Trade and the adoption of a universal language

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Abstract

This paper investigates long-run consequences of international trade between two economies inhabited by two distinct races using different languages. If wages are not equal in autarky, free trade encourages the workers of the low-wage country to learn the language of the high-wage country. As the bilingual population increases in the low-wage country, products are increasingly produced in the dominant-language version. In the long run the language of the high-wage country becomes universally adopted. © 2002 Elsevier Science Inc. All rights reserved.

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1. Introduction

Trade seems to have occurred naturally between tribes and nations since time immemorial. Gunpowder and stirrup invented in China spread to the Western world and changed the course of military history. Cotton developed in the Indus Valley gradually spread to the rest of the world, and immensely improved the quality of life for humanity. However, trade volume has not been really significant until the last few decades. Nations have been trading goods and resources on an unprecedented scale since the early 1970s; the total value of world trade increased from US$332 billion in 1970 to US$3708 billion in 1993 (Yearbook of International Trade Statistics, various years). In the United States, imports represented only about 4% or less
of GDP before 1970, but have hovered around 10% of GDP in recent years. Two large free trade areas also have been formed in Europe and North America during the postwar era.¹

How will this phenomenal expansion of world trade affect trading nations? Two general models have been widely used to analyze trade patterns. The Ricardian trade model assumes differences in labor productivity and attempts to explain trade patterns in terms of comparative advantages arising from the difference in labor productivity between countries. In contrast, in the Heckscher–Ohlin (HO) model, factor prices are equalized and trade patterns are explained in terms of factor abundance (Samuelson, 1948; Jones, 1965).² Welfare consequences of trade restrictions have also received much attention in this literature. Few authors have used these models to consider the impacts of trade on the languages of the trading nations.

Trade and language seem to have prospered in a symbiotic relationship. The alphabet was supposedly invented by the Phoenicians — who were traders in the Mediterranean coastal area around the 12th century B.C. — to facilitate trade, and to keep records of debts arising from trade. Languages, in turn, either facilitate or impede trade among nations. Havrylyshyn and Pritchett (1991) found that three languages — Portuguese, Spanish, and English — are significant in the gravity model. In another study of poor countries, Foroutan and Pritchett (1993) found that French, Spanish, and English are statistically significant. Clearly, the former colonies of France, Spain and England, as well as the United States — onetime colony of England — not only adopted the languages of their former masters but also have maintained trade ties with them. In a recent study that included nine languages, Frankel, Stein and Wei (1995) found that two countries sharing linguistic or colonial links tend to trade roughly 65% more than they would otherwise. Two Chinese-speaking countries appear to trade four times as much as other countries.³

The purpose of this paper is to derive some very long-run consequences of trade, very long-run in the sense that empirical verification of the theory is rather difficult, if we limit empirical tests to regression analyses based on accumulated statistics. Such empirical tests may require gathering statistics over hundreds of generations, but language spreads very slowly, and the pace is often unnoticeable within a single generation.

The proposed model assumes wage disparity between countries. The Heckscher–Ohlin model shows that under certain conditions free trade will equalize factor prices, including wages. However, in the real world we do not observe wage equalization in the strict sense. The presence of illegal immigrants and the continuing inflow of immigrants into high-wage countries provide ample evidence of the nonequalization of wages between countries. It is shown that if wage rates are not equalized, trade will promote the adoption of a universal language among trading economies. If ignorance or lack of understanding between cultures is

¹ Currently, the European Community is more than a free trade area.
² The specific factors model might be considered as an important variant of the Heckscher–Ohlin model in that only one factor is mobile between sectors. Although the Harris–Todaro model is not a trade model per se, it has been used to study the effects of commercial policies (Choi & Beladi, 1993)
³ However, Frankel et al. (1995) state that much of the Taiwan–China trade goes through Hong Kong, and is thus counted twice, and when this effect is corrected, Chinese is no more important than other languages.
2. The basic model

Consider two countries, A and B, inhabited by populations that use two different languages, $a$ and $b$. To lay the basis for analyzing the impacts of trade on languages, we employ the following assumptions:

1. Two races ($x$ and $y$) with equal populations inhabit two countries, the home country A, and the foreign country B.
2. Populations are stable, i.e., the population of each country is evenly divided between male and female workers, all workers mate, and the mating of a male and a female produces a male and a female, whether mating occurs within each pure race or mixed race.
3. There is no difference in labor productivity between the male and female workers.
4. Labor productivity differs between countries, due to weather conditions or differences in capital endowments. Specifically, the home country is a high-wage country.
5. Each country produces two traded goods, 1 and 2, and trade-related services.
6. Transportation costs are zero.
7. Translation services are required to facilitate trade between countries and interpreters can be recruited from either country.
8. Workers are not mobile between countries.
9. The cost of moving between countries and the cost of learning a foreign language are assumed to be zero.
10. Perfect competition prevails in all markets.
11. Two economies are capable of continuing indefinitely and are not beset by wars or other disasters.

This model can be applied to the world with many countries with unequal populations. However, for simplicity, we consider two countries with equal and stable populations, evenly divided between male and female workers in each country. These simplifying assumptions are designed to clearly illuminate the outcomes of trade without involving analytical complexities.

In this model, the service sector hires interpreters to mediate trade. Bilingual interpreters are required to facilitate trade between the two economies. They are assumed to perform interpretation services, including translation and advertising in the other language, explaining business practices, etc. Interpretation services seem to be widely needed even in a free trade area or a common market. For instance, one-fifth of the staff of the European Commission is devoted to the translation and interpretation services.

4 Such a Utopian society is described, for instance, in the Urantia Book (1955).
The number of bilingual interpreters required, \( I_0 \), is simply the sum of the interpreters employed in the import and export sectors:

\[
I_0 = a_{IE}E + a_{IM}M,
\]

where \( E \) and \( M \), respectively denote the amounts of export and import of the home country, and \( a_{IE} \) and \( a_{IM} \) are the numbers of interpreters required per unit in the export and import sectors.

Which country will specialize in the interpretation service? Let \( P_1 \) and \( P_2 \) be the domestic prices of Good 1 and Good 2, respectively. If there are gains to be made from trade, trade volume will be positive, i.e., both \( E \) and \( M \) will be positive. Lowercase will be used to denote foreign variables. Let \( \bar{P}_1 \) and \( \bar{P}_2 \), respectively be the autarky prices of Good 1 and Good 2 in the home country, and \( \bar{p}_1 \) and \( \bar{p}_2 \) be their autarky prices in the foreign country. For both countries to reap gains from trade, free trade prices in each country must be different from the autarky prices, i.e., \( P_1/P_2 \neq \bar{P}_1/\bar{P}_2 \) and \( p_1/p_2 \neq \bar{p}_1/\bar{p}_2 \).

The service producers may be located in either country. Assume that service producers are not partial to either domestic or foreign interpreters, i.e., the mother tongues of the interpreters are irrelevant. The profit of the service sector is (Eq. (1)):

\[
\Pi_0 = (p_1 - P_1)E + (P_2 - p_2)M - WL_0
\]

if interpreters are recruited from the home country, and (Eq. (2)):

\[
\Pi_0 = (p_1 - P_1)E + (P_2 - p_2)M - wL_0
\]

if they are recruited from the foreign country, where \( W \) and \( w \) are the wages of the home and foreign countries, respectively. The service sector uses only labor, and the interpreters are assumed to be equally proficient at least for trading purposes, regardless of their mother tongues. Since country B is a low-wage country (\( w < W \)), it has a comparative advantage in the translation service. Thus, the competitive service sector recruits interpreters from the foreign country.

**Proposition 1:** Assume that trading firms are indifferent between domestic and foreign interpreters. Then the low-wage country has a comparative advantage in providing the translation service, and their workers will be recruited as interpreters.

The zero profit conditions in the domestic markets are written:

\[
P_1 = Wa_{N_1} + Ra_{K_1},
\]

\[
P_2 = Wa_{N_2} + Ra_{K_2},
\]

where \( N_j \) and \( K_j \) are labor and capital inputs used in the home industry \( j \). Similarly, the zero profit conditions in the foreign markets are written:

\[
p_1 = wa_{n_1} + ra_{k_1},
\]

\[
p_2 = wa_{n_2} + ra_{k_2},
\]
where $n_j$ and $k_j$ are labor and capital inputs used in the foreign industry $j$. The foreign price of the exportable is (Eq. (5)):

$$p_1 = P_1 + w_a^{IE},$$

(5)

where $w_a^{IE}$ is the labor cost of interpreters per unit. On the other hand, the foreign price of the importable is (Eq. (6)):

$$P_2 = p_2 + w_a^{IM},$$

(6)

where $w_a^{IM}$ is the unit labor cost of bilingual interpreters resident in the foreign country. The language barrier and the marketing cost as reflected by the employment of interpreters are represented by their *implicit tariffs*, which are measured by:

$$\frac{Q}{P_1} = w_a^{IE},$$

$$\frac{q}{P_2} = w_a^{IM}.$$  

(7)

It should be noted that even if the trading countries do not introduce any explicit tariffs, free trade equalizes neither the output prices nor the factor prices. Implicit tariffs of the language barrier are determined in Eq. (7). Substituting $\Theta$ into Eq. (3), we obtain the domestic prices in equilibrium and the resultant factor prices. Similarly, substituting the implicit tariff $\theta$ into Eq. (4), we obtain the equilibrium foreign output and factor prices ($w$, $r$).

Fig. 1 shows how these language and marketing barriers affect the offer curves. In the absence of these trade-related costs, $O$ and $o$ represent the offer curves of the home and the
foreign countries, respectively. With the implicit tariff effects of the required translation services, both the home and the foreign offers shift to $O'$ and $o'$, respectively. As anticipated, these implicit tariffs reduce trade volume. Equilibrium is attained at the intersection of $O'$ and $o'$, and the equilibrium terms of trade, $P_1/p_2$ are reflected by the slope of the ray, $OB$, from the origin.

Next, workers in the low-wage country must be willing to serve as interpreters. Learning a foreign language might be time-consuming and costly in practice. However, to simplify our analysis, language learning is assumed to be a costless activity. Foreign workers are willing to work as interpreters, not only because they are paid the same wage as the workers in other sectors in that country, but also because acquiring language $a$ offers them or their descendants a chance to migrate to the high-wage country. There is some empirical evidence that workers in the export sectors are generally paid more than those in the import sectors. Workers who can communicate in the language of the high-wage country are likely to command a higher wage in the low-wage country. It is not necessary, however, to invoke this fact. In the low-wage country, a bilingual worker with a good command of the universal language enjoys improved job security; these bilingual workers can be employed in any sector, whereas the monolingual workers who use the national language can find employment only in the traditional sectors that produce traded goods. Thus, a necessary corollary to Proposition 1 is:

**Corollary 1:** Free trade induces the workers in the low-wage country to learn the language of the high-wage country.

### 3. Trade and universal language

In this section, we investigate the adoption of a universal language in two stages. In autarky, the residents of each country are monolingual, using their own native or national language. Once trade begins, in the first stage workers in the low-wage country learn the language of the high-wage country through trade, and hence they become bilingual. In the second stage, although the transition may take several or even hundreds of generations, only the language of the high-wage country survives in the low-wage country and it becomes the universal language.

#### 3.1. The bilingual stage

The language profile in autarky is $(a,b)=(N,n)$, where $N=n$ denotes the populations, and $a$ and $b$ stand for the languages of countries A and B, respectively. Since we are concerned with the spread of a universal language through trade — a very slow process — we assume that the unit period represents a generation, or approximately 25 years.

Since the two countries have equal populations, both countries reap gains from trade unless per capita income of the low-wage country is a negligible fraction of that of the high-wage country. Once trade begins, $I_0$ workers in the low-wage country learn the language of the high-wage country. Thus, in period 1, the emergence of the bilingual population $I_0$ in the low-
wage country changes the language profile of the world to \((a^1, b^1) = (N + I_o, N)\) where the superscripts denote time periods.

Workers are assumed to receive language training naturally from their parents or through on-the-job training as interpreters. If parents are monolingual, their offspring are also monolingual, mastering the parents’ tongue. Likewise, if parents are bilingual, their children also become bilingual. This implies that the next generation of bilingual interpreters will be bilingual likewise. However, jobs are not inherited and the offspring of the interpreters need not become interpreters. Assume that a fraction \(\delta\) of the bilingual children of interpreters choose to work in different industries. Thus, only a fraction \((1 - \delta)\) of the bilingual children of the interpreters become interpreters and \(\delta I_o\) new interpreters are recruited each period. In reality, \(\delta\) is likely to be close to 1. Thus, the language profile follows the sequence:

\[
(a^1, b^1) = (N + I_o, N) \\
(a^2, b^2) = (N + I_o, (1 + \delta), N), \\
(a^3, b^3) = (N + I_o, (1 + 2\delta), N), \\
\ldots
\]

Since the number of bilingual workers in the foreign country has an upper limit \(N\), for all \(t\):
\[I_o, (1 + \delta t) \leq N\]

Let (Eq. (8))
\[
t_o \equiv \frac{N - I_o}{\delta I_o}
\]

Then, at any period \(t > t_o\), the entire foreign population becomes bilingual.

**Proposition 2:** Assume that wage rates are different between two trading countries. If free trade continues for more than \(t_o\) periods, all the workers in the low-wage country become bilingual, and the language of the high-wage country becomes the universal language.

### 3.2. The large country case

Next, consider the case where the high-wage country is small, i.e., \(N\) is a negligible fraction of \(n\). If the home country is small, it cannot affect the world prices, i.e., the autarky foreign prices are free trade world prices,
\[
p_1/p_2 = \bar{p}_1/\bar{p}_2.
\]
and hence, the low-wage, large (foreign) country does not reap gains from free trade. Consequently, the large country becomes passive in trade, and the small country must initiate
That is, the small home country, despite its high wages, must provide the interpretation service to initiate trade. Obviously, the interpreters can be recruited either from the low-wage or high-wage country. However, since the small country must initiate trade, we assume that some interpreters \( I_1 \) are recruited from within that country. Then there exists (Eq. (9)): 
\[
t_1 \equiv \frac{N - I_1}{\delta I_1}
\]  
(9)
such that at any period \( t > t_1 \), the entire population becomes bilingual. Even if some workers in the low-wage, large country were to become bilingual, by assumption their number will be small by the time the small country becomes completely bilingual, and hence the small country’s language, \( a \), does not become a universal language.

**Proposition 3:** Assume that the high-wage country is small and that it must initiate trade. If it recruits some domestic interpreters \( I_1 \), and free trade continues for more than \( t_1 \) periods, then the small country becomes completely bilingual and the language of the large country becomes the universal language.

### 3.3. The second stage: universal adoption of the dominant language

We now investigate the demise of the native language of the low-wage country.\(^5\) Assume that international wage disparity is not reversed, i.e., one country continues to have a higher wage than the other indefinitely. All consumption goods are assumed to have language components. Packaging, advertising, and other services can be provided in either language in the low-wage country. For instance, movies can be produced using either English or Italian. Commodity labels can be written in either English or Chinese. When trade begins, competitive firms must produce every good in two versions, domestic and foreign.

For the sake of argument, suppose each worker consumes one unit of a consumption good. By Proposition 1, consumers in the low-wage, foreign country are already bilingual. Consumers in the home country consume only version \( a \), whereas the bilingual consumers in the foreign country can use either version \( a \) or \( b \).\(^6\) Assume that the bilingual consumers are indifferent between the two versions.

Consider the production cost of producing \((N + v)\) units of version \( a \) and \((n - v)\) units of version \( b \). If the original version is in language \( a \), the production cost is written:

\[
C(N + v, n - v) = c(N + v) + (1 + \beta)c(n - v),
\]

where \( c \) is the generic unit cost of producing either version, and \( \beta \) is the extra cost of producing the other version, using the interpretation services. Differentiating the cost function

\(^5\) The proof for the demise of the native language of a small bilingual country is the same.

\(^6\) For instance, due to differing industrial standards and languages, Phillips, a large Dutch firm, had to make nine different types of television sets for European companies.
with respect to \( v \), we get \( \frac{dC}{dv} = -\beta c < 0 \). Thus, competitive firms produce only version \( a \), and the minimum cost reduces to:

\[
C(N, n) = c(N + n).
\] (10)

On the other hand, if the original version is produced using language \( b \), the production cost is:

\[
C(n - v, N + v) = c(n - v) + (1 + \beta)c(N + v),
\]

and \( \frac{dC}{dv} = \beta c > 0 \). Thus, the competitive firms supply only \( n \) units of version \( b \) to foreign consumers, but \( N \) units of version \( a \) to domestic consumers. In this case, the production cost reduces to:

\[
C(n, N) = cn + (1 + \beta)cN.
\] (11)

Observe that \( C(N,n) - C(n,N) = \beta cN > 0 \). It follows that the production cost is lower if the original version is produced in language \( a \). Thus, producers supply only version \( a \) to consumers in the low-wage country, and stops producing version \( b \). Since only version \( a \) is supplied to foreign consumers, the bilingual population of the foreign country gradually stops using their native language.

**Proposition 4:** Assume that international wage disparity is not reversed. If the bilingual consumers are indifferent between domestic and foreign versions of consumption goods, then for each commodity only the versions of the high-wage country will be supplied to the bilingual consumers. Thus, the language of the low-wage country becomes obsolete and that of the high-wage country is adopted as the universal language.

This proposition shows that once the low-wage country reaches the bilingual stage, firms initiate the monolingual process that culminates in the demise of the original language of the low-wage country. However, even before reaching the bilingual stage, firms may begin this process of elimination by producing only the dominant-language versions of traded goods. For instance, many Japanese and Taiwanese firms are efficient producers of computers, but may produce English models only.

One possible exception to the universal adoption of a single language may occur if each nation alternates between two states, a high-wage state in one period and a low-wage state in the next period. In this case, both countries would become bilingual during the interim period. However, Eqs. (10) and (11) show that the language that becomes universally accepted first will be the sole survivor, except in the unlikely case where both reach the universal status simultaneously.

**4. Concluding remarks**

The findings of this paper have rather striking policy implications. For instance, the model shows that trade protection can only retard the adoption of a universal language. It would be
difficult to conduct an empirical test of the theory developed in this paper, because much of the empirical data has become available only during the last few decades, and the required statistics for any empirical tests would span many centuries, if not a whole millennium. However, there are some telltale signs throughout history that seem to be consistent with the theory.

Aryan-speaking nomads from the Eurasian steppes entered the Indian continent around 1500 B.C., bringing with them bards, wheels, and herds of cattle. The Aryans were a sort of “high-wage” group in those days, encouraging Indians to learn their languages. They left such indelible marks on Sanskrit that it is classed with other Indo-European languages. The present-day Indo-European languages of Northern India are all related to Sanskrit, although it is not generally used any longer. However, this injection of the Aryan blood into the Dravidians was not large enough to change significantly the complexion or the overall feature of the present-day Indians.

Continuous migration of Northern Europeans since Columbus into America — then a country with a small population of native Americans — changed it to a predominantly white nation, although it is alleged that the Europeans’ conflicts with natives and virulent diseases imported by Europeans may have expedited the otherwise natural process.

It also should be noted that the proposed theory is based on the assumption that the trading countries continue indefinitely. Latin was probably the first language that had real potential to become a universal language, but the Roman Empire collapsed within 20 generations.7

Table 1 shows 13 principal languages of the world today. Mandarin is the most widely spoken; but China is currently a low-income area, and if it continues to be one, Chinese is

Table 1
The principal languages of the world

<table>
<thead>
<tr>
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<td>118</td>
<td>110</td>
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</tbody>
</table>

Unit: millions

7 The (western) Roman Empire founded by Augustus in 27 B.C. ended in 476 A.D., lasting about five centuries.
unlikely to become the universal language, although during the 3-year period, 1996–1999, the number of nonnative speakers of Chinese has grown substantially. In the same vein, it is unlikely for Hindi, Spanish, Bengali, Arabic, Russian, Portuguese, and Malay to become the universal language, because the wage rates are low in these regions. Japanese, German, and French-speaking regions are generally high-wage areas, but each accounts for less than 5% of the world population. The English-speaking region is generally characterized by high-wage, and its area is not small, compared with Chinese or other language areas. Thus, it appears that English is now the next best candidate to become a universal language, provided that the English-speaking area continues to have high labor productivity during this century.

References


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8 However, this growth of nonnative Chinese speakers appears to be the result of new bilingual groups who also speak Cantonese, Wu, Min or Hakka, i.e., conversion of residents in the Chinese economic area, not from other language groups.