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Modeling Inflation Rate and Unemployment Rate in Sri Lanka: Validation of Lucas Critique

I M G A S Illukkumbura and T S G Peiris

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Abstract

The Phillip curve has been used by many macro economics policy makers in different countries on decision making process and policy making process on the inflation rate and the unemployment rate related issues in the country. However, economists argue that Phillips curve theorem fails and it misinform policy makers. Although many studies have been conducted for and against the Phillips Curve theorem, less studies has been conducted on application of Phillips Curve in Sri Lankan economy and also there is paucity of literature on validating Lucas Critique in different economies. The analysis of annual inflation rate and unemployment rate in Sri Lanka from 1991 to 2020 is conducted using Vector Autoregressive Model. Johansen Co-integration Test shows that here is no co-integration presence between the relationship of the unemployment rate and inflation rate during the given period. Furthermore, it was found that one lagged unemployment rate and inflation rate shows a positive impact on the time series variables. Thus the study rejects the Phillips Curve relationship in Sri Lankan economy but supports Lucas Critique.

Keywords: Phillips Curve, Lucas Critique, Unemployment, Inflation,

1. Introduction

The relationship between the inflation rate and the unemployment rate is subjected to debates among economists. Alban William Phillips discovered a strong inverse relationship between inflation rate and unemployment rate in the UK during1861 and 1957 and introduced "Phillips Curve Theorem", which later become an important theory in modeling inflation rate and unemployment rate (Samuelson and Solow, 1960; Phelps, 1967; Friedman, 1968; Lucas, 1976). After the Great Recession in 2008 many researchers started presenting evidence against the Phillips Curve relationship (Yhlas and Muhittin, 2019). In July 2019, Jerome Powell, the Chairman of Federal Reserve has declared that the Phillips curve has collapsed. He has further mentioned that the Phillips curve they have been relying on to make the new policies doesn't explain the relationship between the unemployment rate and inflation rate during the economic expansion from 2017 to 2019. The US was successful in maintaining both the inflation rate and unemployment rate at a stable and minimum rate. Therefore they claim the Phillips curve in the US is flattened (Bahn and Clemens, 2019). Gorden (2018) argues that the inflation rate exhibits a neutral response to the unemployment rate during the decade of 2009 to 2018 in US. Therefore he suggests that the Phillips curve is flattened during the past decade. Furthermore, Powell suggests that we should explore a new theory in lieu of the Phillips Curve theorem (Bahn and Clemens 2019). According to some researchers, income inequality is one of the reasons for the malfunction of the Phillips curve as the low-income population cannot influence the price in the market (Sovbetov, Y. and Kaplan, M. (2019). Before finding a new theory or claim the failure of the Phillips Curve, many studies should be conducted in separate economies to testify Powell's claim.

Milton Friedman (1968) and Edmund Phelps (1967) openly criticized the Phillip's hypothesis and maintained that there is no trade-off between unemployment and inflation. Lucas (1976) strongly opposed the proposition of the existence of the Phillips curve. He said workers would foresee high inflation in the future and would demand wage increase from their employers. In this case, there could be the coexistence of high unemployment and high inflation rate which is known as the "Lucas Critique". Sharif and Rajarshi (2013) have found the presence of Lucas Critique: the positive correlation between inflation rate and unemployment rate in 10 OECD countries.

Fumitaka Furuoka and Qaiser Munir (2014) imply that the study supports the existence of the Phillips Curve in the context of a

developing economy, such as Malaysia. Dong Wang (2016) shows a significant negative relationship between inflation and unemployment can be observed in the long run before and after 1997 in Hong Kong.

Sri Lanka is a middle-income country that shows sudden shocks in the inflation rate assumedly caused by printing of excessive money. According to Lucas Critique when there is unexpected money supply, it increases inflation rate in long run and it doesn't reduce unemployment rate. The reason for increasing inflation rate when there is unexpected money supply is increasing demand. But at the same time supply doesn't increase due to low production. Low production in country is a reason for high unemployment rate. Therefore the objective of this study is to identify the relationship between inflation rate and unemployment rate from 1991 to 2020 in Sri Lanka and validate the Lucas critique and justify the importance of Jerome Powell's suggestion of exploring a new theory for Sri Lanka in lieu of the Phillips Curve theorem for government policy making process (Bahn and Clemens 2019).

2. Materials and Methods

Materials

Annual secondary data of the unemployment rate and the inflation rate of Sri Lanka for 30 years from 1991 to 2020 is used for the study.

Methods

The VAR model has proven to be especially useful for describing the dynamic behavior of multivariate economic time series and for forecasting. Therefore this paper uses Vector Auto Regressive Model to model the relationship between two economic variables, inflation rate and unemployment rate of Sri Lanka during the given period. The structure is that each variable is a linear function of past lags of itself and past lags of the other variables. Rudebusch(2002) , Breitung et al. (2004) and Bjφrnland(2000) has used VAR model to demonstrate the relationships emphasized by Lucas Critiques.

Phillip Curve

Phillips curve theorem is used as the base of the relationship between inflation rate and unemployment rate. Concepts of demand and supply can be used to explain the theories of the Phillips Curve. Lack of demanded labor supply increases the inflation rate as the wages increases. In 1958, after analyzing statistical information for more than a century, Phillips concludes that there is a certain level where unemployment becomes consistent with a stable rate of inflation rate. The vertical line (Figure 1) shows the Phillips curve at the natural rate of unemployment which occurs in the long run of an economy.

PE1, PE2, PE3 are Phillips (Figure 1) curves that can be shifted with the unexpected increase in the rate of inflation. An increase in expected inflation causes upward movements to the Phillips Curve which confirms the short-term inverse relationship between unemployment and inflation.

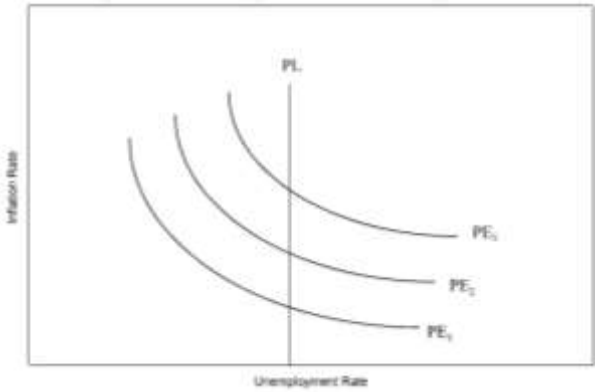

Figure 1: The Phillips Curve Relationship
Source: Ahuja, H. L. (1986). Macro Economics (Theory & Policy)

Lucas Critique

Robert Lucas (1976) introduced the concept of "rational expectations". This concept shows how the inflation rate increases as a result of the government's attempt to reduce the unemployment rate by increasing money supply. But increasing money supply doesn't lower unemployment rate in long-run. Thenuwara (2010), points out that there is a lagged effect of excessive money printing and increasing the price level of

food and energy prices in Sri Lanka during mid-2006 to mid-2008. This evidence is proving the Lucas Critique in Sri Lankan economy.

Vector Auto-Regression Model

Vector Auto regression model captures linear interdependencies among time series variables.

If p is the order of the VAR model, t is the time period, β_p are the parameters, e_t is the residual term and α is the constant then VAR mode is written as

$Y_t = \alpha + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \dots \beta_p Y_{t-p} + e_t$ **[1]**

De-trending and differentiating are used to analyze nonstationary data (Maddala, 2001). In this study unemployment rate (UMP) and inflation rate (INF) are analyzed using VAR model.

3. Results and Discussion

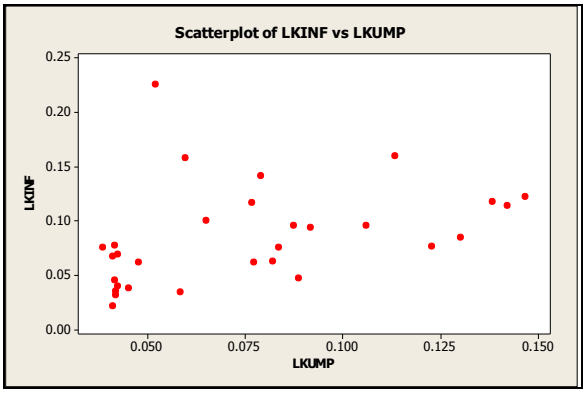

Figure 2: Scatter Plot of Unemployment rate Vs Inflation rate in Sri Lanka

Figure 2 shows the relationship between unemployment rate and inflation rate of Sri Lanka economy from 1991 to 2000. It seems to have a positive relationship.

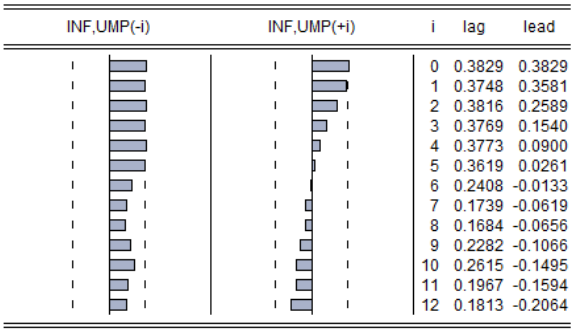

Figure 3: Cross Correlation of Unemployment rate Vs Inflation rate in Sri Lanka

Figure 3 cross correlation correlogram shows that there is a correlation between inflation rate (INF) and unemployment rate (UMP) during the given time lags (null hypothesis: correlation is asymptotically consistent approximations).

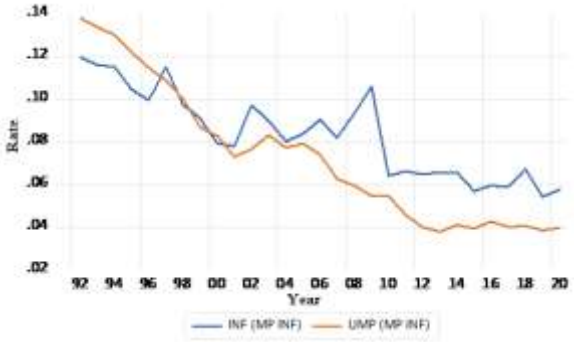

Figure 4: Inflation rate and Unemployment rate

Figure 4 shows that over the time both inflation rate and unemployment rate get decreased. During 1998 to 2001 the inflation rate and unemployment rate take close values but after that the gap increases.

Table 1: ADF and PP tests

	Level		First Difference	
	ADF	PP	ADF	PP
LKINF	0.0112	0.0113	0.0000	0.0001
LKUMP	0.1008	0.1082	0.0017	0.0015

ADF tests and PP tests (Table 1) show that all variables become stationary by applying first difference as all p-values are less than 1% . Therefore it is suitable to apply Vector Auto-Regressive model or Vector Error Correction model for the dataset for the first difference of the dataset.

Table 2: Lag Length Criteria (Sri Lanka)

Lag	AIC	HQ
0	-8.3518	-8.3254
1	-10.7969	-10.7268
2	-10.6279	-10.5111

According to table 2 the suitable lag length for the inflation rate and unemployment rate of Sri Lanka is lag order 1 as selected by Akaike Information Criteria (AIC) and Hannan Quinn (HQ).

Table 3: Johansen Cointegration test (Sri Lanka)

Data Trend:	Linear	Linear	Quadratic
Test Type	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	2	0	0
Max-Eig	0	0	0

Table 3, co-integration test shows there is no co-intergration. There is no linear trend and quadratic trend in data. There are two equations with no trend and zero equations

with liner and quadratic trends as shown in table 3.

Table 4 shows the VAR model estimated using lag order 1 for variables in Sri Lankan economy. According to table 4, there is a significant influence from one lagged inflation rate and one lagged unemployment rate on current inflation rate and the influence is positive.

Table 4: Summary of Vector Auto Regression Model Results (Sri Lanka)

	Eq 2	Eq 3
Variable	Coefficient	Coefficient
UMP(-1)	0.91337	0.39902
	[31.1938]	[1.6034]
INF(-1)	0.02963	0.2313
	[1.3321]	[1.2237]
C	0.00048	0.03298
	[0.19017]	[1.5266]
R-sq	0.9780	0.1953
F Stat	579.25	3.1679
Akaike IC	-7.6535	-3.1679
Schwaz SC	-7.5121	-3.2322

Unemployment rate is mentioned as UMP and inflation rate is mentioned as INF in the table 4. UMP(-1) shows the first lag of unemployment rate and INF(-1) is the first lag of inflation rate.

Below equation 2 and 3 are the Vector Auto Regressive Models derived from the table 4

UnemploymentRate = + 0.00048 + 0.91337*UnemploymentRate (-1) + 0.029637*InflationRate(-1) **[2]**

InflationRate = + 0. 032984+ 0.399022* UnemploymentRate (-1) +0.231383* InflationRate (-1) **[3]**

Table 5: VAR Residual Serial Correlation LM test

Lag	Rao F-Test	df	Prob.
1	1.2458	(4,46)	0.3049
2	1.2570	(4,46)	0.3005

Under the null hypothesis of "no serial correlation at lag h" , table 5 confirms that there is no serial correlation in model 4 and 5.

Table 6: Normality test

Compoenent	Jarque – Bera	df	Prob.
1	0.2762	2	0.8710
2	7.7250	2	0.0210
Joint	8.0012	4	0.0915

Under the null hypothesis of "models are normally distributed", table 6 confirms that the model 4 and 5 are normally distributed.

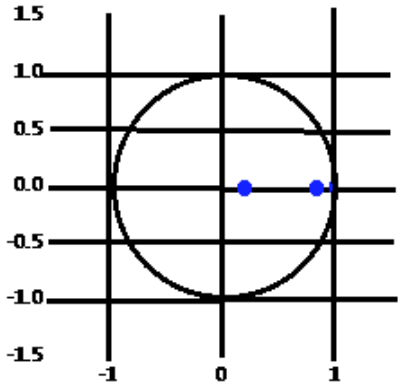

Figure 5: Inverse roots of AR Characteristic Polynomial

According to figure 5 all roots lies inside the circle. If all roots have modulus less than one and lie inside the unit circle, then the estimated VAR is stable (stationary) under the null hypothesis of "the data series is not stationary" and invertible and therefore will give good estimates.

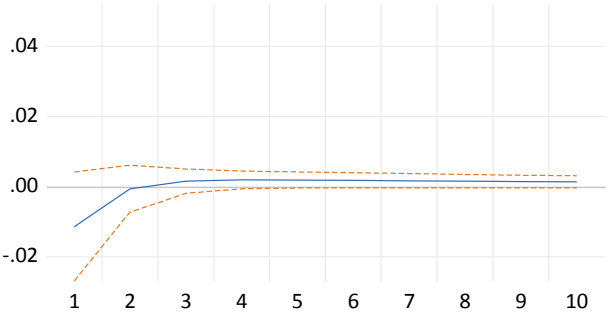

Figure 6: Impulse response of inflation rate to unemployment rate

Figure 6 show that there is a positive response from inflation rate to the shocks from unemployment rate at the first but later the response is flattened.

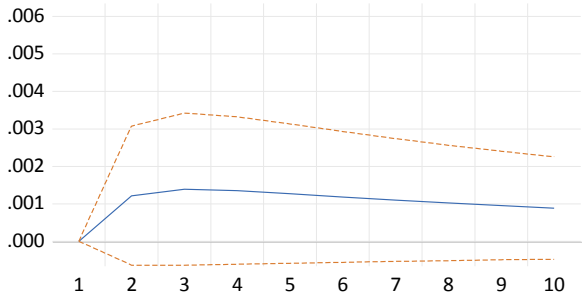

Figure 7: Impulse response of unemployment rate to inflation rate

Figure 7 show that there is a positive response from unemployment rate to the

inflation rate at the beginning and then it become slightly negative with less response.

Table 7: Granger Causality test(Sri Lanka)

Null Hypothesis:	Obs	Chi Statistic	Prob.	Decision
INF does not Granger Cause UMP	29	2.5710	0.1088	Do not Reject
UMP does not Granger Cause INF		1.7746	0.1828	Do not Reject

Granger causality shows the bidirectional short-term effect among the time series variables. There is no granger causality running among inflation rate of Sri Lanka and Unemployment rate towards both directions.

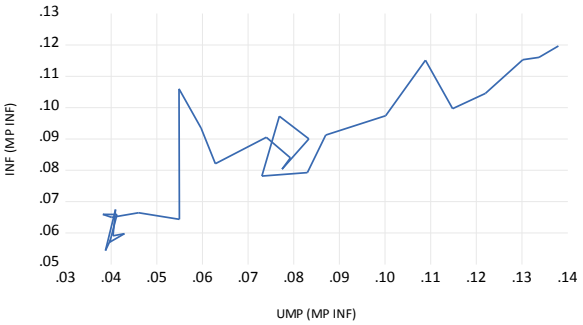

Figure 8: Estimated line of Inflation rate and Unemployment rate in Sri Lanka

Figure 8 shows the static estimates of the VAR model and there is a positive relationship between inflation rate and unemployment rate. It is visible in figure 8, that the relationship between inflation rate and unemployment rate in Sri Lanka violates the Phillips Curve theorem as there is a positive relationship. Phillips curve shows an inverse relationship of the Inflation Rate and the Unemployment Rate. Sri Lanka reports some incidents of printing excess money to balance its budget deficits. Thenuwara (2010), points out that there is a lagged effect of excessive money printing and increasing the price level of food and energy prices in Sri Lanka during mid-2006 to mid-2008.

4. Conclusion

This paper investigated the sensitivity of unemployment rate on inflation rate for the period 1991-2000 in Sri Lanka. As there is a positive relationship between unemployment rate and inflation rate in Sri Lanka, therefore it is recommended that not to use Phillips Curve theorem for economic policy making process in Sri Lanka. The study shows that there is a positive correlation among inflation rate and unemployment rate in Sri Lanka, therefore any government and central decision making which leads to lift the inflation rate such as excess printing money in purpose to cover the budget deficit and foreign exchange deficits; otherwise not proven, should be limited or avoided. If the government is keen about maintaining low unemployment rate, they should consider about reducing the inflation rate and vice versa. The results in this study support the Lucas critique. Lucas indicates the excess money supply increase inflation rate and also it doesn't reduce the unemployment rate as well. Furthermore, this paper supports the claim of Jerome Powell, that the Phillips Curve relationship is no longer valid in some economies.

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