Higher-frequency economic monitoring

Talk at the student seminar to mark the awarding of the Heinrich Hertz Guest Professorship

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1 Introduction

Mr Grießhaber,

Many thanks for your warm welcome and words of introduction. I am very pleased to be leading the student seminar on the day the Heinrich Hertz Guest Professorship is awarded – and at a university where I spent more than a decade in total.

Ladies and gentlemen, dear students,

My talk today will focus on frequencies. The term frequency and the name “Hertz” are closely linked: in physics and technology, frequencies are measured in hertz. The alternating current coming from the plug sockets in our homes has a frequency of 50 hertz, while the processors in modern computers operate at a clock frequency of several gigahertz.

In the economy, too, we work with different frequencies, although they are not measured in hertz. As macroeconomists, we can't conduct experiments like physicists do, let alone generate periodic processes at a predefined frequency. Moreover, economic processes are highly complex and usually unfold over an extended period of time, with a great number of different oscillations often overlapping.

And last but not least, when economists talk about frequencies, they are often referring not to the oscillation length of the economic processes themselves but to the length of time between the data points in statistical time series. For instance, there are economic time series in which a new data point is added only once a year – capital stock being a good example. In other time series, new data become available once a quarter or once a month. The best-known example of quarterly statistics is gross domestic product, or GDP (Gross Domestic Product). Information on industrial output, for instance, is available on a monthly basis.

Accordingly, we refer to such time series as annual, quarterly or monthly data. These are also the three frequencies that we usually work with when looking at macroeconomic relationships. Data with macroeconomic relevance that are available even more frequently are known as high-frequency data. Although the range of data available at such weekly or daily intervals is still comparatively limited, digitalisation means that it is continuously expanding.

High-frequency data are especially important when we need a particularly timely insight into economic activity. And in this talk, I would like to discuss how the Bundesbank uses such high-frequency data in its economic monitoring. However, I would first like to put their specific applications and the methods these require into a broader context and describe the high complexity of macroeconomic data.

I will briefly outline the history of what is probably the most important metric in modern economic analysis: GDP (Gross Domestic Product). I will also explain the special factors and difficulties encountered by statistical offices when calculating GDP (Gross Domestic Product), as well as the impact of the pandemic on the use of high-frequency data. I will then say a few words about price measurement and inflation analysis, as this area of vital importance for us as central bankers is also increasingly benefiting from the availability of high-frequency data.

2 High-frequency data in the financial sector

Before we immerse ourselves in the world of macroeconomic statistics, though, I suggest we take a quick detour into the realm of financial data. Here we can find a veritable wealth of high-frequency data. For some time now, it has been the financial sector that immediately springs to mind when economists hear the term "high-frequency data".

The financial sector probably continues to afford economists the best data collection opportunities today as well. Thanks to digitalisation, even the retrieval of asset prices, interest rates and exchange rates accurate to the second poses no problem. The collection of time series data reached its technical limit here a few decades ago, as it was reliant upon what are known as tick data. The term "tick data" refers to the recording of all price movements made by an asset on one trading day. The intervals between individual points of these data are irregular, which presents a particular challenge when it comes to analysis.

The availability of high-frequency data has opened up great possibilities for estimating volatilities. Tick data in particular allow for an almost constant monitoring of price processes and thus also grant deep insights into the structure of time-varying volatility.

High-frequency financial data can also be used in event-based studies. One such study was recently conducted by researchers at the Bundesbank and the Goethe University Frankfurt.[1] The aim of the study was to determine how significant a role unanticipated news items play in the movements of financial market prices. To this end, the researchers compiled an extensive event database with exact time data. In addition to scheduled macroeconomic data releases, announcements by central banks and bond auctions, the database also included news such as election results, rating downgrades, wars and natural disasters.

The database was then compared against financial market data at fifteen-minute intervals. An example of this can be found in the chart just shown.
Here we can see how yields on ten-year German government bonds changed on 7 October 2011 – the black line. Comparing the event database against yields shows that the largest market movements were, in this case, presumably attributable to publication of the US (United States) labour market report as well as Fitch downgrading the credit ratings of Italy and Spain. The study concludes that macroeconomic news can explain about one-half of all high-frequency financial market movements.

Overall, the study also illustrates one key benefit of high-frequency data: higher frequency not only means information that is more up-to-date, but also the opportunity to identify causal relationships. This is because factors that are not relevant can be hidden when selecting very narrow time windows.

3 Complexity of macroeconomic data

Now, though, let's turn our attention to the world of macroeconomic statistics. Here, digitalisation has only had a slight impact on the frequency of the data collected. In the 1930s, British economist Colin Clark and US (United States) economist Simon Kuznets laid the foundations for the modern concept of gross domestic product.[2] Nowadays, gross domestic product is probably the most important metric in economic monitoring around the globe.

GDP (Gross Domestic Product) measures the value of goods and services produced domestically over a given period, provided that they are not included as intermediate inputs in the production of other goods and services.[3] In order to avoid double-counting, intermediate inputs must be deducted from output. Take, for example, a miller selling flour to a pizza chef. So that the value of the flour is not counted twice, it must be deducted from the value of the pizza.

This is a production side definition. However, many people are more familiar with the expenditure-based approach. It tells us how the goods and services that are produced are used. This definition is as follows: private consumption plus government consumption plus investment plus exports and minus imports.

From the outset, statistical authorities primarily calculated gross domestic product at an annual frequency.[4] The fact that the GDP (Gross Domestic Product) result is based on a large number of basic annual statistics has not changed over the last few decades, although the wait for data on a certain time period, such as the quarter or year that has just ended, is now not as long.

At this point, you might be asking yourself, "What is he talking about? There are also quarterly GDP (Gross Domestic Product) growth rates that regularly appear in the news." Real quarterly gross domestic product and its sub-aggregates are, without doubt, indispensable tools for economic research and forecasting. However, it is not the case that the Federal Statistical Office calculates the quarterly figures and adds them up to the annual figures. With a few exceptions, the opposite occurs.

What the Federal Statistical Office essentially does is interpolate and extrapolate the annual data using higher-frequency (usually monthly) indicators. Of course, this is not a formal mathematical procedure used to interpolate individual annual time series. The quarterly figures must not only match higher-frequency indicators, they also have to correspond to each other in the national accounts – or, as the statisticians say, be consistent. Extensive expert knowledge is therefore incorporated into the calculations in the quarterly national accounts.

Why does the Federal Statistical Office need to use higher-frequency indicators to arrive at quarterly figures based on the annual national accounts data? Well, this is because many data sources are only available on an annual basis and with a considerable time lag.[5] However, quarterly figures cannot be derived from annual data alone. Moreover, the coordination of a macroeconomic accounting system is a very complex multi-stage process. For instance, the current classification of economic sectors divides the economy into 615 economic classes.[6] The use of monthly indicators is therefore indispensable if, as is the case for the Bundesbank, the national accounts are to be used for economic analysis.

However, even the official publication of quarterly real gross domestic product is often not timely enough for the purposes of ongoing economic monitoring. The first quarterly GDP (Gross Domestic Product) release in Germany is referred to as a "flash estimate". It is published one month after the end of the reporting period. We are currently in the fourth quarter. This means that the flash estimate for the third quarter will be published on 31 October. Until then, we have no official information regarding the development of real gross domestic product in the elapsed third quarter.

In addition, this first publication is provisional, as the name "flash estimate" suggests. At the point of its publication, the monthly indicators needed to calculate quarterly GDP (Gross Domestic Product) are not all available in full. Industrial output, for example, is a very important indicator in this respect. It is published on a monthly basis, five weeks after the end of each reporting month. Of course, five weeks is more than one month. In other words, the calculation of the GDP (Gross Domestic Product) flash estimate only factors in industrial output for the first two months of a quarter. The last month is still missing.

Just under two months after the end of the reporting quarter, the second GDP (Gross Domestic Product) release is published. This incorporates all the information from the relevant monthly indicators, which may also lead to revisions to the previously published GDP (Gross Domestic Product) figure. This second publication also includes quantitative data on the sub-components of real GDP (Gross Domestic Product), such as private consumption and investment.

If, however, we cannot wait the one or just under two months for official GDP (Gross Domestic Product) releases and we need a current economic picture of the third quarter as early as today, 5 October, we find ourselves once again relying on indicators. However, not all monthly indicators covering the third quarter are available today. For instance, industrial output for August will not be published until next Monday. In other words, as far as industry is concerned, we are missing two months of the most recent third quarter.

Are there any other monthly indicators that are more readily available? Yes; retail sales, for one, have been around since last Friday. But these also only contain data up to August. Do we have monthly indicators that could help us assess developments in September? The only sources available for this purpose are surveys. For example, the ifo (Information und Forschung) Institute published the ifo (Information und Forschung) business climate index for September on 25 September. However, the survey data provide primarily qualitative information on the current economic situation. All in all, this shows us that we do not have any quantitative information on a monthly basis at this point in time to assess the economic situation in September.

We must therefore look for cyclical data with a higher than monthly frequency, such as weekly and daily data. However, up until a few years ago, short-term business statistics were largely designed to provide quarterly and monthly data. This was also true of our methods for processing these data.

4 High-frequency data and the pandemic

This all changed when the coronavirus pandemic hit. The pandemic caused great suffering worldwide on the personal level. At the same time, it triggered an economic slump of historic proportions. The pandemic also posed dramatic challenges to economic monitoring.[7]

The first coronavirus lockdown in Germany was introduced on 22 March 2020. Public life largely came to a standstill. It quickly became very clear that the economic impact of the pandemic would be severe. This was because the containment measures greatly restricted economic activity. What is more, these measures had been taken simultaneously in almost every country in the world. The impact on global trade was also massive. But to what extent would economic output fall? This question had to be answered at great haste, but was by no means trivial. After all, we had no experience of such a shock at that time.

Official statistics did not provide any information on the situation back then either. At that point – the end of March and beginning of April – we had nothing more than the figures for February. And in February, the pandemic had barely affected economic life in Germany. Although some survey data for March 2020 were available relatively quickly, such as the ifo (Information und Forschung) business climate index, most of the responses had already been received in the first half of March. These surveys therefore painted an overly optimistic picture.

Moreover, the lockdown had an impact on the output of official statistics itself. This was due, in particular, to the fact that it was more difficult for many enterprises, authorities and individuals to continue transmitting their data under pandemic conditions.[8] Data collected by the Bundesbank were also affected. For example, our household wealth survey had to be postponed as it became impossible to conduct it in 2020.[9]

We therefore had to take action in order to swiftly gauge the situation at hand. Our two-pronged approach consisted of tapping into new data sources and preparing the data quickly. For the former, the Bundesbank itself commissioned monthly online surveys of households and enterprises on their expectations and assessments.[10] For the latter, we tried to capture, analyse and exploit as many sources of high-frequency data as possible. Our experts thus joined forces and have achieved impressive results.

Our economists were soon able to use new, weekly and daily high-frequency time series to assess the situation almost in real time. Certainly, because of digitalisation, these data were potentially also available before the pandemic. But the pandemic had accelerated their development.[11]

There were still challenges to overcome, such as adjusting the daily and weekly data for seasonal and calendar effects. This is because daily data in particular can reveal complex periodic patterns. Let us take daily data on electricity consumption as an example. Here we have an overlap of two patterns. The first occurs over the course of the year: in the summer, electricity consumption in Germany is lower than in the winter. The second occurs over the course of the week, as much more electricity is normally used on working days than on weekends and public holidays. However, the usual methods of seasonal and calendar adjustment were developed primarily for quarterly and monthly data. Therefore, our experts had to quickly make some experimental adjustments to these methods in order to be able to prepare high-frequency time series, too.[12]

5 High-frequency data in economic analysis

Now that we have collected the relevant high-frequency data and made adjustments for seasonal and calendar effects, how do we then use them for economic analysis? We can, of course, look at each individual time series and try to answer specific questions in order to obtain a current picture of the economic outlook. Is output going down? Why could this be happening? Or, for example, did the low water levels on the Rhine affect the supply of electricity?

However, if we simply look at the data, it is not possible for us to know how each time series should be weighted. For instance, if two different time series indicate two opposing trends, which effect will prevail? This is why we want a method that will help us to consolidate information from a variety of high-frequency time series. We could then use this information for quantitative assessments of economic activity, too.

For the Bundesbank, the weekly activity index – or WAI (Wöchentlicher Aktivitätsindex), for short – is an important basis for using high-frequency data in economic analysis.[13] How is this index calculated? To do so, we use multiple high-frequency time series that are recorded on a weekly basis from a number of different areas: electricity consumption in Germany, the truck toll mileage index, the number of flights worldwide, air pollution as measured by the concentration of nitrogen dioxide in the air, credit card payments, pedestrian frequency on selected city shopping streets, and the relative Google search frequencies for the terms “unemployment”, “short-time work”, and “state support”. Two additional variables are also included: quarterly real gross domestic product and monthly industrial output, provided that the data are available.

Now we need to estimate a common driver for all of these variables. In order to do this, the data are first transformed into comparable growth rates. However, as the weekly indicators are available more frequently than the figures for quarterly GDP (Gross Domestic Product) and monthly industrial output, we have gaps in our dataset. We fill in these missing observations using the expectation maximisation algorithm.[14] We can now calculate the index with the help of a principal component analysis. I hope you are all still with me!

Ultimately, the weekly activity index represents the common weekly factor of the mixed-frequency dataset. Due to the way it is constructed, the WAI (Wöchentlicher Aktivitätsindex) has a mean value of zero. The WAI (Wöchentlicher Aktivitätsindex) provides the trend-adjusted growth rate of economic activity over the past 13-week average compared with the average of the preceding 13 weeks. Once it has covered a full quarter, we can thus interpret the WAI (Wöchentlicher Aktivitätsindex) as a quarterly trend-adjusted growth rate of economic activity. This is the case either at the end or shortly after the end of a quarter. Positive values for the WAI (Wöchentlicher Aktivitätsindex) can be interpreted as above-average economic growth, while negative values can be seen as below-average growth.

Furthermore, we can also derive an implicit rate of GDP (Gross Domestic Product) growth from the principal component analysis. Specifically, our experts found a high correlation between GDP (Gross Domestic Product) and the WAI (Wöchentlicher Aktivitätsindex) at the ends of quarters. This is another major benefit of the WAI (Wöchentlicher Aktivitätsindex), alongside the possibility of obtaining up-to-date assessments of the economic situation, of course.

During the COVID (Coronavirus Disease)-19 pandemic, when timely assessments were particularly important, the WAI (Wöchentlicher Aktivitätsindex) proved to be an indispensable tool for economic monitoring. The Bundesbank publishes the values of the WAI (Wöchentlicher Aktivitätsindex) on its website. The index was updated most recently at the beginning of this week. The value of the WAI (Wöchentlicher Aktivitätsindex) was zero. This would mean that economic activity is currently growing at an average pace. At the same time, this was also the first update since the end of the third quarter. Therefore, it can be interpreted as the quarterly growth rate of GDP (Gross Domestic Product). Based on the implied GDP (Gross Domestic Product) rate, we can see that real GDP (Gross Domestic Product) rose by an estimated 0.3% in the third quarter.

Taking all available information into account, however, the Bundesbank's experts estimate that economic activity is actually likely to have declined in the third quarter. This shows that, like most empirical methods, the WAI (Wöchentlicher Aktivitätsindex) also has its weaknesses. One of its drawbacks is that the index is not based on any explicit model assumptions. Another disadvantage is that it cannot be interpreted clearly within a single quarter. As an example, if the WAI (Wöchentlicher Aktivitätsindex) suggests growth of 2% over one week in the middle of a quarter, this does not mean that economic activity actually rose by 2% in that week. Perhaps there are other methods that do not have these disadvantages?

As I mentioned earlier, the Federal Statistical Office calculates gross domestic product primarily on an annual frequency and only then, on that basis, determines the quarterly values. Maybe we could repeat this procedure by taking the official quarterly GDP (Gross Domestic Product) figures and interpolating them further to a monthly frequency? Our experts do, in fact, calculate such estimates for Germany and the euro area. We refer to the resulting indicator for Germany as MGDP (Monthly Gross Domestic Product): the "M" stands for "monthly".[15]

For MGDP (Monthly Gross Domestic Product), the official figure for quarterly GDP (Gross Domestic Product) is first broken down to a monthly frequency with the help of monthly indicators. MGDP (Monthly Gross Domestic Product) is structured in such a way that the average of three monthly GDP (Gross Domestic Product) levels produces the quarterly value. As a result, every estimated monthly value has a clear interpretation. The Bundesbank uses the following monthly indicators to interpolate quarterly GDP (Gross Domestic Product): industrial output, price-adjusted retail turnover, price-adjusted goods exports, output in the main construction sector, and price-adjusted turnover in the hotel and restaurant industry.

The mathematical method used here is known as the Kalman filter. Generally speaking, we can use the Kalman filter to estimate unobserved states of linear and non-linear systems. "Unobservability" has a broad definition: it is possible that a signal could just be affected by noise, or it could be entirely unobservable at certain points in time. Nowadays, the algorithm is used in almost all technical and quantitative areas, such as navigation, target tracking, robotics, radar technology, speech recognition, and video stabilisation.

Mixed-frequency data are a natural use case for the Kalman filter. However, forecasts can also be defined as a special case of missing observations – observations that lie in the future. Using MGDP (Monthly Gross Domestic Product), we can make it possible to see changes in aggregate output within a given quarter. In this way, our estimation shows that real GDP (Gross Domestic Product) fell by 7% at the outbreak of the pandemic in March 2020 compared with February of that year, and fell by a further 11% in April 2020 compared with March. MGDP (Monthly Gross Domestic Product) started to recover as early as May 2020. Nevertheless, in the second quarter of 2020, real GDP (Gross Domestic Product) declined at a rate of more than 9% overall. This was due to the fact that the start to the quarter had been so poor.

With MGDP (Monthly Gross Domestic Product) we can also see how short and sharp the pandemic recession was. The fact that things didn't continue to go downhill was due to the massive support measures taken by monetary and fiscal policymakers at the time. However, forecasting models are unable to sufficiently factor in such abrupt downturns.

That said, in this context we benefit from the fact that MGDP (Monthly Gross Domestic Product) is model-based. This means we can apply expert-based adjustments (either upward or downward) to certain variables. This allows us to make use of information that is not known to the models. For example, the easing of coronavirus protection measures as of May 2021 led to a strong rebound in the hotel and restaurant sector. As a result, our experts made several upward adjustments to the data used in MGDP (Monthly Gross Domestic Product). This mainly concerned turnover in the hotel and restaurant sector itself. Ultimately, the average MGDP (Monthly Gross Domestic Product) for the second quarter of 2021 on 7 July was broadly in line with the later flash estimate of the Federal Statistical Office. Without these adjustments, the estimate would have been significantly lower.

Now, you might be asking yourselves: what does MGDP (Monthly Gross Domestic Product) actually have to do with high-frequency data? After all, only the monthly indicators feed into MGDP (Monthly Gross Domestic Product). This is a perfectly justified question. In fact, this is the main disadvantage of MGDP (Monthly Gross Domestic Product) compared with the WAI (Wöchentlicher Aktivitätsindex). In the case of MGDP (Monthly Gross Domestic Product), we cannot use daily or weekly data for GDP (Gross Domestic Product) forecasts – at least not directly. However, it is possible indirectly, as we can build similar models for monthly indicators, too, and extrapolate them initially with daily and weekly data. The extrapolated indicators then feed into MGDP (Monthly Gross Domestic Product).

But can we combine the advantages of the WAI (Wöchentlicher Aktivitätsindex) and MGDP (Monthly Gross Domestic Product) in a single model? Our experts are currently working on such a model and we call it weekly GDP (Gross Domestic Product) or WGDP (Weekly Gross Domestic Product).[16] In the case of WGDP (Weekly Gross Domestic Product), official quarterly GDP (Gross Domestic Product) is broken down to a weekly frequency. Alongside quarterly GDP (Gross Domestic Product), both monthly and weekly indicators feed into the calculation.

Compared with the WAI (Wöchentlicher Aktivitätsindex), the weekly GDP (Gross Domestic Product) figures are very easy to interpret. On a quarterly average, they are roughly equal to quarterly GDP (Gross Domestic Product). Weekly GDP (Gross Domestic Product) gives us a very timely indicator of GDP (Gross Domestic Product) dynamics that can be updated every week. Of course, these features don't come for free, with a relatively high model complexity being the price that has to be paid. Our experts are therefore working on improving the model estimation. On the whole, however, we think that we will be able to replace the WAI (Wöchentlicher Aktivitätsindex) with WGDP (Weekly Gross Domestic Product) following a successful test phase.

6 High-frequency data in inflation analysis

However, economic analysis is not the only area to have experienced an increased need for high-frequency and timely data due to the massive and abrupt global shocks, such as the pandemic and Russia's attack on Ukraine. The availability of high-frequency indicators also benefits the analysis of price developments. This was particularly true during the pandemic and remains so following the start of the Russian war of aggression against Ukraine. This geopolitical conflict has played a key role in amplifying the current wave of inflation, the magnitude of which has not been seen in over four decades.

Against this backdrop, inflation forecasts play a key role, as they form the basis for the ECB (European Central Bank) Governing Council's monetary policy decisions. The price outlook can thus determine the extent to which interest rates are raised or how long they remain at a high level.

In this context, official price data are generally published with a shorter time lag than the economic data I have spoken about. One week ago today, the Federal Statistical Office already reported the provisional inflation rate for September, i.e. even before September had ended. The final figure will be published next Wednesday. Nevertheless, more timely information on how prices are currently developing can facilitate forecasting. This is particularly useful for very volatile inflation components such as prices for clothing and footwear or package holidays. These components often cause significant fluctuations in the inflation rate, even where the underlying price trends remain unchanged. The chart shown displays the overall development of consumer prices in comparison with price developments for package holidays and clothing and footwear.

If, using high-frequency and disaggregated weekly data, we identify fluctuations – such as those of package holidays or clothing and footwear – at the current end in a timely manner, we can better predict the general price trends. High-frequency online prices or scanner data, for example, are helpful in this context.[17]

The Bundesbank has been collecting high-frequency price information for some time now. The method used by our statistical experts is called web scraping, i.e. the automatic reading of content from a website. Specifically, we collect data on prices and product characteristics in the clothing and footwear sectors from the websites of selected online retailers. Of course, we asked the online shops beforehand and obtained their consent. Nowadays, almost all goods are available online. Data collected via web scraping therefore help to predict price indices of the relevant product groups.

Our economists are currently investigating how the auxiliary indicators derived from web scraping can be optimally used. Macroeconomists, as end users, find themselves in the unusually comfortable situation of being able to determine the frequency and composition of the data. After all, in theory, it is possible to increase the frequency of web-scraping data infinitely. But of course, for all practical purposes other than financial market applications, a higher than daily frequency makes little sense.

7 Closing remarks

Ladies and gentlemen,

In my speech I have talked about several use cases of high-frequency data at the Bundesbank. These covered financial markets, economic activity and inflation. However, the frequency in my speech with which I present different areas of our empirical work shouldn't be too high either, so I will now conclude with a few remarks.

How will the high-frequency Bundesbank models develop going forward? Could it perhaps make sense to break down GDP (Gross Domestic Product) to a daily frequency at some point in the future? Our experts will certainly take a look at whether the costs and benefits of doing so are in an adequate ratio.

However, you in the audience could of course turn this question on its head: It was the pandemic, in particular, that advanced the use of high-frequency data, but the pandemic is over. That being the case, are the costs and benefits of the existing models now in a sensible relationship in the current environment?

In fact, even in "normal" times, these models provide timely signals about economic activity at the current end. And we are keeping these instruments available for future shocks, too. The ongoing war in Ukraine has shown us that such unexpected developments can occur at any time.

Thanks to digitalisation, we are able to collect and process ever more data in real time. We are working to incorporate these new data into our analysis and forecasting processes in a beneficial manner. This will help when it comes to making informed decisions.

If you, dear students, would like to work on this topic, we can always do with motivated and capable economists at the Bundesbank. With the development of artificial intelligence, we will certainly take another major step forward in understanding and forecasting economic activity as precisely and quickly as possible. After all, this is a fundamental part of fulfilling our mandate to safeguard price stability.

Thank you for your attention.

Footnotes:

1. Kerßenfischer, M., What moves markets? Deutsche Bundesbank, Research Brief 51, August 2022.
2. Clark, C. (1932), The National Income, 1924-1931, Macmillan, London; Kuznets, S. (1934), National Income, 1929-1932, Senate Document No. 124, 73rd Congress, 2nd session.
3. Gross domestic product (GDP (Gross Domestic Product)) – Federal Statistical Office (destatis.de) *[https://www.destatis.de/EN/Themes/Economy/National-Accounts-Domestic-Product/_node.html]*
4. United Nations (2009), Systems of National Accounts 2008, New York, p. 5.
5. United Nations (2009), System of National Accounts 2008, New York, p. 315.
6. Federal Statistical Office (2008), 2008 classification of economic activities, Wiesbaden.
7. Deutsche Bundesbank, Models for short-term economic forecasting during the recent crises, Monthly Report September 2023, pp. 61-78.
8. Federal Statistical Office, Information is important for coping with the coronavirus crisis, press release No 108 of 23 March 2020.
9. Deutsche Bundesbank, Household wealth and finances in Germany: Results of the 2021 household wealth survey, Monthly Report, April 2023, pp. 25-57.
10. Bernard, R., P. Tzamourani and M. Weber, How are households' consumption plans affected by the COVID (Coronavirus Disease)-19 pandemic?, Bundesbank Research Brief, November 2020; Deutsche Bundesbank, Assessments and expectations of firms in the pandemic: findings from the Bundesbank Online Panel Firms, Monthly Report, April 2021, pp. 33-56.
11. Biancotti, C., A. Rosolia, G. Veronese, F. Mouriaux and R. Kirchner (2020), COVID (Coronavirus Disease)-19 and official statistics: a wakeup call?, Banca d'Italia, Occasional Papers, No 605.
12. Deutsche Bundesbank, Experimental seasonal and calendar adjustment of daily economic indicators, Monthly Report, August 2020, pp. 67-70.

13. Deutsche Bundesbank (2020), A weekly activity index for the German economy, Monthly Report, May 2020, pp. 68-70; Eraslan, S. and T. Götz (2020), An unconventional weekly economic activity index for Germany, Deutsche Bundesbank Technical Paper 02/2020, November 2020.
14. Dempster, A. P., N. M. Laird and D. B. Rubin (1977), Maximum Likelihood from Incomplete Data via the EM Algorithm, Journal of the Royal Statistical Society: Series B (Methodological), Vol. 39, No 1, pp. 1-22; Stock J. H. and M. W. Watson (2002), Macroeconomic Forecasting Using Diffusion Indexes, Journal of Business & Economic Statistics, Vol. 20, No 2, pp. 147-162.
15. Deutsche Bundesbank (2021), Estimating real monthly gross domestic product for Germany and applying it in the short-term economic forecast, Monthly Report, August 2021, pp. 66-67.
16. Eraslan, S. and M. Reif (2023), A latent weekly GDP (Gross Domestic Product) indicator for Germany, Deutsche Bundesbank Technical Paper, forthcoming.
17. Beck, G., K. Carstensen, J.-O. Menz, R. Schnorrenberger and E. Wieland (2023), Nowcasting consumer price inflation using high-frequency scanner data: evidence from Germany, Bundesbank Discussion Paper, forthcoming, and vox.eu column "Real-time food price inflation in Germany in light of the Russian invasion of Ukraine | CEPR (Center for Economic and Policy Research) *[https://cepr.org/voxeu/columns/real-time-food-price-inflation-germany-light-russian-invasion-ukraine]*
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