

HAS THE RELATIONSHIP BETWEEN THE OUTPUT GAP AND INFLATION CHANGED?

In recent years the Riksbank has revised its appraisal of the trade-off between growth and inflation a number of times. Reassessments of the size of the output gap and the level of potential growth have contributed to this. Another reason is an increasingly clear tendency for the low and stable inflation expectations to dampen the price trend. A further factor of importance for the trade-off between growth and inflation is the relationship between inflation and the output gap.

The positive relationship that can be observed empirically between resource utilisation and inflation is usually referred to as the Phillips curve, since it was A.W. Phillips who first drew attention to this relationship in the late 1950s. In the following decade, however, the underlying theory, which originally implied a stable relationship between inflation and the real economy even in the long run, was thoroughly criticised. Theoretical work, for example by M. Friedman and E.S. Phelps, laid the foundation for a modified version, the expectations augmented Phillips curve. According to this theory, inflation is a function of expected inflation as well as demand. A stable relationship between inflation and demand can therefore be expected only for as long as the future inflation expectations of households and firms are unchanged. Today there is fairly broad agreement about this very general formulation, though opinions differ as to what generates the positive relationship and under which circumstances the relationship can be expected to be stable.

The *neo-classical model of inflation* envisages that households and firms cannot distinguish price shifts between different goods and services from changes in the general price level (inflation). They sometimes perceive a general increase in the price level as a favourable relative shift in the price of their own product and therefore increase the supply of that product. According to this theory, the higher and more variable the rate of inflation, the weaker will be the relationship between general price increases and demand because it is assumed that fewer agents then interpret observed price movements incorrectly as relative price shifts.

Neo-Keynesian models focus instead on price rigidities when explaining the Phillips curve. Seen from this angle, the existence of multi-period nominal contracts or adjustment costs associated with price changes hamper price adjustments to shocks, thereby leading to

variations in production and employment. Due to these models the stability in the relationship depends mainly on the functioning of the labour market.

The central message of the expectations augmented Phillips curve is that in the long run there can be no stable trade-off between the rate of inflation and aggregate demand. One implication of this is that increased inflation is not a practical instrument for long-term stimulation of the real economy. Sooner or later, higher inflation leads to rising inflation expectations, so all that is achieved in the longer run is a permanent effect on inflation without real benefits in the form of lower unemployment and increased production.

Inflation in Sweden has decreased markedly in the 1990s. In the 1970s and '80s the annual rate of CPI inflation averaged around 8 per cent. Since 1992 the average rate has been around 2 per cent.

In the early 1990s Swedish economic policy was directed at achieving low inflation; in the autumn of 1992 it proved necessary to abandon the fixed exchange rate in favour of a monetary policy regime with a flexible exchange rate, followed later by the introduction of an explicit inflation target. The budget process was also reformed, together with a target for the public sector financial surplus and a ceiling on central government spending. Other characteristics of the 1990s are a deep and lengthy economic recession and the reduction of external inflation. Work on integrating Sweden in Europe was stepped up and in 1995 Sweden became a member of the European Union. Deciding which factors have been most important for the decreased inflation can therefore be hazardous. One way of structuring the issue and the discussion is to start from a model in the form of a simple standard short-run Phillips curve:

$$\pi_t = \alpha + \beta_1 y_{t-1} + \pi_t^e + \beta_3 \pi_t^* + \varepsilon_t.$$

Inflation is in this model a function of demand y , expected inflation π^e and other factors (external inflation, for example) π^* .

One of the major explanations for inflation's downward shift is, of course, the reduction of inflation expectations. Many of the changes mentioned above, not least the direction of economic policy, have probably contributed in turn to this shift.

After some very bleak years in the early 1990s, the Swedish economy seems to be moving into a period of high growth and rising demand. A central question is whether the developments during the 1990s have altered the slope of the Philips curve (β_1 in the simple model above) so that a given demand pressure now results in

lower inflationary impulses than before.

In terms of the neo-classical model, the decreased inflation as such could be an explanation for the occurrence of such a change. According to the neo-Keynesian approach, which emphasises the functioning of the labour market, an explanation for a flatter slope of the Phillips curve could be instead that various changes may have led to moderating effects on the development of wages (at a given level of unemployment).

An empirical equivalent of the model presented above can be formulated as follows:

$$\pi_t = \alpha + \beta_1 y_{t-4} + \beta_3 \pi_t^{sur} + (1 - \beta_3) \pi_{t-4} + \beta_4 \pi_t^* + \beta_5 r_t.$$

Here the annual rate of CPI inflation is determined by an intercept, a demand variable, expected inflation derived from survey data, registered inflation a year earlier $\pi_t^e = \beta_3 \pi_t^{sur} + (1 - \beta_3) \pi_{t-4}$, external inflation expressed in Swedish prices and changes in oil prices, r .

This model has been estimated on quarterly data from 1980 Q1 to 1999 Q2. Demand is measured in terms of the output gap determined with the production function approach. The equation was also estimated with other measurements of the demand situation, such as the output gap calculated with either a Whittaker-Henderson filter or the Unobserved Components method (UC), and unemployment and its deviations from the NAIRU (estimated with UC). The estimations with those measurements of activity and similar models gave essentially the same results.

For the period 1980 Q1 to 1992 Q4, most of the explanatory variables are significant, with the predicted sign and reasonable numerical values:

$$\begin{aligned} \pi_t = & -0.167 + 0.559 y_{t-4} + 0.857 \pi_t^{sur} \\ & \quad \quad \quad (-0.22) \quad \quad (2.07) \quad \quad (5.19) \\ & + 0.143 \pi_{t-4} + 0.0375 \pi_t^* + 0.0288 r_t, \\ & \quad \quad \quad (-) \quad \quad (0.55) \quad \quad (3.89) \end{aligned}$$

$$R^2 = 0.64.^{34}$$

A 1 percentage point increase in the output gap leads, all else equal, to an increase in the rate of inflation one year ahead of about 0.56 percentage points. The estimation of the component π_t^e can be interpreted as a very high degree of forward-looking expectations among households.

One way of studying whether any structural shifts have occurred in the equation is to estimate the equation recursively, which involves estimating it up to a particular point in time and then re-estimating it after

³⁴ The figures in parentheses are the values for t .

each additional observation has been included. These estimates show that after 1992 the value of β_3 tends to rise.

The value of the output gap parameter, β_1 , is consistently above 0.5 before 1993 but after that year there is a tendency for it to fall to a lower level (Fig B5). However, the changes are not statistically significant for any of the variables.

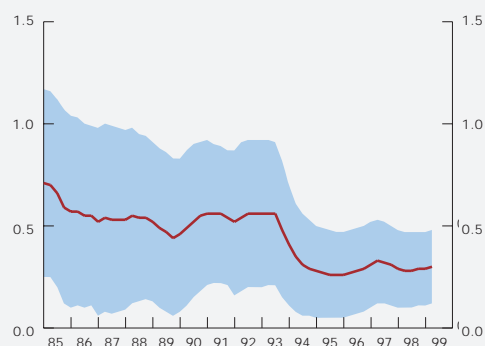
Another test for a shift in the output gap parameter can be made with a regime dummy variable. Such a test gives an estimated value of 0.62 for β_1 in the period up to 1992:4 but a considerably lower value after 1993. As the shift is statistically significant in this test, this approach rejects the hypothesis that the trade-off between growth and inflation has been unchanged in the 1990s.

For several reasons, however, this result must be interpreted very cautiously. As the output gap (as currently estimated by the Riksbank) has been consistently negative since 1993, it may be hazardous to draw conclusions about how a *positive* gap will affect inflation in the future. Clearer indications will have to wait for data on a complete business cycle. There is also some empirical evidence that cyclical effects on inflation are asymmetric: the inflationary impulses from a positive output gap seem to be stronger than the deflationary effect of a negative gap. In that case the lower conjunctural effect in the estimates since 1992 would be occasioned, not by the occurrence of a parameter shift but because the Phillips curve is non-linear as regards effects of positive and negative output gaps.

There appears to be some evidence, moreover, that inflation expectations have become more forward-looking in the 1990s (Fig. B6). It is conceivable that a large part of the cyclical effect is expected and therefore included in the inflation expectations variable.

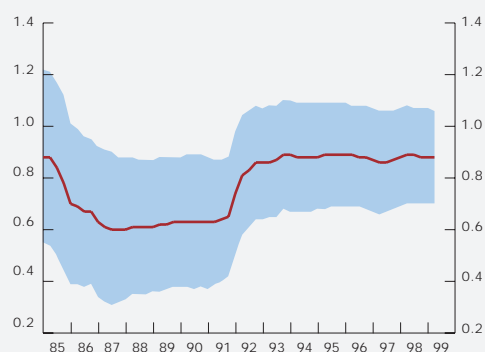
All in all, there seem to be some empirical grounds for the view that the impact of economic activity on inflation has in fact decreased in the 1990s. The magnitude of this reduction is highly uncertain, however, and the possibility that the impact is actually unchanged cannot be ruled out.³⁵

Figure B5. Recursive estimates of the output gap parameter with a 95 per cent confidence interval.



Source: The Riksbank.

Figure B6. Recursive estimates of the inflation expectations parameter with a 95 per cent confidence interval.



Source: The Riksbank.

³⁵ A model that seems to give a good description of inflation's path in Sweden in the 1990s without assuming a parameter shift is used in Chapter 1 of this Report (see Fig. 10) and was discussed in *Inflation Report 1999:2*, pp. 51–52.