ANALYSIS

Estimation of structural unemployment important, but complicated

Finnish economy | 29.06.2017 | Meri Obstbaum, Mikko Sariola

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After the recession following the financial crisis, the US economy has already been growing for 7 years at an average pace of 2%, and the euro area, too, is witnessing a fourth consecutive year of growth. In both regions, the gradual acceleration of economic growth and the strengthening of the labour market have, however, taken place without the build-up of significant price and wage pressures. This raises the question as to how far the economy can still be from its potential output, thus highlighting the need to critically review estimates of the extent of spare capacity in the economy and on the labour market.

Structural unemployment an important yardstick for economic policy

Unused labour market resources are traditionally evaluated through structural unemployment, which reflects the structures of the economy and the labour market. If unemployment is higher than structural unemployment, a decline in unemployment brought about by economic growth will not lead to wage pressures jeopardising a balanced development of the economy. For example, in the euro area, where unemployment has been falling uninterruptedly since 2013, wage growth is, however, still very slow. In Germany, in particular, where unemployment has declined to historic lows, the sluggishness of earnings growth has repeatedly taken experts by surprise.

It is important to identify labour market slack, as the extent of slack gives a direction for governments' economic and employment policies, guides – to a greater or lesser degree – monetary policy and provides an important anchor for wage formation. If the unemployment gap is positive, fiscal or monetary stimulus such as higher public expenditure or lower interest rates can, in principle, reduce unemployment without any significant acceleration in price and wage increases. If, by contrast, the gap has already been closed, the structures of the labour market need to be addressed for reducing unemployment.

There has recently been debate in Finland, too, as to how much employment can improve and unemployment fall now that economic growth has finally taken off. However, if only GDP or the unemployment rate is monitored, it will be difficult to judge whether the resources of the economy are clearly underutilised or perhaps close to the normal state of the economy. A real-time view of structural unemployment would facilitate assessment of the extent of spare capacity in the economy. Such an assessment could then be used in estimating the intensity of price or wage pressures in the context of the current unemployment rate.

According to the Economic Policy Council,[1] the improved cyclical situation gives cause to expect the number of people in employment to rise by only 20,000 to 30,000. The Government's 72% employment rate objective would, however, require growth in the number of employed by about 110,000. The Economic Policy Council thus sees the unemployment as being structural to a significant extent. The Council therefore deems it very unlikely that the employment target could be reached unless there are structural reforms on the labour market to increase labour force participation.

Structural unemployment is an important yardstick for economic and labour market policy decisions, but its quantitative estimation is difficult and may have become even more complicated on the back of developments in recent years. The following analysis draws on the statistical evidence to answer the question of why estimation of structural unemployment at this very moment is increasingly difficult, and presents both a measurement of structural unemployment based on time series methods and an additional way of determining the direction of structural unemployment.

Changes in the labour force participation rate complicate estimation of structural unemployment

International debate on measures of labour market slack has surfaced in recent years, in part, because of contradictory information provided by generally applied indicators. This debate has been particularly lively in the United States, where, according to the Fed's mandate, monetary policy is crucially affected by unemployment as well as inflation.

In the United States, there has been an exceptional increase in the lengthening of unemployment periods. Moreover, a decline in the official unemployment rate has not led to equal growth in the number of employed; instead, the labour force participation rate[2] has continued to fall. Such a decline in the participation rate is, on the whole, a fairly new phenomenon in both the United States and some other advanced economies, and there is as yet no common understanding of the root causes of the decline. In Finland, too, in some recent years the labour force participation rate

has been found to have decreased at the same time as the unemployment rate. Accordingly, lower unemployment has not been channelled in full into employment; instead, labour market participation has weakened despite the cyclical improvement.

The declining participation rate makes estimation of structural unemployment and, by extension, price and wage pressures more difficult. For example, in the United States, from the significant drop in unemployment alone a conclusion could be drawn that there is barely any slack on the labour market, which would in turn point to the need for more restrictive monetary policy in the near future. Meanwhile, based on the labour force participation rate, it would appear that there are more unused resources outside the labour force than suggested by the unemployment rate, and there is no need yet to be concerned about price or wage pressures.

For estimates of structural unemployment and spare capacity, it is important to distinguish which part of the reduction in the labour force participation rate is due to business cycles and which part is structural. Making this distinction is, however, impeded by the deep economic recession and structural changes on the labour market.

Labour markets in the advanced economies have long been shaped by trends that may have led to an increase in the proportion of the population remaining outside the labour market. Technological advances and outsourcing have long been causing a trend decline in middle income jobs in these economies. Population ageing in the advanced economies may be another factor structurally reducing the participation rate.[3] On the other hand, the recession following the financial crisis has also destroyed middle income employment, such as industrial jobs. In addition, the long duration of the post-crisis recession may have resulted in a higher number of discouraged jobseekers than in previous recessions.

It is also possible that originally cyclical unemployment translates into structural unemployment as a consequence of a deep recession. Deep and protracted recessions may increase structural unemployment if, with the prolongation of unemployment, jobseekers' skills are eroded and job-seeking activity weakens. As a result, vacancies are filled more slowly, less new jobs are created and structural unemployment rises. This is known as labour market hysteresis.[4] The hysteresis phenomenon reflects well the difficulties associated with disentangling cyclical unemployment from structural unemployment. There is no unambiguous way of assessing at precisely which stage cyclical unemployment develops into structural unemployment.

Who remain outside the labour market?

It is very hard to estimate how large a proportion of those who have lost their jobs because of recession or structural change will find new employment as the economy recovers. What is the

job-finding probability for those, in particular, who have already been long unemployed or entirely crowded out of the labour market? This could be evaluated by examining not only developments in the size of the labour force, but also its quality.

Are the background factors of the long-term unemployed and those outside the labour force similar to the short-term unemployed in terms of education, profession, sector, region or gender? On the basis of previous research, we know that the likelihood of finding employment is weaker for those with a low level of education than for those with a high level of education, for elderly people than for the middle-aged etc. The duration of unemployment or the time outside the labour market also has an impact on the likelihood of finding employment. As unemployment drags on, active job-seeking may decline and skills may be eroded (hysteresis). Employers may also develop an aversion towards the long-term unemployed, even when their background factors do not differ in reality from those of the short-term unemployed.

Labour market statistics and economic methods offer tools for analysing job-finding probabilities for those remaining outside the labour market, but such work has not been done with a view to estimating structural unemployment and labour market slack, at least not in Finland.

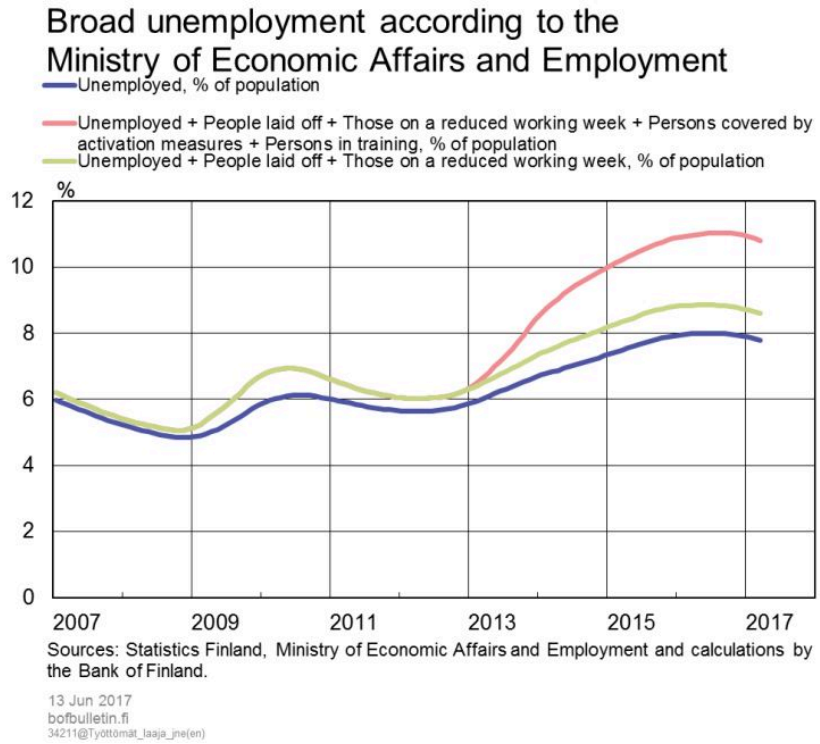
Is the unemployment rate a good measure of labour market slack?

Observations that the official unemployment rate does not describe labour market slack sufficiently broadly have led to the development of broadened measures of unemployment. These types of measures are regularly used, at least in the United States,[5] and have also occasionally been explored by the ECB.[6] Such measures seek to include, in addition to people counted as officially unemployed, also those outside the labour force who could find work if only economic growth were to accelerate, rather than those who are outside the labour force for structural reasons.

Below, we present a review of broad measures of unemployment based on Finnish labour market statistics. Indicators based on Statistics Finland's Labour Force Survey include, besides the unemployed, also those who are classified as part of hidden unemployment[7] and the underemployed[8] (Chart 1). These broader measures show that there are more persons for whom economic growth could help find employment than would be inferred merely from the official unemployment data. It is not surprising that these less stringent criteria indicate there is a larger number of unemployed. It is, however, worth noting that, if broad unemployment is only higher than official unemployment in terms of its level, this will only revise upwards the estimated level of

structural unemployment. The estimate of the extent of slack will not change directly. This signals that the need for structural policy to improve employment is increasingly apparent, but the choice of how unemployment is measured has no relevance for counter-cyclical policy.

Chart 1.



It would be meaningful for counter-cyclical policy if different measures of unemployment behaved differently in business cycles, as this would also change the estimate of the extent of slack. Visual assessment of Chart 1 does not allow us to say much on this matter. It would be easy to assume that there is a considerable degree of slack in the economy in a situation where there is a large proportion of underemployed. Economic recovery and higher demand could then reduce the number of underemployed. Unfortunately, Chart 1 would suggest this does not seem to be the case, with the number of underemployed remaining fairly constant. In recent years, however, unemployment gauged in terms of the broadest measure would appear to have risen by slightly more than the official unemployment rate suggests, and it has not yet moved on to an equally pronounced decline.

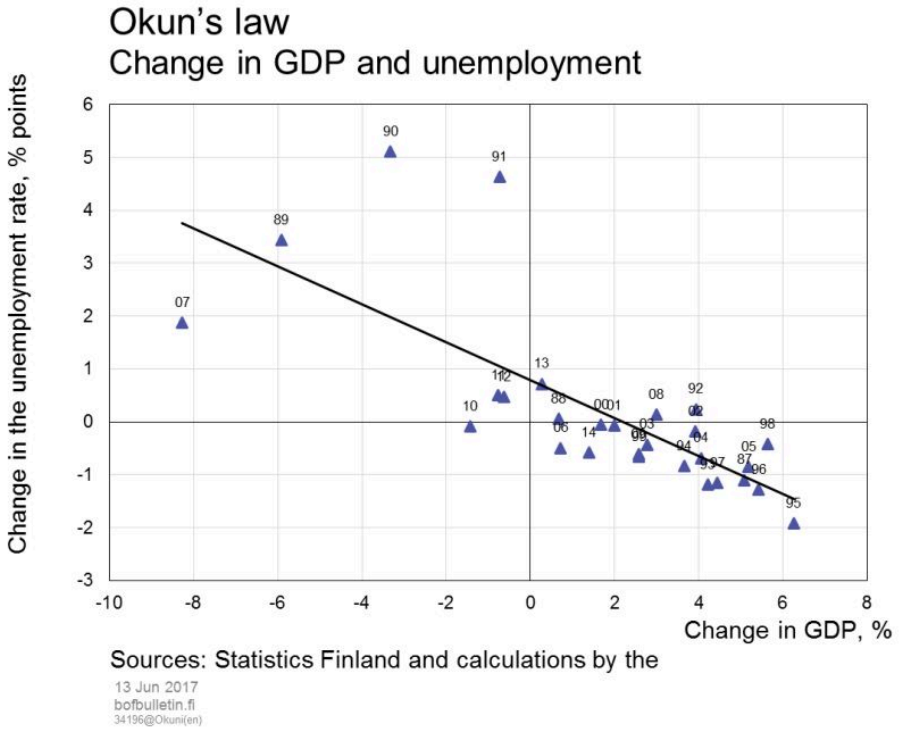
Simple statistical analysis of time series shows that cyclical behaviour across different measures is very similar, except for major turnarounds in the economy. In such situations, the broadest measure in Chart 1 appears to react more strongly than the other measures.[9] The proportion of

underemployed, i.e. those involuntarily engaged in part-time work, decreased very much in the strong economic upswing preceding the financial crisis and increased in the steep downturn in 2009 and 2010. After this, the cyclical behaviour of the different indicators does not differ significantly. The widespread use of lay-offs as an element of elasticity when Finland was in deep recession is likely to explain this phenomenon, as those working less than normal because of lay-offs are included in the underemployed.

In a situation where the economy is recovering from a deep recession, labour market slack can thus be underestimated if official unemployment statistics alone are used for estimation. In Finland's case, it would appear to be important to pay particular attention to the number of workers laid off. Visual assessment and simple statistical analysis are, however, too uncertain to draw very far-reaching conclusions of the actual unemployment gap. For identification of cyclical unemployment and structural unemployment other methods will also be needed, as discussed later in this article.

Broad unemployment measures according to the employment statistics of the Ministry of Economic Affairs and Employment provide a picture similar to that calculated from Statistics Finland's data (Chart 2). These indicators take account of not only unemployed jobseekers but also people laid off, those on a reduced working week, persons covered by activation services fostering employment and those in training. In principle, like the actual unemployed, these are all people who have only temporarily exited the labour market.

Chart 2.



The marked growth in unemployment according to the broadest measure, which includes all these groups, is largely accounted for by the fact that the groups covered by activation services and in training have only existed since 2013. These persons were before statistically classified under other persons outside the labour force. Owing to this statistical change, the differences between the official and the broadest concept of unemployment are not useful for analytical purposes. If the groups covered by activation services and in training are removed from the broad measure of unemployment, the picture will be very similar to that emerging from the statistics compiled by Statistics Finland. The measure including, on top of unemployed jobseekers, also those laid off and those having a reduced working week is comparable to the broadest measure of unemployment calculated on the basis of data compiled by Statistics Finland. According to this gauge, too, official and broad unemployment appear to differ mainly in terms of level, with no significant divergence in cyclical behaviour.

Based on the indicators presented, taking account of the broad measure of unemployment for estimation of labour market slack does not materially change the picture. Structural unemployment estimated on the basis of the broad definition of unemployment may, therefore, simply be at a higher level than if gauged on the basis of official unemployment measures alone. This observation thus refers to structural labour market rigidities rather than volatility in labour

market slack caused by aggregate demand.

Consequently, in the current upswing, the official unemployment rate could still provide a useful point of departure for an evaluation as to how much room there is for a cyclical improvement in employment.

Many types of structural unemployment even in economic theory

The most common concept of structural unemployment stemming from economic theory is the NAIRU.[10] This is based on the relationship between unemployment and inflation well-known in economic theory: changes in monetary policy, or more broadly in aggregate demand, push unemployment and inflation in opposite directions over the short term. According to this relationship, a certain level of unemployment corresponds to a stable rate of inflation. The inflation-unemployment relationship was in some form already present in David Hume's writings in the 18th century, and the term NAIRU has been used since the 1970s.

The NAIRU concept is very closely related to the natural rate of unemployment, whose theory was developed by the Nobel laureates Milton Friedman and Edmund Phelps in the 1960s.[11] Friedman described the natural rate of unemployment as the lowest rate of unemployment that can be achieved in the long run without an acceleration in real earnings growth. The NAIRU, in turn, means more broadly a rate of unemployment consistent with stable inflation. Occasionally, the concept of NAWRU[12] is also used, which means the lowest unemployment rate attainable in an environment of stable wage developments.

In the modern business cycle theory, the NAIRU in its simplest definition results from labour market competition. The less there is competition on the labour market, the higher will be the wages relative to those on effective markets and the higher will be structural unemployment. The degree of competition is, however, a highly abstract concept, and the NAIRU theory as such fails to provide an explanation for the ultimate reasons behind the lack of competition on the labour market and structural unemployment.

Structural unemployment can also be estimated by an equilibrium unemployment model, based on research by such further Nobel laureates as Peter Diamond, Dale Mortensen and Christopher Pissarides, which lays emphasis on labour market frictions related to job search and job creation.[13] Equilibrium unemployment is structural unemployment, just like the NAIRU, but their definitions differ slightly. Unlike in the case of the NAIRU, in the equilibrium unemployment model framework, structural unemployment is not affected by short-term changes in prices and wages,

nor by inflation expectations.

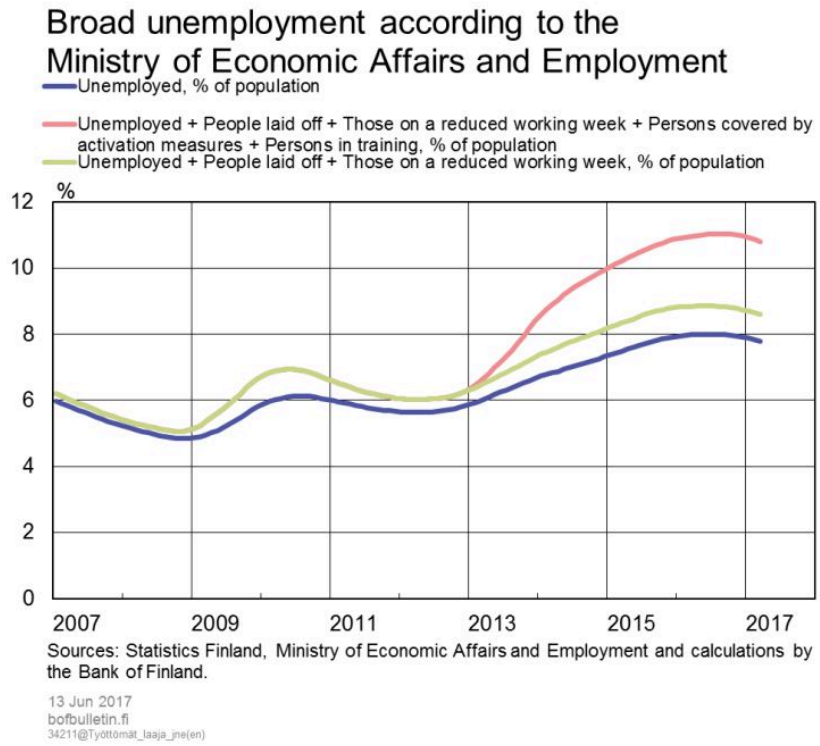
Equilibrium unemployment is only affected by structural factors, such as the effectiveness of the labour market in matching job vacancies and jobseekers, the unemployment benefit replacement rate and the negotiation activity of the social partners. Structural factors thus include both frictional unemployment, caused by the time and costs involved in job search, and the impact on equilibrium unemployment of norms and institutions regulating the functioning of the labour market. There are only limited possibilities to address frictional unemployment, but changes in other structural factors can impact the level of equilibrium unemployment.

How could the NAIRU be measured?

The NAIRU has been estimated with the help of simple time series models, but it is currently measured by widely employed methods exploiting the Phillips curve. The significance of NAIRU estimation is highlighted by the fact that it has a direct link to the level of potential output in the economy and, by extension, to the estimated output gap. A high NAIRU reduces the labour force potentially available for the economy and lowers the level of potential output.

Unfortunately, the NAIRU is very difficult to gauge. The challenge of estimation is due to the NAIRU being an unobserved variable that can only be inferred indirectly from statistics. Chart 3 presents estimates by international organisations of the Finnish NAIRU.

Chart 3.



Statistical methods to separate trend from cycle in unemployment

One approach to NAIRU estimation is to use univariate statistical methods in which different filters decompose time series of economic activity into trend and cycle. One of these methods is the very popular Hodrick-Prescott (HP) filter.[14] The trend of the unemployment rate produced by these methods is, however, only a statistical variable, not an actual NAIRU, as these methods are not based on economic theory.[15]

One significant problem associated with univariate statistical filters is the sensitivity to revisions of the most recent observations of unemployment trend series generated by them, which leads to considerable uncertainty about interpretations of the current situation. This 'end-point problem' means that an understanding of today's NAIRU will change ex post facto as new statistics are released.[16] Other critiques concerning the use of the HP filter have also been presented.[17] Furthermore, it remains the responsibility of the user of the widely applied HP filter to opt for a suitable smoothing parameter, which should reflect the properties of the time series in question. This choice has a material impact on the type of trend produced by the method, in this case the

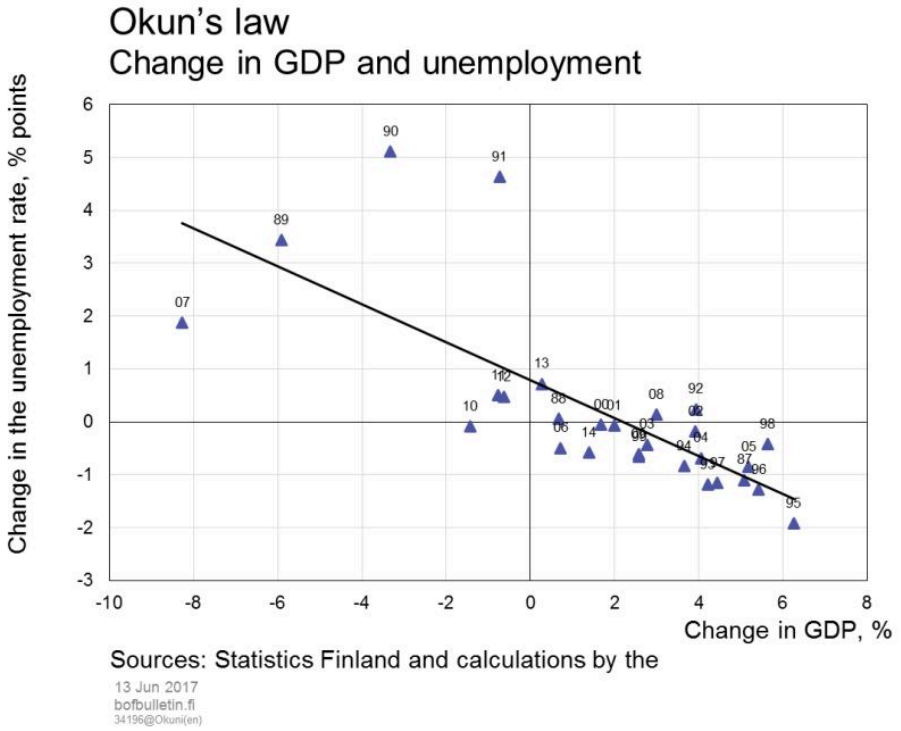
trend in structural unemployment.

Support for NAIRU measurement from economic theory

Another problem associated with the above statistical univariate methods in NAIRU estimation is that they fully disregard economic theory. This shortcoming can be remedied to some extent by making use of semi-structural unobserved components models. Application of this type of multivariate filter (MVF) methods has recently become more widespread.[18] They simultaneously decompose several observed variables into trend and cycle. The observed unemployment is decomposed in the models into an unobserved part, i.e. the NAIRU, and the unemployment gap. Such semi-structural models seek to exploit economic dependencies between variables that are well-known in macroeconomic theory.[19] In this case, it is possible to incorporate into the same framework not only statistical dependencies but also relations derived from economic theory, between, on one hand, wages and unemployment and, on the other hand, unemployment and economic growth. Thus the basic assumption is that the rate of increase in inflation or wages includes important information on the output or unemployment gap prevailing in the economy.

The inverse relationship between inflation and unemployment is often described by means of the Phillips curve. In an economic slump where actual output is lower than potential output, i.e. the negative output gap is large, the rate of increase in prices is moderate. The Phillips equation thus enables creation in the model of a direct link between the output gap and inflation, or between the unemployment gap and the rate of increase in wages.[20] Meanwhile, Okun's law[21] – GDP growth correlates with a decline in the unemployment rate – makes it possible to combine the development of the output gap with that of the unemployment gap. Chart 4 illustrates the relationship between GDP and the observed unemployment rate.

Chart 4.



Accordingly, a multivariate filter method enables combination of the Phillips equation and Okun's law as well as estimation of potential output. These types of models have recently been used in regard to, for example, the United States and the euro area.[22] The models can be augmented with lags or new observed variables if these are believed to bring additional information for estimation of unobserved variables. For example, efforts could be made to improve estimates of the NAIRU by incorporating information on long-term unemployment or other statistics on structural unemployment within the framework of the model.

One good feature of the multivariate filter method is that it is flexible and enables reduction of the sensitivity of results to revisions. However, application of the method in itself does not guarantee robust outcomes. In this method, too, it is a challenge to generate reliable real-time estimates of current structural unemployment, which complicates the use of NAIRU calculations as a short-term guide for policy.

In order to produce more reliable real-time estimates, the method can also be extended so as to take account of open economy considerations, as Darvas and Simon (2015)[23] propose. As well as Darvas and Simon, critics of the sensitivity of results to ex post facto revisions include Borio et al. (2014)[24] and Melolinna et al. (2016),[25] who suggest incorporation of financial indicators into the

models as a solution. Bagrave et al. (2015),[26] in turn, propose the use of inflation and growth expectations in multivariate filter models in order to make results less prone to revisions. Alichi et al. (2017, 2015)[27] show, among other things, that using the capacity utilisation rate reduces the sensitivity of the method to revisions in connection with estimates of potential output and economic slack.

In analysing empirical research results, however, it must always be remembered that the results obtained are surrounded by uncertainty about model parameters and specification, i.e. how the model is constructed. It is clear that, with poorly defined models, no good results can be obtained even if estimation is made with technically highly sophisticated methods. In any case, the multivariate filter method offers a good auxiliary tool that can be harnessed in estimates of economic slack – in other words, in tracing the unobserved.

Even so, irrespective of different methods, measurement of the NAIRU is at best uncertain. As the NAIRU is a time-varying unobserved variable, estimation challenges can never fully be avoided.

Structural unemployment derives from labour market frictions and regulation

In the labour market theory developed by Diamond, Mortensen and Pissarides, equilibrium unemployment is only affected by structural factors, such as the effectiveness of the labour market in matching job vacancies and jobseekers, the unemployment benefit replacement rate and the negotiation activity of the social partners. If there are changes in these structural factors, equilibrium unemployment will seek its way to a new level.

According to the theory, equilibrium unemployment will rise if the job destruction rate grows, wage earners' negotiating power increases, pay demands (reservation wage, i.e. threshold for the required level of pay at which it will be financially worthwhile to start working rather than live on unemployment benefits) edge higher or minimum wages rise. Tightening taxation and higher unemployment benefits raise the reservation wage and add to equilibrium unemployment. Meanwhile, equilibrium unemployment is reduced by improved functioning of the labour market.

It is possible to find empirical counterparts for many of these structural factors. For example, the job destruction rate can be measured in Finland on the basis of either individual data[28] or employment service statistics[29]. The job destruction rate depicts the ratio of new unemployment periods to unemployed jobseekers. The destruction rate has fallen significantly in Finland during the double-dip recession following the financial crisis. But this has not reduced the risk of structural unemployment, as the number of unemployed who have found work has declined by

even more, thereby expanding the group of unemployed.

Factors impacting the reservation wage, such as taxation and unemployment benefits, can also be measured. Tightening labour taxation, level increases in unemployment benefits and their longer duration, as well as higher housing and living allowances raise this threshold, thereby weakening employment incentives.

A key indicator in describing the functioning of the labour market is the Beveridge curve, which illustrates the relationship between unemployed jobseekers and job vacancies. An outward shift of the Beveridge curve is an indication of the impaired functioning of the labour market, as there are simultaneously more of both job vacancies and unemployed jobseekers. This also increases the risk of structural unemployment.

By contrast, it is very hard to measure some factors that affect structural unemployment. Among other things, it is very difficult to give a precise figure for employees' negotiating power. Despite this, the equilibrium unemployment model framework could enable systematic analyses of structural factors underlying structural unemployment and thus provide valuable additional information on the reasons for structural unemployment.

As structural factors impacting equilibrium unemployment do not remain unchanged over time, the level of equilibrium unemployment will also vary. In Finland, estimates of the level of equilibrium unemployment have not been reported, but in Sweden, for example, this is an established procedure for assessment of structural unemployment.[30] In addition to the level, changes in equilibrium unemployment can be roughly measured by means of the factors affecting it.

Conclusion: Making better use of statistics and theory to estimate structural unemployment

The level of structural unemployment and changes therein are key indicators in making decisions on economic and labour market policies. They enable estimates of how much employment can improve as a consequence of economic growth alone and what type of economic and labour market policies should be conducted going forward.

Estimation of labour market slack is, however, very difficult. It may also have become more complicated in recent years, as the economy and labour markets have been shaped simultaneously by population ageing, structural change destroying middle income jobs and an exceptionally protracted recession.

The broader the measure of unemployment used, the higher is unemployment, but this does not yet directly disclose the extent of spare capacity. Broad measures of unemployment constructed on the basis of Finnish employment statistics suggest that the cyclical behaviour of unemployment is very similar irrespective of the measures deployed. Consequently, the broadening of unemployment measures does not necessarily have any significant information value for counter-cyclical policy, even if it can highlight the need for structural policy actions.

The most common way, derived from economic theory, of gauging structural unemployment is the NAIRU, and this is widely used in Finland, too. Its estimation methods have developed over time, but not all challenges can be met, as it traces something that cannot even ex post be observed from statistics.

Estimation of structural unemployment should therefore be supplemented with an exploration of structural factors derived from equilibrium unemployment theory. This would provide a clue as to the frictions and institutional structures that maintain unemployment above its efficient level. This could not only strengthen an understanding of the extent of labour market slack, but also guide the content of structural policy. Improving business cycles only remedy unemployment caused by cyclical variation, whereas labour market structures need to be altered to reduce structural unemployment.

Both statistics and economic theory could thus be exploited much more than at present, with a view to tackling the level of structural unemployment and changes therein. These approaches can also be combined so as to increase information on the extent of labour market slack.

Footnotes

1. Economic Policy Council Report 2016. ↑
2. Labour force participation rate = (unemployed + employed) / population. ↑
3. E.g. Fujita (2014): 'On the Causes of Declines in the Labor Force Participation Rate' deals with the causes of declines in the labour force participation rate in the United States. ↑
4. Blanchard and Summers (1986) paid attention to the hysteresis phenomenon. This means that an increase in the observed unemployment rate also leads to an increase in the structural unemployment rate. Blanchard O., Summers L., 'Hysteresis and the European Unemployment Problem', NBER Macroeconomics Annual 1986, Volume 1. ↑
5. Bureau of Labor Statistics / Alternative Measures of Labor Underutilization. ↑
6. E.g. Task Force of the Monetary Policy Committee of the European System of Central Banks, 2012: Euro area labour markets and the crisis. Occasional Paper Series 138, European Central Bank; and ECB Economic Bulletin, Issue 3/2017. ↑
7. A person outside the labour force who would like to have gainful work and would be

available for work within two weeks, but has not looked for work in the past four weeks. Reasons for hidden unemployment include giving up searching for a job or other reasons, such as studies, caring for children or health reasons. ↑

8. An employed person who is engaged in part-time work because full-time work is not available, or whose working week has been cut back by the employer, or who has had no work due to shortage of orders or customers or because of having been laid off. Thus, underemployed refers to an employed person who would like to do more work. ↑
9. The standard deviation of the cyclical component of unemployment obtained from the HP filter is the largest for the broadest measure of unemployment. ↑
10. Non-accelerating inflation rate of unemployment (NAIRU). ↑
11. Milton Friedman, 'The Role of Monetary Policy', American Economic Review, March 1968, pp. 1–17; Edmund S. Phelps, 'Phillips Curves, Expectations of Inflation, and Optimal Unemployment Over Time', Economica, August 1967, pp. 254–281. ↑
12. Non-accelerating wage rate of unemployment (NAWRU). ↑
13. The equilibrium unemployment theory is presented in, for example, Pissarides: Equilibrium Unemployment Theory. MIT Press, 2000. ↑
14. Hodrick R. J. and Prescott E. C., 'Postwar Business U.S. Cycles: An Empirical Investigation', Journal of Money, Credit and Banking 29, February 1997, 1–16. ↑
15. Other frequently used methods for removing cyclical variation from time series of economic activity are the Baxter-King and the Christiano-Fitzgerald filter. ↑
16. For example, Hamilton J.: Why You Should Never Use the Hodrick-Prescott Filter. January 2017, working paper; Orphanides A. and Van Norden S.: 'The Unreliability of Output Gap Estimates in Real Time', The Review of Economics and Statistics, November 2002, 569–583. ↑
17. The strongest critique perhaps concerns the properties of time series generated by the HP filter. The HP filter adds to the assumed cyclical component a spurious dynamic dependence, which does not necessarily have any basis in the observed time series. ↑
18. Of the earlier literature, worthy of mention is Kuttner's (1994) potential output estimation using an unobserved components method, in Kuttner, K.: 'Estimating Potential Output as a Latent Variable', Journal of Business and Economic Statistics, Vol. 12, No. 3, pp. 361–368, 1994. ↑
19. A more accurate description of the multivariate filter method is available from e.g. Hamilton, J: Time Series Analysis, Princeton University Press, New Jersey, 1994; Andrle M: What Is In Your Output Gap? Unified Framework & Decomposition Into Observables. IMF Working paper WP /13/105, 2013; and Durbin J. and Koopman J.: Time Series Analysis by State Space Methods. Oxford University, 2012. ↑
20. The dependence named after William Phillips (1958) and originally observed from

statistics was questioned in the 1970s, as the oil crisis caused both inflation and unemployment to increase. Subsequently, theories have been developed to explain the observation of Phillips, and nowadays a version of the Phillips curve that takes, in particular, inflation expectations into account is a key equation in the modern business cycle theory. See e.g. Blanchard and Gali (2007). ↑

21. Okun, A.M., 'Potential GNP: Its Measurement and Significance', Proceedings of the Business and Economic Statistics Section, 1962, 98–104 (Washington: American Statistical Association). ↑
22. IMF economists, for example, have actively developed the models: see Benes J., Clinton K., Garcia-Saltos R., Johnson M., Laxton D., Manchev P. and Matheson T.: Estimating Potential Output with a Multivariate Filter. IMF working paper WP/10/285, December 2010. ↑
23. Darvas Z., and Simon A.: Filling the Gap: Open Economy Considerations for More Reliable Potential Output Estimates. Bruegel working paper 2015/11. ↑
24. Borio C., Disyatat P. and Juselius M.: A Parsimonious Approach to Incorporating Economic Information in Measures of Potential Output. BIS Working papers No. 44, February 2014. ↑
25. Melolinna M. and Tóth M.: Output Gaps, Inflation and Financial Cycles in the United Kingdom. Bank of England staff working paper No .585, February 2016. ↑
26. Blagrave P., Garcia-Saltos R., Laxton D. and Zhang F.: A Simple Multivariate Filter for Estimating Potential Output. IMF working paper WP/15/79, April 2015. ↑
27. Alichi A., Bizimana O., Laxton D., Tanyeri K., Wang H., Yao J. and Zhang F.: Multivariate Filter Estimation of Potential Output for the United States. IMF working paper WP/17/106, May 2017; Alichi, A.: A New Methodology for Estimating the Output Gap in the United States. IMF Working Paper WP/15/144, July 2015. ↑
28. See e.g. Ilmakunnas and Maliranta: Recent development of job and worker flows in the Finnish business sector. Finnish Labour Review, 51(3). 2008. ↑
29. See Obstbaum: The Finnish Unemployment Volatility Puzzle. Ministry of Finance Discussion Paper 1/2011. ↑
30. See e.g. Konjunkturinstitutet (2013): 'Lönebildningsrapporten'. ↑

Key words

economic slack, equilibrium unemployment, labour markets, NAIRU, structural unemployment, unemployment