
**Identifying Structural Break in the Phillips Curve for the Selected Countries:
a Dummy Variable Approach**

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Abstract

This paper aims to examine any time depending variation for the trade-off between unemployment and inflation to realize the presence of any structural break in the trade-off. Our previous study confirms that there is a negative relationship between unemployment and inflation in the long run for USA, Germany and France. This trade-off is known as “Phillips Curve”. The Graphical study indicates that there could be some structural break in the trade-off for each of the countries. It indicating that the Trade-off does not follows a constant pattern over time. For this reason dummy variable has been introduced in the model. For USA and France incorporating dummy variable showed significant change in the pattern of the trade-off whether for Germany the dummy variable has not given any noticeable change, indicating that there is a time variation in the trade-off of USA and France.

Keywords: unemployment, inflation, Phillips curve, OLS, ordinary least square, dummy variable.

1. Introduction

The person who is first to introduce the Phillips to public were A.W. Phillips through a single equation model which relates wage to unemployment.(Phillips, 1958). He has created a scattered diagram for this two variable model for UK between 1861-1957. Phillips curve is based on three main assumptions. The core assumption is there is a trade-off between unemployment and inflation in the short run. Due to aggregate supply shock there could be a violation in the properties of a Phillips curve as it can bring both unemployment and inflation at the same point of time. The final assumption is that, there is no trade-off in the long run(McConnell, 2005). That is why economists are always keen to know about the unemployment inflation relationship and their pattern. In this regard it has been also seen in many studies that there is short run trade-off between inflation and unemployment in different countries in different time periods. Though, the rate of low inflation and low unemployment are major economic goals. But it is not possible to achieve both of the economic goals (low inflation and low unemployment) simultaneously. Inflation is the function of monetary policy while unemployment is the function of fiscal policy. The aim of monetary policy is to control the level of inflation or to maintain the sustainable inflation in the economy by sacrificing employment. In contrast the goal of fiscal policy is to make low unemployment in the economy at any rate of inflation. Therefore, coordination among

the policies is very important in order to maintain optimal level of trade-off between inflation and unemployment.

Time series basically observe or studies variables for a long time period. According to various models these relationships between variables remain constant over time. But due to several factors variables might not follow a constant pattern, and when there is some evidence of break of this consistent patterns of the variable it is called structural break.(Aptech, 2022).from the study of the literature is has been identified that, in those studies where a negative relationship has found no further investigation has conducted to see whether the trade-off is consistent or there are variations. The main aim of this study is to eliminate that gap in research and to study the trade-offs from a closer perspective. This study will investigate whether there is some structural break in the trade-off between two variables. A structural break means any abnormality in the pattern of the trade-off there is any variation of the association or robustness of the association the paper will try to identify that variation from the analysis. For the selected countries a negative relationship has been detected earlier. But the pattern of the relationship was unknown. This study will investigate the nature of the relationship in the next few stages. The next section will be covering the literature review of this field. After that there will be a section on the model that the study uses for analysis this section will be followed by graphical analysis, analysis incorporating dummy variable and finally conclusion will be drawn from the overall study.

2. Literature review

The term unemployment and inflation trade-off has been introduced by the name of A.W. Phillips as “Phillips curve” after his famous work Phillips (1958) where he has shown an strong trade-off between unemployment and inflation. Later this has been further analysed by Lipsey where he suggested various adjustment required for Phillips curve(Lipsey, 1960). There was various other researchers who has given their support through their research. Among them Samuelson and Solow (1960) has also supported the existence of a long run trade-off between inflation and unemployment. In order to investigate how to maintain low and stable unemployment and inflation rate for Ethiopia Feto and Jayamohan (2022) found inflation and GDP are positively related where inflation and unemployment are associated inversely. By using panel dataSantoso and Kristiyanto (2021) analyses the effect of inflation and labor wage on unemployment. By using OLS estimation Islam and Mustafa (2017) also found a trade-off between inflation and unemployment. In order to check the Phillips curve long term efficacy Naqibullah, Rahmatullah, Zmarai, Safiullah, and Ahad (2021) also found the trade-off between unemployment and inflation by using ARDL bound test.DiNardo and Moore (1999) uses panel data for Ordinary Least Squares (OLS) and Generalized Least Squares (GLS) estimation and confirmed the existence of Phillips curve. in the other hand there are several studies where the presence of this trade off was absent.Khalid, Akalpler, Khan, and Shah (2021) Conducted a study on South Africa and found no relationship between inflation and unemployment as founded by A.W. Phillips. By using johansen’s maximum likelihood model Shadman-Mehta (1996)showed the existence of long run inverse relationship between unemployment and inflation.

In an attempt to investigate the presence of Phillips curve by examining unemployment and inflation relationship in the long run Daniel, Israel, Chidubem, and Quansah (2021) found no

relationship between unemployment and inflation. Fair (1978) did not find any structural relationship between unemployment and inflation. (Friedman & Schwartz, 1970) opposed the idea of Phillips curve and rejected the trade-off between unemployment and inflation. So there is a keen interest among economist for the assistance of Phillips curve. If exist how it is related or is there is any variation or not? This study from the above literature review is keen to know the exact relationship and the pattern of their relationship.

The above literature suggests us that there are several documents on the debate of the trade of between inflation and unemployment. Though some research suggests that there is a long run trade-off between inflation and unemployment the others do not acknowledged. The study will look for whether there is any trade-off between unemployment and inflation for selected countries in the long run. If the trade-off seems irregular the study will also investigate the structural break, meaning that from when there is deviation in the trade-off. No such document found which investigated the time variation in the trade-off

3. Methodology

In the previous paper (Mustafa, 2017) the emphasize was on the examination of a long run trade-off between unemployment and inflation. The inspiration was from (Perry, 1966)who included lags of the consumer price index as adjustment for the cost of living in his wage price Phillips curve. This research consider Inflation rate, (Inf_t); percentage change in consumer price index as dependent variable. Here, independent variables are unemployment rate, (Un_t); percentage of share of labor force without work but available for and seeking employment and previous year inflation or lagged inflation (Inf_{t-1}). All these variables are taken in this paper in order to examine the Phillips curve for selected countries. The simple Phillips curve could be estimated by using following equation:

$Inf_t = \beta_1 + \beta_2 Un_t + \beta_3 Inf_{t-1} + \epsilon_t$ (1)

β_1 is constant and β_2 and β_3 are slope coefficient and ϵ_t is the error term. This is a multiple regression model (Gujarati, 2004). In the first stage of that study, in order to assess the Phillips curve, unit root test is used to examine the stationary of data sets by using the augmented Dickey-Fuller (ADF) unit root test to examine whether the data stationary or not (Dickey & Fuller, 1981). Then in the second stage this study have conducted the estimation of equation 1. Then it checked the estimation result. Moving forward in the third stage conducted the unit root test again for the residual to investigate whether the variables are co integrated or not. After having confirmation of co integration, This study have checked the correlation coefficient between the independent variables to find out the existence of multicollinearity, if exist in the model we have to mitigate this. Finally we have conducted test for stability. In this paper we use Ramsey RESET test. It shows whether the model is correctly specified or not. After the estimation process there will be a graphical analysis and if there is any structural break. If any sort of structural break remain present there will be another estimation including a dummy to observe the nature of the structural break.

4. Analysis

The estimation output of each country data as estimated following the ordinary Least Square estimation techniques for USA, Germany and France are as follows:

Table 01- Estimation output for USA

Dependent Variable: INF
 Method: Least Squares
 Included observations: 472 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.306439	0.082536	3.712820	0.0002
UN	-0.043777	0.012127	-3.609770	0.0003
INF_LAG	0.993494	0.006291	157.9274	0.0000
R-squared	0.981645			
Adjusted R-squared	0.981567		Mean dependent var	4.436229
S.E. of regression	0.420219		S.D. dependent var	3.095127
Sum squared resid	82.81798		Akaike info criterion	1.110255
Log likelihood	-259.0202		Schwarz criterion	1.136677
F-statistic	12541.53		Hannan-Quinn criter.	1.120648
Prob(F-statistic)	0.000000		Durbin-Watson stat	1.258872

Table 1 represents the estimation output for United States of America (USA). Coefficient value C represents intercept for the model and coefficient value of Unemployment and Inflation _lag is negative and positive respectively. From the probability column at the right we can see all the coefficient is acceptable at 5% level. Value of r square is 0.65 which is quite high. So we can accept the estimation result.

Table 02- Estimation output Germany

Dependent Variable: INF
 Method: Least Squares
 Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.894277	0.656563	2.885142	0.0074
UN	-0.017376	0.007645	-2.272918	0.0309
INF_LAG	0.633872	0.109961	5.764503	0.0000
R-squared	0.651309			
Adjusted R-squared	0.626403		Mean dependent var	2.183387
S.E. of regression	0.924781		S.D. dependent var	1.512994
Sum squared resid	23.94615		Akaike info criterion	2.773246
Log likelihood	-39.98531		Schwarz criterion	2.912019
F-statistic	26.15021		Hannan-Quinn criter.	2.818482
Prob(F-statistic)	0.000000		Durbin-Watson stat	1.529099

In table 2 we can also see a trade-off between unemployment and inflation. All the coefficients are accepted at 5% level as can be seen from the probability values. Once again R-square value is

good to explain the population. So it can be said that there is a trade-off between unemployment and inflation.

Table 03 - Estimation output for France:

Dependent Variable: INF

Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.305579	1.733596	2.483612	0.0193
UN	-0.398205	0.169637	-2.347395	0.0262
INF_LAG	0.778119	0.053341	14.58761	0.0000
R-squared	0.912781			
Adjusted R-squared	0.906551			
S.E. of regression	0.961363			
Sum squared resid	25.87814			
Log likelihood	-41.18797			
F-statistic	146.5149			
Prob(F-statistic)	0.000000			
		Mean dependent var.	3.295935	
		S.D. dependent var.	3.144848	
		Akaike info criterion	2.850837	
		Schwarz criterion	2.989610	
		Hannan-Quinn criter.	2.896073	
		Durbin-Watson stat	2.368597	

Table 3 represents the trade-off between unemployment and inflation for France. A trade-off between inflation and unemployment is also evident here, which is clear from the coefficient value of unemployment and inflation. Probability values indicate that we can consider this association and r-square values are also good.

This work is an expansion of the previous work of (Mustafa, 2017). In the first stage the study will investigate the presence of any structural break in the trade-off between unemployment and inflation by examining the graphical presentation of the variables. To if the graphical analysis indicates any structural break then the study will incorporate time dummy variable for each countries. Finally to investigate the presence of any time depending variation this paper included slope and intercept dummy and analyze the estimated outcome.

5. Graphical Analysis

USA:

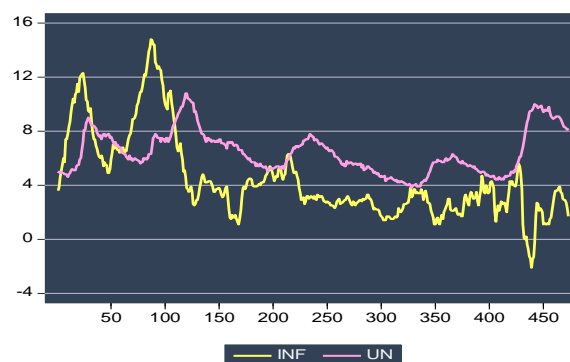


Figure 1

From the Figure - 1 we can easily see that there is a trade-off between inflation and unemployment in the long run for USA. But the graph, indicating that there might be some structural break in this trade-off. Structural break can be identified through the incorporation of a time dummy and to observe its significance.

Germany:

For Germany there is also a trade-off between unemployment and inflation. Figure 2 makes the research interested once again to check whether there is any structural break or not for Germany. Incorporating time variable will lead towards to find out there is any structural break or not.

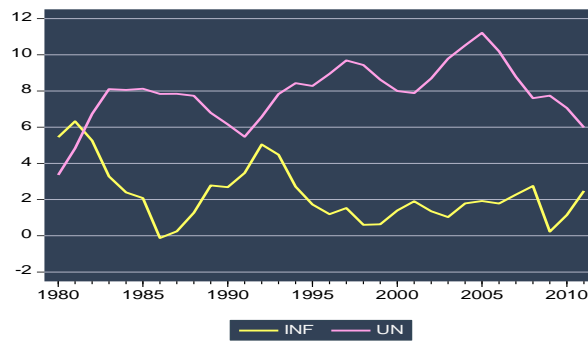


Figure 2

France:

For France there is also a trade-off identified but the slope of the variables fluctuates (Figure 3) over time to investigate the structural break a dummy variable should be incorporated.

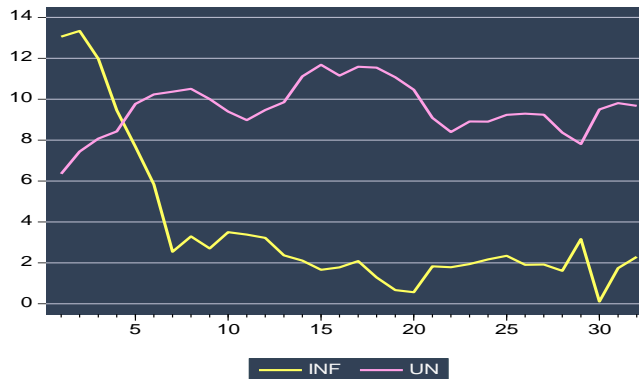


Figure 3

6. Incorporating Dummy Variable

After the graphical analysis of trade-offs between Unemployment and inflation this paper finds that there might be some time depending variation among the variables. To investigate if there is any time variation or not, dummy variable techniques has been applied (Hill, 2011) has been

considered for each countries. As dummy variable can take the values 0 and 1, a new variable has been generated as dummy with an attempt to investigate is there is any time variation among the variables or not. Dummy variable techniques used to identify any variation in the coefficient of the variable observed, before and incorporation of that variable. If the estimation gives a significant coefficient it will indicate us that there is an effect of time variation in the output. If the estimation output gives insignificant output for dummy than it will indicates that there is no effect of time change.

USA:

Intercept Dummy:

The OLS estimation after incorporating time dummy ensure the trade-off between unemployment and inflation. it also indicating that there is a structural break depending on time. The probability statistics for dummy variables is significant. The estimated output now can be written as: Before 1985 the regression model for USA was like the following:

$$\widehat{Inf}_t = 0.756 - 0.065Un_t + 0.965Inf_{t-1}$$

But as there is a structural break in the model depending on time the estimated model from 1985 as this study considered time dummy as 1 the would be:

$$\widehat{Inf}_t = 0.490 - 0.065Un_t + 0.965Inf_{t-1}$$

Interaction Dummy:

The OLS estimation after incorporating interaction dummy ensures that there is a difference in the coefficient of unemployment. The probability statistics for interaction variables is significant. The estimated output for before 1985 is

$$\widehat{Inf}_t = 1.756 - 0.192Un_t + 0.956Inf_{t-1}$$

After 1985 the estimation output will be look like the following where there is an increased coefficient for unemployment about 0.178

$$\widehat{Inf}_t = 0.210 - 0.014Un_t + 0.956Inf_{t-1}$$

Germany:

Intercept Dummy:

OLS estimation with dummy variable suggests that dummy variable is not significant for Germany. The probability statistic of dummy is not significant.it indicates that there is no structural break depending on time for Germany.

Interaction Dummy:

After incorporating interaction dummy we can see that there is a difference of coefficient for unemployment for Germany before and after 1995. Before 1995 the coefficient of unemployment was -0.801 whereas after 1995 it was -.089 showing an increase about 0.712 .So before 1995 the estimation will be as

$$\widehat{Inf}_t = 6.898 - 0.800Un_t + 0.578Inf_{t-1}$$

And after 1995 the estimation will be as

$$\widehat{Inf}_t = 5.497 - 0.089Un_t + 0.578Inf_{t-1}$$

France:

Intercept Dummy:

For France there is a significant result for dummy variable indicating that there is a structural break in the trade-off for France. There is significance difference in the trend of trade-off due to time variation. So after 1984 the estimation model will be as follows:

$$\widehat{Inf}_t = 4.205 - 0.346Un_t + 0.585Inf_{t-1} \dots\dots\dots (11)$$

And for from 1980 to 1984 the model will as follows:

$$\widehat{Inf}_t = 6.535 - 0.346Un_t + 0.585Inf_{t-1} \dots\dots\dots (12)$$

Interaction Dummy:

After incorporating the interaction dummy into the model the estimated output were not statistically significant as the probability for unemployment were insignificant so we cannot strongly conclude that there is a change in the coefficient of unemployment depending on time.

7. Conclusion

Since the inception as a concept “Phillips Curve” has successfully drawn the attention of the policymakers and researchers, as the Phillips curve explains the relationship between unemployment and inflation. These two variables are among the most vital and analyzed variable for macroeconomic performance of an economy. There is evidence of trade-off between unemployment and inflation even in the long run for various studies. But the pattern of the trade-off is not the same in all the cases. Though the variation of the variable should follow a constant pattern in the long run, sometimes it deviates. For some cases there is change in pattern over time. In this study, as the graphical study indicating that there might be some variation in the trade-off between unemployment and inflation for USA, Germany and France. Likewise, various papers this study also found a negative association between unemployment and inflation. To confirm that variation observed in the graphical analysis a modified estimation has to be conducted. This paper examined if there is any structural break or not in the trade-offs by incorporating dummy variable, as it will indicate any variation of trade-off in terms of slopes or intercepts or both. For USA and France dummy variable showed significant result, but for Germany the dummy variable is not significant, indicating that there is a time variation in the trade-off of USA and France. This paper also give emphasize on more precise analysis about Phillips curve. This study only investigated the structural break in the trade-off and only for few countries which is a limitation of the study. In the future, more research can be conducted to investigate the reasons behind the time variation and this structural break. This study should be conducted on various other economies as well to predict the future trends of trade-off between unemployment and inflation. Policymaker also should consider the factors for which there might be variation in the unemployment and inflation trade-off of the studied time period to realize the empirical situation and to adjust the policy as per requirement.

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