Research on the interaction between language and economy

Yusi Wu\textsuperscript{1,a}, Jie Liu\textsuperscript{2,b}, Ping Wang\textsuperscript{2,c}, Yisheng Wang\textsuperscript{1,d}, Peng Zhang\textsuperscript{2,e}, Hongyan Xi\textsuperscript{1,f}

\textsuperscript{1}School of Business Administration Hohai University Changzhou, Jiangsu 213022, China.
\textsuperscript{2}College of Mechanical and Electrical Engineering Hohai University Changzhou, Jiangsu 213022, China.
\textsuperscript{a}1294054460@qq.com; \textsuperscript{b}1643549712@qq.com; \textsuperscript{c}137584860@qq.com; \textsuperscript{d}861956245@qq.com; \textsuperscript{e}1135401844@qq.com; \textsuperscript{f}2385975321@qq.com.

Abstract: With the increasing economic globalization, the language spoken by people has also undergone great changes. This paper analyzes the changes in language use as the economy develops and the impact of regional language on economic globalization. Firstly, we use reliability analysis to analyze the reliability of the collected data, and the results show that the data used in this paper has high reliability. Then, we define the Economic Attraction (EA) to measure the motivation of people learning the language of the country or region, which will give people an idea of the future usage of each language. The results show that the number of users in English and Japanese will increase in the future. Then, selecting a multinational company as a typical example of economic globalization for analysis, the TOPSIS algorithm was used to analyze the location of a multinational company's office in the global region, respectively, Tokyo, London, Dubai, Paris, Madrid, Singapore. And the language of the office staff is Japanese, English, Arabic, French, Spanish, Chinese and English.

1. Introduction
There are currently about 6,900 languages spoken on Earth. About half of the world’s population claim, one of the following ten languages (in order of most speakers) as a native language: Mandarin (incl. Standard Chinese), Spanish, English, Hindi, Arabic, Bengali, Portuguese, Russian, Punjabi, and Japanese. \cite{1,2} However, much of the world’s population also speaks a second language. \cite{3} When considering total numbers of speakers of a particular language (native speakers plus second or third, etc. language speakers), the languages and their order change from the native language list provided. \cite{4} The total number of speakers of a language may increase or decrease over time because of a variety of influences to include, \cite{5} but not limited to, the language(s) used and/or promoted by the government in a country, the language(s) used in schools, social pressures, migration and assimilation of cultural groups, and immigration and emigration with countries that speak other languages. But the economy has an increasing influence on people's daily lives, the economy of other countries has become the biggest factor in learning the language of the country.

With the development of economic globalization, multinational service companies have gradually set up offices overseas to handle daily affairs in order to expand their business. The language learning of office personnel will be affected by the language of the region.
2. Data collection and verification

First, we collect the number of native speakers in the world's 10 major languages and the number of second and third language users for later analysis. The use of these 10 languages is shown in Table 1.

Table 1: ten languages (in order of most speakers) in the word

| Native Language Rank | Native Language | Native Speakers | Second(or 3rd,etc)Language Speakers |
|----------------------|----------------|-----------------|-------------------------------------|
| 1                    | Mandarin Chineses | 897 million     | 193 million                         |
| 2                    | Spanish          | 436 million     | 91 million                          |
| 3                    | English          | 371 million     | 611 million                         |
| 4                    | Hindustani       | 329 million     | 215 million                         |
| 5                    | Arabic           | 290 million     | 132 million                         |
| 6                    | Bengali          | 242 million     | 19 million                          |
| 7                    | Portuguese       | 218 million     | 11 million                          |
| 8                    | Russian          | 153 million     | 113 million                         |
| 9                    | Punjabi          | 148 million     | 1 million                           |
| 10                   | Japanese         | 128 million     | 1 million                           |

Due to the limitations of data collection, we need to analyze the reliability of the data we are looking for.

Here we use $\alpha$-reliability coefficient method to test the reliability of the data. $\alpha$-reliability coefficient method is the most commonly used reliability coefficient. The value of the Cronbach $\alpha$ coefficient usually is between 0 and 1. If the alpha coefficient does not exceed 0.6, it is generally considered that the internal consistency is insufficient; when it reaches 0.7-0.8, the scale has considerable reliability, and when it reaches 0.8-0.9, the reliability of the scale is very good. An important characteristic of the Cronbach $\alpha$ coefficient is that their values increase with the increase of the scale item. Therefore, the Cronbach $\alpha$ coefficient may be artificially and unreasonably increased due to the inclusion of redundant measurement items in the scale. There is also a coefficient that can be used simultaneously with the Cronbach $\alpha$ coefficient. The coefficients can help in the evaluation of whether the calculation of the mean number masks some unrelated measurement items in the calculation of the Cronbach $\alpha$ coefficient. Different researchers have different views on the threshold value of the reliability coefficient. Some scholars believe that the Cronbach $\alpha$ coefficient should be at least 0.8 in the basic research, and the Cronbach $\alpha$ coefficient should be at least 0.7 in the exploration study. In the practice study, the Cronbach $\alpha$ coefficient only needs to reach 0.6.

Then we use SPSS to analyze the reliability of the data. The results are shown in Table 2.

Table 2: Reliability Statistics

| Cronbach’s Alpha | N of Items |
|------------------|------------|
| 0.87             | 10         |

We can get 0.87. In a reasonable range, the data is a high degree of credibility. So we can use the data in the following analysis.

3. Language Learning

3.1 Economic Attraction

Since there are more than two hundred countries and regions, we divide the world into five continents, namely America, Asia, Oceania, Africa, Europe. And for every continent, we selected a typical country. Where we introduce a parameter called Economic Attraction (EA) to show the economy of a region. We assume that the people who want to learn language focus on the economy of the region. We normalize the per capita GDP coefficient and the growth rate of GDP coefficient to value the economic attraction[6].
\[ \text{GDP}^p = \frac{\text{GDP} - \text{GDP}_{\text{max}}}{\text{GDP}_{\text{max}} - \text{GDP}_{\text{min}}} \]  
\[ \text{GDP}^{gr} = \frac{\text{GDP}_{gr} - \text{GDP}_{gr\min}}{\text{GDP}_{gr\max} - \text{GDP}_{gr\min}} \]  
\[ \text{EA} = \text{GDP}^p + \text{GDP}^{gr} \]  

Where \( \text{GDP} \) is the country’s per capita GDP coefficient, \( \text{GDP}^{gr} \) is the growth rate of GDP coefficient of a country, \( \text{GDP}^p \) and is the growth rate of GDP.

We also fully attach great importance to the GDP attraction while choosing the typical country for every continent. They are America for America, Japan for Asia, Australia for Oceania, South Africa for Africa, Spain for Europe. Among them, South Africa is not one of the top 3 countries of GDP in Africa, but its comprehensive national strength can’t be ignored. Compared with the countries that hold higher GDP but only specialize in tourism or resources, we carry out the GDP attraction of South Africa is more stable and reliable. Similarly, Spain’s GDP doesn’t rank first in Europe, but Spanish is one of the top ten influential languages given by the topic. Due to this phenomenon, we exclude the countries that hold higher GDP but only specialize in tourism or resources.

3.2 Language Learning Trend

We apply the five countries per capita GDP in 2013, 2014, 2015, 2016, 2017. The growth rate of the country GDP are listed below in Figure 1 and Table 3.

![Figure 1](image1.png)

**Figure 1**: 2013-2017 GDP per capita of representative countries in five continents

| Nation | America | Japanese | Australia | Africa | Spain |
|--------|---------|----------|-----------|--------|-------|
| Rate   | 6.9     | 6.09     | -7.12     | -8     | -0.16 |

We normalize the per capita GDP coefficient and the growth rate of GDP coefficient to value the economic attraction from 2013 to 2017. We combine the weight of the GDP with the EA in a country in Figure 2. And it can be seen that English and Japanese are highly attractive languages for language learners. Therefore, the number of users in English and Japanese will increase in the future.

![Figure 2](image2.png)

**Figure 2**: Economic attraction of different regions
We use the total EA of four continents as a denominator, each EA of the four continents as a molecular. So we learn the proportion of Asia immigrants in each continent. Similarly, we know the distributions of the other four continents. There are five continents distributions as listed:

Figure 3: Distribution of American immigrant population

Figure 4: Distribution of Asian immigrant population

Figure 5: Distribution of Australian immigrant population

Figure 6: Distribution of African immigrant population
This paper selects a multinational company as a typical example of economic globalization for analysis. The multinational company with offices in New York City in the United States and Shanghai in China, is continuing to expand to become truly international. On one hand, the company formulate regional strategies to build inter-regional webs, improve the distribution of client resources. On the other hand, a company seeks to make the most efficient use of client resources in the different areas.[7] In order to do business better, the staff at the office need to speak the local language.

4. International Offices Options of Multinational Service Company

4.1 Model Building

We use TOPSIS to choose the location of the office. TOPSIS is an effective multi-index evaluation method.[8] This method evaluates positive ideal solution and negative ideal solution. We sort the optimal solution by computing the relative relevance of each ideal solution to the best solution. The steps are as follows:

① Use the method of vector programming to get the canonical decision matrix. Supposing the decision matrix of multi-attribute decision makes problem \( A = (a_{ij})_{m \times n} \), standardized decision matrix \( B = (b_{ij})_{m \times n} \), a technique for order preference by Similarity to an Ideal Solution can be specified as follows:

\[
b_{ij} = a_{ij} / \sqrt{\sum_{n=1}^{n} a_{i,j}^2}, i = 1, 2, \cdots, m; j = 1, 2, \cdots, n
\]  

(4)

② Constitute a matrix of weighted norms \( C = (c_{ij})_{m \times n} \). Suppos that the decision vector given by each attribute is \( w = [w_1, w_2, \cdots, w_{n}]^T \), then

\[
c_{ij} = w_j \times b_{ij}, i = 1, 2, \cdots, m; j = 1, 2, \cdots, n
\]  

(5)

③ Determine positive ideal solution \( C_j^* \) and negative ideal solution \( C_j^0 \). Assume that the \( j \) property value of positive ideal solution \( C_j^* \) is \( c_{j}^* \), the \( j \) property value of negative ideal solution \( C_j^0 \) is \( c_{j}^0 \), then

\[
c_{j}^* = \begin{cases} 
\max_{c_{ij}, j \text{ benefit}}, & j = 1, 2, \cdots, n, \\
\min_{c_{ij}, j \text{ cost}}, & 
\end{cases}
\]

(6)

\[
c_{j}^0 = \begin{cases} 
\min_{c_{ij}, j \text{ benefit}}, & j = 1, 2, \cdots, n, \\
\max_{c_{ij}, j \text{ cost}}, & 
\end{cases}
\]

(7)

④ Calculate the distance between each solution and the ideal solution. The distance \( d \) between
the alternative and the ideal solution is

$$s^* = \sqrt{\sum_{j=1}^{m} (c_{ij} - c^*_j)^2}, i = 1, 2, \cdots, m;$$  \hspace{1cm} (8)

④ The distance $d_i$ between the alternative and the negative ideal solution is

$$s_i^0 = \sqrt{\sum_{j=1}^{m} (c_{ij} - c^0_j)^2}, i = 1, 2, \cdots, m.$$

(9)

⑤ Calculate the number of queuing indicators for each program is

$$f_i^* = s_i^0 / (s_i^0 + s_i^*), i = 1, 2, \cdots, m.$$  \hspace{1cm} (10)

According to $f_i^*$ descending order of the arrangement of programs.

4.2 Model Solution

As we see from United Nations Industrial Development Organization \(^{(9)}\) there are 6 factors about the site selection of the international office: political environment, infrastructure conditions, geographic conditions, policies and institutional environment, modern service industry agglomeration, human resources. We assume the weight of six factors is the same and the chosen cities’ political environment is almost the same.

Considering the 5 factors, we use the city GDP to measuring the level of infrastructure conditions and geographic conditions, per capita GDP measuring the level of the level of modern service industry agglomeration, the number of famous universities measures the human resources.

Based on The World Bank, we know some cities: London, Singapore, Hong Kong, Paris, Tokyo, Dubai, Sydney, Bombay, Moscow, Madrid. Since these cities above attract multinational company, we have these as the locations of national office. Normalize the GDP per capita, the city GDP, the number of famous universities Use the Weighted Average method to get the weights of the GDP per capita, the city GDP, the number of famous universities respectively 0.25, 0.5, 0.25.

We apply MATLAB to calculate the advantage order of the ten cities and the results are in Table 4.

Table 4: Advantage order of the ten cities

| City   | Tokyo | London | Dubai | Paris | Madrid |
|--------|-------|--------|-------|-------|--------|
| Index  | 0.8725| 0.7086 | 0.6017| 0.5825| 0.5623 |
| City   | Singapore | Sydney | Hong Kong | Moscow | Bombay |
| Index  | 0.5537| 0.4412 | 0.4012 | 0.3527| 0.3524 |

Based on the data above, we choose Tokyo, London, Dubai, Paris, Madrid, Singapore for a large multinational service company to open the additional international offices in Figure 8. And the language of the office staff is Japanese, English, Arabic, French, Spanish, Chinese or English.
5. Conclusions
This paper analyzes the interaction between economy and language. First, we use reliability analysis to analyze the reliability of the collected data, and the results show that the data used in this paper has high reliability. The economic attractiveness is defined to estimate the changes in future language use under the influence of the economy. The results show that the number of users in English and Japanese will increase in the future. Then we choose multinational companies as a typical example of economic globalization, use TOPSIS to select the location of the office and the language usage of their employees. At last, these offices are Tokyo, London, Dubai, Paris, Madrid, Singapore.

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