Monetary Policy and Inflation-Output Variability in Developing Economies: Lessons from Sri Lanka

Kesavarajah Mayandy

Central Bank of Sri Lanka

Paul Middleditch

The University of Manchester

Paper Presented at The 12th International Research Conference Central Bank of Sri Lanka 09 December 2019

Introduction

- The debate over the trade-off between inflation and output has been intensely discussed in both theoretical and empirical strands of the business cycle literature
- During 1960s and early 1970s, many economists believed a CB could achieve lower unemployment by accepting higher inflation
 - Traditional Phillips curve shows a temporary tradeoff between the level of inflation and output
- However, unlike a traditional Phillips curve, Taylor (1979) argued for the existence of a "Second Order Phillips Curve"
 - The trade-off between inflation and output can be well described in terms of their variability
 - An attempt to maintain inflation at a stable level would result in larger fluctuations in output
 - The tradeoff arises because monetary policy cannot simultaneously offset both types of variability

Theoretical Literature

Taylor curve : Shows the long-term permanent trade-off between the variability of inflation and output



• CB can reduce the variability of inflation (output) only if they agreed to take a higher level of variability in output (inflation)

Exact position in the Taylor curve depends on the nature of supply shocks and policymaker's preferences on the stabilization of inflation and output

Motivation of this Study



The Sri Lankan economy has experienced a transition from relatively low volatile regimes to more volatile regimes

Supportive Empirical Literature for Sri Lanka

- Existing empirical literature for Sri Lanka has almost exclusively focused on examining the impacts of monetary policy on levels of inflation and output (Amarasekara, 2008; Perera & Jayawickrema, 2013; Vinayagathasan, 2014)
- Amarasekara and Bratsiotis (2015) compared the efficiency of monetary policy in inflation targeting and non-inflation targeting countries over the period 1980-2007.
 - Countries that implemented inflation targeting registered low level of variability in both inflation and unemployment
 - In non-inflation targeting countries, inflation variability was reduced at the cost of increased unemployment variability

Research Problem

The Sri Lankan economy has experienced a transition from relatively low volatile regimes to more volatile regimes

- The main research question this study attempts to address is:
 - Has monetary policy really helped in reducing the inflation-output variability trade-off in Sri Lanka?
- In addressing the above research question, we need to identify
 - How has the inflation-output variability trade-off changed in different monetary policy episodes in Sri Lanka?
 - What was the contribution of monetary policy on macroeconomic performance in different monetary policy regimes in Sri Lanka?

The Objective of this Study

The main objective is to examine the impact of monetary policy on the inflation-output variability trade-off in Sri Lanka (1980-2017)



- Examine the Taylor curve relationship under different monetary policy regimes
 - Identify how the trade-off between the variability of inflation and output evolved over time
 - Examine how demand and supply shocks have affected the persistence of the variability of inflation and output
 - Examine the preference of the CB with regards to the stabilization of inflation



 Examine the contribution of monetary policy on macroeconomic performance under different monetary policy regimes

This study departs from existing literature

Uses monthly datasets and places special focus on the presence of structural breaks in the economy

- The entire sample period will be divided into sub-samples Estimate the preferences of the CB with respect to the stabilization of inflation compared to previous studies, which simply considered average values (Ehelepola, 2015; Paranavithana, Tyers & Magnusson, 2017)

Major Structural Changes in the Sri Lankan Economy

Period	Events			
1977	Introduction of open economic policy and managed floating exchange rate system			
1980s	The CBSL formally adopted a monetary targeting policy framework			
2001 Jan	The CBSL allowed the exchange rate to be determined freely through market forces			
2009 May	The end of civil war			
1 an 1980 to Dec 2000	2 Jan 2001 to May 2009 June 2009 to Dec 201			

Data, Model and Methodology

Data

- The study begins in 1980 to coincide with the adoption of the monetary targeting monetary policy framework in Sri Lanka
- The monthly real GDP series are not available for Sri Lanka
 - Used the interpolation technique proposed by the Fox (2000) to convert the annual series and the quarterly series to the monthly series
- Considered 3-months Tbill rate as the short-term interest rate
- Follows methodology used by Taylor (2013) and Cecchetti and Ehrmann (2002) to estimate
 - Variability of output : $(y y^*)^2$
 - The potential output based on the Hodrick-Prescott (HP) filter approach.
 - Variability of inflation : $(\pi \pi^*)^2$
 - The average inflation rate registered for each regime was considered as targeted inflation
- Data Bases: DCS, CBSL and Bloomburg

Modelling Approach

Model

- We first derived the theoretical Taylor curve equation
 - Min:

$$L = E[\lambda(\pi - \pi^*)^2 + (1 - \lambda)(y - y^*)^2] \qquad 0 < \lambda < 1 \quad (1)$$

• Sub. To:

$$y_t = \varphi(r_t - d_t) + s_t, \quad \varphi < 0$$
 (2)

$$\pi_t = -(r_t - d_t) + \omega s_t \qquad (3)$$

- Dynamics of output and inflation are assumed as a function of interest rate
 - λ Policymaker's aversion to inflation variability
 - φ : Measures the ratio between the responses of output and inflation to a MP shock (Inverse slope of the AS curve), ω : Slope of the AD curve

Modelling Approach

• Combining Eqn 2 and 3, we can derive the optimal policy of the CB

$$r_t = ad_t + bs_t \qquad (4)$$

- Interest rate set by the CB is a linear function of demand and supply shocks. In the presence of both shocks, the CB need to behave optimally to minimize welfare loss
- Substitute Eqn 4 into Eqn 2 and 3 and derive the variances of output (σ_y^2) and inflation (σ_π^2)

$$\sigma_y^2 = (a-1)^2 \varphi^2 + (1+\varphi b)^2 \sigma_s^2 \quad (5)$$

$$\sigma_\pi^2 = (1-\varphi)^2 + (\omega+b)^2 \sigma_s^2 \quad (6)$$

• After substituting Eqn 5 and 6 into Eqn 1 and minimizing the loss function with respect to *a* and *b*, we will derive the following solution

$$a = 1$$
 (7)

- $\boldsymbol{b} = \frac{a(\varphi \omega) \varphi}{a(1 \varphi^2)} + \varphi^2 \quad (8)$
- Solution 7 CB completely offset demand shocks one for one on both output and inflation
- Solution 8 : Reaction of MP to supply shock is complicated because they generate a trade-off 12

Modelling Approach

• Substituting Solutions 7 and 8 into Eqn 5 and 6, we derived the ratio between the variability of inflation and output [Taylor curve].

$$\frac{\sigma_y^2}{\sigma_\pi^2} = \left[\frac{\lambda}{\varphi(1-\lambda)}\right]^2 \qquad (9)$$

Trade-off between the variability of output and inflation depends on the value of λ and φ .

- Based on Eqn 9, we need to estimate
 - i. Ratio between the variability of output and inflation
 - ii. Inverse slope of the AS curve (ϕ) Measures the ratio between the responses of output and inflation to a MP shock
 - iii. Preferences of the CB (λ)

Estimating the Inverse Slope of the AS curve (ϕ)

- Examine the impact of MP on output and inflation
 - Use SVAR model (Kim and Roubini, 2000) to identify MP shocks from a SR restrictions
- Use six variables to estimate a SVAR model in Small Open Economy
 - These variables are well-known variables in monetary business cycle literature

$$X_t = i_t, y_t, \pi_t, E_t, O_t, FF_t \qquad (10)$$

$$\begin{bmatrix} i_{t} \\ y_{t} \\ \pi_{t} \\ E_{t} \\ O_{t} \\ FF_{t} \end{bmatrix} = \begin{bmatrix} \delta_{1} \\ \delta_{2} \\ \delta_{3} \\ \delta_{4} \\ \delta_{5} \\ \delta_{6} \end{bmatrix} + \begin{bmatrix} \varphi_{11} & \varphi_{12} & \varphi_{13} & \varphi_{14} & \varphi_{15} & \varphi_{16} \\ \varphi_{21} & \varphi_{22} & \varphi_{23} & \varphi_{24} & \varphi_{25} & \varphi_{26} \\ \varphi_{31} & \varphi_{32} & \varphi_{33} & \varphi_{34} & \varphi_{35} & \varphi_{36} \\ \varphi_{41} & \varphi_{42} & \varphi_{43} & \varphi_{44} & \varphi_{45} & \varphi_{46} \\ \varphi_{51} & \varphi_{52} & \varphi_{53} & \varphi_{54} & \varphi_{55} & \varphi_{56} \\ \varphi_{61} & \varphi_{62} & \varphi_{63} & \varphi_{64} & \varphi_{65} & \varphi_{66} \end{bmatrix} \begin{bmatrix} i_{t-i} \\ y_{t-i} \\ \pi_{t-i} \\ e_{t-i} \\ O_{t-i} \\ FF_{t-i} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \\ \varepsilon_{6t} \end{bmatrix}$$

$$G_{0} \times X_{t} = \begin{bmatrix} \varepsilon_{i} \\ \varepsilon_{y} \\ \varepsilon_{\pi} \\ \varepsilon_{E} \\ \varepsilon_{0} \\ \varepsilon_{FF} \end{bmatrix} = \begin{bmatrix} 1 & \varphi_{12} & \varphi_{13} & \varphi_{14} & 0 & 0 \\ \varphi_{21} & 1 & \varphi_{23} & 0 & \varphi_{25} & 0 \\ 0 & \varphi_{32} & 1 & 0 & \varphi_{35} & 0 \\ \varphi_{41} & \varphi_{42} & \varphi_{43} & 1 & \varphi_{45} & \varphi_{47} \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} e_{i} \\ e_{y} \\ e_{\pi} \\ e_{E} \\ e_{0} \\ e_{FF} \end{bmatrix}$$

14

Methodology

Estimating the Contribution of MP in Macroeconomic Performance

- The optimal monetary policy is defined as a policy that minimizes the variability of the CB's ultimate objectives from their target
- Macroeconomic performance is defined in terms of both price stability and output stability
 - A reduction in inflation variability for a given variability of output should be identified with an improved welfare loss
- Adopt the methodology used by the Taylor (2013) and Cecchetti and Ehrmann (2002)
- Measure the macroeconomic performance using the welfare loss function

$$P_i = \lambda Var(\pi_i) + (1 - \lambda) Var(y_i) \quad 0 \le \lambda \ge 1$$
(11)
(*i*=1,2,3,.....periods)

$$\Delta P_{it} = P_{it-1} - P_{it} \qquad (12)$$

Methodology

Estimating the Persistence of Variability of Output and Inflation to Demand and Supply Shocks

- Demand shock moves output and inflation in the same direction while supply shock moves them in opposite directions and creates a policy dilemma (Supply shocks will force CB to face a trade-off in the longrun)
- Estimate the Aggregate Demand and Phillips Curve Equations
- Estimate the IRFs to check how the variability of output and inflation reacted in response to demand and supply shocks

Aggregate Demand Equation

$$y_{t} = c_{1,0} + \sum_{i=1}^{n} \delta_{1,t} y_{t-1} + \sum_{i=1}^{n} \beta_{1,t} \pi_{t-1} + \sum_{i=1}^{n} \kappa_{1,t} i_{t-1} + \sum_{i=1}^{n} \phi_{1,t} exr_{t-1} + \sum_{i=1}^{n} \psi_{1,t} oil_{t-1} + \varepsilon_{1,t}$$
(13)

Phillips Curve Equation

$$\pi_{t} = c_{2,0} + \sum_{i=1}^{n} \delta_{2,t} y_{t-1} + \sum_{i=1}^{n} \beta_{2,t} \pi_{t-1} + \sum_{i=1}^{n} \phi_{1,t} exr_{t-1} + \sum_{i=1}^{n} \psi_{1,t} oil_{t-1} + \varepsilon_{2,t}$$
(14) 16

- 1
- Examine the Taylor curve relationship in Sri Lanka
- 2 Study how persistent are variability responses to demand and supply shocks
- 3 Estimate the parameters of Taylor Curve Equations
 - i. Inverse slope of the AS curve
 - ii. Policy makers' aversion to inflation variability
 - Examine the Contribution of Monetary Policy to Macroeconomic Performance in Sri Lanka
 - i. Estimate the Welfare Loss in Sri Lanka

1. Taylor Curve Relationship in Sri Lanka

 According to Taylor (1999), the monetary policy is optimal when the trade-off between the variability of output the variability of output is negative.

 The monetary policy is suboptimal if the tradeoff between the variability of inflation and output is positive (Friedman, 2006).



1. Taylor Curve Relationship in Sri Lanka

Trade-off between the Variability of Inflation and Output

	Average		Average		•	Monetary
Periods	Inflation Rate	Economic Growth Rate	Inflation Variability	Output Variability	⁻ Correlation	Policy Stance
1980-2017	10.4605	5.2020	4.3282	1.1085	-0.0384	Optimal
1980-2000	11.8086	5.0697	4.9142	0.8408	0.2908	Suboptimal
2001-2009	12.5638	4.9079	5.0341	1.4474	-0.1991	Optimal
2009-2017	4.9846	5.8001	2.1949	1.4411	-0.1068	Optimal

- The positive correlation suggest that the CBSL has placed more weight on stabilizing both inflation and output
- Estimating correlation coefficients as a time-varying process would provide more insights on how the Taylor curve relationship has evolved over time

1. Time-Varying Rolling Correlation

- Assumed that the CBSL implemented its MP in a forward-looking manner. The real effects of MP will be materialized after 2 years
- Time-varying correlations analysis shows that MP was operating at both optimal and suboptimal levels



1. Shifts in Taylor Curve Relationship in Sri Lanka

- The distance between the origin and the Taylor curve was small in the post-war period, indicating MP was most satisfactory in reducing the variabilities of output and inflation
 - The opportunity cost of reducing the variability of inflation in terms of output variability was low during the post-war period



1. Taylor Curve and Business Cycles in Sri Lanka

• In most of the periods, the positive trade-off is followed by a slowdown in output growth



Rolling Correlation of Volatilities and GDP Growth (1987-2017)

Suggests that the suboptimal monetary policy could adversely affect economic growth

2. Persistence of Variability of Output and Inflation to Demand and Supply Shocks

- After estimating Aggregate Demand and Philips Curve equations, we estimated the IRFs to check how the variability of output and inflation reacted in response to demand and supply shocks
- Used the generalized IRFs to deal with orderings of the variables

2. Persistence of Variability of Output and Inflation to Demand and Supply Shocks (continued)

1980-2017

1980-2000



2. Persistence of Variability of Output and Inflation to Demand and Supply Shocks (continued)

2001 - 2009

2009 - 2017



3. Parameters of Taylor Curve Equation

3. 1 Inverse Slope of the AS Curve

• Using the estimated IRFs, we calculated the maximum impact of MP shock on inflation and output

Period	Maximu	m Impact	Inverse Slope of
	On Output	On Inflation	Aggregate Supply Curve <mark>(φ)</mark>
Full Sample	-0.0106	-0.4486	0.2893
1980-2000	-0.0322	-0.0049	0.2012
2001-2009	-0.1889	-0.2284	0.2830
2009-2017	-0.2138	-0.3576	0.2937

The Impact of Monetary Policy Shock on Output and Inflation

Inverse slope of the AS curve (ϕ): Three years average of the impact of MP shock on output divided by three years average of the impact of MP shock on inflation

- MP shock has produced a much larger response in inflation compared to output
- We will use the φ to calculate the policymaker's preferences

3. Parameters of Taylor Curve Equation (continued)

3.2 Policymakers' Aversion to Inflation Variability

- Using the ratio between the variability of output and inflation along with the estimated value for φ , we estimated policymakers' aversion to inflation variability (λ)
- However, as the country registered a monthly inflation rate on average of more than 20% during the 1980s and 1990s, a 5% inflation rate as a target could be perceived as an unrealistic policy goal during these periods
 - Assumed that the targeted level of inflation is equivalent to the average level of inflation recorded in each policy regime
 - For comparison purposes, we estimated λ in both cases
- The desired level of inflation (π^*) in the first case equivalent to average inflation while in the second case it is equivalent to the fixed level of 5%
- Throughout the period we assumed that the estimated φ is unchanged

3. Parameters of Taylor Curve Equation (continued)

Shifts in the Aversion to Inflation Variability

	Aversion to Inflation Variability (λ)		
Period	$y^* = trend, \pi^* = average \pi$	$y^* = trend, \pi^* = 5\%$	
Full Sample	0.6504	0.7017	
1980-2000	0.5272	0.6543	
2001-2009	0.6773	0.6085	
2009-2017	0.7278	0.6675	

- **Full Sample:** The λ shows that inflation stabilization remains the major concern of the CBSL
 - When desired inflation was assumed to be 5%, country registered an increased level of aversion to inflation variability (0.7017).
- **Sub-Sample:** The estimated λ values under different policy regimes are quite prominent.
 - 1980-2000 : The CBSL has placed more weight on stabilizing both inflation and output
 - 2009-2017: The CBSL significantly reduced relative weight on output

4. Contribution of MP to Macroeconomic Performance

The Estimated Welfare Loss and Performance Change

Period	Estimated λ	Welfare Loss (For different λ)	Welfare Loss (For constant λ = 0.6505)
1980-2017 (Full Sample)	0.6505	3.2028	3.2028
1980-2000	0.5872	3.2325	3.4904
2001-2009	0.6773	3.8783	3.7816
2009-2017	0.7278	1.9898	1.9315
Performance Gain (Loss) in %	1980-2000 to 2001-2009	(19.974)	(8.342)
	1980-2000 to 2009-2017	38.446	44.664
	2001-2009 to 2009-2017	48.694	48.924

- Slight increase in welfare loss during 2001-2009 (3.7816) compared to 1980-2000 (3.4904)
 - Partly contributed by increased inflation variability caused by adverse supply shocks
- Welfare loss improved significantly during the post-war period (2009-2017)
 - Confirms that MP during this period was optimal compared to other periods
- Larger increase in performance gain indicates substantial improvements in welfare loss 29

4. Contribution of MP to Macroeconomic Performance (continued)

Time-Varying Welfare Loss





- The graph 'A' shows the time-varying welfare loss for constant λ (λ =0.6505) while 'B' shows for different λ
- Welfare loss from fourth quarter of 2016 to the end of 2017 fell significantly though the time-varying correlation analysis showed that MP was suboptimal in this period

Concluding Remarks: Principal Take-aways

Taylor Curve Relationship

- Sri Lanka experienced a transition from relatively higher volatile inflation regimes to more stable regimes, however, the variability of output increased over the periods
 - The reduced inflation variability was attained at the expense of increased output variability
- The patterns of the estimated Taylor curves varied under different monetary policy regimes
- The response of variability of output and inflation to demand and supply shocks are not persistent
- MP shock produced a much larger response in inflation compared to output

Aversion to inflation variability

- The estimated policymakers' aversion to inflation variability suggest that Sri Lanka took the goal of inflation stability very seriously during the study period
 - Aversion to inflation variability has increased substantially at varying degrees over time
 - Policymakers attached a greater level of weight on stabilizing inflation

Welfare Analysis

 Substantial improvements in welfare loss during the post-war period and confirmed that MP during this period was optimal compared to other periods
 ³¹

Thank You