Article

Communicating gross domestic product

Update on how we analyse gross domestic product (GDP), including how to convey data uncertainty and how this relates to newly published estimates of monthly and regional GDP. This is an economic review article.

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Release date:
27 April 2020

Next release:
To be announced

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1 . Executive summary

Given the recent shocks to the UK and global economy and the outlook for the year ahead, coupled with the recent publication of monthly and regional gross domestic product (GDP) estimates, this has provided a timely opportunity to consider our thinking and analysis on how we communicate GDP.

Recent findings by the Economic Statistics Centre of Excellence (ESCoE) has also allowed us to consider how we might want to communicate data uncertainty.

Main findings

Early estimates of GDP are subject to uncertainty around the central estimate, particularly around turning points. This is a phenomenon not unique to the UK. To communicate the potential for revisions to the data, we intend to explore with our users the benefit of publishing confidence intervals around the latest estimates of calendar quarter GDP.

If there are at least two consecutive calendar quarters of contracting GDP, we will continue to acknowledge "technical" recessions in real time and ex-post. User feedback confirms that most commentators continue to focus on this concept. However, our communication will include a more explicit acknowledgement of the scope for revisions and the magnitude of the decline in those quarters.

In communicating the state of the economy, we intend to provide the wider economic context in order to provide a more informed view of GDP estimates. This includes looking at a wider range of available indicators and the role of domestic and/or global factors.

We will not acknowledge "technical" recessions in the rolling three-month GDP estimates or our regional GDP estimates. Monthly estimates are based on a less complete picture of GDP than the calendar quarterly estimates, while regional GDP estimates are more volatile in nature, and periods of contracting output are much more frequent. This reinforces the need to look at the wider economic picture at a subnational level in analysing the state of the economy, as latest point estimates may not provide a clear view of the underlying trend.

We welcome user feedback on these proposals by emailing GDP@ons.gov.uk.

2 . Background

Early estimates of gross domestic product (GDP) are subject to data revisions, reflecting the inherent trade-off between timeliness and accuracy. As we incorporate more comprehensive information from a wide range of surveys and administrative records, we revise those initial estimates. Typically, most interest in the potential scale of data revisions arises around turning points in the economy. This is likely to be particularly relevant over the next year in light of the recent shocks to the UK and global economy following the coronavirus (COVID-19) pandemic and the wider containment efforts.

Turning points refer to where the economy alternates between the recession and expansion phases that describe business cycles. There has been a long-standing convention in the UK that a "technical" recession comprises two consecutive quarters of contracting output[1]. This rule of thumb originated from American presidential speechwriters, where the view was simply that "one period of falling output does not constitute a recession, but that two consecutive quarters do", most likely reflecting that this would provide a better indication of the underlying trend (see Chapter two of Measuring the economy). However, there are drawbacks to such a simple rule, heightened in real time, given the scope for data revisions.

We recognise that the concept of a "technical" recession has been widely accepted by many users. However, the state of the economy is more complicated than could be encapsulated by a simple rule-of-thumb, particularly when there is an inherent level of data uncertainty. One way to help inform the public debate about the state of the economy is to bring out the inevitable uncertainties on how we communicate GDP.

This issue has taken on further prominence following the transformation of the UK National Accounts. The UK has recently become one of the few countries to produce estimates of monthly GDP, leading on its rolling three-monthly estimates as its headline indicator. This has raised interest in whether the concept of a "technical" recession could be extended to cover non-calendar quarters. Furthermore, the UK has recently developed new country and regional estimates of GDP that provide a complete subnational picture for the UK economy for the first time, leading to commentators picking up on whether recessions are taking place in the UK countries and regions. These developments have provided a new lens on the communication challenges arising for each estimate of GDP growth.

In response to these challenges, we explore in this article the potential to be more explicit in how we convey uncertainty as part of our wider communications, specifically looking at introducing confidence intervals around the latest estimates of calendar quarter GDP. We then conclude with how we plan to comment on turning points in real time in the future.

Notes for: Background

1. Further information on recessions is available in this piece by The Economist.

3 . Business cycles

Business cycles are a succession of expansion and recession phases. Recessions phases are periods between a peak and a trough of gross domestic product (GDP). To define turning points based on observed macroeconomic data, an ongoing piece of research by the Economic Statistics Centre of Excellence (ESCoE) explains that "depth is important so that trivial changes in economic activity are not classified as a specific phase" while "duration is vital so that fleeting changes in economic activity are not recorded separately".

Since the 1970s, there have been four persistent periods of contracting output in the UK (Figure 1) related to a range of domestic and/or global developments. However, these features of business cycles are not considered when identifying "technical" recessions based on a simple rule-of-thumb in which there are at least two consecutive quarters of contracting GDP.

Figure 1: A 50-year history of the UK economy

Real gross domestic product growth, quarter-on-the-same-quarter a year ago

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Real gross domestic product growth, quarter-on-the-same-quarter a year ago

Source: Office for National Statistics – Quarterly National Accounts, March 2020

Notes:

1. The figures are consistent with the March 2020 quarterly national accounts.

2. Quarter-on-a-quarter-a-year ago real gross domestic product (GDP) growth.

3. These UK recessions refer to those in 1973, 1980, 1990 and 2008.

4. Q1 equals Quarter 1 (January to March), Q2 equals Quarter 2 (April to June), Q3 equals Quarter 3 (July to September) and Q4 equals Quarter 4 (October to December).

In the United States, the National Bureau of Economic Research (NBER) considers a recession as "a significant decline in economic activity spread across the market, lasting more than a few months, normally visible in real GDP, real income, employment, industrial production, and wholesale-retail sales". This broader concept is more in line with the wider literature on business cycles, as it is the peaks and troughs of the cycle that frame the recession or expansion. While considerable weight is placed on the official estimates of real GDP, the NBER is explicit that it refers to a number of monthly indicators in determining the months of peaks and troughs, and "there is no fixed rule about which other measures contribute information to the process".

Lee and Shields (2011) argue that recessions are multi-dimensional and that "it is generally unhelpful, if not misleading, to suggest that recession can be defined with respect to a single fixed rule". The authors advocate the publication of nowcast probabilities that capture these various features of recessions.

4 . Data uncertainty: real-time versus ex-post view of the UK economy

A further consideration is that the National Bureau of Economic Research (NBER) carries out its assessment of business cycles retrospectively (that is, not in real time) so that "sufficient data are available to avoid the need for major revisions". Revisions are an inevitable feature of the production process, reflecting the trade-off between timeliness and accuracy in compiling estimates of gross domestic product (GDP). This explains why there is inherent [uncertainty](#) surrounding early estimates of GDP. This is not a challenge that is specific to the UK, but one that all national statistical institutes face.

Given the focus on "technical" recessions, there is inevitably much more user sensitivity to a revision around turning points than at other points in the cycle. This highlights why the communication of data uncertainty is even more important at these times. If "technical" recessions are communicated in real time, then there is scope for such periods to be revised away, particularly if uncertainty is not understood by the wider public. This is consistent with recent analysis undertaken by the Economic Statistics Centre of Excellence (ESCoE), which finds that "data revisions to UK GDP lead to a turning point chronology that has fewer and shorter recessions than real-time chronologies".

Figure 2 shows revisions to GDP growth estimates over time, comparing the first estimate with the "final" one. This is taken to be the one published three years after the initial estimate, reflecting the production cycle of UK GDP[1][2]. While there has been an improvement in the quality of early estimates over time, as shown by the lower mean and lower variance of these revisions in more recent times, it highlights that there is a tendency for revisions to be more pronounced around turning points. This is particularly the case when compared with the revision performance in those respective decades.

Figure 2: Revisions between the first and "final" estimate of GDP growth

Five-period moving average of revisions to gross domestic product quarter-on-quarter growth, UK
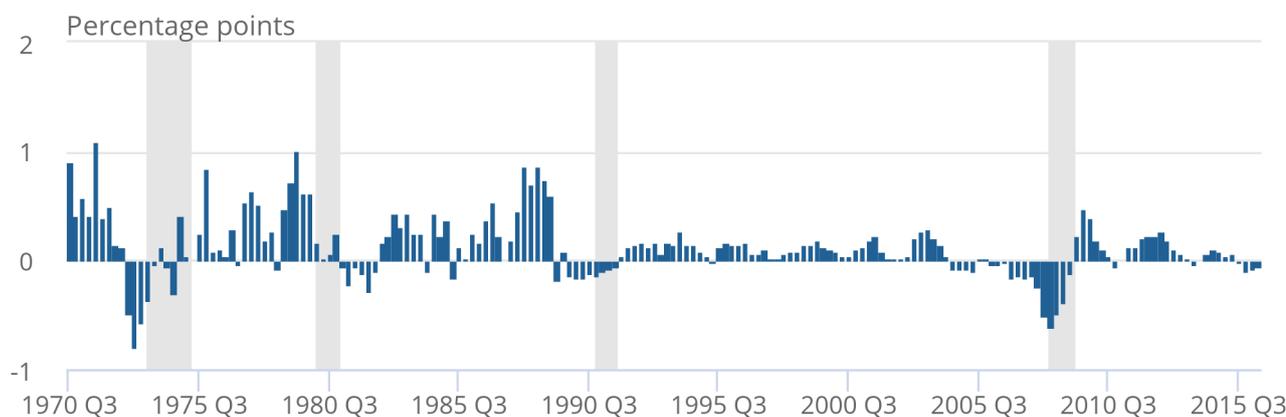
Source: Office for National Statistics – Communicating gross domestic product

Notes:

1. The revisions refer to those between the first estimate and the "final" estimate, considered here to be the one published three years later.

2. For the period Quarter 1 (Jan to Mar) 1970 to Quarter 4 (Oct to Dec) 2016, the MR is 0.13, the MAR is 0.50 and the MSR is 0.66. Revisions range from negative 2.4 percentage points to 3.6 percentage points.

3. For the latest 20-year period, Quarter 1 1997 to Quarter 4 2016, the MR is 0.04, the MAR is 0.22 and the MSR is 0.10. Revisions range from negative 1.5 percentage points to 0.8 percentage points.

4. A five-period moving average of revisions to gross domestic product (GDP) is taken from Quarter 3 (July to Sept) 1970 to Quarter 2 (Apr to June) 2016.

5. Q1 equals Quarter 1 (January to March), Q2 equals Quarter 2 (April to June), Q3 equals Quarter 3 (July to September) and Q4 equals Quarter 4 (October to December).

From the period 1970 to 2016 inclusive, there have been 45 quarters in which the first estimate of GDP recorded a fall in output. However, the "final" estimate has recorded a contraction in only 31 of those quarters. Similarly, there are also an additional six instances when the "final" estimate has shown a contraction in the economy in a quarter that was not picked up in the first estimate. These revisions are not necessarily large, but they help highlight the challenge of leading exclusively on the concept of a "technical" recession

There were notable revisions around the 1970s and 1980s recessions as well as the global financial crisis of 2008. The 1990s recession is the only one where the real-time and ex-post estimates of the path of the recession are largely similar. While recent analysis finds that revisions between the first and "final" estimate are not statistically significant, the scope for revisions to GDP estimates highlights that real-time and ex-post views of the economy are not always the same, particularly for contractions of a mild nature. Displaying the degree of data uncertainty could facilitate more nuanced analysis in periods around "technical" recessions.

Figure 3 shows the likelihood of a final estimate for any calendar quarter recording a contraction in GDP. It is a function of the first estimate of GDP growth in that period and the statistical properties of data revisions at that time. If there was perfect certainty (that is, no revisions), this would take the values of zero or one. This is because the first estimate would contain all the information required to inform the final estimate. However, data revisions explain why this is not the case.

Figure 3: The probability that a "final" estimate of quarter-on-quarter GDP growth is at or below the value zero

The likelihood of a final estimate showing a contraction in gross domestic product, UK

Figure 3: The probability that a "final" estimate of quarter-on-quarter GDP growth is at or below the value zero

The likelihood of a final estimate showing a contraction in gross domestic product, UK

Source: Office for National Statistics – Communicating gross domestic product

Notes:

1. This provides the probability that an estimate of quarter-on-quarter GDP growth is at or below the value zero. It is based on the first estimate of GDP for that quarter and the statistical properties of data revisions are taken over a rolling 10-year period. The probabilities are computed for a normal distribution.

2. The highlighted periods reflect where the 'final' estimate shows periods in which GDP fell.

3. Q1 equals Quarter 1 (January to March), Q2 equals Quarter 2 (April to June), Q3 equals Quarter 3 (July to September) and Q4 equals Quarter 4 (October to December).

The only time that we would have been able to say with certainty that the first estimate provided perfect foresight as to whether output was falling was Quarter 4 (Oct to Dec) 2008 and Quarter 1 (Jan to Mar) 2009. The fall in GDP was so large in these quarters that, irrespective of the likelihood of data revisions, it was still expected that the final estimate of GDP growth would be negative. Similarly, previous analysis explained how the effects of the Queen's Diamond Jubilee and the hosting of the London 2012 Olympic and Paralympic Games led to a displacement of activity through the year, such that the latest estimates show that GDP fell in Quarter 2 (Apr to June) and Quarter 4 2012. The likelihood of the final estimate recording a contraction was high, at 95% and 75% respectively, based on those first estimates.

Notes for: Data uncertainty: real-time versus ex-post view of the UK economy

1. This three-year production cycle includes revisions to survey returns; outturns replacing forecasts; the incorporation of annual benchmarks; and the supply and use tables (SUTs) compilation process. The SUTs framework is used to produce a balanced and complete picture of the flows of products in the economy, in which the balancing of supply and demand of products takes place at the most detailed level possible.

2. There is no concept of a "final" estimate in practice, as further revisions are made beyond the initial three years, mainly reflecting methodological improvements to how we produce the UK National Accounts. For example, this would include the impact of moving from the European System of Accounts (ESA) 1995 to ESA 2010. As such, the "final" estimate can be different from the latest estimate.

5 . Communicating data uncertainty

Estimates of gross domestic product (GDP) are revised as part of the production process, reflecting the incorporation of new data content and methodological improvements to how GDP is compiled. We publish real-time estimates of GDP and undertake analysis to show the extent to which revisions are statistically significant. While this analysis provides users with some insights around the potential scale of revisions, the degree of uncertainty around individual calendar quarter GDP point estimates has never been formalised. One example of where we have been much more explicit as to the level of uncertainty is the publication of mid-year population estimates by local authority, which are subject to bias-adjusted confidence intervals.

Recent analysis by the Economic Statistics Centre of Excellence (ESCoE) has highlighted that "if and how uncertainty information is communicated to the public matters", communicating such uncertainty "improves public's understanding of why data revisions happen". This is based on the premise that the performance of past revisions is a useful approximation of data uncertainty today. One of the main findings of recent ESCoE research is that such intervals "encourages more of the public to view the point estimate as just that, a point within a range of possible outcomes".

The experience of the period around the global financial crisis of 2008 shows that communicating turning points in real time is not straightforward: the first estimates pointed towards a triple-dip recession over that period, subsequently revised away. Analysis of the revision performance for the G20 countries undertaken by the International Monetary Fund (IMF) found similar findings, concluding that revisions in 2008 and 2009 to early estimates were of greater magnitude than in previous years for around half of the G20 countries. It highlights that this is in line with "increased uncertainty of the earlier estimates of quarterly GDP in tougher economic times".

Figure 4 provides some ex-post analysis, showing confidence intervals around the first estimate of GDP growth since 2008. These intervals imply that there is approximately a two-in-three chance that the "final" estimate will be within the estimated range. The half-width of these intervals is equivalent to one standard deviation, as computed using past revisions to GDP. Whilethe latest estimates show that the UK entered a recession in Quarter 2 (Apr to June) 2008, the real-time estimates of GDP did not pick this up until Quarter 3 (July to Sept) 2008, despite a range of other indicators implying otherwise. The inclusion of these intervals helps provide further context around the uncertainty here, highlighting that a contraction in Quarter 2 was within these confidence bounds. That said, despite the inherent uncertainty in those first estimates, this also shows that the first estimates of GDP were outside of these confidence intervals in six of eight quarters around this time; this is more than would be expected.

Given that this performance is only looking at a two-year period, it is not recommended that users consider this as a formal evaluation exercise. It is only to highlight the challenges of communicating turning points around the 2008 global financial crisis.

Figure 4: There is approximately a two-in-three chance that the "final" estimate will be within the confidence intervals

Confidence intervals and the first estimate of quarter-on-quarter gross domestic product (GDP) growth

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Confidence intervals and the first estimate of quarter-on-quarter gross domestic product (GDP) growth
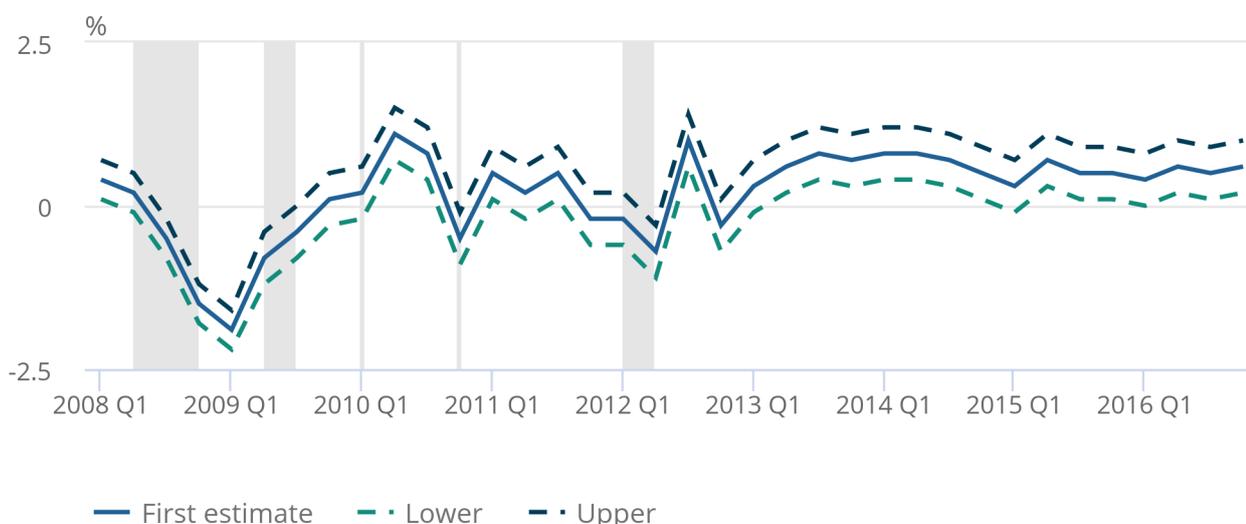
Source: Office for National Statistics – Real-time turning point indicators: a UK focus

Notes:

1. The 68% confidence intervals are based on statistical properties of revisions between the first and "final" estimate of gross domestic product (GDP), computed over a rolling 10-year window and applying a normal distribution.

2. These confidence intervals imply there is approximately a two-in-three chance that the "final" estimate will be within the estimated range.

3. Q1 equals Quarter 1 (January to March), Q2 equals Quarter 2 (April to June), Q3 equals Quarter 3 (July to September) and Q4 equals Quarter 4 (October to December).

Given the views of the ESCoE, we intend to explore with our users the benefit of publishing confidence intervals around the latest estimates of calendar quarter GDP as a helpful way to communicate data uncertainty. If there is a positive response from users, we will consider the feasibility of implementation.

We would look to communicate the uncertainty around the latest estimates of GDP only (that is, showing uncertainty around the most recent calendar quarters published in the latest edition of GDP). As there is a mix of data content in any one edition, we would normally expect confidence intervals to be narrower for more mature estimates and wider for the less mature ones.

Figure 5 shows confidence intervals around the GDP estimates for the last eight quarters published in February 2020. These confidence intervals are wider for the most recent periods, reflecting that these estimates are more likely to be revised. For example, the first estimate for Quarter 4 (Oct to Dec) 2019 shows a picture of flat GDP, but the intervals would imply that that there is a two-thirds likelihood that the "final" estimate will likely be between negative 0.4% and positive 0.4%. Over time, the level of uncertainty around this estimate will reduce as we receive more data content for this estimate.

Figure 5: There is approximately a two-in-three chance that the "final" estimate will be within the confidence intervals

The February 2020 edition of quarter-on-quarter GDP growth and confidence intervals

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The February 2020 edition of quarter-on-quarter GDP growth and confidence intervals
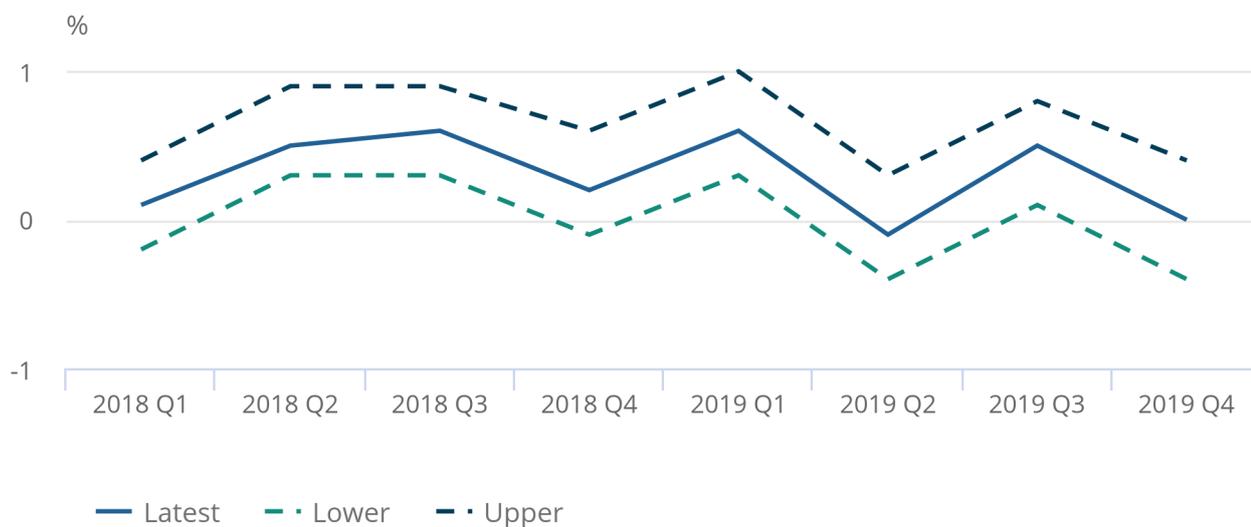
Source: Office for National Statistics – Communicating gross domestic product

Notes:

1. Q1 equals Quarter 1 (January to March), Q2 equals Quarter 2 (April to June), Q3 equals Quarter 3 (July to September) and Q4 equals Quarter 4 (October to December).

6 . Estimating gross domestic product

Monthly gross domestic product

The UK became one of the few countries to produce estimates of monthly gross domestic product GDP in 2018, which has provided users with a timelier and more frequent indicator of movements in the real economy. This has raised the possibility of extending the concept of a "technical" recession to non-calendar quarters in how we comment on the UK economy.

There are three approaches to measuring GDP: output (or production), income and expenditure. These are then balanced to produce a single estimate of quarterly GDP. While we balance the quarterly GDP to the output estimate initially, reflecting that output has the largest data content at the early stage in the production process, signals in the income and expenditure estimates are considered as part of the evolving balancing process. This additional information can be particularly valuable in more uncertain times of the economy, and previous analysis explained how this is considered one of the main benefits of how calendar quarterly estimates of GDP are now produced. In contrast, monthly estimates of GDP are based only on the output approach.

However, there are theoretical and practical reasons for why we do not recommend referring to "technical" recessions in these monthly estimates of GDP and why we will refrain from doing so explicitly in our own communication.

Gross value added (GVA) - the value of an industry's outputs less the value of intermediate inputs to produce those outputs - is considered a proxy for the initial output estimates of GDP. This relies on the change in sales to be a proxy for the change in output and in turn the change in GVA (or, equivalently, there being the same co-movements in sales, output and intermediate consumption). This is reasonable as an initial proxy in "normal" times but may not be the case around turning points of the economic cycle. While this is the case for official monthly and quarterly estimates of GDP, the latter has the benefit of insights from the income and expenditure estimates as part of the production process, thereby providing a much more complete picture of GDP.

Also, for those periods that have been fully balanced through a supply and use tables (SUTs) framework, GVA is aligned to be within a narrow tolerance of quarterly GDP. However, the alignment process that is performed for the quarterly estimates does not take place within the individual months of a quarter.

Country and regional gross domestic product

In 2019, we produced quarterly estimates of GDP for the nine English statistical regions (based on the Nomenclature of Territorial Units for Statistics, NUTS1) and Wales. Coupled with the readily available estimates for Scotland and Northern Ireland[1], these provide a subnational picture for the UK economy for the first time. This has increased interest in whether recessions are taking place at a more local level.

However, recent analysis showed that there was additional volatility in the regional estimates and it was much more likely for countries and regions to experience a fall in output than it was for the UK economy. This was likely to reflect the industry composition at the subnational level, in which certain industries are more likely to experience large fluctuations and/or that specific industries are relatively more exposed to shocks as well as the extent for some of this displaced activity to be picked up by other countries and regions.

For example, if a power station experiences a temporary shutdown, it is likely to have a large impact on its region because it is a major part of the electricity industry in that place. However, the impact is likely to be much smaller on the UK economy, not only because of the existence of many other power stations elsewhere in the UK, but because those plants will likely pick up much of the slack from the temporary closure.

As such, it is more likely for countries and regions to experience "technical" recessions from temporary production disruptions that do not necessarily represent the underlying trend in the regional economy. Consequently, we will refrain from leading on "technical" recessions in our regional analysis but provide a more holistic view of the economic performance of the regional economy.

Notes for: Estimating gross domestic product

1. These regional estimates of GDP are produced by the Scottish Government and the Northern Ireland Statistics and Research Agency (NISRA) respectively. The Scottish estimates provide comparable industry-level estimates of output, while the Northern Irish estimates provide estimates for construction, production and services as well as a private-public split.

7 . Conclusions

Early estimates of gross domestic product (GDP) are subject to revision, reflecting the inherent trade-off between timeliness and accuracy, and this data uncertainty tends to receive most interest around turning points in the economy. Given the recent shocks to the UK and global economy from the coronavirus (COVID-19) pandemic, coupled with recent milestones as part of the transformation of UK National Accounts, this has provided a timely opportunity to consider our thinking and analysis on how we communicate GDP.

While the concept of a "technical" recession has been widely accepted, the state of the economy is more complicated in practice, and it is challenging to encapsulate this with a simple rule-of-thumb only. One way to help inform the public debate about the state of the economy is to bring out the inevitable uncertainties in how we communicate GDP.

Given the revisions performance over the global financial crisis of 2008, the National Statistics Quality Review (NSQR) of National Accounts and Balance of Payments recommended that we undertake a study of the 2008 to 2009 economic cycle with a view to "possible changes that might improve the performance during future economic cycles". Subsequent analysis proposed numerous lessons learned, ranging from the quality of imputing for non-returns to how adjustments are applied in the balancing process. It also highlighted how there might be benefits from there being much more consideration of the wider range of information available in real time, including official and unofficial indicators of underlying activity in the real economy.

Depending on user feedback, we could implement the proposed confidence intervals around the latest estimates of calendar quarter GDP, which would be a marked departure from how we have previously communicated data uncertainty. This would reflect our first efforts to produce estimates of the inherent levels of uncertainty around GDP, which we would look to implement in the future if users would find this a helpful addition.

We welcome user feedback on these changes by emailing GDP@ons.gov.uk.

8 . Authors

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