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Causal Nexus between Inflation and Economic Growth of Japan

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Abstract

This study aims to evaluate the link between economic growth and consumer price index (CPI) in Japan for the period of 1980-2014. Initial series were adjusted for stationarity using the Augmented Dickey- Fuller (ADF) test for unit root followed by the application of Johansen Co-integration Test in order to examine the long-run relationship among the variables, while the causalities were evaluated using Granger Causality model. The empirical results reveal that economic growth and CPI are co-integrated and thus exhibit a long-run relationship between the variables. The Granger causality test supports bi-directional causality between economic growth and CPI in Japan. The paper adopts a time series framework of the Vector Error Correlation Models (VECM) to study the dynamic relationship between economic growth and consumer price index for Japan.

Keywords: Co-integration, Consumer price index, Economic growth, Granger causality test, Inflation, Vector error correction.

1. Introduction

The link between inflation and economic growth is one of the most important controversies in the economic literature. It is widely believed that moderate and stable inflation rates promote the development process of a country, hence the economic growth. Moderate inflation supplements return to savers, enhances investment, and, therefore, accelerates economic growth of the country. Empirical methods for detecting inflation and output growth have been the subject of intensive research in econometrics. Although the inflation growth linkage is a part of the liberal consensus in modern

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economics, there are yet some controversies. Some consensus exists, suggesting that macroeconomic stability, specifically defined as low inflation, is positively related to economic growth. Not everyone shares the same degree of confidence in the consensus conclusions, however. For the most part, the possible role of inflation on the growth process has been ignored.

With respect to the nature of the relationship between inflation and economic growth, Orphanides and Solow (1990) opine that there are three possible results regarding the impact of inflation on output and growth, namely: (i) none; (ii) positive; and (iii) negative. Some of the studies that found no conclusive empirical evidence for either a positive or negative relationship between inflation and economic growth are Wai (1995) and Bhatia (1960). Tobin (1965), who assumed money as substitute to capital, established the positive impact of inflation on growth, his result being known as the Tobin Effect. The negative impact of inflation on growth, also known as the Anti-Tobin Effect, is associated Fisher (1993), Barro (1995), Bruno and Easterly (1995), among others.

With regard to the direction of causality, Wai (1995) opines that there is no meaningful relationship between inflation and economic growth. Furthermore, in one of the studies involving 70 countries- both developed and developing- Kearney and Chowdhury (1997) found no causal relationship between inflation and economic growth in 40 percent of the countries, bi-directional causality in about 20 percent, and a unidirectional (either inflation to growth or vice versa) relationship in the rest. More interestingly, the relationship was found to be positive in some cases, but negative in others.

The bone of contention is that whether inflation is necessary for economic growth or it is detrimental to growth. Basically, the rate of economic growth depends primarily on the rate of capital formation and the rate of capital formation depends on the rate of savings and investments (Datta and Kumar, 2011). World economic growth and inflation rates have been fluctuating. Likewise, inflation rates have been dominating compared to the growth rates in virtually many years (Madhukar and Nagarjuna, 2011) and the relationship between inflation and the economic growth continues to be one of the most important macroeconomic problems. Similarly, Ahmed (2010) maintains that this relationship has been argued in various economic literatures and these arguments show the differences in relation with the condition of world economic order. In accordance with these policies, increases in the total demand caused increases in production and inflation as well. However, inflation was not regarded as a problem in that period, rather considered as a positive impact on the economic growth, which was widely accepted.

In 1970s, countries with high inflation, especially in Latin America, begun to experience a decrease in growth rates and thus caused the emergence of the views stating that inflation has negative effects on the economic growth instead of the positive effects. Evidence showing the relationship between inflation and economic growth from some of the Asian countries, such as India, showed that the growth rate of Gross Domestic Product (GDP) in India increased from 3.5% in 1970s to 5.5% in 1980s, while the inflation rate accelerated steadily from an annual average of 1.7% during 1950s to 6.4% in 1960s and further to 9.0% in 1970s before easing marginally to 8.0% in 1980s (Prasanna and Gopakumar, 2010).

While some of the empirical findings on the relationship of inflation and growth are in the direction that inflation has negligible effects on the growth (Chari et al., 1996), some (Berber and Artan, 2004; Saaed, 2007; Erbaykal and Okuyan, 2008) show that it makes a positive effect on it (Mallik and Chowdhury, 2001). Theoretically, the effect of inflation on the growth is evaluated in the framework of the insufficient use of resources and the changing investment decisions. On the other hand, empirical findings put forward that via overheating the economy, the growth leads to high inflation. In addition, in a closed economy having limited resources, higher growth may lead to low inflation. Thus, the relationship between growth and inflation occurs in two directions. Therefore, the number of studies suggesting the interactions between inflation and economic growth for different countries is quite contradictory. Our study aims to analyze the data obtained from Japan in the period of 1980 to 2014. The relationships between inflation and economic growth were aimed to be analyzed utilizing ARDL Boundary Test Approach.

2. Literature review

The content of this section is concerned with the recent empirical results on the link between inflation and economic growth. In general, most of the previous empirical contributions showed that economic growth is essentially affected by inflation but the sign of this impact is unpredictable. Mallik and Chowdhury (2001) tested the relationship between inflation and growth, utilizing the error correction model for four Asian countries (Bangladesh, India, Pakistan, and Sri Lanka). According to the findings obtained from the study, there is a positive relationship between inflation and growth for the four countries, while inflation is unavoidable for rapidly growing. In addition, there are important feedbacks between inflation and economic growth. These results are highly important for policy suggestions. Moderate inflation is helpful for the growth; however, the rapid economic growth holds back the inflation. Mallik and Chowdhury state this kind of economies being in balance on a knife-edge. As a result, that the economies realize a rapid growth without falling prey to the inflation is rather difficult.

Berber and Artan (2004) tested the relationship between inflation and economic growth for the period of 1987-2003 using Granger causality analysis. According to the findings obtained from the study, inflation affects the economic growth in the negative direction. That is, a 10% of increase in the inflation rate reduces the economic growth in the rate of 1%. In addition, as a result of Granger causality analysis, the relationship of one–directional causality was identified from inflation to economic growth. Saaed (2007) analyzed the relationship of inflation and economic growth for Kuwait, using the data of GDP and CPI. The results point out that there was a potent and opposite directional relationship between GDP and CPI in Kuwait. Bruno and Easterly (1998) investigated possible relationship between inflation and economic growth using cross country data. They found that inflation has negative effect on medium to long term economic growth and showed that the relationship is influenced by countries with extreme values (either very high or very low inflation).

Erbaykal and Okuyan (2008) studied the relationship of inflation and economic growth for Turkey's economy, using the data for the period of 1997-2006. The long term relationship in period was tested by ARDL boundary test developed by Pesaran et al. (2001). As a result of the analyses, in the period of interest, it was net with the existence of the relationship of both causality and co-integration in Turkey. According to the findings, in Turkey, while there is no causality relationship from the economic growth to inflation, there is causality from inflation to the economic growth.

A study to ascertain the existence (or not) of a relationship between inflation and economic growth in Nigeria was carried out by Omoke (2010). The study employed the co-integration and Granger causality test where Consumer Price Index (CPI) was used as a proxy for inflation and the GDP as a perfect proxy for economic growth to examine the relationship. The result of the test showed that, for the period of 1970-2005, there was no co-integrating relationship between inflation and economic growth for Nigeria's data. The results showed the same at different lags. Unidirectional causality was seen running from inflation to economic growth showing that inflation indeed has an impact on growth.

Tan (2008) ascertained whether there is any trade-off between inflation and economic growth in the founding members of ASEAN namely Malaysia, Singapore, Thailand, Philippines, Indonesia, Japan, and South Korea. The purpose of the paper was met by integrating the Phillips curve framework with Okun's theory. Quarterly data of these countries spanning generally from 1991 through 2006/7 were mobilized for the purpose. The empirical results suggest that a trade-off albeit small exists between economic growth and inflation in Singapore, South Korea, and Thailand after the 1997/98 Asian financial crisis years while none in the other countries. In the wake of these findings, one might somehow infer that monetary cooperation is sustainable amongst these sample countries.

In another study by Ayyoub, Chaudhry, and Farooq (2011), a negative and significant inflation growth relationship is found to exist in the economy of Pakistan. The results of the study show that prevailing inflation is harmful to the GDP growth of economy after a certain threshold level. Chaudhry, Qamber, and Farooq (2012) investigate the long and short run relationships of monetary policy, inflation, and economic growth in Pakistan during 1972 to 2010. The results indicate that credit to private sector, real exchange rate, and budget deficit are found elastic and significant variables to influence the real GDP in Pakistan. Real GDP and real exchange rate are causal to each other. The real GDP also causes financial depth (M2GD), domestic credit (CREDIT), and budget deficit (BDEF). The real exchange rate is also causing the financial depth and budget deficit variables.

The foregoing review reveals that empirical studies on the relationship between inflation and other macroeconomic variables such as interest rate, real GDP, money supply, and exchange rate are still very shallow in Japan and other developing economies. Policymakers in Japan need to be armed with causality and direction of the relationship to aid their policymaking efforts.

3. Data and Methodology

3.1. Data source

The study examines the causal relationship between inflation and economic growth in Japan in a bivariate causality framework, where CPI is the proxy for inflation and GDP is the proxy of economic growth. Augmented Dickey Fuller (ADF) test is applied to test the stationarity of the time series data. The Johansen (1988) co-integration test examines the short-run and long-run relationship between inflation and real GDP while Granger causality test is employed to determine the causality between each pair of the variables. Data for Economic growth (GDP) and inflation (CPI) are obtained from various sources of UNCTAD Organization and Economic Survey of Japan. The sample range is 1980 to 2014, which comprises 35 observations. The variables incorporated in this research are Economic growth as an independent variable and Consumer price index as dependent variable.

3.2. Unit root tests

The first step involves testing the order of integration of the individual series under consideration. Researchers have developed several procedures for the test of order of integration. The most popular ones are Augmented Dickey-Fuller (ADF) test of Dickey and Fuller (1981). Augmented Dickey-Fuller test relies on rejecting a null hypothesis of unit root (the series are non-stationary) in favor of the alternative hypotheses of stationarity. The tests are conducted with and without a deterministic trend (t) for each of the series. The general form of ADF test is estimated by the following regression.
where Y is a time series, t is a linear time trend, Δ is the first difference operator, μ is a constant, p is the optimum number of lags in the dependent variable and ω is the random error term.

$$\Delta Y_t = \mu + \gamma Y_{t-1} + \sum_{j=1}^{p} \alpha_j \Delta Y_{t-j} + \beta_t + \omega_t \quad (1)$$

where Y is a time series, t is a linear time trend, Δ is the first difference operator, is a constant, p is the optimum number of lags in the dependent variable and is the random error term.

3.3. Johansen's procedure

After unit root has been confirmed for a data series, the next step is to examine whether there exists a long-run equilibrium relationship among variables. The existence of long-run equilibrium (stationary) relationships among economic variables is referred to in the literature as co-integration which is very significant to avoid the risk of spurious regression. The basic idea behind co-integration is that if, in the long-run, two or more series move closely together, even though the series themselves are trended, the difference between them is constant. It is possible to regard these series as defining a long-run equilibrium relationship, as the difference between them is stationary. A lack of co-integration suggests that such variables have no long-run relationship: in principal they can wander arbitrarily far away from each other (Dickey et al., 1991). We employ the VAR based on co-integration test using the methodology developed in Johansen (1991; 1995). Johansen's methodology takes its starting point in the Vector Auto regression (VAR) of order P given by:

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + Bx_t + u_t \quad (2)$$

where y_t is a *k*-vector of I(1) variables, x_t is a n-vector of deterministic trends, and u_t is a vector of shocks. We can rewrite this VAR as:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + Bx_t + u_t \tag{3}$$

where $\Pi = \sum_{i=1}^{p} A_i - 1, \Gamma_i = -\sum_{j=t+1}^{p} A_j$.

Trace Test Statistic

The trace test statistic can be specified as:

$$\tau_{Trace} = -T \sum_{i=r+1}^{k} \log(1-\lambda_i) \tag{4}$$

where, λ_i is the i th largest eigenvalue of matrix Π and T is the number of observations. In the trace test, the null hypothesis assumes that the number of distinct co-integrating vector(s) be less than or equal to the number of co-integration relations (r).

Maximum Eigenvalue Test

The maximum eigenvalue test examines the null hypothesis of exactly r co-integrating relations against the alternative of *r*+1 co-integrating relations with the test statistic:

$$\tau_{\mathrm{Max}} = -\mathrm{T}\log(1-\lambda_{\mathrm{r+1}}) \tag{5}$$

where λ_{r+1} is the $(r+1)^{th}$ largest squared eigenvalue. In the trace test, the null hypothesis of r=0 is tested against the alternative of r + 1 co-integrating vectors.

3.4. Granger causality test

An attempt has been made to reveal with this test in which direction goes the influence of one variable to another, i.e. whether x causes y, that is, whether x variable influences on the movement of y variable. Using Granger test we will go from the assumption that variables do not influence each other, we reject the hypothesis when the calculated value of F statistics is bigger than theoretical value. It is said that one variable influences the other if coefficients that stand with variable are statistically significant. It happens very often that two variables have mutual influence (Granger 1969).

3.5. Vector error correction model

Vector Error Correction Model (VECM) examines the dynamic adjustment of variables both in the long and short run to their equilibrium state. Short term dynamics which is a measure of deviation from steady state is determined by Error correction model. If the series are co-integrated, it means there is a long-term equilibrium relationship between them so VECM is applied in order to evaluate the short run of the co-integrated series. A negative and significant coefficient of the ECM (i.e. t-l) indicates that any short term fluctuation between variables will give rise to a stable long run relationship between the variables.

Consider the dynamic model:

$$y_t = \alpha y_{t-1} + \beta_1 x_t + \beta_2 x_{t-1} + e_t \qquad (6)$$

where y, x ~ I(1) and e ~ I(0).

In our model y=CPI and x=Economic growth.

4. Results and Findings

4.1. Unit root tests

Johansen co-integration analysis is used to analyze any long-term co-integration relationships between economic growth and CPI. Co-integration analysis is possible if the series are stationary, so in order to check whether series are stationary or not, unit root test of Augmented Dickey-Fuller (ADF) is conducted with the levels and first differences of each series on the condition that the null hypothesis is non-stationary, so rejection of the unit root hypothesis supports stationarity.

Table 1 shows the results of unit root test. It reveals that time series are non-stationary at levels. However, table shows that economic growth and CPI are stationary at 1st difference. Augmented Dickey Fuller unit root

Table 1. Results of augmented Dickey-Fuller test at level &1st difference

	Level						First difference					
	Intercept but no trend			Intercept and trend			Intercept but no trend			Intercept and trend		
Variables	Test Statistics	Critical Value (5%)	Prob.	Test Statistics	Critical Value (5%)	Prob.	Test Statistics	Critical Value (5%)	Prob.	Test Statistics	Critical Value (5%)	Prob.
GDP	-2.1169	-2.9604	0.0356	-3.1905	-3.5950	0.1081	-3.0431	-2.9571	0.0415	-3.9375	-3.5577	0.0218
CPI	-1.8230	-2.9718	0.3621	-1.8276	-3.5806	0.6641	-3.2936	-2.9540	0.0233	-3.6634	-3.5529	0.2571

Source: Data Analysis

analysis test reveals that errors have constant variance and are statistically independent. Therefore, co-integration test can be applied on these variables.

When Augmented Dickey-Fuller Test is conducted with the Level of series, the computed T-statistics (with no trend and with trend) for economic growth is -2.11 and -3.19 which is higher than the upper bound critical values of -2.96 and -3.59 respectively at the 5% significance level. This means that the null hypothesis of unit root is accepted. However, when CPI is the dependent variable, the null hypothesis of unit root is also accepted since the computed T-statistics for CPI is -1.8 and -1.82 with no trend and with trend, respectively, which is higher than the lower bound critical values of -2.97 (with no trend) and -3.58 (with trend) at the 5% significance level.

That means the economic growth and CPI series have a unit root problem and both series are a non-stationary series at levels. Hence Dickey-Fuller (ADF) has conducted with first differences of each series in order to check the unit root problem. (Table 1)

When Augmented Dickey-Fuller Test is conducted at 1^{st} difference of series, the computed T-statistics for economic growth are -3.04 (with no trend) and -3.93 (with trend) which are less than the lower bound critical values of -2.95 (with no trend) and -3.55 (with trend) at the 5% significance level (Table 1). So, the null hypothesis of unit root cannot be accepted, since the computed F-statistics for CPI is -3.2 (without trend) and -3.66 (with trend), which are also less than the lower bound critical values of -2.95 (with no trend) and -3.56 (with trend) at the 5% significance level. This means that the null hypothesis of unit root is rejected, which implies the first difference series of economic growth and CPI achieves stationarity. This is the pre-condition for co-integration test, that is, the variables are integrated of the same order. We, therefore, proceed to the co-integration test to obtain the number of co-integrating equation.

4.2. Johansen co-integration test

Consequently, Johansen co-integration test is used to determine whether there are any long-term co-integration relationships between economic growth and CPI in Japan or not. Two likelihood ratio tests are used, the Trace Test and the Maximum Eigen Value test, to determine the number of co-integrating vectors. The estimation for each series assumes linear deterministic trend unrestricted with intercepts and trends. A lag of 1 to 8 (in 1st differences) is used for each series, based on the Swartz Information Criterion (SIC).

Table 2. Johansen co-integration test

Unrestricted Co-integration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.457910	25.93323	15.494	0.0010
At most 1	0.159310	5.726549	3.8414	0.0167

Trace test indicates 2 co-integrating Eqn(s) at the 0.05 level
*Denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.457910	20.20668	14.264	0.0051
At most 1	0.159310	5.726549	3.8414	0.0167

Max-eigenvalue test indicates 2 co-integrating eqn(s) at the 0.05 level
* Denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Data Analysis.

The above table demonstrates the Johansen co-integration test results. It assures the long-term relationship among the selected variables. The result shows that the series is co-integrated, as both the trace and the maximum eigenvalue tests reject the null hypothesis of no co-integration. It reveals the trace statistics which indicates that there is (2) co-integrating equation between economic growth and CPI in Japan at 5%. Meaning that, they (the variables) move together in the long run. Under the Max-Eigen statistics as shown above, it indicates that there is (2) co-integrating equation between economic growth and CPI in Japan.

From the result, both trace statistic and maximum eigenvalue statistic indicated strong value 2 co-integrations (i.e., our Trace Statistic 25.93 is more than Critical Value 15.49) at the 5 percent level of significance, suggesting that there is long run co-integrating relationship between economic growth and CPI. When we talk about the Unrestricted Co-integration Rank Test here, also our results indicate long run relationship. Here our Max-Eigen Value (i.e. 20.20) is more than Critical Value (i.e. 14.26). Therefore, it may conclude that there exists a stationary, long-run relationship among the variables.

4.3. Granger causality test

Table 3 reveals that as the p-value is higher than 0.05 in the case of CPI to economic growth, hence null hypothesis cannot be rejected, which shows that there is bi-directional causality exists from (i) CPI and economic growth and the p-value is less than 0.05 in the case of economic to CPI, hence null hypothesis can be rejected and alternative hypothesis accepted, which means economic growth causes unidirectional causality from (ii) economic growth to CPI. It is important to note that the pronouncement of causality between the selected variables does not mean that movement in one variable actually causes movements in another variable. To a certain extent, causality basically entails in order of movements in the time series.

Table 3. Pairwise granger causality test results

Null Hypothesis	Obs.	F-Statistic	Prob.	Type of Causality
CPI does not Granger Cause ECONOMIC GROWTH	33	2.94479	0.0691	bi-directional causality
ECONOMIC GROWTH does not Granger Cause CPI	33	7.53714	0.0024	uni-directional causality

Source: Data Analysis

4.4. Vector error correction model

Existence of co-integration among economic growth and CPI gave rise to estimation of Vector Error Correction Model. The significance of the error correction term shows that the burden of short-run endogenous adjustment (to the long term trend) to bring the system back to its long-run equilibrium has to be taken by CPI variable. Relying on the presence of a co-integrating vector, the subsequent vector error correction model (VECM) can be written as follows:

$$\Delta GDP_t = \alpha_1 + \sum_{i=1}^{l} \Phi_1 \Delta CPI_{t-1} + \sum_{i=1}^{p} \xi_1 \Delta GDP_{t-1} + \Psi_1 ECT_{t-1} + \varepsilon_{1t} \qquad (7)$$

$$\Delta CPI_t = \alpha_2 + \sum_{i=1}^{l} \Phi_2 \Delta GDP_{t-1} + \sum_{i=1}^{p} \xi_2 \Delta CPI_{t-1} + \Psi_2 ECT_{t-1} + \varepsilon_{2t} \qquad (8)$$

where Δ is the first-difference operator, ε_{it} are the serially uncorrelated random error terms, ECT is the error correction term coming from the long-run co-integrating relationship, i.e. residuals, and Ψ_i is the adjustment coefficient indicating the weight of adjusted disequilibrium in the past. To get a long-run relationship among the variables the coefficient of Ψ_i should be statistically significant. In this parsimonious VEC model, the lag lengths could be equal to zero for the variables that are not also dependent variables. The coefficients of ECT_{t-1}, Ψ_1 to Ψ_5 capture the adjustments of Δ GDP and Δ CPI towards long-run equilibrium. The short-run causality relationships can be tested through the coefficients of each explanatory variable.

Tables 4 and 5 show the result of long run estimates. From the result, the model could not fit the observed data fairly well as indicated by the adjusted R^2 for CPI and economic growth as 0.253261 and 0.656525 respectively. The reason may be as a result of various abnormalities experienced within the economic fluctuations. It may also imply that the economic growth alone may not be considered as enough to indicate consumer price index position of Japan because other exogenous variables such as real exchange rate, terms of trade, foreign exchange reserves, real interest rate, consumption growth, fiscal deficit, and output growth also influences a lot to Consumer price index, which is omitted here.

Table 4. The result of vector error correction model showing the long run effects

Variables	Coefficient	Standard Error	t-value
ECONOMIC GROWTH (-1)	1.0000		
CPI (-1)	-8.534988	(0.78097)	(10.9286)
C	23.93892		

Source: Data Analysis

Table 5. The result of vector error correction model showing the short run effects

Error Correction	D (ECONOMIC GROWTH)	D (CPI)
Coint. Eq.1[ECM (-1)]	-0.119877	0.034312
	(0.11310)	(0.00829)
D[ECONOMIC GROWTH (-1)]	0.388116	-0.041324
	(0.17368)	(0.01273)
D[ECONOMIC GROWTH (-2)]	0.054634	-0.015027
	(0.22589)	(0.01656)
D[CPI (-1)]	0.347195	0.587030
	(0.22589)	(0.01656)
D[CPI (-2)]	3.151784	0.058898
	(1.92437)	(0.14110)
Constant	-0.003312	0.004879
	(0.02388)	(0.00175)
R-squared	0.373703	0.711924
Adj. R-squared	0.253261	0.656525
Sum sq. resids	0.248444	0.001336
S.E. equation	0.097752	0.007167
F-statistic	3.102770	12.85080
Log likelihood	32.32637	115.9387
Akaike AIC	-1.645398	-6.871168
Schwarz SC	-1.370573	-6.596342
Mean dependent	0.044146	0.006621
S.D. dependent	0.113121	0.012230

Note: Standard error in parenthesis

Source: Data Analysis

The error correction coefficient is (0.119877). It carries the expected negative sign, significant at 5% level and less than one which is appropriate. The coefficient indicates a feedback of about 11.9% of the previous month's disequilibrium in consumer price index which is due to long run deviations in economic growth. From the analysis through VECM values, it is deduced that economic growth and Consumer price index are more co-integrated.

5. Conclusion

The increased economic globalization has resulted in higher economic growth in Japan in last two decades. In this study, we examined the existence of long run relationship between economic growth and CPI in Japan during the last thirty five years (1980-2014).The analysis started with stationary property examination of the underlying time series data. The estimated results confirmed that economic growth and CPI are non-stationary at the level but stationary at the first differences. Hence, they are integrated of order one. The Johansen's multivariate co-integration test evidence from the result suggests that the null hypothesis of no co-integration (r=0) is rejected which indicates that economic growth and CPI are co-integrated and thus exhibit a reliable long run relationship.

Having found co-integration among the variables (economic growth and CPI), we also carried out the Granger-causality using VAR. The result shows the existence of unidirectional causality between economic growth and consumer price index and bidirectional causality between CPI and economic growth. This long run equilibrium relationship is based upon a unidirectional causal relationship, running from economic growth to consumer price index. The above findings clearly indicate that economic growth plays an important role to deciding the consumer price index, both directly and indirectly. The VECM results indicate that there is long term causality between the economic growth and CPI in the Japan.

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