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Estimating the Sacrifice Ratio for Indian Economy: An Empirical Study

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Abstract

This paper investigates the cost of reducing inflation that an economy pays in from of reduction in output. Sacrifice ratios is estimated for India using aggregate supply curve approach and direct method. The study uses quarterly data from Q2–1996 to Q2–2016 in India. Auto-Regressive Distributed Lag (ARDL) model is used for aggregate supply curve approach. However, the time varying sacrifice ratio is estimated for year 2006 to year 2015. Sacrifice ratio is estimated to be 1.30 percent for whole period whereas in period 2006 to 2015 it is ranging from –0.71 to 1.20. Whereas, in case of Ball's direct method four episodes are identified and average sacrifice ratio of all four periods are estimated to be 1.23 and it is varying in the range of –1.56 to 4.55. During RBI's expansionary policies sacrifice ratio is estimated to be higher than contractionary policies.

Keywords: Aggregate Supply Curve, Auto-Regressive Distributed Lag (ARDL), Inflation, Philips Curve, Sacrifice Ratio, Vector Auto-Regressive (VAR)

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Editorial Board Excerpt: Editorial board are in due course answerable for the superiority of the article and meticulous for identifying momentous 'noteworthy topics', sourcing high quality manuscripts, handling routine paperwork, and organizing the flow of manuscripts *(i.e. from author to referees and back in a camera ready shape)*. The two most worth mentioning attributes of any article suitable for GjEiS are (1) having a comprehensive acquaintance of the subject area and (2) being organized. Depending on the size of the piece of writing and its theme intensity, the number of editors can range from one or two people to many more and sometimes to bring lucidity the blind reviewer process enabled to endow with complete justice to accepted article. Initially at the Time of Submission (ToS) submitted paper had a 12% plagiarism which is an accepted percentage for publication as some of the contents are the author's self acknowledge work and copyright free material. The editorial board is of an observation that paper had a successive close watch by the blind reviewer's which at a later stages had been rectified and amended by a co-author (Chander and Vishal) in various phases as and when required to do so. The reviewer's had in a first round time-honored in a diminutive span restructured by an author. The comments related to this manuscript are tremendously noticeable related estimating the Sacrifice Ratio for Indian Economy both subject-wise and research wise by the reviewers during evaluation and further at blind review process too. All the comments had been shared at a diversity of dates by the authors' in due course of occasion and same had been integrated by the author in calculation. By and large all the editorial and reviewer's comments had been built-in in a paper at the end and further the manuscript had been earmarked and decided under "**Empirical Research Paper**" category as its highlights and accentuate the work in relation to Indian economy which is an empirical study.

1. Introduction

Any nation that wishes to bring down inflation rate may endure output losses in the interim period. Sacrifice ratio shows the trade-off between output and inflation. It is the cost of combating inflation, the loss of output that must be shouldered by economy with a specific end goal to accomplish a lessening in inflation. Sacrifice ratio had turned out to be vital since great depression because it crystallizes the measurement of the cost of deliberate inflation. Economists have paid a lot of attention to estimate sacrifice ratio because this ratio plays an important consideration while setting monetary policy. Generally, the monetary policy authority of a nation uses contractionary monetary policy to maintain price stability. However, such strategy accomplishes its objective of decrease in inflation with a related cost in loss of output. The low inflation is accepted to favorably affect the economy which may have the capacity to counterbalance the loss of output. In case of aggregate supply curve approach, for a given potential output, reduction in inflation

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is occurred either due to expected inflation or due to decrease in actual output. In short run, reduction in inflation is caused by economic modernization because it takes time to change expectations for wage setters. Whereas in long run monetary policy expansion and contraction controls the movement in inflation using expected inflation as major attribute. This paper focuses on measuring India's sacrifice ratio. We analyzed quarterly data for year 1996 to year 2016 and used ARDL model to identify relation between inflation and output by taking into consideration policies of central bank and other major external factors. For year 2006 to 2015 time varying sacrifice ratio is estimated. To test the robustness of model modified Philip curve is estimated and relation between inflation and output gap is compared. Using Ball's "Direct Method" sacrifice ratio is estimated during different disinflationary period. We had used same time period in both techniques so that estimates could be compared.

The study proceeds as follow: section 2 presents literature survey, in section 3 there has been detailed description of methodology, concepts used and sources of data used in the study, section 4 includes results and discussion and section 5 concludes the article.

2. Literature Review

Using aggregate supply curve approach sacrifice ratio was estimated by Okun (1978); Gordon and King (1982). Later on Laurence Ball (1994) suggested a different methodology to estimate sacrifice ratio which involves ratio of change in output to change in inflation during different disinflationary period. Taking after the contribution of Laurence Ball (1994); Okun (1978), several attempts were made regarding the matter of sacrifice ratio in developed countries. But, for large and developing nations such as India there are only a few genuine investigation has been done on the topic of sacrifice ratio. This is astonishing on the grounds that in spite of worldwide situation, India has been one of only a handful couple of nations battling the fight against inflation.

In general, it has been found that estimated sacrifice ratios varies across countries and time. Okun (1978) had found that 1 percent decrease in inflation is equivalent to 10 percent reduction in GNP of US economy. Gordon and Kings (1982) who refined Okun's approach concocted a gauge of sacrifice ratio that range from 0 to 8. Ball (1994) comes up with the direct method to estimate sacrifice ratio for US economy by taking into consideration disinflationary period. This is just a case of wide variety of the evaluations of sacrifice ratio over the technique, nation and time. To the extent sacrifice ratio for India is concerned, the evaluations likewise differ considerably over the techniques. Reserve Bank of India (RBI) (2002) in its 'report of currency and finance' estimated sacrifice ratio of 2 percent whereas Kapur and Patra (2003) estimates was varying in range of 0.5 and 4.7. Then, Mitra and Biswas (2015) estimated sacrifice ratio with time varying perspective using aggregate supply curve method.

When an economy experiences higher inflation, policymakers constantly attempt to convey it down to some desirable level. Sacrifice ratio is a cost of reducing inflation, the output loss to achieve a reduction in inflation. Since early 1980s, numbers of paper have attempted to estimate sacrifice ratio using different methodology.

The concept of sacrifice ratio was first introduced by Okun (1978) using Philip curve model for USA. He quantifies the trade-off between inflation and output within a range of 6–18 percentage point with an average of 10 percentage point. In other words, a one percentage point diminution in inflation rate would be associated with 10 percentage point reduction in GDP.

Gordon and King (1982) criticized the methodology of Okun and deliver a more precise estimation of sacrifice ratio using structural vector auto-regression model. They had estimated sacrifice ratio for US economy and their estimation of sacrifice ratio was in a range of 0 to 8 percentage point with an average of 3 percentage point which is roughly half the size of sacrifice ratio estimated by Okun.

Ball (1994) had pointed out the discrepancy in Philip curve approach. He criticized them for compelling the trade-off between output and inflation to be identical throughout disinflation and also during temporary demand fluctuations. Ball estimated sacrifice ratio for 19 industrial countries by proposing a methodology based on an episode specific identification of disinflationary period by locating 'Peak' and 'troughs' in the inflation trend. He then estimated cumulative output loss over each predefined episodes. His estimation of sacrifice ratio was 0–3.5 percentage point with an average of 1.4 percentage point which was much lower than the previous estimation by Gordon and King.

Filardo (1998) estimated sacrifice ratio for USA using non - linear Philip curve which were sensitive to the initial strength of an economy. He has shown that non - linear Philip curve are of 2 types that is concave Philip curve and convex Philip curve. Concave Philip curve is consistent with an economy where firm are not competitive and they have some pricing power. Convex Philip curve is consistent with an economy subject to capacity constraint. He found that sacrifice ratio fluctuates crosswise over three regimes corresponding to period of strong, moderate and weak output growth. His estimation of sacrifice ratio was 2.1 in strong growth regime and 5.0 in weak growth regime.

Turner and Seghezza (1999) estimated sacrifice ratio for 21 OCED countries using aggregate supply curve model. His estimation of sacrifice ratio was lying in range of 2–4 for eleven OCED countries. It was low around 1.6 for Japan, Italy and Netherland and very high for Norway that is around 7. He found that sixteen out of twenty-one OCED countries have long run impact of output on inflation.

Andersen and Wascher (1999) employed three methodologies of estimating sacrifice ratio i.e. aggregate supply curve,

structural wage and price equations also actual development in output and inflation. He had estimated sacrifice ratio for 19 OCED countries for period 1965–98. He found that sacrifice ratio raised from 1.5 during 1965–85 to 2.5 during 1985–98. This demonstrates that inflation stagnation paradoxically cause from intensify credibility of monetary policy in conjunction with wage price rigidities. Therefore, a lower inflation has been followed by flattening of aggregate supply curve which leads to tightening of monetary policy this leads to strong effect on real output than in past, with price adjustment occurring over a long time span.

Cecchetti and Rich (2001) criticized methodology of Ball. They pointed out that Ball's approach had neglected the impact of supply shocks and other demand shocks during disinflationary period. They had estimated sacrifice ratio for USA using quarterly data for period 1959 to 1997, they employed a structural vector auto-regressive model using two, three and four variables. For simplest two variables model indicates that value of sacrifice ratio lies between −0.5 and +3.8, the four variables model indicates value of sacrifice ratio between −43 and +68 which shows degree of imprecision is high.

RBI (2002) reported sacrifice ratio 2.0 percentages in its currency and finance report of 2001–02. It was estimated using aggregate supply curve model for India period 1975–2000.

Kapur and Patra (2003) assessed sacrifice ratio for India (1971–2001) utilizing short-run aggregate supply curve with 10 unique specifications. They argued that the size of sacrifice ratio relies upon choice of price indicator, time period and specification of short-run aggregate supply curve. Their estimation of sacrifice ratio ranged between 0.3–4.70 percentages.

Mitra and Biswas (2015) estimated sacrifice ratio for India using aggregate supply curve method as well as episode specific method. They had estimated it with time varying perspective using state space model and Gibbs sampling. They consider the sacrifice ratio as qualitative concept instead of quantitative concept and obtained a sacrifice curve by plotting time varying parameter along time. They found that sacrifice ratio estimates was higher during monetary expansion i.e. 2.8 and at the time monetary contraction it was 2.3. The sacrifice curve was on peak in Q3: 2003–04 to Q1: 2004–05 periods.

3. Methodology, Concepts and Data Sources

Three methods have been employed to estimate the sacrifice ratio. One approach estimates sacrifice ratio using structural Vector Auto-Regressive (VAR) model (Gordan & King, 1982); sacrifice ratio obtained by using VAR model is sensitive to size of model and imprecision of the estimates of sacrifice ratios is observed to be increment with the entanglement of the model. Second method is to calculate sacrifice ratio as losses in output during a disinflationary episode. This method has preferred standpoint of not compelling sacrifice ratio to be consistent for all disinflationary periods. On other hand approach does not provide any control for supply shock and focus is only on inflation and output not take into consideration correlation at other point in business cycle. Third approach estimates sacrifice ratio using aggregate supply curve i.e., Philip curve. This approach additionally controls for supply shocks and data requirements are less escalated than VAR model and issue of sensitivity is likewise dodged.

There are two implications that must follow while measuring the sacrifice ratio. First, any reduction in inflation because of factors such as fiscal tightening or exogenous exchange rate will not be considered while estimating sacrifice ratio. Second, it involves periods where reduction in observed inflation is permanent and followed by similar movement in expected inflation.

Aggregate supply curve approach:

$$\pi_t = \pi^e + \beta(y_t - y_t^*) \quad (1)$$

Here, π_t is inflation at time t, π^e is expected inflation, y_t is output at time t, y_t^* is potential output and $y_t - y_t^*$ is output gap and β is slope coefficient.

Equation (1) can be written as:

$$\log(WPI)_t = \alpha \log(WPI)_{t-1} + \beta ouputgap_{t-1} + \mu_t$$

$$\log(WPI)_t = \alpha \log(WPI)_{t-1} + \beta ouputgap_{t-1} + \gamma(L)S_t + \mu_t \quad (2)$$

In second equation WPI is wholesale price Index, S_t is to control for major macro-economic factors[1]. Here, α shows the impact of expected inflation on current inflation and β is the impact of output gap. This equation is estimated by using ARDL framework.

ARDL is autoregressive distributed lag model which we use when we have lag value of dependent value as explanatory variable and model is mixture of I (0) and I (1) variables.

$$\log(WPI)_t - \log(WPI)_{t-1} = \beta ouputgap_{t-1} + \gamma(L)S_t + \mu_t \quad (3)$$

Third equation is modified form of Philip curve which is applied to test the robustness of model. This equation is estimated by using finite distributed lag model.

To estimate time invariant sacrifice ratio yearly dummy is used from 2006 to 2015. Dummy variable is interacted with Log WPI at time period t–1 and output gap at time period t–1. Only interactive dummies are taken into model to maintain degree of freedom in model.

Output gap = log (Actual Output) – log (Potential Output)

Potential output is estimated using HP filter with λ = 1600 for quarterly data.

[1] The independent variables have been discussed briefly in the following section

Sacrifice ratio is estimated as:

$$\text{Sacrifice ratio} = \frac{(1-\hat{\alpha})}{\hat{\beta}}$$

Here, α is coefficient of inflation and β is coefficient of output gap.

Laurence Ball's Direct Method

Laurence ball method is also used to estimate sacrifice ratio for different disinflationary periods. In this method, trend inflation is estimated for Q2–1996 to Q2–2016. Here trend inflation is defined as centered moving average of 9 quarters. So, trend inflation of time period t is moving average from t–4 to t+4. This shows that trend inflation is smoothed version of actual inflation.

To define disinflationary period, we first identified 'peaks' and 'troughs' in trend inflation. A peak is a quarter in which trend inflation is higher than previous four quarter and following four quarter. Similarly, for trough is a quarter in which trend inflation is lower than previous four quarter and following four quarter. A disinflationary period is an episode which start with peak and ends at a trough. Sacrifice ratio in these disinflationary periods are estimated by taking ratio of change in output and change in trend inflation.

The paper used the Whole Sale Price Index as an indicator of the price inflation while exchange rate and crude oil prices have been considered to control for the supply shock. The study uses a quarterly dataset with 80 observations from 1996–Q2 to 2016–Q2.

3.1 Dependent Variables

3.1.1 Wholesale Price Index (WPI)

WPI is price of a basket of wholesale goods. WPI is taken as an indicator of inflation.

3.2 Explanatory Variables

3.2.1 Whole Sale Price Index (Lag 1)

The lag of WPI by one time period has been used as an explanatory variable. Deriving from the theory of rational expectations, people expect that prices in period T would be revised by some proportion of the prices in period T–1. Usually a positive relationship is expected between the two in an economy where the inflation tends to increase year by year.

3.2.2 Output Gap

Output gap is difference between actual output and potential output. It should have positive impact on WPI because if actual output is more than potential output than it should impact employment positively which will lead to increase in bargaining power of labor as result of which they demand higher wages. This process will fuel prices through the wage price spiral.

3.2.3 Cash Reserve Ratio (CRR)

Used to control for the impact of monetary policy on inflation. Cash reserve ratio is minimum fraction of total deposits of customer that commercial banks keep as reserve with RBI. It will have negative impact on WPI. Increase in cash reserve ratio results decrease in WPI as the banks will leave with less money to advance loan and credit and pushes up interest rate. Increase in interest rate will result people to borrow less and consume less. Thus, the demand of goods and services goes down which will results in decrease in inflation.

3.2.4 Gross Fiscal Deficit

Gross fiscal deficit defined as the excess of total expenditure including loan of central government over revenue receipts. It is use as control variable. Gross fiscal deficit will have positive impact on WPI. Increase in fiscal deficit will lead to increase in output. Increase in output will increase employment which will increase bargaining power of labor. This will increase wages of labor and increase price of goods.

3.2.4 Exchange Rate

Exchange Rate controls for the impact of international trade on inflation. Increase in exchange rate will have positive impact on inflation. Increase in exchange rate means depreciation of Indian rupee which will make foreign goods expensive for domestic customer and cause increase in demand of domestic good which will lead to increase in price of domestic goods.

3.2.6 Crude Oil

Crude Oil used as a control variable imported inflation. There is a positive relation between crude oil and WPI. Crude oil is a major input for critical activities such as fueling transportation and heating homes. A rise in price of crude oil will lead to rise in input cost and increase prices of goods.

Table 1. List of dependent and explanatory variables along with sources

Variable	Transformation	Unit	Source
Wholesale price Index	Quarterly average of monthly WPI	Index	RBI
GDP (output)	Quarterly, seasonally adjusted	Indian Rupee, Billion	Stats.oced.com
Cash Reserve ratio	Quarterly	Percentage	RBI

Variable	Transformation	Unit	Source
Gross fiscal deficit	Quarterly sum of monthly Gross Fiscal Deficit	Indian Rupee, Billion	RBI
Exchange Rate	Quarterly average of monthly Exchange rate	Rupee per unit of Dollar	RBI
Crude Oil futures	Quarterly average of monthly crude oil	Indian Rupee	Investing.com

4. Analysis and Discussion

Table 2. Test of stationary

Variable	Test Statistic	P-value for Z(t)
Log (WPI)	−1.050	0.7344
Fiscal Deficit	−5.867	0.000*
Crude Oil	−1.718	0.4223
Exchange Rate	0.412	0.9688
Cash Reserve Ratio	−2.827	0.0545
Output gap	−3.272	0.0162*

Source: Results from the Stationarity Test using Stata

Table 2 presents the results of unit root test for stationary. At 5% level of significance it is found that only fiscal deficit and output gap are stationary. Other variables are I(1) series. So, this satisfy the condition of ARDL model that is dependent variable should be I(1) series and independent variable are mix of I(1) and I(0) series.

Table 3. Philip Curve (Equation 2)

ARDL regression				
Model: level				
Sample:	5–81			
Number of obs.	77			
Log likelihood	312.42903			
R-squared	.99904002			
Adj R-squared	.9987421			
Root MSE	.00482098			
log_wpi	**Coef.**	**Std. Err.**	**t**	**P>t**
log_wpi				
L1.	0.5192248*	.1294296	4.01	0.000
L2.	0.1611206	.0996855	1.62	0.111
Fiscal deficit				
--.	5.26e−06*	1.50e−06	3.50	0.001
L1.	4.32e−06*	1.77e−06	2.44	0.018
L2.	4.13e−06*	1.69e−06	2.44	0.018
L3.	2.72e−06	1.73e−06	1.57	0.122
Crude oil				
--.	0.0003945*	.000082	4.81	0.000
L1.	−0.0001242	.0000969	−1.28	0.205
Exchange rate				
--.	0.0011436*	.0004415	2.59	0.012
L1.	−0.0009482	.0004865	−1.95	0.056
Output gap				
--.	0.1599825	.1476371	1.08	0.283
L1.	0.3687794*	.1676111	2.20	0.032
CRR				
--.	0.0006236	.0010907	0.57	0.570
L1.	−0.0005385	.0013428	−0.40	0.690
L2.	−0.0026079*	.0012779	−2.04	0.046
L3.	0.0017159	.0011176	1.54	0.130
Trend	0.0012258*	.0004079	3.01	0.004
_cons	0.7945409*	.2220484	3.58	0.001

Source: Regression analysis using ARDL regression

ARDL model is estimated from a recursive search of optimal numbers of lag through Akaike Information Criteria (AIC). The high value of R square in the regression of about 0.999 represents the fact that our model is capable of explaining most of the variation in the dependent variable.

Log (WPI); at 5% level of significance log of WPI is significant at lag 1. Ceteris paribus, 1 percentage point change in inflation (WPI) at time period t−1 will increase WPI by 0.51 percentage point in time period t.

Output gap; at 5% level of significance output gap is significant at lag 1 and 2. Ceteris paribus, actual output 1 percent above its potential level in period t−1 pushes up WPI by 0.36 percentage point in period t. Increase in actual output above potential output is due to increase in production which will result in increase in income of people. It takes time to people to change their consumption pattern. So there is no significant effect in inflation at time period t. In time period t+1 people will increase their consumption which will increase their demand and result in rise in price of goods and services. At time period t+2 due to increasing price people will keep their consumption constant but actual output will still more than its potential output which will result in excess supply and fall in prices of goods.

Cash Reserve ratio; at 5% level of significance CRR is significant at lag 2. Ceteris paribus, increase in CRR at time period t−2 by 1 percentage point will result in decrease in price of WPI by 0.0026 percentage point at time period t. A fall in CRR is expected to boost the aggregate demand in the economy by stimulating investment due to lower lending rates. As this is long process so it CRR will not have immediate impact on inflation.

Exchange Rate; at 5% level of significance exchange rate is significant at lag 0. Ceteris paribus, depreciation of Indian rupee will have immediate impact on WPI and it will increase WPI by 0.0011 percentage point. As imports form a sizeable portion of the consumption basket, increase in their price is expected to increase price of a household's consumption basket and hence add to the existing inflation.

Crude Oil; at 5% level of significance crude oil is significant at lag 0. Ceteris paribus, increase in price of crude oil will have immediate impact on WPI. One unit increase in oil price will increase WPI by 0.00039 percentage point. As crude oil is majorly use as input in critical activities like transportation. So increase in price of crude oil will result in increase in cost of product and will lead to increase in inflation.

Fiscal Deficit; at 5% level of significance fiscal deficit is significant at lag 0, 1, 2. Ceteris paribus, 5.26e–06 percentage point is increase in WPI due to increase in fiscal deficit by one unit. 4.32e–06 percentage point is increase in WPI one period after temporary increase in fiscal deficit. 4.13e–06 percentage point is increase in WPI two periods after temporary increase in fiscal deficit.

Estimated sacrifice ratio is 1.30 percentage points. This means that a decrease in inflation will cause a 1.30 percentage point decrease in output of India.

4.1 Robustness Test

To test the robustness of model modified Philip curve is estimated using finite distributed lag model in which dependent variable is difference between log WPI at time t and log WPI at time t–1.

Table 4. Modified Philip curve (Equation 3)

Source	SS	df	MS	Number of obs	78
Model	.002807666	16	.000184304	F(15, 62)	6.22
Residual	.001721816	61	.000028467	Prob > F	0.0000
Total	**.004529483**	**77**	**.000058824**	R-squared	0.6199
				Adj R-squared	0.5202
				Root MSE	.00531

Diff_log_wpi	Coef.	Std. Err.	t	P > t
Output gap				
--.	.0410224	.1534032	0.27	0.790
L1.	.3891609*	.1841263	2.11	0.039
L2.	–.5171986*	.130107	–3.98	0.000
CRR				
--.	.0003701	.0011856	0.31	0.756
L1.	–.0006067	.0014791	–0.41	0.683
L2.	–.0026883	.0014003	–1.92	0.060
L3.	.0029084*	.0011345	2.56	0.013
Fiscal deficit				
--.	1.79e–06	1.33e–06	1.34	0.185
L1.	–4.33e–07	1.43e–06	–0.30	0.764
L2.	–2.99e–08	1.40e–06	–0.02	0.983
L3.	–1.70e–06	1.38e–06	–1.24	0.221
Exchange rate				
--.	.0012635*	.0004842	2.61	0.011
L1.	–.0013374*	.0005222	–2.56	0.013
Crude oil				
--.	.0004331*	.0000876	4.94	0.000
L1.	–.0003573*	.0000848	–4.21	0.000
Trend	–.0000715	.0001328	–0.54	0.592
_cons	.007115	.0139374	0.51	0.612

Table 4, at 5% level of significance, output gap is significant at lag 1 and 2. Ceteris paribus, actual output 1 percent above its potential level in period t–1 pushes up ratio of WPI and its lag value by 0.38 percentage point in period t. whereas at time period t–2 actual output 1 percent above its potential level decrease ratio of WPI and its lag value by 0.51 percentage point in time period t. Relation between output gap and WPI is similar in both Philip curve (Table 3) and modified Philip curve (Table 4). Hence, the model used to estimate sacrifice ratio is robust.

4.2 Time Variant Sacrifice Ratio

To estimate time variant sacrifice ratio interactive dummy is used for last 10 years from year 2006 to year 2015 (Table 5).

Table 5. Sacrifice ratio with time varying parameters

ARDL regression	
Model: level	
Sample:	5–81
Number of obs	77
Log likelihood	338.76903
R-squared	.99951568
Adj R-squared	.99903135
Root MSE	.00423054

log_wpi	Coef.	Std. Err.	t	P>t
log_wpi				
L1.	.3892123*	.1382728	2.81	0.008
L2.	–.2508599	.1491579	–1.68	0.101

log_wpi	Coef.	Std. Err.	t	P>t
log_wpi				
Fiscal deficit				
--.	−9.21e−07	1.89e−06	−0.49	0.629
L1.	5.19e−07	1.63e−06	0.32	0.752
L2.	2.46e−06	1.65e−06	1.49	0.144
Crude oil				
--.	.0004332*	.0001074	4.03	0.000
L1.	−.0001275	.0001383	−0.92	0.362
L2.	−.0002108	.0001375	−1.53	0.134
L3.	.0003758*	.000121	3.11	0.004
Exchange rate				
--.	.0023834*	.0006469	3.68	0.001
L1.	−.0011524	.00069	−1.67	0.103
Output gap				
--.	−.0925277	.1804669	−0.51	0.611
L1.	.4806318*	.2032421	2.36	0.023
L2.	−.2826006**	.1416679	−1.99	0.053
CRR				
--.	.0019828	.0011189	1.77	0.084
L1.	.0009578	.0012453	0.77	0.447
L2.	−.0027973*	.0011348	−2.47	0.018
wpid2006	−.0018984	.0014876	−1.28	0.210
wpid2007	−.0058671*	.0028653	−2.05	0.048
wpid2008	−.0015339	.0025628	−0.60	0.553
wpid2009	.0077267*	.002867	2.70	0.010
wpid2010	.0055826*	.0018906	2.95	0.005
wpid2011	.00656*	.0025861	2.54	0.015
wpid2012	.0096525*	.0026845	3.60	0.001
wpid2013	.0074568*	.0031282	2.38	0.022
wpid2014	.0016454	.0030148	0.55	0.588
wpid2015	−.0036329	.0028982	−1.25	0.218
outpd2006	1.012869	1.120351	0.90	0.372
outpd2007	4.378737**	2.506646	1.75	0.089
outpd2008	.0282371	.4910002	0.06	0.954
outpd2009	.8235722*	.3949552	2.09	0.044
outpd2010	.7727374	.6601943	1.17	0.249
outpd2011	.8770031**	.4440938	1.97	0.056
outpd2012	−2.477188	1.860678	−1.33	0.191
outpd2013	−1.324818	1.538207	−0.86	0.394
outpd2014	5.224688*	2.513036	2.08	0.044
outpd2015	−9.225543**	5.162199	−1.79	0.082

log_wpi	Coef.	Std. Err.	t	P>t
log_wpi				
Trend	.0040937*	.0009674	4.23	0.000
_cons	2.08615*	.4349148	4.80	0.000

As shown in Table 4, at 5% level of significance Log WPI is significant at lag 1 and showing a positive relation. So, increase in WPI at time t−1 will lead to .38 percent increase in inflation. For output gap at 5% level of significance it is significant at lag 1 and at 10% level of significance output gap is also significant at lag 2. Using time variant coefficients of WPI and output gap sacrifice ratios is estimated and plotted against time as shown in Figure 1.

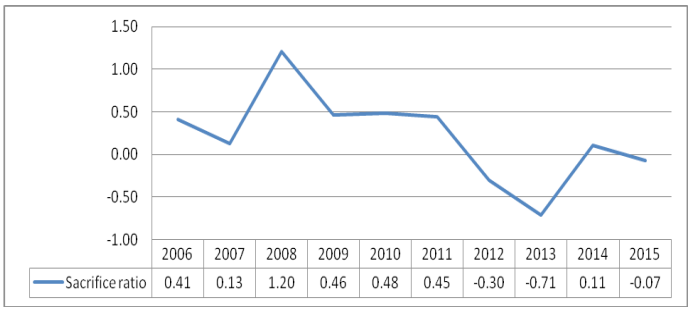

Figure 1. Sacrifice ratio over time

Sacrifice ratio estimates is found to be around average level in year 2006 and 2009 to 2011. During financial year 2008–09 government final consumption increase by 20.2 percent which results in excess demand of goods and services. This excess demand resulted in increase in prices of goods and high inflation during that period. Due to this sacrifice ratio is highest in year 2008. However, sacrifice ratio is falling from year 2011 to year 2013 due to economy slowdown. Industrial sector is majorly impacted by this economy slowdown which resulted in decrease in production and increase in output gap. Inflation was also declined during this time period but continued to be above comfort zone.

4.3 Sacrifice Ratio and Monetary Policy

Sacrifice ratio is also compared which monetary policy for year 2006 to 2015. As shown in Figure 2, it is showing relation between sacrifice ratio and currency to GDP ratio. On left axis I have taken currency to GDP ratio and on right axis sacrifice ratio is taken. It is consider that increase in currency to GDP ratio means expansionary monetary policy whereas decrease in currency to GDP ratio means contractionary monetary policy. Both sacrifice ratio and currency to GDP ratio are moving simultaneously from year 2006 to 2008. Correlation between ratio and currency to GDP ratio is 0.55 which means there is a positive relation between expansionary monetary policy and sacrifice ratio.

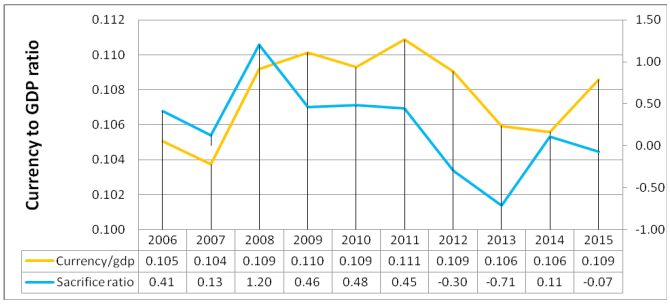

Figure 2. Sacrifice ratio and GDP/currency ratio.

There is monetary contraction in year 2007, 2010 and 2012 to 2014. Average sacrifice ratio for expansionary monetary policy is found to be 0.49 and for contractionary monetary policy it is found to be −0.059. This shows that sacrifice ratio is high for expansionary monetary policy relative to average sacrifice ratio in contractionary monetary policy. After September-2008 government has increase liquidity in market by incorporated a series of downward revision in policy rates. However, due to worldwide recession there was a decrease in export growth rate in the beginning of financial year 2009–10. This resulted in excess supply of goods in domestic market and fall in price of goods and services. This resulted in decrease in inflation and fall in sacrifice ratio. In 2014–15 there was an increase in both government and private consumption which resulted in excess demand of goods and increase in inflation. As there is minimal decrease in currency to GDP ratio which is offset by drastically increase in consumption which resulted in increase in inflation and sacrifice ratio. In financial year 2015–16 there is weak growth of world output and due to declining oil price resulted in decline price of good and reduction in sacrifice ratio in year 2015. This show that overall there is positive relation between monetary policy and sacrifice ratio. But during period of slowdown this relation is distorted by changes in external factors.

4.4 Sacrifice Ratio and Fiscal Policy

Figure 3 is showing relation between sacrifice ratio and fiscal policy. On left axis I have taken fiscal deficit as percentage of GDP and on right axis sacrifice ratio is taken. It is consider that increase in fiscal deficit means expansionary fiscal policy and decrease in fiscal deficit means contractionary monetary policy. As shown in Figure 3 both sacrifice ratio and fiscal deficit are moving simultaneously. Correlation between sacrifice ratio and fiscal deficit is 0.33 this shows positive relation between fiscal policy and sacrifice ratio. There is fiscal contraction in 2007, 2010, 2012, 2013 and 2015.

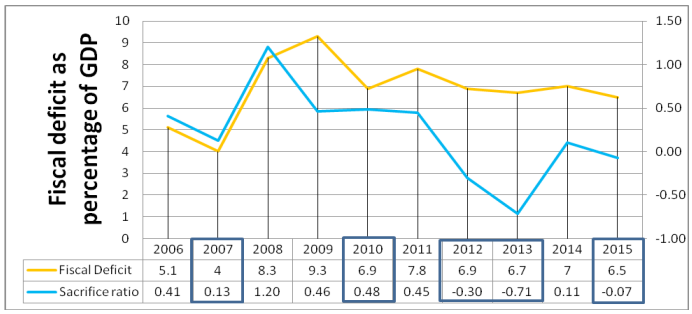

Figure 3. Fiscal Deficit and Sacrifice ratio.

Average sacrifice ratio in period of fiscal contraction is estimated at −0.011 and in case of fiscal expansion it was estimated at 0.554. This shows that sacrifice ratio is high for expansionary fiscal policy relative to contractionary fiscal policy. As explained earlier in financial year 2009–10 decrease in export growth resulted in decrease in sacrifice ratio. So, in this case also overall relation is positive between sacrifice ratio and fiscal deficit is positive both are moving simultaneously except in year 2009–10.

4.5 Sacrifice Ratio using Laurence Ball Method

In this section, sacrifice ratio is estimated using Laurence Ball method.

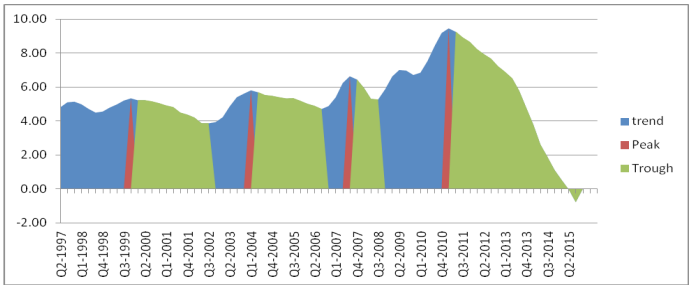

Figure 4. Trend inflation.

Table 6. Sacrifice ratio for disinflationary periods

Period	Start	End	Output gap	peak Inflation	Trough inflation	change in inflation	Sacrifice ratio
1	Q4–1994	Q3–2002	6.6985	5.34	3.87	1.47	4.55
2	Q1–2004	Q3–2006	−1.7241	5.81	4.71	1.10	−1.56
3	Q3–2007	Q3–2008	2.3122	6.64	5.27	1.38	1.68
4	Q1–2011	Q3–2015	2.8206	9.47	−0.79	10.25	0.28

Figure 4 is showing plot of trend inflation against time. Here, trend inflation is estimated by taking centered moving average of nine quarters. As shown in Figure 4 episodes are identified as disinflationary period.

Table 6 it is showing sacrifice ratio for different disinflationary periods that are identified. In all four episodes, sacrifice ratio is highest in period year 1995 to 2002 and least in period year 2004 to 2006.

Comparing, the results of direct method with aggregate supply curve approach. In case of disinflationary period 2011 to 2015 sacrifice ratio is ranging from –0.71 to 0.45 and direct method has estimated sacrifice ratio of 0.28 which is within the range. So, this shows that during disinflationary period both approach are showing similar results.

5. Conclusion

This paper examine sacrifice ratio for India using two major techniques i.e. aggregate supply curve approach and Ball's approach. Estimates of sacrifice ratio implies that a 1 percentage point reduction in inflation cause a 1.3 % reduction in output. From year 2006 to year 2015, sacrifice ratio is estimated in range of –0.71 to 1.20. It is discovered that Crude oil, exchange rate and fiscal deficit are having immediate impact on inflation. However, change in output gap is impacting inflation in next quarter. Cash reserve ratio is impacting inflation after two quarters. It is found that average sacrifice ratio is higher in expansionary RBI policies relative to contractionary RBI policies.

From year 2006 to 2015 sacrifice ratio is found to be highest in year 2008 due to increase in government final consumption and during year 2013 sacrifice ratio is lowest due domestic economy slowdown which had impacted industrial sector of India. This shows that sacrifice ratio varies over time due to government intervention, major crisis and slowdown in an economy.

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Annexure-I

Estimating the Sacrifice Ratio for Indian Economy: An Empirical Study

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