F > 0$. 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 one. All these foreign merchants have their websites only in the foreign language: the home country is so small that it is not worthwhile for a foreign merchant to build his website in the language of the home country and to support transactions in the language of the home country. In addition, all merchants in the home country are assumed to have their websites only in the home language.

We assume that only bilingual consumers of the home country can transact with foreign merchants of platform 1. Furthermore, we assume that platform 1 provides options to carry out search either only in a single language or in both languages. Basically, monolingual consumers can conduct their queries only in the home language whereas bilingual consumers

arises because each usage fee directly enters into the multiplier, which affects the denominator of the pricing formula.

[11] Our model and analysis can be easily extended to the case in which both platforms are foreign ones (such as Google versus Yahoo or Bing).

can conduct their queries in both languages. Actually, Google provides such options.

In the case of monolingual consumers or in the case of platform 2, we assume that the volume of searches carried out by a consumer who formed the habit of using platform i increases with n_i and each query leads to a transaction between the consumer and a merchant which generates, in expected terms, a net surplus of $a > 0$ to the consumer and a profit of $b > 0$ to the merchant. In addition, for simplicity, we assume that the number of queries per consumer increases linearly with n_i.

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.

In the case of bilingual consumers using platform 1, they can interact with domestic and foreign merchants. We assume that the offerings of the merchants of country H have some overlap with the offerings of the merchants of country F: 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 merchants, we have $n_1 - 2\gamma n_1 n^F > 0$, which implies the following assumption.

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

Hence, a bilingual consumer trades with $n_1 + n^F - 2\gamma n_1 n^F$ merchants instead of $n_1 + n^F$. We assume that when a product is offered by both a domestic merchant and a foreign merchant, a consumer's query leads to either merchant with the same probability. Therefore, $n_1 + n^F - 2\gamma n_1 n^F$ trades are divided between $n_1 - \gamma n_1 n^F$ domestic trades and $n^F - \gamma n_1 n^F$ foreign ones.

Although we abstract from search results that are not sponsored, we capture a consumer's benefit from non-sponsored search by a constant u,[12] which is assumed to be large enough such that every consumer ends up using one of the two platforms.

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 trade between consumers and merchants:

Table 1: surplus in each platform

[12] We do not need to make u depend on whether a consumer is monolingual or bilingual; given that we consider either $\alpha = 0$ or $\alpha = 1$ (i.e. all domestic consumers are homogeneous in terms of whether they are monolingual or bilingual), making u depend on whether a consumer is monolingual or bilingual will give the same result (except for the comparison of domestic welfare).

	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 merchant's surplus	$x_1(1 - \alpha\gamma n^F)$	x_2

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

Qualitative interpretation of our assumptions is the following. Given that both platforms have the same mass of domestic consumers, a domestic merchant prefers joining the domestic platform to joining the foreign platform. Given that both platforms have the same mass of domestic merchants, a monolingual consumer is indifferent between the two but a bilingual consumer prefers the foreign platform to the domestic platform.

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 merchants.

2. Domestic merchants make decisions to subscribe to platform 1 and/or platform 2 and each domestic 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: $t > 1$[13] (i.e. more generally $t > abf$).

A2 is a stability condition. Precisely, suppose that some consumers switch from platform 2 to platform 1. Then this will increase the mass of merchants subscribed to platform 1 while decreasing the mass of merchants 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

[13] The precise meaning of A2 is given in section 3 when we explain the multiplier.

decrease in i's market share in consumers and which in turn makes i's profit a concave function of p_i.

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 affects 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 a trade between a consumer and a merchant is platform-specific as represented by $a_i > 0$ for a consumer and $b_i > 0$ for a merchant with $i = 1, 2$. 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

$$a_1 n_1 - tx = a_2 n_2 - t(1 - x), \tag{1}$$

which is equivalent to

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

Let x_i represent platform i's consumer market share (i.e. $x_1 = x$ and $x_2 = 1 - x$).

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

$$(x b_1 - p_1) - n_1 = 0; \tag{3}$$

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

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

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

where the denominator of the last term $2t - (a_1 b_1 + a_2 b_2) > 0$ is assumed to be positive from A2.[14]

[14] $2t > a_1 b_1 + a_2 b_2$ is a generalization of A2 to when $a_1 b_1 \neq a_2 b_2$.

Platform i maximizes its profit given by

$$\pi_i = p_i n_i = p_i(x_i b_i - p_i). \tag{6}$$

From the first order condition, we obtain:

$$p_i = \frac{x_i b_i}{2 + m\frac{a_i b_i}{2t}}, \tag{7}$$

where

$$m \equiv \frac{1}{1 - (a_1 b_1 + a_2 b_2)/(2t)} = \frac{2t}{2t - (a_1 b_1 + a_2 b_2)}.$$

m represent the multiplier in our two-sided market. To explain it, suppose that a unit mass of consumers switch from platform 2 to 1. From (3) and (4), this increases n_1 by b_1 while reducing n_2 by b_2. Then, from (2), x increases by $(a_1 b_1 + a_2 b_2)/2t$. For a similar reason, this increase in x by $(a_1 b_1 + a_2 b_2)/2t$ will induce an additional increase in x by $[(a_1 b_1 + a_2 b_2)/(2t)]^2$ etc. At the end, the total increase in x is equal to m. Actually, A2 is equivalent to $m > 0$. (7) shows that all other things being equal, an increase in m reduces the equilibrium price of each platform i.

Actually, we can define the Lerner index of merchants in platform i as

$$L_i \equiv \frac{x_i b_i - p_i}{x_i b_i} = 1 - \frac{1}{2 + m\frac{a_i b_i}{2t}}.$$

Basically, merchants' surplus in platform i is divided between merchants and the platform and L_i (respectively, $1-L_i$) represents merchants' share (respectively, the platform's share). In any shared equilibrium, L_i is constant and depends only on common factors (m, t) and platform specific factor $a_i b_i$. In particular, as m increases, L_i increases. Therefore, we can view m as *a measure of platform competition*; the stronger the competition between the two platforms, the larger is the share captured by merchants. What is interesting is that this measure of the degree of competition increases 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 L_j increases. The converse is also true.

Proposition 1 *Consider the model of platform competition in a closed economy in which the surplus from a trade between a consumer and a merchant depends on the identity of platform. Under A2, in any shared equilibrium,*

(i) the Lerner index of merchants in platform i represents merchants' share in merchants' gross surplus and is given by

$$L_i = 1 - \frac{1}{2 + m\frac{a_i b_i}{2t}},$$

where $m = \frac{1}{1-(a_1b_1+a_2b_2)/(2t)}$ (>0) *is a measure of the platform competition.*

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

In the next sections, we consider the model of international trade with $a_i = b_i = 1$ for $i = 1, 2$. Then, when consumers are bilingual, because of the direct substitution between domestic merchants and foreign merchants in platform 1, roughly speaking[15], it is as if a_1 becomes $1 - 2\gamma n^F$ and b_1 becomes $1 - \gamma n^F$ whereas a_2 and b_2 do not change and are equal to one. Therefore, we have the result that bilingualism reduces the degree of platform competition.

Remark: To show that the competition softening (or strengthening) effect in Prop 1 comes from (two-sided) network externalities, we consider a standard Hotelling model (i.e. one-sided market without network externalities) where each consumer buys only one unit and each firm charges a uniform price. Assume that the utility from buying a unit from firm i $(i = 1, 2)$ is $u_i > 0$ and that it is large enough to make the market fully covered. In addition, suppose $u_1 - u_2 = \Delta u > 0$. Then, it is easy to see that as Δu increases, the equilibrium market share of firm 1 increases, the equilibrium price charged by firm 1 increases whereas that of firm 2 decreases. However, if we consider each equilibrium price divided by the firm's market share, it is constant and does not depend neither on the firm's identity nor on Δu since the impact of a firm's change in its price on its market share is constant. This is consistent with the result that the equilibrium price charged by firm 1 increases whereas that of firm 2 decreases as Δu increases.

4 Monolingual consumers

In this section, we study the case in which all domestic 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.

4.1 Shared equilibrium

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.

[15] The exact formula is a bit different but the intuition is correct (see Proposition 5).

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

$$x_1 = \frac{1}{2} - \frac{1}{2}\frac{(p_1 - p_2)}{t-1}. \tag{8}$$

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

$$p_i = \frac{x_i b}{2 - \frac{\partial x_i}{\partial p_i} b} \tag{9}$$

where

$$\frac{dx_i}{dp_i} = -\frac{1}{2}\frac{1}{t-1} < 0. \tag{10}$$

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

4.2 Tipping equilibrium

Under A2, 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 merchants. Hence, a consumer's expected utility 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 to obtain u rather than joining Platform 1 and obtaining $u + 1 - t$ since $t > 1$.

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

Proposition 2 *When all domestic 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 domestic consumers are bilingual. In what follows we shall use the following parameter:

Definition 1 $\Gamma = 1 - (1 - \gamma n^F)(1 - 2\gamma n^F) = \gamma n^F \left(3 - 2\gamma n^F\right) \in [0, 1)$.

Γ measures the reduction in the efficiency of platform 1 in the trade between domestic consumers and domestic merchants, which is caused by the international trade. More precisely, in the absence of the trade, the efficiency of platform 1 can be measured by ab, which is equal to 1. The international trade reduces the (expected) surplus that a domestic merchant obtains from having an additional domestic consumer from one to $(1-\gamma n^F)$ and the (expected) surplus that a domestic consumer obtains from having an additional domestic merchant from one to $(1-2\gamma n^F)$. Therefore, the trade reduces the efficiency measure of platform 1 by Γ.

5.1 Shared equilibrium

As in the previous section, we first study a shared equilibrium.

Let x denote the location of the consumer who is indifferent between the two platforms. We have:

$$n_1 + n^F - \gamma 2 n_1 n^F - t x_1 = n_2 - t(1-x), \tag{11}$$

which is equivalent to

$$x_1 = \frac{1}{2} + \frac{n^F - 2\gamma n_1 n^F + n_1 - n_2}{2t}. \tag{12}$$

The mass of merchants on each platform should satisfy the following equations:

$$x_1(1-\gamma n^F) - p_1 = n_1; \tag{13}$$

$$(1-x_1) - p_2 = n_2. \tag{14}$$

Substituting n_1 with $x_1(1-\gamma n^F) - p_1$ and n_2 with $(1-x_1)-p_2$ in (12) and solving it for x_1 gives

$$x_1 = \frac{1}{2} + \frac{-\Gamma/2 + n^F - (p_1 - p_2) + 2\gamma n^F p_1}{A} \tag{15}$$

where

$$A \equiv 2(t-1) + \Gamma > 0.$$

Platform 1's profit is

$$\Pi_1 = p_1 n_1 = p_1(x_1(1-\gamma n^F) - p_1). \tag{16}$$

Platform 2's profit is

$$\Pi_2 = p_2 n_2 = p_2(1 - x_1 - p_2). \tag{17}$$

F.O.C. of Π_1 with respect to price p_1 gives

$$x_1(1-\gamma n^F) - 2p_1 + p_1(1-\gamma n^F)\frac{\partial x_1}{\partial p_1} = 0. \tag{18}$$

F.O.C. of Π_2 with respect to price p_2 gives

$$(1 - x_1) - 2p_2 - p_2 \frac{\partial x_1}{\partial p_2} = 0. \tag{19}$$

These equations are equivalent to

$$p_1 = \frac{x_1(1-\gamma n^F)}{2 - (1-\gamma n^F)\frac{\partial x_1}{\partial p_1}} = \frac{x_1(1-\gamma n^F)}{2 + \frac{(1-\gamma n^F)(1-2\gamma n^F)}{A}}, \tag{20}$$

$$p_2 = \frac{1-x_1}{2 + \frac{\partial x_1}{\partial p_2}} = \frac{1-x_1}{2+\frac{1}{A}}, \tag{21}$$

where $p_1 > 0$ from A1.

Substituting the prices with the expressions of (20) and (21) in (15) gives

$$x_1^B = \frac{t - 1 + n^F + \frac{1}{2+\frac{1}{A}}}{A + \frac{1}{2+\frac{1}{A}} + \frac{1-\Gamma}{2+\frac{1-\Gamma}{A}}}, \tag{22}$$

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

$$n^F \leq t - 1 + \Gamma + \frac{1-\Gamma}{2 + \frac{1-\Gamma}{2(t-1)+\Gamma}}. \tag{23}$$

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 equilibrium. Assuming $x_1 = 1$, then the mass of merchants 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

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

This is an equilibrium if platform 2 cannot attract consumers and therefore merchants at a price $p_2 = 0$. 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 (15) :

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

or

$$n^F > \frac{2t-1+\Gamma}{2}. \tag{24}$$

Let $\underline{n^F} \equiv t-1+\Gamma+\frac{1-\Gamma}{2+\frac{1-\Gamma}{2(t-1)+\Gamma}}$ and $\overline{n^F} \equiv \frac{2t-1+\Gamma}{2}$. We have $0 < \underline{n^F} < \overline{n^F}$. Summarizing, we have:

Proposition 3 *Suppose A1 and A2. When all domestic consumers are bilingual,*

(i) We have a "shared" equilibrium if the condition $n^F \leq \underline{n^F}$ *holds. 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, there is an equilibrium in which platform 1 corners the market and charges the monopoly price* $p_1^T = \frac{(1-\gamma n^F)}{2}$.

(iii) For $\underline{n^F} < n^F < \overline{n^F}$, *we have a cornering equilibrium in which platform 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 prices and domestic welfare for $a = b = f = 1$.

6.1 Prices and market shares in a shared equilibrium

In this subsection, we study how bilingualism affects the market shares and prices charged by the platforms in the home country.

We have

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

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 platform ($x_1^B > 1/2$) if

$$n^F > \Gamma\left(\frac{1}{2} - \frac{1}{\left(2+\frac{1}{A}\right)\left(2+\frac{1-\Gamma}{A}\right)}\right). \tag{25}$$

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 platform 1 caused by the international trade whereas n^F measures a consumer's gain from international trade, it is intuitive that the trade decreases the market share of platform 1 if n^F is smaller than a certain fraction of Γ.

Proposition 4 *Suppose A1 and A2. The consumers market share of the foreign platform is higher under bilingualism if* $n^F \geq \Gamma(1+3\Gamma)/2(1+\Gamma)(1+2\Gamma)$ *and lower if* $n^F \leq \Gamma/4$. *For intermediate values, there exists* $\hat{t}$ *such that* $x_1^B > 1/2$ *if and only if* $t > \hat{t}$.

Proof. Follows from the fact that the RHS of (25) decreases with t. ■

Figure 1 shows that for $t = 1,1$ and $\gamma = 1.9$, platform 1's market share initially decreases and then increases as n^F increases.

We now compare the Lerner index of merchants in each platform in shared equilibrium. Let L_i^M (respectively, L_i^B) denote the Lerner index of merchants in platform i when consumers are monolingual (respectively, when consumers are bilingual). We have:

$$\begin{aligned} L_1^M &= L_2^M \equiv \frac{x_i^M - p_i^M}{x_i^M} = 1 - \frac{1}{2 + \frac{1}{2(t-1)}}; \\ L_2^B &\equiv \frac{x_2^B - p_2^B}{x_2^B} = 1 - \frac{1}{2 + \frac{1}{2(t-1)+\Gamma}}; \\ L_1^B &\equiv \frac{x_1^B(1-\gamma n^F) - p_1^B}{x_1^B(1-\gamma n^F)} = 1 - \frac{1}{2 + \frac{1-\Gamma}{2(t-1)+\Gamma}}. \end{aligned}$$

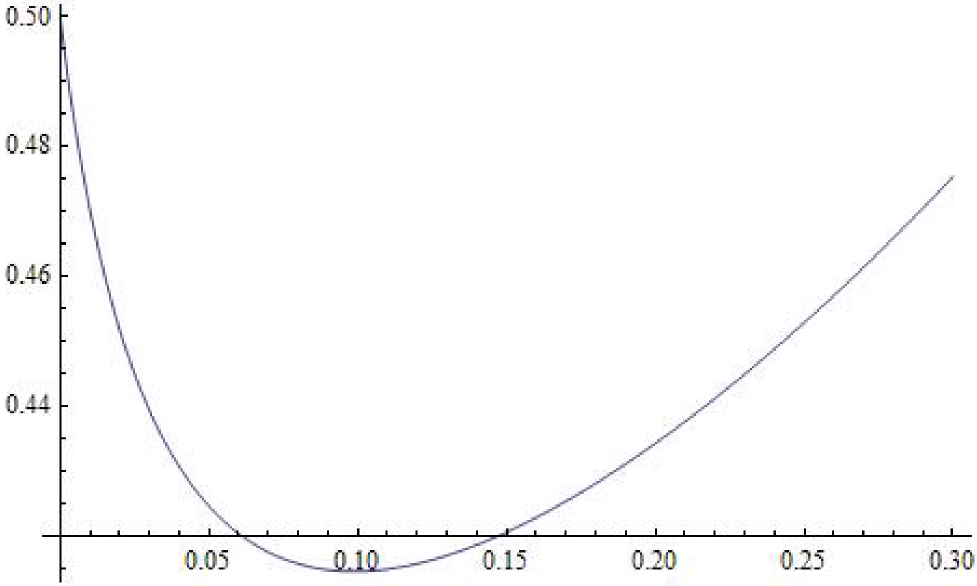


Figure 1: Platform 1's market share when consumers are bilingual (for $t = 1.1$, $\gamma = 1.9$)

All the above indexes are constant and do not depend on the exact market shares. We have:

Proposition 5 *Suppose A1 and A2. Bilingualism softens platform competition: it reduces the Lerner index of merchants in each platform. In other words, bilingualism makes merchants in each platform capture a lesser share of their surplus. More precisely, we have:*

$$\begin{aligned} L_i^M &= 1 - \frac{1}{2 + \frac{1}{2(t-1)}} > L_2^B = 1 - \frac{1}{2 + \frac{1}{2(t-1)+\Gamma}} > L_1^B = 1 - \frac{1}{2 + \frac{1-\Gamma}{2(t-1)+\Gamma}} \text{ for } \gamma n^F > 0; \\ L_i^M &= L_2^B = L_1^B \text{ for } \gamma n^F = 0. \end{aligned}$$

Trade between bilingual consumers and foreign merchants comes with the cost of making trade between a domestic merchant and a consumer less valuable in platform 1. Namely, international trade reduces the expected surplus that a consumer in platform 1 obtains from an additional domestic merchant from 1 to $(1-2\gamma n^F) \equiv a_1'$ whereas it reduces the expected surplus a domestic merchant in platform 1 obtains from an additional consumer from 1 to $(1 - \gamma n^F) \equiv b_1'$. As is explained in section 3, these two effects reduce the multiplier. When consumers are monolingual (i.e. $a_i = b_i = 1$ for $i = 1, 2$), the multiplier is

$$m^M = \frac{t}{t-1}.$$

When consumers are bilingual (i.e. $a_1 = a_1'$, $b_1 = b_1'$, $a_2 = b_2 = 1$), the multiplier is

$$m^B = \frac{t}{t - 1 + \frac{\Gamma}{2}},$$

which is smaller than m^M, which explains $L_i^M > L_i^B$ for $i = 1, 2$. A part from this multiplier effect, the fact that the international trade makes domestic trade in platform 1 less efficient has a direct effect of increasing the price charged by platform 1, which explains $L_2^B > L_1^B$.

Consider now the gross surplus that a domestic merchant obtains from a platform. On the foreign platform it obtains a gross surplus $x_1^B \left(1 - \gamma n^F\right)$ which is smaller than 1/2 if

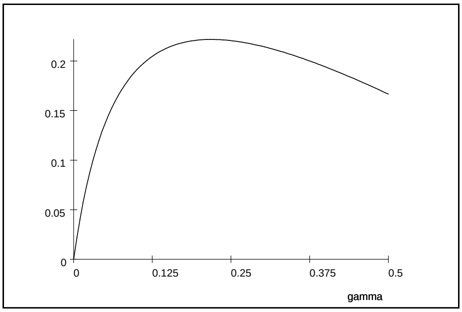
$$\left(\frac{t - 1 + n^F + \frac{1}{2+\frac{1}{A}}}{A + \frac{1}{2+\frac{1}{A}} + \frac{1-\Gamma}{2+\frac{1-\Gamma}{A}}}\right)\left(1 - \gamma n^F\right) < \frac{1}{2}$$

This holds for t large since then x_1^B is close to 1/2.

More generally we have

$$\left(\frac{\frac{1}{2+\frac{1}{\Gamma}}}{\frac{1}{2+\frac{1}{\Gamma}} + \frac{2}{2+\frac{1-\Gamma}{\Gamma}}}\right)\left(1 - \gamma n^F\right) < x_1^B \left(1 - \gamma n^F\right) < 1 - \gamma n^F \qquad (26)$$

where the LHS obtains for $t - 1 + n^F$ close to 0, and is smaller than 1/2 as shown in the graph below, while the RHS obtains for $x_1^B = 1$ and is larger than 1/2.



Graph: L.H.S. of (26)

Thus the transactions generated for a domestic merchant by the foreign platform may increase or decrease. Notice that due to a price increase, the mass n_i of merchants at platform i decreases if the number of transactions expected by a merchant decreases. This allows to conclude that

Corollary 1 *Suppose $n^F \geq \Gamma/4$. For t large enough, $x_1^B > 1/2$ and $n_i^B < n^M$ for $i = 1, 2$.*

Proof. For t large we have $1 - x_1^B < 1/2$ and $x_1^B \left(1 - \gamma n^B\right) < 1/2$. ■

6.2 Prices and merchants' participation under tipping

In the case of the tipping equilibrium the only relevant comparison is for L_1 and n_1. So assume that $2n^F > 2t - 1 + \Gamma$

First notice that the Lerner index is

$$L_1^T = \frac{1}{2} < L_i^M = 1 - \frac{1}{2 + \frac{1}{2(t-1)}}.$$

So merchants capture a smaller share of surplus. However the mass of consumers is also higher; we have $\left(1 - \gamma n^F\right)/2 = n_1^T$ which is smaller than n^M[16] if

$$1 + \frac{1}{2}\frac{\gamma n^F}{1 - 2\gamma n^F} > t.$$

Thus when there is little differentiation and large overlap between foreign and domestic content, under the condition $2n^F > 1 + \Gamma$, there is tipping and the price increase by the foreign platform more than offsets the market share increase. As a result, the production of domestic content decreases. On the contrary, if there is enough differentiation and little overlap, ~~tipping~~ increases the supply of domestic content.

6.3 Domestic welfare

In this subsection, we study how the social welfare of the home country changes as α changes from $\alpha = 0$ to $\alpha = 1$. Does bilingualism increase social welfare of the home country? 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 $a = b = f = 1$. Note first that the domestic welfare in the original model when consumers are bilingual is defined as:

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

where the term in the first bracket represents consumer surplus and the term in the second bracket represents firms' profits (i.e. the sum of the domestic platform's profit and the domestic merchants' profits); $\frac{(n_1)^2+(n_2)^2}{2f}$ takes into account both merchants's profits and their

[16] Comparing n_1^T with n^M is right given that we assume that a merchant's (platform-specific) fixed cost of entry is the same and does not depend on the identity of the platform.

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 total profit 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

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

Then, 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 weight of the profit 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 the total profit in the normalized model.

We first study some special cases analytically and then run simulations for general case.

6.3.1 When $\gamma = 0$

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

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

where

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

We first note that in the monolingual case,

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

We below assume $1 - \lambda - \frac{t}{2} > 0$, meaning that consumer surplus (net of the surplus from non-sponsored search) is positive in the monolingual case. This assumption is satisfied if t

is not too large. Then, we have

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

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

Regarding profits, we have

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

Basically, the total mass of domestic merchants under bilingualism 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 merchants and decreases those of platform 2. This in turn increases merchants' total profits because of economies of scale in the interaction between consumers and merchants; for given total number of consumers and merchants, 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 profit is ambiguous and we find that the marginal decrease in platform 2's profit dominates the marginal increase in merchants' profit 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 the total profit if and only if $n^F > \widehat{n}^F$. Summarizing, we have:

Proposition 6 *Suppose* $\gamma = 0$ *and* $1-\lambda-\frac{t}{2} > 0$.

(i) Consider the shared equilibrium when consumers are bilingual.

(a) Consumer surplus increasingly increases with n^F*;*

(b) Total profit decreases with n^F *up to* $\overline{n}^F \equiv \frac{\lambda}{2\beta}$ *and then increases with* n^F*.*

(ii) When bilingualism decreases total profit, there is a threshold weight on profit such that bilingualism decreases domestic welfare for any weight (b/a) above the threshold.

The result that bilingualism can decrease domestic welfare even when $\gamma = 0$ seems to be surprising.

6.3.2 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. 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 $n_2^B < n_2^M = n_1^M$.

Consider first platform 2. The prices paid by merchants 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 merchants' subscriptions since merchants generates positive externalities to consumers. Therefore, an increase in the subscription price, which reduces the mass of merchants 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 merchants $(n_1^B - 2\gamma n_1^B n^F + n^F)$ is smaller than n_1^M. Domestic merchants suffer as well since they pay a higher subscription price whereas the expected number of transactions per merchant decreases due to the competition from foreign merchants. Therefore, we have:

Proposition 7 *Suppose that bilingualism does not affect each platform's consumer market share. Then, bilingualism always reduces domestic welfare because*
(i) the welfare generated by platform 2 is smaller
(ii) both consumers and domestic merchants get smaller surplus or profit in platform 1.

Basically, only competition-softening effect of bilingualism matters in this case. Hence, we have a clear-cut welfare implication.

6.3.3 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 $\Pi(1,1,1,n^F,\gamma) < \Pi(1,1,1,0,\gamma)$

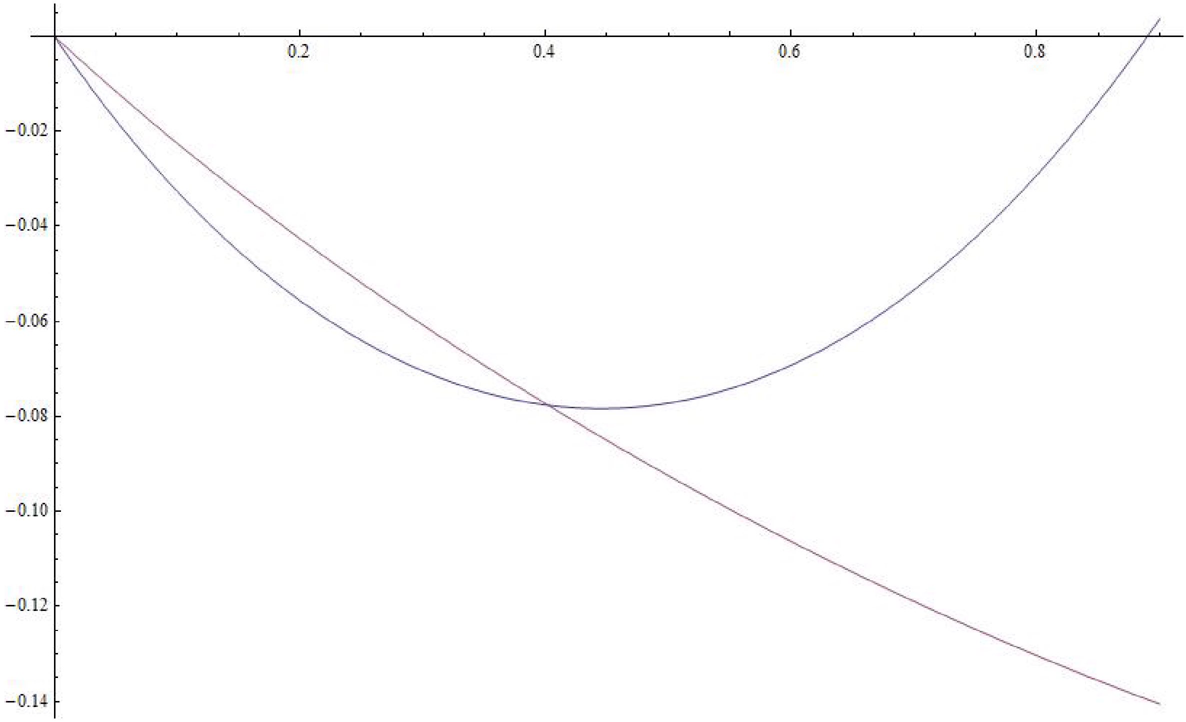


Figure 2: $CS(1,1,1,n^F,\gamma) - CS(1,1,1,0,\gamma)$ (the blue curve) and $\Pi(1,1,1,n^F,\gamma) - \Pi(1,1,1,0,\gamma)$ (the red curve) for $t = 1.3$ and $\gamma = 0.5$

Figure 2 shows the results for $t = 1.3$ and $\gamma = 0.5$. As n^F increases, $CS(1,1,1,n^F,\gamma) - CS(1,1,1,0,\gamma)$ decreases and then increases while $\Pi(1,1,1,n^F,\gamma) - \Pi(1,1,1,0,\gamma)$ always decreases.

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). As is expected, for γ relatively larger than n^F (close to the upper-left corner)) bilingualism decreases both consumer surplus and profits while the opposite holds for γ relatively smaller than n^F (close to bottom-right corner). 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 profits. As figure 2 and 3 suggest that in these countries, there is a conflict of interest between consumers and merchants such that merchants' surplus per transaction becomes more important relative to consumer surplus per transaction (i.e. as b/a increases), bilingualism would decrease 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 merchant surplus (although it decreases the profit of domestic platform).

7 Conclusion

In this section, we conclude by deriving implications of our results on Google's market shares in the world (see Figure 4 in the appendix).

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. Although we did not analyze what is going on in the Foreign country (i.e. U.S.A.), our results can explain 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 domestic consumer surplus at the cost of reducing profits of domestic merchants and domestic platform. 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

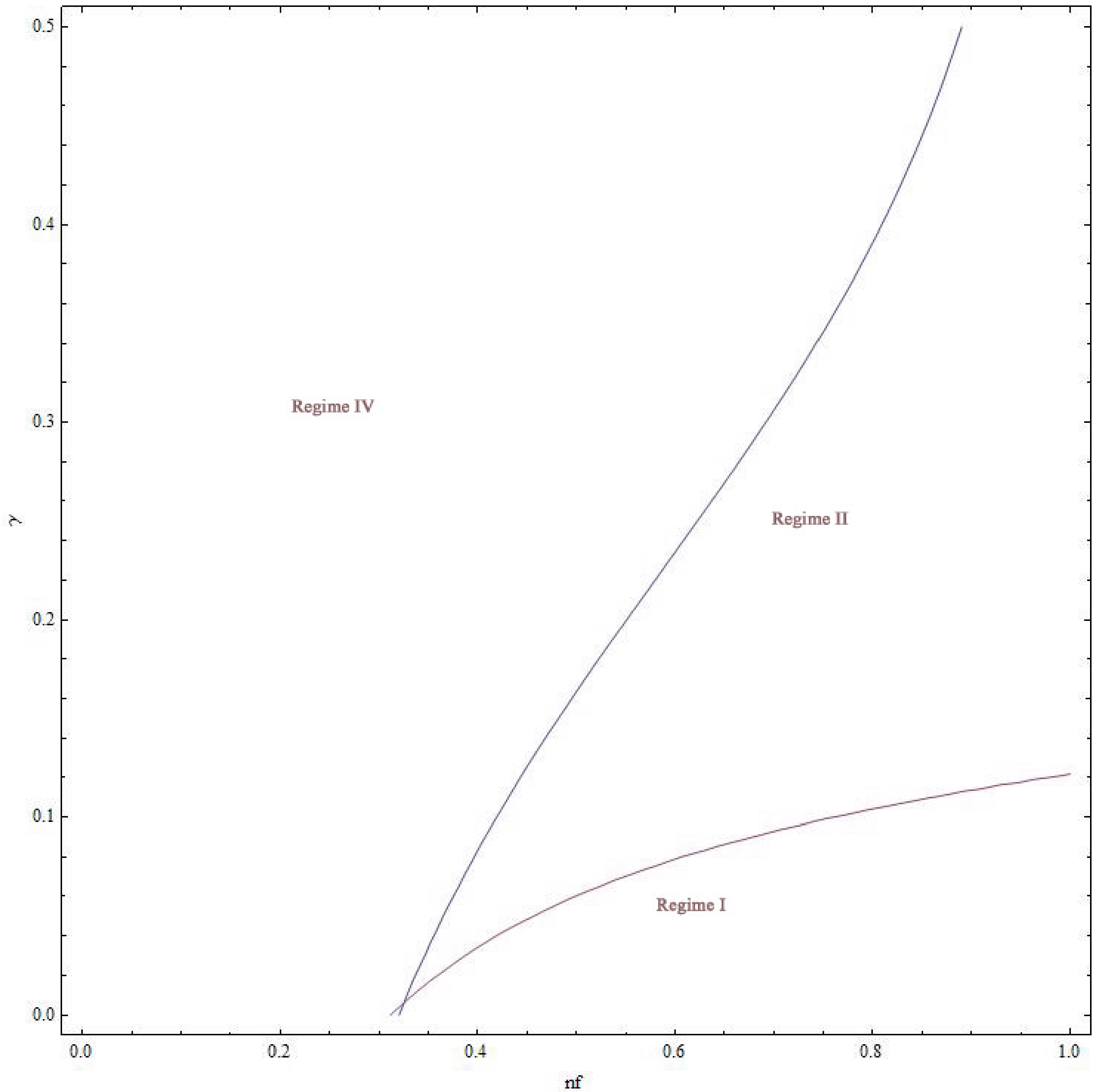


Figure 3: Contour of $CS(1,1,1,n^F,\gamma) = CS(1,1,1,0,\gamma)$ (the blue curve) and $\Pi(1,1,1,n^F,\gamma) = \Pi(1,1,1,0,\gamma)$ (the red curve) for $t = 1.3$

in domestic language when there is little differentiation of search service and a large overlap between North American and domestic content.

For our analysis, cultural factors should also matter as they affect the volume of relevant US content for a given country as well as the substitution effect due to presence of competing foreign and domestic content.

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. 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.

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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. Let $s \geq 0$ be the government subsidy for each merchant to subscribe to each platform. 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

$$x_i = \left[\frac{1}{2} + \frac{a(n_1 + n^F - 2\gamma n_1 n^F) - an_2}{2t}\right],$$

$$n_1 = \left(x_1(1 - \gamma n^F)b - p_1 + s\right) f,$$

$$n_2 = \left(x_2 b - p_2 + s\right) f.$$

We can normalize the original model as follows:

We do the following normalization:

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

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

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

$$\widetilde{n}_1 = \left(\widetilde{x}_1(1 - \gamma n^F) - \widetilde{p}_1 + \widetilde{s}\right).$$

$$\widetilde{n}_2 = \left(\widetilde{x}_2 - \widetilde{p}_2 + \widetilde{s}\right).$$

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

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

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

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

Note that A1 is the same both in the original model and in the normalized model. A2 in the normalized model is equivalent to $t > abf$ in the original model, which is a generalization of A2 in the original model.

9.2 Google's market share in each country

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 4: Google's market share in each country