

■ The driving forces behind trends in the economy can be analysed using a production function

In this report, the Riksbank complements the analysis of resource utilisation with a production function approach. This approach includes an explicit assessment of potential employment and the potential number of hours worked. The method makes it easier to understand the driving forces behind trends in the economy. For example, potential labour force participation is expected to increase in the period ahead, as a consequence of both demographic factors and economic policy. The production function is one of several approaches that the Riksbank will use in its analysis of resource utilisation in the future. However, the Riksbank will continue to adopt a broad approach and therefore study a number of different indicators that will be weighed together with other information to form an overall assessment of resource utilisation.

The Riksbank conducts a policy of flexible inflation targeting. This means that the repo rate is normally set with the aim of attaining an appropriate balance between stabilising inflation around the inflation target and stabilising the real economy, for example in terms of production and employment. A high rate of growth and full employment are not targets for monetary policy because monetary policy cannot increase economic growth or employment in a lasting way by being systematically expansionary. The best that monetary policy can do – apart from stabilising inflation around the inflation target – is to attempt to reduce the fluctuations in the real economy; that is to strive to stabilise production and employment around development paths that are sustainable in the long term.

A measure of resource utilisation is often used as an overall picture of the development of the real economy. This attempts to measure to what extent the productive resources of the economy – labour and capital – are used in relation to what is sustainable. However, resource utilisation cannot be observed directly but must be estimated using a statistical or econometric method, or studied on the basis of various surveys.

The Riksbank has chosen to adopt a broad approach to the analysis of resource utilisation and presents a number of different indicators of resource utilisation in its Monetary Policy Reports and Monetary Policy Updates. Some of these indicators come from surveys in which the respondents are asked about the current situation or future prospects in their companies. Other indicators, such as the employment rate or unemployment, can say something about how strained the situation is on the labour market as a whole. Another indicator is the production gap. This is used to try to estimate how total production relates to what can be assumed to be a normal level. On the basis of all these indicators and other information, the Riksbank makes an overall assessment of resource utilisation. There is no single measure that reflects this overall assessment. The Riksbank's final assessment of resource utilisation is instead qualitative in nature and is often expressed as "higher than normal", "normal" or "lower than normal".

In the case of measures such as how hours worked, employment or GDP deviate from their respective trends, the Riksbank has to date

primarily calculated the trends using the so-called HP filter.²⁵ However, this filter is associated with a number of problems. One such problem is that the method tends to allow the trend to end up close to the last outcome in the series filtered, which means that the estimate of resource utilisation always ends up relatively close to zero at the end of the estimate period. Another problem is that the filter is a purely statistical method that lacks economic links. This means that new outcomes for the series to be filtered affect the estimate of the trend in a rather mechanical way, so that the estimate of resource utilisation is also revised more or less mechanically. As it is a purely statistical filter it is also difficult to interpret the estimated trends in economic terms.

As a result of the problems associated with the HP filter and other more statistically-oriented methods, the Riksbank has chosen to complement the analysis with another method of calculating the trends. This method is usually called the production function approach and is used by many forecasters who attempt to determine what the situation is regarding resource utilisation.²⁶ One advantage of the new method is thus that it will facilitate comparisons with other forecasters. In addition, it will be possible to break down the trends from the production function approach into the contributions made by hours worked (and their components), capital services and total factor productivity.²⁷ This makes it easier to interpret and understand the assessments that lie behind the view of trend development.

The Riksbank's adoption of a production function approach to complement the analysis of resource utilisation does not mean, however, that this will be the only measure of resource utilisation that will be analysed in the future. Making exact estimates of resource utilisation is difficult, irrespective of the method used, and the Riksbank will continue to take a broad approach to the analysis of resource utilisation.

The production function approach

In the production function described here, production is determined by the production factors – capital and labour.²⁸ In addition, there is a measure of technological development that is usually referred to as total

25 The HP filter takes its name from the economists who made this method popular in economic applications, see R. J. Hodrick and E.C. Prescott, "Post-war U.S. Business Cycles: An Empirical Investigation", *Journal of Money, Credit and Banking*, Vol. 29(1), pp. 1-16, 1997. For a simple description, see the section on the Hodrick-Prescott filter in M. Apel, J. Hansen and H. Lindberg, "Potential production and production gap", *Economic Review*, 1996:3, Sveriges Riksbank.

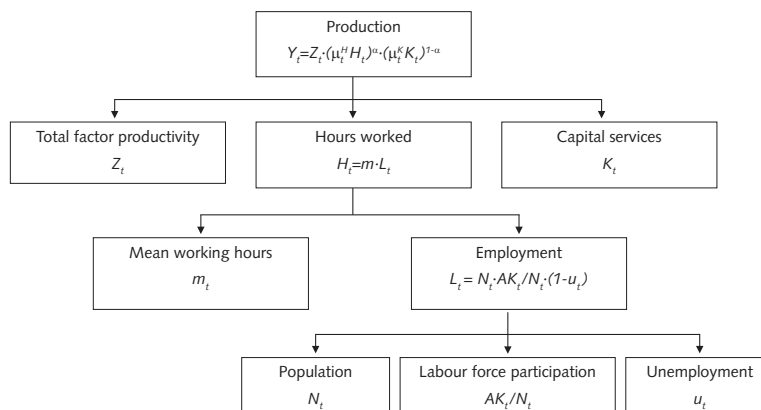
26 For a more detailed description of the production function approach see M. Apel, J. Hansen and H. Lindberg, "Potential production and production gap", *Sveriges Riksbank Economic Review*, 1996:3, Sveriges Riksbank. See also P-O. Beffy, et. al. "New OECD Methods for Supply-Side and Medium-Term Assessments: A Capital Services Approach", OECD, Economics Department Working Papers, No. 482, 2006 and C. Denis, "Calculating Potential Growth Rates and Output gaps – A Revised Production Function Approach", *European Economy*, Economic Papers, No. 247, 2006.

27 The term capital service is to be distinguished from the term capital stock. The capital stock measures the value of machinery, buildings, ICT capital and so on. When calculating capital services, one attempts to adjust the different types of capital on the basis of how productive they are. Normally, this means that highly-productive types of capital, e.g. ICT capital, are adjusted upwards in relation to other types. For a more detailed discussion see "Hours, capital and technology – what means most?", Appendix 6 of the Long-term Planning Commission Report 2008, SOU 2008:14.

28 Formally, it is only the capital services and the hours worked that are actually used for productive purposes that are included in the production function. In Figure 1 this is illustrated by the two parameters that measure the degree of utilisation of the production factors, μ_t^H and μ_t^K , which are both between 0 and 1. For example, if the capital is only used to 75 per cent of its full capacity then $\mu_t^K=0.75$. Similarly, if a person is employed and receives wages for 40 hours a week, but in practice is only used for 30 hours a week to produce goods, then $\mu_t^H=0.75$.

factor productivity (TFP). Hours worked can be broken down into average hours worked and the number of people employed, which in turn can be broken down further (see Figure B19).

Figure B19. Outline of the production function approach



The production function can be used to describe both actual and trend, or potential, production. Like most of the other institutions that use the production function approach, the Riksbank assumes that the actual and the potential capital services coincide.²⁹ This means that the difference between actual and potential production, the so-called production gap, is due to a TFP gap and an hours gap in the form of the deviations of employment and average hours worked from their potential levels. Employment can in turn be described on the basis of unemployment, labour force participation and population trends. Break downs, or decompositions, of this type make it simpler to interpret the driving forces behind the trend development of GDP, the number of hours worked and employment. For example, the assumption that unemployment can be lower in the long term will increase potential employment and thus the potential number of hours worked, which will increase potential production (see Figure B19).

It is difficult to assess technological development

Technological development is included in the production function as an important factor that determines both actual and potential production. On the basis of observed values for GDP, hours worked and the capital services, the production function can be used to calculate a so-called Solow-residual (see Figure B20).³⁰

We can see that the Solow-residual fluctuates considerably over time. For example, it fell dramatically in connection with the financial crisis. This is partly because the companies retained their personnel and their physical capital in the initial phase of the crisis. When production capacity is not used to the full, a falling Solow-residual will arise. To find actual technological development, TFP, all of the cyclical movements

²⁹ This simplifying assumption is made partly because it is notoriously difficult to measure capital stocks and calculate capital services.

³⁰ See R. M. Solow, "Technical Change and the Aggregate Production Function", *The Review of Economics and Statistics*, Vol. 39, No. 3, pp. 312-320, 1957. For an application see "Hours, capital and technology – what means most?", Appendix 6 of the Long-term Planning Commission Report, 2008, SOU 2008:14.

that stem from variations in the utilisation of the production factors must therefore be filtered out.³¹ Like most of the other institutions that use the production function approach, the Riksbank currently does this using an HP filter.³²

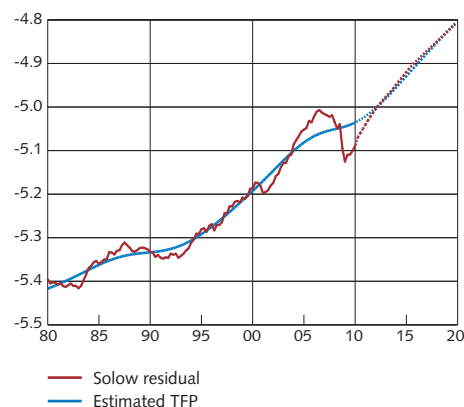
HP filtering the Solow-residual removes some of the fluctuations in the series, but this estimated TFP also fluctuates somewhat over an economic cycle and declined during the initial phase of the crisis (see Figure B20). This indicates that the HP filter is not completely successful in filtering out all the variations in the utilisation of the production factors. Moreover, the estimate of technological development will be revised every time the National Accounts are revised. As estimates of technological development are associated with problems of this type, estimates of the production gap will also be associated with the same problems. It may therefore be an advantage to attach a little greater importance to the development of the labour market when analysing resource utilisation.

Potential employment and potential numbers of hours worked are increasing

The potential level of the number of those employed and the number of hours worked is ultimately determined by changes in population trends and the composition of the population over time.³³ The younger and older age groups have both a lower mean level of labour force participation (due, for example, to the fact that they are studying or retired) and a lower level of average hours worked compared to the 25–54 age group. As labour force participation, unemployment and average hours worked vary between population groups, the number of hours worked will be affected by both the growth of the population as a whole and how the different population groups develop as a percentage of the population. The Riksbank therefore uses a disaggregated model that takes such demographic effects into account.³⁴

Potential employment and hours worked are also affected by economic policy. The main impact of economic policy is in terms of variations in labour force participation. Reforms in the educational, taxation and labour market fields such as the expansion of higher education, amended tax regulations and changes in social insurance schemes affect the level of participation in the labour force. Incentives to move into or out of the labour market are also governed, for example, by changes in the pension scheme. The assessment is that potential labour force participation will increase in the period ahead (see Figure B21). This is mainly because of lower income taxes for those in work and lower payment levels from the social insurance schemes, both factors that

Figure B20. Solow residual and estimated TFP
Index 1980 = 100



Note. TFP stands for total factor productivity. Broken lines represent the Riksbank's forecast.

Source: The Riksbank

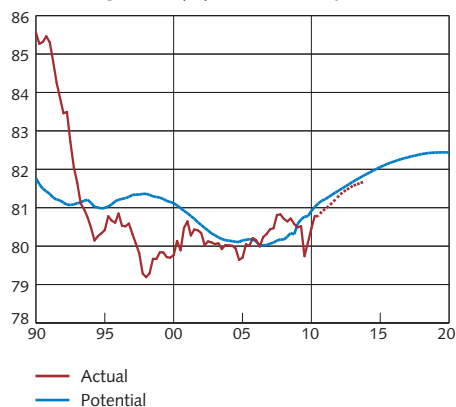
31 With the production function used in Figure B19, the Solow-residual will be $Z_t(\mu_t^L)^{\alpha}(\mu_t^K)^{1-\alpha}$, i.e. the degree of utilisation of labour and the degree of utilisation of capital are included in the measure.

32 Estimating TFP by HP filtering the Solow-residual is of course not an optimal solution given all the problems previously mentioned with regard to the HP filter. Work on finding a better method of estimating TFP is currently underway at the Riksbank.

33 The Riksbank uses the population forecasts produced by Statistics Sweden.

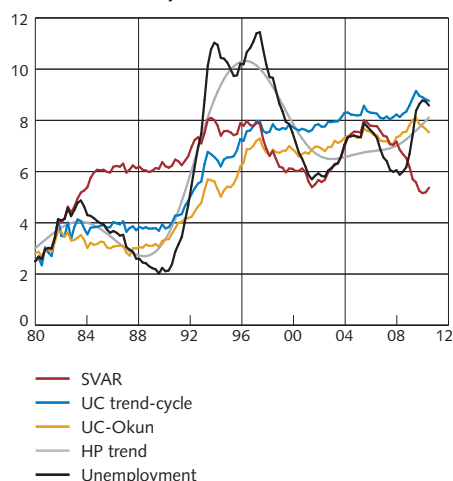
34 The model is described in "Hours, capital and technology – what means most?", Appendix 6 of the Long-term Planning Commission Report 2008, SOU 2008:14.

Figure B21. Labour force participation, actual and potential
Percentage of the population, 16–64 years old



Note. Broken lines represent the Riksbank's forecast
Sources: Statistics Sweden and the Riksbank

Figure B22. Actual unemployment and model assessments of long-term unemployment
Per cent of labour force



Note. SVAR is a structural VAR model. The model includes GDP and unemployment. Long-term unemployment is the level of unemployment that would have been observed in the absence of demand shocks. The cyclical variation has been filtered out of the HP trend.

Sources: Statistics Sweden and the Riksbank

increase the incentive to work.³⁵ It is also due to the fact that the trend towards a higher degree of labour force participation among older age groups is expected to continue.³⁶

Finally, the assessment of the level of long-term unemployment plays a central role in the analysis of resource utilisation on the labour market. Although there are sound arguments for saying that long-term unemployment can never be zero, it is difficult to determine exactly how high it is. The results of empirical studies vary greatly and there are wide uncertainty bands around the estimates (see Figure B22). However, most of the model estimates and assessments appear to agree on two points. First, that long-term unemployment was lower before the crisis of the 1990s than after and, second, that the labour market reforms implemented in the mid-2000s are reducing long-term unemployment.

The Riksbank assumes that long-term unemployment will continue to fall somewhat in the period ahead due to policy effects (see Figure B23). The two most important factors behind this are lower income taxes for those in work and the lower payment levels from the social insurance schemes.³⁷ In the latest crisis, the observed increase in unemployment was much smaller compared with historic links between GDP and activity on the labour market. The Riksbank's assessment is that the increase will not have any lasting effects on long-term unemployment.

All in all, this means that the potential number of hours worked will increase in the period ahead (see Figure B24). This is primarily due to an increase in potential labour force participation (see Figure B21). The fact that potential labour force participation will increase in the period ahead is due to both demographic factors and the effects of economic policy. If we add the contributions from the different gaps we will get a picture of the deviations of GDP, hours worked and employment from their respective trends. Compared to the gaps where trends are calculated using an HP filter, all of the gaps are currently at a lower level with the new method (see Figures 1:27 and 1:28 in the report).

A break down of potential GDP growth

One of the advantages of the production function approach is that, as has just been demonstrated, it makes it possible to break down production into its contributions from various underlying determining factors. The results from the production function described here show that potential GDP growth will decline somewhat in 2010 and 2011, which is linked to the low levels of investment. Potential GDP growth will then gradually

³⁵ For studies of the effects of these economic policy measures on labour force participation see H. Sacklén 2009, "Arbetsutbudseffekter av reformer på inkomstskatteområdet 2007-2009" (The effects of reforms in the field of income tax on the supply of labour 2007-2009) a report from the economics department at the Ministry of Finance 2009. See also the report of the Long-term Planning Commission (2008), SOU 2008:105 and "Yttrande om promemorian Ett förstärkt jobbskatteavdrag" ("Response to the memo A higher tax deduction for those in work"), Fi2009/6109).

³⁶ This trend is linked to an improvement in the general state of health and to a reformed pension system that makes it more profitable to carry on working.

³⁷ Views vary on the magnitude of the effects of economic policy on long-term unemployment, see for example A. Bassanini and R. Duval, "Employment Patterns in OECD Countries: Reassessing the Role of Policies and Institutions", OECD Social, Employment and Migration Working Papers, No. 35, 2006, A. Forslund, "Den svenska arbetslösheten: en översikt" ("Swedish unemployment: a review"), Studies in Fiscal Policy 2008/4, Fiscal Policy Council, and H. Sacklén, "Arbetsutbudseffekter av reformer på inkomstskatteområdet 2007-2009" ("The effects of reforms in the field of income tax on the supply of labour 2007-2009"), report from the economics department of the Ministry of Finance 2009.

increase. Towards the end of the period, approximately 75 per cent of potential GDP growth will stem from technological development and the remainder primarily from an increase in the potential number of hours worked. The primary factor behind the increase in the potential number of hours worked is an increase in potential labour force participation (see Table B4).

Table B4. Decomposition of potential GDP growth
Annual percentage change

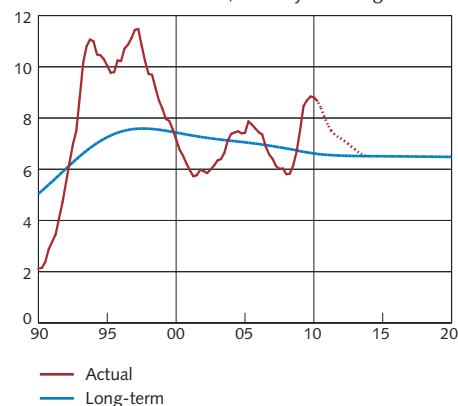
| | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|------------|------------|------------|------------|------------|
| Potential production | 1.8 | 1.6 | 1.4 | 1.7 | 2.0 |
| Of which technology | 0.5 | 0.8 | 1.1 | 1.4 | 1.6 |
| Of which potential capital services | 0.6 | 0.2 | -0.1 | 0.1 | 0.3 |
| Of which potential hours worked | 0.8 | 0.7 | 0.4 | 0.2 | 0.2 |
| Of which potential average working hours | -0.1 | 0.0 | 0.0 | 0.1 | 0.1 |
| Of which population | 0.5 | 0.3 | 0.1 | 0.0 | -0.1 |
| Of which potential labour force participation | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 |
| Of which long-term unemployment | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 |

Source: The Riksbank

Conclusion

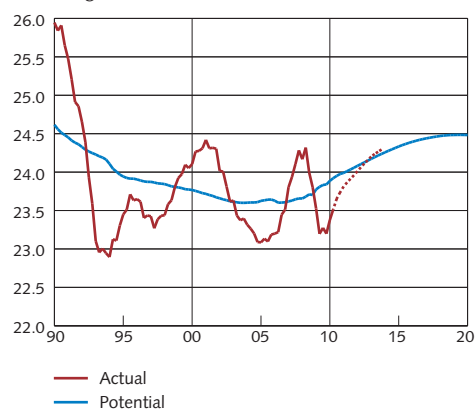
The Riksbank has complemented its analysis of resource utilisation with another method for the calculation of long-term, sustainable levels for GDP, the number of hours worked and employment. One advantage of using a so-called production function approach is that the various trends can be given an economic interpretation. Another advantage is that other forecasters use approximately the same method, which makes comparisons with these forecasters easier. The method does not mean, however, that the Riksbank has adopted a measure of resource utilisation that works in all situations and that can be used directly to draw conclusions concerning which monetary policy is most appropriate. The Riksbank will continue to take a broad approach to the analysis of resource utilisation in which various indicators and other information will play the same role as previously.

Figure B23. Actual and long-term unemployment
Per cent of labour force, 16–64 years of age



Note. Broken lines represent the Riksbank's forecast
Sources: Statistics Sweden and the Riksbank

Figure B24. Hours worked, actual and potential
Number of hours per capita and week, 16–64 years of age



Note. Broken lines represent the Riksbank's forecast
Sources: Statistics Sweden and the Riksbank