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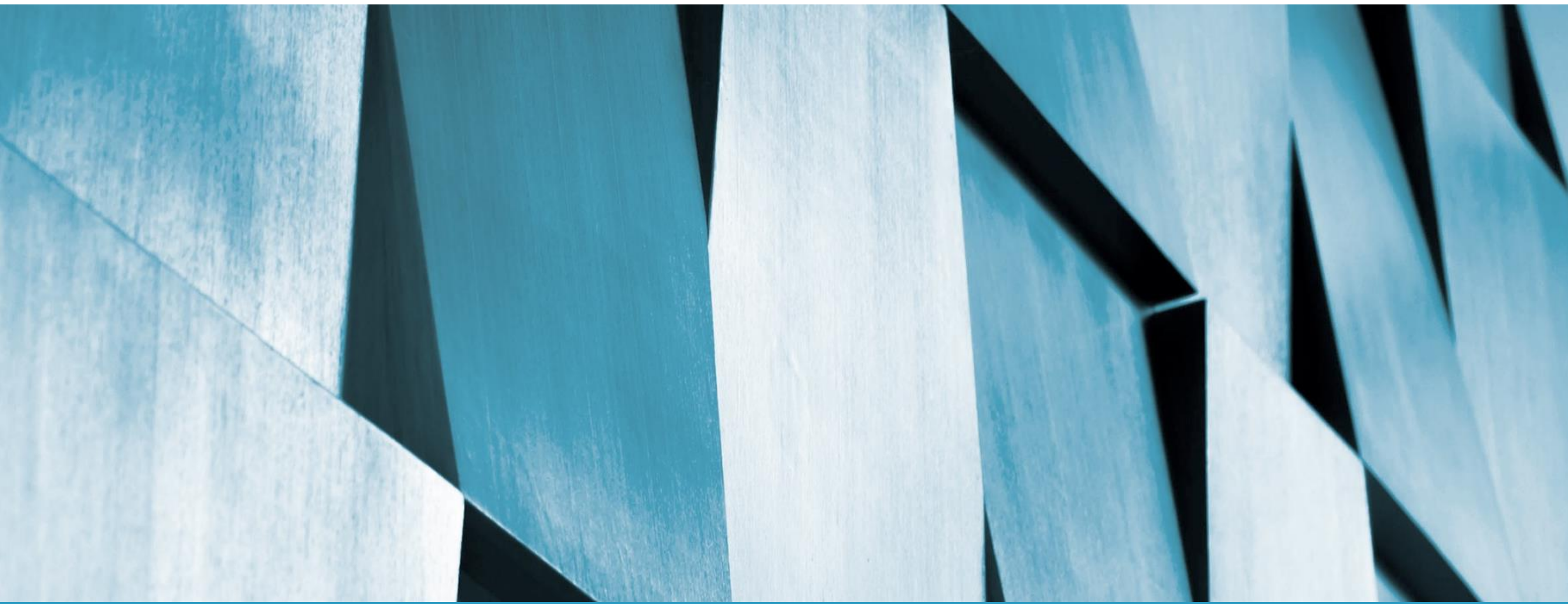

Revisions to quarterly labour productivity growth

PC productivity insights

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Key points

- **Estimates of quarterly labour productivity growth are frequently used by decision makers in both the private and public sector. Determining the size of typical revisions can provide a better understanding of how to use productivity estimates in making decisions. While we know ABS data is subject to revision, we expected labour productivity estimates to stabilise over time. Our analysis, however, shows that measured labour productivity does not approach a 'true' estimate; rather, the figure is consistently changing.**
- **The nature of the revisions means that the reliability of the original estimate is approximately the same for the estimate one year, or even three and four years after its original release.**
- **This paper discusses two possible options to assist in the interpretation of the labour productivity estimates:**
  - applying confidence intervals helps inform the reliability of the quarterly estimates
  - relying on the longer-term trend of productivity (such as productivity through the year) reduces the volatility and improves the reliability of the estimates.
- **Approximately 70% of estimates fall within -0.4 to 0.5 percentage points of the original quarterly estimate three years after the original release. This range holds relatively stable from three years after the original release onwards.**
- **There are some patterns that emerge in the revisions:**
  - on average, June figures are revised downward while September figures are revised upward
  - there is a tendency for larger estimates, both positive and negative, to have a larger revision
  - positive estimates are more likely to be revised downward, and negative estimates are more likely to be revised upward. In other words, the original estimate tends to be more extreme, before being revised towards zero
  - revisions are largest in the September quarter, when the ABS benchmarks their estimates.

Introduction

Revision is one of the exquisite pleasures of writing (Malamud 1988)

Authors tend to delight in revising their work. Revisions to the words on a page allow authors to adjust their message until they have perfected it. But for those relying on data to make decisions, revisions can be problematic. Large revisions to data can cause decision makers to lose confidence in the data and to question data-based advice. Those relying on data prefer accurate, timely and stable data, to make informed policy decisions.

Estimates of quarterly labour productivity growth are frequently used by decision makers in both the private and public sector. Determining the size of typical revisions can provide a better understanding of how to use productivity estimates in making decisions.

Productivity data comes from the ABS quarterly labour productivity estimates – which, like any data series, is subject to revision (box 1). Some caution institutions and policymakers against trusting the original estimate as revisions to the data could change the final outcome and interpretation of the data (Ellis 2023).

Underpinning this warning is the assumption that labour productivity estimates will be revised in the first few quarters following the original release, and then stabilise over time.

Our research supports the hypothesis that estimates are revised. However, contrary to our prior hypothesis, we find that revisions do not reach a 'final' value. Rather, they are continuously revised, with each revision representing a small step away from (or, over time, back towards) the original estimate.

Subsequently, the reliability of the original estimate is approximately the same for the estimate one, or three, years after its original release. In other words, policymakers should trust original estimates as much as they trust figures that have been revised. That level of trust can be informed by the confidence intervals mapped in this paper.

There are also some patterns among the revisions which help us further understand the nature of the revisions to the data.

Box 1 – Why are there revisions to ABS data?

A revision is the difference between an initial labour productivity estimate and any updated estimate. The ABS identify three key reasons why revisions to data occur: the incorporation of new data, adjustments to chain volume series and seasonal factors, and the introduction of new and improved data sources or methods (ABS 2021c).

GDP data is subject to revision due to benchmarking for three years after publication. In addition, there is a 'historical revisions' program, which allows more substantial updates to concepts, classifications, methods and data sources. These revisions are reflected further back in time (ABS 2021c). It is also important to note that revisions do not imply an error in the original estimate. It simply reflects that improved information comes available over time (ABS 2021c).

A key challenge for the ABS in revising data is the trade-off between **accuracy and reliability**. Reliability refers to whether or not the data present a consistent, coherent picture of the Australian economy. A greater number of revisions can imply less reliability. However, this must be weighed up against **accuracy**, which measures the proximity of an estimate to its desired concept and notional true value. That is, while revisions may improve accuracy of an estimate, they decrease reliability of the original estimate (ABS 2021a).

Box 2 – Two types of revisions

There are two types of revisions that are considered in this analysis:

- A **revision from the original estimate**: the difference between the estimate for a given quarter and the estimate at the original release. For example, in the table below the revision 10 quarters since the original release is -0.1 (depicted by the light blue line below).
- A **period-to-period revision**: the difference between the estimate for a given quarter and the quarter before it. For example, in the table below the period-to-period revision 10 quarters since the original release is 0.1 (depicted by the dark blue line below). This gives insight into whether revisions stabilise.

Quarterly productivity estimate (%)

		Quarters since original release											
Reference period	Original estimate	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Dec-2006	1.1	1.1	1.3	0.7	1	1	1	0.8	0.9	0.9	1	0.8	1.2

Period-to-period revision

Revision from the original estimate

Source: PC analysis of ABS (2010, Australian National Accounts: National Income, Expenditure and Product, Cat. no. 5206.0, table 1).

Observations of labour productivity estimates

Labour productivity revisions do not stabilise

Contrary to our prior hypothesis, labour productivity estimates do not stabilise, and are revised for many years after the original release (figure 1).[1]

It is worth noting that labour productivity is a ratio of two very large numbers – GDP, and hours worked – and revisions to either of these series could be the source of instability. Further research could decompose the contribution of revisions from hours growth and output growth in the Australian data.

Figure 1 shows the distribution of period-to-period revisions over time.[2] We would expect this distribution to converge around zero over time if estimates were to stabilise and reach a 'final' value (that is, the change from quarter-to-quarter should be zero percentage points). Instead, the distribution of these revisions only modestly narrows over time. For example, the variance of the period-to-period revisions two years (eight quarters) after the original release is actually larger than the variance one period after the original

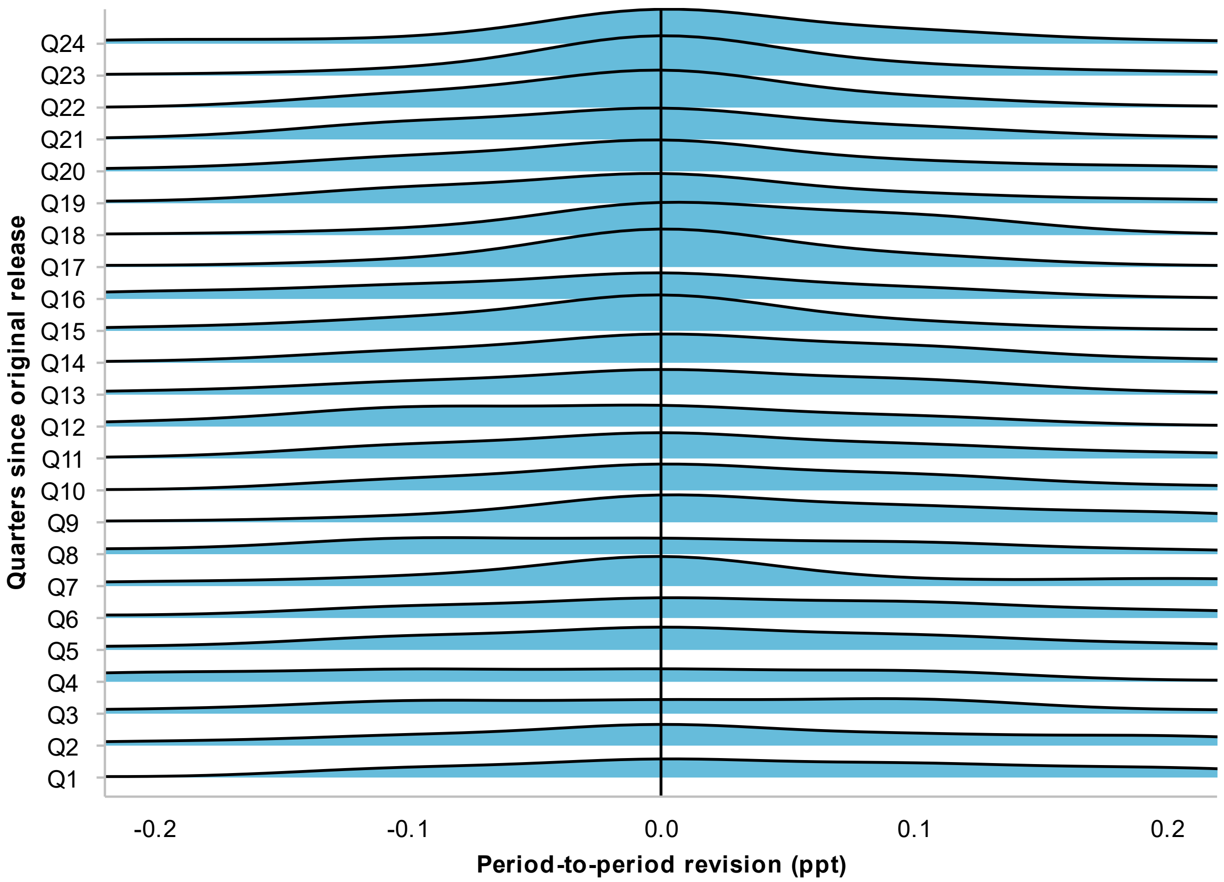
[1] This is consistent with overseas data. For example, an extended period of revisions was found in the United States (Glaser et al. 2024). They determined that the change was driven by non-trivial revisions to output growth that occurred up to 10 years after the original release of an estimate.

[2] The distributions are estimated probability density functions that provide the probability that a revision will be within a given range of values, where greater density signals greater probability.

release – in other words, the changes that occur to labour productivity data between the seventh and eighth quarters after the original release (Q8) are larger than the changes from the original release to Q1.

Figure 1 – Revisions still occur six years (24 quarters) after their original release

Probability density functions for quarterly period-to-period revisions, 2006–2023



Source: PC analysis of ABS (2023, Australian National Accounts: National Income, Expenditure and Product, Cat. no. 5206.0, table 1).

Interpreting these revisions

Decision makers and analysts need to undertake up-to-date analysis of the economy, using the best information available, and productivity matters fundamentally for our understanding of the economy. Decision makers and analysts therefore need a way to use and interpret the most recent productivity data, noting it will be subject to revisions for a number of years. Importantly, a revision does not imply the original estimate is inaccurate – it simply means that more information has become available.

This paper identifies two possible options open to decision makers to improve the efficacy and assist in the interpretation of the labour productivity estimates.

1. Use a confidence interval to inform their understanding of the reliability of the estimates. Confidence intervals are instructive to understand the magnitude of the revisions.
2. Look at productivity estimates over a longer period of time (such as productivity over a year) to reduce volatility.

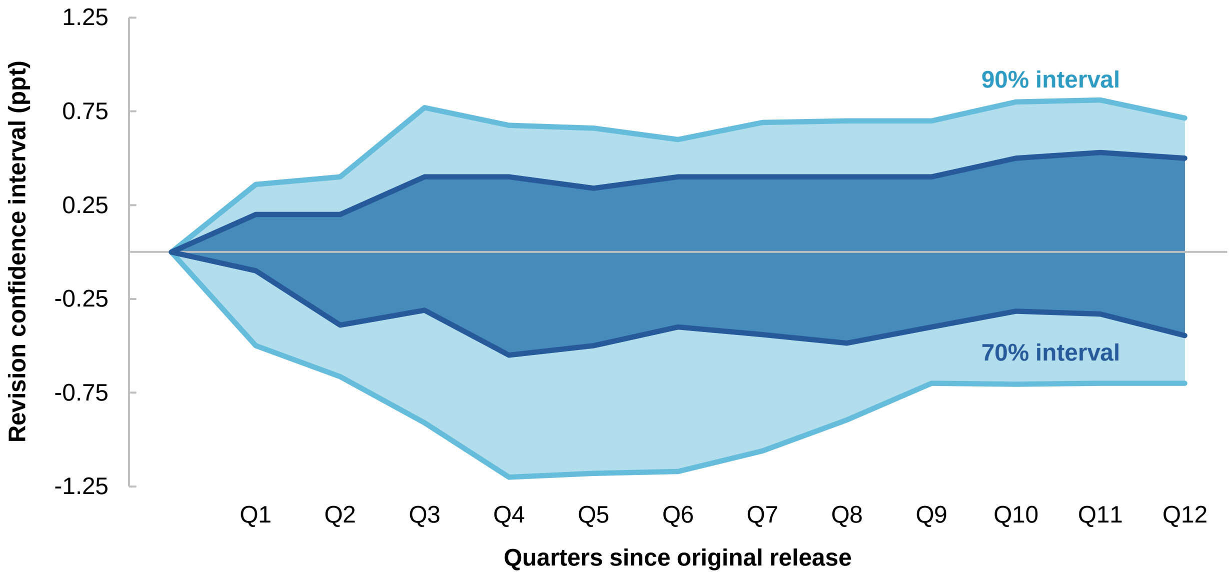
Confidence intervals can inform policymakers of the reliability of each estimate

A confidence interval – an estimate of the band within which an estimate is likely to land – can provide a tangible trust level for policymakers when they are interpreting and using quarterly labour productivity estimates. They can guide policymakers by informing them of the reliability of any given estimate at any point in time.

The confidence interval for revisions to a single productivity estimate increases most significantly in the first year following the original release, before stabilising. Figure 2 shows that 70% of estimates fall within -0.4 to 0.5 percentage points relative to the original estimate three years after the original release. Applying that to the June 2024 quarter productivity estimate (-0.8% productivity growth), we can say that there is a 70% likelihood that this estimate will be within -1.2% to -0.3% in three years' time. Given the relatively flat upper and lower bounds of the confidence interval, it is likely that estimates will remain within this bandwidth further out.[3]

Figure 2 – The confidence interval for revisions grows for four quarters before stabilising

70% and 90% confidence intervals for revisions from original[a,b], 2006–2023



a. Confidence intervals for revisions for each quarter since the original release are estimated using a non-parametric cumulative density function that utilises percentiles within the data. That is, the 5th and 95th percentile of the sample data are used to estimate the 90% confidence interval for revisions under the assumption that future revisions will follow the same process as previous revisions. **b.** The confidence intervals are not sensitive to outliers that occur as a result of conceptual or methodological changes to productivity.

Source: PC analysis of ABS (2023, Australian National Accounts: National Income, Expenditure and Product, Cat. no. 5206.0, table 1).

Going forward, quarterly productivity bulletins will consider how to include a confidence interval around quarterly estimates, to convey a sense of trust in the productivity estimate and to assist decision makers with understanding the latest revisions and releases.[4]

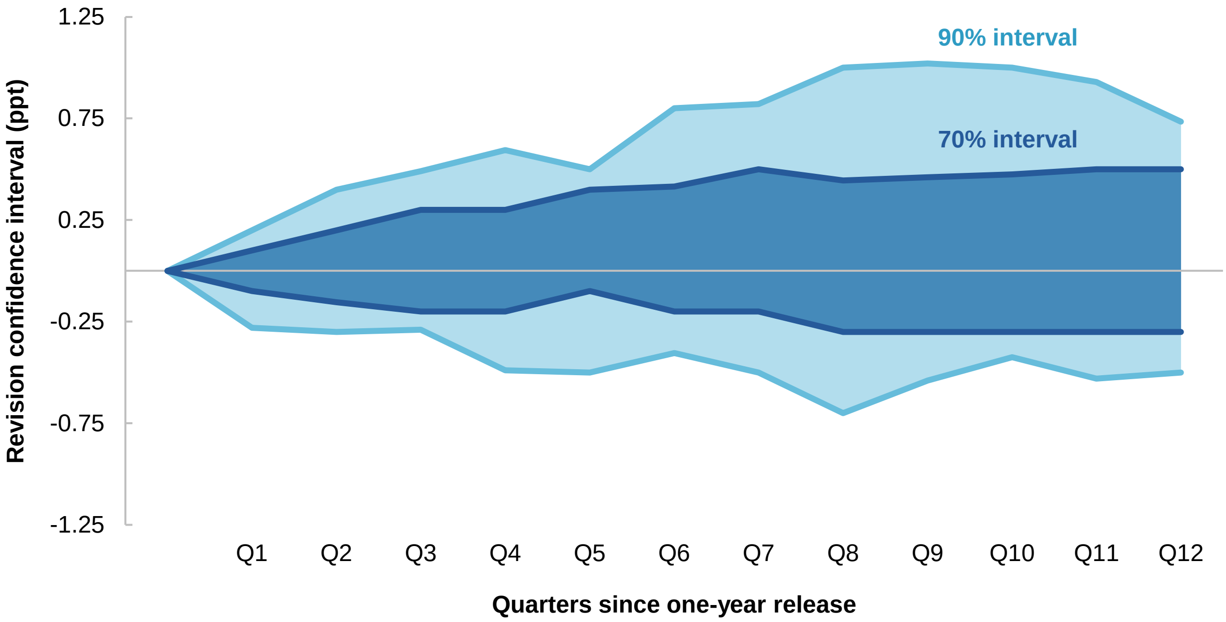
[3] Bishop et al. (2013) use data that includes four years of revisions after the original release. The results of the analysis remain consistent if we extend our data analysis from three to four years after the original release for figure 1 and figure 2.
[4] It would also be instructive to consider how the confidence intervals change depending on the size and magnitude of the original estimate. This sample size was deemed inadequate to meaningfully conduct this analysis at this point in time.

The confidence interval implies the reliability of the estimate does not improve after one year

It is worth noting that the stabilising nature of the confidence interval does not imply that the reliability of the estimate improves after the original release. if one was to redo the confidence intervals - setting the original estimate as the estimate four quarters after release - the confidence interval bands follow the same pattern: it expands most significantly at the beginning before stabilising (figure 3).

Figure 3 – The confidence interval for productivity estimates looks similar even if the observations start one year later

70% and 90% confidence intervals for revisions relative to the one year estimate[a,b], 2006–2022



a. Confidence intervals for revisions for each quarter since the original release are estimated using a non-parametric cumulative density function that uses percentiles within the data. That is, the 5th and 95th percentile of the sample data are used to estimate the 90% confidence interval for revisions under the assumption that future revisions will follow the same process as previous revisions. **b.** The confidence intervals are not sensitive to outliers that occur as a result of conceptual or methodological changes to productivity.

Source: PC analysis of ABS (2023, Australian National Accounts: National Income, Expenditure and Product, Cat. no. 5206.0, table 1).

This suggests that the reliability of the initial quarterly labour productivity growth statistic is approximately equal to the estimate in one year. Further, our analysis shows that this holds true for the estimate in three or four years as well. It follows that any analysis which draws on the initial estimate would be sound, as the reliability of the estimate does not necessarily improve one year (or four years) into the future.

Using a longer-term trend (such as growth through the year) improves the reliability and reduces the volatility of estimates

Taking productivity estimates over the *year* rather than the quarter tends to reduce the volatility and improve the reliability of the estimate. Such a practice is consistent with ABS advice to consider data over a longer time horizon when considering their statistical releases.

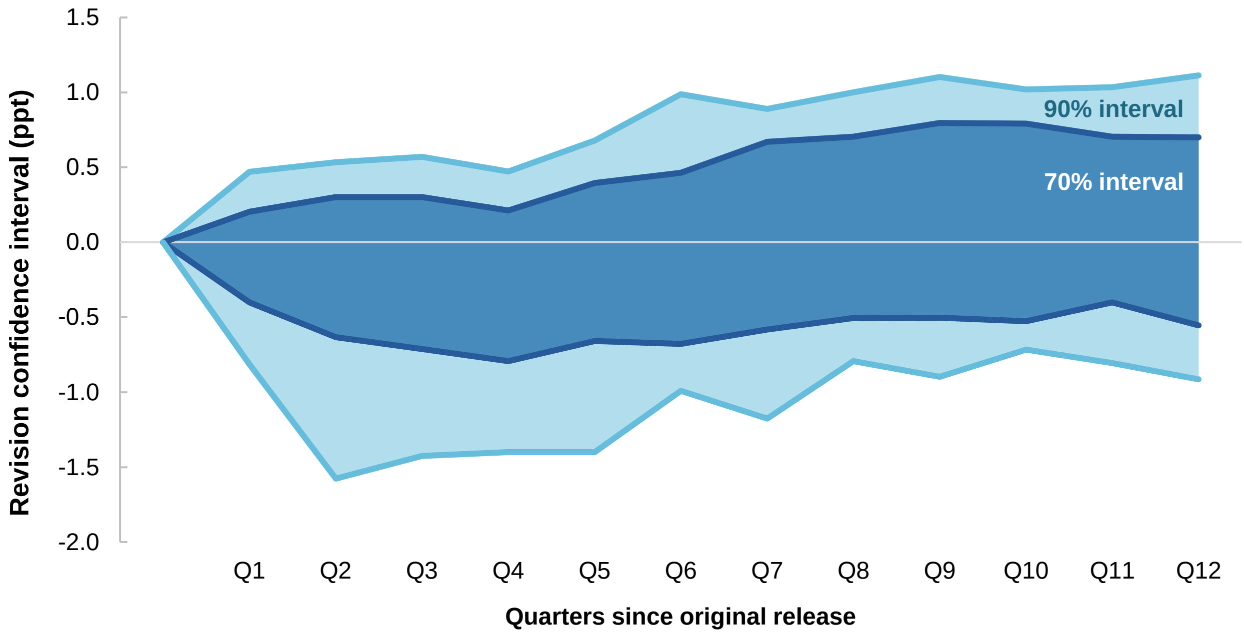
When estimating confidence intervals to productivity estimates *over the year*, the confidence intervals for revisions are similar to confidence intervals for quarterly figures. Figure 4 shows that 70% of estimates fall within -0.5 to 0.5 percentage points relative to the original estimate three years after the original release.

However, the annual estimate of productivity is larger than the quarterly figure (for example, the average absolute original estimate for quarterly productivity is 0.7% and 1.6% for productivity over the year). A similarly sized confidence interval over a larger productivity estimate would tend to indicate the estimate is more reliable. (For example, consider a 1 percentage point confidence interval around an estimate of 1%, and an estimate of 50% – a policymaker should have more confidence in the accuracy of the 50% estimate, as the confidence interval of the revision is smaller as a proportion of the larger estimate.)

In sum, using the most recent four quarters of data to paint an annual picture of productivity, rather than focussing on the most recent quarterly figure, will reduce the impact revisions have on the productivity estimate.

Figure 4 – Revisions to annual productivity estimates are similar to revisions for quarterly estimates

90 and 70% confidence intervals for revisions from original[a], annual data, 2006–2023



a. Confidence intervals for revisions for each quarter since the original release are estimated using a non-parametric cumulative density function that uses percentiles within the data. That is, the 5th and 95th percentile of the sample data are used to estimate the 90% confidence interval for revisions under the assumption that future revisions will follow the same process as previous revisions.

Source: PC analysis of ABS (2023, Australian National Accounts: National Income, Expenditure and Product, Cat. no. 5206.0, table 1).

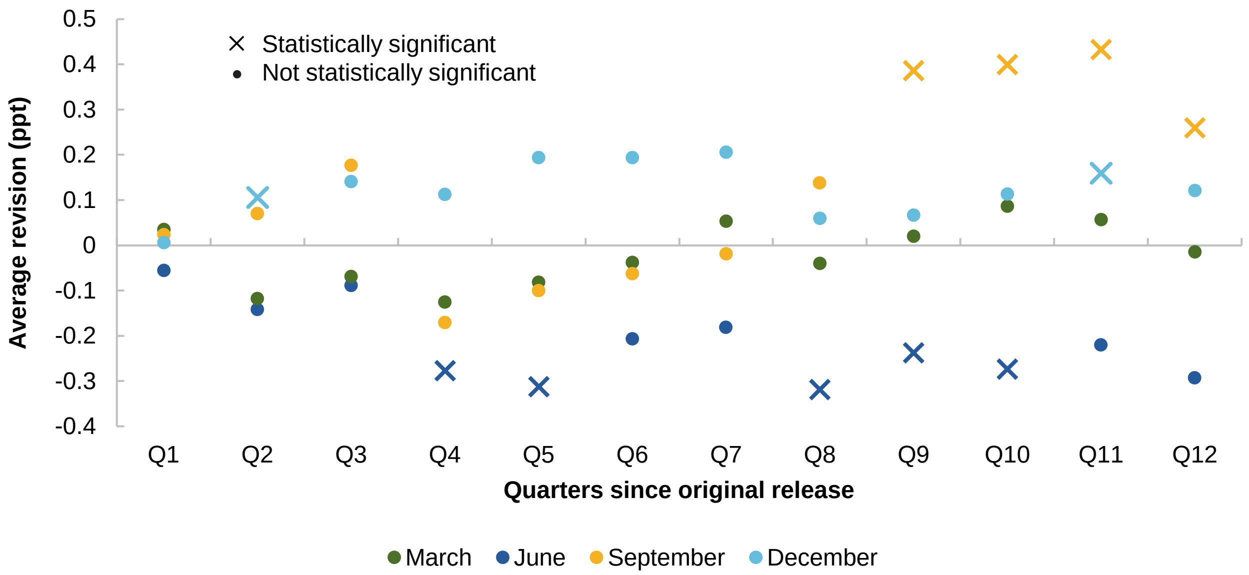
Patterns among the revisions

There are also some patterns that become evident when the sample is broken down into subsamples.

For example, revisions are equally likely to be either upward or downward. However, original June quarter estimates are, on average, revised downward and original September quarter estimates are, on average, revised upward (figure 5). The reasons for this are not immediately clear.

Figure 5 – On average, June estimates are revised downward while September estimates are revised upward

Average revision from original, subsampled by reference period quarter[a,b], 2006–2023



a. For example, the navy dot for the third quarter represents the average revision for the subsample of June quarter figures three quarters since the original release. **b.** Crosses represent averages that are statistically significantly different from zero, circles represent averages that are not (at the 5% level of significance).

Source: PC analysis of ABS (2023, Australian National Accounts: National Income, Expenditure and Product, Cat. no. 5206.0, table 1).

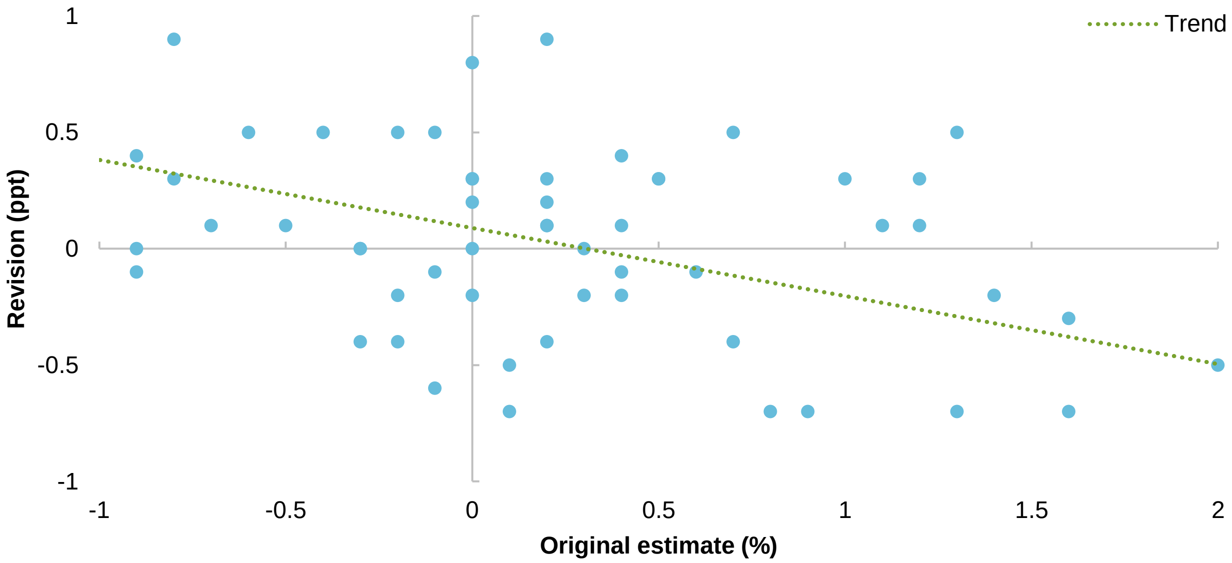
There is also a tendency for larger estimates (both positive and negative) to have a larger revision. Further, positive estimates to be revised downward, while negative estimates tend to be revised upward. In other words, the original estimate tends to be more extreme, before being revised towards zero (figure 6).[5]

The latter finding is the opposite relationship to that found by Bishop et al. (2013, pp. 14–15) for GDP revisions. They find that GDP estimates in downturns tend to be revised downward and in upswings tend to be revised upward.

[5] The revision specified is the revision relative to the original estimate three years since the original release. The regression results are in the appendix.

Figure 6 – Revisions tend to attenuate the estimates

Scatter plot of revisions three years since the original release and their original estimate[a,b], 2006–2020



a. Each blue dot represents a given reference period's original estimate and revision three years since the original release.
b. The trend line is the line of best fit, that is, the slope and constant are derived from an ordinary least squares regression.

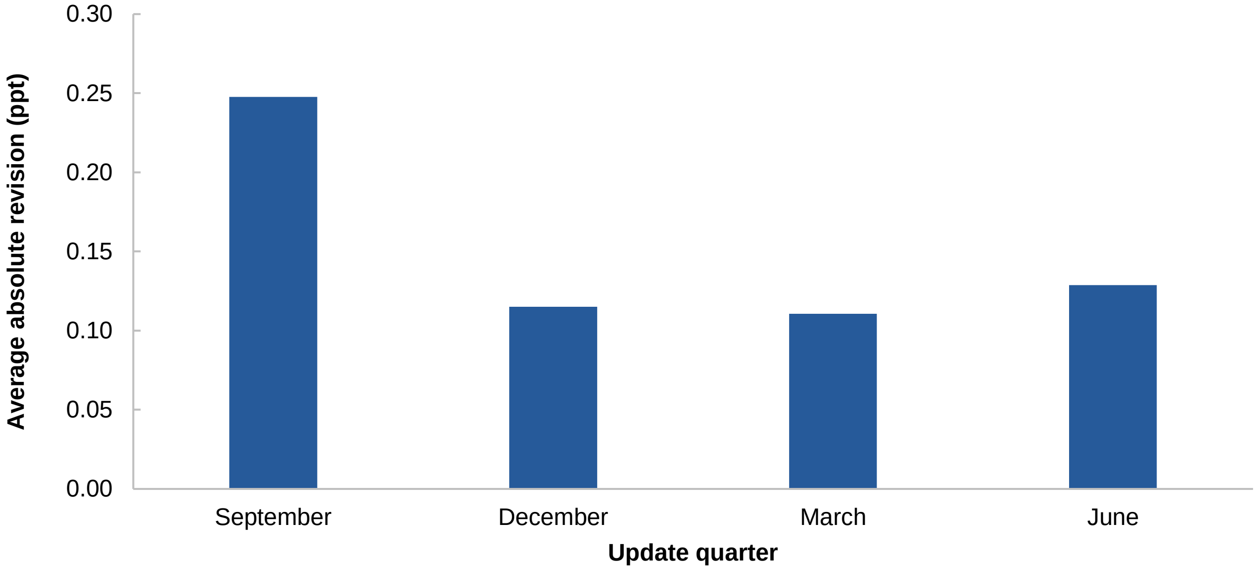
Source: PC analysis of ABS (2023, Australian National Accounts: National Income, Expenditure and Product, Cat. no. 5206.0, table 1).

Finally, changes to estimates are largest in the September quarter release (figure 7). This coincides with the time that the ABS update the quarterly estimates to align with benchmarks (ABS 2021b), where the whole set of estimates are revised.[6]

[6] The process of benchmarking is where the quarterly figures undergo a mathematical procedure to ensure that they are temporally consistent with annual figures (ABS 2021d).

Figure 7 – The September quarter update has the largest average absolute period-to-period revision

Average absolute period-to-period revision, by quarter of update[a,b], 2006–2023



a. The absolute period-to-period revisions are broken down by the quarter of the update period. That is, the sample of the September quarter includes any revision that occurs with the September quarter release. **b.** The sample includes revisions that occur within the first three years of the original release.

Source: PC analysis of ABS (2023, Australian National Accounts: National Income, Expenditure and Product, Cat. no. 5206.0, table 1).

Appendix

Regression analysis

To determine if there was a relationship between revisions and the original estimate, the following regression was undertaken:

$$Revision_i = \beta_0 + \beta_1 Original\ estimate_i + \varepsilon_i$$

Regression results are shown in table 1 (revision regressed against the original estimate) and table 2 (the absolute revision regressed against the absolute original estimate). The results in table 1 show whether there is an association between the sign of the original estimate and the direction of the revisions. For example, whether or not a positive (or negative) estimate is more likely to be revised up or down. The results in table 2 show whether there is an association between the absolute size of the original estimate and the absolute size of the revision. For example, whether larger productivity estimates are associated with a larger revision.

Table 1 – Regression results (revision)[a]

R-squared	0.27			
Observations	58			
	Coefficients	**Standard error**	**t-stat**	**P-value**
Intercept	0.09	0.05	1.62	0.11
Original estimate	-0.29***	0.07	-3.98	0.00

a. *p<0.10; **p<0.05; ***p<0.01.

Table 2 – Regression results (absolute revision)[a]

R-squared	0.19			
Observations	58			
	Coefficients	**Standard error**	**t-stat**	**P-value**
Intercept	0.23***	0.07	3.46	0.00
Absolute original estimate	0.22**	0.10	2.21	0.03

a. *p<0.10; **p<0.05; ***p<0.01.

Abbreviations

ABS	Australian Bureau of Statistics
GDP	Gross Domestic Product
PC	Productivity Commission

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