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Interpreting economic data - the trade-off between inflation and output: estimating the sacrifice ration.

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Interpreting Economic Data

**The Trade-Off between Inflation and Output:
Estimating the Sacrifice Ratio**

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Introduction

Inflation has always been a key policy concern for governments. It is generally agreed that a persistently rising price level causes disruption to the smooth operation of the economy and reduces the efficiency of the price mechanism. Moreover bringing down inflation is costly in that it can result in a downturn in economic activity or even an outright recession. In this article we will examine some of the issues of interest to policy makers using data for the UK economy over the period 1970 to 2002. Our main focus will be on the measurement of the *sacrifice ratio* or the loss of output required to bring inflation down from an initially high level. The plan of the article is as follows. In the next section we discuss the recent economic history of inflation in the UK economy. We show how we can obtain a measure of the deviation of output from trend and that there is a clear relationship between this variable and changes in the rate of inflation. Following this, we show how we can derive a measure of the sacrifice ratio which will allow us to quantify the costs of bringing down inflation. Finally, we present our conclusions and some questions for further discussion.

Output and Inflation

Figure 1 shows annual percentage changes in the consumer price index for the UK economy between 1971 and 2002. During this period there have been several episodes of high inflation. In particular there have been peaks in inflation in 1975, 1980 and 1990. The first two of these peaks can be associated with rapid increases in the price of crude oil while the reasons for the third are less clear.

[Insert Figure 1 here]

Our objective in this article is to assess the relationship between changes in the rate of inflation and the real economy as measured by real Gross Domestic Product (GDP). Of course GDP tends to grow through time and therefore we need to extract the trend from the data before we can examine its relationship with inflation. To do this we use the method of moving averages. By this we mean that the trend is measured by taking the average of the current year's data, the data for the previous two years and that for the following two years. Therefore the trend is a *centred five-year moving average* for GDP. Once we have calculated the trend it is then straightforward to calculate a measure of the business cycle as the percentage deviation of each year's data from the trend (as shown in Figure 2). Readers interested in learning more about this method might like to consult an earlier Interpreting Economic Data article ('Taking Off - The Development of the Air Travel Industry in the United States') in which this method was discussed in some detail.

[Insert Figure 2 here]

From Figure 2 we see that there were business cycle peaks in 1973, 1979 and 1989 and troughs in 1975, 1981 and 1992. It is interesting to note that each business cycle peak was followed by an acceleration of inflation in either the next year or the year afterwards. There is therefore clear evidence that inflation is related to the recent past behaviour of GDP. What we now wish to do is to quantify this relationship by calculating just how much inflation rises when output rises above trend or alternatively to what extent will inflation fall when output falls below trend.

The Sacrifice Ratio

The sacrifice ratio measures the relationship between changes in inflation and deviations of output from its trend value. Suppose we wish to bring the inflation rate down by one percentage point, then the sacrifice ratio tells us how many percentage points of GDP we

will lose in order to achieve this. This is an obvious policy issue for the government or the Central Bank when designing an appropriate monetary policy for the economy.

It is not always easy to calculate the sacrifice ratio accurately and there are reasons to believe that it may not be constant. However, we can at least use the historical data to get some idea of its value and to assess if there is any evidence that it is changing over time. One method is to look at the experience of the economy during a period in which inflation fell significantly. For example, Table 1 gives data for inflation and deviations of output from trend for the period 1978-1983. From this we see that inflation reached a peak in 1980 and then fell sharply. The fall in inflation over the period 1980 to 1983 amount to just over 13%. At the same time the economy moved into recession with output falling consistently below trend during the period. The sum of the annual percentage shortfalls of output from trend from 1980 to 1983 amounts to 4.03%. Taking the ratio of these two figures gives us a sacrifice ratio of 0.3% i.e. the output lost in order to bring inflation down by 1% amounts to 0.3% of trend GDP.

	Inflation	Output Deviation from Trend
1978	8.22	1.10
1979	13.47	2.86
1980	17.97	-0.11
1981	11.88	-2.44
1982	8.59	-1.46
1983	4.61	-0.03
Change in inflation 1980-1983		-13.37
Cumulative Output Loss 1980-1983		-4.03
Sacrifice Ratio		0.30

Table 1: Calculation of the Sacrifice Ratio 1980-1983

One of the key questions we need to ask is whether the sacrifice ratio is constant or whether it varies significantly over time. We can address this question by using data for another period in which inflation fell significantly to see if the sacrifice ratio we calculate is different from that given in Table 1. Data for the early 1990s is helpful here since this was again a period in which inflation reached a peak and then fell due to a prolonged recession. Table 2 gives the relevant data for the period 1988 to 1993 and shows a very similar pattern to that found for the earlier period. In this case inflation fell by just under 8% between 1990 and 1993 while the cumulative output loss over this period amounted to 3% of GDP. Taking this ratio of these numbers gives us a sacrifice ratio of 0.39 – a little higher than that for the earlier period but close enough to indicate a reasonably stable relationship.

	Inflation	Output Deviation from Trend
1988	4.91	1.73
1989	7.80	1.78
1990	9.48	1.25
1991	5.85	-0.94
1992	3.73	-1.99
1993	1.56	-1.39
Change in inflation 1980-1983		-7.91
Cumulative Output Loss 1980-1983		-3.08
Sacrifice Ratio		0.39

Table 2: Calculation of the Sacrifice Ratio 1990-1993

One the problems with the method we have used so far is that it does not use all the available data (and therefore all the available information) to construct the estimate of the sacrifice ratio. It is therefore possible that we might get a better estimate if we can find a method which uses all the information available to us. An alternative method which does this is to choose a best-fit line through the scatter of points relating the change in inflation

to the deviation of output from trend. Figure 3 shows the scatter of points linking these two variables. Note that we have chosen to relate the change in inflation to the one year lagged value of the output gap. The reason for this is that the graph of the two series shown in Figure 2 indicated that there were important lags in this relationship. In addition we experimented with various lags and found that a one-period lag produced the closest grouping of points around the best-fit line (as shown in the diagram). Economic theory suggests that there should be a positive relationship between these variables and this is in fact what we observe in the data.

[Insert Figure 3 here]

We can obtain an estimate of the sacrifice ratio from the scatter diagram as follows. First we obtain estimates of the intercept and slope of the best fit line as shown in the equation below:

$$\pi_t - \pi_{t-1} = -0.09 + 1.43 y_{t-1}^d$$

where π is the rate of inflation and y^d is the deviation of output from trend. This equation indicates that a 1% fall in output below trend will reduce inflation by 1.43%. The sacrifice ratio measures the fall in output needed to reduce inflation by 1%, therefore in this case we can estimate it by taking the reciprocal of the slope coefficient i.e.

$\frac{1}{1.43} = 0.70$ (to two significant figures). Therefore this method gives us a somewhat

higher value of the sacrifice ratio than we obtained when we looked at the two periods of falling inflation in isolation. It is not clear which method will give us the more reliable estimates but one possibility is that the first method, by concentrating on periods of falling inflation, is biasing the estimate of the sacrifice ratio downwards. This might be the case if inflation was falling during these periods for other reasons unrelated to the deviation of output from trend.

Disinflation and the Sacrifice Ratio

Disinflation refers to the process of bringing down an initially high rate of inflation to a level which is acceptable to the policy maker. For example, in the early 1990s the rate of inflation had risen to around 10% and it was generally agreed that this was too high. A general consensus among economists and policy makers was that a low positive rate of about 2.5% would be more appropriate. In circumstances like this the sacrifice ratio is of interest because it tells us how much output we must sacrifice in order to achieve our inflation target. In the previous section our scatter diagram estimate of the sacrifice ratio was $\frac{1}{1.43} = 0.70$. Therefore on this basis we would need to sacrifice $0.70 \times 7.5 = 5.25\%$ of trend output in order to bring inflation down to its target rate. Alternatively, if we had used our estimate of the sacrifice ratio based on the period 1980-1983 then the output cost would be only $0.30 \times 5.25 = 2.25\%$. These calculations illustrate why it is important to have an accurate measure of the sacrifice ratio since the value it takes affects the cost-benefit calculations of the disinflation policy significantly.

There remains another important issue to consider even when we have decided on the value for the sacrifice ratio. The value chosen gives us the total output cost associated with the disinflation policy. However, it does not tell us how the loss of output is to be distributed over time. We have two main possibilities, we can either opt for a 'short sharp shock' or 'cold turkey' policy in which inflation is brought down very rapidly with large short term loss of output or we can opt for a 'gradualist' policy in which the output loss in any given year is small but in which it takes a long time to bring inflation down to its target.

We can illustrate the alternative disinflation paths available to the policy maker by the use of an example. Suppose that the sacrifice ratio is 0.7 and the objective is to bring

inflation down from 10% to 2.5%. It follows that the total output loss is 5.25%. Now consider two strategies, the first is to engineer a fall in output of 2.625% below trend for two years, while the second is to engineer a fall in output of 1.05% below trend for 5 years. In both cases the total output loss is 5.25% so both should bring inflation down to the target value. The alternative time paths are given in Table 3. Note that we have continued to assume a one year lag before a fall in output has an impact on inflation.

	Cold Turkey' Approach		Gradualist Approach	
	Inflation % per annum	Output % Deviation from Trend	Inflation % per annum	Output % Deviation from Trend
0	10.0	0.000	10.0	0.000
1	10.0	-2.625	10.0	-1.050
2	6.2	-2.625	8.5	-1.050
3	2.5	0.000	7.0	-1.050
4	2.5	0.000	5.5	-1.050
5	2.5	0.000	4.0	-1.050
6	2.5	0.000	2.5	0.000

Table 3: Alternative Disinflation Paths with Sacrifice Ratio = 0.7

Conclusions

In this article we have used data for the UK economy to obtain estimates of the sacrifice ratio or the extent to which output must fall below trend in order to bring down inflation. We need to treat these estimates with some caution since we have seen that two different methods have produced rather different results. It is also possible to show that the method we use to extract the trend from the output data also affects the estimate of the sacrifice ratio significantly. However, provided we are careful and recognise the problems involved in the analysis, the sacrifice ratio can prove to be an important piece of information in the design of economy policy.

Data: All data in this article were taken from the IMF International Financial Statistics Database. Inflation is the percentage change in the consumer price index and output is measured as GDP at constant prices.

Questions for Thought and Further Discussion

1. Suppose the sacrifice ratio is 0.75 and the policy authorities wish to bring inflation down from 7% to a level of 2%. How much output must be sacrificed to achieve the inflation objective?

2. The table below gives figures for inflation and deviations of output from trend for the US economy over the period 1974-1976. Use them to derive an estimate for the sacrifice ratio for the US economy? (You should obtain a value of about 1.02)

	Inflation	GDP Deviation from Trend
1974	11.0	-0.1
1975	9.1	-3.2
1976	5.7	-1.0
1977	6.5	-0.2

3. Use the Phillips curve diagram to discuss the process of bringing inflation down from 10% to 2.5% (a) when the policy authorities adopt a 'cold turkey' approach and (b) when they adopt a gradualist approach.

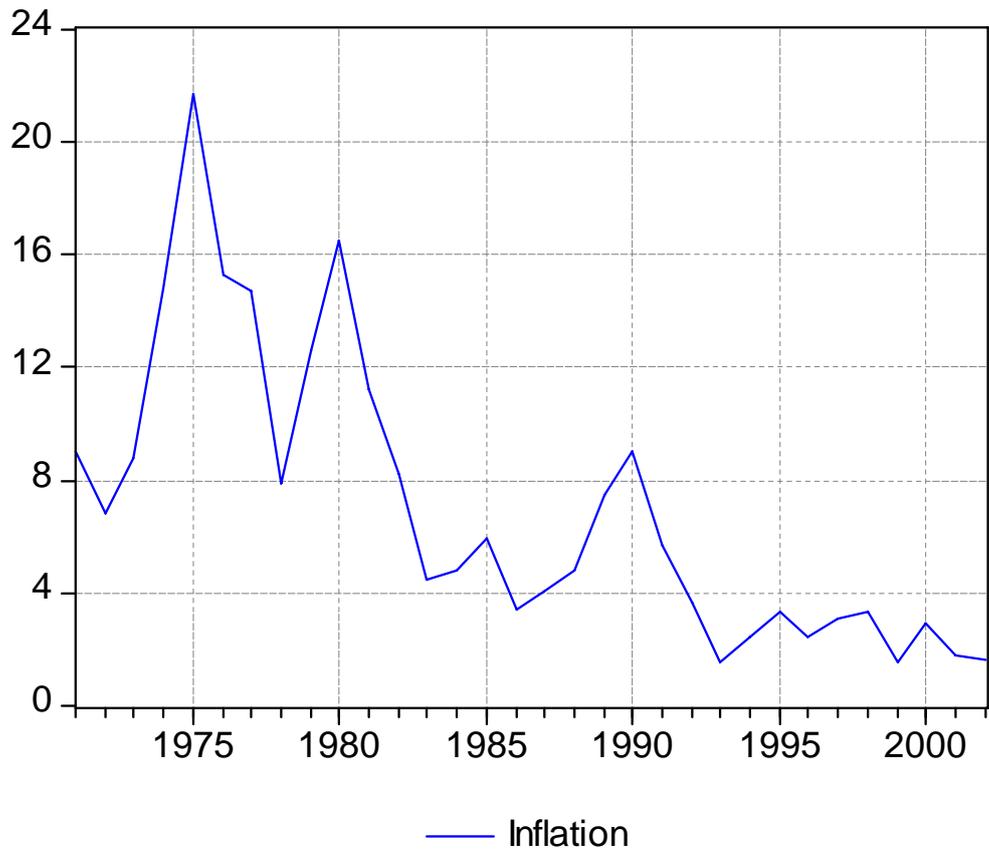


Figure 1: % Change in Consumer Price Index 1971- 2002

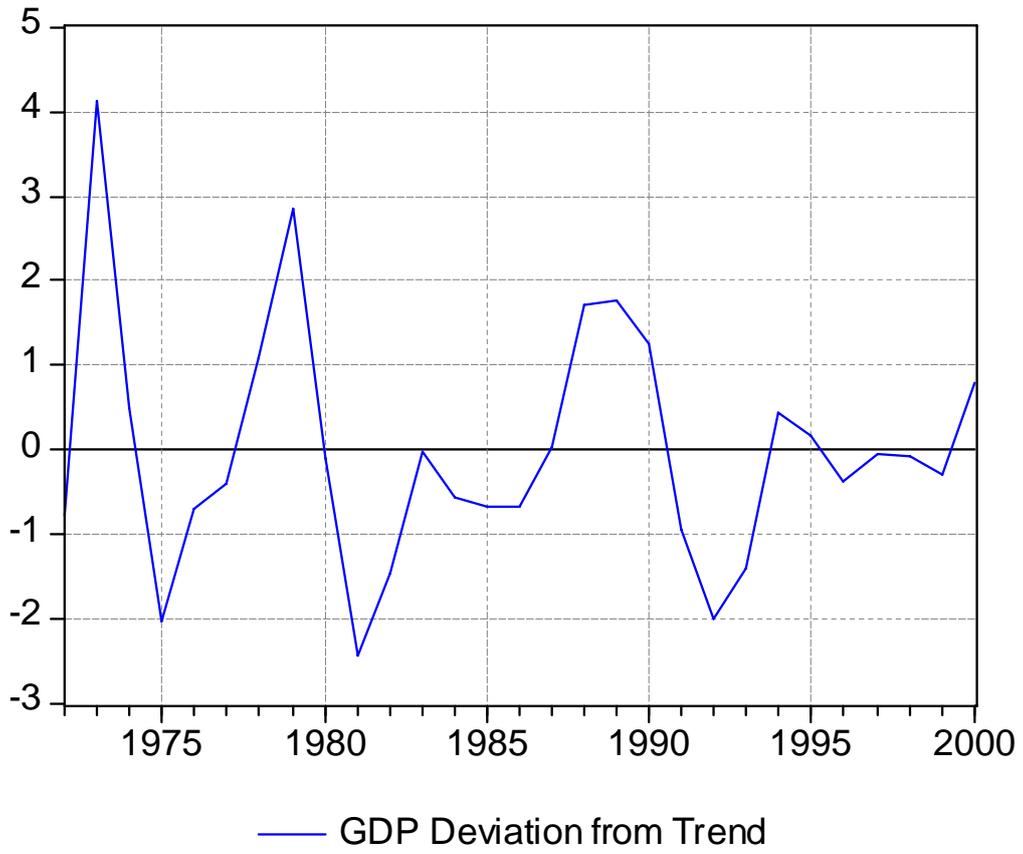


Figure 2: GDP % Deviation from Trend

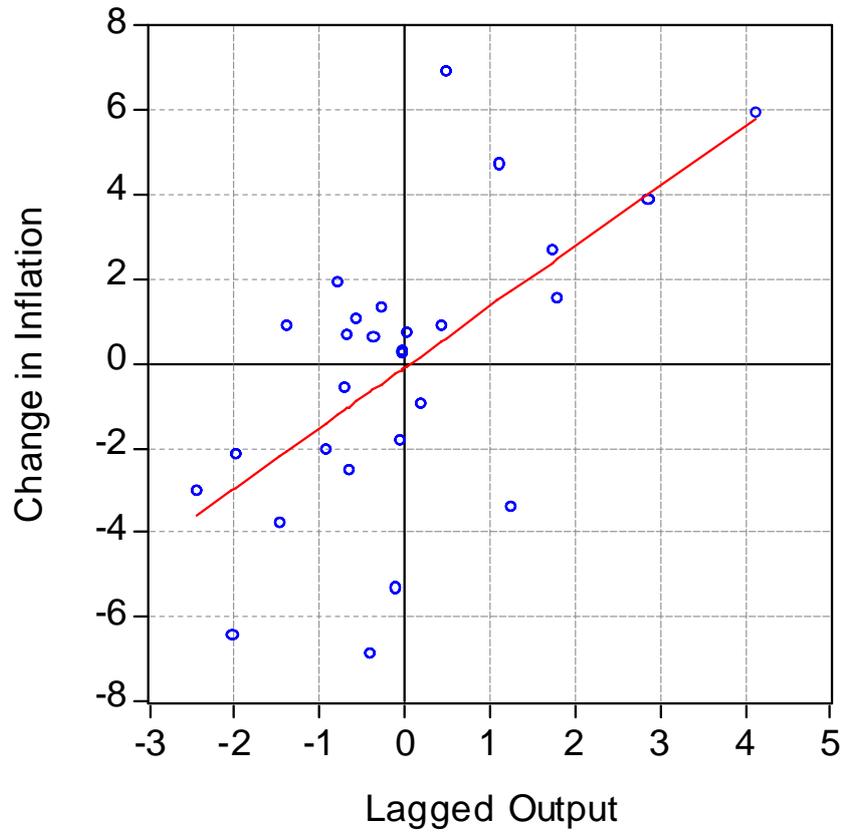


Figure 3: Change in Inflation against Lagged Output