Testing Credibility of Inflation Targeting: Evidence from Sacrifice Ratio

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Abstract

Inflation targeting (IT) has been popular in emerging economies. This paper measures sacrifice ratio for 13 Asian economies. The proposed study makes use of episode method technique for the period 1970 to 2014. Empirical findings based on annual data suggest that IT regime has significant role in achieving low sacrifice ratio. The IT countries is managed to forgo 0.11 to 0.23 percent loss in real GDP in order to achieve a fall in 1 percent level of long run inflation. Similarly, non-IT countries have suffered from 1 to 1.23 percent loss of real GDP in order to gain 1 percent decline in the long run inflation rate. This low sacrifice ratio in IT countries were explain by IT regime. Other determinants like Initial Inflation, Openness, Central Bank Independence, Real Exchange Rate, and Inflation history were found significant in explaining the sacrifice ratio in Asian economies. However, speed of inflation remained insignificant through the calculations.

Keywords: Disinflation, Sacrifice Ratio, Episode Method

JEL Classification: E52, E58

JEL Classification: E4, E5, E6, C01

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Introduction

It is well known from standard macroeconomic text that there exist a tradeoff between inflation and unemployment in the short run. In the meantime it is suggested that a credible monetary policy can reduce the rate magnitude of tradeoff to a low level. Inflation targeting (IT) regime has been popular across the globe, especially in emerging economies since its inception in the early 1990's. A dozens of studies have confirmed the effectiveness of IT regime in various macroeconomic aspects such as reducing inflation, inflation and growth volatility, and curbing expectations etc.[1] However, there has been debate in the academic sphere regarding the effectiveness of IT in reducing the disinflation cost. The disinflation cost, which is in other words known as sacrifice ratio, is defined as the percentage loss in the annual real GDP in order to achieve a 1 percentage fall in the long run inflation. When Goncalves and Carvalho (2009) arrived at the conclusion that IT has significant impact in reducing sacrifice ratio, In the meantime, Brito (2010) claimed that IT has no significant impact on disinflation cost. Similarly, Mazumder (2014) arrived at same conclusion that there is no credibility bonus from the IT regime neither in OECD economies nor in non OECD economies. But later De Roux and Hofstetter (2014) found that IT framework has potentiality to reduce the sacrifice ratio significantly. They show that IT and speed of disinflation can be used alternatively as a credible monetary policy to achieve a low sacrifice ratio. It is believed that the explicitly enhanced features of IT framework could be proved as a credible monetary policy. The high level of transparency though effective communications and explicit quantitative target with accountability makes the policy more credible.[2] The findings of Mazumder (2014) for non-OECD economies has been tested in the light of two other episode methods such as Zhang (2005) and Hofstetter (2008). It is proved in several studies that Ball (1994) method, which

[1] Mishkin et al. (2001), Sevnsson (2010), Numann and Hagen (2002).
[2] Dincer and Eichengreen (2007) shows that inflation targeting is more transparent that any other regime such as exchange rate regime etc.

Mazumder (2014) used in his study, underestimates the true cost of disinflation by not accounting the additional cost of output due to persistency.

So, this study makes an attempt to find out the credibility aspects of IT regime. In nutshell, this paper focuses on the significant role of IT in achieving low sacrifice ratio compared to non IT countries. Our work differs from the existing literature in two ways. Firstly, we present

The rest of the paper is structured as follows: Section II presents a review of relevant literature of the determinants of sacrifice ratio. Section III describes the episode methodology. Sections IV discusses the results. Section V presents Robustness test. Finally, concluding remarks are offered in the last section.

II. Review of Literature

Different methods have been used to calculate the sacrifice ratio in both developed and developing economies. Okun (1978) made a first attempt to estimate sacrifice ratio for the U.S economy. Using Philips curve method an average sacrifice ratio of 10 percent was found. However, some other studies claimed that Okuns' measure is not a time varying measure of sacrifice ratio. It assumes the disinflation cost on output to be the same in the time of increasing inflation and disinflation. To solve the problem of Okuns' method, Ball (1994) developed a new method called 'episode method' of sacrifice ratio. This method selects the episode which follows a period of contractionary monetary policy and then measures the sacrifice ratio for that episode. Taking all OECD countries he found an average sacrifice ratio of 1.4 percentage for quarterly data and 0.8 for annual data. But Zhang (2005) followed the Ball's (1994) method with some modification in the measurement of trend output. The changes could capture the high persistency effects in the output recovery process. For a quarterly sample that starts from 1960Q1 to 1999Q4, he found an average sacrifice ratio of 2.5 for G-7 countries which is different from 1.4 using Ball's method. So, he claimed that Ball's (1994) method is underestimating the true cost of output from a disinflationary policy. In addition, Hofstetter (2008) calculated the sacrifice ratio for Latin American Countries with further modifications in the Zhang's (2005) method. Using an annual data from 1973 to 2000, he found an interesting result of sacrifice ratio for sample countries. The sacrifice ratio was 1.68 for 1970's and 1980's whereas for 1990's the ratio was negative. He again confirmed that Ball's method underestimated the cost of disinflation. Senda

and smith (2008) considered OECD countries and used three different episode methods to calculate sacrifice ratio. With a sample of both quarterly and annual time series, they found sacrifice ratio of 1.65 for quarterly data and 1.17 for annual data. They also observed that sacrifice ratio estimation through Zhang (2005) is higher than Ball's method and lower than Hofstetter (2008) method. But later it was pointed out that the episode method was not able to identify the loss of output explicitly induced by tight monetary policy shocks (Cecchetti, 1994; Belke and Boing, 2014 and Dholakia, 2015). As a result, the estimate through episode method is not only considered as the impact of demand shock but also the influence of supply shocks. Durai and Ramachandran (2014) used an episode method to estimate sectoral sacrifice ratio for India. Their calculation showed that the negative sacrifice ratio (-0.1 to -2) in firm sector gets offset by the positive sacrifice ratio (0.7) in non-firm sector yielding an overall low sacrifice ratio. Dholakia and Virinchi (2015) used both regression approach and episode method to calculate disinflation cost for India. His estimation of the sacrifice ratio varied from 1.7 to 3.8 depending upon the inflation measure and method used in the calculation.

III. The Episode Method

There are three different episode methods in the literature to calculate the sacrifice ratio. Ball (1994) was the first episode method to sacrifice ratio. Later, Zhang (2005) and Hofstetter (2008) modified Ball's (1994) method of calculation. In spite of Popularity, Ball (1994) method remained an unattractive for underestimating true cost of disinflation. A vast literature is found using episode methods to estimate the sacrifice ratio. However, those studies were limited to advanced countries only.

This method calculates the sacrifice ratio for both quarterly and annual data. It calculates episode specific sacrifice ratio. An episode is identified from the trend inflation. For annual data the trend inflation for a year is interpreted as the 8 quarter moving average of actual inflation. The trend inflation for year *t* is the average of four quarters inflation of that year and 2 quarters in each side. From that trend inflation, inflation peak and trough is identified. In annual data, year *t* is an Inflation peak (trough) if the trend inflation is higher (lower) than the *t-1* and *t+1* year. Here, instead of using 4-quarter period, he has used 1 year time period. Then a disinflation episode is defined if the trend inflation falls by 1.5 rather than 2 percent as before between inflation peak and inflation trough.

Output Gap:

Output gap is calculated by taking difference between potential output and actual output. In both the methods, the potential output is reached by calculating the growth rate of HP filter. But in

Zhang (2005) method, the potential output for an episode is calculated by taking the growth rate at the peak of an episode. In Hofstetter (2008), potential output is calculated in similar fashion but consider additional 1 year lag period to output loss. He assumed that output loss starts 1 year before the start of an episode. Then as usual, the output loss is calculated till next 1 year after an episode is end. The main advantage of this two model is that it does not force the trend output to return to potential level 1 year after a disinflation is over.

The sacrifice ratio is calculated as

$$SR = \frac{Output\ Gap}{Declined\ Trend\ inflation}$$

Here, output gap is defined as the difference between potential output and actual output. The decline in trend inflation is calculated as the difference between the trend inflation at peak and trend inflation at trough.

IV. Data and Sacrifice Ratio

The data on inflation, Real GDP and Real exchange rate are obtained from the International Macroeconomics Data set of the U.S Department of agriculture (USDA). The Gross Debt data is taken from IMF's World Economic Outlook database 2015.[3] Our sample ranges from 1970 to 2014 for 13 Asian countries. The inflation is measured as the percentage change in consumer price index (CPI). We followed the Ball (1994) methodology to identify the episodes with two modifications. First of all the trend inflation is calculated as the three year moving average of actual inflation. Secondly, we discarded the episodes that shows an inflation peak of above 25 percent. Here, the advantage of having a large sample is to make a sensible comparison of the results between IT and non-IT countries. The Table 1 shows details of all episodes and corresponding sacrifice ratios for the sample countries.

[3] But here the data starts at 1980 and ends at 2014 for all sample countries.

Table 1

Country	Episode	Length	Peak	Disinflation	Zhang	Hofstetter	Speed	IT Dummy	Year of IT adoption
Korea	1990	6	8.03	3.42	3.89	4.61	0.17	0	April. 1998
Korea	1996	4	5.62	3.26	-0.34	-0.40	0.25	1	
Indonesia	1978	7	15.5	8.89	1.49	1.73	0.14	0	July. 2005
Philippines	1971	4	19.64	11.02	0.68	0.86	0.25	0	January. 2002
Philippines	1978	3	16.27	5.16	0.06	0.10	0.33	0	
Philippines	1988	12	13.91	11.27	-2.97	-3.20	0.08	0	
Thailand	1972	3	13.05	7.36	1.15	1.56	0.33	0	May. 2000
Thailand	1978	6	14.08	12.37	1.18	1.39	0.17	0	
Thailand	1995	4	6.47	5.31	0.01	0.77	0.25	0	
Thailand	2005	4	4.11	2.04	-3.78	-4.77	0.25	1	
Israel	1988	15	18.8	18.28	-0.10	-0.08	0.07	1	June.1997
China	1997	5	5.24	3.25	1.10	1.39	0.20	0	
China	1987	3	14	8.8	1.03	1.39	0.33	0	
China	1993	6	17.72	18.16	0.67	0.82	0.17	0	
Hong Kong	1996	2	2.89	3.33	2.79	4.23	0.50	0	
Hong Kong	1980	5	11.35	7.11	2.82	3.41	0.20	0	
Hong Kong	1988	11	10.59	13.69	1.28	1.41	0.09	0	
Taiwan	1972	3	20.29	15.37	1.01	1.35	0.33	0	
Taiwan	1978	6	15.03	14.86	1.62	1.91	0.17	0	
Taiwan	1988	13	4.26	4.45	6.49	7.10	0.08	0	
Pakistan	1972	4	23.54	15.74	0.23	0.30	0.25	0	
Pakistan	1978	7	10.69	6.09	2.09	2.44	0.14	0	
Pakistan	1993	8	11.69	8.58	-0.31	-0.33	0.13	0	
Iran	1979	5	21.17	9.39	-2.67	-3.21	0.20	0	
Iran	2006	3	18.75	4	-1.24	-1.64	0.33	0	
Kuwait	1976	10	8.54	7.52	-7.86	-8.66	0.10	0	
Kuwait	1988	4	7.77	7.31	-1.20	-1.49	0.25	0	
Malaysia	1972	3	10.79	6.83	1.85	2.50	0.33	0	
Malaysia	1979	6	7.39	6.74	2.48	2.93	0.17	0	
Malaysia	1995	6	3.8	2.4	4.95	5.84	0.17	0	
Malaysia	2005	4	3.69	1.87	-1.49	-1.80	0.25	0	
Singapore	1973	3	14.84	13.56	1.18	1.58	0.33	0	
Singapore	1979	6	6.92	7.04	4.13	4.76	0.17	0	
Singapore	1989	12	3.07	3.44	12.00	13.07	0.08	0	
Mean (All)		**5.97**	**11.45**	**8.17**	**1**	**1.23**	**0.21**		
Mean (IT)		**6.18**	**12.31**	**8.03**	**0.11**	**0.23**	**0.2**		
Mean (non-IT)		**5.86**	**11.04**	**8.24**	**1.43**	**1.7**	**0.21**		

Following the Ball (1994) procedure we end up with 34 episodes, a reasonable number of sample, for the Asian countries. We observed that most of the countries have experienced an average number of two to four episodes with a mean length of episodes to be five years long. Interestingly, most of them are concentrated in the period of 1970 to 1980 showing a major disinflation occurred in the 70s for the sample countries. Here, we have modified De Roux and Hofstetter's (2014) criteria to define an episode is under IT regime or not. We assumed that a disinflation episode occurred at least 50% in the IT period is considered as the IT led disinflation. This assumption was made in order to verify the argument of Bernanke et al. (1999)-credibility bonus from IT regime is not observed for the first episode.[4] With this proposed criteria, we have obtained 3 IT episodes for the entire sample. Finally, sacrifice ratio was presented using Zhang (2004) and Hofstetter (2008) methods. The rationality of including these two methods underlines its superiority in capturing the persistency effects. The main problem with Ball (1994) method is that it fails to count the long lived effects of disinflation and as a result ignores the additional output loss. Further, Mazumder (2014) has already used this method for a large sample including all Asian economies. But his study lacks power in explaining the true cost since only Ball (1994) method was used to measure the disinflation cost.

The average sacrifice ratio for the entire sample is 1 for Zhang method and 1.23 for Hofstetter method. In the meantime, Mazumder (2014) found sacrifice ratio of 0.11 for the same sample using Ball (1994) method.[5] This result confirms the widely cited view that the Ball (1994) method underestimates the true cost of disinflation. Yet again, we get higher sacrifice ratio by taking long lived and lagged effects into account for the sample countries. The estimated sacrifice ratio is in the line with some of the advanced countries results (Ball, 1994 and Zhang, 2005 and De Roux and Hofstetter, 2014). The high disinflation cost for this two methods indicates that the disinflation has persistency effect. Further, the magnitude of output loss is significant thus suggest that the disinflation is costly across the Asian countries. However, this story is not same for all the countries in sample. If we look at the sacrifice ratio by dividing the sample into both IT countries and non-IT countries, it is observed that IT group have enjoyed little cost of disinflation compare to non-IT group. The Table 1 reports the mean value of

[4] The adoption date of IT regime in the member countries are taken from Bank of England report, 2012.
[5] We just added up the sacrifice ratio calculated in the Mazumder (2014) paper for our sample countries. The sacrifice ratio for our sample is 0.11 for same time period that we have considered here. .

sacrifice ratio for two methods. The mean sacrifice ratio for former group is 0.11 for Zhang method and 0.23 for Hofstetter method respectively. Conversely, the non-IT group have suffered from mean sacrifice ratio of 1 for Zhang method and 1.23 for Hofstetter method. In other words, we can say that the IT countries is managed to forgo 0.11 to 0.23 percent fall in real GDP in order to achieve a fall in 1 percent level of long run inflation. Similarly, non-IT countries have suffered from 1 to 1.23 percent loss of real GDP in order to gain 1 percent decline in the long run inflation rate.

III. Sacrifice Ratio Dynamics over four Decades

Sacrifice ratio in 1970s and 1980s:

The disinflation cost for 1980s have shown a mild increase in the sacrifice ratio then 1970s. The average sacrifice ratio is 0.57 for Zhang method in 1970s and 0.76 for Hofstetter method. Similarly, sacrifice ratio for the decade 1980s is little higher and it is 0.91 for Zhang method and 1.06 for Hofstetter method.[6] This low sacrifice ratio can be explained by the high initial inflation. The sample countries have pursued disinflation policy during high inflation at the start of a disinflation episode. The mean inflation peak was 14.51 for 1970s and 10.46 for 1980s. As we know that initial inflation work as a nominal rigidity, then high trend inflation has tendency to reduce the inflation output trade-off and hence low disinflation cost.

Sacrifice ratio in 1990s:

The sacrifice ratio is substantial for the decade 1990s. This period has shown an increase in the average sacrifice ratio of 2.04 in Zhang method and 2.12 in Hofstetter method. This kind of similar phenomena is experienced by Zhang for G-7 countries. According to him, this high disinflation cost might be due to slow recovery in the output growth. It means, after recession output takes time to return to the potential level. Interestingly, we observed same problem of slow recovery of output, in Asian economies, after the disinflation. Further, looking at the initial level of inflation it was confirmed that the low peak in 1990s has resulted in high sacrifice ratio. The average inflation peak was 7.68 in 1990s compare to 14.51 in 1970s and 10.46 in 1980s respectively. This indicates that the country having low inflation rate at the starting of

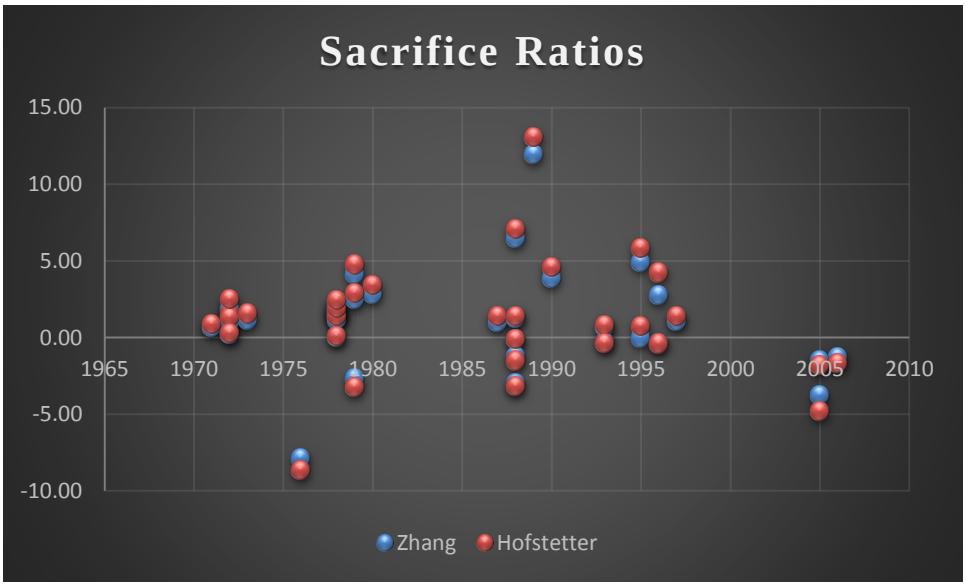
[6] We have excluded one episode of having a highlighter in the series.

disinflation has tendency to suffer from high sacrifice ratio. It is obvious that reducing 2 % of initial inflation is different from reducing 7 % of initial inflation. Further detail explanation has been given in the next section. Although another possibility may be the measurement error in the HP method, but it was found insignificant from the calculation of HP filter series.

Sacrifice ratio in 2000s:

The period 2000s has shown negative sacrifice ratio indicating that there is no harm to reduce inflation. It means, the loss in real GDP is insignificant in following a contractionary monetary policy for Asian economies. This result may be traced to the idea of Hofstetter (2008) where it was found that disinflation is costless for Latin American and Caribbean countries. The results remain unchanged irrespective of methods used to calculate the sacrifice ratio. One possible explanation was given by Hofstetter that the factors like trade reforms, appreciation in real exchange rate could contribute to enjoy low sacrifice ratio in an emerging economies.

Figure 1



The scattered plot of sacrifice ratios shows that the sacrifice ratio has increased in late 1980s and ends in late 1990s. The Figure 1shows the dynamics of sacrifice ratio over the four decades. The increase in the both red and blue dot in late 1980s and decline to lower level in late 1990s confirms the sacrifice ratio has increased for that decade. Furthermore, looking at extreme side of

the graph it is found that the sacrifice ratio was positive for 1970s and 1980s but turned into negative in 2000s.

IV. Determinants of Sacrifice Ratios

Here, we have tried to find out the factors that significantly reduces the sacrifice ratios. In the literature there have been several studies that have addressed this issues. For the first time Ball (1994) raised this issues and studied several determinants that explain sacrifice ratio. He found that both high speed of disinflation and high initial inflation are significantly reducing sacrifice ratio. Zhang (2005), Hofstetter (2008), Senda and Smith (2008), Mazumder (2014), De Roux and Hofstetter (2014) also supported the view. Subsequently other studies claimed that the openness, central bank independence, transparent central bank and history of inflation have significant role in achieving low sacrifice ratio (Temple, 2002; Bowdler, 2009; Chortareas et al., 2002; Senda and Smith, 2008). However, most of these studies have focused on advanced countries only. Mazumder (2014) studied non-OECD countries and found some of the important determinant to be insignificant that were significant in advanced countries. However, there is debate among researcher regarding the effectiveness of inflation targeting as an important determinant of sacrifice ratio. Goncalves and Carvalho (2009) did a study on OECD countries to access the significance of IT in achieving small sacrifice ratio. Their study found that IT has potentiality to reduce disinflation cost significantly in the member countries compared to non-IT countries. Conversely, Brito (2010) claimed that IT has no credible bonus for the member countries. He shows that sacrifice ratio is high for OECD countries once the common economic conditions is taken into consideration. Extending Goncalves and Carvalho's (2009) sample, he even found that sacrifice ratio is high in IT countries compared to non-IT countries. Mazumder (2014) also had similar findings for both OECD and non- OECD countries. But in the meantime, De Roux and Hofstetter (2014) came up with one important findings that the IT and speed can be used as substitute for low sacrifice ratio. They considered both Goncalves and Carvalho's (2009) sample and Brito's (2010) sample and show that IT remain a significant determinants to reduce sacrifice ratio. Even after controlling for common economic conditions, the result remained significant across the episode methods.

4.1 Inflation Targeting and Sacrifice Ratio

The Table 2 presents the OLS results of some of the important determinants that significantly influence sacrifice ratio. The rationality of using OLS method to a panel data is that this method is more popular and commonly used in literature.

Table 2 Determinants of Sacrifice Ratio

Dependent Variable:	Zhang SR	Hofstetter SR	Zhang SR	Hofstetter SR	Zhang SR	Hofstetter SR
IT	-3.15**	- 4.17**	-3.51**	-4.26**		
	(1.55)	(1.72)	(1.51)	(1.81)		
Speed	-3.38	-2.12	6.67	6.76	3.49	5.87
	(7.06)	(8.24)	(5.10)	(5.34)	(5.20)	(6.26)
Length			0.36	0.27	0.28	0.33
			(0.29)	(0.33)	(0.32)	(0.35)
Disinflation	0.003	0.03			-0.15	-0.16
	(0.08)	(0.10)			(0.10)	(0.11)
RER	-0.0001**	-0.0002**			-0.0001***	-0.0002***
	(0.00003)	(0.0003)			(0.00003)	(0.00004)
Peak	-0.15**	-0.19**	-0.17*	-0.20**		
	(0.07)	(0.08)	(0.08)	(0.10)		
Constant	3.84	4.14	-0.30	-0.81	0.03	-0.39
	(2.75)	(3.06)	(2.49)	(3.03)	(2.25)	(2.62)
R-squared	0.18	0.20	0.20	0.22	0.12	0.12

Notes: The dependent variable is Zhang SR and Hofstetter SR. Zhang SR means sacrifice ratio through Zhang method. Similarly, for Hofstetter SR. Speed is disinflation rate for an episode. Length is the duration of an episode. Disinflation is the amount of fall in inflation in an episode. Peak is the initial level of inflation at the start of an episode. RER is the real exchange rate. IT is a dummy variable for inflation targeting regime. White robust standard errors in parentheses.

*** indicates 1% level of significance.
** indicates 5% level of significance.
* indicates 10% level of significance.

From the estimation our findings suggest that IT remains a significant determinant in reducing the sacrifice ratio for Asian economies. The coefficient of IT is significant at 5 % level of significance throughout the results. Here, disinflation under IT period has resulted in significant fall in sacrifice ratio, say 3.15 to 4.26 percent. The result remained unchanged irrespective of methods and specifications used in the estimation. This result reject the Mazumder's (2014) argument that IT is not an important determinants in non-OECD countries to explain sacrifice ratio. Thus, it confirms the credibility aspect of inflation targeting which De Roux and Hofstetter (2014) have suggested in their work. The IT regime works as a credible monetary policy by establishing a strong commitment to a quantitative target. The explicit target not only helps the people to make rational expectations but it has also an important role to play in reducing the nominal rigidity. The strong commitment and high transparency through constant effective communications to the economic agents works as an effective anchor to the expectations and hence helps to achieve a less costly disinflation.

4.2 Speed of disinflation, Initial level of inflation and Sacrifice Ratio

There is a debate between gradualism versus "cold turkey" approach regarding the process of disinflation. Taylor (1983) favoured gradualism and argued that disinflation in slow process can lead to low sacrifice ratio. He argued that wages and prices respond slowly to the monetary policy shock since the expectations are adaptive type in nature. A quite contrast to that, Sargent (1983) pointed out that fast disinflation can achieve low sacrifice ratios because of the quick adjustment of people's expectations. Our findings support the view of Mazumder (2014) who claimed that the speed of disinflation is not a significant determinants in developing countries. Here, we have used 1/d as the speed of disinflation instead of $\frac{\Delta\pi}{d}$. This changes is made to avoid the spurious correlation between sacrifice ratio and speed of disinflation. The statistical significance of speed coefficient remained negligible throughout the models and specifications. The sign of the coefficient is not consistent throughout the estimations. The negative sign in the two cases confirms that the speed is negatively related to sacrifice ratio but it has no significant role to reduce sacrifice ratio.

Ball, Mankiw and Romer (1988) show that high trend inflation reduces the nominal rigidity through shorter duration of contact and hence experience low tradeoff between output and

inflation. While testing the argument, Zhang (2005) study found a significant negative relationship exist between inflation peek and sacrifice ratio. However, Ball (1994) and De Roux and Hofstetter (2014) suggested that there exist weak relationship between high inflation peak and sacrifice ratio. Our result in Table 2 show that the relation between initial inflation and sacrifice ratio is strong and bears correct sing. The high statistical significance and negative sing indicates that countries can experience less costly disinflation if the disinflation is pursued at high peak. By following a disinflation policy at higher peak the countries can reduce sacrifice ratio by 15 to 19 percent. This findings goes against the Mazumder's (2014) view that the initial inflation is irrelevant for non-OECD countries.

4.3 Real Exchange Rate and Sacrifice Ratio

It is commonly believed that appreciation in the exchange rate will lead to low inflation through cheap imports and vice-versa. Fisher (1988) shows that appreciation in the real exchange rate lead to low sacrifice ratio. This appreciation in the currency might be due to massive flow of capital into the respective countries. Hofstetter (2008) found insignificant impact of currency appreciation on sacrifice ratio. The calculated coefficient is negative and significant at 5% level of statistical significance. Our results support the view of Fisher (1988) which indicates that the appreciation in real exchange rate (RER) has significant negative impact on sacrifice ratio. The results are consistent whatever models and specifications are used as shown in the Table 2 and 3.

4.4 Nominal Wage Rigidity and Sacrifice Ratio

Ball (1994) and Boschen and weise (2001) argued that there exist an inverse relationship between nominal wage rigidity and sacrifice ratio. It means, the country having more flexible wage regime has tendency to achieve low sacrifice ratio from disinflation. We have used history of inflation as a proxy to measure the nominal wage rigidity. The history of inflation is defined as the 10 years average of preceding inflation of a disinflation episode. This definition is borrowed from Hofstetter's (2008) interpretation of history of inflation. From the Table 3, we observe that history of high inflation has tendency to achieve low sacrifice ratio. The coefficients shows correct sign and is significant at 5% and 10% level of significance. This findings support the argument of Hofstetter that there exist a negative relation between history of inflation and

sacrifice ratio. However, the statistical significance of H^{10} changes when Hofstetter method is used.

Table 3 Determinants of Sacrifice Ratio

Dependent variable:	Zhang SR	Hofstetter SR	Zhang SR	Hofstetter SR	Zhang SR	Hofstetter SR
IT			-2.76**	-3.36**		
			(1.36)	(1.68)		
Speed			-3.53	-2.71		
			(7.03)	(8.38)		
RER	-0.0002***	-0.0002**			-0.002***	-0.0001***
	(0.0003)	(0.0002)			(0.0004)	(0.0003)
H^{10}	-0.01**	-0.01*				
	(0.007)	(0.008)				
Openness^{PWT}			0.01**	0.01**		
			(0.008)	(0.008)		
CBI					-7.35**	-8.19**
					(3.47)	(3.80)
CBI*Openness					0.08**	0.09**
					(0.04)	(0.04)
Constant	1.39**	1.67**	0.40	0.36	1.17	1.49
			(1.91)	(2.23)	(0.59)	(0.64)
	(0.63)	(0.71)				
R-squared	0.06	0.07	0.28	0.27	0.26	0.27

Note: H^{10} refers to the average ten years inflation at the starting of an episode. Openness is the Penn World Tables' measure of trade openness. CBI is an index of the central bank independence taken from Polillo and Guillen (2005). CBI*Openness is the interaction of both factors. White robust standard errors in parentheses.

*** indicates 1% level of significance.
** indicates 5% level of significance.
* indicates 10% level of significance.

4.5 Openness and Sacrifice Ratio

Romer (1993) stressed importance on the degree of openness and fall in inflation. The high openness can influence the output-inflation tradeoff through exchange rate induced fall in

inflation. Temple (2002) found a weak connection between openness and sacrifice ratio. Our result goes against the Mazumder's argument that openness is irrelevant for non-OECD countries. The coefficient is significant at 5 % level indicating that the countries having more openness in trade can have low sacrifice ratio. It means, disinflation under a high open economy has positive result in terms of low output loss.

4.6 Central Bank Independence (CBI) and sacrifice ratio

It is believed that higher central bank independence (CBI) is associated with low sacrifice ratio, although there are others who argued in opposite direction. It means that more the central bank is independent from political interference, larger the power of central bank to achieve lower sacrifice ratio. In the Table 3 we find the supporting evidence in favour of central bank independence to reduce sacrifice ratio. The coefficient of CBI is significant at 5 % level and shows expected sign. The negative sign of coefficient indicates that high independence of central bank is related to low disinflation cost. The credibility bonus from independence has significant impact on sacrifice ratio.

4.7 Interaction effects of Openness and CBI on Sacrifice Ratio

Daniels et al. (2005) viewed that countries openness with central bank independence has significant role in reducing sacrifice ratio. So, we jointly considered to access the effects on sacrifice ratio. The OLS regression presented in the Table 3 suggest that a country with high openness combined with high central bank independence, has tendency to achieve higher sacrifice ratio. The coefficient of openness*CBI is significant at 5% level but bears incorrect sign. This findings states that the joint effects is irrelevant to achieve a low sacrifice ratio. In other words, the country under joint effects should not pursue disinflation policy because it is costly.

V. Robustness check

To check the robustness of our findings we replicates some of our main results using country specific fixed effects method. It is suggested that panel data should be tested through country specific fixed effect model instead of OLS method. So by testing the fixed effect model, we arrive at the same conclusion. The clear result is reported in Table 4 and 5.

Table 4

```
Fixed-effects (within) regression               Number of obs      =        34
Group variable: id                              Number of groups   =        13

R-sq:  within  = 0.2844                         Obs per group: min =         1
       between = 0.0405                                        avg =       2.6
       overall = 0.1510                                        max =         4

                                                F(2,19)            =      3.78
corr(u_i, Xb)  = -0.2553                        Prob > F           =    0.0416
```

zhang	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
peak	-.2031397	.1077261	-1.89	0.075	-.4286131	.0223337
itdummy	-5.488341	2.285282	-2.40	0.027	-10.27149	-.7051904
_cons	3.818392	1.366186	2.79	0.012	.9589324	6.677852
sigma_u	2.8973536					
sigma_e	2.4765253					
rho	.57783266	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(12, 19) =     2.40                 Prob > F = 0.0424
```

Table 5

```
Fixed-effects (within) regression               Number of obs      =        34
Group variable: id                              Number of groups   =        13

R-sq:  within  = 0.3236                         Obs per group: min =         1
       between = 0.0413                                        avg =       2.6
       overall = 0.1636                                        max =         4

                                                F(2,19)            =      4.55
corr(u_i, Xb)  = -0.2741                        Prob > F           =    0.0244
```

hofstetter	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
peak	-.2263928	.1175596	-1.93	0.069	-.4724479	.0196622
itdummy	-6.78935	2.493888	-2.72	0.014	-12.00912	-1.569583
_cons	4.424722	1.490894	2.97	0.008	1.304244	7.545199
sigma_u	3.3729674					
sigma_e	2.7025877					
rho	.60901325	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(12, 19) =     2.62                 Prob > F = 0.0296

.
```

The inflation targeting (IT) is a significant determinants to explain the sacrifice ratio. The IT coefficient is statistically significant at 5 % and 1% level. In addition, initial inflation found to be statistically significant at 10% level. The interesting fact is that the IT remained significant determinates in few more replications.[7]

VI. Conclusion

This study highlighted the debate of credibility gain from inflation targeting regime. After estimating through episode methods, we arrive at two main conclusions. Firstly, we find inflation targeting as a significant determinants of sacrifice ratio in emerging countries. This result goes against the findings of Mazumder (2014) who argued that IT is irrelevant for non-OECD countries. Secondly, our result supports the view of De Roux and Hofstetter (2014), which is IT has credible bonus effects in member countries. By comparing the sacrifice ratio of IT countries

[7] Those results are not reported here.

with non-IT countries, we observed that sacrifice ratio is significantly lower in former group compared to later group. This conclusion was consistent with the arguments of Goncalves and Carvalho (2009). They claimed that IT does matters for the member countries. So, it is clear that countries under IT regime have advantages to achieve lower output loss from a disinflation. So, policy suggestion would be that those countries need to continue under IT regime to achieve low disinflation cost. Secondly, the countries that wants to start the disinflation policy at higher peak can go ahead with no more harm to output growth.

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