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Multivariate Time Series Analysis on Correlation Between Inflation Rate and Employment Rate with Gross Domestic Product

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Abstract: Bearing in mind that GDP is the main indicator of a country's standard of living, this paper attempts to study the correlations that exist between inflation rate and employment with GDP. The variables were selected based on relevant economic theories that allow such interactions among variables. The study has been done using multivariate times series analysis available in STATA software. In the long run, the results indicate that the inflation rate does not affect the GDP while the employment rate has negative relationship with the GDP. Granger Causality is applied to test the causality between the variables. The findings revealed that both independent variables have unidirectional relationship with GDP in the short run. It is to be concluded that by using time series data, the researcher can discern the movement of variables clearly. It is recommended that future researchers should improve the reliability and validity of the results by replacing the other independent variables such as level of income, population and others.

Key words: Multivariate time series analysis · Gross domestic product · Inflation rate · Employment rate

INTRODUCTION

GDP is the value of total production of goods and services in a country over a specified period, typically a year. The GDP is a measure of a country's overall economic output which can be determined in three ways, all of which should in principle give the same result. The most common approach to measure GDP is by using the expenditure method:

GDP = Private Consumption + Gross Investment + Government Spending + (Exports - Imports) (1)

Malaysians are always reminded that in 1975 the GDP dropped causing a great slump and creating a recession with a GDP growth rate of only 0.8 percent, compared to 8.3 percent in 1974. Based on [1] this is one of the effects of increase in oil prices and then substantial price increase in 1973 was bought about mainly by shortage of food and raw materials arising from bad weather and increased aggregate demand.

According to the above circumstances which occurred in 1975, the researcher has chosen one of variables that may relate with fluctuation of GDP which is inflation rate. Inflation means either an increase in the money supply or an increase in price levels. From[1], generally, when we hear about inflation, we are hearing about a rise in prices compared to some benchmark. The study on the effects of inflation on economic growth continues to be an important and complex topic in economics. Based on statement of[2], if inflation has real economic effects, then governments can influence economic performance through monetary policy. Besides the inflation, the researcher has considered total employment as one of the variables in the model since economic growth and employment are correlated. Referring from [2], the relationship between unemployment and GDP is called *Okun's Law*.

[1]Barnes., 2009. The importance of Inflation and GDP. Retrieved March 11, 2011 from http://www.investopedia.com/article/06/gdpinflation asp

[2]WikiAnswers, (2009), What Is the Relationship between Unemployment and GDP. Retrieved March 11, 2011 fromhttp://wiki.answer.com/Q/sWhat_ is_the_relation ship_of_ unemployment_and_GDP

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It is the association of a higher national economic output with the decrease in national unemployment. This is because in order to increase the economic output of a country, people will need to go back to work, thus lowering unemployment.

Generally, Gross Domestic Product (GDP) is a common measure of the economic well-being of a society or the total economic activity within an economy. Referred to [3], when government officials plan for the future, they consider the various economic sectors contributing to it. The function of GDP also has been explained by [4] where GDP is among the most commonly used macroeconomic indicators, as it is a measure of total economic activity within an economy. The GDP growth calculated as the annual change is used as a measure of the macroeconomic conditions. Besides that GDP is also one of the results of the country's economic activities based on the statement of [5], GDP expresses the content of physical flows of "capital, industrial production, services, resources and agricultural product". Regarding to [6], economic growth of an economy refers to the expansion of its production possibility set, as a result of accumulation of primary factors such as labor and capital (physical and human), or improvement of production technologies.

According to [7], the structuralisms argue that inflation is necessary for economic growth, whereas the monetarists argue the opposite. An empirical study [8] suggested a negative and nonlinear relationship; when the agents decide the level of labor output and an increase in inflation reduces labor supply and producing a decrease in economic production. Based on [9], inflation does not affect real output in the long run, but that in the short-run inflation negatively affects output. Similarly, [10, 11] found that, there is no causal relationship between inflation and economic growth. Meanwhile, [12] concluded that there is a nonlinear relationship between inflation and economic growth. On the other hand based on [13], inflation may also cause misperception of the relative price levels and lead to inefficient investment plans and therefore affects productivity inversely. According to [14], inflation may distort price signals and reduces the ability of economic agents to operate efficiently.

According to a journal article written by [15], one branch of the literature models inflation dynamics and estimates the unemployment rate compatible with inflation stability. There is a positive relationship between inflation and unemployment as stated by [16], while [17] found a negative correlation between unemployment and economic growth. This negative relationship is supported by [18] in their article which stated that, the results revealed that there is a negative relationship between unemployment and inflation in Namibia. According to Okun's Law, an increase of the economic growth rate by 3% is expected to reduce the unemployment rate by 1%. In addition, according to [19], an increase in output growth of 1% leads to an increase in productivity and employment growth of half a percentage point each.

Furthermore, based on article written by [20], economy is able to generate more job opportunities with each percentage point of GDP growth. However, [21] argued that there is no relationship between unemployment and inflation. Evidence by [22] suggested that restructuring of major economic sectors reduce the relationship between economic growth and employment. From another point of view, the volume of employment is given by the point of intersection between the aggregate demand function and the aggregate supply function [23]. The aim of this study is to examine the correlation between inflation rate and employment with gross domestic product.

Methodology: This study examined the correlation between inflation rate and total employment with gross domestic product. It uses time series data ranging from 1982 to 2006 and the scope is in Malaysia. The researcher applied STATA software to process the data using log-log model in this study. The logarithm equation is as below:

$$\ln(GDP_t) = \alpha + \beta_1 \ln(INF_t) + \beta_2 \ln(EMP_t) + u_t \qquad (2)$$

Unit Root Tests: Unit root tests are important to test the integration between the variables involved in the research conducted. The basic idea of unit root test, the order of integration of a series is given by the number of time a series must be differentiated in order to produce a stationary series, as proposed by [24, 25].

Co-Integration Test: To test for integration each of variable, the researcher adopted the tests used by [26] since this particular method is claimed to be superior to the regression used by [27-28] used method tests for all the number of co-integrating vectors between the variables. We can test the null hypothesis using the following two likelihood ratio tests statistics.

Trace Test:

$$\lambda_{trace} = t\sum_{i=r+1}^{n} \log(1-\hat{\lambda}_i),\ r = 0,1,\ldots,n-1 \qquad (3)$$

Where N is the total number of observations the λ_{trace} tests the null hypothesis that the number of distinct cointegrating vector is less than or equal to r against a general alternative. T trace has a chi square distribution with M-r degrees of freedom. The big values of T trace provide evidence which is against the hypothesis of r or lesser co-integration vectors.

Maximal Eigenvalue Test: This is for estimating r cointegrating vectors against the alternative of r+1 cointegrating vectors. This test evaluates the null hypothesis:

Ho: r = r0 (Co-integration)
H1: r = r0 +1 (No co-integration)

$$\lambda_{max} = -T\log(1-\lambda_{T+1}).\ r = 0.1,....n-1 \quad (4)$$

Where λ_1 is the estimated values of the characteristic roots (eigenvalues) obtained from the estimated matrix, r is the number of cointegrating vectors and T is the number of usable observations. The λ_{max} statistics uses the null that there are less than or equal to r versus exactly r+1 co-integrating vectors.

Vector Error Corrected Model (VECM): According to [29], the dynamic relationships among the variables can be analyzed through the VECM once the existence of co-integration is established. VECM is used to capture the short-run dynamics and to establish the direction of causality in a Granger-temporal sense. [27] shows that in the presence of co-integration, there always exists a corresponding error-correction representation, which implies that changes in the dependent variable are a function of the level of disequilibrium in the co-integrating relationship, captured by the error-correction term (ECT), as well as changes in other explanatory variables.

Granger Causality Test: The purpose of Granger Causality test is to determine the causality among the variables. Although the researcher has conducted the co-integration test which indicates the presence or absence of Granger causality, it does not indicate the direction of causality between the variables. Thus, the causality test helps us to verify whether change in any series can be explained by the other two series. Equation below can be explicitly expressed as follows:

$$\Delta\ln GDP = \delta0 + \delta1\ \Sigma\delta1i\ \Delta\ln GDPt\text{-}1 + \delta2\Sigma\delta2i\ \Delta\ln INFt\text{-}1 + \delta3\ \Sigma\delta3i\ \Delta\ln EMPt\text{-}i + \delta4\ ect\ t\text{-}1 + \mu t \quad (5)$$

Where ect t-1 is the error correction term generated from the co-integrated regression from the Johansen multivariable process, μt are disturbance terms, ? denote first differences required to induce stationary for corresponding variables and the estimated coefficient of δ1, δ2 ……δ3 indicates the 'short run' causal effects, shown by the F-test of the explanatory variables whereas the coefficient of ECT causal relationship implied through the significance of the t-statistics. The relevant error correction term must be included to avoid misspecification and omission of important constraints.

RESULTS AND DISCUSSION

Descriptive Statistics: Table 1 shows the descriptive statistics including the minimum and maximum values, mean, standard deviation, variance and coefficient of variation. Standard deviation is a widely used measure of the variability or dispersion, being algebraically more tractable though practically less robust than the expected deviation or average absolute deviation. A low standard deviation indicates that the data points tend to be very close to the mean, vice versa. Standard deviation for GDP per capita RM5034.343, standard deviation for inflation is 25.33092 and total employment is at 1668958. In addition, coefficient of variation (CV) is a normalized measure of dispersion of a probability distribution. In the table above, CV for GDP per capita is 0.4878561 while inflation's is 0.1904981 while total employment's is 0.2173514. The general rule is; the higher the CV, the greater the dispersion in the variable.

Unit Root Tests: Both Augmented [24, 25] have been tested at level and first difference. From both of ADF and PP tests, the results of unit root test for t-statistics are statistically not significant at level, meaning that the null hypothesis is not rejected. This indicates that these series are non-stationary at their level form. Consequently, the process is continued into the first difference values of the data. From the results in Table 2, all variables are now stationary at first difference. Thus, all of the respective null hypotheses are rejected suggesting the presence of unit root and co-integration.

Table 1: Descriptive Statistics

stats	gdp	inf	emp
min	4273	101.4	5249000
max	20841	187.1	1.03e+07
mean	10319.32	132.972	7678616
sd	5034.343	25.33092	1668958
cv	.4878561	.1904981	.2173514
variance	2.53e+07	641.6554	2.79e+12

Table 2: Results for Unit Root Tests (At First Difference)

Variables	ADF statistic	PP statistic	Results
Gross Domestic Product	0.0081	0.0088	Significant and the null hypothesis is rejected.
Inflation rate	0.0000	0.0000	Significant and the null hypothesis is rejected.
Employment rate	0.0001	0.0000	Significant and the null hypothesis is rejected.

Table 3: Results of Johansen test for Cointegration

Johansen tests for cointegration

Trend: constant — Number of obs = 22
Sample: 1985 - 2006 — Lags = 3

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	21	115.00778	.	44.0008	29.68
1	26	129.26667	0.72645	15.4830	15.41
2	29	136.36397	0.47545	1.2884*	3.76
3	30	137.00816	0.05688		

Table 4: VECM Cointegrating Equation

Cointegrating equations

Equation	Parms	chi2	P>chi2
_ce1	2	386.995	0.0000

Identification: beta is exactly identified
Johansen normalization restriction imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
lngdp	1	.	.	.	.	.
lninf	-.1934455	.1495494	-1.29	0.196	-.4865569	.099666
lnemp	-2.542053	.129393	-19.65	0.000	-2.795659	-2.288448
_cons	31.90099	.	.	.	.	.

Co-Integration Test: The results from the Johansen Co-integration test are illustrated in Table 3 below. The results are based on the maximum eigenvalue and the trade test statistics. From the table, the trace statistics value which are p=0 and p=1 are greater than the critical values, so that, the null hypothesis is rejected at 1% significance level .Since the trace statistics are significant at p=2, suggesting that co-integration exists among the variables. This implies that GDP and the explanatory variables moves closely to achieve the long run equilibrium.

The equation consists of a trend value at 31.9009. From the Table 4, the result of inflation rate is not significant on GDP in the long run relationship. This result is similar to findings by [12, 30]. However this situation may change in the short run as founded by [9]. On the other hand, the total employment has negative relationship with GDP, where for every 1% increase in total employment, a decrease of 2.5421% in the GDP per capita will follow. The result of this study which examines the relationship between employment and gross domestic product is in conflict to the hypothesis stated by the researcher. Thus, the researcher has some suggestions in improving the employment and boosting the gross domestic product in our country. Although the number of employed is high, it does not mean that it can increase the GDP automatically.

Productivity element is important in enriching the human capital in this country, where knowledge will become the main input for the workers. In addition, the government can reduce the unemployment rate by diversifying the sectors in our country. It is suggested that the government should industrialize the non-industrial sector such as the agricultural sector so that it will cushion any unemployment problems occurring from change in development structure. Therefore, the combination between agricultural and industrial sector can develop the new sector and can attract the citizens to work and contribute to the GDP and accelerate the economic growth.

Table 5: Granger Causality Test Results Based On Vector Error Correction Model (VECM)

	Independent Variables		
Dependent Variables	GDP	Inflation rate	Employment rate
Gross Domestic Product	-	.0060	.0209
Inflation rate	.3060	-	.0050
Employment rate	.8830	-	-

Granger Causality Test: Between the GDP and inflation rate, the result of the study shows that computed p-value is less than 1%, 5% and 10% significance level, meaning that the null hypothesis can be rejected. It can be concluded that inflation rate can influence GDP in the short run dynamics. On the other hand, since the computed p-value, (.3060) is greater than 1%, 5% and 10% significance level, the null hypothesis cannot be rejected, since the GDP does not influence the inflation rate. Therefore, the causality relationship is only unidirectional. From the result of causality between the GDP with employment, the computed p-value is 2.09%, means that the p-value is significant at 5% level. As a result, the null hypothesis can be rejected where the employment can influence the GDP in the short run. In the reverse, a p-value of 88.30% is recorded, suggesting that there is no significance. The null hypothesis cannot be rejected since p-value is not significant. Thus, GDP does not influence the employment in the short run. There is only a unidirectional causality between the GDP and employment.

CONCLUSION

In conclusion, inflation rate and employment rate influence the GDP in the short run. On the other hand, the GDP is unable to affect the inflation rate and employment rate. Therefore, the result is called unidirectional since only one variable can influence the other variable in the short run. In addition, there is no relationship between inflation rate and the GDP in the long run. At the same time, there is a negative relationship between employment and GDP in the long run. It is recommended that future researchers should improve the reliability and validity of the results by replacing the other independent variables such as level of income, population and others.

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