

## Box 2 Measuring the output potential of the economy

The output potential of an economy is defined as the level of output consistent with full utilisation of all production factors. Potential output is therefore determined on the production side of the economy, i.e. by its capital stock, labour use and available technology. Consequently, potential output is determined by how successful the economy is in utilising these factors of production.

In the short run, aggregate demand of the economy can cause it to operate at a production level different from its potential. If the level of output is above capacity, a positive output gap develops which is reflected in excess demand for goods and labour. Eventually the positive output gap forces up wages and prices, causing inflation to rise. An economy operating below its output capacity, on the other hand, develops a negative output gap which, all things being equal, eases inflationary pressures.

Potential output plays an important role in assessments of the medium-term economic outlook and in implementation of economic policy, including monetary policy. Economic growth which is caused by increasing output capacity, for example when new technology boosts productivity, need not necessarily put pressure on prices. Demand-driven growth which generates a positive output gap, on the other hand, poses a risk of accelerating inflation. Demand-driven growth in excess of long-term growth capacity need not, however, necessarily lead to higher inflation if there is slack in the economy, i.e. if underutilised factors of production are available. Thus, potential output and the cyclical position of the economy are among the key assumptions in assessments of the medium-term price outlook.

The problem, however, is that potential output cannot be observed from available data. Potential output and the output gap therefore need to be estimated using statistical methods. Output gap assessments are therefore subject to a high degree of uncertainty. Various methods have been suggested and the outcomes from several of them are presented here. In all cases it is assumed that actual output can be divided into a trend and a cycle part. Previously, the trend was commonly treated as a fixed time trend. The problem with that method is that potential output is forced to grow at a fixed growth rate and therefore cannot decrease. It also assumes that all shocks are temporary, despite the fact that most economists today agree that many shocks have permanent effects on potential output.

This method has therefore largely been abandoned.

The Hodrick-Prescott (HP) filter represents an attempt to solve these problems and is also very simple to apply. Instead of assuming that potential output grows at a fixed rate, it allows for a more flexible growth rate. However, the growth rate tends to be very smooth. The main problem with this method is that estimation of trend output involves the use of future as well as historical data. Thus it is not particularly suitable for forecasting potential output. The end-point estimates also tend to be highly sensitive to forecasts of future values.

Another method is based on using a production function for the economy.<sup>1</sup> This usually involves a Cobb-Douglas specification of the production function

$$(1) \quad Y_t = A_t N_t^a K_t^{1-a}$$

where  $Y_t$  is the output level of the economy at constant prices,  $A_t$  is total factor productivity of the economy (i.e. aggregated productivity of labour, capital and other factors of production),  $N_t$  is labour input and  $K_t$  the capital stock, while  $a$  is the share of wages in the total value added in the economy and is assumed to be constant over time (using the value 65% which is roughly the average wage share over the period).

In estimating potential output, total factor productivity represents the share of output not explained by the production factors in equation (1). The HP-filter is then applied to  $A_t$  to derive the trend process for total factor productivity. The actual capital stock is generally used, since it is very smooth and the HP-filter would yield virtually the same process. However, many methods can be used for assessing the labour trend. The simplest is to apply the HP-filter to actual labour input. Another approach would be to divide the labour supply into its components

$$(2) \quad N_t = H_t L_t (1 - u_t)$$

1. Further approaches can also be used for estimating the output gap. These include multivariate time series analysis (see, for example, Box 1 in Monetary Bulletin 2000/2) and state of space models (see e.g. the article by Lúdvik Eliasson (1998), "Mæling á íslenskri hagsveiflu á ársfjórðungsgrunni" [Estimating the Icelandic Business Cycle at Quarterly Frequency], Central Bank of Iceland Economics Department, unpublished manuscript). These and other methods are being developed at the Economics Department to enable regular publication of output gap figures for Iceland.

where  $H_t$  is the participation ratio,  $L_t$  is the number of individuals of working age (15-64) and  $u_t$  is the unemployment rate. Actual data for the participation rate and working age population are generally used, since both series are quite smooth.<sup>2</sup> An attempt is then made to measure the underlying unemployment level in the economy, i.e. the level which is consistent with constant inflation (known as the natural rate of unemployment or the non-accelerating inflation rate of employment, NAIRU). This concept is closely connected with potential output since both are linked to the location in the business cycle corresponding to zero pressure on inflation. Estimation of this equilibrium unemployment rate is subject to the same uncertainty as estimation of potential output. One approach would be to apply the HP-filter to actual unemployment. Another possible approach would be to use an unemployment rate thought to reflect the underlying structure of the domestic labour market. Here, NAIRU is assumed to be 2.5%. An unemployment rate of less than 2.5% means that the labour market is subject to pressure, while unemployment of more than 2.5% means that labour is underutilised.

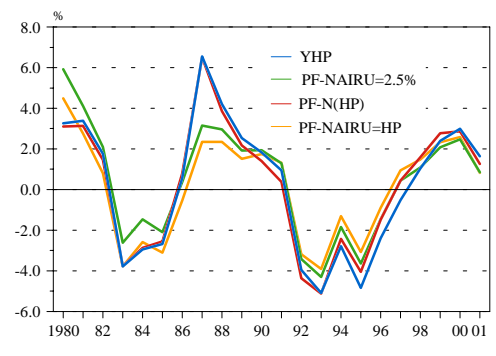
Chart 1 shows different assessments of the output gap in Iceland over the period 1980-2001:<sup>3</sup>

1. Potential output estimated by applying the HP-filter to  $Y_t$  (YHP)
2. Based on the production function approach, applying the HP-filter to  $N_t$  (PF-N(HP))
3. Based on the production function approach, with NAIRU = 2.5% (PF-NAIRU=2.5%)

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2. The drawback is that it assumes all changes in labour participation to be permanent, for example the increase in 1987 and in the past few years.
  3. The underlying trends are estimated using data for the period 1963-2005 to minimise the impact of the end-points. The data source is the National Economic Institute.

Chart 1

### Different measures of the output gap



4. Based on the production function approach, with NAIRU estimated with the HP-filter (PF-NAIRU=HP)

As the chart shows, alternative methods yield different estimation of the output gap, although the business cycle development is quite similar. The greatest divergence is in 1987 where two methods assume that only part of the increased labour participation was permanent while the others assume it to be entirely permanent. Considerable slack was present in the economy over the periods 1983-1985 and 1992-1996. Actual output, however, has been in excess of potential since 1998. The output gap peaks this year, ranging from 2½-3%, depending on the method used.<sup>4</sup> According to this assessment and the underlying National Economic Institute forecast, the output gap will disappear in 2002-2003.

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4. If the increase in labour participation in recent years is permanent, the lower figure can be expected to be more realistic. If it is only partly permanent, the higher value is probably more accurate.