Office for Statistics Regulation

UK Statistics Authority

Spotlight on Quality

Producer Price Indices

(produced by the Office for National Statistics)

Assessment Report 378

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Office for Statistics Regulation

We provide independent regulation of all official statistics produced in the UK. Statistics are an essential public asset. We aim to enhance public confidence in the trustworthiness, quality and value of statistics produced by government.

We do this by setting the standards they must meet in the Code of Practice for Statistics. We ensure that producers of government statistics uphold these standards by conducting assessments against the Code. Those which meet the standards are given National Statistics status, indicating that they meet the highest standards of trustworthiness, quality and value. We also report publicly on system-wide issues and on the way statistics are being used, celebrating when the standards are upheld and challenging publicly when they are not.

Executive Summary

Spotlight on Quality: Assuring Confidence in Economic Statistics

ES.1 As a result of the UK's departure from the EU, Eurostat no longer provides external assurance of the UK's economic statistics. We recognise that key stakeholders, and the wider public, need additional assurance, specifically on the quality and independence of economic statistics.

ES.2 We are now delivering a series of quality-focused assessments to provide this enhanced assurance, using a newly developed assessment framework that focuses more intensively on the quality of economic statistics. The assessment framework will be developed further as the Spotlight on Quality: Assuring Confidence in Economic Statistics programme progresses.

What we found

ES.3 We have identified eight actions for ONS to improve the quality of the Producer Price Indices (PPI). Implementing these actions will ensure that the statistics continue to meet the highest standards of the Code of Practice for Statistics. We expect ONS to publish an action plan by September 2023, setting out how it intends to improve the quality of the PPIs, and report back to us every six months on progress on implementing the actions.

ES.4 ONS has made some major improvements to the quality and international comparability of the PPIs in recent years, mainly through method changes that have brought the methods in line with international best practice and the needs of users. The most significant change is the implementation of annual rebasing and chain-linking, which ensures that PPIs are better equipped to adapt to structural changes in the UK economy, while enabling comparison of price changes over time. ONS has also changed the headline input index to a gross measure. The single headline input index on a gross measure reflects international best practice and user needs.

ES.5 However, to deliver these improvements, ONS has paused work on updating the samples of the three statutory surveys used to collect price data. Production of PPIs also relies on an inflexible legacy system, the Ingres relational database, which poses risks to the quality of the statistics.

ES.6 ONS's current statistics prioritisation framework prioritises more-prominent, market-sensitive economic statistics such as consumer price inflation over statistics with a lower profile and smaller user base such as PPIs. While it is right that ONS prioritises the more-important statistics, years of under-prioritisation have negatively affected the quality of the PPIs.

ES.7 Without reprioritisation and investment, there is a risk that the quality of the PPIs will further decline and that they become less robust, particularly in their primary use as a deflator for other economic series. It is good that ONS is now formalising development plans to address some of the main quality issues with the statistics, including the survey samples and legacy system.

ES.8 The price statistics experts from the international statistical community that we spoke to praised ONS's methods and agreed that ONS follows international best practice in producing PPIs. The business prices team told us that it intends to

remain consistent with international best practice as much as possible for producing PPIs but will examine where it may be appropriate to depart from international best practice to best meet UK users' needs.

ES.9 ONS is not achieving the target number of price observations for the three surveys used to collect price data, and in some cases is now unable to provide a reliable deflator for certain industries. Updates to the sample were paused in 2019, to implement the above methods changes, and this has affected the representativeness of the samples. Not updating the sample has also exacerbated the impact of sample attrition, which has increased substantially in recent years.

ES.10 As with other ONS business surveys, the COVID-19 pandemic significantly affected the response rates of the three surveys. The falling response rates mean that the business prices team has less data to compile the indices from. As a result, the team is carrying out far more imputation than it used to before the pandemic, which it told us can lead to price changes that are less representative of transactions.

ES.11 We see these survey issues as the biggest threat to the quality of the statistics. It is essential that ONS reviews and updates the samples for all three surveys to improve the quality of the PPIs for all users (Requirement 1). Additionally, ONS should review its imputation methods to ensure that they are fit for purpose and not introducing bias (Requirement 6).

ES.12 ONS is currently developing an electronic questionnaire for the three surveys and expects to roll out this long-awaited improvement at the end of 2024 or early 2025. We welcome the move to online data collection. The use of electronic data collection methods will support higher quality data by making data easier to return for manufacturers and enabling point of collection validation.

ES.13 The legacy Ingres-based system is inflexible, vulnerable to processing errors, and has hindered significant development of certain aspects of the production process. It is good that ONS is planning to migrate all existing business surveys to a new, more flexible platform, and is implementing an Ingres-reduction strategy in the meantime. Replacing the Ingres-based system is essential for futureproofing the production and development of PPIs (Requirement 2).

ES.14 The quality assurance (QA) process for the PPIs is well-established. However, a series of errors identified between November and December 2022 highlighted gaps in the QA process. The business prices team used this an opportunity to strengthen its QA process: it asked ONS's Methodology and Quality Division (MQD) to carry out a review of the process, to provide an additional layer of assurance. The improvements implemented as a result of the review have reduced the risk of future errors, and we welcome the team's openness to peer review. ONS could further strengthen its QA process by implementing the outstanding recommendations of the MQD review. Users told us that they welcomed the ONS's transparency and advanced notice about the errors.

ES.15 A range of other well-established survey and administrative data sources are used to produce the PPIs. These sources have been used for a long time, but their suitability and quality have not been fully reviewed in recent years (Requirement 5).

ES.16 The business prices team engages proactively with users of the PPIs within and outside ONS, for example, through regular bilateral meetings and cross-government business prices groups. Users who use the statistics for the purposes

of forecasting and indexing contracts told us they are generally satisfied with quality and timeliness of the data.

ES.17 Currently, ONS publishes a large number of indices, some of which are likely to be poor quality due to the small sample sizes, and some are likely to be unused. The business prices team should rationalise the number of indices it produces, focusing on producing high quality indices that meet user needs (Requirement 7).

List of Requirements

- **Requirement 1**: To improve the quality of the PPIs and ensure that they meet users' needs, ONS should undertake a review of the necessary sample size and sample optimisation for the PPI, EPI and IPI surveys by July 2024, and update the samples accordingly by July 2025. In the meantime, ONS should consider what remedial changes it can make to improve sampling arrangements sooner than 2025.
- **Requirement 2**: To safeguard the quality of PPIs, ONS should publicly commit to clear and achievable transformation plans for developing a robust, flexible and sustainable producer price inflation statistics system. This should enable RAP principles to be applied throughout and allow new sources to be used and new methods to be implemented. ONS should publish and promote the plans as part of the wider PPI improvement plans by September 2023.
- **Requirement 3:** Within six months of moving to the Statistical Processing Platform, ONS should review the PPI data validation processes and checks to ensure they provide an appropriate level of quality assurance and are adaptable to the prevailing general level of price increases.
- **Requirement 4:** To improve its understanding of revisions and minimise their impact on quality, ONS should carry out a revisions analysis every year. Where revisions are found to be significantly different from zero, ONS should investigate their source and, where necessary, make appropriate improvements to the methods for producing PPIs.
- **Requirement 5:** To ensure the continued suitability of data sources used to produce PPIs, by July 2024, ONS should review the suitability and quality of all current data sources and improve its understanding of the quality assurance carried out by data suppliers. To help users understand how PPIs are compiled, ONS should add a high-level process map to quality documentation explaining how the different sources contribute to the final estimates.
- **Requirement 6**: To ensure the best available methods are being used, by July 2024, ONS should review its imputation methods, including assessing whether they are still fit for purpose and not introducing bias.
- **Requirement 7**: To maximise the usefulness and quality of the published indices, and optimise the use of available resources, ONS should rationalise the number of indices produced by July 2024. It should take into account users' needs and sample size limitations.
- **Requirement 8**: To enhance transparency and provide reassurance to users about quality, by July 2024, ONS should ensure that its published information about data sources, methodology and quality assurance covers all aspects of the production of the statistics and is suitable for a range of users. ONS should review and update this information whenever needed to reflect current processes.

1. Introduction

1.1 Spotlight on Quality: Assuring Confidence in Economic Statistics programme

1.1.1 In our role as an independent regulator, we carry out assessments of official statistics by reviewing their trustworthiness, quality and value. In the context of the UK's departure from the EU, with Eurostat no longer providing external assurance of the UK's economic statistics, we recognise that key stakeholders, and the wider public, need additional assurance specifically on the quality and independence of UK economic statistics.

1.1.2 As part of our Spotlight on Quality: Assuring Confidence in Economic Statistics programme, we are now delivering a series of quality-focused assessments to provide this enhanced assurance. Following discussions with stakeholders, we developed an initial assessment framework that focuses more intensively on the quality of economic statistics. This is based on the Code of Practice for Statistics, with elements from other assessment frameworks, such as the International Monetary Fund's (IMF) Data Quality Assessment Framework. These quality-focused assessments examine whether the statistics are produced using suitable data sources, appropriate methods, and transparent quality assurance; whether the statistics are internationally comparable; and whether the statistics meet the quality needs of users and are not materially misleading.

1.1.3 The assessment framework will be developed further as the programme progresses. Our website contains more information about the current status of the programme.

1.2 Producer price inflation statistics

1.2.1 Producer Price Indices (PPIs), produced by the Office for National Statistics (ONS), measure changes in the prices of goods bought and sold primarily by UK manufacturers including price indices of materials and fuels purchased (input prices) and factory gate prices (output prices)[1].

1.2.2 ONS publishes monthly, quarterly and annual PPIs. The indices are split into the Producer Price Index (PPI), Export Price Index (EPI) and Import Price Index (IPI). Two types of data are used in the calculation of the PPI: prices quoted by manufacturers for their products and the sales values that are used to provide a weight for the product in the index.

1.2.3 PPI has one of the longest-running time series of any economic statistic. The PPI time series goes back to 1957 with figures for manufactured products for the domestic market excluding duty. Aggregate PPI for crude petroleum is available from 1974 and inputs into manufacturing available from 1985.

1.2.4 A related set of statistics, the quarterly Services Producer Price Indices (SPPI), was not reviewed as part of this assessment.

[1] The factory gate price is the amount received by UK manufacturers for the goods that they sell to the domestic market. It includes the margin that businesses make on goods, in addition to costs such as labour, raw materials and energy, as well as interest on loans, site or building maintenance, or rent.

1.3 Uses of PPI

1.3.1 PPIs have three main uses, which are reflected in the International Monetary Fund (IMF) PPI Manual: as a deflator of other economic series, including GDP (their primary use); as an economic indicator; and as a basis for indexing prices in contracts.

- As a deflator of other economic series – PPIs are used to adjust other economic time series for price changes, including estimates of Gross Domestic Product (GDP). They are used in the production approach to GDP for elements of both intermediate consumption and output as part of the double deflation framework[2] introduced by ONS in 2021. They are also used extensively in ONS's short-term GDP estimates. ONS's National Accounts and trade statistics teams use them widely and are the primary users of the statistics.
- As an economic indicator – PPIs capture price movements prior to the wholesale and retail margins and may therefore be an indicator of subsequent price changes for consumers, the latter of which are measured through the Consumer Price Index (CPI). City economists and HM Treasury use PPIs as an early indicator of inflationary pressures in the economy and the Bank of England uses them as part of monetary policy development.
- As the basis for indexing prices in contracts – PPI data are commonly used in indexing purchase and sales contracts, which typically specify amounts of money to be paid at some point in the future. UK government departments are starting to link contracts to PPIs. For example, the Ministry of Defence links defence contracts to the relevant indices to ensure the cost of the contracts tracks changes in prices. Indexing contracts to PPI reduces the costs incurred by government departments as the government department and contractor are assured that the contract reflects the current economic environment[3].

1.3.2 PPI data are an invaluable upstream indicator for the UK Government's Situation Centre (SitCen) which supports the Cabinet Office Briefing Room (COBR) with data and analysis used as part of decision making. The data were recently used to understand the impact of the Russian invasion of Ukraine as well as anticipating price rises of key commodities that are contributing to the rising cost of living. Additionally, EPI and IPI data are being increasingly used to understand the post EU-exit economy.

1.4 Data sources

1.4.1 PPIs are compiled using survey and administrative data from a range of sources. Most price data are collected using three statutory monthly surveys, which ask manufacturers to provide a price for the product(s) that they regularly produce. The monthly survey for PPI is the largest and has a target sample of 6,750 price quotations from approximately 5,000 UK manufacturers. The monthly EPI and IPI surveys each have a target sample of approximately 3,600 price quotations from approximately 1,900 UK manufacturing exporters and approximately 1,500

[2] Double deflation separately deflates output and intermediate consumption to arrive at the production measure of Gross Value Added (GVA) in chained volume measures (CVMs).
[3] By indexing the contract payments to an index, contractors are assured that their future compensation accurately reflects future costs incurred. Therefore, the contractor reduces the risk premium that they charge to the government.

importers. ONS's Business Data Operations Division (BDOD) (the 'data collection team') is responsible for conducting the statutory surveys.

1.4.2 The PPI survey uses a stratified sample design based on revenue, number of manufacturers and the volatility of prices. The sample is chosen from manufacturers that have been selected for ONS's annual UK Manufacturers' Sales by Product (PRODCOM) survey[4]. The sampling units are respondent-product pairs, created by matching respondents to the products they manufacture. For example, if one respondent makes three different products then three respondent-product pairs are created. The sample used to be updated annually and was selected from the previous year's PRODCOM returns, but this annual updating was paused in 2019 to facilitate the introduction of the annual chain-linking methodology (discussed below). Updating the PPI sample has yet to resume due to an ongoing review of the methods to be used.

1.4.3 The EPI and IPI samples are sourced from HM Revenue and Customs (HMRC), which records exports and imports by VAT-registered trader. ONS stratifies the sample to improve the efficiency of the sample in calculating product weights.

1.4.4 The collection of prices is via a pre-printed paper form containing the most recent details provided to ONS. Respondents also have the option to request a PDF form. Forms are sent to manufacturers at the beginning of each month and ask manufacturers to check if the specification for the products they are providing are up to date and representative. Manufacturers then return their latest prices and any future prices if they know they will not change for the next three months. Alternatively, manufacturers can return prices via telephone data entry (TDE) (for the PPI survey only).

1.4.5 Data are also sourced from administrative systems and survey data provided by third parties, for example, agricultural price indices from the Department for Environment, Food and Rural Affairs (Defra) and energy price indices from the Department for Energy Security and Net Zero (DESNZ). In addition to other government departments and organisations, prices are collected from various published sources including published magazines or directly from the internet and used in the index in the same way as survey prices. Examples include the Financial Times for precious metals and non-ferrous metals prices, Smithfield Market for the prices of meat products and the International Coffee Organisation for the prices of imported coffee beans. A full list of administrative sources can be found in Annex A.

1.5 Data processing and systems

1.5.1 ONS uses two databases or systems to produce the PPIs. Data from all survey and administrative sources are collected and collated in an Ingres relational database where price relatives are calculated and processed. Index calculation and aggregation is carried out in ONS's Data Access Platform (DAP). Until 2020, this was done in Ingres. The primary purpose for moving the index aggregation from Ingres to DAP was to allow ONS to implement the annual chain-linking methodology for PPI (see 2.5.5). DAP has also provided the business prices team with the ability to build its own analytical tools so that it can interrogate and understand PPI data more rapidly.

[4] ONS's PRODCOM survey measures sales of products by UK manufacturers and reflects actual transactions taking place in the economy.

1.5.2 The PPI system in Ingres is coded in-house. The database was established in the 1980s and since then has been expanded and added to but not had a full redesign. Over time the work and maintenance of PPI has become more complex as it has aimed to meet growing user demands of other ONS teams, including the National Accounts and trade statistics teams that use PPIs to deflate other economic series. ONS is not investing resources in improving Ingres systems; the focus is now on reducing reliance on 'legacy systems' and migrating processes on to more-sustainable platforms.

2. Findings

2.1 PPIs have been under-prioritised, which has affected quality

2.1.1 As part of the Spending Review 2021, ONS developed a statistics prioritisation framework, which set out high-level priorities for ONS based on statutory requirements, spending review commitments and alignment with strategic goals. The framework prioritises the development of more-prominent, market-sensitive economic statistics such as consumer price inflation over statistics with a lower profile and smaller user base such as PPI. While it is right that ONS prioritises the more-important statistics, years of under-prioritisation have negatively affected the quality of the PPIs.

2.1.2 The business prices team has prioritised certain quality improvements over others. In particular, it prioritised the development and implementation of the annual chain-linking methodology. While this method has significantly improved the quality of the statistics and brought the methods in line with international best practice, the change came at the expense of updates to the PPI survey samples, which have been paused since 2019. This report highlights several other examples where a lack of investment has adversely affected quality, including the use of legacy systems.

2.1.3 Without reprioritisation and investment, there is a risk that the quality of the PPIs will further decline and that they become less robust, particularly in their primary use as a deflator. It is good that ONS is now formalising development plans to address some of the main quality issues with the statistics, including changes to the survey samples and moving away from the legacy Ingres-based system. Once finalised and fully resourced, ONS should publish the development plan to be transparent with users about the changes it is going to make and how these will improve the quality of the statistics for all users.

2.2 Reviewing and updating the PPI, EPI and IPI survey samples is essential for improving the quality of the statistics

2.2.1 Most data required to produce PPIs are collected directly from manufacturers via the PPI, EPI and IPI surveys. The number of products in the samples changes due to products being removed from the index, either as they are no longer being manufactured, exported, imported or because products are no longer the most representative of the sales of the product's category.

2.2.2 In 2005 ONS carried out a review to determine the optimal sample size for the PPI survey. This work determined that 9,000 price observations from around 5,000 manufacturers were required to calculate a robust PPI measure. In 2006, because of savings made as part of the UK Government efficiency programme, ONS subsequently reduced the PPI sample target by 25% to 6,750 price observations. The re-optimisation of the sample meant the sample in some sectors expanded and the sample in other sectors reduced. ONS focused on maintaining the accuracy of the high-level PPI, although inevitably the reduction in overall sample size meant a loss in the number of lower-level indices published because of lower quality.

2.2.3 A similar review of optimal sample size has not been conducted on EPI and IPI since the surveys were set up. Since 2006, the target sample for EPI has been 3,640 price observations and for IPI 3,550 price observations.

2.2.4 Currently, ONS is not achieving the target price observations for all three surveys. The number of products currently in the sample fluctuates from month to month, but for PPI in June 2023 the number was below the target, at 5,623 price observations. ONS is meeting the target sample for EPI (3,659 price observations in June 2023) but is well below the target for IPI (1,898 price observations in June 2023). Although the overall target sample for EPI was achieved, the business prices team told us that the distribution across industries of price observations is uneven.

2.2.5 Considering that the EPI survey covers the same industrial sectors as PPI but aims to measure prices within those sectors on both EU and non-EU bases, and the IPI survey covers a wider range of sectors than both PPI and EPI, the current sample sizes are not adequate for a robust measure, particularly for the lower-level indices. ONS considers EPI and IPI to be 'low' or 'limited' coverage surveys.

2.2.6 The business prices team told us that for some sectors and industries the EPI and IPI sample coverage is now too low to provide a reliable deflator and adequately measure the price changes of key volatile commodities. Users within ONS who use business price indices to deflate other economic series also raised concerns with us that the quality of certain indices is limited, to the point where they are no longer suitable for deflation. For example, the ONS deflators team told us that it uses around 20 PPIs as proxies for IPIs because the IPIs are not of suitable quality for use as deflators.

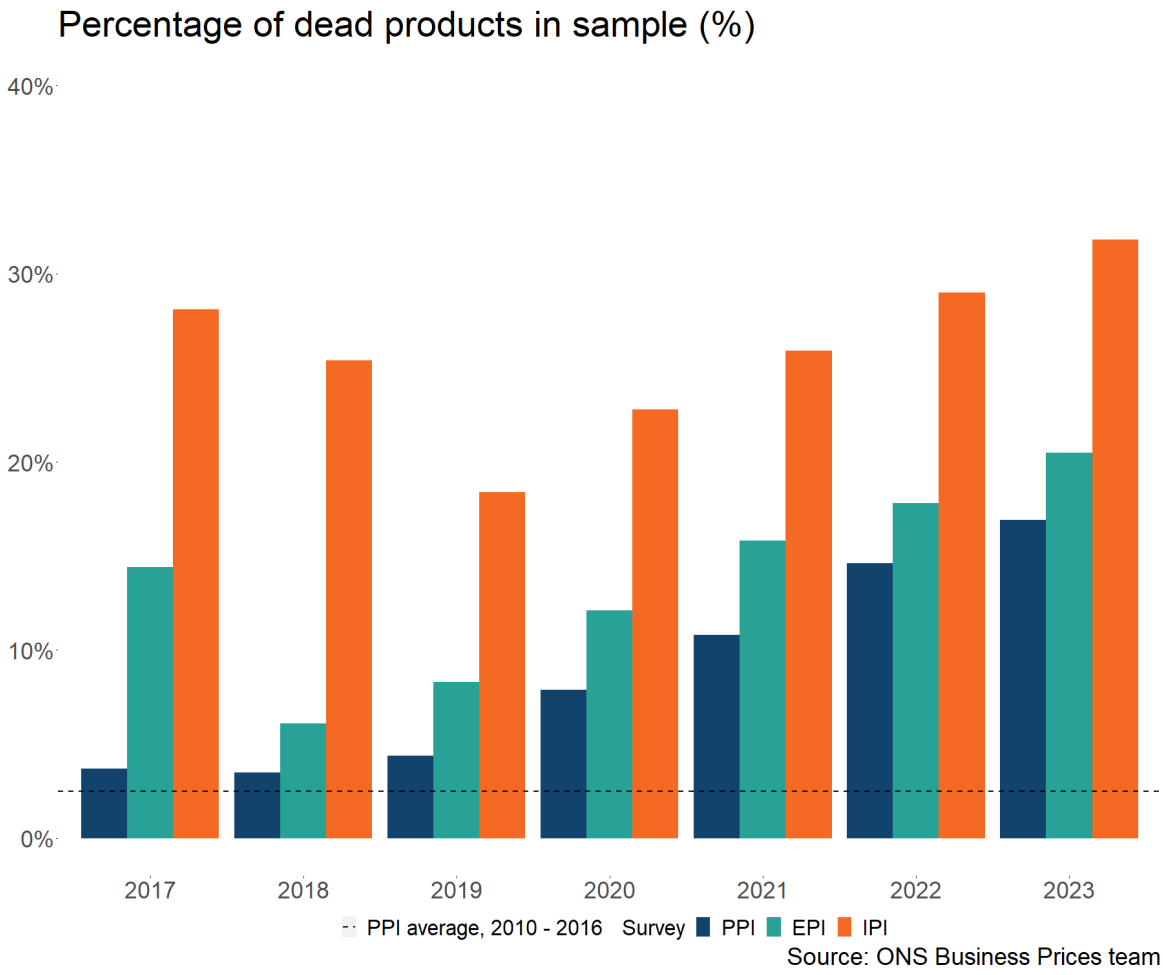
2.2.7 At various points the business prices team has attempted to boost the sample size of the surveys, but these efforts have not been successful. For example, in November 2016, the business prices team proposed to increase EPI and IPI sample sizes to 6,000 price quotations each. This was expected to have two benefits: it would eliminate any indices within the surveys that are constructed from single price observations; and it would improve the coverage of export and import indices. However, due to complications with the mapping of export and import data and the prioritisation of methodological improvements including annual chain-linking , updates to the samples were paused. Changes to the sample are now done on a needs-must basis by the data collection team and are generally focused on maintaining the PPI sample.

2.2.8 This lack of investment in updating the PPI, EPI and IPI samples poses risks to quality. For instance, the samples have become less-representative of trading manufacturers because they do not capture new manufacturers or new product lines. However, existing sampling processes do allow ONS to capture more-representative products from manufacturers already in the sample, as it asks manufacturers for the most representative product they produce.

2.2.9 Not updating the sample also increases the potential effect of sample attrition, which refers to products for which ONS no longer collects price observations because businesses in the sample are no longer active (referred to as "dead" products) but have not been replaced and yet still assigned a weight. Sample attrition has increased substantially since the sample updates were paused in 2019 and is particularly affecting the quality of the lower-level indices. Since 2019, the percentage of dead products in the PPI, EPI, and IPI survey samples has increased year on year and now stands at 17%, 20% and 32% respectively

(Figure 1). Figure 1 also shows that between 2017 and 2019 there was a decline in sample attrition for some surveys, particularly the IPI survey.

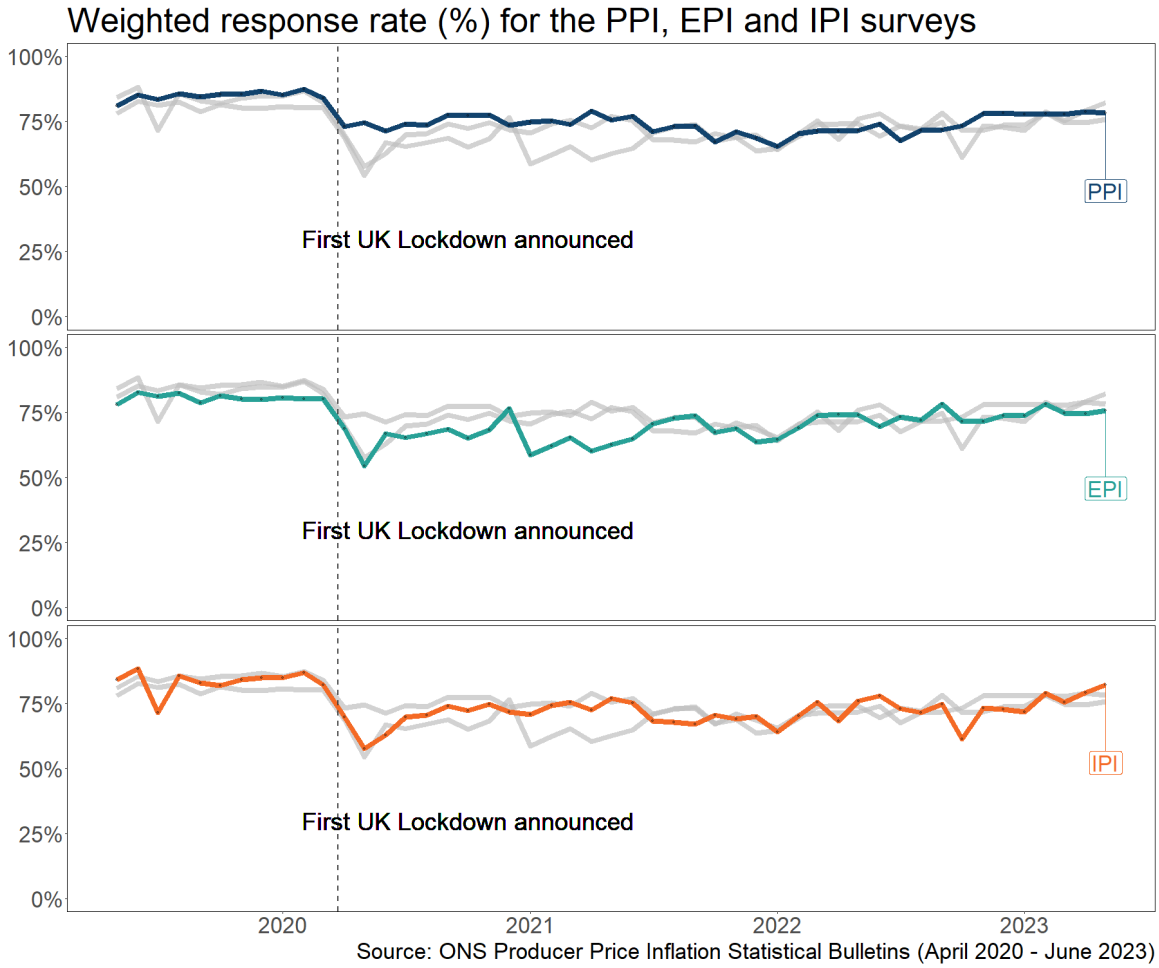
Figure 1. Percentage of dead products in the PPI, EPI and IPI survey samples between 2017 and 2023



Survey response rates have fallen in recent years

2.2.10 As with other ONS business surveys, the COVID-19 pandemic significantly affected the number of respondents returning price data for the PPI, EPI and IPI surveys. ONS publishes response rates for all three surveys in the monthly statistical bulletin. These show that average response rates are currently around ten percentage points lower than they were before the pandemic. For PPI, the average weighted response rate between June 2022 and May 2023 was around 75% (range: 67.7% to 79.9%), compared with approximately 85% between May 2019 and March 2020 (range: 81.0% to 87.4%). The EPI and IPI surveys had similarly large falls in response rate over the same time period (Figure 2).

Figure 2. PPI, EPI, and IPI weighted response rates between May 2019 and May 2023



Source: ONS Producer Price Inflation Statistical Bulletins (April 2020 - June 2023)

2.2.11 Changes in working patterns during the COVID-19 pandemic have contributed to falling response rates, with more people were working from home. During the early part of the pandemic many survey response forms were sent to premises that were unoccupied. In addition, due to a restructure within ONS's Business Data Operations Division, there is less resource to chase non-responders. The dedicated response chasing team was disbanded, with responsibility for response chasing transferred to the data collection team. As a result, fewer manufacturers are chased, and it has become more challenging to clear the backlog of non-responders. To minimise the impact of falling response rates the business prices team has asked the data collection team to take a more targeted approach to non-responders, by chasing responses from businesses in highly weighted industries in the PPI, which seems a sensible approach.

2.2.12 The falling response rates for all three surveys mean that ONS has less data to compile the indices from. As a result, more imputation is applied to the data compared to pre-pandemic periods. This can lead to less-representative trends in price changes, which affects the quality of the PPI estimates (see 2.5.10). Not only does low response rates adversely impact the data, but due to legacy systems, prolonged periods of non-response can result in notable revisions to previously published data (see 2.3.2).

2.2.13 It is essential that ONS addresses the issues with the PPI, EPI and IPI survey samples. Therefore, reviewing and updating the samples for all three surveys, but particularly EPI and IPI, should be a priority for improving the quality of the statistics for all users. We recognise the efforts of the business prices team to make remedial changes to the samples and acknowledge the team's recognition that a wider review is needed. We also recognise that such a review may take some time to carry out. Given these factors, we encourage the business prices team to reconsider what else it might do with the resources available to quickly boost or reduce the sample in the areas it knows are suboptimal.

Requirement 1: To improve the quality of the PPIs and ensure that they meet users' needs, ONS should undertake a review of the necessary sample size and sample optimisation for the PPI, EPI and IPI surveys by July 2024, and update the samples accordingly by July 2025. In the meantime, ONS should consider what remedial changes it can make to improve sampling arrangements sooner than 2025.

Moving survey data collection online will support higher quality data

2.2.14 Most manufacturers respond to the PPI surveys via telephone data entry (TDE): the data collection team told us that 61% of respondents in the PPI survey provided data via TDE in June 2023. ONS is currently developing an electronic questionnaire (EQ) for the PPI, EPI and IPI surveys, and expects to roll out this long-awaited improvement towards the end of 2024 or early 2025. This is part of an ONS-wide drive to move all statutory survey collection online. The larger economic surveys, including the Annual Business Survey, were prioritised first. The PPI surveys continue to be deprioritised because of the challenges associated with moving these surveys online. Sending a respondent's product specification (i.e. a pre-populated questionnaire) back to them has been the main blocker of moving the PPI surveys online, but there are also challenges associated with protecting the confidentiality of data received from and sent to manufacturers.

2.2.15 We welcome the move to online data collection. The use of EQs, and other electronic data collection methods, will support higher quality data by making data easier to return for manufacturers and enabling point of collection validation. As part of ONS's plans for rolling out EQs, the business prices team is looking to implement several additional collection and processing improvements such as developing Ingres's capability to use data from EQs and automation of some aspects of the production pipeline. These additional improvements will further improve data quality, by reducing the burden on both manufacturers and the data collection team, and by giving the data collection team greater control over the data.

2.3 Production of PPIs relies on an inflexible legacy system, but there are plans in place to replace it

2.3.1 The business prices team told us that the Ingres-based system for producing PPIs is vulnerable to processing errors and poses several risks to the quality of the statistics. A lot of PPI data are input manually by the data collection team, which is resource-intensive, and increases the risk of human error. For example, new respondents' price data, exchange rate data from published internet sources and IPI source data (100+ products) are all input manually. Certain aspects of the process have become more manual since the COVID-19 pandemic. Due to the change in working patterns during the pandemic, many manufacturers now

complete a PDF form rather than enter data via telephone. The PDF forms need to be processed manually, which takes up additional resource.

2.3.2 ONS also told us that the Ingres system is inflexible and difficult in several ways:

- It has limited functionality to apply Reproducible Analytical Pipeline (RAP) principles, for example to automate existing processes.
- It is inflexible when it comes to handling missing data, which compounds the issues of falling response rates. The system does not accept gaps in price returns. For example, if a manufacturer has previously provided prices up until November 2022 and has not made any responses until ONS directly contacts them, for the missing data, the ONS will impute estimated prices for the missing months. If the manufacturer provides a price in March 2023, in most cases, the data collection team must enter the November 2022 price for all periods up to January 2023 before the February price can be entered. This replaces the previous imputed value which may cause a revision in previously published data.
- It is not good at dealing with new, non-traditional data sources and has struggled to keep pace with structural changes in the economy, for example, advances in sectors such as telecoms and computer hardware.

2.3.3 Furthermore, any significant development of the 'front end' of PPI (sampling, data collection and validation) is hindered by reliance on Ingres. For these reasons, ONS is planning to migrate all existing business surveys run on Ingres onto a new, more-flexible platform: the Statistical Processing Platform (SPP). In the meantime, ONS is implementing an Ingres-reduction strategy that aims to: ensure the effective integration of EQ collection tools; give the data collection team greater control over response and validation; and integrate non-survey data sources within data, for example, the telecoms deflator and existing administrative data sources.

2.3.4 Replacing the Ingres-based system is essential for futureproofing the production and development of PPIs. We recognise that there are plans in place to do this and that they will take some time to implement. Currently, there is no information in the public domain about the plans to transform the systems used to produce PPIs.

Requirement 2: To safeguard the quality of PPIs, ONS should publicly commit to clear and achievable transformation plans for developing a robust, flexible and sustainable producer price inflation statistics system. This should enable RAP principles to be applied throughout and allow new sources to be used and new methods to be implemented. ONS should publish and promote the plans as part of the wider PPI improvement plans by September 2023.

2.4 The quality assurance process is well-established but can be strengthened

Validation tests act as an early warning of large price movements

2.4.1 The business prices team has a positive relationship with the data collection team. As part of conducting the PPI surveys, the data collection team assures the quality of the price data collected from manufacturers. The two teams meet monthly to review data. At these meetings, the business prices team provides an overview to the data collection team of what has been published and the impacts of the data collection team's work. The data collection team told us that it finds the business

prices team supportive; for example, if it fails to get a manufacturer's response after three attempts, it sends the query to the business prices team to make the final decision.

2.4.2 The data collection team carries out two main automated validation tests, which are used to check the monthly movement of prices and act as an early warning:

- Dubious prices – monthly price movements of plus or minus 12% or more are labelled as 'dubious' and are checked with respondents for confirmation of the increase or decrease.
- Incredible prices – monthly price movements of plus or minus 30% or more are labelled as 'incredible' and are checked with respondents for confirmation through a valid explanation for the price change.

2.4.3 The data collection team then contacts respondents to clarify the price data and updates Ingres accordingly. The values in para 2.4.2 have been used since early 2022, when they were adjusted to reflect increases in the volatility of prices; the threshold for dubious and incredible prices used to be plus or minus 7.5% or more and plus or minus 20% or more, respectively. When inflation was low, these lower thresholds were appropriate for checking for outliers in price changes. However, with annual input producer price inflation rates reaching 24% in June 2022, the number of legitimate price changes that were failing the validation tests increased sharply. To ensure the tests were proportionate, and to manage the workload of the data collection team, the business prices and data collection teams jointly reviewed the validation tests and adjusted the thresholds[5]. Since then, the thresholds for the validation test have been reviewed quarterly. It is good that the business prices team continues to review them in collaboration with the data collection team.

2.4.4 Apart from the 2022 adjustments, the validation gate thresholds have not been formally reviewed for a long time. It is important that ONS reviews and updates the validation checks so that they provide an appropriate level of quality and are adaptable to changes in the economy. The move to a new processing platform (see 2.3.3) provides a good opportunity to do this.

2.4.5 This validation process is not the only method used to identify incorrect price data. Subsequent analysis of results by the business prices team will highlight the more significant prices changes that are impacting results, which in some cases might be smaller price changes for high-weighted products. The data collection team then follows up with respondents to gather the correct data.

Requirement 3: Within six months of moving to the Statistical Processing Platform, ONS should review the PPI data validation processes and checks to ensure they provide an appropriate level of quality assurance and are adaptable to the prevailing general level of price increases.

Curiosity meetings are an effective component of quality assurance

2.4.6 The second layer of quality assurance (QA) is the business prices team's 'curiosity' meetings. In these meetings the team aims to understand which unexpected price movements are genuine and then makes judgements about how suitable it is to include the relevant data. The team considers whether price

[5] The new thresholds were calculated by modelling the number of price movements that failed the validation tests and resetting them so that, on average, the same volume of price movements failed the tests as with the previous thresholds.

movements for a product with a small weight are having an amplified effect as a result of imputation, as these are considered to be detrimental to index quality and their effect must be mitigated. This is done on a case-by-case basis.

2.4.7 There are two curiosity sessions within the monthly production cycle: one that looks specifically at PPI, EPI and IPI, and another that brings together all ONS's price indices (PPI, CPI, House Price Index (HPI)). These meetings are used to interrogate and query data after the indices have been produced and are held prior to the writing of the statistical bulletin. The meetings will flag if the prices of any products are having an unexpected impact on the indices, including those which do not fail the validation tests.

2.4.8 One growing area of focus for the curiosity meetings is the impact of imputation on the suitability of data, which is discussed below. The business prices team is also increasing the number of congruence checks it carries out as part of the curiosity meetings; it is looking to expand the data sources it uses to validate and corroborate EPI and IPI data. Because these indices have low sample coverage, at times they reflect specific products rather than general trends in those sectors, so there is a greater need for validation with alternative data sources. It is good that the team is exploring the use of alternative data sources to corroborate indices. We encourage the team to be transparent about which data sources it uses for this.

A formal quality review is carried out every year

2.4.9 In addition to the QA carried out for each publication cycle, the business prices team carries out a more formal annual quality review, using the Statistical Quality Maturity Model (SQMM) self-assessment tool developed by ONS. The SQMM review is done in consultation with the quality champions in the division, and the business prices team keeps a log of the discussions. The review identifies any areas for improvement and highlights areas that should be picked up in the curiosity sessions. It is good that the team carries out more-formal reviews of quality, and we encourage it to share the main findings of these reviews with users and explain how they are improving the quality of the statistics.

The quality assurance process has been improved since a series of errors

2.4.10 Between November and December 2022, the business prices team identified a series of errors in the statistics. These errors were mostly driven by the incorrect allocation or linking of weights (see Annex B for further details). The errors demonstrated that there were gaps in the business prices team's QA process. The business prices team cancelled the publication of statistics in December 2022 to allow it to undertake further investigations.

2.4.11 The business prices team asked ONS's Methodology and Quality Division (MQD) to review the QA process for the PPIs, including the code used to produce them. This review provided an additional layer of assurance about the robustness of the QA processes and whether these were proportionate to the complexity and impact of the output.

2.4.12 The MQD review made some recommendations for improving the QA process, including several essential improvements that had to be made before any further publication of the statistics. These included increasing the number of QA checks on database queries and improving senior oversight of QA. The review informed the decision to cancel the publication of the statistics in December 2022. The business prices team made all essential improvements before it started

republishing the monthly statistics in January 2023. These improvements have reduced the risk of future errors and we welcome the team's openness to peer review.

2.4.13 The review identified a range of other improvements that would further strengthen the QA process, such as designing and implementing a formal error management process and expanding the range of QA checks to include a broader definition of values of concerns. Implementing these recommendations would further enhance the quality of the statistics.

ONS should regularly analyse revisions

2.4.14 The statistics are revised according to the PPI revisions policy, which is in line with ONS's National Accounts Revisions Policy. Figures for the latest two months are provisional and the latest 12 months could be revised. Several users told us that the revision window is too long and that revisions can be very volatile. They said they would like the revision window and the size of the revisions to be minimised, as the current arrangements can cause issues with pricing contracts.

2.4.15 ONS told us that when Ingres was still being used to process data, the revision window was only five months and most indices' values were stable by the end of that window. The window was extended to 12 months with the movement to DAP but with the expectation that most data would be stable by five months; similar to the old Ingres process. However, due to the impact of the pandemic on respondent behaviour ONS now receives more late returns, which means that significant revisions span a longer period. ONS told us that the move from paper-based to online data collection (with the introduction of the EQ for the surveys, discussed earlier), is expected to give it greater control over revisions, by fixing imputed data after it is satisfied with the response level. This is expected to prevent subsequent revisions by retaining what it considers to be a sufficient estimate of the data.

2.4.16 While the business prices team records revisions to the data and publishes revisions triangles for the latest five-year period, it does not carry out regular analysis of revisions. This is another gap in the QA process. We carried out our own indicative analysis of PPI revisions to understand the volatility of the indices and the robustness of the preliminary figures (see Annex C). We found that, in general, preliminary figures are revised upwards, but the size of revisions is small. This suggests that improvements could be made to the survey or results systems to enable revisions to be centred more closely on zero.

Requirement 4: To improve its understanding of revisions and minimise their impact on quality, ONS should carry out a revisions analysis every year. Where revisions are found to be significantly different from zero, ONS should investigate their source and, where necessary, make appropriate improvements to the methods for producing PPIs.

The suitability and quality of all data sources should be reviewed

2.4.17 As explained earlier, most price data are collected via the three monthly surveys, but some price data come from other survey and administrative sources provided by third parties (see Annex A for full list). Many of these sources have been used for a long time, but their suitability and quality have not been fully assessed in recent years.

2.4.18 The business prices team engages directly with the suppliers of some of these other data sources. For example, DESNZ supplies ONS with a time series of energy prices data, which includes a monthly index number and a summary brief. The brief contains charts and a quality report with commentary about how estimates have changed and the scale of the revisions. This helps ONS contextualise major price changes which aids interpretation for users.

2.4.19 It is important that ONS understands the quality of all data sources used to compile the PPIs and communicates their quality to users. Our Quality Assurance of Administrative Data (QAAD) Toolkit would be helpful for this. We also think more-proactive engagement and closer dialogue with other data suppliers would enable ONS to better manage the quality of the statistics, particularly as initial QA is carried by the data supplier rather than the business prices team. This was also highlighted as an area for improvement in the MQD review (see 2.4.11).

Requirement 5: To ensure the continued suitability of data sources used to produce PPIs, by July 2024, ONS should review the suitability and quality of all current data sources and improve its understanding of the quality assurance carried out by data suppliers. To help users understand how PPIs are compiled, ONS should add a high-level process map to quality documentation explaining how the different sources contribute to the final estimates.

2.5 Recent improvements in methods mean that ONS adheres to international best practice

2.5.1 International best practice for producing the PPIs is outlined in the IMF PPI Manual. The manual was produced in collaboration with four other international economic organisations, including Eurostat, and was last updated in 2010. In 2012, Eurostat published a handbook on PPI which brought together best practice across EU member states and reflected recommendations outlined in the IMF PPI Manual.

2.5.2 The price statistics experts from the international statistical community that we spoke to praised ONS's methods and agreed that, in general, ONS works in line with international best practice. They also said it might be helpful if ONS highlighted the areas where it is less harmonised with international best practice.

2.5.3 The business prices team told us that it intends to remain consistent with international best practice as much as possible for producing PPIs but will examine where it may be appropriate to depart from standard international practice to best meet UK users' needs. For example, the business prices team suggested expanding the scope of the statistics to include areas of the economy with particular interest to users such as imports of natural gas.

2.5.4 In 2020, ONS made three changes to the way it produces and publishes PPIs. These have improved the quality and international comparability of the PPIs and brought the methods in line with international best practice and the needs of users. The most significant change is the implementation of annual rebasing and chain-linking. ONS also moved from leading with a 'net of inter-sector transactions' measure to a gross measure in its industry weightings and removed duty from the headline indices.

Annual rebasing and chain-linking

2.5.5 Annual chain-linking is a well-established method for price statistics. Chain-linking is used as part of annual rebasing where the indices' weights are updated every

year. Previously, the weights were updated only every five years. Annual chain-linking is considered international best practice and is recommended by Eurostat[6]. The main advantage of annual rebasing is that it maintains accurate and representative weightings, which is beneficial for measuring a dynamic economy such as the UK's. For example, advances in the computer hardware industry led to new products frequently replacing obsolete products. By implementing annual chain-linking, PPIs are better equipped to adapt to structural changes in the economy, reducing bias, and enabling comparison of price changes over time.

Net to gross measures of industry weightings

2.5.6 ONS moved from leading with a 'net of inter-sector transactions' measure to a gross measure in its industry weightings. A gross measure includes the sales within two manufacturers in the same sector while a net measure excludes these transactions. There is a trade-off between these measures. The IMF PPI manual recommends using net measures as it avoids the problem of double counting transactions in the production process (for example, when one industry's output is another's input). However, the manual recognises that the gross measure is recommended over a net measure for deflating the sales revenue of industries as, by definition, the sales revenue of industries is a gross measure. As part of the user consultations for the methods changes, ONS found that users preferred a gross measure of inflation and that users of the net series were not fully aware of the calculation methods or what the net series was articulating. Publishing a single headline input index on a gross measure is a good example of where ONS has balanced international best practice against the needs of UK users.

Removal of duty

2.5.7 ONS removed duty from its headline PPIs. According to the IMF PPI Manual, it is international best practice to capture basic prices, as the valuation basis used is important in capturing the revenue received or costs faced by manufacturers. Basic prices are the amount received by the manufacturer from the purchaser for a unit of a good or service produced minus any tax, plus any subsidy[7]. Basic prices are preferred over other valuation methods as they capture the per-unit revenue received by the manufacturer and filter out distortive effects such as fiscal policy. Removal of duty from the headline index ensures that the valuation basis for PPIs is consistent with international best practice and therefore improves international comparability.

Index construction methods

2.5.8 ONS uses the Laspeyres-Lowe index formula to compile the PPIs (see Annex D for further details about index formulae). The international statistical community considers the Laspeyres-Lowe formula suitable for compiling PPI; it is used by many Organisation for Economic Co-operation and Development (OECD) member countries. The Laspeyres-Lowe index could be subject to extensive bias if the indices weights are not updated frequently enough. However, as ONS is rebasing its indices annually due to chain-linking, the impact of this bias is largely mitigated.

2.5.9 ONS produces PPI in two ways: by economic activity and by type of goods. A third internationally recognised way of producing PPIs is by stage of processing (raw

[6] The UK was still a member of the EU when ONS consulted on the changes to methodology.
[7] Eurostat, 2017, *Glossary: Basic price*, Available from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Basic_price

materials, intermediate goods, and finished goods)[8]. Only some non-EU OECD countries such as Australia publish PPIs that have been produced using this method, so the UK's PPIs are not directly comparable to the PPIs of those countries. This is a limitation of PPIs; because of such differences in methods, they are less internationally comparable than other prices indices (consumer and housing price indices).

Imputation methods should be reviewed

2.5.10 Price data are imputed when price data have not been received from manufacturers. The falling response rates for all surveys (discussed earlier) mean that the business prices team has less data to compile the indices from. As a result, the team is carrying out far more imputation than it used to before the pandemic, which it told us can lead to less-representative trends in price changes. Price data are also imputed for products for which price data are no longer collected because the product is no longer produced, but which has not yet been removed from the sample (so still has a weight).

2.5.11 The business prices team told us it sees the impact of imputation as one the main threats to the quality of PPIs. The falling response rates reduce the robustness of imputed values as they are based on a smaller selection of data. The potential negative impact of inaccurate imputation is magnified by the increase in sample attrition (also discussed earlier), as products which must be imputed represent a greater proportion of their indices. With increased reliance on imputation on increasingly smaller subsets of price data, it is important to regularly review the imputation methods.

Requirement 6: To ensure the best available methods are being used, by July 2024, ONS should review its imputation methods, including assessing whether they are still fit for purpose and not introducing bias.

Adjusting for the changing quality of products

2.5.12 The aim of PPIs is to measure the price change of products of fixed quality over time, but the quality of products may change over time. For example, as the speed of computer processors increases, buyers of processors will receive a higher quality product[9]. When constructing PPIs, statistics producers must adjust their indices for quality changes in products to ensure that they measure only pure price changes. Not properly adjusting for quality changes may lead to biased indices which distort price changes.

2.5.13 The IMF PPI manual outlines two types of methods for quality adjusting:

- Explicit methods: these methods use external information to quantify the quality difference between the old and replacement product. The methods estimate the extent of the quality and pure price changes with less reliance on assumptions.
- Implicit methods: a measurement technique is used to compare the old product with its replacement, so that the extent of the quality and pure price change is determined by the assumptions of the method chosen.

[8] See section 7 of the OECD's Frequently Asked Questions about Producer Price Indices.
[9] If the manufacturer maintains the price despite a quality change, it can be viewed as a fall in price as consumers are now receiving a better quality good for the same price.

2.5.14 Explicit methods are generally viewed as more reliable but are more resource intensive to implement. The 2016 Independent Review of UK Economic Statistics identified that between 3-9% of the UK's PPIs were explicitly quality adjusted to some extent. ONS has since stopped explicitly quality adjusting the PPIs as it was too resource intensive and required too much manual intervention. The business prices team told us it now only uses an implicit method of quality adjustment known as chaining, which assumes that the price difference between the previous and replacement product in the same period, are solely due to quality differences[10]. ONS could be more transparent about the methods it is using to account for changes in the quality of products and the effect on the estimates of applying the method.

2.5.15 Some explicit quality adjustment is carried out by ONS's deflator team (the team responsible for researching, developing and improving the deflators used), to prepare the indices for use as a deflator in National Accounts. The computer hardware and peripheral equipment PPI is explicitly quality adjusted as it is inadequate for deflation in its non-adjusted state. While it is good that ONS is explicitly quality adjusting this index, it may be more efficient if it was quality adjusted by the business prices team. It would also improve coherence by ensuring that all users of the PPI data have access to the same quality data.

2.6 ONS engages proactively with users about quality and methods

2.6.1 The business prices team's main forum for engaging with users about quality and methods is ONS's cross-government business prices group, which includes key stakeholders from HM Treasury, the Bank of England, the Department for Business and Trade, and other bodies. There is also a cross-government inflation analyst group, which includes a broader range of government users and meets quarterly to discuss price statistics.

2.6.2 The business prices team has a close working relationship with primary users within ONS. For instance, it has fortnightly meetings with the ONS deflator team to discuss any issues arising from the use of PPIs across ONS economic statistics teams, including the trade statistics team. In addition, the business prices team has joint steering group meetings with National Accounts teams several times a year to discuss their PPI requirements.

2.6.3 ONS consulted users extensively about the recent methods changes. The business prices team ran two user consultations (in 2017 and 2019) to gather users' views on the proposed changes and how they would affect their use of the statistics.

2.6.4 We asked a range of users covering the three main uses of PPI (see 1.3.1) for their views on the quality of the PPIs. Users outside ONS who use PPIs as the basis for indexing prices in contracts told us that the quality meets their needs and that they are satisfied with the level of granularity in the indices, for example, data at lower levels of industry and product level. Users who use the PPIs as an early

[10] The Eurostat (2012) handbook on constructing PPIs, states that "[this] method… should only be used if there is a considerable quality difference between the old and new representative products, and no additional information is available for the application of another quality correction procedure. Applying the chaining quality adjustment procedure will bias the index to show no price change over time".

economic indicator for forecasting inflation also said they are satisfied with the quality, in particular with the timeliness and relevance of the data.

2.6.5 The business prices team responded positively to user feedback during this assessment. Several users that we spoke to requested that ONS publish the weights used to compile the indices, as these are useful for forecasting the movement of indices. ONS had not published the weights used to compile the indices since 2020. We mentioned this to the business prices team and from March 2023, it started to publish the weights of the product groupings as part of the statistical bulletin.

2.6.6 The business prices team handled the series of errors very well. It was transparent with users about the nature of the series of errors and the scale and impact of the resulting corrections. For example, it issued a correction notice about the diesel fuel weight error, and a further notice about the cancellation of the statistics that highlighted the table error and the mapper error (see Annex B). Users told us they welcomed ONS's openness and advance notice about the errors, despite the inconvenience caused by the cancellation of the December 2022 publication.

2.6.7 Currently, ONS publishes a large number of indices (1,540 PPI, EPI and IPI indices), most of which are lower-level indices. Some of these lower-level indices are likely to be poor quality due to the small sample sizes (discussed earlier), and some are likely to be unused. The business prices team should rationalise the number of indices it produces, focusing on producing high quality indices that meet user needs. This needs to be done in the context of a longer-term, wider review of the use of alternative data sources to produce PPIs.

Requirement 7: To maximise the usefulness and quality of the published indices, and optimise the use of available resources, ONS should rationalise the number of indices produced by July 2024. It should take into account users' needs and sample size limitations.

2.7 ONS should be more transparent about all areas of quality

2.7.1 ONS publishes a Quality and Methodology Information (QMI) report for the PPIs. The report gives a brief overview of data sources and methods used to compile the statistics, their strengths and limitations, and the QA process. It discusses all the key quality dimensions (relevance, coherence, etc) and highlights some limitations, such as the limited coverage of the EPI and IPI surveys.

2.7.2 However, ONS does not publish information about several important areas of quality, which means that users do not have a complete view of the quality of the statistics. In particular, it does not explain:

- **Statutory surveys**. The QMI report contains no information about the sample design of the PPI, EPI and IPI surveys, even though these are the main source of price data used to compile the statistics. It does not describe the issues with sample attrition and response rate highlighted in this report (see 2.2) and does not discuss the impact of the economic shocks on data collection, such as the COVID-19 pandemic and the war in Ukraine.
- **Administrative data sources**. The QMI report contains no information about the quality of the various administrative data sources used, how ONS reviews the suitability of those sources for producing the statistics, and how ONS (and the data suppliers) assures the quality of the data (see 2.4.17).

- **Systems**. The QMI report contains no information about the Ingres production system, including the challenges and limitations of using the system for collating and processing data, and how this might impact the quality of the PPIs (see 2.3).

2.7.3 In addition, ONS has not updated information about quality regularly – the QMI report was last updated in November 2020 – which means that some information is no longer relevant and does not reflect the current quality of the statistics. In some cases, it gives users a misleading picture of quality.

- **Quality adjustment**. The language used in the QMI report implies that ONS explicitly adjusts for the quality change of products. It only explicitly quality adjusts one index, and this is done by ONS's deflator team rather than the business prices team (see 2.5.15), so these adjustments are currently not included in the published PPIs.
- **Quality labelling**. Until November 2020, PPIs were published with quality classifiers that identified indices with low product coverage and encouraged users to treat these with caution. ONS stopped publishing the classifiers because they were not in the scope of the transition to the DAP platform. The QMI report and metadata state that ONS still publishes classifiers.
- **Standard errors**. The QMI report states that standard errors for PPIs are published annually (as a table alongside the statistical bulletin), but they were last published in March 2019.
- **Quality assurance**. ONS changed the 'dubious' and 'incredible' validation test thresholds to manage the workload of the data collection team (see 2.4.3). The QMI report does not explain these changes.

2.7.4 Up-to-date information about the data sources, methodology and QA process is important to enhance trustworthiness, give users a better understanding of the quality of the statistics, and support appropriate use and interpretation of the statistics.

2.7.5 We welcome the level of transparency about the recent method changes (see 2.5). ONS published a series of articles about the changes and their impacts on the statistics. One article outlined the broad changes to methods and sources. While this article provided details and assurance about the implemented methods, it could have been clearer about why the changes were made, especially in terms of meeting international best practice, and how they improved the quality of the statistics. For example, users would benefit from a clearer explanation of the benefits of moving from net to gross measures of industry weightings.

2.7.6 ONS also produced a technical article which outlined the formulae and processes behind chain-linking. It contains helpful visualisations and intuitive explanations that are accessible to a less technical audience. Another article explained the changes to the weighting of the headline indices due to structural variations in the economy and changes to the methodology and sources used to produce the weights. This article was helpful in differentiating the sources of variation in weights and reduced the uncertainty around the impact of the methodology.

2.7.7 While the level of detail in these articles is helpful and proportionate to the complexity of the methods, the accessibility of this information could be improved by bringing it together in place, and by signposting it more clearly in the QMI report.

2.7.8 It is good practice to highlight uncertainty around the statistics to support interpretation and appropriate use of the statistics. The quality classifiers mentioned earlier used to provide helpful guidance for users about the quality of individual indices. By removing the classifiers, ONS is not being as transparent about quality as it could be; it may give users the misleading impression that the index has no quality issues even if the index is unreliable. ONS still has the information to produce the classifiers but does not publish them; users can still request the classifiers by contacting ONS.

2.7.9 Standard errors are another useful indicator of uncertainty around the indices, but the business prices team also stopped published this information, to focus resource elsewhere. While most of the users we spoke to did not use the previously available information on standard errors, some users thought it might be useful if ONS produced a one-off article that explains the uncertainty around the PPI estimates. We encourage ONS to be clearer about the extent and nature of uncertainty around the indices.

Requirement 8: To enhance transparency and provide reassurance to users about quality, by July 2024, ONS should ensure that its published information about data sources, methodology and quality assurance covers all aspects of the production of the statistics and is suitable for a range of users. ONS should review and update this information whenever needed to reflect current processes.

Annex A: PPI data sources

ONS producer prices statutory surveys

- **Monthly Survey for Index Numbers of Producer Prices** – collects prices used to compile the PPIs. A sample of manufacturers is selected from ONS's UK Manufacturers' Sales by Product (PRODCOM) survey.
- **Monthly Survey for Index Numbers of Export Prices** – collects prices for products manufactured and exported from the UK, used to compile the EPIs. Includes all UK trading businesses within the manufacturing and mining sectors registered with HM Revenue and Customs (HMRC) for Value Added Tax (VAT) or Pay As You Earn (PAYE).
- **Monthly Survey for Index Numbers of Import Prices** – collects prices for goods and raw materials imported into the UK, used to compile the IPIs. Includes all UK trading businesses within the manufacturing and mining sectors registered with HMRC for VAT or PAYE.

Main data sources used for weighting

- **PRODCOM (ONS)** – most sales values and volumes for UK manufacturing are sourced from the PRODCOM survey.
- **Annual export and import sales value data (HMRC)** – used as weights in the EPIs and IPIs. The coverage is split between trade to or from an EU and non-EU country, which correlates with the index structure in the EPI and IPI.
- **Annual Business Survey (ABS) (ONS)** – a sample survey that collects annual sales data for UK businesses across the whole economy, including businesses within the manufacturing sector, and was also used during the last rebasing exercise. ABS data are used for calculating annual sales values that include duty; annual sales values for the water and forestry support service indices; and annual sales values for products that are not covered by other sources.

Survey and administrative data from other government departments and organisations

- Agriculture – Department for Environment, Food and Rural Affairs (Defra)
- Energy (including crude oil) – Department for Energy Security and Net Zero (DESNZ)
- Fish – Marine Management Organisation (MMO)
- Water Supply – Water Services Regulatory Authority (OFWAT)
- Basic Iron and Steel products – International Steel Statistics Bureau
- Timber – Forest Research

Published sources of price data

- Commodities such as oil, gold and copper – Financial Times
- Exchange rates – Financial Times

- Wheat and grains, oilseeds and oil, fats and nuts – Bloomberg
- Milling and feed wheat – Agricultural and Horticulture Development Board
- Metal Ores and Kaolin – Industrial Minerals
- Other Metal Products – Metal Bulletin
- Rubber – The Rubber Board
- Cotton – IndexMundi
- Coffee – International Coffee Organization
- Tea – International Tea Committee

Annex B: PPI errors

B.1 Between November and December 2022, ONS identified a series of errors in the PPIs:

- **Diesel fuel was not allocated a correct weight within the output price index**. This resulted in Petroleum Products being around half the correct weight of 6.5% since the start of the 2022. The correction in Output PPI weights, and the inclusion of diesel prices within the data, meant that from January to October 2022 Petroleum Products had the largest positive contribution to the 12-month rate of output inflation. The error did not affect the overall trend, but it led to the headline 12-month output price rate being revised up by an average of 1.8 percentage points during this period. For October 2022 Petroleum Products contributed 6.1 percentage points to the 12-month rate (revised from 0.0). The issue occurred because of a processing error during manual intervention. The business prices team corrected all affected datasets.
- **Human error resulted in not updating the indices in the published table**. This happened because some material was copied from one Digital Access Platform (DAP) to another as part of the process of correcting the Diesel fuel error. PPI is calculated and compiled using two pipelines; a ‘monthly’ pipeline used to calculate all data for all periods direct from source data, and a ‘publication’ pipeline that stores data so that the business prices team has ongoing repository of published data. Within DAP, one database is used to facilitate the monthly PPI releases and another is used to run any data tests. The business prices team introduced a set of internally consistent spreadsheets to match the data already on the website.
- **The two most recent mapper files for 2021 were used instead of the 2022 file**. The mapper files help link the monthly price data to the annual weights. Because there is no consistent classification for PPI, these mapper files help ensure that the various data are fed into the right indices with the right weights. These errors only affected the PPI input price index. The business prices team rebuilt the mapper files because there was an error in the 2022 mapper file and reviewed all other existing mapper files.
- **Some historical data (pre-2021) were incorrectly hidden from the time series viewer on ONS’s website**. The issue was caused by how the central database handles price indices that are imported from DAP. ONS corrected these data when it started republishing the PPIs in January 2023 and worked with DST to put in place checks for the import process.

Annex C: Revisions analysis

C.1 The aim of our revisions analysis was to understand to volatility of the indices and the reliability of preliminary figures. In particular, we wanted to understand the direction and size of revisions.

C.2 We took data from the Producer Price Inflation Time Series datasets covering the period from April 2021 to May 2023. These datasets are published alongside the monthly statistical bulletin and provide a time series for the PPIs, EPIs and IPIs. It is important to note that this is an indicative analysis. It is not a complete analysis of revisions to all PPIs, EPIs and IPIs. Instead, it is based on a subset of 129 indices that are published in every dataset – the headline output and input index and 127 lower-level indices.

C.3 The analysis was carried out on percentage growth rates. For each index, we calculated the annual percentage growth rate as the difference in the index value for a given month and the same period 12 months earlier, divided by the index value for the earlier time period.

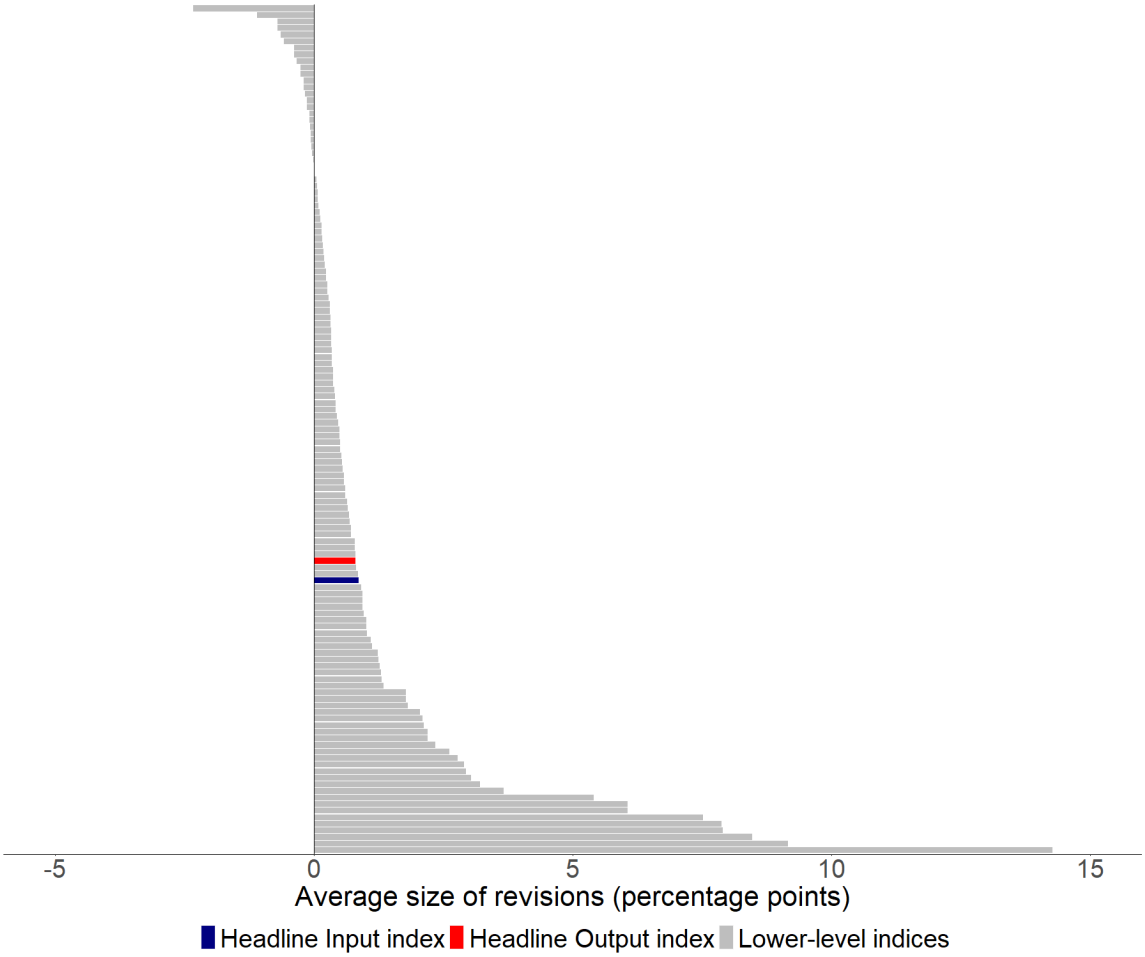
C.4 For each month, we calculated the revision as the percentage point difference between the first published estimate and the final growth rate published 12 months later, as the revision window for PPIs is 12 months. We did this for each of the annual growth rates for years ending June 2021 to May 2022, the latter of which is the latest available that has been fully revised. For each of the 129 indices, we then calculated the average size of revision as the mean of the revisions for each of the 12 annual growth rates.

C.5 We recognise that the 12-month period we have chosen may not be representative of the direction and size of revisions made over a longer time period. For instance, our analysis includes revisions made following the series of errors identified between November and December 2022 (see Annex B), and these revisions were relatively large.

C.6 We found that the headline indices are frequently revised upwards. For the headline output index, the annual percentage growth rate for any given month is revised upwards, on average, 0.80 percentage points. For the headline input index, the annual percentage growth rate for any given month is revised upwards, on average, 0.86 percentage points. This shows that the preliminary figure underestimates the true size of the price change. Because the average size of these total revisions is less than one percentage point it is unlikely that revisions will cause a change in the direction of price movements (for example, the revised index showing positive growth whereas the initial estimate suggested negative growth). We did not test whether the average size of revisions was significantly different from zero.

C.7 We found the same pattern for the lower-level indices: they are consistently revised upwards, although the average size of revisions tends to be small. This suggests that the indices are systematically underestimating price changes. Figure C.1 shows the average size of revisions for our subset of 129 indices.

Figure C.1. Average size of revisions between June 2021 and May 2022 for our subset of 129 indices



Annex D: Detailed methods information

Index Formula

D.1 There is a variety of index formulae available for producing price indices. The IMF's PPI manual says that the Fisher index is widely considered the "best" index formula. However, it is resource intensive and impractical to use as it requires compiling the Paasche index which uses current sales volumes alongside current prices to compile (see below). According to the OECD's PPI database (which is no longer updated), only one OECD member country (Iceland) uses the Fisher Index, while the remaining countries, including the UK, use types of Laspeyres indices such as the Lowe index (Table D.1).

D.2 The Fisher index is defined as the geometric average of the Laspeyres and Paasche Index:

$$I_F^t = \sqrt{I_L^t \times I_P^t}$$

Where I_F^t is the Fisher Index in period t, I_L^t is the Laspeyres Index in period t, and I_P^t is the Paasche index in period t.

D.3 The Laspeyres index is a base weighted index that tracks the price of a fixed "basket of goods" over time. The Laspeyres index defines how much a basket of goods in a base period would cost in other periods:

$$I_L^t = \frac{\sum_{i=1}^{n} p_i^t q_i^0}{\sum_{i=1}^{n} p_i^0 q_i^0} = \sum_{i=1}^{n} \frac{p_i^t}{p_i^0} s_i^0$$

Where p_i^t is the price of item i in period t, q_i^0 is the quantity sold of item i in period 0, and s_i^0 is the index weight of item i in period 0.

D.4 The Paasche index is a current weighted index that tracks the price of a fixed "basket of goods" over time. The Paasche index defines how much a basket of goods in the current period would cost in other periods:

$$I_P^t = \frac{\sum_{i=1}^{n} p_i^t q_i^t}{\sum_{i=1}^{n} p_i^0 q_i^t} = \sum_{i=1}^{n} \frac{p_i^t}{p_i^0} s_i^t$$

Where p_i^t is the price of item i in period t, q_i^t is the quantity sold of item i in period t, and s_i^t is the index weight of item i in period t.

D.5 ONS uses the Laspeyres-Lowe Index which is very similar to the Laspeyres Index and can be described as a modified Laspeyres Index. It is defined as:

$$I_{Lowe}^t = \frac{\sum_{i=1}^{n} p_i^t q_i^b}{\sum_{i=1}^{n} p_i^0 q_i^b} = \sum_{i=1}^{n} \frac{p_i^t}{p_i^0} s_i^b$$

Where I_{Lowe}^t is the Lowe index in period t, p_i^t is the price of item i in period t, q_i^b is the quantity sold of item i in period b, and s_i^b is the index weight of item i in period b.

D.6 The primary difference between the Laspeyres and the Laspeyres-Lowe index is that the base period for the Laspeyres-Lowe index will not necessarily be period 0, i.e. the period that the current period is being compared against. It is very likely that b<0 and will precede period 0. The base weights are price updated to reflect the prices in period 0.

D.7 The Laspeyres-Lowe index is a suitable formula for compiling producer price indices as evidenced by its wide use by the international statistical community. The main limitation of the Laspeyres-Lowe index is that it is vulnerable to substitution bias, which is where consumers shift away from products which increase in price. This means that the revenue weights used to compile the index may not be representative as products are substituted for others and the relative revenues change. The theoretical direction of bias is unclear, but it may affect the reliability of the index. Because ONS updates the weights annually, the effect of substitution bias is minimised.

International comparability

D.8 Table D.1 below highlights the variation across G7 countries in the methods used to compile PPIs. Only some countries annually rebase and chain-link their PPIs. As explained in the main report, explicit quality adjustment is the recommended method for adjusting for the changing quality of products. Only the UK and Italy use implicit quality adjustment to estimate quality changes.

Table D.1 Methods used by G7 Countries to compile PPIs

Country	Index method	Frequency of rebasing	Explicit quality adjustment	Quality adjustment methods
UK	Chained Laspeyres-Lowe	Annually	No	Chaining
Canada	Fixed-base Laspeyres	Every five years	Yes	Expert adjustment and other methods
France	Chained and Fixed base Laspeyres	Annually (headline indices); every five years (lower-level indices)	Yes	Hedonic regression, chaining
Germany	Modified Laspeyres	Every five years	Yes	Chaining, direct price comparison, matched modelling, option prices, expert assessment, hedonic regression
Italy	Chained Laspeyres	Annually	No	Chaining
Japan	Chained Laspeyres	Annually	Yes	Direct comparison, chaining, production cost, hedonic regression, option cost
USA	Modified Laspeyres	Every five years	Yes	Direct comparison, chaining, hedonic regression