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Phillips curves and openness: New evidence from selected Asian economies

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Abstract

This paper chooses three Asian countries (Japan, South Korea and Malaysia) as case studies to examine the relationship between the Phillips curve and openness. The justification for the choice of these countries is that Japan is a moderately open economy while Malaysia is a highly open economy. South Korea is in-between these two extremes. The main finding of the present study is that as a country opens up to global market by increasing the amount of imports, the slope coefficient of the Phillips curve becomes smaller. In other words, the findings suggest that the Phillips curve tends to be flatter in more open economies.

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1. Introduction

N. Gregory Mankiw chose the tradeoff between inflation and unemployment as a topic for his Harry Johnson Lecture, which was subsequently published in *The Economic Journal* in 2001. In the lecture, Mankiw mentioned that one of ten fundamental principles of economic science is that "Society faces a short-run trade-off between inflation and unemployment". As Mankiw (2001) commented, "The tradeoff is inexorable because it is impossible to make sense of the business cycle, and in particular the short-run effects of monetary policy, unless we admit the existence of a tradeoff between inflation and unemployment". He recognized, though, that some economists believe that "the inflation-unemployment tradeoff was still a speculative idea" and that the tradeoff remains "mysterious" because "the economic profession has yet to produce satisfactory theory to explain it" (Mankiw 2001).

To add a new twist to the mystery, the tradeoff relationship between inflation and unemployment or the so-called "Phillips curve" has been more often estimated under the settings of "closed economy". More recently, some pioneer studies have examined the relationship between openness and the Phillips curve in open economy settings. However, no consistent empirical evidence has been produced to explain and clarify this intricate relationship, thus adding a new inflation-unemployment puzzle.

The Phillips curve remains a solid foundation for macroeconomic theory. As Hart (2003, 108) observed, "The Phillips curve still plays a prominent role in macroeconomic theory and associated empirical work". Nevertheless, it has attracted quite harsh criticisms from groups of scholars belonging to the "monetarist" and the "neoclassical economics" schools of thought. Considering these facts, the present paper attempts to provide an additional insight into the topic and examines the relationship between the Phillips curve and openness. It chooses three Asian countries (i.e. Japan, South Korea and Malaysia) as case studies to analyse the Phillips curves in the settings of open economy.

The justification for the choice of these countries is as follows: Japan is a moderately open economy while Malaysia is a highly open economy. South Korea can be located somewhere in-between these two extremes. Further, Japan is an industrial state which has relatively strong manufacturing and services sectors. This means that Japan is a self-sufficient and moderately open economy where the share of imports in its Gross Domestic Product (GDP) constitutes about 10 percent.

On the other hand, Malaysia, a former British colony, represents a typical developing country which has strong international trade linkages with other countries. Beginning from the 1980s, Malaysia has made considerable efforts to further open up the economy by welcoming foreign investments. As a result of a string of successful policies, Malaysia has become a highly open economy with the share of imports exceeding 70 percent in the country's GDP.

South Korea is a wealthy developing nation. Its economy has an interesting mix of traits of an industrial state and a developing country. Imports constitute approximately 30

percent of South Korea's GDP.
The present paper consists of five sections. Following this Introduction, Section 2 offers a brief literature review of the studies on the Phillips curve while Section 3 outlines the theoretical considerations and introduces the research method. Empirical findings are reported and discussed in Section 4. Section 5 offers concluding remarks.

2. Literature review

William Phillips put forward the hypothesis of a negative relation between inflation and unemployment in 1958 (Phillips 1958). This hypothesis has been tested and empirically confirmed by Samuelson and Solow (1960) and Gordon (1971). The confirmation is now known as the "Solow-Gordon confirmation". However, economist who belonged to the different schools of economic thought meted out harsh criticisms of the hypothesis (see Friedman 1968, Lucas 1976, Phelps, 1967). Because of these criticisms, in the 1980s, the Phillips curve was largely ignored by the economists and policy-makers.

In the 1990s, there occurred a revival of interest in the Phillips curve research and the topic again became "the subject of intensive debate (for example, the symposium in the *Journal of Economic Perspectives)*" (Debelle and Vickery 1998, 384). Among numerous research studies, King and Watson (1994) tested the Phillips curve hypothesis using U.S. post-war macroeconomic data. Their findings provided empirical support to the existence of the trade-off relation between unemployment rate and inflation rate in the United States. A study by Hogan (1998) examined the Phillips curve using U.S. macroeconomic data for the period from 1960 to 1993. The findings of the study supported the existence of a significant and negative relationship between unemployment and inflation although the traditional Phillips curve seemed to over-predict the rate of inflation.

Recent methodological innovations allow a more thorough examination of the Phillips curve. For example, some researchers have employed panel data analysis to test the "common" Phillips curve in different countries over the same period of time. DiNardo and Moore (1999) examined 9 OECD (Organisation for Economic Co-operation and Development) member countries and confirmed the existence of the "common" Phillips curve in these countries. Turner and Seghezza (1999) employed the panel data method to examine the Phillips curve in 21 OECD countries over the period from the early 1970s to 1997. The researchers concluded that the overall result provided a "strong support" for the existence of the "common" Phillips curve among the 21 OECD member countries.

Shadman-Mehta (2001) re-evaluated the trade-off relationship between inflation and unemployment using UK data for the period from 1860 to 1999. The researcher concluded that the wage equation cannot be inversed to determine the unemployment rate. Islam et al. (2003) examined the Phillips curve hypothesis in the context of the United States economy over the period 1950-1999. They found out that inflation rate and unemployment rate were weakly cointegrated and the long-run causality was unidirectional from the unemployment rate to the inflation rate. As Islam *et al*. (2003, 111) concluded, "This study, thus, affirms that the long-run Phillips curve relation still holds, although in weak form".

Several researchers have made attempts to empirically examine the output-inflation tradeoff or the Phillips curve in the open economy settings. For example, Temple (2003) tested Romer's hypothesis about a lower sacrifice ratio (the steeper slope of the Phillips curve) in more open economies. However, the findings of the study yielded weak empirical evidence for the existence of a negative correlation between openness and the sacrifice rate which led Temple (2003) to a conclusion that the study provided little support for this theoretical predication.

Loungani, Razin and Yuen (2001) tested openness and the output-inflation tradeoff by choosing the extent of capital control as a proxy of openness. According to their findings, in the countries with greater restrictions on capital mobility, a given reduction in the inflation rate is associated with a smaller loss in output. In other words, the results indicated the existence of a negative relationship between the degree of openness and the sacrifice ratio.

A review of literature on this topic was done by Wynne and Kersting (2007). According to the researchers, the theory suggests that there should be a negative relationship between openness and the inflation rate, and that the Phillips curve should be steeper in more open economies. However, as Wynne and Kersting (2007) pointed out, the empirical results obtained in various studies on the topic could not yield consistent results.

3. Theoretical Considerations and Research Method

In his seminal paper, David Romer (1993) pointed out that openness can affect the trade-off relationship between output and inflation. He argued that unanticipated monetary shocks affect both prices and real output. In his theoretical model, the difference between actual output and the "natural" rate of output is positively related with difference between actual inflation and expected inflation (Romer 1993, 872). This relation can be expressed by:

$$y - y^* = \beta\,(\pi - \pi^e) \tag{1}$$

where β is slope coefficient, y is actual output, y^* is the natural rate or equilibrium value of output, π is inflation rate, and π^e is expected inflation rate.[1] Romer (1993, 873) argued that a greater degree of openness raises the amount of inflation associated with a given expansion of domestic product and reduces the parameter β in equation (1). Therefore, equation (1) can be rearranged into:

$$\pi - \pi^e = 1/\beta\,(y - y^*) \tag{2}$$

Furthermore, $1/\beta$ can be replaced by $-\gamma$ while the "output gap" (i.e., $y - y^*$) can be replaced by the "unemployment gap" (i.e., $u–u_n$) or the difference between actual unemployment (u) and the natural rate of unemployment (u_n):

$$\pi - \pi^e = -\gamma\,(u–u_n) \tag{3}$$

[1] A more comprehensive model specification will include persistence effects (i.e. $y_{t-1} - y^*_{t-1}$).

where γ is slope coefficient which can be considered as the slope of the Phillips curve.

This paper examines the relationship between the Phillips curve and openness in three Asian countries, such as Japan, South Korea, and Malaysia for the period from 1980 to 2005. All the data were obtained from the World Development Index 2007 produced by the World Bank.

In the present paper, openness is measured by the percentage of imports of goods and services in total amount of Gross Domestic Product (GDP). This study estimates the slope of the Phillips curve in the following three steps: 1) unit roots tests, 2) estimation of natural rate of unemployment, and 3) estimation of the Phillips curve slope.

First of all, a standard stationarity test, i.e. the augmented Dickey-Fuller (ADF) unit root test, is employed in this paper to examine the stationarity of date series. Dickey and Fuller (1979) suggested a unit root test based on the following regression,

$$\Delta z_t = \mu + \beta t_{t-1} + \delta z_{t-1} + \varepsilon_t \quad (4)$$

where z is the variable of interest, t is linear time trend, μ is constant, β and δ are slope coefficients, and ε_t is an error term.

In cases where error terms are serially correlated, the method has to be modified. The simplest way to do that is to add several lags of the dependent variable Δy_t in equation (1) in order to ensure that ε_t appears as white noise.[2] This test for stationarity is known as the ADF test. The ADF test is based on the following regression,

$$\Delta z_t = \mu + \beta t_{t-1} + \delta z_{t-1} + \sum_{i=1}^{n} \gamma_i \Delta z_{t-i} + \varepsilon_t \quad (5)$$

where γ is slope coefficients, and ε_t is an error term.

The null hypothesis is that $\delta = 0$. This means that unit root exists in y_t. If the null hypothesis is rejected, then y_t is stationary.

The second step in this study is to estimate the natural rate of unemployment. The equation (3) can be re-arranged to:

$$\pi = \pi^e - \gamma (u - u_n) \quad (6)$$

Under the adaptive expectations hypothesis, the expected inflation (π^e) equals to the last period's inflation (π_{t-1}) (Ball and Mankiw 2002). Also, two additional assumptions would be necessary to estimate the natural rate of unemployment in these countries, such as 1) u_n (natural rate of unemployment) is a constant, and 2) the natural rate of unemployment

[2] White noise is an uncorrelated random error term with zero mean and constant variance (Gujarati, 2003, p.838).

is equal to the NAIRU (non-accelerating rate of unemployment). Under these assumptions, equation (4) can be re-written as:

$$\Delta\pi_t = \gamma u_n - \gamma u_t + \varepsilon_t \quad (7)$$

where $\Delta\pi_t$ is the change in inflation in the year t, u_n is the natural rate of unemployment, u_t is unemployment rate in the year t, γ is slope coefficient, and ε_t is an error term. The change in inflation ($\Delta\pi_t$) is equal to a difference between the current value of inflation (π_t) and the one-year lagged value of inflation (π_{t-1}).

Equation (7) can be used to estimate the natural rate of unemployment (u_n) by regressing the change in inflation ($\Delta\pi$) on a constant and the unemployment rate (u_t). If the slope coefficient (γ) becomes a negative value, the natural rate of unemployment is equal to the ratio of constant term to the absolute value of the slope coefficient. On the other hand, if the constant term becomes a negative value, the natural rate of unemployment is equal to the ratio of absolute value of constant term to the slope coefficient.

The final step in this study is to estimate the slope of the Phillips curve by using the following equation:

$$\pi_t = \pi_{t-1} - \gamma\,(u_t - u_n) + \varepsilon_t \quad (8)$$

where π_t is inflation rate in the year t, π_{t-1} is inflation in the year $t-1$, γ is slope coefficient of the "unemployment gap", u_t is unemployment rate in the year t, u_n is the natural rate of unemployment, and ε_t is an error term.

Under the adaptive expectations hypothesis, equation (8) is obtained from equation (4) by replacing expected inflation (π^e) with a one-year lagged value of inflation (π_{t-1}). In this expectations-augmented Phillips curve, γ can be considered as the slope of the Phillips curve.

4. Empirical Results

As the first step of the empirical analysis, 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 1. Despite minor differences in the findings as reported in the table, the obtained results indicate that all null hypotheses of unit roots in the unemployment rate (u_t) and the inflation rate (π_t) in the three Asian countries are rejected.

This means that these time-series data are stationary at levels. In other words, the two variables in Japan, South Korea and Malaysia are integrated of order zero, I(0). Thus, this paper uses Ordinary Least Square (OLS) method to examine the unemployment-inflation tradeoff.

Table 1: ADF Unit Root Test

Japan		
	Levels	
	Constant without trend	Constant with trend
Unemployment rate	-1.408(3)	-3.289(3)*
Inflation rate	-4.410(0)***	-4.253(1)**
South Korea		
	Levels	
	Constant without trend	Constant with trend
Unemployment rate	-2.877(1)*	-2.803(1)
Inflation rate	-5.822(0)***	-5.011(0)***
Malaysia		
	Levels	
	Constant without trend	Constant with trend
Unemployment rate	-3.293(2)**	-1.955(2)
Inflation rate	-4.137(1)***	-3.496(1)*

Figures in parentheses indicate number of lag structures
*** indicates significance at 1% level
**indicates significance at 5% level
*indicates significance at 10% level

In the second step, the natural rate of unemployment in the three Asian countries (i.e., Japan, South Korea and Malaysia) is estimated using equation (5). The natural rate could be estimated from the regression of the change in inflation ($\Delta\pi_t$) on unemployment rate (u_t) and a constant.

Malaysia's estimated natural rate of unemployment at 8.5 percent is relatively higher than that in the other two countries. Japan's natural rate of unemployment is estimated at 5.92 percent while South Korea's natural rate of unemployment is the lowest at approximately 2.30 percent.

The final step of the analysis is to estimate the slope of the Phillips curve using equation (8). This empirical model regresses the change in inflation ($\Delta\pi$) on a constant, the one-year lagged value of inflation (π_{t-1}), the and "unemployment gap" (u_t - u_n). The main findings are reported in Table 2.

As the findings indicate, the R-squared in Japan's regression model is 0.810. This means that more than 80 percent of the variances in the dependent variable are explained by the

independent variables. Both the constant and the one-year lagged value of inflation (π_{t-1}) are statistically significant. This means that the last period's inflation rate has a significant positive relationship with the current value of inflation (π_t).

Table 2: Estimation of the Phillips curve
Dependent variable: inflation rate (π_t)

Japan Natural rate of unemployment (5.92 percent) and Openness (9.8 percent)		
	coefficient	t-statistic
Constant	-0.919	-2.310**
π_{t-1}	0.438	4.664***
$u_t - u_n$	-0.533	-3.142***
R-squared	0.810	
Akaike information criterion	2.175	
Schwarz information criterion	2.323	
South Korea Natural rate of unemployment (2.30 percent) and Openness (32.9 percent)		
	coefficient	t-statistic
Constant	2.533	2.967***
π_{t-1}	0.529	6.186***
$u_t - u_n$	-0.476	-1.100
R-squared	0.645	
Akaike information criterion	4.800	
Schwarz information criterion	4.947	
Malaysia Natural rate of unemployment (8.50 percent) and Openness (77.2 percent)		
	coefficient	t-statistic
Constant	0.720	1.026
π_{t-1}	0.403	1.788*
$u_t - u_n$	-0.163	-0.955
R-squared	0.327	
Akaike information criterion	3.402	
Schwarz information criterion	3.551	

*** indicates significance at 1% level
**indicates significance at 5% level
*indicates significance at 10% level

More importantly, the "unemployment gap" ($u_t - u_n$) is statistically significant at 1 percent level. This indicates that there is a statistically significant negative tradeoff relationship between inflation rate and unemployment in Japan. The slope of the Phillips curve (γ) is estimated at 0.533.

On the other hand, R-squared in South Korea's regression model is 0.645. This implies that approximately two-thirds of the variances in the dependent variable are explained by the independent variables. Similar to Japan's regression model, a constant term and the last period's inflation are statistically significant and have a positive relationship with the current value of inflation. However, the "unemployment gap" has a negative but non-significant relationship with inflation. For South Korea, the slope of the Phillips curve (γ) is estimated at 0.476.

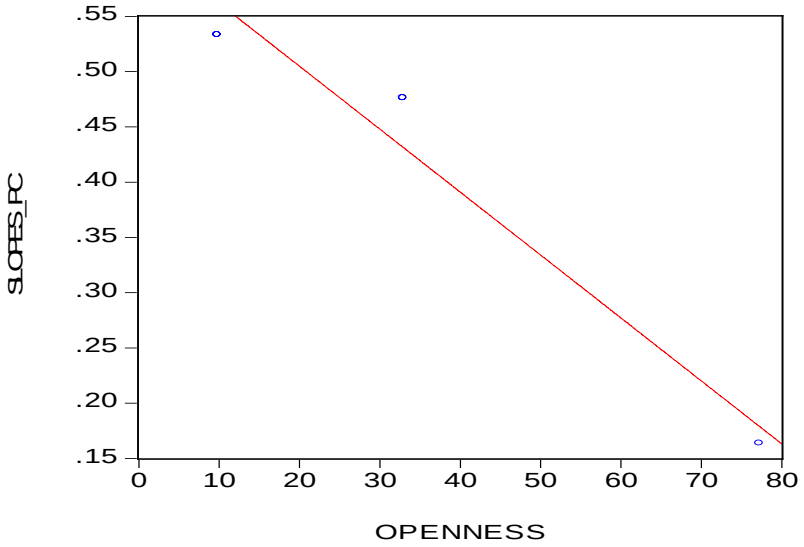
Finally, R-squared in Malaysia's regression model is relatively low (0.327). This indicates that only approximately one-third of variances in the dependent variable are explained by the independent variables. Only one independent variable (π_{t-1}) has a significant relationship with the dependent variable (π_t). Similar to South Korea's regression model, the "unemployment gap" has a non-significant negative relationship with the inflation rate. The slope of the Phillips curve (γ) in Malaysia is estimated at 0.163.

Table 3: Openness and slopes of the Phillips curve

	Openness	**Slope of Phillips curve (γ)**
Japan	9.8	0.533
South Korea	32.9	0.476
Malaysia	77.2	0.163

The relationship between openness and the slope of the Phillips curve for each of the three countries is reported in Table 3. As the table shows, as an economy becomes more open and the amount of imports as a percentage of national income increases, the slope of the Phillips curve becomes flatter. In other words, there would be a higher sacrifice rate (the flatter slope of the Phillips curve) in the more open economies.

Figure 1: Scatter plot



The scatter plot in Figure 1 visually presents the relationship between openness and the slope of the Phillips curve.

In a nutshell, empirical findings of the present study show that as a country opens up to the global market by increasing the amount of imports, the slope coefficient of the Phillips curve becomes smaller. In other words, the Phillips curve in more open economies tends to be flatter. It is hoped that these findings could provide additional empirical evidence and contribute to demystifying the inflation-unemployment puzzle.

5. Concluding Remarks

The Phillips curve remains an important foundation to understand the workings of the business cycle and the short-run effects of monetary policy. At the same time, the basic mechanism of the Phillips curve remains a "mystery". Furthermore, several research studies that have examined the relationship between openness and the Phillips curve failed to produce consistent findings to explain this intricate relationship.

Therefore, this paper attempted to examine the relationship between unemployment and inflation by choosing three Asian countries with different degrees of openness (i.e., Japan, South Korea and Malaysia) as case studies. Among the three countries, Japan is a relatively closed economy with openness at 9.8 percent while Malaysia is a relatively open economy with openness at 77.2 percent. South Korea is a moderately open economy with openness at 32.9 percent.

The main finding of the present study is that as a country opens up to the global market by increasing the amount of imports, the slope coefficient of the Phillips curve becomes smaller. This indicates that the more open economies tend to have a flatter Phillips curve.

There are some limitations to this research study, the main one being a lack of reliable data. Especially, in developing countries, there is a lack of data on both unemployment rate and inflation rate. Also, the data on inflation rate tend to be more reliable than the data on unemployment. Future studies on the Phillips curve may want to expand the scope of research into other areas. This could lead to a better understanding of the intricate relationship between inflation and unemployment.

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