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FIND OUT THE RELATIONSHIP BETWEEN EDUCATION BUDGET AND UNEMPLOYMENT RATE IN TAIWAN BY THE AUTOREGRESSIVE DISTRIBUTED LAG MODELS

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ABSTRACT

The relationship between the unemployment rate (%) and the education budget is discussed in this paper. The time-series data are subtracted from archives of the Directorate-General of Budget, Accounting and Statistics (DGBAS), Ministry of Education (MOE), and Ministry of Labor (MOL) in Taiwan. Totally 39 years (from 1981 to 2019) of data are scrutinized for analysis. Both the unemployment rate and education budget are not stationary checking by the augment Dickey-Fuller (ADF) unit-root test. The spurious result will be obtained if the ordinary least square method is used to perform the regression. The first difference of both time series are stationary and can be denoted as I(1). A further check the residuals of the regression by the cointegration test shows the residuals are not stationary (not cointegrated), then the more complicated autoregressive distributed lag (ARDL) models are chosen to solve this difficult problem. After analyzing two nonstationary and not cointegrated time series, the author finds that increasing the education budget can reduce the unemployment rate. The calculated unemployment rates are checked with the real ones, the average error of the past 39 years is amazingly less than 10.0%, more precisely, only 9.76%. Under the assumption of constant increment of the annual education budget, to increase the one-unit education budget (10^{11} NT) will roughly reduce 0.313% of the unemployment rate in Taiwan.

Keywords: spurious, augmented Dickey-Fuller (ADF), cointegration, ARDL

1. Introduction

People who are available to work but unable to find jobs in the previous four weeks are unemployed [1,4,5]. Negative effects such as anxiety about the future, lower living standard, without a feeling of security may impact those who lose their jobs. Hence, almost all governments around the world would try their best to reduce the unemployment rate, which counts the ratio of those who lose jobs and the population in the labor force [1]. The labor force counts people aged 15 and above who are available in the labor market in Taiwan [2,5] and it is slightly different from the USA, which calculates people aged 16 and above in the labor market [1,4]. The government of Taiwan also tries to use all means to reduce the unemployment rate. Monetary and fiscal policies are usually used to revive a dimming economy. And international cooperation such as signing free trade agreements (FTA) may also be a way to reduce trade barriers with each other. When the above-mentioned methods become impotent, what is left is education. Human capital is the accumulation of investments in people, such as education and on-the-job training. Like all forms of capital, an investment in humans by the expenditure of resources may raise productivity in the future [1]. Different from the stock market, investment in

Vol. 5, No. 05; 2020

ISSN: 2456-3676

human capital may take years to get a return. But is it suitable to put the "employment rate" in the evaluation index for the subsidy programs of the Ministry of Education (MOE)? From the other side to see this subsidy index is: Increasing the education budget can reduce the unemployment rate. It is the issue to be discussed in this paper.

This paper is inspired by two observations. The first one is that the educational system in the United States of America is much better than Taiwan, especially in higher education. From the latest study of NAFSA [8], the largest nonprofit organization association dedicated to international education and exchange shows that 1,043,839 international students studying at U.S. colleges and universities contributed $41 billion and supported more than 458,290 jobs to the U.S. economy during the 2018-2019 academic year [8]. The second inspiration is that the Ministry of Education [3] in Taiwan lists the "employment rate" of students graduated from colleges and universities to be an index in evaluating the teaching proficiency of a school and be a parameter for subsidizing vocational schools, colleges, and universities [3]. The fundamental thinking of MOE may be that if a school can manage its resources well, then it can produce graduates with good quality, and to find a job more easily. Therefore, the unemployment rate will be reduced. Will such chain effects work? The author tries to explore this problem objectively and to find the relationships between education quality and unemployment rate. Because of the quality of education is difficult to measure, the author assumes that the education budget may somehow reflect the goodness of quality.

If increasing the education budget can reduce the unemployment rate, then the government should increase the budget on education. On the contrary, if the unemployment rate has no or little correlation with the education budget, then the requirements from MOE [3] are groundless and should be scrapped out from its policy as well as removed from the list of evaluation index.

To find the correlation between the education budget of Taiwan and the unemployment rate, the data from DGBAS [2], Ministry of Labor [5], and Ministry of Education [4] are used in the analysis. The statistical analyses, such as augmented Dickey-Fuller unit-root test, cointegration, autoregressive distributed lag methods, and Lagrange multiplier test, are performed by the famous STATA software, and all graphs are drawn by Minitab, the other outstanding commercial package.

The total education budgets from 1981 to 2019 are used to find the relationship with the unemployment rate. Because of the education is perpetual, the quality of education in the past will influence the future achievement of students, also the employment rate. Hence, in this paper, the author uses the total education budget rather than the partial education budget for high school and up, that is, 15 years and older.

2. Unemployment Rate and Education Budget

The time series of unemployment rates from 1981 to 2019 in Taiwan can be obtained for the archives in DGBAS [2] and MOL [5], and the corresponding unemployment data in the USA are obtained from the Bureau of Labor of Statistics [4] for comparison. The education budget time series in the same period is subtracted from the Ministry of Education [3].

Vol. 5, No. 05; 2020

ISSN: 2456-3676

2.1 Education Budget Adjusted by the Consumer Price Index (CPI)

Since education is an item in the "basket" of consumer spending [1], in this study, the education budget is adjusted by the consumer price index (CPI) which takes 2016 as the base year. The original and adjusted education budget (10^{11} NT), CPI, as well as the unemployment rate of Taiwan and the USA are shown in Table A1 in Appendix A.

The time series of the unemployment rate from 1981 to 2019 for both Taiwan and the USA are shown in figure 1.

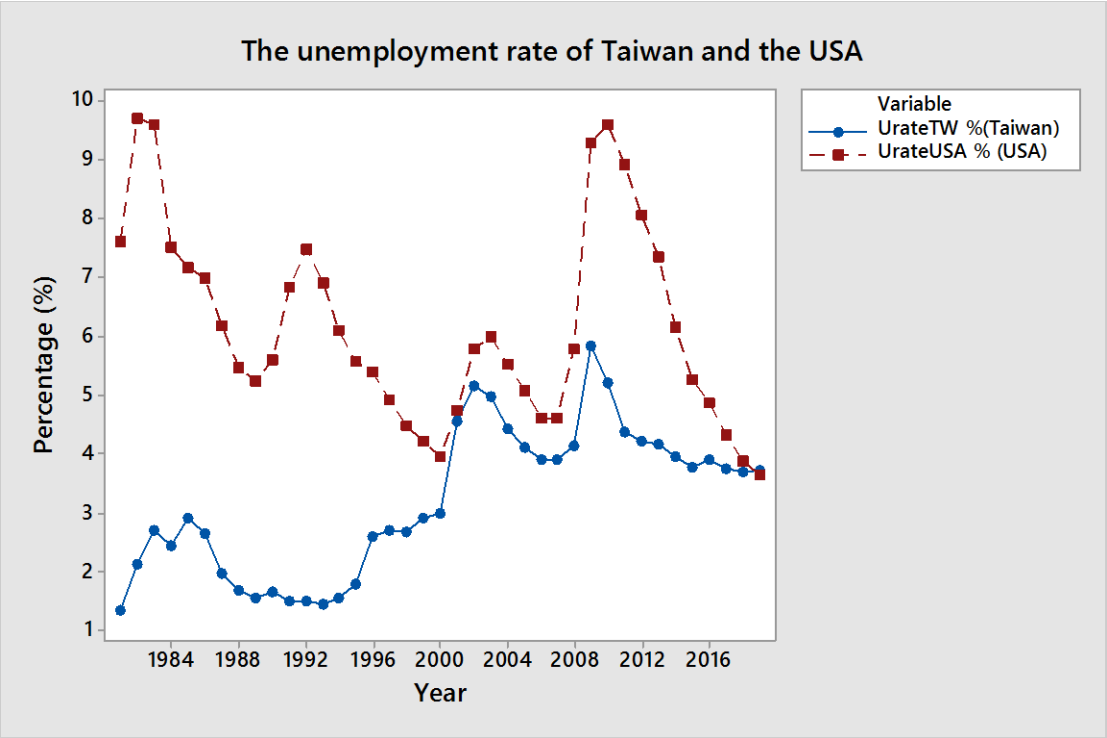

Figure 1: The unemployment rate (%) of Taiwan and the United States of America from 1981 to 2019

From the above figure, one finds the unemployment rate in the USA is higher than that in Taiwan from 1981 to 2018, but in 2019 the USA's unemployment rate down to 3.67%, lower than Taiwan's 3.73%. However, the average unemployment rate is 3.07 and 6.19 for Taiwan and the USA, respectively. From the above figure, one finds a country with good higher education does not necessarily have a lower unemployment rate. Averagely speaking, the unemployment rate in the USA is 2.02 times (6.19/3.07=2.02) higher than that in Taiwan.

2.2 Correlation between Education Budget (10^{11} NT) and Unemployment Rate (%)

The time series of the education budget and unemployment rate from 1981 to 2019 are plotted in figure 2. The total education budget which is adjusted by the consumer price index (CPI) is used in this study. The basic idea is that education is essentially important to a country, and money

Vol. 5, No. 05; 2020

ISSN: 2456-3676

spent on each level of education may influence the future unemployment rate, although the unemployment rate is counted from the age of 15 and above.

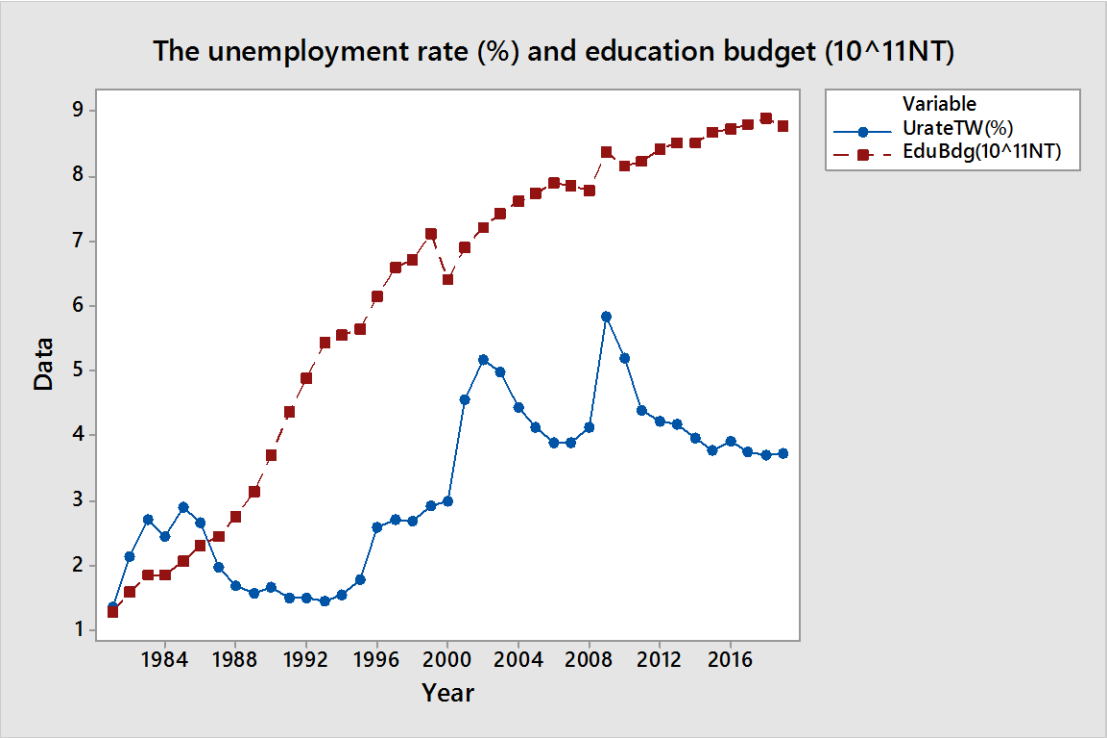

Figure 2: The unemployment rate (%) and education budget (10^{11} NT) from 1981 to 2019

The regression between the unemployment rate and education budget is expressed as:

$$UrateTW_t = 1.006 + 0.362 EduBdg_t \qquad (1)$$

(t-value) *(2.76)* *(6.51)*

(p) *(0.009)* *(0.000)*

R^2 = *53.42%*

$R^2_{(adj)}$ = *52.16%*

Where the subscript *t* in the equation (1) represents time, $UrateTW_t$ is the unemployment rate (%) of Taiwan at time *t*, and $EduBdg_t$ is the education budget (10^{11} NT) of Taiwan at time *t*.

From equation (1), one finds that to increase one unit of the education budget (10^{11} NT= 0.1 trillion) will increase 0.362 units of the unemployment rate. This result is peculiar to common knowledge. Usually, one may ponder the opposite way, that is, to increase the education budget will reduce the unemployment rate. The *t-values* of the constant and budget terms are 2.76 and

Vol. 5, No. 05; 2020

ISSN: 2456-3676

6.51 respectively, and they are significant at the 5% level. R^2 is the coefficient of determination [6,7], which measured the percentage of the dependent variable in $UrateTW_t$ can be explained 53.42% by the independent variable $EduBdg_t$. $R^2_{(adj)}$ is the coefficient of determination adjusted by the appropriate degrees of freedom, and in this case, 52.16%.

2.3 Check the Stationarity of Unemployment Rate and Education Budget Time Series

Based on the theory, two nonstationary time series cannot be used in regression for avoiding spuriousness, unless they are cointegrated [6,7]. The following few subsections are used for checking the stationarity of the unemployment rate and education budget time series by the augmented Dickey-Full method [7].

2.3.1 Check the Stationarity of the Unemployment Rate Time Series

A stationary variable is one that is not explosive, nor trending, and nor wandering without returning to its mean [6, 7]. One can check the stationarity of a time series using visual inspection, or by more formal tests, such as unit-root tests. Dickey-Fuller, one of the unit-root tests, was used to check the stationarity of a time series in this paper. The Dickey-Fuller test has a variety of forms and is generally referred to as the augmented Dickey-Fuller (ADF) test [7].

2.3.1.1 The Stationarity Check of the Unemployment Rate

The unemployment rate time series in Taiwan from 1981 to 2019 is noted as $UrateTW_t$, and the result of the ADF test is as follows:

$$\Delta UtateTW_t = 0.384 - 0.110 UrateTW_{t-1} + 0.226 \Delta UrateTW_{t-1} \qquad (2)$$

(t-value) *(1.64)* *(-1.61)* *(1.42)*

(p) *(0.001)* *(0.021)* *(0.661)*

Table 1: The critical values and augmented Dickey-Fuller (ADF) unit-root test results of the unemployment rate of Taiwan

$\tau(t)$ Test statistic	1% Critical value	5% Critical value	10% Critical value
-1.61	-3.43	-2.86	-2.57
MacKinnon approximate *p*-value for $\tau(t)$ = 0.4768			

From the above table, one finds the $\tau(t)$ test statistic -1.61 > -2.86 (5% critical value), the hypothesis test $H_0 : \gamma = 0$ (nonstationary) is not rejected, and $H_1 : \gamma < 0$ (stationary) is rejected. In other words, the unemployment rate time series of Taiwan is not a stationary one.

2.3.1.2 Check the Stationarity of the First Difference of the Unemployment Rate

One simple way to make the average unemployment rate to be stationary is to take the first difference of the time series. If the first difference of a time series is stationary, it is the first

Vol. 5, No. 05; 2020

ISSN: 2456-3676

difference stationary and denoted as I(1). The first difference in the average unemployment rate time series is plotted in figure 3.

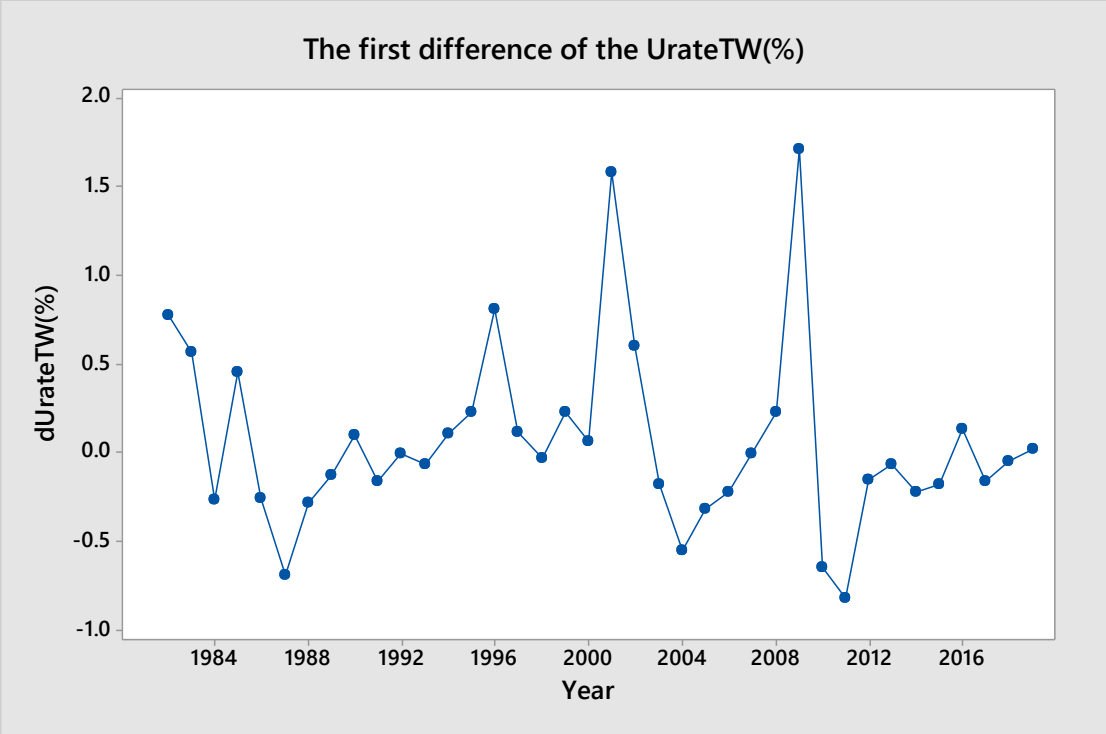

Figure 3: The first difference in the unemployment rate (%) in Taiwan

The ADF is still used to check the stationarity of the first difference in the unemployment rate in Taiwan. The test result is as in the following equation and Table 2.

$$\Delta(\Delta UrateTW_t) = 0.031 - 0.812\Delta UrateTW_{t-1} \qquad (3)$$

(t-value) *(0.37)* *(-5.03)*

(p) *(0.717)* *(0.000)*

Table 2: The critical values and Dickey-Fuller (ADF) unit-root test results of the first difference in the unemployment rate of Taiwan

$\tau(t)$ Test statistic	1% Critical value	5% Critical value	10% Critical value
-5.029	-3.43	-2.86	-2.57
MacKinnon approximate *p*-value for $\tau(t)$ = 0.000			

Vol. 5, No. 05; 2020

ISSN: 2456-3676

From the above table, one finds the $\tau(t)$ test statistic -5.029 < -2.86 (5% critical value), the hypothesis test $H_0 : \gamma = 0$ (nonstationary) is rejected, and $H_1 : \gamma < 0$ (stationary) is not rejected. In other words, the first difference in the unemployment rate time series of Taiwan is a stationary one.

In other words, the first difference of the average unemployment rate in Taiwan is a stationary one and denoted as I(1).

2.3.2 Check the Stationarity of the Education Budget Time Series

In this subsection, the ADF method is still used to check the stationarity of the education budget and the first difference of this time series.

2.3.2.1 Check the Stationarity of Educational Budget

The education budget from 1981 to 2019 has been plotted in figure 2. The ADF test of the education budget is as follows:

$$\Delta EduBdg_t = 0.472 - 0.043 EduBdg_{t-1} - 0.073 \Delta EduBdg_{t-1} \quad (4)$$

(t-value) *(3.43)* *(-2.43)* *(-0.44)*

(p) *(0.001)* *(0.021)* *(0.661)*

Table 3: The critical values and augmented Dickey-Fuller (ADF) unit-root test results of the education budget

$\tau(t)$ Test statistic	1% Critical value	5% Critical value	10% Critical value
-2.43	-3.43	-2.86	-2.57
MacKinnon approximate *p*-value for $\tau(t)$ = 0.1336			

From the above table, one finds the $\tau(t)$ test statistic -2.43 > -2.86 (5% critical value), the hypothesis test $H_0 : \gamma = 0$ (nonstationary) is not rejected, and $H_1 : \gamma < 0$ (stationary) is rejected. In other words, the education budget time series in Taiwan is not a stationary one.

2.3.2.2 Check the Stationarity of the First Difference of the Education Budget

Same as the previous section, the first difference in the education budget will be used to check its stationarity. The plot of the first difference of the education budget is in figure 4.

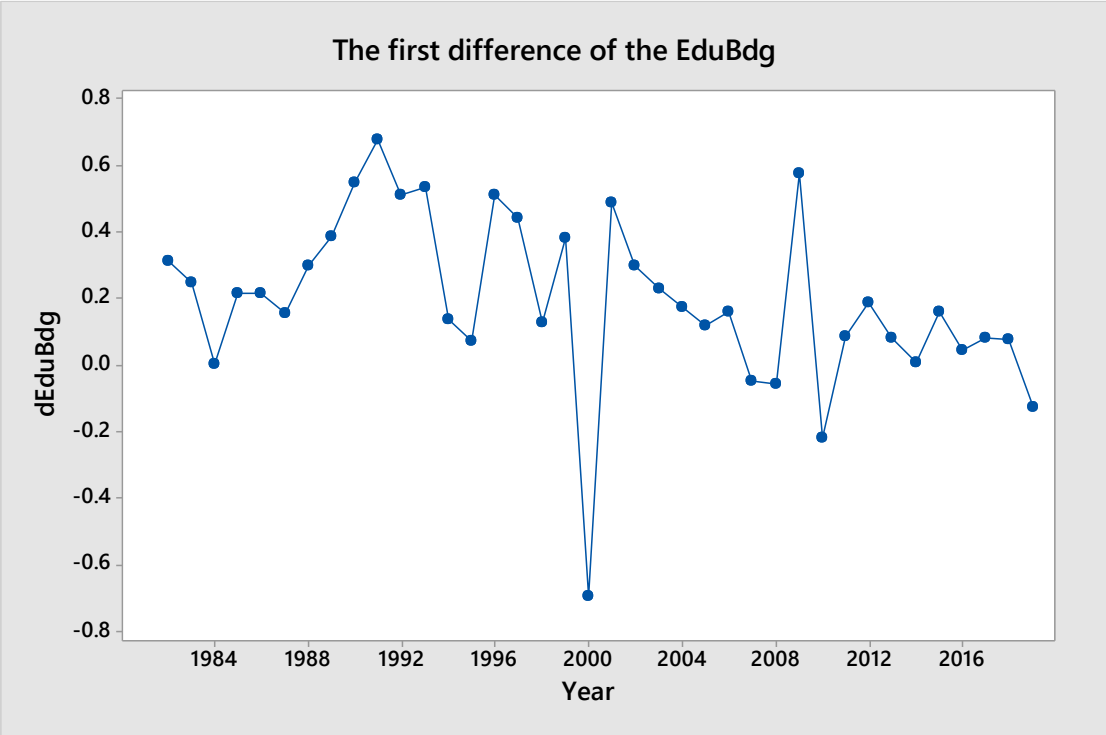

Figure 4: The first difference of education budget in Taiwan

$$\Delta(\Delta EduBdg_t) = 0.187 - 0.967\Delta EduBdg_{t-1} \qquad (5)$$

(t-value) *(3.34)* *(-5.62)*

(p) *(0.002)* *(0.000)*

Table 4: The critical values and augmented Dickey-Fuller (ADF) unit-root test results of the first difference of education budget of Taiwan

$\tau(t)$ Test statistic	1% Critical value	5% Critical value	10% Critical value
-5.616	-3.43	-2.86	-2.57
MacKinnon approximate *p*-value for $\tau(t)$ = 0.000			

From the above table, one finds the $\tau(t)$ test statistic -5.616 < -2.86 (5% critical value), the hypothesis test $H_0 : \gamma = 0$ (nonstationary) is rejected, and $H_1 : \gamma < 0$ (stationary) is not rejected. In other words, the first difference of the education budget time series of Taiwan is a stationary one and denoted as I(1).

Vol. 5, No. 05; 2020

ISSN: 2456-3676

3. The Spuriousness and Cointegrated Relationship of the Regression Equation

This section is used to verify the regression equation is proper or not. Two nonstationary time series cannot be used directly in regression unless they are proved to be cointegrated [7]. The checking flow charts are drawn in Appendix B by the author.

3.1 Spuriousness of the Regression of Unemployment Rate Concerning Education Budget

The regression equation of the unemployment rate and education budget is expressed in the equation (1), and it is repeated here for the convenience of later discussion.

$$UrateTW_t = 1.006 + 0.362 EduBdg_t \qquad (1) \text{ (repeated)}$$

(t-value) (2.76) (6.51)

(p) (0.009) (0.000)

The unemployment rate and education budget in equation (1) are interesting. The *t*- value *6.51* (*p-value=0.000*) in the parameter of $EduBdg_t$ term is significant at the 5% level. The adjusted R^2_{adj} is 52.16% is quite satisfactory. However, equation (1) means the unemployment rate will increase by 0.362 units as the education budget increases one unit. It is beyond the realization of common sense. Subconsciously, if education can reduce the unemployment rate, then the parameter in front of $EduBdg_t$ should be negative.

The equation (1) can be correct only if nonstationary time series are cointegrated, it means they are related [6,7].

3.2 Cointegration Test of a Regression Equation

Two nonstationary time series should not be used in regression analysis for avoiding spuriousness [6,7] unless they are cointegrated. The cointegration of residuals of the regression of equation (1) shall be checked. If the cointegration exists, the ordinary least square method can be used to express the long-term condition, or the error correction model can be used for the short-term expression [7]. If $EduBdg_t$ and $UrateTW_t$ are nonstationary I(1) (I(1) means after the first difference the time series is stationary). If no further evidence, it is reasonable to expect the residuals (denoted as $ehat_t$) $ehat_t = UrateTW_t - \beta_1 - \beta_2 EduBdg_t$ to be I(1) also. However, if they are I(0), $UrateTW_t$ and $EduBdg_t$ are said to be cointegrated [7].

The cointegration test for the residuals of equation (1) is:

$$\Delta ehat_t = -0.007 - 0.162 ehat_{t-1} \qquad (6)$$

(t-value) (-0.09) (-1.76)

(p) (0.930) (0.087)

Table 5: The critical values and augmented Dickey-Fuller (ADF) unit-root test results of the residuals of the regression

$\tau(t)$ Test statistic	1% Critical value	5% Critical value	10% Critical value
-1.761	-3.96	-3.37	-3.07
MacKinnon approximate *p*-value for $\tau(t)$ = 0.3999			

From the above table, one finds the $\tau(t)$ test statistic -1.761 > -3.37 (5% critical value), the hypothesis test $H_0 : \gamma = 0$ (not cointegrated) is not rejected, and $H_1 : \gamma < 0$ (cointegrated) is rejected. In other words, the residuals of the regression of the $UrateTW_t$ and $EduBgd_t$ are not stationary, hence they are not cointegrated. The null hypothesis $H_0 : \gamma = 0$ (not cointegrated) cannot be rejected at the 5% significance level.

3.3 Autoregressive Distributed Lag (ARDL) Models

Since $UrateTW_t$ and $EduBgd_t$ are not stationary, and they are not cointegrated, then the flow chart figure B1 in Appendix B goes to the ARDL models. After trial and error, the following equation can be obtained:

$$\Delta UrateTW_t = 0.080 + 0.829\Delta EduBdg_t - 1.091\Delta EduBdg_{t-1} + 0.417\Delta UrateTW_{t-1} \quad (7)$$

(t-value)	*(0.81)*	*(3.19)*	*(-3.81)*	*(3.01)*
(p)	*(0.424)*	*(0.003)*	*(0.001)*	*(0.005)*

Each term in the equation (7) is significant (except the constant term), it means each parameter in equation (7) is not zero at the 5% significance level. The constant term is recommended to be kept in the equation by most scholars [7]. The mathematical expression Δ is the time difference of the value of the variable at time *t* subtracts the value at time *t-1*.

$$\Delta UrateTW_t = UrateTW_t - UrateTW_{t-1} \quad (8)$$

$$\Delta EduBdg_t = EduBdg_t - EduBdg_{t-1} \quad (9)$$

The equation (7) can be further extended as the following type by the help of equations (8) and (9).

$$\begin{aligned} UrateTW_t = {} & 0.080 + UrateTW_{t-1} + 0.829(EduBdg_t - EduBdg_{t-1}) \\ & - 1.091(EduBdg_{t-1} - EduBdg_{t-2}) + 0.417(UrateTW_{t-1} - UrateTW_{t-2}) \end{aligned} \quad (10a)$$

Vol. 5, No. 05; 2020

ISSN: 2456-3676

Or can be expressed a more obvious form as follows:

$$UrateTW_t = 0.080 + 1.417UrateTW_{t-1} - 0.417UrateTW_{t-2} + 0.829EduBdg_t - 1.920EduBdg_{t-1} + 1.091EduBdg_{t-2} \quad (10b)$$

One finds that the unemployment rate at time *t* is a function of the unemployment rate of previous and further ahead of time (*t-1* and *t-2*) and the education budget of this year (*t*) and the previous two years (*t-1* and *t-2*). The unemployment form is no longer as simple as the equation (1).

3.4 Breusch-Godfrey Lagrange multiplier (LM) test for the Higher Order of Autocorrelation

The residuals of the ARDL model should not be autocorrelated to make sure the effectiveness of the regression model [7]. Instead of using the Durbin-Watson statistic for the first-order serial correlation, the Breusch-Godfrey Lagrange multiplier (LM) test is used in this study to test higher-order autocorrelation [7]. The $LM = TxR^2$ statistic has an asymptotic $\chi^2_{(1)}$ distribution under the null hypothesis, and where T is the sample size and R^2 is the goodness-of-fit statistic [7]. The testing result is in the following table.

Table 6: Breusch-Godfrey Lagrange multiplier (LM) test for the higher order of autocorrelation

Lags(p)	Chi2 (χ^2)	Degrees of freedom	*p*-value > chi2 (χ^2)
1	0.613	1	0.4336
2	0.627	2	0.7309
3	1.170	3	0.7603
4	1.222	4	0.8745
5	2.159	5	0.8267

H_0: no serial correlation (autocorrelation)

From the above table, one finds that in each lag (p) the H_0: no serial correlation cannot be rejected at the 5% significance level. The residuals of regression are not autocorrelated with each other. In other words, the ARDL equation (7) is a suitable one to express the relationship between the unemployment rate and the education budget.

3.5 Check Errors

The unemployment rate and education budget proposed by equation (10) need to be further checked for its accuracy. The error in the percentage of each year are calculated between the real and proposed unemployment rate equation, and they are shown in Appendix C. For the past 39 years (from 1981~ 2019), the average error is 9.75%, which is in the acceptable range.

Vol. 5, No. 05; 2020

ISSN: 2456-3676

3.6 Further Simplification to Get a Rough Estimation

From previous subsections, the author approved that equation (7) can be used to obtain the relationship between the unemployment rate and education budget with an average error of 9.75%. In this subsection, the author further makes two assumptions, and hope it can let equation (7) more readable. If the difference of the education budget and unemployment rate are assumed to be identical in each year, which means:

$$\Delta UrateTW_t = \Delta UrateTW_{t-1} = \Delta UrateTW \qquad (11a)$$

And,

$$\Delta EduBdg_t = \Delta EduBdg_{t-1} = \Delta EduBdg \qquad (11b)$$

With the assumptions of the equations (11a) and (11b), equation (7) can be simplified to be:

$$\Delta UrateTW = 0.137 - 0.450\Delta EduBdg \qquad (12)$$

From the above equation, one finds the parameter of the incremental of the education budget ($\Delta EduBdg$) is negative (-0.450). In other words, when the incremental of the education budget ($\Delta EduBdg$ is positive), the unemployment rate decreases. If each year the education budget increases one unit (10^{11} NT), the difference in the unemployment rate is:

$$\Delta UrateTW = 0.137 - 0.450 = (-0.313) \qquad (13)$$

Equation (13) shows that each year the education budget increases one unit (10^{11} NT= 0.1 trillion NT), the unemployment in Taiwan will decrease by 0.313%.

4. Conclusions:

1. The augmented Dickey-Fuller (ADF) test is used to determine the stationarity of a time series. The results show that both the unemployment rate (%) and the education budget are nonstationary and not cointegrated. If using the ordinary least squares method to get the regression equation, it will be spurious.
2. One finds that the unemployment rate at time *t* is a function of the unemployment rate of previous and further ahead of time (*t-1* and *t-2*) and the education budget of this year (*t*) and the previous two years (*t-1* and *t-2*). The unemployment form is no longer as simple as the equation (1), rather, equation (7 or 10) should be used.
3. The autoregressive distributed lag (ARDL) models can be used to simulate the relationship between the unemployment rate and the education budget. Comparing the calculated unemployment rates obtained by equation (10) with the real ones, the average error for the past 39 years (from 1981 to 2019) is only 9.75%, and it is quite satisfactory.

Vol. 5, No. 05; 2020

ISSN: 2456-3676

4. Under the assumption of the identical difference of education budget ($\Delta EduBdg$) and unemployment rate ($\Delta URateTW$) in each year, a simplified relationship, equation (12), can be obtained. It means if each year increases one unit of the education budget (10^{11} NT), the unemployment rate will reduce about 0.313%. It means, to increase the education budget can reduce the unemployment rate. However, the education budget is only one factor to affect the unemployment rate; it seems more variables should be considered to make this paper more perfect.

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Vol. 5, No. 05; 2020

ISSN: 2456-3676

Appendix A: The Unemployment Rate and Education Budget from 1981 to 2019

Table A1: Average unemployment rate and education budget of Taiwan and the USA from 1981 to 2019

Year	UrateTW (%)	UrateUSA (%)	Origin_Edu_Bdg(10^{11}NT)	CPI (2016=100)	EduBdg (10^{11}NT)
1981	1.36	7.62	0.74	57.07	1.30
1982	2.14	9.71	0.95	58.75	1.61
1983	2.71	9.60	1.11	59.55	1.86
1984	2.45	7.51	1.11	59.54	1.87
1985	2.91	7.19	1.24	59.44	2.08
1986	2.66	7.00	1.38	59.85	2.30
1987	1.97	6.18	1.48	60.16	2.46
1988	1.69	5.49	1.68	60.94	2.76
1989	1.57	5.26	2.01	63.63	3.15
1990	1.67	5.62	2.45	66.25	3.70
1991	1.51	6.85	3.01	68.65	4.38
1992	1.51	7.49	3.51	71.72	4.90
1993	1.45	6.91	4.01	73.83	5.43
1994	1.56	6.10	4.28	76.86	5.57
1995	1.79	5.59	4.50	79.67	5.64
1996	2.6	5.41	5.06	82.12	6.16
1997	2.72	4.94	5.47	82.87	6.60
1998	2.69	4.50	5.67	84.26	6.73
1999	2.92	4.22	6.01	84.41	7.12

Vol. 5, No. 05; 2020

ISSN: 2456-3676

2000	2.99	3.97	5.49	85.47	6.42
2001	4.57	4.74	5.90	85.46	6.91
2002	5.17	5.78	6.15	85.29	7.21
2003	4.99	5.99	6.33	85.05	7.44
2004	4.44	5.54	6.58	86.42	7.61
2005	4.13	5.08	6.84	88.42	7.73
2006	3.91	4.61	7.02	88.95	7.89
2007	3.91	4.62	7.11	90.55	7.85
2008	4.14	5.80	7.31	93.74	7.80
2009	5.85	9.28	7.78	92.92	8.38
2010	5.21	9.61	7.65	93.82	8.16
2011	4.39	8.93	7.85	95.15	8.25
2012	4.24	8.08	8.18	96.99	8.43
2013	4.18	7.36	8.33	97.76	8.52
2014	3.96	6.16	8.44	98.93	8.53
2015	3.78	5.28	8.57	98.63	8.69
2016	3.92	4.88	8.73	100	8.73
2017	3.76	4.34	8.87	100.62	8.82
2018	3.71	3.89	9.07	101.98	8.89
2019	3.73	3.67	8.99	102.55	8.77

Note:

1. UrateTW (%) : Percentage of unemployment rate in Taiwan
2. UrateUSA (%): Percentage of unemployment rate in the USA
3. Origin_Edu_Bdg (10^{11} NT, 0.1 trillion): Original education budget before CPI adjustment
4. CPI : Consumer Price Index (2016 = 100)
5. EduBdg (10^{11} NT) : Education budget adjusted by the CPI
6. 1 NT = 0.034USD (September 28, 2020)

Vol. 5, No. 05; 2020

ISSN: 2456-3676

Appendix B: Flow chart for stationary and nonstationary time series analysis

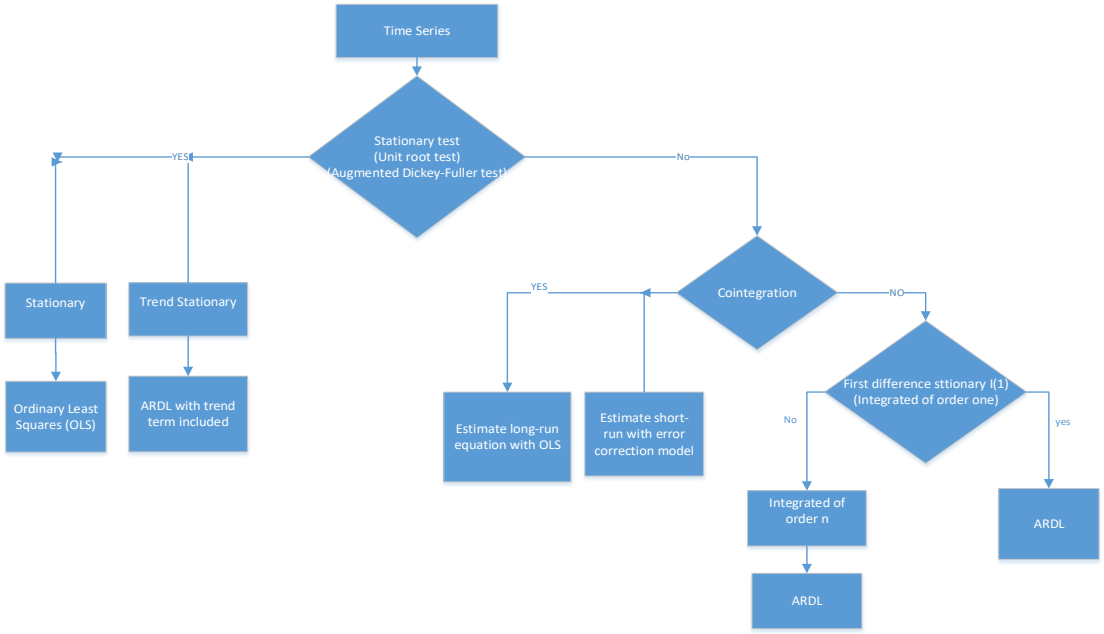

Figure B1: Flow chart for the stationary and nonstationary time series analysis

Vol. 5, No. 05; 2020

ISSN: 2456-3676

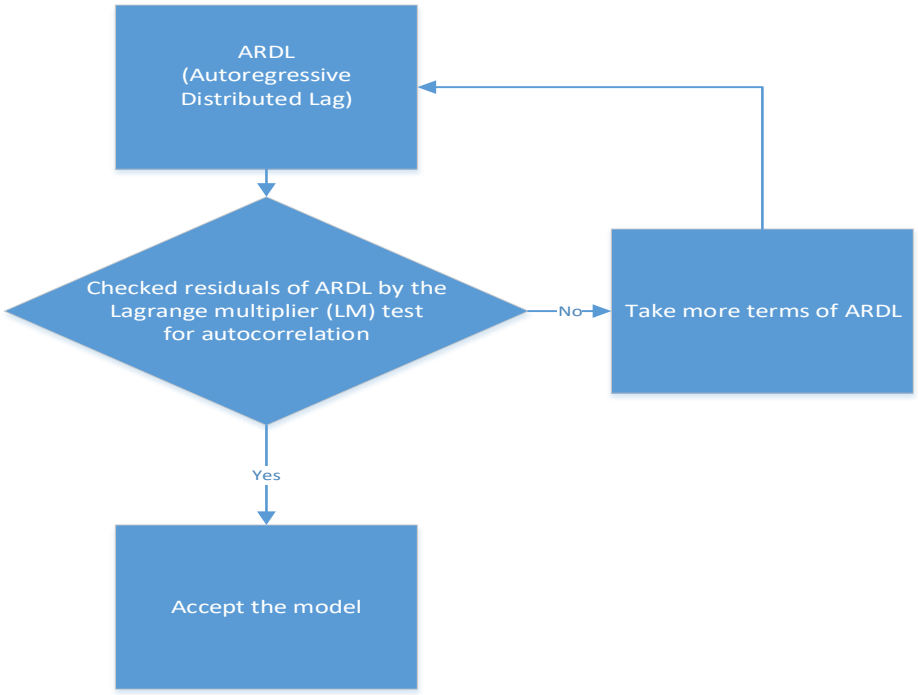

Figure B2: Higher-order check of the autocorrelation of the residuals of the ARDL model by the Lagrange multiplier test

Note:

(1) OLS: Ordinary Least Squares
(2) ARDL: Autoregressive Distributed Lag models
(3) ADF: augmented Dickey-Fuller test
(4) LM: Lagrange multiplier test (check higher order of the autocorrelation)
If H_0 : no serial correlation (autocorrelation) is true, then $LM = T \times R^2$ has an approximate $\chi^2_{(1)}$ distribution where T is the sample size and R^2 is the goodness-of-fit statistic [7].

Appendix C: Error check between the calculated and real unemployment rate

Table C1: Error check in percentage (%) between the calculated and real unemployment rate

Year	UrateTW (%)	EduBdg (10^{11} NT)	Urate_Calculated (%)	Error (%)
1981	1.36	1.30	NA	NA
1982	2.14	1.61	NA	NA
1983	2.71	1.86	2.41	10.97

Vol. 5, No. 05; 2020

ISSN: 2456-3676

1984	2.45	1.87	2.76	12.50
1985	2.91	2.08	2.60	10.69
1986	2.66	2.30	3.13	17.51
1987	1.97	2.46	2.53	28.24
1988	1.69	2.76	1.84	8.95
1989	1.57	3.15	1.65	4.81
1990	1.67	3.70	1.63	2.27
1991	1.51	4.38	1.76	16.29
1992	1.51	4.90	1.20	20.29
1993	1.45	5.43	1.48	1.83
1994	1.56	5.57	1.03	33.83
1995	1.79	5.64	1.60	10.70
1996	2.6	6.16	2.31	11.14
1997	2.72	6.60	2.83	3.94
1998	2.69	6.73	2.47	8.19
1999	2.92	7.12	2.94	0.58
2000	2.99	6.42	2.10	29.73
2001	4.57	6.91	4.26	6.74
2002	5.17	7.21	5.02	2.81
2003	4.99	7.44	5.37	7.52
2004	4.44	7.61	4.89	10.10
2005	4.13	7.73	4.20	1.66
2006	3.91	7.89	4.08	4.41
2007	3.91	7.85	3.69	5.71
2008	4.14	7.80	3.99	3.53

Vol. 5, No. 05; 2020

ISSN: 2456-3676

2009	5.85	8.38	4.86	17.00
2010	5.21	8.16	5.83	11.90
2011	4.39	8.25	5.33	21.52
2012	4.24	8.43	4.19	1.25
2013	4.18	8.52	4.12	1.36
2014	3.96	8.53	4.15	4.81
2015	3.78	8.69	4.07	7.68
2016	3.92	8.73	3.65	6.92
2017	3.76	8.82	4.08	8.41
2018	3.71	8.89	3.75	1.05
2019	3.73	8.77	3.58	3.98
			Average Error =	9.75

Note: NA means not applicable