

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

Doh-Shin Jeon[†], Bruno Jullien[‡] and Mikhail Klimenko[§]

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Abstract

Even though on-line transactions face much less frictions than off-line ones, language remains as a key barrier to trade. This paper analyzes how bilingualism affects competition between on-line platforms. 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 dominance 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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[†]Toulouse School of Economics (GREMAQ, IDEI) and CEPR. dohshin.jeon@gmail.com

[‡]Toulouse School of Economics (GREMAQ, IDEI).

[§]Georgia Institute of Technology

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 share in search services in each country in the world is astonishing (see the table in the appendix)¹: whereas its share of the search queries market 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

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 share in the home country? Does bilingualism make platform competition fiercer? Does

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

²One 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 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 increase in export growth and a 1.1-percentage-point increase in import growth.

bilingualism increase domestic welfare? The answers to these questions generate insights useful to understand to what extent Google's dominance 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 (perhaps the most interesting one) 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. However, we find that if bilingualism leads to the tipping equilibrium in which the foreign platform charges a monopoly price, then it increases the welfare of the Home country.

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, soft-

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

ware, 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.^{4 5}

In our model, language-related trade costs differences are formalized in way that is

⁴The 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.

⁵More 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.

similar to Lazear (1999)⁶ 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 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

⁶Church and King (1993) also present a model similar to that of Lazear.

merchants whose fixed cost of entry is uniformly distributed over $[0, M]$ 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, in the model, 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,⁷ use different algorithms for search and different ways to display search results.⁸ 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.⁹ Therefore, 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.¹⁰ 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: $\alpha = 0$ (respectively, $\alpha = 1$) means that all the consumers of the home country are monolingual (respectively, bilingual). Each

⁷Search on world wide web is carried on the information copied and stocked in the data center of each search engine.

⁸For 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.

⁹In section 3 where 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.

¹⁰Our model and analysis can be easily extended to the case in which both platforms are foreign ones (such as Google versus Yahoo or Bing).

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 on-line 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 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 $a_i > 0$ to the consumer and a profit of $b_i > 0$ to the merchant. In addition, for simplicity, we assume that the number of queries per consumer increases linearly with n_i . For simplicity, we assume $a_i = b_i = 1$ for $i = 1$ and 2 throughout the paper¹¹ except in section 3 where we analyze the multiplier effect in a closed economy.

In the case of bilingual consumers using platform 1, they can interact with domestic and

¹¹Even with this specification, the formula of the equilibrium market share is quite complex when consumers are bilingual (see (24)).

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 is 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 when $a_i = b_i = 1$:

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 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.

¹²We 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).

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: $2t > a_1b_1 + a_2b_2$ ¹³ (i.e. $t > 1$ when $a_i = b_i = 1$).

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 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.

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

For this purpose, we consider a closed economy in which the surplus from a trade between a consumer and a merchant depends on the platform as is specified in the model: $a_i > 0$ for a consumer and $b_i > 0$ for a merchant with $i = 1, 2$

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

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

which is equivalent to

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

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 uniformly with density one, the mass of merchants who join platforms 1 and 2 are determined by:

$$x b_1 - p_1 - n_1 = 0; \quad (3)$$

$$(1 - x) b_2 - p_2 - n_2 = 0. \quad (4)$$

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

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

where the denominator of the last term $2t - a_1 b_1 - a_2 b_2 > 0$ from A2. Then, we have

$$\frac{\partial x_i}{\partial p_i} = -\frac{a_i}{2t - a_1 b_1 - a_2 b_2}. \quad (6)$$

Platform i maximizes its profit given by

$$\pi_i = p_i n_i = p_i (x_i b_i - p_i). \quad (7)$$

From the first order condition, we obtain:

$$p_i = \frac{x_i b_i}{2 - \frac{\partial x_i}{\partial p_i} b_i}. \quad (8)$$

In general, the equilibrium consumer market shares can be asymmetric. In this case, (8) shows that the platform with a higher market share will charge a higher price, all other things being equal. This in turn suggests that if bilingualism changes the consumer market share, we need to distinguish the changes in prices caused by the change in the market

share from the changes in prices caused by the fact that bilingualism affects the degree of platform competition. In order to isolate the latter, we consider the average fee per transaction (i.e. the price p_i divided by mass of consumers of platform i). (8) shows that the average fee per transaction is constant (given the parameters) and is given by

$$\frac{p_i}{x_i} \equiv \widehat{p}_i = \frac{b_i}{2 + \frac{a_i b_i}{2t - a_1 b_1 - a_2 b_2}}. \quad (9)$$

From (9), it is clear that there is a common factor $2t - a_1 b_1 - a_2 b_2$ which affects each platform's average fee per transaction. To explain this common factor, 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 becomes

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

where m means the multiplier. Actually, A2 is equivalent to $m > 0$. The average fee per transaction becomes

$$\widehat{p}_i = \frac{b_i}{2 + m \frac{a_i b_i}{2t}}.$$

It is quite intuitive that an increase in the value of the multiplier (i.e. an increase in m) strengthens platform competition and hence reduces the average fees per transaction. Hence, we can consider m as a *measure of the degree of platform competition*.

What is interesting is that the measure of the degree of competition is affected by 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 the degree of platform competition increases. The converse is also true: if platform i becomes less efficient (i.e. a_i or b_i decreases), it has a positive spillover on platform j since the degree of platform competition decreases.

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 platform. Under A2, in any shared equilibrium,*

(i) *the average fee per transaction charged by platform i is given by*

$$\widehat{p}_i = \frac{b_i}{2 + m \frac{a_i b_i}{2t}},$$

where $m = \frac{1}{1 - (a_1 b_1 + a_2 b_2) / (2t)} > 0$ 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 induces platform j to reduce $\hat{p}_j$: conversely, if platform i becomes less efficient (i.e. a_i or b_i decreases), it softens platform competition and induces platform j to increase $\hat{p}_j$.

In the next sections, we consider the model of international trade and assume $a_i = b_i = 1$ for $i = 1, 2$. Then, when consumers are bilingual, because of the direct substitution between domestic merchants and foreign merchants in platform 1, roughly speaking¹⁴, 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.

¹⁴The 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

$$x_1 = \frac{1}{2} - \frac{1}{2} \frac{(p_1 - p_2)}{t - 1}. \quad (10)$$

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

$$p_i = \frac{x_i b}{2 - \frac{\partial x_i}{\partial p_i} b} \quad (11)$$

where

$$\frac{dx_i}{dp_i} = -\frac{1}{2} \frac{1}{t - 1} < 0. \quad (12)$$

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:*

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

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

Γ measures the reduction in the efficiency of platform 1 in the domestic market, which is caused by the international trade. More precisely, in the absence of the trade, the efficiency of platform 1 is measured by $a_1 b_1$, which is equal to 1. The international trade reduces the (expected) surplus that a domestic merchant obtains from an additional domestic consumer from one to $(1 - \gamma n^F)$ and the (expected) surplus that a domestic consumer obtains from 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:

$$n_1 + n^F - \gamma 2n_1 n^F - tx_1 = n_2 - t(1 - x), \quad (13)$$

which is equivalent to

$$x_1 = \frac{1}{2} + \frac{n^F - 2\gamma n_1 n^F + n_1 - n_2}{2t}. \quad (14)$$

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

$$x_1(1 - \gamma n^F) - p_1 = n_1; \quad (15)$$

$$(1 - x_1) - p_2 = n_2. \quad (16)$$

Substituting n_1 with $x_1(1 - \gamma n^F) - p_1$ and n_2 with $(1 - x_1) - p_2$ in (14) and solving it for x_1 gives

$$x_1 = \frac{1}{2} + \frac{-\Gamma/2 + n^F - (p_1 - p_2) + 2\gamma n^F p_1}{A} \quad (17)$$

where

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

Platform 1's profit is

$$\Pi_1 = p_1 n_1 = p_1(x_1(1 - \gamma n^F) - p_1). \quad (18)$$

Platform 2's profit is

$$\Pi_2 = p_2 n_2 = p_2(1 - x_1 - p_2). \quad (19)$$

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

$$x_1(1 - \gamma n^F) - 2p_1 + p_1(1 - \gamma n^F) \frac{\partial x_1}{\partial p_1} = 0. \quad (20)$$

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

$$(1 - x_1) - 2p_2 - p_2 \frac{\partial x_1}{\partial p_2} = 0. \quad (21)$$

These equations are equivalent to

$$p_1 = \frac{x_1(1 - \gamma n^F)}{2 - (1 - \gamma n^F) \frac{\partial x_1}{\partial p_1}} = \frac{x_1(1 - \gamma n^F)}{2 + \frac{(1 - \gamma n^F)(1 - 2\gamma n^F)}{A}}, \quad (22)$$

$$p_2 = \frac{1 - x_1}{2 + \frac{\partial x_1}{\partial p_2}} = \frac{1 - x_1}{2 + \frac{1}{A}}, \quad (23)$$

where $p_1 > 0$ from A1.

Substituting the prices with the expressions of (22) and (23) in (17) gives

$$x_1^B = \frac{t - 1 + n^F + \frac{1}{2 + \frac{1}{A}}}{A + \frac{1}{2 + \frac{1}{A}} + \frac{1 - \Gamma}{2 + \frac{1 - \Gamma}{A}}}, \quad (24)$$

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

$$n^F \leq t - 1 + \Gamma + \frac{1 - \Gamma}{2 + \frac{1 - \Gamma}{2(t - 1) + \Gamma}}. \quad (25)$$

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 (17) :

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

or

$$n^F > \frac{2t - 1 + \Gamma}{2}. \quad (26)$$

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:*

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

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

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

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

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

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

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

$$n^F > \Gamma \left(\frac{1}{2} - \frac{1}{\left(2 + \frac{1}{A}\right) \left(2 + \frac{1-\Gamma}{A}\right)} \right). \quad (27)$$

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 27 decreases with t . ■

We now compare average fees per transaction. In the case of monolingual consumers or in the case of platform 2, the measure of transactions (per domestic merchant) in a platform is just equal to its consumer market share. But when consumers are bilingual, in the case of platform 1, the measure is $x_1^B(1 - \gamma n^F)$. Let $\hat{p}_i^B$ denote the average fee per transaction in platform i for the bilingual case; $\hat{p}_i^M$ is similarly defined.

Proposition 5 *Suppose A1 and A2. Bilingualism softens platform competition: it increases both platforms' average fee per transaction, and more for the foreign platform than for the domestic platform. That is, the average fees per transactions are given by:*

$$\hat{p}^M = \frac{1}{2 + \frac{1}{2(t-1)}} < \hat{p}_2^B = \frac{1}{2 + \frac{1}{2(t-1)+\Gamma}} < \hat{p}_1^B = \frac{1}{2 + \frac{1-\Gamma}{2(t-1)+\Gamma}} \text{ for } \gamma n^F > 0 \text{ and}$$

All the prices are equal for $\gamma n^F = 0$.

The trade between bilingual consumers and foreign merchants comes with the cost of making the trade between a domestic merchant and a consumer less valuable in platform 1. Namely, the 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 $\hat{p}^M < \hat{p}_2^B$. Furthermore, 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 since we have:

$$\begin{aligned}\hat{p}_1^B &= \frac{p_1^B}{x_1^B b'_1} = \frac{1}{2 + m^B \frac{a'_1 b'_1}{2t}} = \frac{1}{2 + m^B \frac{1-\Gamma}{2t}}; \\ \hat{p}_2^B &= \frac{p_1^B}{x_2^B} = \frac{1}{2 + m^B \frac{a'_2 b'_2}{2t}} = \frac{1}{2 + m^B \frac{1}{2t}}\end{aligned}$$

This explains $\hat{p}_2^B < \hat{p}_1^B$.

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

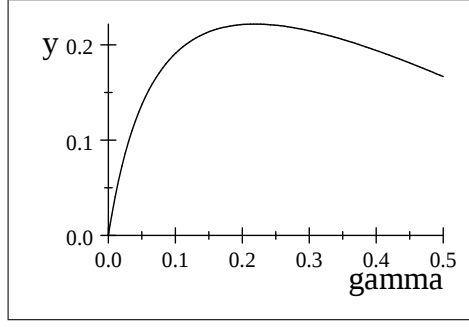
$$\left(\frac{t-1 + n^F + \frac{1}{2+\frac{1}{A}}}{A + \frac{1}{2+\frac{1}{A}} + \frac{1-\Gamma}{2+\frac{1-\Gamma}{A}}} \right) (1 - \gamma n^F) < \frac{1}{2}$$

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

More generally we have

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

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 $1/2$.



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 $x_1^B (1 - \gamma n^B) < 1/2$. ■

6.2 Prices and merchants' participation under tipping

In the case of the tipping equilibrium the only relevant comparison is for p_1 and n_1 . So assume that $2n^F > 2t - 1 + \Gamma$

First notice that the normalized price is

$$\hat{p}_1^T = \frac{1}{2} > \hat{p}^M,$$

so that again the price is higher. However the mass of consumers is also higher; we have $(1 - \gamma n^F) / 2 = n_1^T$ which is smaller than $n^M = (1 - \hat{p}^M) / 2$ ¹⁵ if $\gamma n^F > \hat{p}^M$ or

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

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 raises the supply of domestic content.

¹⁵Comparing 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.

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 the social welfare of the home country? Home country's social welfare when all domestic consumers are monolingual is given by

$$W^M = 2n^M - p^M n^M - 2 \int_0^{n^M} y dy - 2t \int_0^{1/2} y dy.$$

The first term represents the total surplus generated by trade between domestic merchants and domestic consumers $(a + b) [n_1^M x_1^M + n_2^M x_2^M]$. $p^M n^M$ is the foreign platform's profit. The remaining terms represent the fixed cost incurred by domestic merchants and the transportation cost incurred by domestic consumers. We have:

$$W^M = \frac{(2t - 1)(12t - 9)}{4(4t - 3)^2} - \frac{t}{4}.$$

For $t > 1$, W^M decreases with t and $W^M = 1/2$ at $t = 1$.

When all domestic consumers are bilingual, then the domestic welfare in a shared equilibrium is given by

$$\begin{aligned} W^B = & 2 [(n_1^B - \gamma n_1^B n^F) x_1^B + n_2^B x_2^B] + (n^F - \gamma n_1^B n^F) x_1^B - p_1^B n_1^B \\ & - \left(\int_0^{n_1^B} y dy + \int_0^{n_2^B} y dy \right) - t \left[\int_0^{x_1^B} y dy + \int_0^{x_2^B} y dy \right]. \end{aligned}$$

Let us first consider the case of $\gamma = 0$. Then, in the shared equilibrium, we have:

$$x_1^B = \lambda n^F + 1/2, p_i^B = \mu x_i^B, n_i^B = (1 - \mu) x_i^B,$$

where

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

Hence,

$$\begin{aligned} W^B = & \left(2(1 - \mu) - \frac{(1 - \mu)^2}{2} - \frac{t}{2} \right) ((x_1^B)^2 + (1 - x_1^B)^2) + n^F x_1^B - \mu(1 - \mu)(x_1^B)^2; \\ \frac{dW^B}{dn^F} = & x_1^B + \lambda \left[2 \left(2(1 - \mu) - \frac{(1 - \mu)^2}{2} - \frac{t}{2} \right) (2x_1^B - 1) + n^F - 2\mu(1 - \mu)x_1^B \right]. \end{aligned}$$

In the appendix, we show that $\frac{dW^B}{dn^F} > 0$. Furthermore, in the tipping equilibrium with the monopoly price, we have $W^B = \frac{5}{8} + n^F - \frac{t}{2}$ when $\gamma = 0$. Hence, $\frac{dW^B}{dn^F} > 0$ holds as well.

Consider now the special case in which the consumer's market share of each platform is not affected by bilingualism. Given $x_1^M = x_1^B = 1/2$, we note that maximizing domestic social welfare requires subsidizing merchants' subscriptions since merchants generates positive externalities to consumers. Therefore, an increase in the subscription prices reduces the pie generated in each platform from the domestic trade, which implies that $n_2^B < n_2^M$. Furthermore, the fact that both platforms have the same market share means $n_1^B - 2\gamma n_1^B n^F + n^F = n_2^B$. Therefore, even if we include the international trade, bilingualism reduces the pie generated by platform 1. In summary, we have:

- bilingualism decreases the total pie generated by the domestic platform
- in the foreign platform
 - consumers suffer from bilingualism because the total "effective" mass of merchants ($n_1^B - 2\gamma n_1^B n^F + n^F$) is smaller
 - domestic merchants suffer because they face a higher price per transaction and the number of transaction decreases due to the competition from foreign merchants.

Consider now the other extreme of the tipping equilibrium with the monopoly price when all domestic consumers are bilingual. Then, we have:

$$W^B = \frac{(1 - \gamma n^F)}{8}(5 - 9\gamma n^F) + n^F - \frac{t}{2},$$

where $2t < 1 + n^F [2 - \gamma(3 - 2\gamma n^F)]$ (i.e. condition (26)) must be satisfied. For given n^F , W^B decreases with γ . For given γ , we have

$$W^B = \frac{1}{8} \left\{ 9\gamma^2 \left(n^F - \frac{(7\gamma - 4)}{9\gamma^2} \right)^2 - \frac{(7\gamma - 4)^2}{9\gamma^2} + 5 \right\} - \frac{t}{2}.$$

Therefore, if $\gamma < 4/7$, W^B increases with n^F ; otherwise, W^B decreases up to $n^F = (7\gamma - 4)/9\gamma^2$ and then increases with n^F . We find that in this tipping equilibrium, the welfare is always higher when consumers are bilingual than when they are monolingual. This is because in the tipping equilibrium, we have $n^F - \Gamma/2 > t - 1/2$; hence the gain from trade is large relative to the reduction in the efficiency of platform 1 whereas the transportation cost of consumers is relatively small.

Proposition 6 (*domestic welfare*) Suppose A1 and A2.

(i) When $\gamma = 0$, bilingualism increases domestic welfare.

(ii) When $\gamma > 0$

(a) If the consumer market share is not affected by the change from monolingual consumers to bilingual consumers, bilingualism reduces domestic social welfare.

(b) Suppose that under bilingualism, the tipping equilibrium with monopoly price prevails. Then, bilingualism increases the domestic welfare. The welfare decreases with γ but can decrease or increase with n^F .

Proof. See the Appendix ■

7 Conclusion

In this section, we conclude by deriving implications of our results on Google's market shares in the world (see Figure 1 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. Basically, a relatively large fraction of bilingual consumers in home country allows Google to leverage its dominance in U.S.A. such that a tipping equilibrium can prevail in home countries. Furthermore, our results show that this dominance of Google in home countries, if due to bilingualism, is not undesirable from the point of view of the home countries' welfare since bilingualism increases home countries' welfare when the tipping equilibrium prevails. However, this may come at the cost of reducing the production of content in domestic language which occurs when there is little differentiation of search service and a large overlap between North American and domestic content. Hence, if for reasons not presented in our model, one gives importance to the development or protection of a sector producing national content, bilingualism can conflict with the objective of this "cultural" policy.

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 congestion 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 dominance in U.S.A. to home countries. Hence the congestion effect that reduces domestic merchant participation may be smaller. Paradoxically, in these countries, an increase in the fraction of bilingual consumers can decrease home countries' welfare if this does not affect much Google's market share and hence the competition-softening effect of bilingualism dominates.

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9 Appendix

9.1 Proof of Proposition 6

Proof of (i). We have:

$$\frac{dW^B}{dn^F} = x_1^B + \lambda \left[2 \left(2(1 - \mu) - \frac{(1 - \mu)^2}{2} - \frac{t}{2} \right) (2x_1^B - 1) + n^F - 2\mu(1 - \mu)x_1^B \right].$$

Case 1: for $t \in (1, 2]$.

We find that for $t > 1$,

$$\begin{aligned} 1 - \lambda 2\mu(1 - \mu) &> 0; \\ 2(1 - \mu) - \frac{(1 - \mu)^2}{2} - \frac{t}{2} &\geq 0 \text{ iff } t \leq 2.0328. \end{aligned}$$

This proves $\frac{dW^B}{dn^F} > 0$ for $t \in (1, 2]$.

Case 2: for $t > 2$. From $x_1^B = \lambda n^F + 1/2$

$$\frac{dW^B}{dn^F} = (1 - 2\lambda\mu(1 - \mu)) (\lambda n^F + 1/2) + \lambda \left[2 \left(2(1 - \mu) - \frac{(1 - \mu)^2}{2} - \frac{t}{2} \right) 2\lambda n^F + n^F \right].$$

Since $1 - \lambda 2\mu(1 - \mu) > 0$

$$\begin{aligned}
\frac{dW^B}{dn^F} &> 2(1 - \lambda 2\mu(1 - \mu)) \lambda n^F + 4\lambda^2 \left(2(1 - \mu) - \frac{(1 - \mu)^2}{2} - \frac{t}{2} \right) n^F \\
&= 2\lambda n^F \left[1 - \lambda\mu(1 - \mu) + 2\lambda \left(2(1 - \mu) - \frac{(1 - \mu)^2}{2} - \frac{t}{2} \right) \right] \\
&= 2\lambda n^F [1 + \lambda(3(1 - \mu) - t)] \\
&> 2\lambda n^F [1 + \lambda(3/2 - t)] \\
&= \frac{2n^F}{2(t - 1 + \frac{1}{2 + \frac{1}{2(t-1)}})} \left[1 + \frac{1}{2(t - 1 + \frac{1}{2 + \frac{1}{2(t-1)}})} (3/2 - t) \right] > 0 \text{ for } t > 2.
\end{aligned}$$

Proof of (ii)(a). See the main text written before the proposition.

Proof of (ii)(b). Since $2t < 1 + n^F [2 - \gamma(3 - 2\gamma n^F)]$ holds, a lower bound of W^B is given by

$$\begin{aligned}
&\frac{(1 - \gamma n^F)}{8}(5 - 9\gamma n^F) + n^F - \frac{1 + n^F [2 - \gamma(3 - 2\gamma n^F)]}{4} \\
&= \frac{(1 - \gamma n^F)}{8}(5 - 9\gamma n^F) + \frac{n^F}{2} + \frac{\gamma n^F(3 - 2\gamma n^F)}{4} - \frac{1}{4} \\
&=
\end{aligned}$$

Furthermore, from $2t < 1 + n^F [2 - \gamma(3 - 2\gamma n^F)]$ and $t > 1$, we have $2n^F > n^F \gamma(3 - 2\gamma n^F) + 1$. Therefore, the above lower bound of W^B is larger than

$$\begin{aligned}
&\frac{(1 - \gamma n^F)}{8}(5 - 9\gamma n^F) + \frac{n^F \gamma(3 - 2\gamma n^F) + 1}{4} + \frac{\gamma n^F(3 - 2\gamma n^F)}{4} - \frac{1}{4} \\
&= \frac{(1 - \gamma n^F)}{8}(5 - 9\gamma n^F) + \frac{2n^F \gamma(3 - 2\gamma n^F) + 2}{8} + \frac{2\gamma n^F(3 - 2\gamma n^F)}{8} - \frac{1}{4} \\
&= \frac{1}{2} + \frac{(1 - \gamma n^F)^2}{8} > \frac{1}{2}
\end{aligned}$$

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 1: Google's market share in each country