E C O N O M I C S B U L L E T I N

Does the "Phillips Curve" Really Exist? New Empirical Evidence from Malaysia

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Abstract

The hypothesized trade-off relationship between inflation rate and unemployment rate has been known as the "Phillips curve". Though the Phillips curve has played an important role in the decision-making process on macroeconomic policy, there have been critics who doubted the existence of the "Phillips curve". Despite a number of studies on the Phillips curve, there has been a lack of research that probed the hypothesis in the developing countries' context. This paper chooses Malaysia as a case study to empirically examine the relationship between inflation rate and unemployment rate. The most interesting finding of this paper is the existence of a long-run and trade-off relationship – and also causal relationship -- between the unemployment rate and the inflation rate in Malaysia. In other word, this paper has provided an empirical evidence to support the existence of the Phillips curve in the case of Malaysia.

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1. Introduction

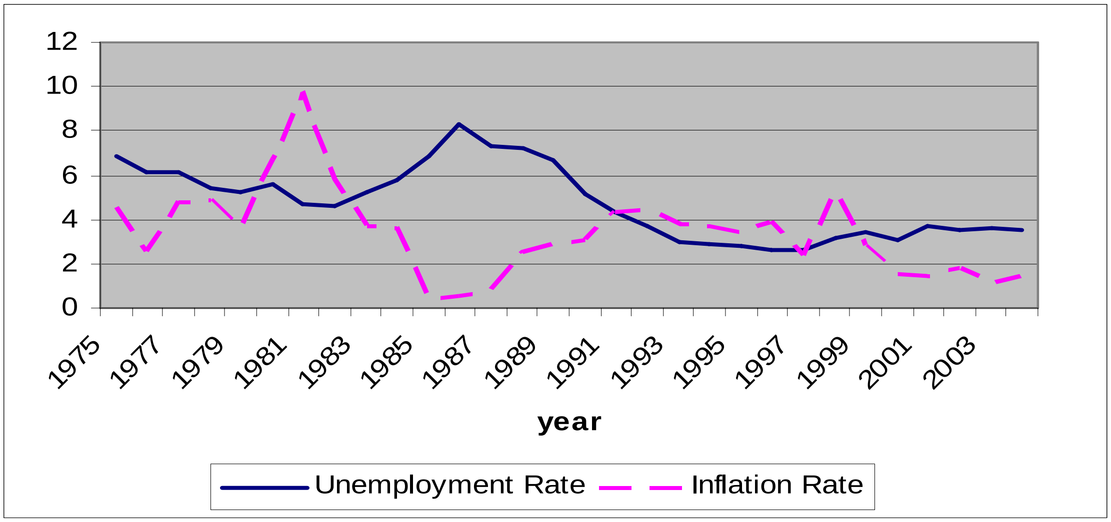
In 1958, William Phillips proposed that there existed a trade-off relationship between unemployment and inflation in the United Kingdom. Since then, the inverse relationship between unemployment and inflation has been known as the “Phillips curve”. Although some criticisms have been voiced regarding the basic assumptions of this hypothesis, the Phillips curve remains one of the most important foundations in macroeconomics. It has been half a century since Phillips propounded his idea, and the subject of “Phillips curve” has captivated the minds of many researchers and engendered numerous academic inquiries.

Besides having a theoretical importance, the Phillips curve carries important political implications. It is a fact that one of the main policy targets of central banks is the price stabilisation through inflation control. Central banks tend to develop their monetary policies in such a way that would enable them to keep inflation as low as possible. However, the dilemma is that if there exists an inverse relationship between inflation and unemployment, the central banks would be able to maintain low inflation rates only by the means of high unemployment. Thus, the hard choice would be between having a combination of low-inflation and high-unemployment or *vice versa*. In this context, the Phillips curve has remained an important consideration for decision-makers and the central banks.

Despite the availability of numerous studies on the Phillips curve, there is still a lack of systematic empirical analysis that examines the hypothesis in the context of a developing country as the majority of research had focused on the developed nations. Considering important economic and political implications that the Phillips curve hypothesis entails, the current inquiry chooses Malaysia as a case study to analyse the relationship between unemployment rate and inflation rate. This study uses several econometric analyses to probe the workings of the Phillips curve in Malaysia. The main research question of the present study is “Whether there exists a trade-off relationship between unemployment and inflation in Malaysia?”

The relationship between unemployment rate and inflation rate in Malaysia is an interesting example. There has been an inverse relationship between unemployment rate and inflation rate. In the 1970s, unemployment rate in Malaysia was above 5 percent (see Figure 1). In 1981 and 1982 it became lower than 5 percent. Since 1983, unemployment rate gradually increased and reached 8.7 percent in 1987. However, since 1988, unemployment rate kept decreasing due to the economic boom in the country and amounted to 2.6 percent in 1997. From 1998 to 2004, unemployment rate remained moderate at approximately 3.5 percent.

Figure 1: Unemployment and Inflation in Malaysia (1975-2004)



Compared to unemployment rate, there have been greater fluctuations in inflation rate in Malaysia between 1975 and 2004. In the second half of the 1970s, Malaysia's inflation rate was approximately 4 percent. In 1980, the inflation rate increased and reached 6.6 percent, and increased further to 9.7 percent in 1981. However, since 1982 inflation rate kept decreasing and amounted to less than 1 percent in 1985. In the first half of the 1990s, inflation rate was stable at approximately 4 percent. Due to the Asian economic crisis of 1997, inflation rate in Malaysia increased to 5.2 percent in 1998. From 2000 to 2004, inflation rate stabilized and remained approximately 1.5 percent.

This paper consists of five sections. Following this Introduction, Section 2 briefly reviews some previous research studies on the Phillips curve. Section 3 discusses research methodology used in the current inquiry to analyse the relationship between unemployment and inflation. Section 4 reports and discusses research findings. Concluding remarks are offered in Section 5.

2. Literature Review

William Phillips published his seminal work entitled "The Relationship between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom 1861-1957" in 1958. According to Phillips, there was a strong negative association between unemployment and inflation in the country during the period covered in his study. This trade-off relationship identified by Phillips is known as the Phillips curve. Since William Phillips made this pronouncement in the end of the 1950s, numerous research studies have been done with the aim of either confirm or refute his proposition.

Paul Samuelson and Robert Solow were among the first researchers who supported the Phillips hypothesis. Samuelson and Solow (1970) examined the relationship between the two macroeconomics variables in the context of the United States. The results led to a conclusion that there existed an inverse relationship between unemployment and inflation rates in the USA. Furthermore, Solow (1970) and Gordon (1971) confirmed the existence of a negative trade-off relationship between unemployment and inflation using U.S. macroeconomic data. These empirical findings have been known as the "Solow-Gordon affirmation" of the Phillips curve.

Although William Phillips based his hypothesis on a strong theoretical foundation, the debate on whether the Phillips curve really exists dates back to the 1960s. As Islam *et al.* (2003: 107) note, "Since its inception, the Phillips curve hypothesis has been open to debates". For example, Milton Friedman (1968) and Edmund Phelps (1967) openly criticised the hypothesis and maintained that there is no trade-off relationship between unemployment and inflation.

Furthermore, Robert Lucas (1976) strongly opposed the proposition of the existence of the Phillips curve. He argued that there could have existed a trade-off relationship between unemployment and inflation if the workers did not expect that the policy makers would try to create an artificial situation where high-inflation is pared with low-unemployment. Otherwise, the workers would foresee the high inflation in the future and would demand wage increase from their employers. In this case, there could be co-existence of high unemployment and high inflation rate which is known as the "Lucas critique".

In the 1970s, economists began to loose interest in doing research on the Phillips curve. As Debelle and Vickery (1998:384) commented, "The Phillips curve fell into a period of neglect in academic circles during the 1980s, while remaining an important tool for policy makers". However, the 1990s witnessed a revival of the academic interest in the Phillips curve and "the Phillips curve has again been the subject of intensive debate (for example, the symposium in the *Journal of Economic Perspectives)"* (Debelle and Vickery, 1998:384).

Generally, empirical finds have shown the mixed results. Some researcher found the significant trade-off relationship between unemployment rate and inflation rates and other does not. Among research studies done in the 1990s, Alogoskoufis and Smith (1991) show the empirical evidence to support the "Lucas critique" which denied the existence of trade-off relationship. By contrast, King and Watson (1994) tested the existence of the Phillips curve using the U.S. post-war macroeconomic data. Their findings provided empirical support to the existence of the trade-off relationship between unemployment and inflation in the USA over the researched period. King and Watson (1994) concluded that there could exist Phillips curve if long-run and short-run noise are eliminated from the data

Hogan (1998) examined the Phillips curve using the U.S. macroeconomic data from 1960 to 1993. Results of that study revealed there had been a significant and negative relationship between unemployment and inflation although the Phillips curve appeared to over-predict the rate of inflation. Hansen and Pancs (2001) examined the existence of the Phillips curve in Lativa. They also found out that there is a significant correlation between the unemployment rate and the actual inflation rates.

Furthermore, Faridul Islam *et al.* (2003) examined the hypothesis of Philips curve through US economic data from 1950 to 1999. They found out the weak long-run co-integrating relationship and long-run causality between unemployment and inflations. They agued that "the U.S stabilization policy should still be able to exploit the trade-off relationship between the unemployment rate and the inflation rates". On the other hand, Hart (2003) tested the Phillips hypothesis by employing the hourly wage earning. He concludes that during inter-war period (1926-66) in Britain, the Phillips curve is "not supported by our data".

A recent methodological innovation in the studies assessing the Phillips curve has been the use of panel data analysis to analyse a "common" Phillips curve in different countries. For example, John DiNardo and Mark Moore (1999) used panel data analysis to examine 9 member countries of the Organisation for Economic Co-operation and Development (OECD). The researchers used the method of Ordinary Least Squares (OLS) and Generalised Least Squares (GLS). Their findings confirmed the existence of the "common" Phillips curve in these OECD countries. As DiNardo and Moore concluded, "In sum, we believe that our results show a remarkable robust relationship between relative inflation and relative unemployment".

Turner and Seghezza (1999) also employed the panel data method. They examined the Phillips curve in 21 OECD countries over the period from the early 1970s to 1997. To analyze the pooled data, Turner and Seghezza used the method of Seemingly Unrelated Estimation (SURE) rather than the OLS. The researchers concluded that the overall result provided a "strong support" for the existence of the "common" Phillips curve among the 21 chosen member countries of OECD.

Arratibel *et al.* (2002) analyzed New Keynesian Phillips curve with forward-looking expectations by using panel data. They found that the unemployment rates have significant relationship with non-tradable inflation rates. By contrast, Masso and Staehr (2005) used the dynamic panel data method and failed to identify a significant relationship between unemployment rate and inflation rates.

3. Research Methodology

The current study uses Vector Error Correction Model (VECM) analysis to test the existence of the Phillips curve in Malaysia for the period from 1973 to 2004. Three separate econometric methods are used in this research, i.e., 1) unit root test, 2) Johansen cointegration test, and 3) Granger causality based on the VECM. The simple Phillips curve could be estimated by using following equation:

$$IFR_t = \alpha_0 + \beta_1 UER_{t-1} + \varepsilon_t, \qquad (1)$$

where α_0 is constant and β_1 is slop coefficient. IFR_t is inflation rate in Malaysia in the year t, UER_t is the unemployment rate in Malaysia in the year t and ε_t is the error term On the other hand, incorporating natural rate of unemployment into the model, the "standard" Phillips curve could be expressed

$$IFR_t = \alpha\ (L)\ IFR_{t-1} + \beta\ (L)\ (UER_t - NUER_t) + \varepsilon_t, \qquad (2)$$

where $\alpha\ (L)$ and $\beta\ (L)$ are polynomials in the lag operation, $NUER_t$ is natural rate of unemployment or NAIRU (non-accelerating rate of unemployment) in Malaysia in the year t, and. According to Debelle and Vockery (1998), "most of the existing theoretical and empirical literatures" have been based on the equation 2. The equation could be modified as:

$$IFR_t = \alpha\ (L)\ IFR_{t-1} + \beta\ (L)\ UEG_t + \varepsilon_t, \qquad (3)$$

where UEG_t is the "unemployment gap" (i.e. the actual unemployment rate minus natural rate of unemployment rate). Support for the Phillips curve would require negative and significant coefficients for the unemployment gap. The empirical analysis will be based on the equation 3.

In the first stage of the study, in order to assess the Phillips curve in Malaysia, unit root test is used to examine the stationarity of data sets. The current paper uses the augmented Dickey-Fuller (ADF) unit root test to investigate the stationarity (Dickey and Fuller 1979, 1981). The ADF test is based on the following regression,

$$\Delta y_t = \mu + \beta_{t-1} t + \sum_{i=1}^{n} \gamma_i \Delta y_{t-i} + \varepsilon_t \qquad (4)$$

where t is a linear time trend, Δ is the difference operator. β and γ are slop coefficients. ε_t is the error term. The ADF tests tend to be sensitive to the choice of lag length n which is determined by minimising the Akaike information criterion (AIC) (Akaike 1974).

The AIC criterion is defined as:

$$AIC(q) = T \ln\left(\frac{RRS}{n-q}\right) + 2q \qquad (5)$$

where T is the sample size, RRS is the residual sum of squares, n is lag length, q is the total number of parameters estimated.

In the second stage, this study would employ the Ordinary Least Squares (OLS) regression model if the variables are integrated of order zero. On the other hand, if the variables are integrated of order one, the Johansen cointegration test would be used to check the long-run movement of the variables (Johansen 1988, 1991). The Johansen cointegration test is based on maximum likelihood estimation of the K-dimensional Vector Autoregressive (VAR) model of order p,

$$Z_t = \mu + A_1\ \Delta Z_{t-1} + A_2\ \Delta Z_{t-2} + \ldots A_{k+1}\ \Delta Z_{t-p+1} + \varepsilon_t \qquad (6)$$

where Z_t is a $k \times 1$ vector of stochastic variables, μ is a $k \times 1$ vector of constants, A_t is $k \times k$ matrices of parameters, and ε_t is a $k \times 1$ vector of error terms. The model could be transformed into an error correction form:

$$\Delta Z_t = \mu + \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \ldots \Gamma_{k+1} \Delta Z_{t-p+1} + \pi Z_{t-1} + \varepsilon_t \quad (7)$$

where π and $\Gamma_1 \ldots, \Gamma_{k+1}$ are $k \times k$ matrices of parameters. On the other hand, if the coefficient matrix π has reduced rank, $r < k$, then the matrix can be decomposed into $\pi = \alpha\beta'$. The Johansen cointegration test involves testing for rank of π matrix by examining whether the eigenvalues of π are significantly different from zero. There could be three conditions: 1) $r = k$, which means that the Z_t is stationary at levels, 2) $r=0$, which means that the Z_t is the first differenced Vector Autoregressive, and 3) $0<r<k$, which means there exists r linear combinations of Z_t that are stationary or cointegrated.

For example, if r is equal to 1, then the relationship between the variables could be written as:

$$\begin{bmatrix} \Delta IFR_t \\ \Delta UEG_t \end{bmatrix} = \begin{bmatrix} \mu_1 \\ \mu_2 \end{bmatrix} + \sum_{i=1}^{k-1} \begin{bmatrix} \Gamma_{i,11} \, \Gamma_{i,12} \\ \Gamma_{i,21} \, \Gamma_{i,22} \end{bmatrix} \begin{bmatrix} \Delta IFR_{t-i} \\ \Delta UEG_{t-i} \end{bmatrix} + \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} [\beta_1 \, \beta_2] \begin{bmatrix} \Delta IFR_{t-1} \\ \Delta UEG_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \end{bmatrix} \quad (8)$$

The vector β represent the r linear cointegrating relationship between the variables. The current study uses the Trace (Tr) eigenvalue statistics and Maximum (L-max) eigenvalue statistics (Johansen 1988; Johansen and Juselius 1990). The likelihood ratio statistic for the trace test is:

$$Tr = -T \sum_{i=r+1}^{p-2} \ln(1 - \hat{\lambda}_i) \quad (9)$$

where $\hat{\lambda}_{r+1}, \ldots\ldots\ldots, \hat{\lambda}_p$ are the smallest eigenvalues of estimated $p - r$. The null hypothesis for the trace eigenvalue test is that there are at most r cointegrating vectors. On the other hand, the L-max could be calculated as:

$$L - \max = -T \ln(1 - \hat{\lambda}_{r+1}) \quad (10)$$

The null hypothesis for the maximum eigenvalue test is that r cointegrating vectors are tested against the alternative hypothesis of $r+1$ cointegrating vectors. If trace eigenvalue test and maximum eignevalue test yield different results, the results of the maximum eigenvalue test should be used because power of maximum eigenvalue test is considered greater than the power of the trace eigenvalue test (Johansen and Juselius 1990).

Table 1: Johansen Test Model Specification

	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept in CE	No	Yes	Yes	Yes	Yes
Intercept in VAR	No	No	Yes	Yes	Yes
Linear Trend in CE	No	No	No	Yes	Yes
Linear Trend in VAR	No	No	No	No	Yes

CE denotes cointegrating equation, VAR denotes Vector Autoregression

Among major problems of the Johansen cointegration test is that the test statistics are very sensitive to the choice of model specification and the lag length. As shown in Table 1, five (5) different model specifications are used for the Johansen cointegration test.

The optimal model specification and the lag length are determined by minimising the Akaike information criterion (AIC) (Akaike 1974). In the third stage, this study runs the Granger-causality test based on the following the VECM:

$$\Delta(IFR)_t = b_1 + \sum_{i=1}^{n} b_{2i}\Delta(UEGt-i) + \sum_{i=1}^{n} b_{3i}\Delta(IFRt-i) + b_4 ECT_{t-1} + \varepsilon_t \qquad (11)$$

where u_{t-1} is the lagged error correction term.

This paper uses the Granger-causality test based on the VECM. There are two advantages to using this method rather than the standard Granger causality test. First of all, the Wald test of the independent variables indicates the short-run causal effect. Secondly, significant and negative error correction term (ECT_{t-1}) indicates the long-run causal effects.

4. Empirical Results

Prior to the empirical analysis, the natural rate of unemployment or NAIRU. The NAIRU could be estimated from the regression of the percentage change in the inflation (CIFR) on the unemployment (UER). The estimated regression equation is:

CIFR = 0.86 – 0.24UER

According to the regression line, the natural rate of unemployment is approximately 3.6 percent. Thus, the unemployment gap (UEG) could be estimated from unemployment rate minus natural rate of unemployment rate (3.6 percent). The ADF root test was conducted in order to examine the stationarity of the variables. The results from the ADF test are shown in Table 2.

Despite minor differences in the findings as reported in the table, the obtained results indicate that the two variables -- *UEG* and *IFR* -- are integrated of order one, I(1).

Table 2: ADF Unit Root Test

	Levels		First Difference	
	Constant without trend	Constant with trend	Constant without trend	Constant with trend
IFR	-1.291(9)	-0.539(9)	-5.639 (0)**	-5.920(0)**
UEG	-1.373(4)	-2.086(6)	-4.818 (0)**	-4.750(0)**

Notes: Figures in parentheses indicate number of lag structures
** indicates significance at 1% level
* indicates significance at 5% level

In the second stage, the Johansen cointegration test was used to test the long-run movement of the variables. As Engle and Granger (1987) pointed out, only variables with the same order of integration could be tested for cointegration. As such, in the present study, both variables could be examined for cointegration.

First of all, the Akaike Information Criterion (AIC) was used to determine optimal lag length selection while maximum lag length is set for three (3). Table 3 shows that optimal lag length for the Johansen cointegration test is one (1), which minimises the AIC.[1]

Table 3: Optimal Lag Length Selection for the Johansen Test (Maximum Lag Length=3)

Lag Length	AIC
0	8.070
1	5.904*
2	6.040
3	6.016

AIC denotes the Akaike Information Criterion
*indicates optimal lag length selected by the AIC

Secondly, the AIC was used again to determine the most appropriate model specification for the Johansen cointegration test. As Table 4 shows, the best model specification is Model 4 and number of cointegrating equation is one (1).

Table 4: Optimal Model Specification Selected by the Akaike Information Criterion

	Model 1	Model 2	Model 3	Model 4	Model 5
Number of CEs = 0	7.074	7.074	7.118	7.118	7.173
Number of CEs = 1	6.422	6.368	6.415	5.941*	6.008
Number of CEs = 2	6.636	6.621	6.621	6.129	6.129

CE denotes cointegrating equation
*indicates optimal model selection selected by the AIC

[1] Sewa (1978) argues that Akaike Information Criterion could choose the models of higher order than the true model. However, Sewa points out that this bias could be negligible when the selected lag length is less than (N/10), where N equals numbers of observation.

Results of the cointegration tests are reported in Table 5 and Table 6. Both the Trace Eigenvalue test and the Maximum Eigenvalue test indicate one cointegrating equation. The findings indicate that there exists the long-run relationship between the two variables (i.e., *UEG* and *IFR*), which means that these variables are co-integrated.

Table 5: The Johansen Cointegration Test (Trace Eigenvalue Statistic)

Eigenvalue	Trace statistic	5 percent critical value	1 percent critical value	Number of co-integrating equations
0.779	49.66	25.32	30.45	None**
0.135	4.36	12.25	16.26	At most 1

The result corresponds to VAR's with one lag
** indicates significance at 1% level

Table 6: The Johansen Cointegration Test (Maximum Eigenvalue Statistic)

Eigenvalue	Max statistic	5 percent critical value	1 percent critical value	Number of co-integrating equations
0.779	45.30	18.96	23.65	None**
0.135	4.36	12.25	16.26	At most 1

The result corresponds to VAR's with one lag
** indicates significance at 1% level

In other words, although the variables are not stationary at levels, in the long run, they closely move with each other. Long-run cointegration when the variables are normalised by cointegrating coefficients could be expressed as:

$$IFR = -0.913 \ln UEG - 0.232 \text{ Trend}$$

This cointegrating vector equation indicates that there exists a negative long-run relationship between inflation rates and unemployment rates. These results support the existence of a trade-off relationship between inflation rate and unemployment rate. In other words, the findings reveal that Malaysia represents a textbook example of the Phillips curve workings where unemployment rate and inflation rate have the inverse relationship.

Finally, the Granger-causality method based on the VECM was employed to examine the long-run and short-run casual relationships between the two variables. Firstly, the Akaike Information Criterion was used to determine the optimal length for the causality test. As Table 7 shows, optimal lag length for causality test is two (2) which minimises the AIC.

Table 7: Optimal Lag Length Selection for Causality Test (Maximum Lag Length=3)

Lag Length	AIC
0	4.890
1	4.104
2	3.829*
3	4.012

AIC denotes the Akaike Information Criterion
*indicates optimal lag length selected by the AIC

Next, results of the Wald Test and t-tests are reported in Table 8. The findings show that the error correction term (ECT_{t-1}) is statistically significant and negative. This means that there is a long-run Granger causality between the inflation rate and unemployment rate. In other words, the long-run Granger causality *does* confirm the existence of the long-run equilibrium relationship between unemployment rate and inflation rate in Malaysia as indicated in the Johansen cointegration test.

Table 8: Granger-Causality Test based on VECM
Dependent Variable: Δ*IFR*

Variable	**Degree of Freedom**	**Wald Test Statistics**
Δ*UEG*	2	5.002*
	Coefficient	**t-statistic**
ECT_{t-1}	-0.359	-2.614**

Note: To test for causality when variables are co-integrated, the following Granger causality test based on the VECM could be used:

$$\Delta(IFR)_t = b_1 + \sum_{i=1}^{n} b_{2i}\Delta(UEGt-i) + \sum_{i=1}^{n} b_{3i}\Delta(IFRt-i) + b_4 ECT_{t-1} + \varepsilon_t$$

1) Short-run causality: the joint significance of the coefficients is determined by the Wald Test
2) Long-run causality: the level of significance for error correction term (ECT_{t-1}) is determined by the t-statistics.

The result corresponds to VAR's with six lags
** indicates significance at 5% level
* indicates significance at 10% level

As the results of the Wald test indicate, the Granger causality between the variables is detected in the short-run. This means that there was causal relationship between unemployment rate and inflation rate over short periods of time in Malaysia. In other words, Malaysia's unemployment rate *does* "Granger cause" inflation rate in the short-run.

In a nutshell, empirical findings of the present study show that there is a long-run relationship – and also causality -- between Malaysia's unemployment rate and inflation rate. These findings provide an additional empirical support to the existence of the Phillips curve in the context of a developing country, which is the main finding of the empirical analysis done in this study.

5. Concluding Remarks

The existence of a negative relationship between unemployment and inflation proposed by William Phillips has become an important foundation for the macroeconomic management. Taking into consideration an intense debate that the original hypothesis by Phillips has engendered and a fact that the majority of the previous research studies on the Phillips curve have been conducted in the context of the developed economies, the current study's aim was to conduct an empirical analysis to assess the relationship between unemployment rate and inflation rate in the Malaysian context. Three different methods were employed in this paper to examine the relationship between the two variables.

Since the unit root tests indicated that inflation rate could be considered as integrated of order one and unemployment rate could be considered as integrated of order one, the study proceeded using the Johansen cointegration methods to examine the long-run relationship between unemployment and inflation.

The findings of the current research showed that there existed the cointegrating relationship – as well as causal relationship -- between inflation rate and unemployment rates in Malaysia. In other words, the current study offered an additional empirical support for the existence of the Phillips curve. These findings encourage a closer look at the existence of the Phillips curve in other Asian countries, such as Thailand, Singapore, Indonesia, etc. Assessing the existence of the Phillips curve in other Asian economies could be insightful because different socio-economic backgrounds of the Asian countries could influence the relationship between unemployment rate and inflation rate in each particular country.

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