How Costly is the Deliberate Disinflation in India? Estimating the Sacrifice Ratio

Ravindra H. Dholakia
Kadiyala Sri Virinchi

W.P. No. 2015-08-01
August 2015

The main objective of the working paper series of the IIMA is to help faculty members, research staff and doctoral students to speedily share their research findings with professional colleagues and test their research findings at the pre-publication stage. IIMA is committed to maintain academic freedom. The opinion(s), view(s) and conclusion(s) expressed in the working paper are those of the authors and not that of IIMA.

INDIAN INSTITUTE OF MANAGEMENT
AHMEDABAD-380 015
INDIA

HOW COSTLY IS THE DELIBERATE DISINFLATION IN INDIA?

ESTIMATING THE SACRIFICE RATIO

Ravindra H. Dholakia and Kadiyala Sri Virinchi[1]

Abstract

Methods followed in earlier studies for estimating the sacrifice ratio or the real cost of deliberate disinflation have focused only on aggregate supply side ignoring aggregate demand. The present study considers the adjustment path obtained as a locus of short run equilibria to arrive at a theoretically acceptable sacrifice ratio. The study uses quarterly data from the period between 1996-97Q1--2013-14Q4 in India and employs both the regression as well as the direct methods to estimate the ratio. The results have revealed a sacrifice ratio ranging from 1.7 to 3.8 depending on the method and the measure of inflation used. Such a magnitude of the real cost of disinflation in India, also relevant in the long run, clearly contradict the dominant view among policymakers that the trade-off, if any, is negligible. Deliberate disinflation policy needs to consider the real cost of sacrificing output and employment particularly when its magnitude is substantial.

[1] Authors are respectively Professor of Economics at IIM Ahmedabad and Post-Graduate student at University of Hyderabad who was also an intern at IIM Ahmedabad during December 2014. Email: rdholkia@iimahd.ernet.in; virinchi523@gmail.com

HOW COSTLY IS THE DELIBERATE DISINFLATION IN INDIA? ESTIMATING THE SACRIFICE RATIO

When an economy experiences persistent high inflation, politicians and policy makers invariably make efforts to bring it down to an acceptable level. Perceived gains of low inflation in terms of higher economic growth and distribution often outweigh the real costs of output loss and increased unemployment incurred to lower the inflation rate. While the perceived gains of low inflation are debatable both theoretically and empirically (Barro, 1995; Fischer, 1993; Sarel, 1996; Motley, 1994; Feldstein, 1996; and Andrés and Hernando, 1999), sacrifice ratio crystalizes the quantification of costs of deliberate disinflation. Following the seminal contribution of Okun (1978), we find several studies on the subject of sacrifice ratio in the developed economies summarized in a brief review by Mitra et al (2014). But, for the fast growing developing countries like India there are only a few serious studies to estimate the sacrifice ratio (Kapur and Patra, 2003; Durai and Ramachandran, 2013; Dholakia, 2014; and Mitra et al., 2014). This is surprising because contrary to the global scenario, India has been one of the few countries fighting the battle against inflation. Now that India's monetary policy stance has officially shifted to inflation targeting, estimation of sacrifice ratio for the economy should become pertinent in policy making. The present paper makes an attempt to estimate the sacrifice ratio for the Indian economy in the post-reform period after examining the conceptual and measurement issues that earlier studies have not satisfactorily addressed.

The following section discusses the concept and definition of the sacrifice ratio with implications on its measurement. The third section then reviews earlier studies on the subject and particularly in India with a focus on their estimates and methodology. The fourth section describes the method followed in the present paper to estimate the sacrifice ratio in India with details on the data used. Results of both the regression based method and direct method are presented in the fifth section. The final section summarizes the findings with concluding remarks.

CONCEPT AND DEFINITION

When an economy follows a deliberate disinflationary policy to reduce inflationary expectations so as to achieve a fall in the observed inflation rate, it has to sacrifice some output and employment during the process as per the accepted macroeconomic theory. The concept of the sacrifice ratio is based on taking aggregate of such output loss over time to achieve the observed reduction in inflation rate. More precisely, it is defined as the percentage of potential output sacrificed in order to obtain one percentage point reduction in the inflation rate (Mankiw, 2010).

From such a concept of the sacrifice ratio, several implications on its possible measurement follow. First, it requires a deliberate attempt by monetary authorities to reduce inflation over a period of time. Any reduction in inflation rate that occurs because of other factors such as positive supply shocks, independent continuous fiscal tightening or exogenous exchange rate appreciation is not to be considered while estimating sacrifice ratios. Second, it involves episodes where the reduction in the observed inflation rate is permanent and accompanied by similar movement in the expected inflation. Third, the cases of dramatic reductions in inflation (from hyperinflations) are also not covered, since hyperinflations tend to distort the normal consumer-producer interactions while setting wage-price equations. Fourth, the output losses are considered on a cumulative basis over a period of time during which the inflation rate comes down. As a result, the sacrifice ratio measures the phenomenon over the adjustment path and not along any given curve such as short run aggregate supply or demand. In fact, the adjustment path is a locus of short run equilibria obtained through intersection of shifting short run aggregate supply and demand curves. Therefore, although the sacrifice ratio has obvious links to the concept of short run trade-off between inflation and output, it is very much relevant even in the long run when such a trade-off is absent. Thus, the sacrifice ratio essentially captures cumulative negative deviations from the long term trend level of output.

The last point is important because there is a serious confusion among practitioners and policy makers in India based on the argument that there is no long run trade-off between inflation and output since the long run Phillips curve is vertical and hence there is no sacrifice of output to reduce inflation in the long run (Rajan, 2014). This argument is valid only if we take the trend of output over a fairly long period to get the least square trend line ensuring zero aggregate deviation. In other words, the time duration to define such a long run should be taken not when the output is just restored to the trend level but when it overshoots and nullifies the negative deviation of the past. The concept of the sacrifice ratio, on the other hand, considers the cumulative negative deviation of output from the trend line only till it attains the trend line. Thus, the sacrifice of cumulative output during the adjustment period does not disappear and presents a relevant tool for evaluating alternative adjustment paths implicit in different strategies for disinflation.

Given such a concept of the sacrifice ratio, it is relevant to consider briefly the major causes that would determine its magnitude in an economy attempting to disinflate. The phenomenon of inflation persistence is an important cause. The more persistent the inflation, the tougher it will be for the monetary policy to disinflate, and the tougher the disinflation, the greater will be the costs associated with it. Khundrakpam (2008) finds that compared to international standards, inflation persistence in India is low and ranges between 2-4 quarters. This would tend to make the sacrifice ratio relatively smaller in India. Inflation persistence can also be due to the credibility problems of the monetary authority. According Ball (1991), the monetary authority can make clearer announcements and more importantly stick to them in order to decrease the cost of disinflation significantly.

Another cause influencing the magnitude of the sacrifice ratio is the hysteresis hypothesis. Short term monetary shocks or aggregate demand fluctuations may have effects on long run output (Blanchard and Summers, 1986). Ball (1997) finds that countries which have undergone long periods of disinflations have not only suffered short term output losses, but have also seen a secular rise in the natural rate of unemployment. Similarly, countries that have followed counter cyclical expansionary policies have not only achieved a reduction in unemployment levels , but have also been able to rein in inflation in levels similar to countries that have continued the tight policies even in face of recession (Ball, 1999).

Another determinant of the sacrifice ratio is the speed of disinflation. Theoretically, following a path of fast disinflation, referred to as cold turkey is likely to reduce the sacrifice ratio, since it helps people adjust their inflationary expectations faster. While Taylor (1980) found lower sacrifice ratio for gradualism than for cold turkey, there are several studies finding the opposite (Ball, 1994; Zhang, 2005; Mazumder, 2014). Kapur and Patra (2003) argue that the magnitude of the sacrifice ratio depends on the shape of the Phillips curve. A convex Phillips curve favors the cold turkey view, whereas a concave Phillips curve favors the gradual disinflation.

Finally, independence of central bank can be an important determinant of the sacrifice ratio in the country. Walsh (1995) argues that on average a higher degree of central bank independence is associated with lower levels of inflations. And an institutional mechanism of lower inflations would make price and wage contracts less flexible, leading to higher sacrifice ratio. On the other hand, independence of central bank may decrease sacrifice ratio due to credibility bonus. Empirical findings in this regard are contradictory and not conclusive (Hutchison and Walsh, 1998; Diana and Sidropoulous, 2004; Posen, 1998; and Mazumder, 2014).

These determinants of the sacrifice ratio are extremely relevant for the policy makers if they have a very wide choice to decide on all those aspects. However, in practice, when a particular situation is faced, choice regarding most of them in the immediate context is effectively non-existent for the policy makers. These factors, therefore, define the environment within which the policy maker has to operate. While these factors can and do vary across countries and over a long period of time within a given country, they are more or less given for a particular country over relatively a shorter time period.

LITERATURE REVIEW

The model developed by Lucas (1973) provides the conceptual basis for the empirical studies on the sacrifice ratio. The model builds aggregate demand from the standard IS-LM framework, and the aggregate supply based on the assumption of full labor market clearance. The major conclusion of this study is that the so called trade-off is inversely proportional to the volatility of inflation in the respective countries. Okun (1978) opines that inflation, though anticipated, has serious consequences for the real economy as it distorts the institutions that economize on "information, prediction, and transactions costs through ongoing buyer-seller relationships". Using the then available 6 different versions of Phillips curve, he quantifies the trade-off to be within the range of 6 to 18 percentage points with an average of 10 percentage point of output loss for every one percentage point decline in inflation for the US economy. Gordon and king (1982) criticize Okun's methodology on the basis that it fails to consider the changing nature of sacrifice ratio during the period of disinflation. They try to estimate the sacrifice ratio for the US economy during post war period using the quarterly data from 1947-81 and employing both traditional as well as the theoretical VAR models. They obtain a sacrifice ratio in the range of 0 to 8, which is roughly half the size obtained by Okun. Filardo (1998) has shown that the sacrifice ratio varies across regimes corresponding to weak, moderate and high growth rates. He finds that the ratio during a weak growth regime is at 5, whereas at strong levels of growth, it stands at 2.1. Cecchetti and Rich (2001) criticize the prior studies for failing to control for non-monetary factors. They further argue that prior studies fail to distinguish the actions of monetary policy into ones involving policy shift from the ones involving systematic responses to the state of the economy. Using the quarterly data for the period between 1959 and 1997 for the US economy, they employ a structural VAR technique with multiple levels of sophistication and conclude that the results on the sacrifice ratio lack precision, as it is prone to changes with the increased sophistication of the model employed.

However, Ball (1994) was the first to point out the inherent discrepancy in such regression based approaches. He criticized them for constraining the output inflation tradeoffs to be the same during the disinflation as well as in cases of increase in trend inflation or during temporary demand fluctuations. He also questioned the implicit assumption of linearity of the Phillips curve in all the previous studies. His basic objection to the regression based approach is that it constrains the sacrifice ratio to be same for all the disinflations within a time series. He circumvented it by proposing a non-parametric approach, which gives episode specific sacrifice ratios. Based on the output and inflation data of 19 OECD economies from 1960-1992, he obtains various sacrifice ratios with an average value of 1.8 to 2 using both the annual and quarterly data. Andersen and Walscher (1999) employing three alternate approaches of aggregate supply, structural wage price relations, and Ball's direct method obtain an average sacrifice ratio of 2.5 across 19 industrialized countries. They also find that with a decline in average rates of inflation, the sacrifice ratio has increased in almost all the surveyed countries. Zhang (2005) criticizes Ball's method for ignoring the long-lived effects of sacrifice ratio. Further he cites Ball's own research where he has shown presence of hysteresis effects.

Therefore, Zhang advocates the use of HP filter to predict the trend output without making any assumptions about the time taken for output to return to its trend. The sacrifice ratios thus obtained are higher than Ball's estimates and range from 2.5 to 6.

RBI (2002) made the first explicit mention of the sacrifice ratio for the Indian economy to be 2 using the aggregate supply function based on the annual data from 1971-2000. A further detailed study by Kapur and Patra (2003) finds the sacrifice ratio to be in the range of 0.3 to 4.7 using the short run aggregate supply curve with 10 alternate specifications. Durai and Ramachandran (2013) estimate the sacrifice ratio for different sectors of the economy using the annual data from the period 1950-2009. They find that the farm sector on average has a negative sacrifice ratio, which offsets the positive values found in the non-farm sector to yield a very small aggregate ratio for the economy. Both these studies, however, consider only the short run aggregate supply functions almost completely ignoring the aggregate demand factors. Recently, Dholakia (2014) attempted to consider both the short run dynamic aggregate demand and supply factors to estimate the sacrifice ratio in India at 1.2 attributable only to the monetary policy using annual data from 1980-81 to 2011-12. He also estimates the ratio using the direct method by identifying disinflation episodes and finds it in the range of 1.8 to 2.1. A recent study by Mitra et al. (2014) uses both the direct method as well as the time varying parameters framework to estimate the sacrifice ratio. They consider the sacrifice ratio as a qualitative rather than quantitative concept and obtain a "sacrifice curve". It circumvents the earlier criticism levied by Ball (1994) on the regression based approach, but still suffers from the limitation of ignoring the dynamic aggregate demand factors in the estimation.

METHODOLOGY AND DATA

Most of the studies measuring sacrifice ratio are based on the aggregate supply curve, which is derived from the Phillips curve. The main problem with these regression based approaches is that they constrain sacrifice ratio to be the same for the entire time period. Further, as Ball (1994) points out, these studies would give perverse results if disinflation is a phenomenon which has "unique" characteristics of its own. In addition to that, the functional form, as well as the variables to be included in the model is arbitrarily specified. The most important criticism that Dholakia (2014) levies on these approaches is that they fail to consider the series of short run equilibria between shifting dynamic aggregate supply (DAS) curve and the dynamic aggregate demand (DAD) curve which underscore the concept of the sacrifice ratio. In the present study, therefore, we have followed Dholakia (2014) and considered a DAS-DAD model based on the standard IS-LM framework for DAD (Dornbusch and Fischer, 1990) and production, wage-price relationship for setting prices and extended expectation augmented Phillips curve for DAS (Dholakia and Sapre, 2012).

The equations of DAD and DAS so derived are given by –

$$\mathbf{Y = Y_{-1} + h\beta\,(\Delta A^*) + b\beta\,(Ms^*/P)(gMs - \pi) + hb\beta(\Delta\,\pi^e) + hj\beta(ePf/P)(ge + \pi f - \pi) \Rightarrow DAD(1)}$$

Where, Y and Y_{-1} are respectively the current and last period output, A* is autonomous expenditures, Ms* is money supply, P is price level, gMs is growth in money supply, π and π^e are respectively inflation rate and expected inflation rate, e is exchange rate, Pf is foreign price level, ge is growth in exchange rate, $\boldsymbol{\pi}$**f** is foreign inflation rate, h is interest sensitivity of demand for liquidity, b is the interest sensitivity of demand for investment, j is exchange rate sensitivity of the net exports, and $\boldsymbol{\beta}$ is the fiscal policy multiplier in the IS-LM framework.

$$\mathbf{\pi = \pi^e + \in[(Y-Y^*)/Y^*] + (n/q)\,(gY - gY^*) + supply\ shocks \Rightarrow DAS\ (2)}$$

Where, Y* is the trend rate of output, $\in$ is the sensitivity of the inflation rate to the output gap, n is the sensitivity of inflation to the changes in unemployment rate, and q represents the Okun's law; and gY and gY* represent growth rates of output and trend output respectively.

The DAD equation above shows that the demand side relationship between the inflation rate and output would remain stable only when the last period's output (Y_{-1}), changes in fiscal policy, growth of nominal money supply, REER and its growth, foreign inflation, and change in expected inflation remain the same. Similarly, the DAS equation shows that expected inflation rate, the trend level of output (Y*) and growth gap from the trend rate of growth would shift the supply side relationship between inflation rate and output. Therefore, if there is any deviation from the long term state of rest, the DAD and DAS curves would keep shifting till they again attain new state of rest, which is reached when output (Y) equals trend rate of output (Y*) and when inflation rate (π) stabilizes and equals the expected inflation (π^e).

Solving DAS and DAD equations and further simplification would give us

$$\boldsymbol{\pi = b_1\pi_{-1} + b_2 (\pi_{-1} - \pi_{-2}) + b_3\, g_{MS} + b_4\, \Delta\, (FD/GDP) + b_5\, (Y_{-1} - Y^*)/Y^* + b_6(REER) + b_7\, \pi us + b_8(g_Y - g_{Y^*}) + b_9(oil\ prices) + b_{10}\, (Drought\ Dummy)} \text{------------- } \mathbf{(3)}$$

$$\boldsymbol{(Y - Y^*)/\ Y^* = a_1\pi_{-1} + a_2\, (\pi_{-1} - \pi_{-2}) + a_3\, g_{MS} + a_4\, \Delta\, (FD/GDP) + a_5\, (Y_{-1} - Y^*)/Y^* + a_6(REER) + a_7\pi us + a_8(g_Y - g_{Y^*}) + a_9(oil\ prices) + a_{10}\, (Drought\ Dummy)} \text{ ---------- } \mathbf{(4)}$$

Where FD/GDP is the proportion of fiscal deficit in the gross domestic product of the country and all other variables are as defined earlier. Following Andersen and Wascher (1999), lagged inflation is taken as expected inflation. The equations (3) and (4) give the short-run equilibrium values of the two independent variables in terms of exogenous variables including growth in money supply. Moreover, equations (3) and (4) through the coefficients of g_{MS} would provide the sacrifice ratio. The short-run sacrifice ratio is given by (a3/b3). However, the long-run sacrifice ratio is [(a3/(1-a5)] /[b3/(1-b1)].

We have estimated the sacrifice ratio using the quarterly data from 1996-97Q1---2013-14Q4, unlike most of the studies in India that use the annual data. Output is measured as GDP at factor cost at constant prices; Inflation is measured as Year-on-Year change in Consumer Price Index (CPI) for industrial workers, Wholesale Price Index (WPI), and GDP Deflator. M3 growth rate is measured as annual point to point change. Drought dummy is taken to be 1 for deficient rainfall (calculated as deviation of more than 5% rainfall than the average) and 0 otherwise. REER is taken on export weighted basis, based on CPI. FD represents Combined State and Central Fiscal deficits. But the lack of Data regarding FD on a quarterly basis made us to drop it. All the above data are taken from Database of Indian Economy, Reserve Bank of India. Oil prices (US) are obtained from Energy Information Administration. Rainfall data is taken from the India Meteorological Department.

Direct Approach:

The direct approach to estimate the sacrifice ratio requires identification of disinflationary episodes by first constructing a trend rate of inflation. Trend inflation rate is estimated as a centered 9-quarter moving average of quarterly inflation. The intuition behind the usage of trend inflation is that it is more stable and is a better representative, compared to the normal measure which is prone to temporary fluctuations and shocks. Thus this trend in a way gives us a smoothened version of normal inflation. This also helps in extracting significant policy induced shifts in inflations from the temporary shocks (Ball, 1994). Based on the trend, peaks and troughs are identified as respectively the maximum and minimum values in the surrounding 9 quarters. After the identification of peaks and troughs, finally, a disinflationary episode is identified as one wherein, trend inflation falls from a peak to a trough. This gives us our denominator of the sacrifice ratio, provided the disinflation episode shows deliberate tightening of monetary policy culminating in reduced monetary growth.

The estimation of potential output is a contentious issue. Several scholars have criticized the method used by Ball (1994) for having “peculiar” assumptions about potential outputs (see Friedman, 1994; Cecchetti, 1994; Andersen and Walscher, 1999). We, therefore, refrain from making any assumptions about potential output, and rather use the HP-filter[1] to estimate trend GDP to obtain the output gap as the difference of actual and trend values of GDP. Output losses are measured as cumulated values of output gap that have occurred during the period of disinflation. It gives us the numerator of the sacrifice ratio[2].

The principal criticism against the direct method to estimate the sacrifice ratio is that it fails to hold other factors or influences on output and inflation constant while considering the impact of monetary tightening. As a result, the sacrifice ratio estimated through the direct method would also incorporate the effects of all supply and demand shocks and would not measure the effect of only deliberate monetary policy.

RESULTS AND DISCUSSION

After running the regressions for equations (3) and (4), several variables were found to be statistically insignificant. So by following a step-wise regression, we removed insignificant variables to improve the goodness of the fit and reliability of the estimates for further use. Moreover in all cases, regression diagnostics show that the equations are free from multi-collinearity (through VIF) and autocorrelation. Hence the coefficients can be meaningfully interpreted. The presence of serial correlation is tested through Durbin's alternate statistic (where null hypothesis of no serial correlation cannot be rejected even at 10% significance level). Only final significant results are reported.

Table 1 presents the estimates of the equation 4 above where Output Gap is regressed on Growth in Money Supply (M3), Lagged Output Gap, GrowthGap, USinflation, USOilprices, and REER Growth Rate. Only these variables turned out statistically significant in the final round of the step-wise regression.

Table 1: Estimate of Regression for Eq.4 with Output Gap as Dependent Variable

Independent Variables	Coefficients	Standard Errors	t-Statistic	P-value	95% confidence interval	
M3growthrate2	0.7379	0.1066	6.92	0.000	0.5247	0.9510
Growthgap2	0.1552	0.0318	4.88	0.000	0.0916	0.2187
LLOG	0.7496	0.0461	16.27	0.000	0.6575	0.8418
USInflation	0.3628	0.1694	2.14	0.036	0.0239	0.7017
USOilprices	0.0156	0.0065	2.38	0.021	0.0025	0.0286
REERGrowthRate	0.0947	0.0365	2.59	0.012	0.0216	0.1678
No. of Observations= 66; $F(6,60)$= 102.35; R^2= 0.9110; Adjusted R^2= 0.9021						
Note: OG and LLOG represent respectively output gap and lagged output gap, and M3growthrate2 and Growthgap2 represent respectively money supply growth and difference in actual and trend rates of growth.						

Estimates reported in Table 1 are all significant at 5% level and represent an excellent fit with the explanatory power above 90%. According to our estimates, growth of broad money supply has a significant positive impact on the output gap in India. The elasticity, other things remaining the same is about 0.74 with a 95% confidence interval estimate of 0.52 to 0.95 in the short run. The long run estimate of the elasticity would be 2.95 with a 95% confidence interval estimate of 1.53 to 6.01.

Tables 2, 3 and 4 present the estimates of equation 3 above with inflation rate based on respectively GDP Deflator, Consumer Price Index (CPI) and Wholesale Price Index (WPI) regressed on Lagged Inflation, Difference of Lagged Inflations, and Growth Rate in Money Supply (M3).

Table 2: Estimate of Regression for Eq.3 with Inflation Based on GDP Deflator as Dependent Variable						
Independent Variables	Coefficients	Standard Errors	t-Statistic	P-value	95% confidence interval	
LaggedInflation	0.8258	0.0623	13.24	0.000	0.7012	0.9504
Diffof LaggedInfl	0.3736	0.1196	3.12	0.003	0.1346	0.6126
M3growthrate2	0.2284	0.0938	2.44	0.018	0.0410	0.4157
No. of Observations= 66; $F(3,63)$= 418.5; R^2= 0.9522; Adjusted R^2= 0.9499						

All estimates presented in Table 2 are statistically significant at 5% level and the explanatory power is above 90%. When inflation rate is measured through GDP Deflator, our estimates show a statistically significant positive impact of growth of broad money on the inflation. The short run elasticity is estimated at 0.23 with a 95% confidence interval estimate of 0.04 to 0.42. However, the long run elasticity estimate turns out to be 1.31 with the 95% confidence interval estimate of 0.14 to 8.38.

Table 3: Estimate of Regression for Eq.3 with Inflation Based on CPI as Dependent Variable						
Independent Variables	Coefficients	Standard Errors	t-Statistic	P-value	95% confidence interval	
LaggedInflation	0.8520	0.0573	14.86	0.000	0.7374	0.9504
Diffof LaggedInfl	0.2388	0.1232	1.94	0.057	-0.0074	0.4850
M3growthrate2	0.2508	0.1084	2.31	0.024	0.0342	0.4674
No. of Observations= 66; $F(3,63)$= 379.5; R^2= 0.9476; Adjusted R^2= 0.9451						

When the inflation rate is measured through CPI, the regression estimates presented in Table 3 show a very good fit with the explanatory power above 90%. All coefficients are significant at 6% level. It also shows a significant positive impact of growth of broad money on the consumer inflation. The short run elasticity turns out to be 0.25 with a 95% confidence interval estimate of 0.03 to 0.47. Similarly the long run elasticity is 1.69 with a 95% confidence interval of 0.13 to 9.42.

Table 4: Estimate of Regression for Eq.3 with Inflation Based on WPI as Dependent Variable						
Independent Variables	Coefficients	Standard Errors	t-Statistic	P-value	95% confidence interval	
LaggedInflation	0.7885	0.0583	13.52	0.000	0.6719	0.9050
Diffof LaggedInfl	0.5508	0.1094	5.03	0.000	0.3321	0.7695
M3growthrate2	0.2772	0.0869	3.19	0.002	0.1035	0.4509
No. of Observations= 66; $F(3,63)$= 456.8; R^2= 0.9561; Adjusted R^2= 0.9540						

If the inflation rate is measured through WPI as officially it used to be before 2011-12, our estimates presented in Table 4 show a very good fit with the explanatory power above 95%. All coefficients are significant at 1% level. Growth of broad money shows a significant positive impact on the WPI inflation in India. The short run elasticity is estimated at 0.28 with the 95% confidence interval estimate of 0.10 to 0.45. The long run elasticity is estimated at 1.31 with the 95% confidence interval estimate of 0.32 to 4.75.

Thus, Tables 2, 3 and 4 clearly show that the basic relationship between inflation rate and the growth of broad money holds in India with all the three alternative measurements. The estimates of the coefficients are also not substantially different and are dimensionally very similar. We may now consider the estimates of both short-run and long run sacrifice ratios for India, using all the three alternative measurements of the inflation rate. Results are reported in Table 5.

Table 5: Estimates of Sacrifice Ratio in India based on Alternative Inflation Measures							
Inflation Measures	Dependent Variable: Inflation Rate		Dependent Variable: Output Gap			Short run Sacrifice Ratio	Long Run Sacrifice Ratio
	Coefficient of Lagged Inflation (b1)	Coefficient of Money Growth (b3)	Coefficient of Money Growth (a3)	Coefficient of Lagged Output Gap (a5)			
GDP Deflator	0.8258	0.2284	0.7379	0.7496		3.2310	2.2480
CPI	0.8520	0.2508	0.7379	0.7496		2.9422	1.7395
WPI	0.7885	0.2772	0.7379	0.7496		2.6618	2.2488

The sacrifice ratio in India turns out to be around 3 in the short run and around 2 in the long run, the exact magnitude depending on the measure of inflation considered. The long run in this context is the period it takes the system to return to the long run time trend. Thus, since the cumulative loss of potential output to reduce the expected inflation rate from one long run equilibrium state to another is considered in the sacrifice ratio, it is the long run estimate of the ratio that correctly reflects the sacrifice involved.

The long run ratio turns out to be lower than the short run sacrifice ratio, because when the monetary authority gets committed to follow a tight money policy leading to a downward shift in DAD, it cuts the observed inflation with a substantial fall in output. But as time passes, people start adjusting their inflationary expectations downward leading to a rightward shift in the DAS, which raises output and employment in the short run reducing the pain of lost output to some extent. When this adjustment works its way through to the new long run equilibrium with lower inflation, the cumulative loss in output per percentage point reduction in the inflation rate would turn out to be less than what would be obtained along the short run aggregate supply curve or the short run sacrifice ratio given above. It is for this reason that the estimates of sacrifice ratio based only on the aggregate supply curve ignoring the adjustment path of short run equilibria between DAD and DAS are not the right ones.

All the existing studies on sacrifice ratio in India, except Dholakia (2014), do not estimate the sacrifice ratio in the long run considering the adjustment path of short run equilibria. Dholakia (2014) estimates the long run sacrifice ratio, but uses annual data with the result that his estimate of the ratio is in the range of 1. Use of quarterly data in the present study provides a more appropriate estimate of the sacrifice ratio in India.

Direct Method:

Using the Direct Method following Ball (1994), we identified 2 episodes each with GDP deflator and CPI based inflation, and one with WPI based inflation[3]. The episodes, where significant reduction in money growth rate was not observed, and also the ones which followed a drought were rejected for reasons expressed earlier in the paper. Fall in money growth rate is expressed as the difference between maximum and the minimum values of M3 growth rate observed in the disinflationary episode[4]. Table 6 presents the results.

Table 6: Estimates of Sacrifice Ratio in India through Direct Method					
DISINFLATIONARY EPISODE	Disinflation	Sacrifice Ratio	Fall in Money Growth(M3)	Initial level of Inflation	Speed
GDP Deflator					
1998-99Q1--2000-01Q4	3.8062	2.4267	5.7920	7.1029	0.3460
2010-11Q3--2013-14Q1	2.3908	3.6682	4.7252	9.0932	0.2391
CPI					
1997-98Q3--2000-01Q2	6.3818	1.9766	5.7920	10.0953	0.5802
2009-10Q2--2011-12Q3	2.2247	2.7568	5.0087	11.3157	0.3178
WPI					
2010-11Q4--2012-13Q4	2.5435	3.7960	4.7252	9.1669	0.3179
Note: Speed is measured as ratio of Disinflation to Number of Quarters i.e., period of Disinflation					

As can be clearly seen from Table 6, the lowest sacrifice ratio is obtained for the fastest disinflation lending support for the "cold-turkey" way of disinflation. However, these are too few observations and again without ensuring that other disturbing factors are held constant, which is the basic limitation of the direct method to estimate the sacrifice ratio. Lack of sufficient number of episodes does not allow us to draw reliable conclusions for other determinants such initial level of inflation, speed, etc. as well. Our estimates of the sacrifice ratio based on the quarterly data by the direct method are broadly comparable with Mitra et al. (2014) and on higher side compared to similar estimates based on the annual data by Dholakia (2014), which is expected.

CONCLUDING REMARKS

In the present paper, we have considered the theoretical concept of the sacrifice ratio and reviewed the literature on its estimation in general and in Indian context. The concept in theory refers to the cumulative loss of potential output per percentage point reduction in the long run equilibrium inflation rate. It has to be measured along the adjustment path of the economy transiting from one long run equilibrium with high inflation to another one with low inflation rate through a series of short run equilibria. The regression based method used by us, therefore, is different from all previous studies on the subject except Dholakia (2014). We have used quarterly data unlike Dholakia (2014) who used the annual data and, therefore, expectedly our estimate of the sacrifice ratio is on the higher side than his study.

We have also tried to estimate the sacrifice ratio for the Indian economy using the direct method and found higher and different estimates of the ratio for different episodes of disinflation. Our estimates by the direct method lend support to the hypothesis of lower sacrifice ratio for faster disinflation. However, too few observations and basic limitations of the direct method would not make such conclusions very reliable. Though the regression based sacrifice ratio in India gives uniform average estimate for the whole period, it is more reliable and usable as the cost of deliberate disinflation policy because it is closest to the theoretical concept. Our results show that the sacrifice ratio in India is around 2. Although this number is somehow obtained by several studies including RBI (2002) even by following a very questionable methodology, its validity can now be established through a theoretically consistent and appropriate methodology followed in the present paper.

We have argued in the present paper that the sacrifice ratio as the real cost of disinflation to the society is relevant not only in the short run, but also in the long run defined as the period when the economy just recovers from downturn and returns to the long run path. Some policy makers in India think contrary and tend to underplay the real cost of disinflation to the society. The concept of sacrifice ratio is neither inconsistent with nor opposed to inflation targeting by RBI. It is only a measure for the real cost of disinflation in the society that can inform the policy makers to take well considered decisions and be prepared for the implied trade-offs.

NOTES

1-Use of alternate techniques for filtering like Baxter and King, Beveridge Nelson decomposition etc. has yielded similar results.

2-It is important to note that the sacrifice ratio is defined in terms of cumulative loss of output and not employment. Since the direct method takes real GDP, it does not depend on the assumption of constant labor productivity that many economists object to.

3-Using WPI based inflation, 2 episodes were identified, but one was discarded because there was no significant reduction in money supply growth.

4- In essence, 5 percentage points decline in M3 growth rate converts roughly into 25% reduction in its own percentage terms.

References

Andersen, P. S. and W. L. Wascher. (1999). "Sacrifice Ratios and the Conduct of Monetary Policy in Conditions of Low Inflation", BIS Working Papers, 82.

Andrés, J. and I. Hernando. (1999). "Does inflation harm economic growth? Evidence from the OECD", in The costs and benefits of price stability (pp. 315-348), University of Chicago Press.

Ball, L. (1991). "The genesis of inflation and the costs of disinflation" (No. W3621). National Bureau of Economic Research.

Ball, L. (1994). "What Determines the Sacrifice Ratio?" in Monetary Policy, ed. N. G.Mankiw, Chicago: University of Chicago Press, pp. 155-182.

Ball, L. (1997). "Disinflation and the NAIRU," in Reducing Inflation: Motivation and Strategy, eds. C.D. Romer and D.H. Romer, Chicago: University of Chicago Press, pp.167-194.

Ball, L. (1999). "Aggregate Demand and Long-Run Unemployment," Brookings Papers on Economic Activity, 2, pp. 189-251.

Barro, R. (1995). "Inflation and Economic Growth", Bank of England Quarterly Review, May.

Blanchard, O. and L. H. Summer. (1986). "Hysteresis and the European Unemployment Problem", NBER Macroeconomics Annual.

Cecchtti, G. S. 1994. "Comment" in Monetary Policy, ed. N. G.Mankiw, Chicago: University of Chicago Press, pp. 188-193.

Cecchetti, G. S. and R. W. Rich. 2001. "Structural estimates of the US sacrifice ratio". Journal of Business & Economics Statistics, 19, no. 4: 416–27.

Dholakia, R.H. (2014). "Sacrifice Ratio and Cost of Inflation for the Indian Economy", IIM-A Working Paper No. 2014-02-04, Indian Institute of Management, Ahmedabad..

Dholakia, R.H. and A. Sapre. (2012). "Speed of Adjustment and Inflation – Unemployment Trade-off in Developing Countries – Case of India", Journal of Quantitative Economics, 10(1), Jan-June, pp. 1-16.

Diana, G., Sidiropoulos, M., 2004. Central bank independence, speed of disinflation and the sacrifice ratio. Open Econ. Rev. 15, 385–402.

Durai, S. R. S. and M. Ramachandran. (2013). "Sectoral effects of disinflation: Evidence from India". Macroeconomics and Finance in Emerging Market Economies, 6(1), 77-87.

Feldstein, M. (1996). "The Costs and Benefits of Going from Low Inflation to Price Stability", NBER Working Paper No. 5281.

Filardo, A. J. (1998). "New Evidence on the Output Cost of Fighting Inflation," Federal Reserve Bank of Kansas City Economic Review (Third Quarter), 33-61.

Fischer, S. 1993. “The role of macroeconomic factors in growth”. Journal of Monetary Economics, 32:485-512.

Friedman, B. 1994. “Comment”, in Monetary Policy, ed. N. G.Mankiw, Chicago: University of Chicago Press, pp. 182-188.

Furher, J. C. (2011). “Inflation persistence”, in Handbook of Monetary Economics, eds. B. M. Friedman and M. Woodford, Chapter 9, Volume 3, pp. 423—486. San Diego CA: Elsevier.

Gordon, R. J. and S. R. King. (1982). "The Output Cost of Disinflation in Traditional and Vector Autoregressive Models." Brookings Papers on Economic Activity, Vol. 1, ed. W.C. Brainard and G.L. Perry, pp.205-244.

Hutchison, M. and C. Walsh. (1998). “The output–inflation tradeoff and central bank reform: evidence from New Zealand”. The Economic Journal, 108, 703–725.

Kapur M. and M. D. Patra. (2003). “The Price of Low Inflation”, RBI Publications, 33952, January.

Khundrakpam, J. K. (2008). “How Persistent is Indian Inflationary Process, Has it Changed?” Reserve Bank of India Occasional Papers, Vol. 29, No. 2, Monsoon, pp. 23-45.

Lucas, R. E. (1973). “Some international evidence on output-inflation tradeoffs”, The American Economic Review, 326-334.

Mazumder, S. (2014). “Determinants of the Sacrifice Ratio: Evidence from OECD and non-OECD countries”, Economic Modelling, 40, 117-135.

Mankiw, N. G. (2010). ‘Macroeconomics’, 7th Edition, New York, Worth Publishers.

Mitra, P, D Biswas and A Sanyal. (2015). “Estimating Sacrifice Ratio for Indian Economy: A Time Varying Perspective”, RBI Working Paper Series WPS (DEPR): 01/2015, June.

Motley, B. 1994. "Growth and Inflation: A Cross-Country Study." Prepared for the Center for Economic Policy Research-Federal Reserve Bank of San Francisco conference, March.

Okun, A. (1978). “Efficient disinflationary policies”, American Economic Review, pp. 348-52.

Posen, A. (1998). “Central Bank Independence and Disinflationary Credibility: A Missing Link?”, Oxford Economic Papers, Vol. 50, No. 2, April.

Rajan, R. (2014). Interview Mint (newspaper) available at http://www.livemint.com/Politics/15mf7YJb8K5xvFeZ8ISaYI/Raghuram-Rajan-We-can-bring-inflation-within-more-tolerable.html

Reserve Bank of India (2002), Report on Currency and Finance, 2000-01.

Sarel, M. 1996. “Nonlinear effects of inflation on economic growth”. ZMF Staff Papers 43:199-215.

Taylor, J. B. (1980). "Aggregate Dynamics and Staggered Contracts," Journal of Political Economy, vol. 88, pp. 1-22.

Walsh, C. 1995. “Output–inflation Tradeoffs and Central Bank Independence”. FRBSFEconomic Letter.

Zhang, L. (2005). “Sacrifice Ratios with Long-lived Effects”. International Finance,231-62.

Appendix on Regression Diagnostics

Durbin's Alternate Test Statistic

Equation	Lags(p)	Chi2	Df	Prob>Chi2
Equation 4	1	2.094	1	0.1479
Equation 3 based on GDP Deflator	1	1.569	1	0.2104
Equation 3 based on CPI	1	0.097	1	0.7554
Equation 3 based on WPI	1	0.794	1	0.3729

Variance Inflation Factor

Equation 3 based on GDP Deflator

Variable	***VIF***	***1/VIF***
LaggedInflation	***5.13***	***0.194849***
Diffof LaggedInfl	***5.06***	***0.197584***
M3growthrate2	***1.09***	***0.917000***
Mean	***3.76***	

Equation 3 based on CPI

Variable	***VIF***	***1/VIF***
LaggedInflation	***3.93***	***0.254507***
Diffof LaggedInfl	***3.85***	***0.259855***
M3growthrate2	***1.06***	***0.944507***
Mean	***2.95***	

Equation 3 based on WPI

Variable	***VIF***	***1/VIF***
LaggedInflation	***4.85***	***0.206141***
Diffof LaggedInfl	***4.75***	***0.210391***
M3growthrate2	***1.11***	***0.898525***
Mean	***3.57***	

Equation 4

Variable	***VIF***	***1/VIF***
M3growthrate2	***4.50***	***0.222025***
Growthgap2	***1.60***	***0.625954***
LLOG	***3.47***	***0.288179***
USInflation	***4.50***	***0.222240***
USOilprices	***4.12***	***0.242631***
REERGrowthRate	***1.01***	***0.986399***
Mean	***3.20***	