

Box IV-1

Why did Iceland's potential output contract in the wake of the financial crisis?

Iceland's GDP contracted by about 10% between 2008 and 2010.¹ Over that same period, a 2.3% output gap developed into a 4.4% output slack, according to the Central Bank of Iceland's baseline forecast – a turnaround equivalent to 6.7 percentage points.² This implies that potential output is considered to have contracted by about 3.7% during the period. This Box discusses the causes of that contraction.

Determinants of potential output

In the Central Bank's macroeconomic model, potential output is estimated using a standard Cobb-Douglas production function³

$$(1) Y^* = A * E^{\beta} K^{1-\beta}$$

where Y^* represents potential output, which is the level of production that can be achieved through efficient utilisation of the factors of production without generating wage and price pressures. On the right side of equation (1) are the determinants of potential output: the factor inputs (labour, E^* , and capital, K) and a measure of how well the inputs are utilised (total factor productivity, A^*). β represents the share of labour in total value added, and $1-\beta$ is the share of capital.

It is standard to assume that the capital stock is always fully utilised and that potential output is determined by the underlying trend paths of labour utilisation and total factor productivity rather than by observed labour utilisation or total factor productivity. The trend path of labour utilisation is expressed as

$$(2) E^* = p^* N (1 - u^*)$$

where p^* is the trend labour participation rate, N is the total working age population (based on the 16-64 age group),⁴ and u^* is equilibrium unemployment rate (the unemployment rate consistent with constant wage and price levels, also referred to as the non-accelerating inflation rate of unemployment, or NAIRU).

Changes in potential output between two periods can therefore be written as

$$(3) \Delta \ln(Y^*) = \Delta \ln(A^*) + \beta [\Delta \ln(p^*) + \Delta \ln(N) + \Delta \ln(1 - u^*)] + (1 - \beta) \Delta \ln(K)$$

where $\Delta \ln$ denotes the change in the natural logarithm of the variable concerned. Potential output can therefore fall if total factor productivity contracts, if labour participation declines, if the population of working age drops, if equilibrium unemployment rises, or if the capital stock shrinks.

1. This refers to changes between annual figures for 2008 and 2010. Within the period, the contraction was somewhat larger: from its peak in Q2/2008 until the trough in Q1/2010, GDP contracted by almost 11½%.

2. The output slack (or gap) is defined as the difference between actual GDP and its measured potential.

3. The final estimate is based on the average of various methods of assessing the underlying trends of the factors of production and total factor productivity although all of the methods are based on the production function in equation (1). See Ásgeir Danielsson, Magnús F. Gudmundsson, Svava J. Haraldsdóttir, Thorvarður Tjörvi Ólafsson, Ásgerður Ó. Pétursdóttir, Thórarinn G. Pétursson og Rósa Sveinsdóttir (2009), „QMM: A quarterly macroeconomic model of the Icelandic economy“, Central Bank of Iceland, *Working Paper*, no. 41.

4. p^*N is therefore the size of the labour force; that is, the number of persons in the labour market, whether employed or unemployed.

Possible effects of the financial crisis on production factor utilization

Research suggest that potential output often contracts in the wake of financial crises, and that the loss can even be permanent. There could be numerous reasons for this.⁵ For example, labour participation could fall because the employment outlook deteriorates so much that a portion of the labour force chooses to exit the labour market entirely.⁶ The population of working age could also decline if a portion of the labour force emigrates in the aftermath of a crisis. Furthermore, labour utilisation could contract if equilibrium unemployment rises – for instance, because of a need to shift resources between sectors (e.g., from the non-tradable sector to the tradable sector). The retraining and restructuring that must take place can take time, and the labour market's ability to match employers' needs with workers' abilities and knowledge could be eroded. Equilibrium unemployment can also rise if a portion of the labour force's skills or expertise is lost or becomes obsolete because of high unemployment. The same can happen if labour market regulations make it harder to find a new job or if benefits programmes are structured so as to reduce the incentive to seek new jobs (see also Sections IV and VI).

In addition, the capital stock can contract in the wake of a financial crisis if, for example, tighter access to credit forces firms to reduce investment substantially. Declining asset prices in the wake of a financial crisis can also weaken corporate balance sheets and erode the collateral value of the assets affected, which can further impede investment. Heavy corporate indebtedness and general uncertainty about the economic outlook can intensify these effects. Moreover, fixed capital can be lost if firms become insolvent or a portion of fixed capital is scrapped, e.g. through selling it outside the country.

Finally, potential output can contract if total factor productivity shrinks; that is, if access to credit for profitable investments becomes tighter, or if the crisis results in reduced investment in research and development. On the other hand, a financial crisis can encourage streamlining or result in the discontinuation of unprofitable commercial activities.

Contribution of the factors of production to the contraction in potential output

Table 1 shows the contribution of individual factors to the above-mentioned 3.7% contraction in potential output in 2008-2010. The contribution from changes in the working-age population has also been divided into the effects of changes due to net migration during the period and those stemming from natural population growth. In all calculations, it is assumed that $\beta = 0.7$ in accordance with the Central Bank's macroeconomic model.

As the table shows, 0.3 percentage points of the contraction in potential output can be attributed to the contraction of the capital stock. Most of it, however, is due to the weakening of the labour market. The decline in the labour force led to a 0.6% reduction in potential output. This reflects the offsetting effects of net emigra

5. See, for example, International Monetary Fund (2009), „What's the damage? Medium-term output dynamics after financial crises". *World Economic Outlook*, Chapter 4. October 2009.

6. Some might choose, for instance, to go to school, while others have the option of retiring early. The labour force could therefore contract because more people move leave the labour market and collect disability benefits. On the other hand, declining family income could force more household members to enter the labour market.

tion of labour, which reduced potential output by 2%, and natural population growth, which added 1.4% to potential output. In addition, labour participation declined considerably, eroding potential output by a further 2.5%.⁷ Finally, equilibrium unemployment is considered to have risen by nearly 1 percentage point during the period, reducing potential output by 0.6%. In all, the slack in the labour market in 2008-2010 reduced potential output by approximately 3.7%, in addition to the above-mentioned 0.3% due to the contraction of the capital stock. It was somewhat offset, however, by an increase in total factor productivity.

Table 1 Changes in potential output 2008-10 and contribution of factors of production

Factor of production	%
Change in total factor productivity	0.3
Change in capital stock	-0.3
Change in labour participation	-2.5
Net emigration	-2.0
Natural population change	1.4
Change in equilibrium unemployment	-0.6
Change in potential output	-3.7

The table shows the contribution of individual factors of production to changes in potential output from 2008 through 2010, based on equation (3).

Factor utilisation and the output slack

The output slack (or gap) measures whether the factors of production in an economy are overutilised (if there is an output gap) or underutilised (if there is an output slack). An output gap is usually accompanied by wage and price pressures – and thus by rising inflation – whereas a slack reduces inflationary pressures. If the output slack is pronounced enough, it can even result in deflation. Estimating the output slack or gap is therefore of great importance in evaluating inflation pressures at any given time.

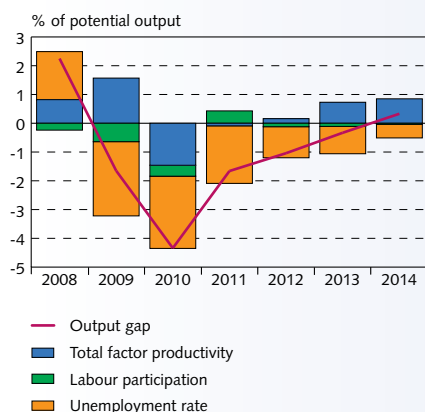
As has been stated previously, the output gap during the run-up to the financial crisis gave way to an output slack that reached a maximum 5% in mid-2010. According to the Central Bank's baseline forecast, it is assumed that the slack will gradually diminish and will disappear by the first half of 2014 (see Sections I and IV). By applying analysis comparable to the above, it is possible to identify the main drivers of this trend. In order to do this, it is necessary to assume that observed GDP is determined by a production function comparable to equation (1). The output slack, g , can then be written as

$$(4) \quad g \approx \ln(Y/Y^*) = \ln(A/A^*) + \beta \ln(p/p^*) + \beta \ln[(1-u)/(1-u^*)]$$

An output slack develops if total factor productivity is below its trend level, if labour participation is below its trend level, and if measured unemployment exceeds equilibrium unemployment. Chart 1 shows the corresponding breakdown of the output slack during the period 2008-2014.

As can be seen, there was a discernible output gap in 2008, driven by unemployment below its equilibrium level and the fact that the strain on the factors of production exceeded the level

Chart 1
Output gap components 2008-2014¹



1. Central Bank of Iceland baseline forecast 2011-2014.
Sources: Statistics Iceland, Central Bank of Iceland.

7. The effect of labour participation may be overestimated, as trend labour participation is somewhat coloured by the unusually high participation rate during the pre-crisis years. It is therefore likely that a portion of the labour participation that is considered permanent in this discussion was actually temporary.

consistent with price stability. In 2009, the situation reversed dramatically and a sizeable slack developed, owing to unemployment in excess of its equilibrium level and labour participation below trend. However, the strain on the factors of production remained greater than could be sustained for the long term. In 2010, when the slack reached a maximum, all of these variables exerted pressure in the same direction. The forecast assumes that the output slack will gradually diminish as utilisation of the factors of production returns to normal levels.