International Journal of Advanced Engineering and Management Research
Vol. 2 Issue 4, 2017

www.ijaemr.com ISSN: 2456-3676

STATIONARY AND COINTEGRATION TEST OF EDUCATIONAL BUDGET PER UNIVERSITY STUDENT AND UNEMPLOYMENT RATE IN TAIWAN

Ko-Ming Ni

Department of Information Management, Ling Tung University, Taiwan

ABSTRACT

The relationship of the unemployment rate (%) and the educational budget per university student is discussed in this paper. The university students in Taiwan enjoy the highest educational budget per person and most of them will join to the job markets after graduation. Based on these factors, the educational budget per student (in 1,000 USD) was chosen to study its relationship with the unemployment rate. The time series data from 1978 to 2015 were obtained from DGBAS public archive. After using augment Dickey-Fuller (ADF) test, the educational budget per university student and unemployment rate are not stationary, but after first difference both are stationary, and can be denoted as I(1). After regression, a positive parameter 0.4598 was obtained. It means increasing one unit of educational budget will increase 0.4598 unit of unemployment rate. A further check into the residuals of the regression by the cointegration test shows the residuals are not stationary (not cointegrated). In other words, the regression equation between unemployment rate and educational budget per university student is spurious. The more complicated vector autoregressive (VAR) model then was used to solve this spurious problem. The VAR model, which also got the change of unemployment rate at time t, has positive relationship with the change of the educational budget at time t-1. However, all the parameters obtained by the VAR model are insignificant in 5% level. In other words, even the regression equations obtained by the VAR model are unreliable either. The only explanation is that the unemployment rate and educational budget per university student has very slim relationship. It seems that the Ministry of Education (MOE) in Taiwan seems should remove the requirement of "employment rate" of a school's graduated students as an indicator in its subsidy program. Because there is no or just a slim relationship between unemployment rate and educational budget.

Key Words: Spurious, augmented Dickey-Fuller (ADF), Cointegration Test

1. Introduction

People who are available to work but unable to find jobs in the previous four weeks are unemployed (Mankiw). Negative effects such as anxiety about the future, lower living standard, without feeling of security may impact on 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 population in labor force (Mankiw). The labor force counts people aged 15 and above who are available in the labor market in Taiwan (DGBAS) and it is slightly different from the USA, which calculates people aged 16 and above in the labor market (Mankiw; BLS). 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 assigning free trade agreement (FTA) may also be a way to reduce trade barrier 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 human by expenditure of resources may raise productivity in the future (Mankiw). Different from the stock market, the investment in 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 educational 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 NASFA, a 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 $32.8 billion and supported more than 400,000 jobs to the U.S. economy during the 2015-2016 academic year (NASFA). The second inspiration is that the Ministry of Education (MOE) 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 (MOE). 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 in an objective way 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 educational budget may can somehow reflect the goodness of quality.

If increasing educational budget can reduce unemployment rate, then the government should increase budget on education. On the contrary, if the unemployment rate has no or little correlation with educational budget, then the requirements from MOE 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 educational budget of Taiwan and unemployment rate, the data from DGBAS are used in the analysis. The statistic and graphing software used in this paper is Stata.

The educational budget per university student in Taiwan is the highest in comparison with other levels of schools, and most of university students after graduation will join job markets. Hence, in this study the educational budget per student from 1978 to 2015 is used to find the relationship with the unemployment rate. The education budget per university student is believed more suitable than the educational budget distributed to all students. The educational budget in year 2015 is the newest data one can find in DGBAS public archive although now it is already 2017. The unemployment rate is also obtained from the same government organization.

2. Unemployment Rate and Educational Budget

The unemployment rates of Taiwan recorded in DGBAS [2] are from 1978 to 2015, and the corresponding unemployment data in the USA are obtained from the Labor of Statistics (BLS).

2.1 Educational Budget per University Student Adjusted by Consumer Price Index (CPI)

Since education is an item in the "basket" of consumer spending(Mankiw), in this study, the educational budget is adjusted by the consumer price index (CPI) which takes 2011 as the base year. The original and adjusted educational budget per university student (in 1,000 USD), CPI, as well as the unemployment rate of Taiwan and USA are as in Table A1 in Appendix A.

The time series of the unemployment rate from 1978 to 2015for both Taiwan and the USA are shown in Figure 1.

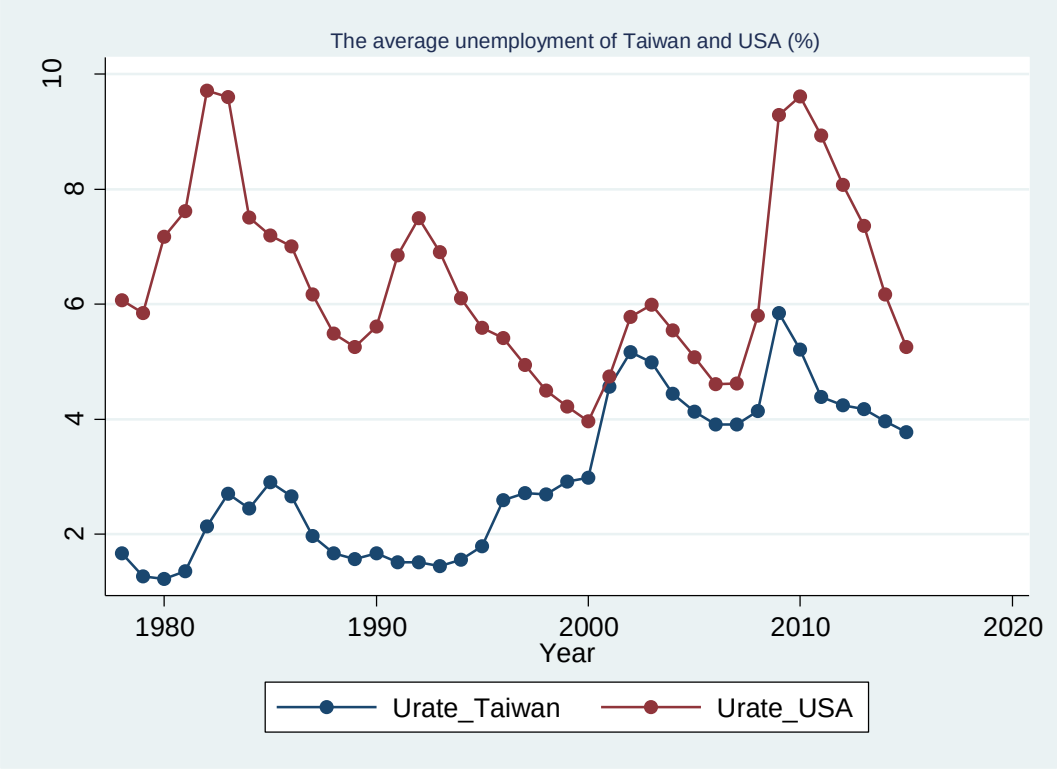

Figure 1: Yearly unemployment rate (%) of Taiwan and the United States of America from 1978 to 2015

From the above figure, one finds the unemployment rate in the USA is higher than that in Taiwan

in each year from 1978 to 2015. The average unemployment rate is 3.0 and 6.4 for Taiwan and USA, respectively. From the above figure, one finds a country with good education does not necessarily have lower unemployment rate. Averagely speaking, the unemployment rate in the USA is 2.13 (6.4/3.0 = 2.13) times of that in Taiwan.

2.2 Correlation between Educational Budget per University Student (1,000 USD) and Unemployment Rate (%)

The time series of educational budget per student and unemployment rate from 1978 to 2015 are plotted in Figure 2.

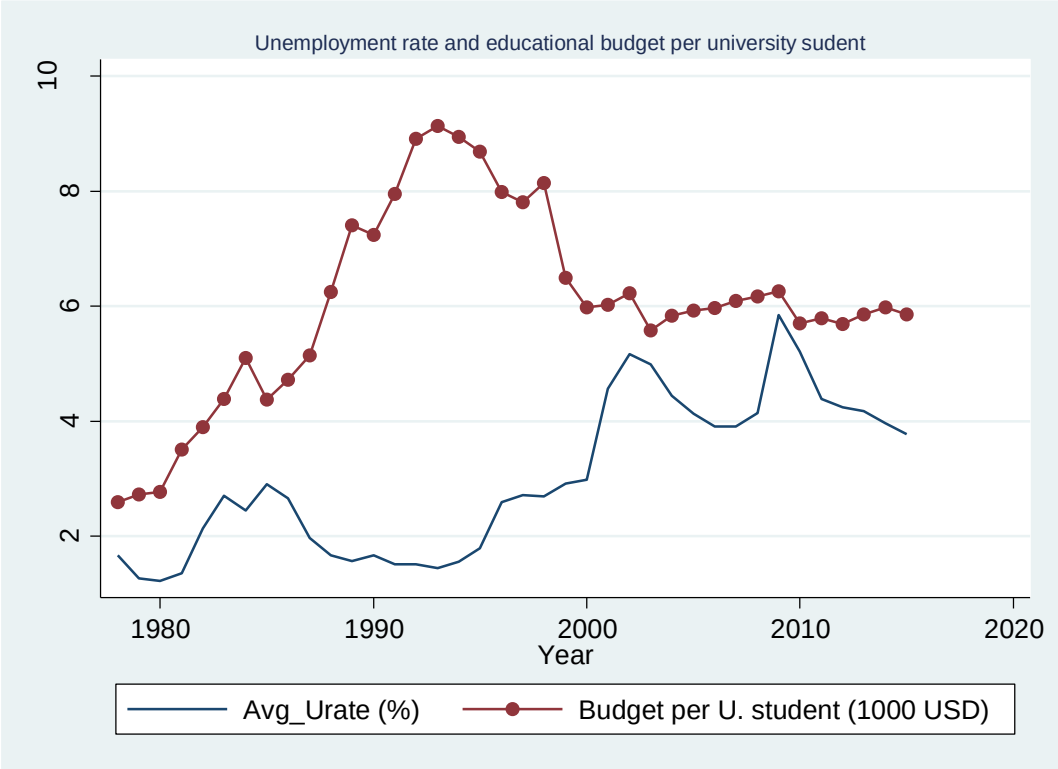

Figure 2: The unemployment rate (%) and educational budget per university student (1,000 USD) from 1978 to 2015

2.1 Check the Stationarity of Average Unemployment Rate (%)

A stationary variable is one that is not explosive, nor trending, and nor wandering aimlessly without returning to its mean (Hill, Griffiths, and Lim). One can check the stationarity of a time series by means of 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 generally referred as the Augmented Dickey-Fuller (ADF) test (Hill, Griffiths, and Lim; Hyndman and Athanasopoulos).

Figure 3: Average unemployment rate (%) from 1978 to 2015 in Taiwan

The augmented Dickey-Fuller test of the stationarity of the time series of the unemployment rate is shown in Table 1.

Table 1: The critical values and Augmented Dickey-Fuller (ADF) unit-root test results for average unemployment rate

$\tau(t)$ Test statistic	1% Critical value	5% Critical value	10% Critical value
-1.34	-3.43	-2.86	-2.57
MacKinnon approximate *p*-value for $\tau(t)$ = 0.6114			

From the above table, one finds the $\tau(t)$ test statistic -1.34 > -2.86 (5% critical value), the hypothesis test $H_0 : \gamma = 0$ (nonstationary) cannot be rejected, and $H_1 : \gamma < 0$ (stationary) is rejected. In other words, the time series of the average unemployment rate in Taiwan is not stationary.

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 first

difference stationary and denoted as I(1). The first difference of average unemployment rate time series is plotted in Figure 4.

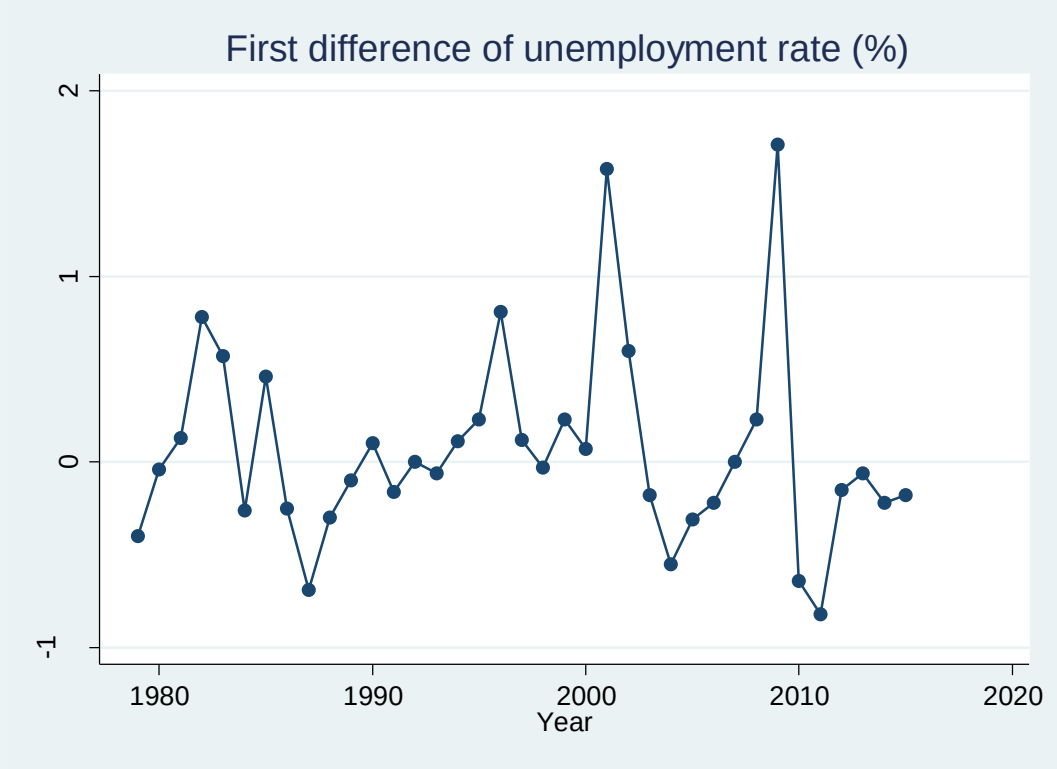

Figure 4: The first difference of average unemployment rate in Taiwan

The ADF is still used to check the stationarity of first difference of average unemployment rate in Taiwan. The test result is shown in Table2.

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

$\tau(t)$ Test statistic	1% Critical value	5% Critical value	10% Critical value
-4.82	-3.43	-2.86	-2.57
MacKinnon approximate *p*-value for $\tau(t)$ = 0.0001			

From the above table, one finds the $\tau(t)$ test statistic -4.82 < -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 average unemployment rate in Taiwan is a stationary one and denoted as I(1).

2.2 Check the Stationarity of Educational Budget per University Student (1,000 USD)

The educational budget per university student (in 1000 USD) from 1978 to 2015 was plotted in Figure 5.

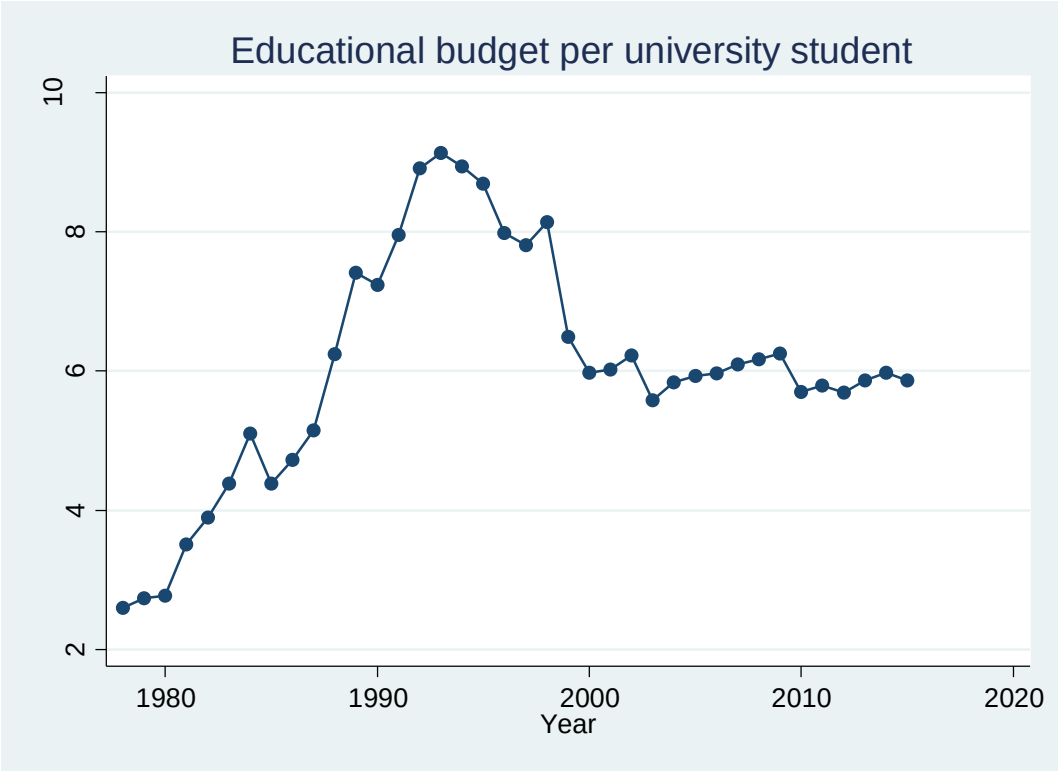

Figure 5: Educational budget per university student (in 1,000 USD) from 1978 to 2015

In the same way, the ADF will be used to check whether the educational budget per university student (in 1,000 USD) from 1978 to 2015 is stationary or not. The test result is shown in Table 3.

Table 3: The critical values and Augmented Dickey-Fuller (ADF) unit-root test results of the educational budget per university student (in 1000 USD)

$\tau(t)$ Test statistic	1% Critical value	5% Critical value	10% Critical value
-2.12	-3.43	-2.86	-2.57
MacKinnon approximate *p*-value for $\tau(t)$ = 0.2345			

From the above table, one finds the $\tau(t)$ test statistic -2.12 >-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 educational budget per university student in Taiwan is not a stationary one.

Same as the previous section, the first difference of educational budget per university student will be used to check its stationarity. It can be plotted in Figure 6.

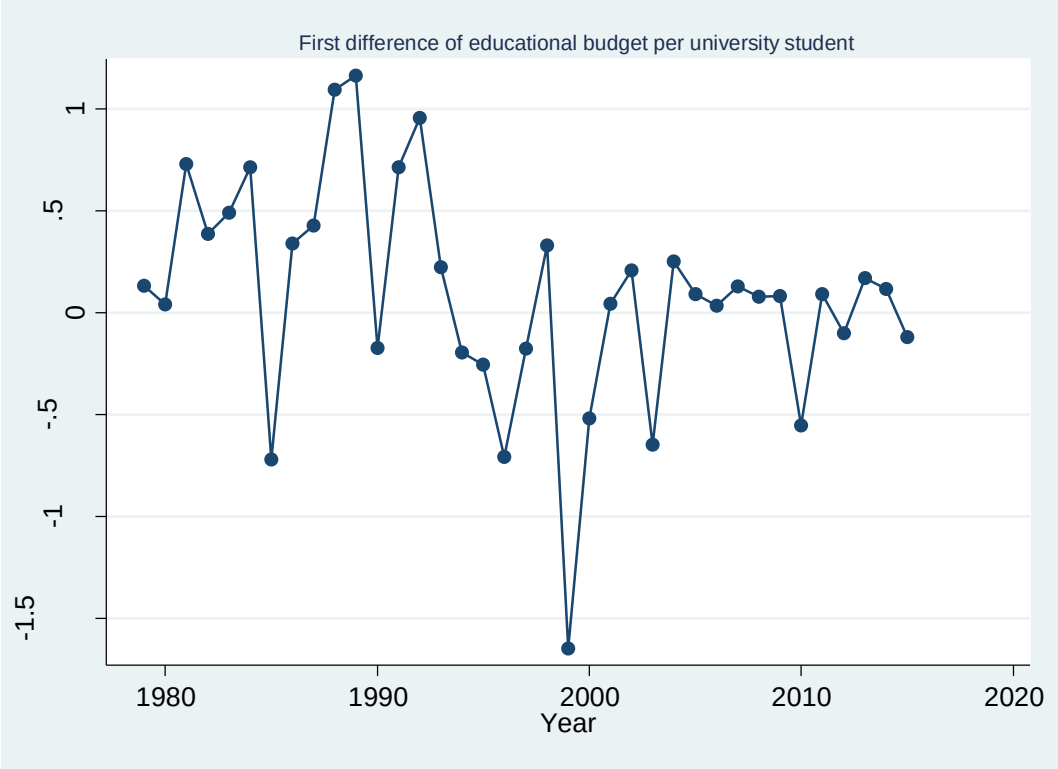

Figure 6: The first difference of educational budget per university student in Taiwan

Table 4: The critical values and Augmented Dickey-Fuller (ADF) unit-root test results of the first difference of the average unemployment rate.

$\tau(t)$ Test statistic	1% Critical value	5% Critical value	10% Critical value
-4.60	-3.43	-2.86	-2.57
MacKinnon approximate *p*-value for $\tau(t)$ = 0.0001			

From the above table, one finds the $\tau(t)$ test statistic -4.60 < -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 educational budget per university is a stationary one and denoted as I(1).

3. The spuriousness and Cointegrated Relationship of a Regression Equation

3.1 Regression of Unemployment Rate with Respect to Educational budget

$$Avg\_Urate = 0.4598Budget \quad (1)$$

(t) *(11.2)*

$R^2_{adj} = 76.6\%$

The regression average unemployment rate and educational budget per university student in Equation (1) is interesting. The *t* value*11.2* (*p-value=0.000*) is significant in 5% level. The adjusted R^2_{adj} is 76.6% is quite satisfactory. However, Equation (1)means the unemployment rate will increase 0.4598 unit as educational budget increases one unit. It is beyond the realization of a common sense. Subconsciously, if education can reduce unemployment rate, then the parameter in Equation (1) should be negative.

3.2 Cointegration Test of a Regression Equation

Two non stationary time series should not be used in regression analysis for avoiding spuriousness (Hill, Griffiths, and Lim; Hanke and Wichern). From the above section, both the average unemployment rate and educational budget per university student are nonstationary. If these two time series are used to make regression analysis, the spuriousness may exist.

The cointegration of residuals of the regression of Equation (1) shall be checked. If the cointegration exists, the vector error correction (VEC) model will be used. On the other hand, if the cointegration effect does not exist, the vector autoregressive (VAR) model will be applied (Hill, Griffiths, and Lim). The residuals of Equation (1) are:

$$\hat{e}_t = Avg\_Urate_t - 0.4598Budget_t \quad (2)$$

Where $\hat{e}_t$ is the residual at time *t*, Avg_Urate_t, and $Budget_t$ are the average unemployment rate and educational budget per university student at time *t*, respectively.

The unit-root test for the stationarity in the residuals is:

$$\Delta\hat{e}_t = -0.0927\hat{e}_{t-1} + 0.2873\Delta\hat{e}_{t-1} \quad (3)$$

(t) (-1.44) (1.75)

Table 5: The critical values for the cointegration test

$\tau(t)$ Test statistic	1% Critical value	5% Critical value	10% Critical value
-1.44	-3.39	-2.76	-2.47
MacKinnon approximate *p*-value for $\tau(t)$ = 0.158			

From the above table, one finds the $\tau(t)$ test statistic -1.44> -2.76 (5% critical value), the hypothesis test $H_0 : \gamma = 0$ (not cointegrated) is not rejected, and $H_1 : \gamma < 0$ (cointegrated) is rejected. Please note that if the cointegration does not exist, the regression Equation (1) is spurious. In other words, the Equation (1) is false and should not be used. Instead, the VAR model shall be used to get more reliable result.

3.3 Vector Error Correction (VAR) Model

After the vector autoregressive (VAR) analysis, the following equations can be obtained:

$$\Delta Avg\_Urate_t = 0.2177\Delta Avg\_Urate_{t-1} + 0.10617\Delta Budget_{t-1} \quad (4)$$

(t) (1.34) (0.39)

Expanding the above equation, one gets:

$$Avg\_Urate_t = 1.2177 Avg\_Urate_{t-1} - 0.2177 Avg\_Urate_{t-2} + 0.10617\Delta Budget_{t-1} \quad (5)$$

$$\Delta Budget_t = -1.2215\Delta Avg\_Urate_{t-1} + 0.2344\Delta Budget_{t-1} \quad (6)$$

(t) (-0.73) (1.45)

From Equation (4), the change of average of unemployment rate at time *t* is positive related to the change of average unemployment rate at time *t-1*, and also positive related to the change of educational budget per university student. If the change of budget at time *t-1* is positive, the unemployment rate at time *t* will increase. This is unreasonable, but the *t-values* for ΔAvg_Urate_{t-1} 1.34 (*p-value=0.182*) and for $\Delta Budget_{t-1}$ 0.39 (*p-value=0.696*) are insignificant in 5% level. In other words, the Equation (4) obtained by VAR model is unreliable. More precisely, the unemployment rate and educational budget per university student may have no relationship.

Similarly, each of the parameter in Equation (6) is also insignificant in 5% level. The Equation (6) is not reliable either.

From the above discussion, the reasonable judgement is the educational budget per university student has no relationship with the unemployment rate. The "employment rate" should not be a requirement index used in the subsidy programs of the Ministry of Education in Taiwan.

4. Conclusions

After the above objective analyses, some observations can be obtained:
(1). The unemployment rate of the United States of America is higher than that of Taiwan in each year from 1978 to 2015. Although the educational system in USA is better than Taiwan, especially in higher education, the average unemployment rate there is 2.13 times than that in Taiwan. It means, the better educational system does not necessarily have a lower unemployment rate.
(2). The time series of unemployment rate and educational budget per university student from 1978 to 2015 are not stationary. Furthermore, the augmented Dickey-Fuller (ADF) unit-root test of the regression of unemployment rate and educational budget is not stationary (not cointegrated). The regression equation *Avg_Urate = 0.4598 Budget* is spurious.
(3). The stationarity does not exist for both unemployment rate and educational budget per university student, and the residuals of regression also fail to pass the cointegration test. Therefore, the vector error correction (VEC) model cannot be used. Instead, the vector autoregressive (VAR) model is used.

(4). The vector autoregressive (VAR) model is used to find the relationship between unemployment rate and educational budget per university student. Equation (4) is repeated here just for explanation:

$$\Delta Avg\_Urate_t = 0.2177\Delta Avg\_Urate_{t-1} + 0.10617\Delta Budget_{t-1} \quad (4)$$

(t) *(1.34)* *(0.39)*

The change of the unemployment rate at time *t* is positive related to the change of unemployment rate at time *t-1* and positive related to the change of educational budget at time *t-1*. However, the *t-value* of each parameter in the equation is not significant in 5% level.

(5). The regression Equation (1) yielded from VAR model may not be reliable because its parameters are statistically insignificant in 5% level. In other words, the average unemployment rate and educational budget per university student may be not correlated. More precisely, the increasing (or decreasing) educational budget does not have direct relationship with the unemployment rate.

5. References

[1] Mankiw, N. G. (2018) *Principles of Economics 8th Edition*, Cengage Learning Asia Pte Ltd, Singapore.

[2] Directorate-General of Budget, Accounting and Statistics (DGBAS), Executive Yuan R.O.C. (Taiwan 2017). Retrieved fromhttp://www.dgbas.gov.tw

[3]Ministry of Education (MOE) Web Site (Taiwan 2017). Retrieved from http://edu.law.moe.gov.tw

[4] Bureau of Labor Statistics (BLS) of the United States Department of Labor (2017). Retrieved from http://www.bls.gov

[5] Hyndman, R. J. and Athanasopoulos, G. *Foresting: Principles and practice*. (2014). OTexts.com.

[6] Hanke, J. E., & Wichern, D. W. (2009). *Business Forecasting*, 9th ed. New Jersey: Pearson Prentice Hall.

[7] Hill, R. C., Griffiths, W. E., and Lim, G. C. (2012). *Principles of Econometrics*, 4th ed. Asia: John Wiley & Sons.

[8] NAFSA International Student Economic Value Tool (2017).Retrieved from http://wwwnafsa.org

Appendix A:

Table A1: Average unemployment rate and educational budget per university student (in 1,000 USD) after CPI adjustment

Year	Urate _Taiwan (%)	Budget per U. student (NT)	CPI	Budge per U. student after CPI adjustment (1,000USD)	Urate_USA (%)
1978	1.67	33270	39.47	2.78	6.07
1979	1.27	46137	43.32	3.51	5.85
1980	1.23	61006	51.56	3.90	7.18
1981	1.36	79889	59.97	4.39	7.62
1982	2.14	95632	61.74	5.10	9.71
1983	2.71	83256	62.59	4.38	9.60
1984	2.45	89704	62.57	4.72	7.51
1985	2.91	97666	62.47	5.15	7.19
1986	2.66	119285	62.9	6.24	7.00
1987	1.97	142284	63.23	7.41	6.18
1988	1.67	140782	64.04	7.24	5.49
1989	1.57	161547	66.87	7.95	5.26
1990	1.67	188484	69.63	8.91	5.62
1991	1.51	200211	72.15	9.14	6.85
1992	1.51	204730	75.37	8.94	7.49
1993	1.45	204795	77.59	8.69	6.91
1994	1.56	195870	80.77	7.98	6.10
1995	1.79	198611	83.73	7.81	5.59
1996	2.60	213401	86.31	8.14	5.41
1997	2.72	171730	87.09	6.49	4.94

1998	2.69	160713	88.56	5.98	4.50
1999	2.92	162184	88.71	6.02	4.22
2000	2.99	169906	89.82	6.23	3.97
2001	4.57	152275	89.82	5.58	4.74
2002	5.17	158866	89.64	5.84	5.78
2003	4.99	160950	89.39	5.93	5.99
2004	4.44	164518	90.83	5.96	5.54
2005	4.13	171965	92.92	6.09	5.08
2006	3.91	175263	93.48	6.17	4.61
2007	3.91	180800	95.16	6.26	4.62
2008	4.14	170602	98.51	5.70	5.80
2009	5.85	171821	97.66	5.79	9.28
2010	5.21	170506	98.6	5.69	9.61
2011	4.39	178065	100	5.86	8.93
2012	4.24	185097	101.93	5.98	8.08
2013	4.18	182901	102.74	5.86	7.37
2014	3.96	184910	103.97	5.86	6.17
2015	3.78	187271	103.65	5.95	5.26

Note: 1 USD=30.37 NT (July 13, 2017)