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Norges Bank's output gap estimates

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Introduction

Output gap estimates have an important role in monetary policy. The Regulation on Monetary Policy states: "The operational target of monetary policy shall be annual consumer price inflation of approximately 2.5 per cent over time" and "… monetary policy shall … contribut[e] to stable developments in output and employment."[2]

The Regulation does not specify the level at which output and employment should be stabilised. A reasonable interpretation is that monetary policy should contribute to stabilising output and employment around the maximum sustainable level of output over time. This level of output is often referred to as equilibrium output or potential output.

Potential output is determined by developments in productivity and labour supply. These factors are in turn influenced by underlying economic conditions such as demographic trends, the qualifications of the labour force, wage formation, the tax system and the financial system. Potential output does not necessarily grow steadily over time. For example, immigration can change fairly rapidly, persons of working age may change their view of the trade-off between work and leisure or a technological breakthrough can lead to higher growth in productivity. Hence, potential output is the result of underlying economic conditions and not a technical concept.

The difference between actual and potential output is referred to as the output gap or capacity utilisation in the economy.[3] The output gap will be zero if actual output follows potential output. Because it may take time for changes in the supply side of the economy to feed through to actual output and demand, and because economic disturbances on the demand side of the economy may occur, there will often be a difference between actual and potential output.

If actual output is higher than potential output, pressures in the economy are too high, pushing up price and cost inflation and increasing the risk of a severe downturn. If actual output is lower than potential output, the resources in the economy are being under-utilised, resulting in welfare

[1] Thanks to colleagues in Norges Bank for comments and suggestions. Any remaining errors are the authors' own responsibility

[2] See Report No 29 (2000-2001) to the Storting: Guidelines for economic policy

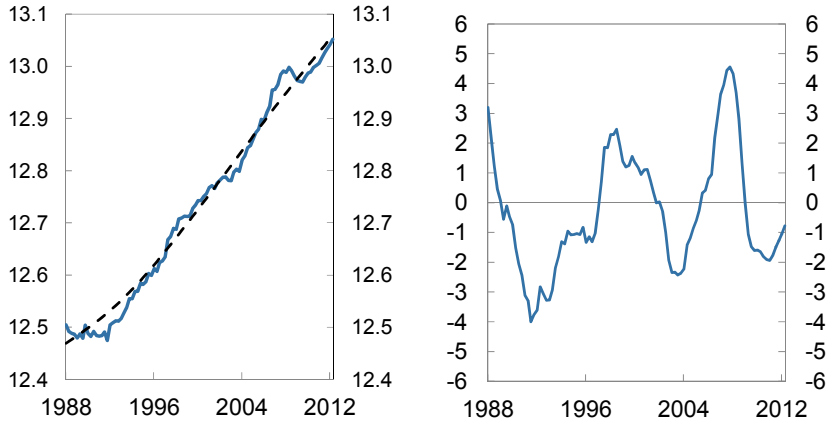
[3] In formal terms, the output gap is measured as the percentage difference between mainland GDP and estimated potential mainland GDP

losses. If activity is lower than normal, some people may be permanently excluded from the workforce. A weak labour market at the beginning of a working career, for example, may also increase the probability of unemployment later. Substantial fluctuations in the economy can contribute to increased uncertainty, weakening the basis for profitable investment.

Potential output is not observable and has to be estimated. There is thus uncertainty surrounding the output gap not only today and ahead, but also historically. Sources of uncertainty are whether the model chosen is appropriate for estimating potential output and the output gap (model uncertainty), the parameters in the various approaches have to be projected or estimated (parameter uncertainty), and the historical figures and the estimates on which the output gap is based may be revised ex post (data uncertainty). For example national accounts are often revised. Chart 1 shows the level of actual mainland GDP and an illustration of potential output, drawn as a trend line through actual output. The challenge is to estimate this trend line.

Chart 1 shows a technical calculation of trend GDP for mainland Norway and the associated output gap. When *Monetary Policy Report* 3/11 was published such a calculation indicated that the availability of resources in the economy was considerable through 2011 and into 2012, yet Norges Bank's assessment was that capacity utilisation was around normal last autumn. This article examines our assessment.[4]

Chart 1 Mainland GDP, trend[1)] and the output gap[2)]
Mar 88 – Jun 12.



1) The trend is estimated using an HP-filter (λ=40000). Mainland GDP from quarterly national accounts 1978 q1-2011 q2 and estimates from MPR 3/11 for 2011 q3-2014 q4. Logarithms.

2) The output gap is measured as the percentage difference between mainland GDP and the estimated trend . The gap is a three-quarter moving average

Sources: Statistics Norway and Norges Bank

[4] All figures are based on the data in *Monetary Policy Report* 3/11.

Different concepts of the output gap

Potential output and the output gap can be understood in different ways. The interpretation of the term output gap depends among other things on the purpose of the gap. A distinction can be made between three concepts for the output gap. First, the gap can be regarded as a historical description of the cyclical situation. Second, it can be an inflation indicator. A decisive criterion for an accurate gap will then be how well it correlates with (future) inflation. Third, the output gap can be regarded as a measure of welfare. There are costs related to business cycles. For example, high unemployment will involve obvious welfare costs both for the individual and for society as a whole because resources are under-utilised.[5]

According to Norges Bank's criteria for an appropriate interest rate path, the interest rate path should "… provide a reasonable balance between the path for inflation and the path for overall capacity utilisation in the economy".[6] Since inflation is directly taken into account in the assessment, capacity utilisation must be interpreted as a measure of welfare rather than an inflation indicator. This interpretation also seems to be in keeping with the wording of the Regulation where it states that monetary policy should contribute to stable developments in output and employment.

The output gap should capture the overall utilisation of resources in the economy. In order to achieve a consistent balance between the path for inflation and the path for the output gap, it is appropriate, though challenging, to sum up our assessment of overall capacity utilisation in the economy in a quantifiable variable.

Estimation methods[7]

Growth in potential output will, as mentioned, vary over time as a result of factors such as variations in inward labour migration, other demographic conditions and underlying productivity growth. The economy can be exposed to various shocks that can influence the assessments of both historical and future trend growth. For example, the financial crisis has given rise to unusually high uncertainty surrounding estimates of potential output. The high rate of growth prior to the crisis seems in retrospect to have been unsustainable. Pre-crisis measures of potential

[5] An alternative approach to assessing the output gap as a welfare loss is to use New-Keynesian equilibrium models. Such models provide a basis for estimating other, more theoretical types of output gap. Potential output can be estimated as the level of output that would prevail if all prices and wages were flexible. The welfare loss thus comprises the under-utilisation in the short term of potential output as a result of sticky prices and wages. Estimating the output gap in this way is demanding and relies on being able to identify the different shocks that have affected the economy and estimate how they would have affected a potential growth in the absence of wage and price stickiness. For more details about these concepts, see Woodford (2003) and Vetlov et al. (2011)

[6] See Monetary Policy Report 3/11 and Qvigstad (2005)

[7] There are a number of general articles about the various estimation methods. See for example Proietti T. (2008) and Bjørnland, Brubakk and Jore (2004). See als0 Benito et al. (2010).

output may therefore have been too high.[8] It is also uncertain to what extent the financial crisis in itself will affect potential output ahead. Events such as these imply that estimates cannot be based on a simple mechanical trend.

Potential output and the output gap can be estimated in several ways:

- Estimate a trend in GDP. Potential growth will typically be close to a historical average and will change relatively slowly. Examples of such techniques are linear trend estimates, the Hodrick-Prescott filter and band-pass filters. These techniques are simple to use in practice and provide useful information about potential output.
- The production function method. An enterprise's output depends on hours worked, the real capital stock and the technical structure of production. Output also depends on how efficiently the enterprise combines labour, real capital and production structure – total factor productivity. Potential output for the whole economy can be derived by estimating the potential values for the different variables in enterprises' production.
- Methods that seek to identify potential output through relationships between a number of variables, using for example multivariate filters, unobservable component methods, structural vector autoregressive models and DSGE models.

There is considerable uncertainty linked to the calculation of potential output. For Norway, the uncertainty is particularly high as the labour supply is very flexible owing to immigration among other factors. It may thus be useful to attempt to estimate the output gap directly without estimating potential output, by using various indicators of the activity level in the economy without having to calculate potential growth. These indicators can include labour market figures such as unemployment, the ratio of vacancies to unemployed workers, labour force participation and wage developments. Reports from enterprises in Norges Bank's regional network and indicators of capacity utilisation in Statistics Norway's business tendency survey for manufacturing provide direct information about resource utilisation in enterprises.

Norges Bank's output gap[9]

The starting-point for Norges Bank's estimates of potential output is a technical trend calculation of mainland GDP. We have used a Hodrick-Prescott filter (HP filter)[10], which is a simple and

[8] For an analysis of other countries, see for example ECB (2011)
[9] For previous descriptions of Norges Bank's method of estimating the output gap, see *Inflation Report* 1/2000, 1/2003 and 3/2006
[10] See Hodrick and Prescott (1997)

widely used method for decomposing a (seasonally adjusted) time series into a trend component and a cyclical component.

This method allows for gradual changes in trend output over time. Using an HP filter requires choosing a parameter, often referred to as λ, that expresses the extent of variability in potential output that is allowed for. There is no set answer as to the value this parameter should have. A high λ indicates that trend growth is relatively smooth, while a low λ allows for wider variations in trend growth.

An HP filter used mechanically has well known shortcomings.[11] The method uses information from only one, albeit key, variable. Trend estimates towards the end of the period are particularly uncertain and sensitive to new data. This can be counteracted to some extent by adding on projections to the actual data in the trend calculation. There are also examples in the literature that show that the HP filter in some situations can show artificial cyclical movements.

Therefore, we use cross checks for the historical output gap. First, we assess whether the HP-based historical cyclical movements are reasonable compared with other measures of cyclical movements in the economy, such as information from Norges Bank's regional network and unemployment. This analysis provides a basis to estimate the smoothing parameter λ, which on an uncertain basis is set to 40000. This implies a relatively rigid trend.

In addition, we use other and more complicated methods to support our assessments of the output gap (see for example Bjørnland et al (2004)), including the production function method and different variants of unobservable component models. Norges Bank's macroeconomic model NEMO also provides a basis for estimating the output gap. In the model, potential output can change in the near term. For example, the model might interpret a permanent fall in demand as an indication that the potential for future income has been reduced. This is reflected in a permanent fall in productivity and thereby in potential output. To what extent a fall in GDP will lead to a more negative output gap will thereby depend on the factor driving the decline in GDP.

Trend estimates are inherently subject to uncertainty, particularly towards the end of a time series. We therefore assess the output gap in the current situation against a few key indicators that can measure capacity utilisation in the economy. This kind of review also provides a basis for communicating a more overall assessment of capacity utilisation in the economy than could be offered by a gap based on GDP alone. The following section describes key indicators used in Norges Bank's assessment of the output gap. The order in which they are presented also reflects the weight given to the various indicators.

[11] See for example ECB (2000)

Unemployment

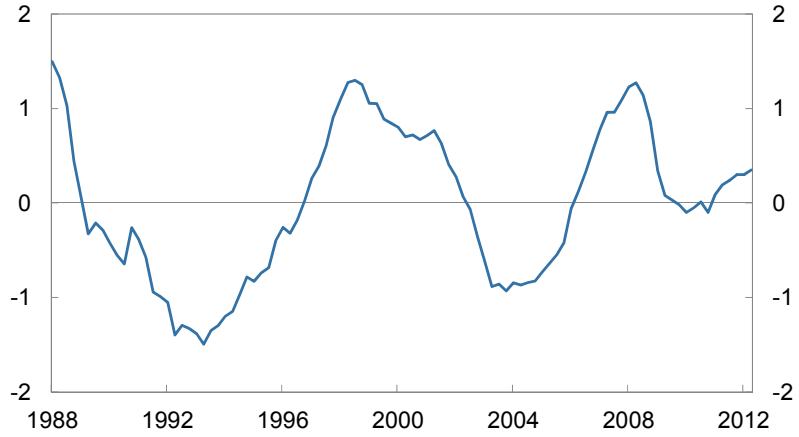
The labour market provides a good indication of resource utilisation in the economy and is explicitly mentioned in the Regulation on Monetary Policy. Unemployment is closely linked to the welfare cost of business cycles and is easier to understand than, for example, a GDP gap.

The level of unemployment provides a direct estimate of the extent of available resources in the economy – and thereby of the output gap – without having to calculate potential output. There is also a fairly close relationship between the output gap and unemployment. When economic growth picks up, unemployment normally falls a quarter or two later. In the literature, this relationship is referred to as Okun's law[12] and has also proved to be relatively stable for Norwegian data.[13]

Compared with GDP, there is little variation in unemployment from quarter to quarter. Unemployment figures are only revised to a limited extent and are published frequently. Unemployment can therefore more easily capture underlying developments in resource utilisation in real time. Unemployment will probably lag slightly in relation to the output gap. On the other hand, labour market figures are made available fairly promptly.

Chart 2 Unemployment gap

Difference between a trend level of unemployment[1)] and registered unemployment. Percentage points. Unemployment as percentage of labour force. Mar 88-Jun 12[2)].



1) The trend level of unemployment is estimated using an HP-filter to 2005 (λ=40000). From 2006 to 2011 the trend level is the average of unemployment for the past 15 years
2) Forecast from MPR 3/11 for 2011 Q1-2012 Q2.

Sources: Norwegian Labour and Welfare Administration (NAV) and Norges Bank

[12] From Arthur M. Okun, "Potential GNP: Its Measurement and Significance", Cowles Foundation, Yale University, Cowles Foundation Paper 190, reprinted from the 1962 Proceedings of the Business and Economic Statistics Section of the American Statistical Association

[13] See the Schweigaard lecture by Governor Øystein Olsen, 8 September 2011: Use of models and economic theory in Norges Bank

In order to calculate an unemployment gap, a structural level of unemployment must be estimated.[14] This is an unobservable variable like potential output. The structural level of unemployment must therefore be estimated, involving many of the same challenges as estimates of potential output. However, compared with potential output, the structural level of unemployment probably changes fairly slowly and varies within a relatively limited range. The structural level of unemployment will partly depend on the functioning of the labour market, which probably does not change markedly from one year to the next. The actual change in unemployment is thus also a good indicator of changes in the gap.

A structural level of unemployment is often defined as the level of unemployment that is consistent with stable price or wage inflation over time. Since price and wage inflation are also affected by other factors in addition to unemployment, estimates must also take these other factors into account. A simple alternative is to estimate the average level of unemployment over a period – for example the previous fifteen years – as changes in structural unemployment are limited in the short and medium term.

An unemployment gap is shown in Chart 2. The gap indicates that although resource utilisation fell considerably in the wake of the financial crisis, there was no deep recession. Capacity utilisation, in terms of unemployment, has picked up gradually since 2009 and was somewhat higher than normal in autumn 2011.

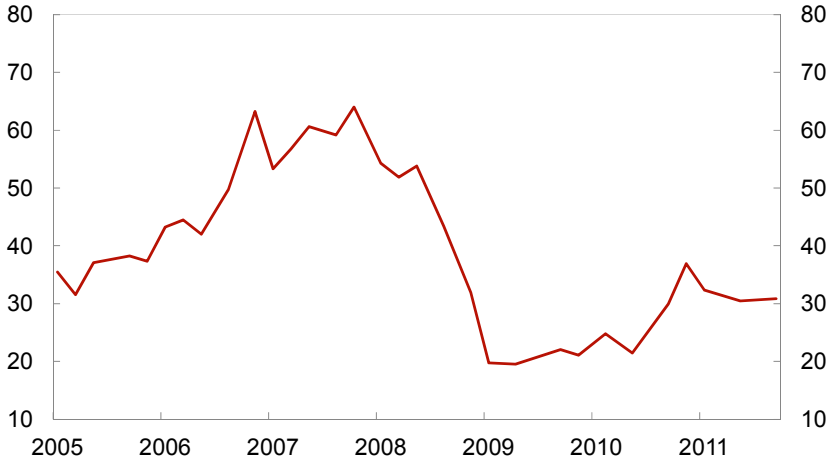
Capacity utilisation in enterprises

Unemployment is an important part of assessing resource utilisation, but it is not the whole story. When output declines – as for example during the financial crisis – enterprises can choose to maintain the workforce for a period. While this curbs the rise in unemployment, the effect is matched by excess capacity in the enterprises.

[14] We use the term structural unemployment to emphasise that the gap is intended to reflect welfare costs. If the gap were to be an inflation indicator, we could alternatively have used the terms NAIRU/NAWRU or equilibrium unemployment. However, it is difficult to distinguish between the different concepts in practice. For more details on the various concepts of unemployment, see Richardson (2000)

Chart 3 Capacity constraints in Regional network

Share of firms that would have some or considerable difficulty accommodating a rise in demand. Per cent. Jan 05 – Sep 11.



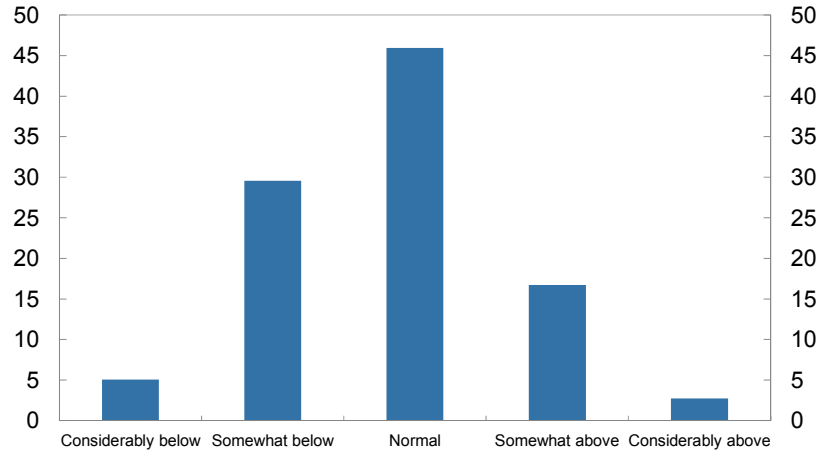
Source: Norges Bank

To gain information on the extent of excess capacity in enterprises, we regularly ask our regional network contacts whether they will have problems accommodating a rise in demand. The share of enterprises facing capacity constraints was higher in autumn 2011 than in summer 2010 and was close to the share that indicates a normal level of capacity utilisation (see Chart 3).

Each round of reports from Norges Bank's regional network focuses on a different theme. In September 2011 and November 2010 enterprises were asked specifically about the degree of capacity utilisation. It was emphasised that capacity utilisation at 100 per cent does not mean maximum production, but a degree of utilisation of existing production equipment and labour that is sustainable over time. A majority of enterprises indicated in September that capacity utilisation was normal or slightly below normal (see Chart 4). Compared with the survey in November 2010, capacity utilisation had increased.

Chart 4 Characterisation of degree of capacity utilisation in Regional network

Private sector, total. Per cent. September 2011.

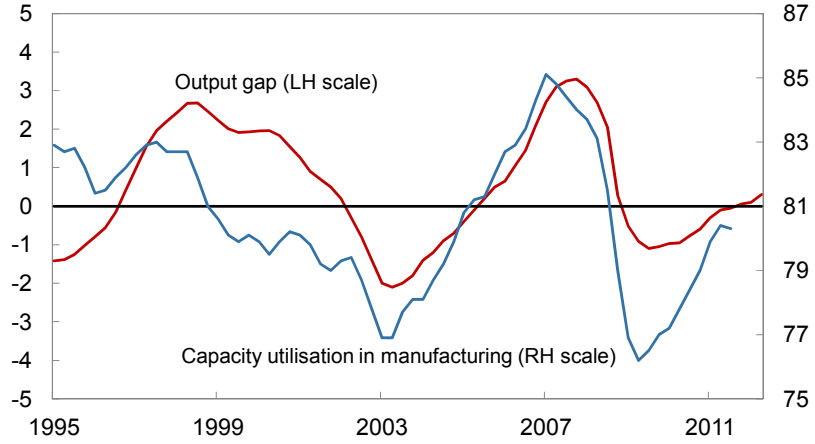


Source: Norges Bank

A cross check of capacity utilisation in manufacturing is provided by Statistics Norway's business tendency survey. Enterprises are asked to report the degree of capacity utilisation that is reflected by the level of production. Historically, the average degree of capacity utilisation is about 80 per cent. Capacity utilisation in manufacturing has increased since mid-2009 and was close to a normal level in September last year (see Chart 5).

Chart 5 Capacity utilisation in manufacturing[1)] and the output gap[2)]

Mar 95-Sep 11. Estimate of the output gap to Jun 12.



1) Statistics Norway's business tendency survey.
2) Estimate of output gap MPR 3/11.

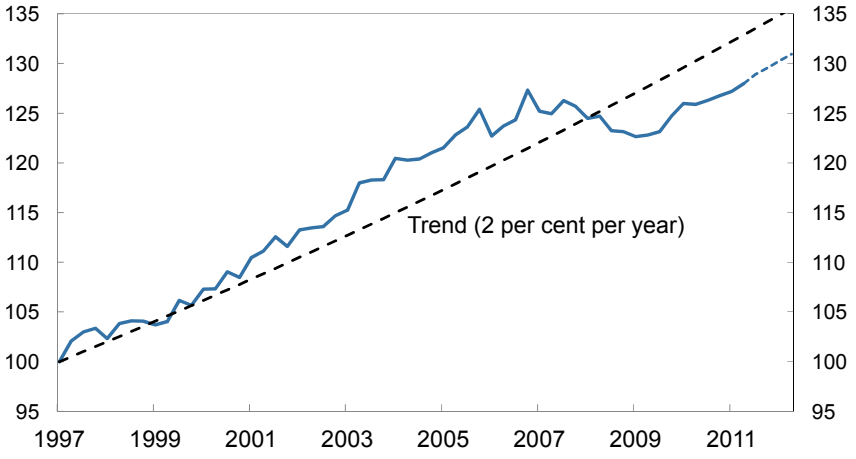
Sources: Statistics Norway and Norges Bank

Capacity utilisation in enterprises can also be assessed based on productivity. Low productivity may indicate that the enterprise's resources are not being utilised to the full. The level of productivity was clearly lower than a continuation of the pre-crisis trend would imply (see Chart 6). In 2008 the level of labour productivity fell significantly and was approximately unchanged in 2009. One explanation for this is that enterprises to a great extent maintained the workforce through the financial crisis, possibly reflecting a desire to retain staff that might be difficult to recruit later. At the same time, low interest rates provided the financial leeway for enterprises to hold onto staff. Although enterprises have improved their utilisation of productive capacity in terms of labour and equipment since 2009, productivity is still low. In isolation, this would imply that excess capacity in enterprises was still considerable.

On the other hand, there was little else to indicate that the level of excess capacity in enterprises was high. Employment rose, indicating that enterprises did not have surplus labour. Norges Bank's regional network reported that capacity utilisation was close to normal. It thus appears that trend productivity growth was low following the financial crisis, thereby dampening growth in potential output. Lower growth in trend productivity can be related to a decline in investment, the permanent loss of some capacity during the financial crisis and reduced risk appetite among banks and companies. High immigration may also have had a negative effect on underlying productivity through for example language problems or because relevant qualifications are generally lower among immigrants than among Norwegian workers.

Chart 6 Productivity gap

Mainland Norway – GDP per hour worked. Index, seasonally adjusted figures, market value. Mar 97-Jun 11, projection to Jun 12 from MPR 3/11.



Sources: Statistics Norway and Norges Bank

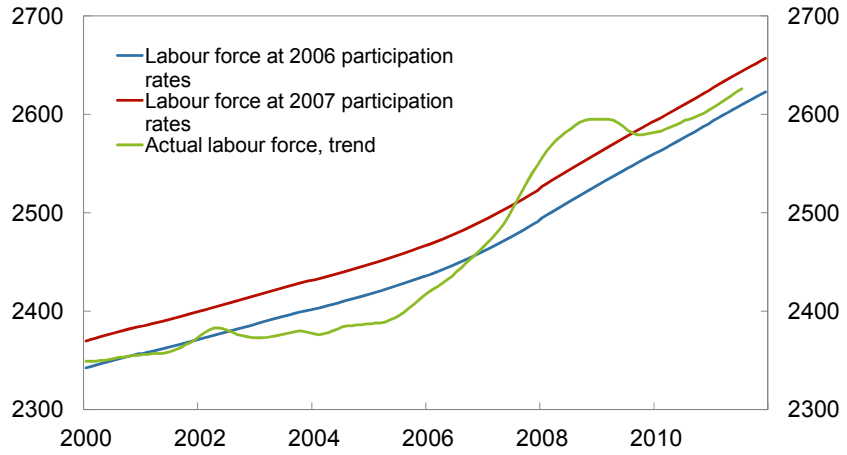
International experience of previous financial crises indicates that the negative impact on output levels is permanent. According to an IMF study, the level of output seven years after the crisis was estimated to be on average 10 per cent lower than it would have been in the absence of a crisis.[15] Experience varies widely from country to country and from crisis to crisis. The financial crisis had a relatively small impact on the Norwegian economy and the more permanent effect on the level of output will probably be lower than indicated by the IMF analysis. At the same time, it must be expected that lower potential growth abroad will also influence underlying growth in the Norwegian economy.

Labour force participation

Unemployment and capacity utilisation in enterprises are important indicators of the extent of available resources. However, the unemployed only make up a small part of potential labour supply. The potential labour force in persons is the working age population multiplied by the propensity to work.

Chart 7 Actual trend in the labour force and the labour force as a result of demographic developments[1)]

Seasonally adjusted. In 1000s. Jan 00-Des 11.



1) Labour force given that the participation rate in each age group remains unchanged at 2006/2007 level.

Sources: Statistics Norway and Norges Bank

Labour force participation fluctuates with the business cycle, but is also affected by more long-term conditions. Labour force participation rose sharply during the previous period of economic expansion, but has fallen considerably through the downturn. The situation in 2006-2007, when the labour market was approximately in balance, can be used as a reference point for normal

[15] See IMF *World Economic Outlook*, September 2009, Chapter 4, "What's the damage? Medium-Term Output Dynamics after Financial Crises"

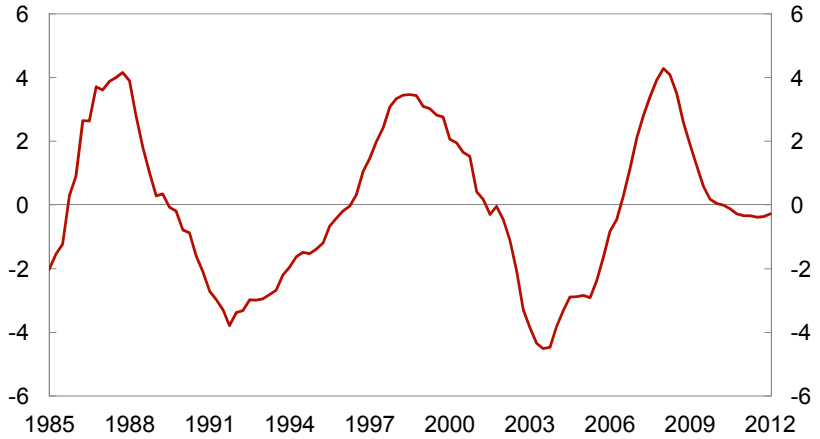
labour force participation. However, demographic developments, which have in isolation reduced the labour force participation rate since 2006-2007, must be taken into account. The share of working-age elderly has increased and the participation rate for this group is relatively low. By holding the participation rates for the different age groups at the 2006 and 2007 level respectively, we can illustrate how the labour force would have developed as a result of demographic changes (see Chart 7). Taking into account demographic changes, the labour force participation rate is at about the 2006-2007 level. The chart also shows that the labour force has grown approximately in pace with the working-age population over the past year. This also implies that labour force participation rates are close to a normal level.

Labour supply in hours

The labour supply in hours also depends on how many hours each person works. The labour hours supplied can vary with the business cycle. For example, enterprises may in periods use overtime to a greater extent (and at greater cost) than is sustainable over time. As an additional aid in our assessments of the output gap, we also calculate the difference between actual hours worked and trend hours worked. This can provide an overall picture of pressures in the labour market. The calculations suggest that the cyclical downturn in the wake of the financial crisis led to a normalisation of the very tight labour market, but that the labour market has been relatively resilient to the recession (see Chart 8).

Chart 8 Hours gap[1)]

Percentage difference between hours worked in mainland Norway and an estimated trend level. Mar 85-Jun 12. Projection from MPR 3/11.



1) The trend is calculated using an HP-filter (λ=40000). Hours worked from national accounts 1978 to 2011 Q2 and projections from MPR 3/11 for 2011 Q3 to 2014 Q4. The gap is a three-quarter moving average.

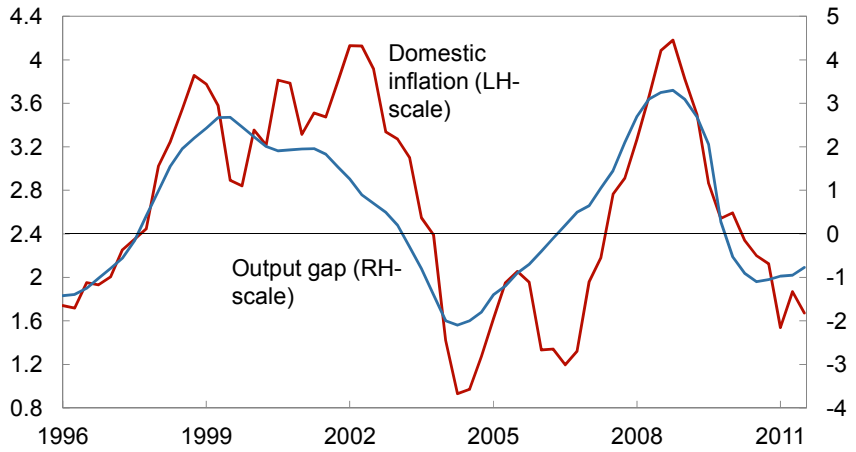
Sources: Statistics Norway and Norges Bank

Output gap and inflation

Even though we primarily think of the output gap as a welfare measure and not an indicator of future inflation, there is in practice a relationship between the output gap and inflation. It takes time for the output gap to have an impact on wage and price inflation. In addition, a positive output gap can accompany declining inflation for a period if import prices fall. Analyses of the Norwegian economy indicate that there is a 4-5 quarter lag in the response of inflation to a pickup in GDP growth.[16] Today's price and wage inflation do not therefore provide information about the output gap today, but about what it was approximately a year ago. Chart 9 shows Norges Bank's output gap and domestic inflation, with the output gap backdated four quarters.

Chart 9 Domestic inflation[1)] and the output gap

Estimate of the output gap from MPR 3/11.The output gap is backdated four quarters. Mar 96-Sep 11.



1) Year-on-year rise in prices for domestically produced goods and services.

Sources: Statistics Norway and Norges Bank

The chart shows that the fall in domestic inflation seemed to have come to a halt and that there were signs of a pickup in autumn 2011. This could be consistent with the trough in the output gap in mid-2010 and the subsequent pickup in capacity utilisation.

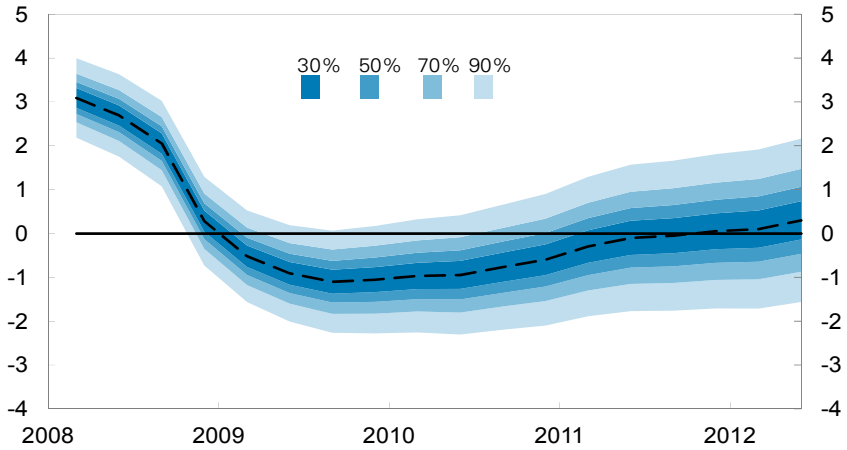
[16] See the Schweigaard lecture by Governor Øystein Olsen, 8 September 2011: Use of models and economic theory in Norges Bank.

Conclusion

The output gap quantifies aggregate capacity utilisation in the economy. Norges Bank's output gap assessment starts with a trend calculation (HP filter) of mainland GDP. Such trend estimates are inherently subject to uncertainty, particularly towards the end of the sample period. We therefore adjust the estimates based on other key information about capacity utilisation in the economy. The most important sources of adjustments are reviewed in this paper. In our assessments, particular emphasis is given to developments in the labour market. Unemployment is a good measure of welfare and provides a good gauge of the level of economic activity. As labour market figures are published regularly and seldom revised, they are therefore very useful in real-time assessment of capacity utilisation in the economy. In our assessment of capacity utilisation in enterprises, particular emphasis is given to the reports from Norges Bank's regional network.

In *Monetary Policy Report* 3/11, Norges Bank's assessment was that capacity utilisation in the Norwegian economy was close to a normal level (see Chart 10). An estimation of the GDP gap using the HP-filter suggested that there were still unutilised resources in the economy. However, weight was given to the slightly lower level of unemployment than the average for the past decade and the pickup in wage growth. This implied in isolation that the output gap was positive. Nor did excess capacity in enterprises appear to be high. Norges Bank's regional network reported that the share of enterprises facing capacity constraints had increased and was close to a normal level. Labour demand in the enterprise sector had risen. Statistics Norway's business tendency survey indicated that capacity utilisation was close to the historical average. The uncertainty of output gap estimates is illustrated using fan charts, not only for the output gap in the future but also for the current economic situation.

Chart 10 Estimated output gap[1)] in MPR 3/11
Quarterly figures. Per cent 2008 Q1 – 2012 Q2



1) The output gap measures the percentage difference between mainland GDP and the estimated potential mainland GDP

Source: Norges Bank

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