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EXPLORATION OF TAIWAN'S UNEMPLOYMENT FACTORS IN DIFFERENT AGES BY GREY RELATIONAL ANALYSIS

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Abstract

This research classified the unemployment rate according to age and 11 influential factors during the period of 2001 to 2014, which were used to determine the factors affecting the overall unemployment rate and unemployment rate of different ages, as well as their relational degrees, through grey relational analysis. The research results show that the average unemployment weeks, average salary structure, exchange rate, Consumer Price Index (CPI), and approved number of imported foreign workers have significant effect on the overall unemployment rate, as well as the unemployment rates of 15-24 years old, 25-44 years old, and 45-64 years old, among which the average unemployment weeks and average salary structure have the greatest impact; while gross export value, Economical-growth- rate (EGR), composite index of coincident index, Gross Domestic Product (GDP), and National Income (NI) have significant effect on the unemployment rate of those more than 65 years old. According to further research of the association between influential factors, GDP is the leading influential factor, and it also affects other 10 factors; in quantitative ranking, NI is affected most significantly, followed by EGR. If EGR is excluded, GDP is the most important, followed by CPI.

Key Words: Unemployment rate, Age group, Grey relational analysis, Grey theory, Labor

Introduction

Since 1996, Taiwan's unemployment rate has exceeded 2%. Between 2000 to 2008, the dot-com bubble, the American 911 Incident, and the global Financial Crisis affected the global economy, and caused drastic fluctuations to Taiwan's unemployment rate. By2009, the unemployment rate reached the highest level (5.85%), and there were 639,000 unemployed people.

O'Higgins (2001) found that the unemployment rate in each country is related to the overall economy and the variables of the macro-economy, including national income, exchange rate, economic growth rate, CPI, etc. The results show that: 1. The unemployment rate has effect on itself during the underdeveloped period, and shows significant negative correlation; 2. The national income has negative effect on the unemployment rate; 3. It can be known from Granger causality test that both the exchange and EGR will affect the unemployment rate; 4. It can be known from the result of Granger causality test between the 4 variables that EGR will affect NI and CPI, CPI will affect NI, and a mutual feedback relationship between the exchange rate and NI is also found.

According to the research of American economist Okun (1962), when the unemployment rate is higher by 1 % than the full employment, it will cause 2.5% drop in GDP. Blanchard (1986) found that the larger Okun's coefficient means the greater progress the country has made. Foreign direct investment into the labor market will affect the demand and salaries of relative skilled workers (Feenstra & Hanson, 1997; Taylor, 2000). Huang et al. (2012) applied grey GM(1,1) to predict the number of foreign workers, unemployment rate, unemployed people's average unemployment weeks, the employed population in the manufacturing industry, and the number of insured under labor insurance in Taiwan in 2012, and the results show that the data have seen significant growth.

Based on the above literature review, 11 factors affecting the unemployment rate are integrated by this paper, and used as the research subjects, including GDP, NI, EGR, CPI, Mainland China's total investment amount approved by Taiwan, gross export value, exchange rate, unemployed people's average unemployment weeks, average salary structure (average salary of industry and service business), the approved number of imported foreign workers, and the composite index of the coincident index.

Methodology

Regarding age, this research classifies unemployment rate into 4

categories: 15~24 years, 25~44 years, 45~64 years, and more than 65 years, and takes the period of2001 to 2014 as the research period.

Grey relational analysis

Professor Deng Julong proposed Grey Relational Analysis in the Grey Theory, which is a kind of measurement method to determine the degree of correlation between discrete series. When the grey relational grade is obtained, only sequence x_0 is the reference sequence among all the sequences, and it is called the "local grey relational grade"; among all the sequences, when any sequence x_i=1,2,3……m can be used as the reference sequence, and it is called the overall grey relational grade; the space formed by the factor space and comparability is called the grey correlation space.
where,
i=0,1,2,3,.....m, ∈M represents m sequences,
k=0,1,2,3,.....n, ∈N represents each sequence has n factors

$$x_0 = (x_0(1), x_0(2), \cdots, x_0(k))$$
$$x_1 = (x_1(1), x_1(2), \cdots, x_1(k))$$
$$x_2 = (x_2(1), x_2(2), \cdots, x_2(k))$$
$$\vdots = \vdots$$
$$x_m = (x_m(1), x_m(2), \cdots, x_m(k))$$

Grey relational coefficient

When only sequence x_0 is the reference sequence, the other sequences x_i are the comparative sequences, the grey relational coefficient is defined, as follows:

$$\gamma(x_0(k)x_i(k)) = \frac{\Delta_{\min} + \zeta\Delta_{\max}}{\Delta_{oi}(k) + \zeta\Delta_{\max}} \quad (1)$$

where $k = 1,2,3,\cdots,n$, $i = 1,2,3,\cdots,m$
i. x_0 is the reference sequence, x_i is one specific comparative sequence.
ii. $\Delta_{oi} = \| x_0(k) - x_i(k) \|$: the absolute value of the k[th] difference between x_0 and x_i (2)
iii.

$$\Delta_{\min.} = \min_{j \in i} \min_{\forall k} \| x_0(k) - x_j(k) \| \quad (3)$$

iv.

$$\Delta_{\max.} = \max_{j \in i} \max_{\forall k} \| x_0(k) - x_j(k) \| \quad (4)$$

v.ζ: distinguishing coefficient: ζ∈ [0,1], the general distinguishing coefficient is 0.5, and can be suitably adjusted according to the actual needs; and the value after adjustment can only change the relative value, but will not affect the sequence of the Grey Relational Grade (Deng,2003).

Grey Relational Grade

After the grey relational coefficient is obtained, its average is taken as the Grey Relational Grade, which is defined as follows:

$$\gamma(x_i, x_j) = \frac{1}{n}\sum_{k=1}^{n}\gamma(x_i(k), x_j(k)) \quad (5)$$

In actual application, the importance of the various factors to the system is not completely different. Grey Relational Grade refers to grey relational coefficients with unequal weight, and is defined, as follows:

$$\gamma_{ij}\gamma(x_i, x_j) = \sum_{k=1}^{n}\beta_k\gamma(x_i(k), x_j(k))$$

When the value of the Grey Relational Grade gets closer to 1, it indicates that it has higher relational degree with the reference sequence; conversely, when it gets closer to 0, it means that it has lower relational degree with the reference sequence.

Grey Relational Ordinal

Grey relational grade refers to the relational degree of 2 sequences, and the sequence of their respective relational degree values is the most important message. Therefore, grey relation is conducted between m comparative sequences and the same one reference sequence, and then, they are sorted according to value to form one relationship of size, which is called the Grey Relational Ordinal, and defined as reference sequence x_0 and comparative sequence x_i.

Grey Relational Ordinal in Overall Grey Relational Grade

In the overall Grey Relational Grade, each sequence can become a canonical sequence. Therefore, after all the Grey Relational Grades are obtained, they can be sorted by the eigen-vector method to gain one $m \times m$ matrix, and this matrix is called "grey relational matrix R" (see below).

$$R_{m\times m}=\begin{bmatrix} \gamma_{11} & \gamma_{12} & \cdots & \gamma_{1m} \\ \gamma_{21} & \gamma_{22} & \cdots & \gamma_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ \gamma_{m1} & \gamma_{m2} & \cdots & \gamma_{mm} \end{bmatrix} \quad (6)$$

After the matrix is generated and each element is the value of the Grey Relational Grade, the method to gain weight is, as follows:

1. Establish the eigenvalue [R] $m \times m$ matrix of the goal to be obtained.
2. Gain the $AR=\lambda R$ of matrix.
3. Gain the eigenvector (R) of matrix: forming $P^{-1}RP=\text{diag}\{\lambda_1, \lambda_2, \lambda_3, \ldots, \lambda_n\}$ (7)

Take the eigenvector corresponding to maximum eigenvalue λ max, and the value of each corresponding element in this eigenvector is the weight (take the absolute value).

The relational degree between the overall unemployment rate and 11 factors, as well as the relational degree between the unemployment rates of different ages and 11 factors, can be obtained by this research through the above-mentioned(1)-(5). In order to determine the most important influential factor from the 11 factors, the eigenvalue is obtained from the above-mentioned (6)-(7), and then sorted.

Empirical Results and Analysis

Grey Relational Analysis is applied to conduct correlation analysis between the influential factors of the overall unemployment rate and unemployment rate in different ages, and the research subjects of the overall unemployment rate and unemployment rate in different ages (including 4 categories: 15~24 years, 25~44 years, 45~64 years, and more than 65 years) are used as the reference sequence, which are respectively indi-

cated by $x_0 \sim x_{04}$; the statistical data of the 11 influence factors (including GDP, NI, EGR, CPI, Mainland China's total investment amount approved by Taiwan, gross export value, exchange rate, average unemployment week, average salary structure, the approved number of imported foreign workers and composite index of coincident index) are comparatively sequenced as x1~x11, and original data takes the statistical data of2001 to 2014 as the sampling scope. The sequence and item code are shown in Table 1 and the original data are summarized in Table 2.

Grey Relational Analysis

Step 1 Data pre-processing

The original sequence data are normalized for the grey generating of initialization, where the 1st element xi(1) in the sequence is taken as the reference value for data processing, and uses the formula

$$x_i^*(k) = \frac{x_i(k)}{x_i(1)},$$

i =0,1,2,3,….,11; k =1,2,3,……,14

Step 2 Calculation of difference sequence

Use equation $\Delta_{oi} = | x_0(k) - x_i(k) |$ to calculate the difference between comparative sequence and reference sequence, and then, their absolute value is calculated to obtain the difference sequence, wherein i =0,1,2,3,….,11, k =1,2,3,……,14

Step 3 Obtaining of maximum and minimum.

Use equation $\Delta_{\max.} = \max_{j \in i}^{\max.} \forall k \| x_0(k) - x_j(k) \|$ to obtain the maximum value, and the maximum value is 9.5766

Use equation $\Delta_{\min.} = \min_{j \in i}^{\min.} \forall k \| x_0(k) - x_j(k) \|$ to obtain the minimum value, and the minimum value is 0.

Step 4 Calculation of grey relational coefficient

The distinguishing coefficient (ζ) is taken as 0.5 in this research, and uses formula $\gamma(x_i(k), x_j(k)) = \frac{\Delta\min + \zeta\Delta\max}{\Delta_{oi}(k) + \zeta\Delta\max}$ to calculate the grey relational coefficient, $\gamma(x_i(k), x_j(k)) = \frac{0 + 0.5 \times 9.5766}{\Delta_{oi}(k) + 0.5 \times 9.5766}$, wherein i =0,1,2,3,….,11, k =1,2,3,……,14.

Step 5 Obtainment of Grey Relational Grade

Use equation $\gamma(x_i, x_j) = \sum_{k=1}^{n} \beta_k \gamma(x_i(k), x_j(k))$ to calculate the Grey Relational Grade, among which β_k is the weight value. This research adopts average weight , thus, β_k = 1/14 · i =0,1,2,3,….,11, k =1,2,3,……,14

Step 6 Ranking of the grey relational ordinal

The data and ranking of the reference sequence can be gained from Table 3. According to the empirical results, the last relational degree of the influential factors in each group is EGR.

Table 1. List of Sequence, Item Code and three raw data treatment methods

Sequence	Item (original value)	Item (translation of EGR)	Item (deletion of EGR)
Canonical sequence, x_0	Overall unemployment rate		
x_{01}	Unemployment rate of 15~24 years old		
x_{02}	Unemployment rate of 25~44 years old		
x_{03}	Unemployment rate of 45~64 years old		
x_{04}	Unemployment rate of more than 65 years old		
Comparative sequence, x_1	GDP		
x_2	(NI)		
x_3	EGR	EGR after translation	(CPI)
x_4	(CPI)		Mainland China's total investment amount approved
x_5	Mainland China's total investment amount approved		Gross export value
x_6	Gross export value		Exchange rate
x_7	Exchange rate		Average unemployment week
x_8	Average unemployment week		Average salary structure
x_9	Average salary structure		Approved number of imported foreign workers
x_{10}	Approved number of imported foreign workers		Composite index of coincident index
x_{11}	Composite index of coincident index		Overall unemployment rate

Source: sorted by this research

Based on literature review and the anticipated results of the majorities, EGR is closely related to the unemployment rate. The influential factor of the unemployment rate of more than 65 years old is obviously different from that of other groups, and the other 3 categories and the overall unemployment rate are affected by average unemployment weeks, average salary structure, CPI, exchange rate, the approved number of imported foreign workers, the composite index of coincident index, gross export value, Mainland China's total investment amount approved,

Table 2. Original Data in this research

Item	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
OUR	4.57	5.17	4.99	4.44	4.13	3.91	3.91	4.14	5.85	5.21	4.39	4.24	4.18	3.96
Age of 15-24	10.44	11.91	11.44	10.85	10.59	10.31	10.65	11.81	14.49	13.09	12.47	12.66	13.17	12.63
Age of 25-44	4.17	4.73	4.47	3.97	3.78	3.79	3.86	4.02	5.93	5.35	4.46	4.38	4.27	4.13
Age of 45-64	2.92	3.38	3.76	3.20	2.79	2.31	2.24	2.54	3.90	3.39	2.64	2.31	2.25	2.09
More than 65	0.06	0.13	0.14	0.07	0.43	0.28	0.16	0.17	0.13	0.19	0.15	0.17	0.14	0.10
GDP	300,450	308,875	318,590	348,479	375,769	388,589	408,254	416,961	392,065	446,105	485,653	495,845	511,614	530,043
NI	266,664	274,853	287,190	313,121	333,521	341,757	352,952	353,896	332,285	385,290	417,057	421,779	440,559	457,725
EGR (%)	-1.26	5.57	4.12	6.51	5.42	5.62	6.52	0.70	-1.57	10.63	3.80	2.06	2.23	3.77
CPI	89.82	89.64	89.39	90.83	92.92	93.48	95.16	98.51	97.66	98.60	100.00	101.93	102.74	103.97
MCTI	27.84	67.23	76.99	69.41	60.07	76.42	99.71	106.91	71.43	146.18	143.77	127.92	91.90	102.77
Gross export value	126,314	135,316	150,600	182,370	198,431	224,017	246,676	255,628	203,674	274,600	308,257	301,180	305,441	313,695
Exchange rate (NTD/USD)	33.80	34.58	34.42	33.42	32.17	32.53	32.84	31.52	33.05	31.64	29.46	29.61	29.77	30.37
AUW	26.13	30.26	30.54	29.40	27.59	24.28	24.24	25.25	27.49	29.68	27.67	26.04	26.18	25.89
AVS	41,960	41,530	42,065	42,680	43,159	43,488	44,392	44,367	42,182	44,359	45,508	45,589	45,664	47,300
ANIFW	304,605	303,684	300,150	314,034	327,396	338,755	357,937	365,060	351,016	379,653	425,660	445,579	489,134	551,596
CICI	57.32	60.89	64.98	72.38	75.56	80.04	85.39	84.36	75.51	94.55	100.29	100.05	102.11	106.87

Note: OUR: Overall unemployment rate; GDP: million USD; NI: million USD; MCTI: Mainland China's total investment amount approved (100 million USD); AUW: Average unemployment weeks; ASS: Average salary structure (NTD); ANIFW: The approved number of imported foreign workers (person); CICI: Composite index of coincident index (Source: sorted by this research)

and EGR all rank positions from the bottom among the influential factors of various groups.

Conclusion and Suggestions

According to the research results shown in Table 4, during the period of2001 to 2014, with the exception of the unemployment rate of more than 65 years old, a total of 5 factors (including average unemployment weeks, average salary structure, exchange rate, CPI, and the approved number of imported foreign workers) have significant effect on the overall unemployment rate and the unemployment rate of other categories (15~24 years, 25~44 years, and 45~64 years), among which the average unemployment weeks and average salary structure have the greatest impact; gross export value, EGR, composite index of coincident index, GDP, and NI have significant effect on the unemployment rate of more than 65 years old. Surprisingly, gross export value and composite index of the coincident index rank the top several positions among the influential factors of the unemployment rate of more than 65 years old; therefore, it is worthy of in-depth research, analysis, and exploration in follow-up research.

It is inferred that the impact of the global economic and trade network market, population changes due to the low birth rate and aging, energy shortages, and the development trend of an international and flexible labor market, competition is rendered more fierce and difficult for the current labor population entering the workplace.

The unemployment rate of aged people is affected by gross export value, thus, the government should try its best to improve the competitiveness of home products to increase exports. The youth unemployment rate remains high, thus, it is necessary to improve teaching contents and methods, and closely integrate workplace needs. Finally, the government must try to improve the domestic economy and investment environments, reward investments, increase foreign investments and exports, and strengthen the integration mechanism between foreign worker policy, industrial policy, and employment policy.

There are numerous factors affecting the unemployment rate, and there are still many other factors not found. More accurate unemployment rate data regarding different ages (the age group of every 10 years is changed to every 5 years or every 1 year) would probably improve the accuracy of research; longer study periods and increased sample size will determine more influential factors. During the process of data collection, this research found that the “atypical quantity of employment”, as counted since 2008, did not conform to the period of this research, thus, this factor was deleted.

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Table 3. Category Integration Table (Grey Relational Grade) and Grey Relational Ordinal

Grey Relational Grade $\gamma(x_i,x_j)$ $j=1,2,...,11$	$\gamma(x_0,x_j)$	$\gamma(x_{01},x_j)$	$\gamma(x_{02},x_j)$	$\gamma(x_{03},x_j)$	$\gamma(x_{04},x_j)$
Ranking	Overall unemployment rate	15~24 years old	25~44 years old	45~64 years old	More than 65 years old
1	γ(x0,x7)=0.9825	γ(x01,x4)=0.9828	γ(x02,x8)=0.9849	γ(x03,x8)=0.974	γ(x04,x6)=0.8659
2	γ(x0,x8)=0.9822	γ(x01,x9)=0.9785	γ(x02,x9)=0.9767	γ(x03,x7)=0.9722	γ(x04,x11)=0.836
3	γ(x0,x9)=0.9711	γ(x01,x8)=0.9743	γ(x02,x4)=0.9754	γ(x03,x9)=0.9582	γ(x04,x1)=0.8306
4	γ(x0,x4)=0.9699	γ(x01,x10)=0.9679	γ(x02,x7)=0.9751	γ(x03,x4)=0.9570	γ(x04,x2)=0.8281
5	γ(x0,x10)=0.9436	γ(x01,x7)=0.9631	γ(x02,x10)=0.9513	γ(x03,x10)=0.9329	γ(x04,x5)=0.8164
6	γ(x0,x2)=0.9310	γ(x01,x2)=0.9549	γ(x02,x2)=0.9392	γ(x03,x2)=0.9222	γ(x04,x10)=0.8157
7	γ(x0,x1)=0.9267	γ(x01,x1)=0.9509	γ(x02,x1)=0.9357	γ(x03,x1)=0.9188	γ(x04,x4)=0.7988
8	γ(x0,x11)=0.9142	γ(x01,x11)=0.9381	γ(x02,x11)=0.9228	γ(x03,x11)=0.908	γ(x04,x8)=0.7963
9	γ(x0,x6)=0.8582	γ(x01,x6)=0.8804	γ(x02,x6)=0.8686	γ(x03,x6)=0.8553	γ(x04,x9)=0.7962
10	γ(x0,x5)=0.6984	γ(x01,x5)=0.7142	γ(x02,x5)=0.7066	γ(x03,x5)=0.6990	γ(x04,x7)=0.7860
11	γ(x0,x3)=0.5932	γ(x01,x3)=0.5842	γ(x02,x3)=0.5908	γ(x03,x3)=0.5949	γ(x04,x3)=0.5465

Source: sorted by this research

Table 4. Summary Table of the Top 5 Influence Factors of Unemployment Rate in Each Category

Ranking / Category		1	2	3	4	5
Overall unemployment rate	Original value	Exchange rate	AUW	ASS	CPI	ANIFW
	Translation of EGR	Exchange rate	AUW	ASS	CPI	ANIFW
	Deletion of EGR	Exchange rate	AUW	ASS	CPI	ANIFW
15~24 years old	Original value	CPI	ASS	AUW	ANIFW	Exchange rate
	Translation of EGR	CPI	ASS	AUW	ANIFW	Exchange rate
	Deletion of EGR	CPI	ASS	AUW	ANIFW	Exchange rate
25~44 years old	Original value	AUW	ASS	CPI	Exchange rate	ANIFW
	Translation of EGR	AUW	ASS	Exchange rate	CPI	ANIFW
	Deletion of EGR	AUW	ASS	Exchange rate	CPI	ANIFW
45~64 years old	Original value	AUW	Exchange rate	ASS	CPI	ANIFW
	Translation of EGR	AUW	Exchange rate	ASS	CPI	ANIFW
	Deletion of EGR	AUW	Exchange rate	ASS	CPI	ANIFW
More than 65 years old	Original value	Gross export value	CICI	GDP	NI	MCTI
	Translation of EGR	Gross export value	EGR	CICI	GDP	NI
	Deletion of EGR	Gross export value	CICI	GDP	NI	ANIFW

AUW: Average unemployment weeks ; ASS: Average salary structure (NTD); ANIFW: The approved number of imported foreign workers (person); MCTI: Mainland China's total investment amount approved; CICI: Composite index of coincident index (Source: Sorted by this research)