Computer Dynamic Forecast Model with Adaptability through the Method of Rank-Sum Ratio

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Abstract. At present, global political and economic relations are very tense. After the occurrence of major political, economic and financial shocks, it will have a significant impact on the employment of all countries. Our goal is to analyze the impact of the trade war on China's imports and exports and on employment rate in the United States. Firstly, according to sino-us trade countermeasures and referring to SitcRev2, the goods were classified according to the added value of technology. Then, the coefficient of variation method was used to obtain the weight value. Secondly, the rank-sum ratio comprehensive evaluation method is used in to evaluate and rank the imports and exports of China and the United States from 2007 to 2018. Based on the above analysis and the factors affecting the employment rate, we establish a employment rate economic model. Through the collected data, VAR stationarity test and Granger causality test are conducted on the model. Finally, the specific impact of the trade war on the US employment rate is obtained through impulse response and variance decomposition.

Keywords: Employment rate economic model, Rank-sum ratio.

1. Introduction
Trade disputes between China and the United States have recently become the focus of worldwide attention [1]. They concern not only China and the United States, but also the world economy and the world's political, military and diplomatic landscape. The issue of employment has always been the primary issue concerning the sound economic development and social stability of all countries in the world [2]. High-quality employment is an important part of a better life for the people and an inherent requirement for high-quality economic development. Therefore, it is crucial to build an economic model of employment rate.

2. Model Establishment

2.1. Coefficient of variation method
According to SitcRev2, 238 commodities are classified according to the value added of technology [3]. In order to eliminate the influence of different dimensions of each evaluation index, it is necessary to use the coefficient of variation of each index to measure the difference degree of each index value [4]. The variation coefficient formula of each index is as follows:

\[ C_v = \frac{\sigma}{\mu} \]

where \( C_v \) is the variation coefficient, \( \sigma \) is the standard deviation, and \( \mu \) is the mean value.
\[ V_i = \frac{\delta_i}{\bar{x}_i} \quad (i = 1, 2, \ldots, n) \]

\( V_i \) is the coefficient of variation, also known as the standard deviation coefficient; \( \delta_i \) is the standard deviation; \( \bar{x}_i \) is the average. The weight of each index is:

\[ w_j = \frac{V_i}{\sum_{i=1}^{n} V_i} \]

After calculation in SPSS, we get the weight value of China's import and export to the US, as shown in the figure below:

![Figure 1. The weight of China's imports and exports to the United States.](image)

2.2. Rank-sum ratio comprehensive evaluation method

Based on the structural data of major commodity categories from 2007 to 2018, we adopted the rank-sum ratio comprehensive evaluation method to evaluate the period from 2007 to 2018\[5\]. The specific steps of the method are as follows:

(1) Rank. The evaluation object of this paper is 2007-2018, and the evaluation index is 10 major commodity categories. The 10 evaluation indicators of 12 evaluation objects are arranged into a raw data table with 12 rows and 10 columns. The rank of each index evaluation object was compiled, in which the efficiency index was compiled from the smallest to the largest, the cost index was compiled from the largest to the small rank, and the average rank was compiled for those with the same index data. The resulting rank matrix is denoted as \( R = (R_{ij})_{mn} \).

(2) Calculate the rank-sum ratio. According to the formula:

\[ RSR_i = \frac{1}{mn} \sum_{j=1}^{n} R_{ij}, i = 1, 2, \ldots, n \]

When the weights of each evaluation index are different, the weighted rank sum ratio is calculated as follows:

\[ WRSR_i = \frac{1}{n} \sum_{j=1}^{m} w_j R_{ij}, i = 1, 2, \ldots, n \]

\[ \sum_{j=1}^{m} w_j = 1 \]

\( w_j \) is the weight of the evaluation index.

(3) Calculate the units of probability. Prepare RSR(WRSR) frequency distribution table in order from small to large. List the frequency \( f_i \) of each group. The cumulative frequency \( cf_i \) of each group was calculated. Calculate the cumulative frequency \( p_i = cf_i / n \). Convert \( p_i \) to Probit, \( \text{Probit} \) is the \( p_i \) quantile of the standard normal distribution plus 5.
(4) Calculate the linear regression equation. The Independent variable is Probit, the independent variable is RSR. The formula of linear regression equation:

\[ RSR(WRSR) = a + b \times \text{Probit} \]

(5) Sorted sort. The evaluation objects were sorted according to the RSR estimation value calculated by the regression equation.

This process was carried out in MATLAB and the following results were obtained:

| Year | 2018 | 2017 | 2016 | 2015 | 2014 | 2013 | 2012 | 2011 | 2010 | 2009 | 2008 | 2007 |
|------|------|------|------|------|------|------|------|------|------|------|------|------|
| WRSH | 5.46 | 6.12 | 6.17 | 6.23 | 7.10 | 6.26 | 6.93 | 6.92 | 5.99 | 5.58 | 8.25 | 6.98 |
| China's export ranking to the United States | 12 | 9 | 8 | 7 | 2 | 6 | 4 | 5 | 10 | 11 | 1 | 3 |
| WRSR | 5.80 | 6.25 | 7.08 | 6.07 | 5.99 | 5.81 | 6.23 | 6.48 | 7.23 | 7.03 | 6.84 | 7.15 |
| China's import ranking to the United States | 12 | 7 | 3 | 9 | 10 | 11 | 8 | 6 | 1 | 4 | 5 | 2 |

Figure 2. Year rank of China's imports and exports to the United States.

According to Figure 2, we can intuitively see the lowest value in 2018, which indicates that the trade war has a great impact on China's imports and exports.

2.3. Employment rate economic model

Based on the above analysis and the factors affecting the employment rate, the following is the theoretical derivation of the relationship between each factor and the employment rate. First, suppose that the total output of a country conforms to the production function (1).

\[ P = T^a \times C^\beta \times L^\lambda \times M^\gamma \]  

(1)

Where \( P \) is the total output, \( T \) is the technical factor, \( C \) is the capital, \( L \) is the labor force, \( M \) is the monopoly coefficient of the product, \( \beta \) and \( \gamma \) are the factor share coefficient, \( \alpha \) is the efficiency that allows the factor to change the production process, and \( \eta \) is the monopoly ratio of the product. In order to maximize production, the product of marginal revenue of labor and wage (\( w \)) should be equal to the product of marginal revenue of capital and its use cost (\( c \)), that is, to eliminate the capital input in (1), we can get:

\[ P = T^a \times (\frac{L}{b} \times \frac{w}{c})^\beta \times L^\lambda \times M^\gamma \]  

(2)

When different countries produce different products, a country's domestic demand for commodities is met by both domestic and foreign production. When the equilibrium condition of supply equals demand is reached and the influence of exchange rate is considered, the following import and export equation can be obtained [6]:

\[ ex = \phi_0 + \phi_1 \times e \times y_1 \times M_1 + b_1 \]  

(3)

\[ im = \phi_0 + \phi_1 \times y_2 \times M_2 + b_2 \]  

(4)
is export,  is import,  is exchange rate between the US and China,  is income used by China to consume the US exports to it,  is income used by the US to consume imports from China, from equations (3) and (4), we can get:

\[ \phi_1 \times y_2 \times M_2 = (\phi_0 - \phi_0) + \phi_1 \times e \times y_1 \times M_1 + (h_1 - b_2) - (ex - im) \]  

(5)

From (2) and (5), we can get:

\[ (1 - \phi_1) \times y_2 \times M_2 = T^\alpha \times \left( \frac{q_1 \times L}{q_2} \right) \times L^\beta - \left[ (\phi_0 - \phi_0) + \phi_1 \times e \times y_1 \times M_1 + (h_1 - b_2) - (ex - im) \right] \]  

(6)

By logarithmic processing on both sides of Equation (6), it can be obtained as follows:

\[ \ln L^\beta = \gamma_0 + \gamma_1 \times \ln \frac{w}{c} + \gamma_2 \times \ln P + \gamma_3 \times \ln (ex - im) + \gamma_4 \times \ln e + \gamma_5 \times \ln T + b \]  

(7)

\[
\begin{align*}
\gamma_0 &= -\frac{\ln q_1 \times y_1}{q_1 + q_2} + \frac{[q_1 \times \ln q_1 - q_1 \times \ln q_2 + \ln (\phi_0 - \phi_0)]}{q_1 + q_2} \\
\gamma_1 &= \frac{q_1}{q_1 + q_2} \\
\gamma_2 &= \frac{1 - \phi_1}{q_1 + q_2} \\
\gamma_3 &= \frac{1}{q_1 + q_2} \\
\gamma_4 &= \frac{\alpha}{q_1 + q_2} \\
b &= \frac{(h_1 - b_2)}{q_1 + q_2}
\end{align*}
\]

According to the employment rate calculation formula, it is assumed that the number of willing to work is , the total number of population is , and the ratio of willing to work to the number of employed is . Define the employment rate as follows[7]:

\[ E = \frac{Y_1 + L}{Y} = \frac{L}{Y} (\frac{1}{x} + 1) \]  

(8)

The logarithm of both sides of equation (8) can be obtained as follows:

\[ \ln E = \ln \frac{L}{Y} (\frac{1}{x} + 1) \]  

(9)

Substitute equation (9) into equation (7) and get:

\[ \ln E = \beta_0 + \beta_1 \ln W + \beta_2 \ln P + \beta_3 \ln (ex - im) + \beta_4 \ln e + \beta_5 \ln L + \beta_6 \ln M + \varepsilon \]  

(10)
According to the above theoretical model, the explanatory variable in the empirical model is the employment rate of the US, and the explanatory variable is the US-China trade deficit. Other influencing factors include the US economic development, US-China exchange rate, US-China product monopoly value, US-China per capita wage and technological development level. The model is set as follows:

\[
\varepsilon = \ln \left( \frac{1}{x} \right) - \ln Y + b
\]

\[
\ln E = \beta_0 + \beta_1 \ln \text{TRADE} + \beta_2 \ln \text{GDP} + \beta_3 \ln \text{WAGE} + \beta_4 \ln \text{EXR} + \beta_5 \ln T + \beta_6 \ln M + \varepsilon
\]

\(\ln E\) is the logarithm of employment rate in the United States, \(\ln \text{TRADE}\) is the logarithm of trade deficit with China, \(\ln \text{GDP}\) is the logarithm of GDP, \(\ln \text{WAGE}\) is the logarithm of per capita wage, \(\ln \text{EXR}\) is the logarithm of exchange rate between the United States and China, \(\ln T\) is the logarithm of technical level, \(\ln M\) is the logarithm of product monopoly.

3. Model Test

3.1. VAR system stability test

First, in the EViews software we performed unit root checks on all variables and used information criteria to determine the lag order. Then the stability of VAR system is tested by eigenvalue method [8]. The results of running in EViews software are shown in Figure 3:

All eigenvalues in the figure are located within the unit circle, so the VAR system is stable.

3.2. Granger causality test

Granger causality test method is adopted to test the causal relationship of each variable in the model, and part of the test results are shown in Figure 4.
3.3. Impulse response function analysis and variance analysis

In the EViews software, the dynamic impact effect of each factor on the employment rate of the United States is analyzed through the impulse response graph model, and the results were shown in the figure below [9]:

**Figure 4.** Granger test results.

| Explained variable | Explanatory variable               | Chi-square statistics | P value | Conclusion                                             |
|--------------------|-----------------------------------|------------------------|---------|--------------------------------------------------------|
| The employment rate | US China trade deficit            | 1.81                   | 0.4     | The US China trade deficit is not the Granger of the U.S. employment rate |
| The employment rate | Economic growth                   | 1.34                   | 0.51    | The economic growth is not the Granger of the U.S. employment rate |
| The employment rate | Wages                             | 1.93                   | 0.38    | The wages are not the Granger of the U.S. employment rate |
| The employment rate | US China exchange rate            | 3.96                   | 0.14    | The US China exchange rate is not the Granger of the U.S. employment rate |
| The employment rate | Technical level                   | 6.21                   | 0.05    | The level of technology is the Granger of the U.S. employment rate |
| The employment rate | Monopoly of American and Chinese products | 1.63                   | 0.43    | The monopoly of American and Chinese products is not the Granger of the U.S. employment rate |

**Figure 5.** The impact of China-US trade deficit, economic growth and wage levels on US employment.

**Figure 6.** The impact of technology level, US-China exchange rate and US-China product monopoly on US employment.

The variance decomposition method of prediction error is used to calculate the contribution ratio of each variable in the model to the mean square error forecast of the explained variable. The results of analysis of variance are as follows:
4. Conclusion

The Granger causality test results show that there is a causal relationship between the US-China trade deficit and the US employment rate. The following conclusions can be drawn from the impulse response graph and variance decomposition results:

1. From the perspective of impulse response function, the influence of China-US trade deficit on the rise of employment rate in the US is manifested as a process of "suppression-promotion-inhibition". According to the results of variance decomposition, in the promotion stage, the contribution rate of China-US trade deficit is only 1.10%~1.45%, and the contribution rate of China-US trade deficit is 8.70%, which has a great restraining effect.

2. Combined with the model, it can be seen that the impact of economic growth on the employment rate of the United States is cyclical, with positive and negative shocks alternating.

3. The effect of wages on the rise of Employment in the United States is "promotion-depression-promotion".

4. The influence of the US-China exchange rate on the employment rate of the US is first promoted and then suppressed. In the short term, the rise of the exchange rate will reduce the export and the aggregate demand, which is not conducive to employment.

5. The influence of US-China product monopoly on the rise of employment in the United States is "suppression-promotion-inhibition".

6. Technical level restrained the rise of employment rate in the United States in the early stage, then promoted the rise of employment rate in the United States, and the effect of technical level on employment rate in the United States increased with the passage of time, indicating that technical progress is conducive to the growth of employment in the long run.

References

[1] Tan Yaxin. On Sino US trade disputes [J]. China Circulation Economy, 2019, (27): 40 - 41.
[2] Huang Ying, Xie Yuantai. Briefly Discuss the Employment Difficulties of Labor Forces in Large Population Countries [J]. Advances in Social Sciences, 2020, 9 (5): 757 - 770.
[3] Zhou Jun, Hong Chenxiang, Wang Jun. Analysis of China-US Import and Export of Commodity Trade Structure under the Trade War: 2007-2016 [J]. Shanghai Management Science, 2019, 41 (3): 76 - 83.
[4] Yan Jun, Wang Ting, Qin Jue. Research on ecological sensitivity analysis of Ma’anshan Jiangxinzhou based on the method of variation coefficient[J]. Ecological Science, 2020, 39 (2): 124 - 132.
[5] Liu Liyan, Sun Aifeng. Comprehensive Evaluation Model of Nursing Quality Based on Rank Sum Ratio Method [J]. China Health Industry, 2020, 17 (12): 63 - 65.
[6] Goldstein M, Khan M S. Income and price effects in foreign trade [J]. Trade Currencies and Finance. 1985: 3 - 81.

[7] Helpman E, Itskhoki O. Labour market rigidities, trade and unemployment [J]. The Review of Economic Studies, 2010, 77 (3): 1100 - 1137.

[8] Gao Jieying, Lian Yonghui. Research on the Spillover Effect of RMB Foreign Exchange Market—An Analysis Based on DCC-MVGARCH Model [J]. Journal of Sichuan University (Social Science Edition), 2020, (3): 138 - 147.

[9] Tao Yong, Wang Xiaojian. The Research on the Conduction Effect of Credit Inputs on Profit of Private Enterprises--Based on the Panel VAR Model and Analysis of Pulse Response Function [J]. West China Finance, 2019, (7): 46 - 50.