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Real-time indicators and nowcasting**Publication and analysis of real-time indicators in the United Kingdom context****Prepared by the Office for National Statistics, United Kingdom¹***Summary*

The Office for National Statistics (ONS) in the United Kingdom (UK) publishes a weekly real-time economic indicator suite, including datasets from government and commercial sources such as real-time spending data from the Bank of England's clearing system, traffic camera counts, flight data, shipping data, job advert indices, and gas prices. In this paper, we discuss challenges and opportunities in understanding and meeting user needs, data acquisition, developing partnerships with suppliers, and rotating our suite of indicators for high-pressure production. We also highlight how we use real-time data in the quality assurance of the UK National Accounts.

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I. Introduction

1. The quest for faster and more accurate economic indicators has long been a pursuit of policymakers and economic researchers.
2. In 2019, the ONS Data Science Campus took on this challenge through the ‘Faster Indicators of UK Economic Activity’ project. The project had ambitious aims, which were to identify close-to-real-time big data and administrative datasets that represented useful economic concepts, create a set of indicators that allowed early identification of significant economic changes, and provide insight into economic activity at a level of timeliness and granularity not possible with official economic statistics.
3. To achieve these objectives, the project explored three data sources: 1) HM Revenue and Customs (HMRC) Value Added Tax (VAT) returns, 2) ship tracking data from automated identification systems (AIS), and 3) road traffic sensor data for England. The research findings revealed that VAT returns could provide a useful early indication of the direction of the economy, ship tracking data gave an early indication of trade, and road traffic sensor data provided insights into any logistics issues around the major ports of the UK. The ONS released these data on a regular basis throughout 2019, with VAT, road sensor and ship tracking data released monthly.
4. However, the onset of the COVID-19 pandemic in 2020 created an urgent need for more timely data to monitor the effects of the pandemic across a much wider range of activity in the economy and society. To meet this need, the ONS created a new fortnightly business survey called the Business Impact of Coronavirus Survey (BICS), and the existing Opinions and Lifestyle survey (OPN) shifted from monthly to weekly data collection. The results from these surveys were published as specific releases, and the headlines from each were included in the Faster Indicators release to bring related and real-time information together.
5. Over the next three years, the real-time project has continued to evolve and adapt to respond to other challenges being experienced in society and the economy. For example, there was a policy focus on the supply chain of products and goods to businesses and the cost-of-living crisis. The fortnightly BICS was adapted to encompass wider issues facing companies, and its name was changed to the Business Impacts and Conditions Survey² (currently at Wave 78 as of March 2023).
6. Today, there is a large suite of real-time indicators, covering various areas such as business insights and workforce, consumer behaviour, transport, and energy. These indicators rotate in and out of publication according to policy need. In 2022, the name of the release was changed to Real-time Indicators to align with international terminology.

II. Meeting user needs

A. Introduction

7. Real-time information can be incredibly useful for policy makers in assessing the current state of the economy and making informed decisions.
8. In the UK, the Bank of England is one such policy user that relies on real-time data to monitor the economy and make decisions on monetary policy. Other policy users may include government departments responsible for economic policy and forecasting, as well as private sector firms that need to make strategic decisions based on economic trends.
9. Acquiring real-time data can be a complex process that involves working in partnership with data suppliers. In some cases, this may involve developing new data collection methods or tools that can provide real-time information. It may also involve negotiating with data suppliers to gain access to their data in real-time. To ensure that the

²

<https://www.ons.gov.uk/businessindustryandtrade/business/businessservices/bulletins/businessinsightsandimpactontheukeconomy/latest>

data is accurate and reliable, it is important to work closely with data suppliers to establish clear data quality standards and to regularly monitor the data for any anomalies or errors.

10. Opportunities to work with data suppliers and develop real-time indicators can arise quickly, but it can be more difficult to establish partnerships with different data sources. For example, some data sources may be more difficult to work with due to legal or regulatory constraints, or because of concerns around data privacy and security. Nonetheless, it is important to remain vigilant and to explore all possible partnerships in order to develop the most comprehensive real-time indicators possible.

11. One of the key benefits of working across public and private companies is that it can lead to more comprehensive and accurate real-time indicators. Public sector organisations, such as government departments, often have access to data that is not available to private sector firms, such as data on tax receipts or public spending. Conversely, private sector firms may have access to proprietary data that can provide unique insights into economic activity. By working together and sharing data, both public and private sector organizations can develop a more complete picture of the economy, which can be useful for policy makers and private sector decision-makers alike.

B. Case study 1: Example of how we worked in partnership with the Bank of England

12. The Bank of England (BoE) monitors daily CHAPS (Clearing House Automated Payments System) payments made by credit and debit card payment processors to approximately 100 major UK retail corporations. This dataset is considered a reliable indicator of consumer spending in supermarkets and large stores, especially during the pandemic when cash transactions decreased, and card payments became more prevalent. To ensure accurate and appropriate use of the data, ONS collaborated with BoE to establish protocols for data delivery. Aggregated data, rather than unit level data, were provided to ONS, and BoE reviewed and approved the final commentary and wording used in the ONS release. BoE also supplied a comprehensive background document³ on the methodology to help users understand the strengths and limitations of the data.

13. The CHAPS data are now published weekly and include daily indices by five spending categories: aggregate, delayable, social, staple, and work-related. These indices are indexed to February 2020 as a pre-pandemic baseline and presented as a seven-day rolling average to smooth out volatility around weekends. Additionally, a monthly indicator is produced and used to track the official monthly ONS Retail Sales Index. However, it is important to note that the data has limitations, such as the lack of seasonal adjustment and the impact of inflation, which is not removed from current prices. These limitations can result in a large increase in spending at the end of each month and around bank holidays. As the indicators continue to develop, efforts will be made to address these limitations, such as adding elements of seasonal adjustment and deflation where possible.

C. Case study 2: Example of how we worked in partnership with private providers

14. In 2020, the COVID-19 pandemic resulted in significant restrictions on travel, particularly international air travel. As a result, there was a need to monitor flights entering and leaving the UK for statistical purposes, both during and after the implementation of restrictions. To this end, ONS identified a freely available source of daily flight figures from EUROCONTROL, a pan-European, civil-military organization that supports European aviation. EUROCONTROL's Aviation Intelligence and Performance Review Unit provides independent collection and validation of air navigation services performance-related data and intelligence gathering. ONS collaborated with EUROCONTROL to republish daily flight numbers for the UK, alongside other countries, from their dashboard, with added

³ <https://www.bankofengland.co.uk/payment-and-settlement/chaps-faster-indicator>

commentary and comparisons to pre-pandemic levels to ensure the data was relevant to UK users.

15. However, the flights data from EUROCONTROL have some limitations. They include international arrivals and departures to and from the UK (including crown dependencies) and domestic UK flights but exclude overflights (flights that pass over UK territory). Additionally, the dataset captures all flight movements that operate under Instrument Flight Rules (IFR), including commercial flights carrying passengers and cargo, as well as non-commercial flights such as private and military flights. Finally, the data from EUROCONTROL do not include information on the volume of passengers or cargo carried on UK flights, which is important to understand, especially in the context of the pandemic, where flights might not be operating at full capacity or could be empty.

16. To address these issues, ONS decided to also publish data on air passenger numbers at Heathrow airport from the Civil Aviation Authority (CAA) monthly bulletin⁴. The CAA is the statutory corporation responsible for overseeing and regulating all aspects of civil aviation in the UK. Most UK airports⁵ report the number of passengers arriving and departing to the CAA, but ONS focused on Heathrow data as it is routinely available earlier in the collection cycle than the full dataset of all airports and represents almost a third of all UK air passengers. This indicator includes only passengers on commercial airlines on passenger-only or combined passenger and cargo flights.

17. By using these two datasets, ONS has been able to build a comprehensive picture of the airline industry in the UK, tracking changes in flights and passenger numbers over time.

III. Current status of our suite of real-time indicators

18. As we have moved into the post-COVID-19 world, the weekly publication has adapted to provide insights into emerging economic and social trends within the UK. This has resulted in the continued expansion to the published suite of indicators, but also the continuous review of our users' needs in terms of each indicators frequency of publication.

19. Our suite of real-time indicators is actively monitored to ensure continued relevance to users. Table 1 shows the full list of real-time indicators we have available. These are published according to different scheduling, reflecting the frequency of the indicator and the demand.

20. Our indicators are grouped into 4 key themes: 1) Business insights and workforce; 2) Transport; 3) Consumer behaviour; 4) and Housing and Energy.

⁴ <https://www.caa.co.uk/>

⁵ <https://www.caa.co.uk/data-and-analysis/uk-aviation-market/airports/uk-airport-data/>

Table 1
Summary of the UK real-time indicators grouped by four main themes

Indicator	Source	Frequency	Description
<i>Business insights and workforce</i>			
Online job adverts	Adzuna	Weekly	Experimental online job advert indices covering the UK job market, using a snapshot of data from job advert aggregating website Adzuna
Redundancies	Insolvency services	Weekly	Advanced notification of potential redundancies from HR1 forms submitted by employers to the Insolvency Service's Redundancy Payments Service
Company incorporations, voluntary dissolutions, and compulsory dissolutions	Companies House	Weekly	Data for company incorporations, voluntary dissolutions, and compulsory dissolution first gazettes in the UK
Data on sales and jobs in small businesses	Xero	Monthly	This is used to provide data on both sales and jobs in these small businesses. Sales are measured based on the face value of invoices issued by firms within each month (including via apps attached to the Xero account). Jobs are measured by the number of unique employees of a business who are issued a payslip in a month.
VAT new businesses and business turnover	HMRC	Monthly	Value Added Tax (VAT) diffusion indexes and new VAT reporters. Diffusion indices show changes in business turnover (total value of all sales and other outputs excluding VAT) and expenditure (total value of purchases and all other inputs excluding VAT) for both quarter-on-quarter and month-on-month.
Online job adverts	Adzuna	Weekly	Experimental online job advert indices covering the UK job market, using a snapshot of data from job advert aggregating website Adzuna
<i>Transport</i>			
UK flights	EUROCONTROL	Weekly	Daily flights data comprising international arrivals and departures to and from the UK (including Crown dependencies) and domestic UK flights, but excluding overflights (flights that pass over UK territory)
Traffic camera activity	Regional LG bodies	Weekly	Daily traffic camera counts data for mobility indices covering the UK developed by ONS Data Science Campus (DSC)
Shipping visits	exactEarth	Weekly	Weekly and daily shipping data using the UN Global Platform and developed by DSC
Flights passenger number	Civil Aviation Authority (CAA)	Monthly	Air passenger numbers from Heathrow, only passengers on commercial airlines (on passenger only or combined passenger and cargo flights) are included in this indicator
Road traffic in Great Britain	Department for Transport	Monthly	The data is based on around 275 automatic traffic count sites across Great Britain. The samples of automatic traffic counters are stratified by area, road classification, and road management and have been designed to be representative of national traffic

Indicator	Source	Frequency	Description
<i>Consumer behaviour</i>			
CHAPS spending on credit and debit cards	Bank of England	Weekly / Monthly	Weekly and monthly CHAPS payments made by credit and debit card payment processors to around 100 major UK retail corporates
Revolut card spending	Revolut	Weekly	Card spend data from Revolut, a financial technology company with around 4.8 million users in the UK
Demand for fuel per transaction	VISA/BEIS	Weekly	Estimated quantity of automotive fuel demand per average transaction used to isolate real demand after adjusting for growth in fuel prices. This indicator captures how consumer demand for fuel changes in response to rising fuel prices per visit at pumps over time.
Retail footfall	Springboard	Weekly	Daily indices include footfall within three main types of retail destination – high streets, shopping centres and retail parks
Weekly transactional data for Pret A Manger	Pret A Manger	Weekly	Weekly transactional data, comparing weekly in-store transactions against the average level of the first four weeks of 2020. Used to give early indications of UK mobility and commuting trends.
<i>Housing and energy</i>			
Energy Performance Certificate lodgements	MHCLG	Weekly	Data for new and existing dwellings in England and Wales, used to give early insights into the UK housing market.
System Average Price of gas	National Grid	Weekly	Daily and weekly changes in gas prices, using the system average price (SAP)
System Price of electricity	Elexon	Weekly	Daily average of the half-hourly system prices and averaged again over the preceding seven days to bring out the trends and smooth volatility.

IV. Weekly production approach

A. Introduction

21. Producing weekly real-time statistics comes with the challenge of working to tight deadlines. The team receives data throughout Monday and Tuesday each week, which is then processed and formatted to allow for the publication of datasets and analysis by 9:30am each Thursday. Table 2 provides a high-level overview of the weekly schedule.

Table 2
High level summary of the weekly production schedule

	Monday	Tuesday	Wednesday	Thursday	Friday
AM	Selection and confirmation of the indicators for this week.	Processing the chosen indicators through statistical pipelines; and quality assurance of indicators	Internal Stakeholders feedback on draft reviewed and addressed. Additional checks with data suppliers to ensure they are happy with content. Quality assurance. Submit to internal Publishing Team	Bulletin published at 9:30am. Review live publication and answer any media and user queries.	Team administration day
PM	Processing the chosen indicators through statistical pipelines; and quality assurance of indicators	Send written sections to data suppliers and stakeholders. Prepare data for charts and dashboards. Draft circulated to internal stakeholders for comment and feedback.	Further changes and quality assurance are made via our preview site. Final proofread made by the team and senior sign-off.	Weekly wash-up and review with entire team	Team administration day

22. Each indicator listed in Table 1 is assigned to a member of the production team who takes the lead on receiving the data, processing it through the pipeline, and creating or updating any accompanying outputs. The data is received by ONS through secure email or open-source platforms provided by the supplier. Most indicators can be processed through internally developed automated scripts such as Python or R, which will be further explained in section 3.1.

23. After the data processing is completed, another team member is assigned to quality assure all elements of the indicator and provide feedback. Once both team members are satisfied with the accuracy and quality of the outputs, it is reviewed and signed off by the head of the team. Some indicators are sent out to the data supplier for comments and feedback prior to Thursday's release.

24. At the close of play each Tuesday, the draft publication is shared internally with key stakeholders to allow for feedback, which is then incorporated by lunchtime on Wednesday. Wednesday morning is utilized for another round of quality assurance on all outputs, which are proofread internally by ONS's publication team. Final quality assurance checks are completed Wednesday afternoon, and the publication and its outputs are reviewed by the nominated senior sign-off officer, who approves the release for publication.

25. Overall, the production team consists of 11 full-time equivalent (FTE) staff members, including five staff members (FTE) who facilitate the weekly round and a development team of four people (FTE). An additional staff member works between the two teams to enable the branch to respond to emerging challenges and shifting priorities. Both teams are overseen by a head of the branch to ensure smooth running of the entire Real-time indicators team. The development team has been instrumental in creating and improving automated data processing systems, which allows for large quantities of outputs to be produced quickly and accurately. Without these developments, ONS would not be able to continue expanding its suite of real-time indicators without an unsustainable investment of resources.

26. The real-time indicators team has a diverse set of skills and experiences, ranging from data scientists, statistical officers, to economists. The team also includes economic apprentices who learn on the job with ONS while completing their degree in tandem. The team serves as a hub within ONS for innovative methods and practices, utilizing skills such as R and Python coding, Power BI, time series analysis, and stakeholder management.

B. Automation and data assurance

27. To ensure the sustainability and accuracy of the real-time indicators outputs, the team aimed to automate statistical data processing pipelines wherever possible.

28. The primary approach to achieving this goal was to move data processing away from Microsoft Excel and towards a programming language like Python and/or R. To follow best practices, the team strived to meet as many criteria as possible within the principles of Reproducible Analytical Pipelines (RAP), as defined in the “Quality Assurance of Code for Analysis and Research document”⁶ published by the UK Government Analysis Function.

29. Before sharing any code with the production team, it undergoes a peer review process, and the outputs are quality assured, providing multiple data scientists with the opportunity to provide feedback on the code. Another benefit of using a programming language in the fast-paced production round is the significant time saved when processing data. For example, replacing Excel with Python for one of the more intensive indicators reduced data processing time from approximately 3 hours each week to approximately 10 minutes.

30. These time-saving measures have two main benefits. Firstly, time previously spent manually processing the data can now be spent on analysis, resulting in more in-depth written sections included in the publication. Secondly, it enables the suite of indicators to expand. These two benefits combine to create a publication that contains more detailed written analysis on a broader range of topics, making it a more valuable tool for both policy makers and the enquiring citizen.

31. The team recently introduced the Power BI tool to visualize the data. Each indicator has its own Power BI 'report', which allows analysts to examine that data source in depth. Power BI 'dashboards' are also utilized, bringing together data for each of the publication's themes and providing an additional method of quality assurance. Figure 1 provides an example of the Power BI dashboard, which is currently an internal tool to ensure quality assurance.

Figure 1
Example of the Power BI Dashboard for quality assurance



⁶ <https://analysisfunction.civilservice.gov.uk/policy-store/quality-assurance-of-code-for-analysis-and-research/>

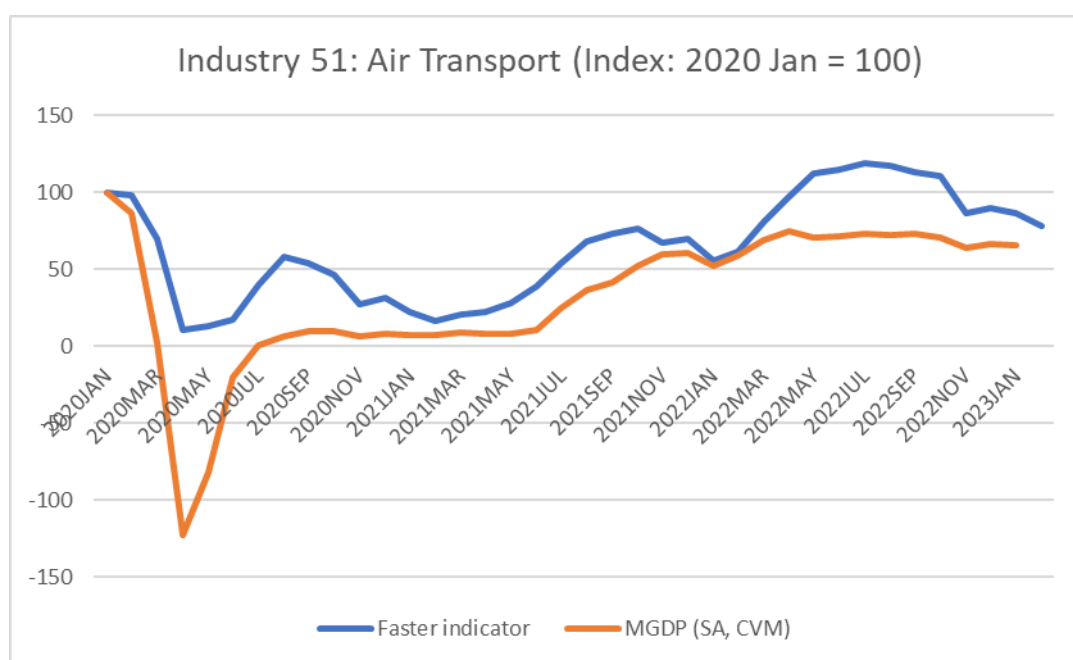
32. Combining reproducible analytical pipelines and Power BI has also enabled the team to partially automate the quality assurance process. In both systems, console messages (or in some cases html files) are generated, which inform the analysts whether the checks have passed or failed, and in the case of failure, the likely cause and who is best to be contacted for the issue to be resolved.

V. Embedding real-time indicators into National Accounts quality assurance and production

33. As well as being used by a wide range of policy and decision makers, academics and the public, real-time indicators have a role to play within the ONS as well. For instance, when compiling monthly GDP (Gross Domestic Product) for the UK⁷ the ONS will look at the real-time indicators within any given industrial sector as evidence for any movements we are seeing in the aggregated UK monthly GDP data. For example, if we are looking at the restaurant sector we will compare the movements we are seeing in monthly GDP with the Operable restaurant reservation dataset, the comparison of air transport, and for elements of retail spending we will look at the spending categories within the various consumer spending indicators we have on a real-time basis including CHAPS and Revolut.

Figure 2

Monthly GDP estimates for air transport are quality assured using real-time indicators for the industry



34. This innovation has progressed to such a degree that we now publish within the weekly real-time indicators release a chart showing how the fortnightly BICS data on business turnover (compiled into a standardised balance estimate) compares with an equivalent aggregation of monthly GDP (excluding those sectors which BICS does not sample such as the government dominated industries of health and education, denoted by GDP*). We do the same with the CHAPS monthly data and the Retail Sales Inquiry datasets as well, and the correlation has proved to be reliable.

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<https://www.ons.gov.uk/economy/grossdomesticproductgdp/bulletins/gdpmonthlyestimateuk/january2023>

Figure 3a
The Business Insights and Conditions Survey (BICS) standardised turnover balance estimate and monthly GDP* estimates follow similar trends, full span June 2020 until February 2023. Note change in question in February 2022

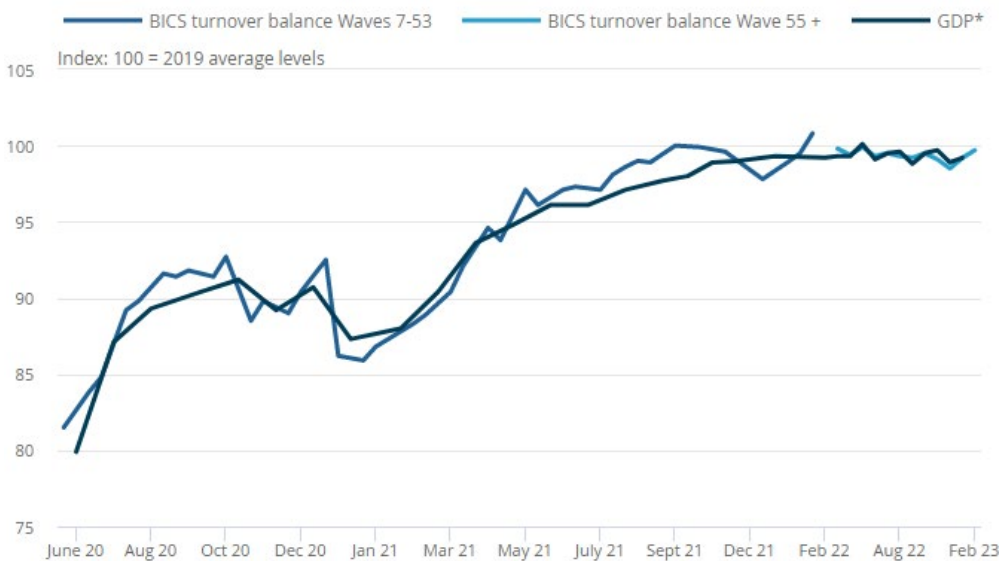


Figure 3b
Zoomed in: the Business Insights and Conditions Survey (BICS) standardised turnover balance estimate and monthly GDP* estimates follow similar trends, February 2022 until February 2023 (after change in question)

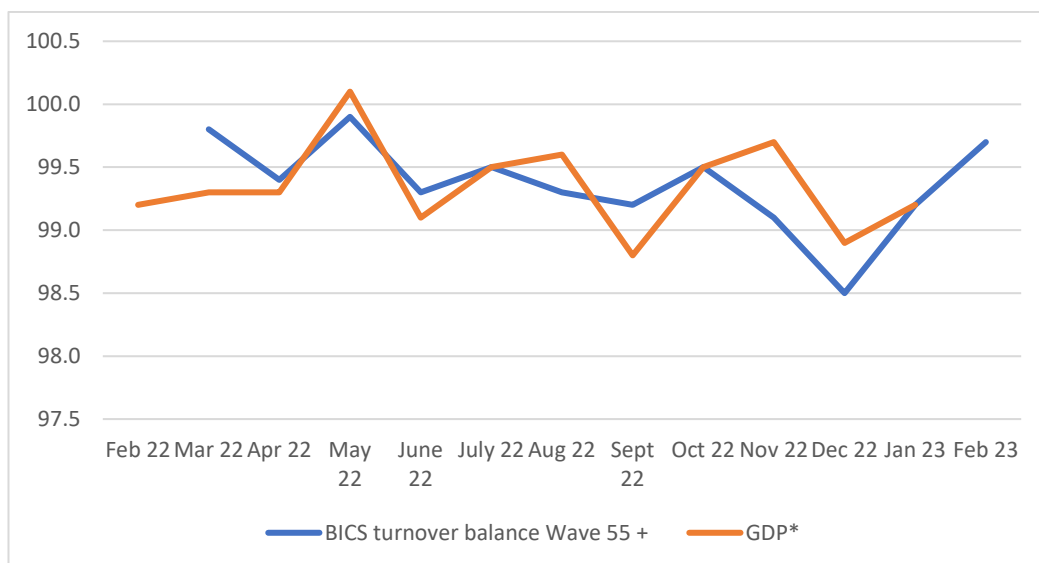
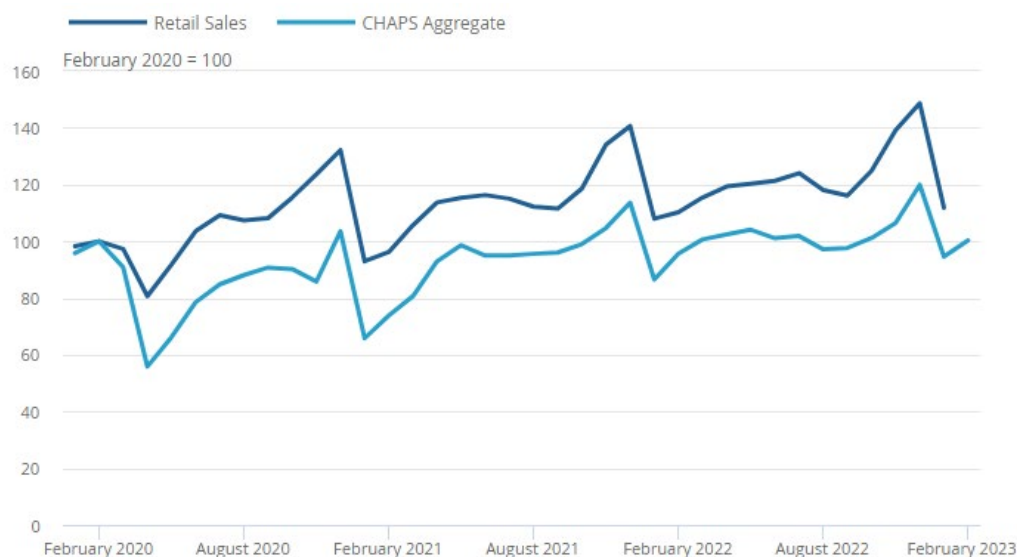


Figure 4

Retail sales data follow a similar trend to the CHAPS index of aggregate credit and debit card spending

Indices: February 2020 = 100, monthly average, non-seasonally adjusted, nominal prices and retail sales values, January 2020 to February 2023



35. All of this leads ONS to believe that there is a role for real-time indicators to enhance or supplement the data collection of ONS indicators, providing we are aware of the limitations of the real-time indicators which can be in their collection methods, their coverage, or their compilation methods.

VI. Further developments

36. ONS is committed to further improvements of our current suite of real-time indicators. One area which is of particular importance is the application of seasonal adjustment to our high-frequency indicators and we are now reaching a point whereby there exists a long enough back series to start undertaking this process.

37. There are also internal projects underway within ONS to provide additional enhancements for our current indicators, both as a result of user feedback and also methodological reviews into the collection and processing to ensure our outputs are as robust as they can be.

38. Separate research is ongoing on how best to apply nowcasting techniques in the context of economic indicators, including the creation of composite indicators which can bring together strength of signal from related indicators.

39. In tandem with continuing to improve current suite of real-time indicators, we are also expanding to add new data sources to our release in response to emerging economic and social challenges within the UK. Table 3 gives a brief overview of possible future indicators.

Table 3
Development work plan for real-time indicators

Scope item	Category
Onboarding of anonymised utility bill data, with the objective of publishing aggregated data on gas and electricity usage and analysis to assess cost of living.	New indicator
More granular geographical data (e.g., for online job adverts and other labour market indicators)	New indicator
Monthly regional renter affordability	New indicator
Enhancing indicators for shipping to use cargo manifests and the port of origin	New indicator
Aggregated insights from anonymised telecoms data	New indicator
Standalone interactive data dashboard	Bulletin improvement
Increased regularity of dataset publication (datasets to be published throughout the week when they are available, rather than being tied to a set weekly bulletin)	Bulletin improvement
Application of seasonal adjustment for high frequency series	Bulletin improvement

Appendix

40. Office for National Statistics, “Economic activity and social change in the UK, real-time indicators” landing page. Link:

<https://www.ons.gov.uk/economy/economicoutputandproductivity/output/bulletins/economicactivityandsocialchangeintheukrealtimeindicators/latest>

41. Office for National Statistics, “Economic activity and social change in the UK, real-time indicators methodology”. Link:

<https://www.ons.gov.uk/economy/economicoutputandproductivity/output/methodologies/coronavirusandthelatestindicatorsfortheukeconomyandsocietymethodology>
