

# The impact of the COVID-19 pandemic on forecast uncertainty of macroeconomic data releases

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## Abstract

Macroeconomic data releases are very important benchmarks of the economy. Therefore, the vast majority of financial market analysts and traders closely monitor both the projected estimates and, the intuitively more impactful actual values. In this research, we focus on the uncertainty associated with macroeconomic data forecasts measured by the surprise indicator (SI). Moreover, we examine whether the distribution of SI depends on the economy, category of indicator or time, considering pre-pandemic, pandemic and post-pandemic periods in the context of the COVID-19 crisis. We also propose the construction of a sentiment indicator that is intended to aggregate all information that is jointly released through macroeconomic indicators.

**Key words:** macroeconomic, data, release, uncertainty, surprise, sentiment, indicator, forecast, actual

## 1. Introduction

In contemporary economics the performance of stock exchanges or exchange rates has an essential impact on the real economy, while data on the real economy impacts stock exchanges and exchange rates. The ultimate direction of interaction depends on the size of the economy that is the source of the data. Therefore, we can expect that the most influential macroeconomic data comes from the US. It is clear that due to globalization not only the US stock exchanges, but also other stock exchanges can be impacted by both domestic and the US macroeconomic data. Macroeconomic news announcements are the most important risk factors for financial markets. This is the case because the state of the economy reflected in these announcements is one of the main sources of risk. Moreover, this source of risk cannot be accounted for as a diversifiable risk.

Our extended study comprises macroeconomic data of selected economies and takes into account a number of announced macroeconomic indicators and their relations to the median of the forecasted values of these indicators and risk given by the standard deviation of forecasts. The study uses intraday data. It is clear that if the median of forecasts is not in line with the actual value of an announced macroeconomic indicator (i.e. its expected value

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significantly differs from the actual value) the reaction of various markets to this announcement may be stronger.

This paper is organized as follows:

- In Section 2 we present an overview of the selected literature concerning the impact of macroeconomic announcements on the financial markets. Most of the results overviewed in this section are based on event study methodology. The second possible approach refers to the simple notion, which is not widespread in the financial literature, namely the macroeconomic surprise indicator. We reviewed two recent studies which used the definition of this indicator.
- Section 3 explains the underlying macroeconomic data examined in this research.
- Section 4 contains the results of the empirical studies.
- In Section 5 we propose an aggregate index that could be used as a proxy of domestic market sentiment.
- Section 6 contains the final remarks, conclusions and potential fields for further research.

The macroeconomic data used in the study are from the United States of America, the United Kingdom, China, the Eurozone, Germany, Japan and Poland.

The next section provides a short (selected) literature overview of the importance of macroeconomic news announcements.

## 2. Literature overview

Macroeconomic data announcements have a great impact on the treasury bond market, stock markets, exchange rates, interest rates and other economic variables.

News on macroeconomic data from different countries plays a particularly important role for stock markets. In this short overview we will concentrate on the literature concerning this issue, especially the importance of the US macroeconomic data announcements. The empirical results presented in the contributions listed below were mostly calculated by means of event study methods. There is a much lower number of contributions which referred to the surprise variable. If the data released correspond precisely to the expected value, this variable defined below will be equal to zero. At the end of this section we review two recent papers using surprise variables in order to quantify the impact of macroeconomic surprises on different economic variables such as equity prices or the exchange rates of different currencies.

Taking into account the role of the US economy throughout the world, information concerning its condition is of great interest in the economic literature. The effects of main US macroeconomic news announcements on stock prices have been checked for markets at different stages of development: developed stock markets (Andersen et al. (2007), Boyd

et al. (2005), Harju & Hussain (2011), Li & Hu (1998), Pearce & Roley (1983), Nikkinen & Sahlström (2004), Schwert (1981)), as well as emerging markets, e.g. in Central and Eastern Europe (see Gurgul et al. (2012), Gurgul et al. (2013), Gurgul & Wójtowicz (2014), Gurgul & Wójtowicz (2015), Hanousek et al. (2009)). In their well-known and frequently cited contribution Nikkinen & Sahlström (2004) examine the impact of the US and domestic macroeconomic news on the German and Finnish markets. They discovered the dominant role of macroeconomic information from the US. According to the authors, the impact of announcements from the US on the volatility of both markets under consideration was stronger than the effect of domestic information. This investigation was continued by Nikkinen et al. (2006). The contributors examined the impact of the US macroeconomic news announcements on a broad group of 35 stock markets around the world. Among the stock markets under study there were some developed and emerging markets in Europe. The study concludes that unexpected macroeconomic news from the US economy affects volatility on developed stock markets in Europe and Asia. However, volatility on emerging European markets (including Poland) did not react to unexpected announcements of American macroeconomic data. This demonstrated the main difference between developed and emerging European markets with respect to the impact of information coming from the US. Quite different results were presented by Gurgul et al. (2012). They detected a significant reaction of the daily returns of the main Warsaw stock index WIG20 to unexpected news about inflation and industrial production in the United States. The basic difference between these results may follow from an analysis of data from different periods. Nikkinen et al. (2006) take into consideration returns from July 1995 to March 2002, i.e., from the initial period of the development of WSE. The study by Gurgul et al. (2012) is based on more recent data.

More precise results on the impact of the US macroeconomic news on European markets were obtained by applying intraday data. For example, Harju & Hussain (2011) use 5-minute returns to investigate the impact of US macroeconomic news announcements on the British, French, German, and Swiss stock markets. They prove the significant and immediate impact of such news on volatility and 5-minute returns on these markets. Similar results are presented by Dimpfl (2011), who analyzes 1-minute DAX returns, and by Gurgul & Wójtowicz (2015), who analyze 5-minute ATX returns. Additionally, the study of the changes in the strength of the reaction of ATX returns to US data announcements over subsequent years presented by Gurgul & Wójtowicz (2015) leads to the conclusion that investors on the Vienna Stock Exchange reacted most strongly during the global financial crisis of 2007-2009.

An empirical analysis of the effect of macroeconomic news on intraday data has been conducted for European emerging markets by Hanousek et al. (2009). The authors conclude that the Czech and the Hungarian stock markets reacted to macroeconomic news from both the US and EU. However WSE is affected only by announcements from the Eurozone. This stream of research was continued by Hanousek & Kočenda (2011). They show that emerging stock markets in the CEE region are mainly sensitive to macroeconomic information from the EU. Quite different results are presented in Gurgul & Wójtowicz (2014). They detect that unexpected news from the US economy implies a significant and very strong reaction of the WIG20 index as early as the first minute after the announcements. This

extended analysis proves that the US macroeconomic announcements also significantly influence medium and small stock indices of the stock exchange in Warsaw. However, the reaction is slower than in the case of the largest companies.

In our computations, we use the surprise index (SI). An analogous measure of uncertainty is used in the contributions by Heinlein & Lepori (2022) and Jäggi et al. (2019). An important difference is that our study (unlike the study below) is based on high frequency data. Heinlein & Lepori (2022) investigated the response of the UK asset prices to a large set of domestic scheduled, macroeconomic announcements using data at a daily frequency from 1998 to 2017. Surprises about retail sales, claimant count rate, GDP, and industrial production have the most prevalent effects across the four asset classes in their dataset. A large number of macroeconomic announcements increase trading activity on the stock market, whereas there is barely any (only minor) evidence that announcements (surprises) affect the volatility of asset prices. Heinlein & Lepori (2022) also proved that the effects of macroeconomic surprises depend not only upon the state of the economy but also on the state of the stock market (bull vs bear).

The impact of macroeconomic surprises can be detected not only on the capital market, since it has also important monetary implications. Jäggi et al. (2019) studied the reaction of CHF and JPY to macroeconomic surprises and changes in a broader market environment before and during the crisis using high-frequency data. The results published by the contributors demonstrate that CHF and JPY are traditionally more sensitive to macroeconomic surprises than other currencies. This reflects the fact that macroeconomic surprises have an effect on uncertainty and risk aversion. Jäggi et al. (2019) stressed that this link was further increased during the crisis. The authors underlined that it could not be broken by the specific measures adopted by monetary authorities to limit the appreciation trend. In addition the contributors found some evidence that, during the crisis, CHF and JPY responded more strongly to surprises generating an appreciation than to surprises leading to a depreciation. Moreover, both currencies also systematically reacted to changes in the general market environment. According to the authors, this result is resistant to the applications of two measures of the market environment: VIX and a novel index based on Bloomberg wires.

In the following section the datasets, including extensive intraday macroeconomic data announcements for selected economic areas are presented.

### **3. Datasets**

In the first part of this section we describe data from time period 2018 – 2023 given in three subintervals, each of two years in length. In the second part we describe macroeconomic data in detail.

We have decided to divide our macroeconomic data sample into three intervals:

- Pre-pandemic period (2018-2019);
- COVID-19 pandemic (2020-2021);
- Post-pandemic period (2022-2023).

There are two main reasons that support this division. Firstly, we designed equally long periods in order to have comparable number of observations in all three time intervals. Secondly, we deem this partitioning as justified in the context of COVID-19 data.

The source of the macroeconomic data is Bloomberg Terminal, which allows professionals and researchers across multiple industries to access both real-time and historical feeds across a wide range of categories.

Examples of fields that are available in the feed: Date, Time, Event, Period, Surv(M), Actual, Prior, Revised, S, Ticker, Day, Surv(A), Surv(H), Surv(L), Freq., Ests., Std Dev, Surprise, Category, Subcategory, R, First Rev., Last Rev., Country/Region.

For our research the quantitative metrics that help us to define the surprise index are the most crucial ones:

**Definition 1** *For the given quantitative macroeconomic data release (at the time  $t_0$ ) we define surprise index (SI) as follows:*

$$SI_{t_0} = \frac{Surv(M)_{t_0} - Actual_{t_0}}{StdDev_{t_0}}, \quad (1)$$

where  $Surv(M)$  is the median of survey forecasts referring to this particular macroeconomic data release at the time  $t_0$ ,  $Actual$  is an immediate announcement of the indicator (not including further updates) and  $StdDev$  is the standard deviation of forecasts.

Therefore, the surprise index is a simple metric that takes into account two dimensions that we wished to capture:

- How far away from the market consensus the actual macroeconomic data release was;
- Uncertainty of market analysts forecasts.

Based on the construction of the surprise index as a ratio of the above factors, we deem that it is indeed a good proxy of the importance of new information appearing on the market. We assume that the efficient markets hypothesis is true, that new information should not be included in the asset prices at the moment of release, but it is likely to impact them in the very short run.

Another important metric that is leveraged in this study is the relevance factor. This is an indicator ranging from 0 to 100 that aims to measure the importance of a particular macroeconomic indicator. This is approximately the ratio between the number of Bloomberg Terminal's users that have set up the alerts on the particular indicator to the total number of users that have created at least one notification on their accounts.

The composition of the economies was due to a few reasons. Firstly, we have picked the biggest economies in the world: the United States of America, China, Japan, Germany and the United Kingdom. Moreover, Germany is the biggest European economy and the largest trading partner of Poland. The Eurozone's macroeconomic data is considered to be important data as it is aggregated data across the countries that use euro as the official currency. It should be noted that euro is the most important foreign exchange reserve currency, obviously after USD. We included Poland as a minor emerging market.

All available macroeconomic data announcements were downloaded from the Bloomberg Terminal. Then, we applied a few filters to facilitate later quantitative procedures:

- Filtering out events for which "Actual" value was empty or not available;
- Leaving out cases where "Surprise" value cannot be calculated (missing median or standard deviation of forecasts);
- Omitting events for which the time was only approximate, i.e. the whole day instead of exact time point during the day.

For instance, the US data was the richest dataset available amongst the economies considered. From the initial number of 10827 announcements (from 117 categories), 7273 (from 99 categories) remained after filtering.

In all economies under study there is no visible relationship between surprise and relevance. This statement is supported by Pearson's linear correlations and rank correlations (Spearman's and Kendall's), which are very close to zero in all cases, as denoted in Table 1.

**Table 1:** Relationship between relevance and surprise of macroeconomic data releases across economies – measured by correlation metrics

|                 | China   | Eurozone | Germany | Japan  | Poland | UK     | USA     |
|-----------------|---------|----------|---------|--------|--------|--------|---------|
| <b>Pearson</b>  | -0.0393 | 0.0177   | -0.0336 | 0.0057 | 0.0231 | 0.0073 | -0.0177 |
| <b>Spearman</b> | -0.0468 | 0.0269   | -0.0329 | 0.0072 | 0.0158 | 0.0089 | -0.0085 |
| <b>Kendall</b>  | -0.0304 | 0.0179   | -0.0219 | 0.005  | 0.0109 | 0.0061 | -0.0058 |

Therefore, it seems as if the quality of analysts' forecasts does not depend on the importance of the metric. It might be counter-intuitive as one might suspect that most important releases receive much more attention from market participants than minor announcements.

It is also important to acknowledge that in order to measure the impact of macroeconomic news announcements on any financial instruments, we have to consider only those indicators that are released when the particular asset is tradeable. As one might expect, the major factor that influences the time of day of the majority of releases is the economy's time zone – the scatterplot can clearly divide the data into visible clusters.

After the preliminary characteristics of the relationships between surprise and relevance indicators for the selected macroeconomic releases, in the next section we will present the empirical results of our computations and testing procedures.

#### 4. Empirical results – single indicator level

We would like to begin with some simple exploratory data analysis. Standard descriptive statistics are available from the authors upon request. These are, namely, minimum, maximum, mean, skewness and kurtosis. They are calculated for surprise indicator values, separately for each type of macroeconomic event, per the 2-year periods defined previously.

Then, we calculated the p-values of the Kruskal-Wallis and ANOVA tests for all the economies examined. The order is as follows: Table 2 – Germany, Table 3 – China, Table 4

– the Eurozone, Table 5 – Japan, Table 6 – Poland, Table 7 – the United Kingdom and Tables 8, 9 – the United States. The significance level is set to 5% – all categories of macroeconomic announcements that have at least one p-value smaller or equal than 5% are marked in bold font.

**Table 2:** P-values of Kruskal-Wallis, ANOVA, Kolmogorov-Smirnov and Anderson-Darling tests for Germany

| Indicator                          | K.W         | ANOVA  | K.S_1         | K.S_2  | K.S_3  | A.D_1         | A.D_2       | A.D_3  |
|------------------------------------|-------------|--------|---------------|--------|--------|---------------|-------------|--------|
| Budget Maastricht % of GDP         | 0.7408      | 0.952  | 0.6667        | 1      | 1      | 0.1675        | 1           | 0.7852 |
| Capital Investment QoQ             | 0.1133      | 0.1432 | 0.6601        | 0.2827 | 0.087  | 0.2697        | 0.1713      | 0.056  |
| <b>CPI EU Harmonized MoM</b>       | 0.1148      | 0.448  | <b>0.041</b>  | 0.2055 | 0.7972 | <b>0.0136</b> | 0.0731      | 0.8507 |
| <b>CPI EU Harmonized YoY</b>       | 0.2635      | 0.9008 | <b>0.0381</b> | 0.0744 | 0.7762 | <b>0.0154</b> | <b>0.03</b> | 0.9227 |
| CPI MoM                            | 0.6595      | 0.9492 | 0.3651        | 0.5885 | 0.9921 | 0.2924        | 0.3982      | 0.77   |
| CPI YoY                            | 0.606       | 0.9414 | 0.3074        | 0.4458 | 0.7204 | 0.2208        | 0.2737      | 0.5636 |
| Current Account Balance            | 0.3833      | 0.4134 | 0.4726        | 0.14   | 0.3261 | 0.3612        | 0.1816      | 0.4626 |
| Exports SA MoM                     | 0.8164      | 0.9485 | 0.6794        | 0.686  | 0.9935 | 0.6141        | 0.8176      | 0.9913 |
| Factory Orders MoM                 | 0.3911      | 0.3689 | 0.2628        | 0.4426 | 0.6798 | 0.2589        | 0.4137      | 0.9129 |
| Factory Orders WDA YoY             | 0.3775      | 0.2586 | 0.686         | 0.686  | 0.8982 | 0.2536        | 0.3372      | 0.6643 |
| GDP NSA YoY                        | 0.4667      | 0.7482 | 0.5055        | 0.5425 | 0.5425 | 0.2155        | 0.3469      | 0.3022 |
| GDP SA QoQ                         | 0.8432      | 0.4858 | 0.4056        | 0.6483 | 0.7673 | 0.1981        | 0.3762      | 0.8715 |
| <b>GDP WDA YoY</b>                 | 0.1785      | 0.1935 | 0.0873        | 0.4257 | 0.1553 | <b>0.022</b>  | 0.1306      | 0.1683 |
| GfK Consumer Confidence            | 0.6585      | 0.5697 | 0.8982        | 0.1307 | 0.6794 | 0.6998        | 0.2469      | 0.5011 |
| Government Spending QoQ            | 0.2189      | 0.5031 | 0.5594        | 0.0948 | 0.1103 | 0.2778        | 0.2823      | 0.2112 |
| IFO Business Climate               | 0.7614      | 0.7163 | 0.7067        | 0.4425 | 0.8728 | 0.5933        | 0.4683      | 0.868  |
| IFO Current Assessment             | 0.9419      | 0.9531 | 0.9348        | 0.8983 | 0.5961 | 0.9184        | 0.9926      | 0.7517 |
| IFO Expectations                   | 0.4837      | 0.8513 | 0.7503        | 0.2628 | 0.4542 | 0.8069        | 0.249       | 0.7243 |
| <b>Import Price Index MoM</b>      | <b>0.05</b> | 0.0826 | <b>0.0189</b> | 0.6985 | 0.2578 | 0.0161        | 0.5344      | 0.1593 |
| <b>Import Price Index YoY</b>      | 0.0676      | 0.0884 | <b>0.0238</b> | 0.601  | 0.4224 | <b>0.0235</b> | 0.3967      | 0.2426 |
| Imports SA MoM                     | 0.7712      | 0.8501 | 0.9942        | 0.8938 | 0.449  | 0.8892        | 0.9041      | 0.491  |
| Industrial Production SA MoM       | 0.4547      | 0.309  | 0.8822        | 0.4358 | 0.8938 | 0.8262        | 0.2756      | 0.5704 |
| Industrial Production WDA YoY      | 0.4826      | 0.2985 | 0.6723        | 0.6725 | 0.4286 | 0.6435        | 0.3329      | 0.5971 |
| PPI MoM                            | 0.244       | 0.1273 | 0.2395        | 0.8982 | 0.4955 | 0.1177        | 0.9288      | 0.25   |
| PPI YoY                            | 0.1508      | 0.0957 | 0.4325        | 0.6044 | 0.117  | 0.1014        | 0.8236      | 0.1486 |
| Private Consumption QoQ            | 0.6855      | 0.921  | 0.6601        | 0.9801 | 0.6224 | 0.391         | 0.6339      | 0.5674 |
| Retail Sales MoM                   | 0.2867      | 0.247  | 0.4294        | 0.686  | 0.2578 | 0.3847        | 0.531       | 0.1147 |
| Retail Sales NSA YoY               | 0.8509      | 0.9403 | 1             | 0.8939 | 0.6804 | 0.9701        | 0.5545      | 0.3321 |
| Trade Balance                      | 0.5013      | 0.427  | 0.686         | 0.182  | 0.6539 | 0.7046        | 0.2291      | 0.7201 |
| Unemployment Change (000's)        | 0.0967      | 0.285  | 0.686         | 0.2537 | 0.137  | 0.6718        | 0.1703      | 0.0553 |
| <b>Unemployment Claims Rate SA</b> | 0.1953      | 0.2583 | <b>0.0484</b> | 0.4229 | 0.2183 | 0.6124        | 0.1053      | 0.2288 |
| ZEW Survey Current Situation       | 0.7293      | 0.8761 | 0.6666        | 0.6727 | 1      | 0.771         | 0.5936      | 0.9956 |
| ZEW Survey Expectations            | 0.7958      | 0.5245 | 0.686         | 0.8982 | 0.6804 | 0.6708        | 0.6834      | 0.4678 |

In the case of China we have only one significant indicator, for Eurozone – two, for Germany – one, for Japan – four, for Poland – two, for the United Kingdom – eight and for United States – eleven.

In the above-mentioned tables, we also report the p-values of the Kolmogorov-Smirnov and Anderson-Darling tests for all the economies examined. The significance level is unchanged (5%) – all categories of macroeconomic announcements that have at least one p-value smaller or equal than 5% are marked in bold font.

Note that we have chosen the following notation:

- Tests referring to the comparison between pre-crisis and crisis periods are marked as **1**;
- For periods before crisis and after crisis – **2**;
- Crisis and post-crisis tests are denoted as **3**.

**Table 3:** P-values of Kruskal-Wallis, ANOVA, Kolmogorov-Smirnov and Anderson-Darling tests for China

| Indicator                     | K.W           | ANOVA         | K.S_1         | K.S_2         | K.S_3         | A.D_1         | A.D_2         | A.D_3         |
|-------------------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| <b>1-Year Loan Prime Rate</b> | 0.5878        | 0.6106        | 0.0873        | 0.0666        | 0.9254        | <b>0.0427</b> | <b>0.0396</b> | 1             |
| <b>5-Year Loan Prime Rate</b> | 0.8926        | 0.8041        | 0.1538        | 0.287         | 0.272         | <b>0.031</b>  | 0.2148        | 0.613         |
| Aggregate Financing CNY       | 0.9           | 0.7601        | 0.6397        | 0.9239        | 0.4425        | 0.6253        | 0.9186        | 0.6507        |
| CPI YoY                       | 0.1365        | 0.1365        | 0.0968        | 0.0889        | 0.8719        | 0.3024        | 0.1779        | 0.792         |
| <b>Exports YoY</b>            | 0.0856        | 0.2048        | 0.3008        | 0.7666        | 0.0778        | 0.1689        | 0.865         | <b>0.0324</b> |
| Exports YoY CNY               | 0.1263        | 0.0903        | 0.2506        | 0.8531        | 0.2191        | 0.1114        | 0.8809        | 0.1502        |
| Fixed Assets Ex Rural YTD YoY | 0.8749        | 0.6077        | 0.6127        | 0.8604        | 0.3866        | 0.3711        | 0.6433        | 0.4125        |
| Foreign Reserves              | 0.9834        | 0.9907        | 0.888         | 0.5607        | 0.8184        | 0.8334        | 0.6387        | 0.5699        |
| GDP SA QoQ                    | 0.4788        | 0.3813        | 0.9702        | 0.2124        | 0.6601        | 0.4656        | 0.1137        | 0.3893        |
| <b>GDP YoY</b>                | 0.1621        | 0.2992        | 0.5594        | 0.2528        | <b>0.0145</b> | 0.5199        | 0.0911        | <b>0.0247</b> |
| <b>GDP YTD YoY</b>            | 0.1996        | 0.2198        | <b>0.0482</b> | 0.6713        | 0.2827        | 0.0931        | 0.3892        | 0.3728        |
| Imports YoY                   | 0.4508        | 0.4035        | 0.5901        | 0.6274        | 0.5713        | 0.5152        | 0.619         | 0.1664        |
| <b>Imports YoY CNY</b>        | 0.0724        | 0.1089        | 0.9692        | 0.1133        | <b>0.0273</b> | 0.9598        | 0.0743        | <b>0.0219</b> |
| Industrial Production YoY     | 0.7127        | 0.9823        | 0.5623        | 0.1745        | 0.9813        | 0.3457        | 0.227         | 0.9522        |
| Industrial Production YTD YoY | 0.8952        | 0.5659        | 0.8316        | 1             | 0.8574        | 0.6018        | 0.9955        | 0.6266        |
| Manufacturing PMI             | 0.8595        | 0.6377        | 0.686         | 0.9942        | 0.6726        | 0.339         | 0.7705        | 0.6659        |
| Money Supply M0 YoY           | 0.2927        | 0.5252        | 0.2642        | 0.2181        | 0.72          | 0.3593        | 0.2091        | 0.7086        |
| Money Supply M1 YoY           | 0.1802        | 0.0525        | 0.1364        | 0.6794        | 0.4402        | 0.0533        | 0.4108        | 0.2089        |
| <b>Money Supply M2 YoY</b>    | 0.146         | 0.1251        | 0.4167        | <b>0.0477</b> | 0.6558        | 0.1661        | <b>0.0323</b> | 0.289         |
| New Yuan Loans CNY            | 0.9633        | 0.8712        | 0.9935        | 0.658         | 0.4295        | 0.97          | 0.4766        | 0.2608        |
| Non-manufacturing PMI         | 0.6472        | 0.7859        | 0.8882        | 0.6726        | 0.2628        | 0.7882        | 0.6756        | 0.2378        |
| <b>PPI YoY</b>                | <b>0.0092</b> | <b>0.0068</b> | 0.0539        | 0.0529        | <b>0.0298</b> | 0.059         | <b>0.0262</b> | <b>0.0058</b> |
| Retail Sales YoY              | 0.6713        | 0.8002        | 0.9813        | 0.3283        | 0.832         | 0.8232        | 0.3366        | 0.8429        |
| Retail Sales YTD YoY          | 0.6002        | 0.4347        | 0.8236        | 0.3253        | 0.6179        | 0.908         | 0.2897        | 0.2842        |
| Trade Balance                 | 0.7331        | 0.79          | 0.56          | 0.9551        | 0.8248        | 0.5568        | 0.8711        | 0.7766        |
| Trade Balance CNY             | 0.7304        | 0.6855        | 0.5304        | 0.7374        | 0.6558        | 0.6391        | 0.531         | 0.7091        |

**Table 4:** P-values of Kruskal-Wallis, ANOVA, Kolmogorov-Smirnov and Anderson-Darling tests for the Eurozone

| Indicator                     | K.W           | ANOVA         | K.S_1         | K.S_2  | K.S_3         | A.D_1         | A.D_2        | A.D_3         |
|-------------------------------|---------------|---------------|---------------|--------|---------------|---------------|--------------|---------------|
| <b>Consumer Confidence</b>    | 0.356         | 0.2166        | <b>0.0412</b> | 0.1364 | 0.6234        | <b>0.0326</b> | 0.1096       | 0.6587        |
| CPI Core YoY                  | 0.3232        | 0.4001        | 0.5148        | 0.273  | 0.7023        | 0.4285        | 0.1151       | 0.5524        |
| <b>CPI Estimate YoY</b>       | 0.4883        | 0.4536        | 0.4845        | 0.0416 | 0.3923        | 0.1392        | <b>0.017</b> | 0.2995        |
| CPI MoM                       | 0.5966        | 0.325         | 0.2608        | 0.173  | 0.1884        | 0.2468        | 0.1322       | 0.386         |
| CPI YoY                       | 0.4897        | 0.2484        | 0.1019        | 0.2556 | 0.7387        | 0.3076        | 0.9699       | 0.4786        |
| <b>Economic Confidence</b>    | <b>0.0018</b> | <b>0.002</b>  | 0.0656        | 0.8893 | <b>0.0111</b> | <b>0.0069</b> | 0.7846       | <b>0.0009</b> |
| <b>GDP SA QoQ</b>             | 0.5419        | 0.6523        | 0.1363        | 0.4346 | 0.9642        | <b>0.0461</b> | 0.3436       | 0.6967        |
| <b>GDP SA YoY</b>             | 0.1522        | 0.5229        | <b>0.0271</b> | 0.8871 | <b>0.0372</b> | <b>0.0143</b> | 0.9997       | <b>0.0246</b> |
| Govt Expend QoQ               | 0.6448        | 0.9218        | 0.2124        | 0.9879 | 0.8364        | 0.5281        | 0.7212       | 0.7675        |
| Gross Fix Cap QoQ             | 0.767         | 0.4308        | 0.9801        | 0.5859 | 0.5859        | 0.7778        | 0.4691       | 0.5962        |
| Household Cons QoQ            | 0.4605        | 0.9482        | 0.205         | 0.5998 | 0.9751        | 0.1572        | 0.3344       | 0.9836        |
| <b>Industrial Confidence</b>  | <b>0.0035</b> | <b>0.0071</b> | <b>0.0037</b> | 0.6691 | <b>0.0042</b> | <b>0.0022</b> | 0.6116       | <b>0.001</b>  |
| Industrial Production SA MoM  | 0.519         | 0.4803        | 1             | 0.2466 | 0.2537        | 0.9955        | 0.3459       | 0.5772        |
| Industrial Production WDA YoY | 0.5595        | 0.4635        | 0.8815        | 0.429  | 0.2576        | 0.6258        | 0.4247       | 0.1352        |
| M3 Money Supply YoY           | 0.1613        | 0.2062        | 0.6446        | 0.2271 | 0.1996        | 0.5606        | 0.1682       | 0.1329        |
| PPI MoM                       | 0.6791        | 0.5654        | 0.6255        | 0.3921 | 0.4041        | 0.6179        | 0.4767       | 0.4445        |
| PPI YoY                       | 0.5709        | 0.7642        | 0.8828        | 0.4295 | 0.4195        | 0.6146        | 0.632        | 0.5074        |
| Retail Sales MoM              | 0.1917        | 0.4482        | 0.4358        | 0.124  | 0.2531        | 0.532         | 0.0628       | 0.1248        |
| Retail Sales YoY              | 0.5641        | 0.6399        | 0.4296        | 0.6794 | 0.1362        | 0.6528        | 0.8087       | 0.2143        |
| Sentix Investor Confidence    | 0.555         | 0.5496        | 0.2527        | 0.8982 | 0.6795        | 0.2302        | 0.7289       | 0.5174        |
| Services Confidence           | 0.4949        | 0.475         | 0.4425        | 0.6794 | 0.6798        | 0.4758        | 0.7335       | 0.5508        |
| Trade Balance SA              | 0.743         | 0.8618        | 0.9159        | 0.3625 | 0.8596        | 0.9762        | 0.5694       | 0.7622        |
| Unemployment Rate             | 0.3828        | 0.4488        | 0.4279        | 0.9053 | 0.2303        | 0.8876        | 0.9747       | 0.7178        |

To summarize the results of testing the differences in the distributions of macroeconomic surprises in the three periods under consideration, the fraction of indicators of significant differences (at least one test rejecting the null hypothesis) oscillates between 9.3% for Japan to 30.8% for China (for the Eurozone – 26.1%, for Germany – 18.2%, for Poland – 11.5%,



**Table 5:** P-values of Kruskal-Wallis, ANOVA, Kolmogorov-Smirnov and Anderson-Darling tests for Japan

| Indicator                             | K.W           | ANOVA         | K.S. 1        | K.S. 2 | K.S. 3        | A.D. 1        | A.D. 2        | A.D. 3        |
|---------------------------------------|---------------|---------------|---------------|--------|---------------|---------------|---------------|---------------|
| Annualized Housing Starts             | 0.3706        | 0.7978        | 0.6558        | 0.2575 | 0.2342        | 0.5767        | 0.2477        | 0.1753        |
| BoP Current Account Adjusted          | 0.7209        | 0.232         | 0.4361        | 0.6723 | 0.6726        | 0.4681        | 0.8262        | 0.2723        |
| BoP Current Account Balance           | 0.6336        | 0.6705        | 0.4425        | 0.686  | 0.252         | 0.2503        | 0.4497        | 0.2546        |
| Capital Spending Ex Software YoY      | 0.5234        | 0.6999        | 0.2827        | 0.6601 | 0.6601        | 0.2738        | 0.3332        | 0.338         |
| Capital Spending YoY                  | 0.3027        | 0.8994        | 0.2827        | 0.9801 | 0.2827        | 0.182         | 0.83          | 0.2884        |
| <b>Coincident Index</b>               | 0.1633        | 0.4681        | 0.2528        | 0.2843 | 0.052         | 0.1881        | 0.336         | <b>0.0443</b> |
| <b>Consumer Confidence Index</b>      | <b>0.0138</b> | 0.0647        | <b>0.0054</b> | 0.0659 | 0.342         | <b>0.0042</b> | <b>0.0287</b> | 0.2734        |
| Core Machine Orders MoM               | 0.85          | 0.7333        | 0.9942        | 0.9024 | 0.8939        | 0.8968        | 0.9188        | 0.8744        |
| Core Machine Orders YoY               | 0.9265        | 0.9248        | 0.9024        | 0.9942 | 0.686         | 0.7574        | 0.9667        | 0.8715        |
| <b>Eco Watchers Survey Current SA</b> | 0.1283        | <b>0.0362</b> | 0.2578        | 0.2575 | <b>0.0299</b> | <b>0.0447</b> | 0.1352        | <b>0.0468</b> |
| Eco Watchers Survey Outlook SA        | 0.5566        | 0.3626        | 0.2628        | 0.2613 | 0.8982        | 0.3117        | 0.3245        | 0.5998        |
| Exports YoY                           | 0.2887        | 0.4837        | 0.4445        | 0.4364 | 0.6736        | 0.2155        | 0.1354        | 0.4004        |
| GDP Annualized SA QoQ                 | 0.4754        | 0.4199        | 0.9522        | 0.0879 | 0.3033        | 0.8778        | 0.1266        | 0.3885        |
| GDP Business Spending QoQ             | 0.4122        | 0.5469        | 0.6036        | 0.3959 | 0.0928        | 0.6533        | 0.3094        | 0.0781        |
| GDP Deflator YoY                      | 0.3629        | 0.07          | 0.3139        | 0.2308 | 0.3787        | 0.5749        | 0.2469        | 0.2087        |
| GDP Nominal SA QoQ                    | 0.7669        | 0.4487        | 0.7229        | 0.6594 | 0.6225        | 0.9155        | 0.6595        | 0.631         |
| GDP Private Consumption QoQ           | 0.5953        | 0.3638        | 0.3749        | 0.0927 | 0.517         | 0.279         | 0.2448        | 0.6062        |
| GDP SA QoQ                            | 0.4824        | 0.5109        | 0.5743        | 0.206  | 0.2916        | 0.6548        | 0.12          | 0.2857        |
| Household Spending YoY                | 0.3009        | 0.3655        | 0.9115        | 0.4493 | 0.2628        | 0.8205        | 0.2806        | 0.2014        |
| Housing Starts YoY                    | 0.2886        | 0.5132        | 0.6736        | 0.6794 | 0.0678        | 0.4561        | 0.5307        | 0.1297        |
| Imports YoY                           | 0.5667        | 0.5722        | 0.4425        | 0.8843 | 0.6731        | 0.3823        | 0.6441        | 0.5757        |
| Industrial Production MoM             | 0.7919        | 0.7639        | 0.9024        | 0.686  | 0.686         | 0.7316        | 0.7387        | 0.7256        |
| Industrial Production YoY             | 0.6782        | 0.6641        | 0.4426        | 0.6798 | 0.6752        | 0.1253        | 0.4024        | 0.6261        |
| Job-To-Applicant Ratio                | 0.7114        | 0.9219        | 0.1825        | 0.9696 | 0.5581        | 0.2803        | 0.9533        | 0.6459        |
| Jobless Rate                          | 0.3474        | 0.219         | 0.3875        | 0.6208 | 0.1078        | 0.2237        | 0.3216        | 0.1218        |
| Labor Cash Earnings YoY               | 0.2202        | 0.332         | 0.3281        | 0.2653 | 0.6794        | 0.3406        | 0.1183        | 0.5474        |
| Leading Index CI                      | 0.2205        | 0.1548        | 0.5845        | 0.061  | 0.4044        | 0.4193        | 0.0713        | 0.4948        |
| Monetary Base End of period           | 0.3801        | 0.4375        | 0.3333        | 0.6667 | 1             | 0.2975        | 0.6267        | 1             |
| Monetary Base YoY                     | 0.3189        | 0.6064        | 0.5           | 0.6    | 1             | 0.1247        | 0.3491        | 0.9762        |
| Money Stock M2 YoY                    | 0.214         | 0.1116        | 0.2138        | 0.5958 | 0.1039        | 0.061         | 0.3675        | 0.1464        |
| <b>Money Stock M3 YoY</b>             | 0.1094        | <b>0.0214</b> | 0.0861        | 0.7311 | 0.2764        | <b>0.0118</b> | 0.3669        | 0.1015        |
| Natl CPI Ex Fresh Food YoY            | 0.2421        | 0.2623        | 0.3177        | 0.3639 | 0.6821        | 0.0657        | 0.0746        | 0.9804        |
| Natl CPI YoY                          | 0.3988        | 0.4425        | 0.7193        | 0.6387 | 0.999         | 0.2019        | 0.6741        | 0.8336        |
| PPI MoM                               | 0.2148        | 0.1186        | 0.2273        | 0.9909 | 0.4195        | 0.1749        | 0.7889        | 0.2065        |
| PPI Services YoY                      | 0.764         | 0.7845        | 0.9828        | 0.4457 | 0.947         | 0.8227        | 0.5287        | 0.8737        |
| PPI YoY                               | 0.4237        | 0.3774        | 0.6349        | 0.4324 | 0.9916        | 0.3116        | 0.1867        | 0.8628        |
| Real Cash Earnings YoY                | 0.7447        | 0.7997        | 0.4205        | 0.6526 | 0.9942        | 0.3327        | 0.6624        | 0.9312        |
| Retail Sales MoM                      | 0.6351        | 0.4622        | 0.4425        | 0.8938 | 0.6794        | 0.2491        | 0.6778        | 0.4816        |
| Retail Sales YoY                      | 0.8635        | 0.8926        | 0.686         | 0.449  | 0.8982        | 0.5033        | 0.2586        | 0.7907        |
| Tankan Large All Industry Capex       | 0.9489        | 0.9813        | 0.6601        | 0.6601 | 0.9801        | 0.637         | 0.5407        | 0.6688        |
| Tankan Large Mfg Index                | 0.2787        | 0.3366        | 0.2827        | 0.2827 | 0.6601        | 0.0856        | 0.3955        | 0.5445        |
| Tankan Large Mfg Outlook              | 0.8325        | 0.663         | 0.9702        | 0.6601 | 0.9702        | 0.9141        | 0.6183        | 0.9479        |
| Tankan Large Non-Mfg Index            | 0.717         | 0.7724        | 0.9801        | 0.6601 | 0.9801        | 0.83          | 0.5308        | 0.6472        |
| Tankan Large Non-Mfg Outlook          | 0.2144        | 0.1509        | 0.9702        | 0.2528 | 0.2827        | 0.8873        | 0.161         | 0.1595        |
| Tankan Small Mfg Index                | 0.4439        | 0.5356        | 0.2572        | 0.6601 | 0.6601        | 0.1288        | 0.4257        | 0.637         |
| <b>Tankan Small Mfg Outlook</b>       | 0.077         | <b>0.0465</b> | 0.6601        | 0.087  | 0.1702        | 0.3664        | <b>0.0289</b> | 0.1945        |
| Tankan Small Non-Mfg Index            | 0.3589        | 0.539         | 0.2827        | 0.2827 | 0.9702        | 0.2265        | 0.1661        | 0.9203        |
| Tankan Small Non-Mfg Outlook          | 0.6914        | 0.656         | 0.6224        | 0.6224 | 0.9801        | 0.8558        | 0.7994        | 0.7641        |
| Tertiary Industry Index MoM           | 0.3706        | 0.1836        | 0.2576        | 0.3075 | 0.177         | 0.3024        | 0.178         | 0.2179        |
| Tokyo CPI Ex-Fresh Food YoY           | 0.4978        | 0.7377        | 0.1791        | 0.228  | 0.293         | 0.3219        | 0.2115        | 0.2504        |
| Tokyo CPI YoY                         | 0.4997        | 0.5494        | 0.7664        | 0.8777 | 0.6285        | 0.5838        | 0.5442        | 0.4852        |
| Trade Balance                         | 0.6945        | 0.6137        | 0.9928        | 0.8982 | 0.8939        | 0.9481        | 0.6486        | 0.7499        |
| Trade Balance Adjusted                | 0.9066        | 0.8031        | 0.8982        | 0.6794 | 0.8791        | 0.5868        | 0.709         | 0.6929        |
| Trade Balance BoP Basis               | 0.1884        | 0.1631        | 0.6634        | 0.8928 | 0.1322        | 0.5484        | 0.5262        | 0.0647        |

for the United Kingdom – 23.7%, for United States – 26.3%). In general, we observe significant differences in the distributions of surprise indicators related to inflation and unemployment across most of the economies under consideration in these periods. Another conclusion is that, in general, the bigger the economy, the higher the fraction of indicators of significant differences (with the exception of Japan). Across examined economies, the

**Table 6:** P-values of Kruskal-Wallis, ANOVA, Kolmogorov-Smirnov and Anderson-Darling tests for Poland

| Indicator                   | K.W    | ANOVA         | K.S_1         | K.S_2  | K.S_3         | A.D_1         | A.D_2  | A.D_3         |
|-----------------------------|--------|---------------|---------------|--------|---------------|---------------|--------|---------------|
| Average Gross Wages MoM     | 0.3927 | 0.1263        | 0.1366        | 0.686  | 0.8891        | 0.19          | 0.2035 | 0.5778        |
| Average Gross Wages YoY     | 0.4008 | 0.2329        | 0.2628        | 0.6794 | 0.4435        | 0.1638        | 0.2808 | 0.354         |
| Construction Output YoY     | 0.9081 | 0.6002        | 0.8982        | 0.2575 | 0.2628        | 0.7662        | 0.1387 | 0.3768        |
| CPI Core MoM                | 0.5374 | 0.4214        | 0.7427        | 0.9533 | 0.9406        | 0.7062        | 0.9632 | 0.9673        |
| CPI Core YoY                | 0.6387 | 0.9479        | 0.934         | 0.6839 | 0.9533        | 0.7072        | 0.9497 | 0.6878        |
| <b>CPI MoM</b>              | 0.1532 | 0.1186        | 0.0539        | 0.7858 | 0.0979        | <b>0.0438</b> | 0.8467 | 0.1185        |
| <b>CPI YoY</b>              | 0.0533 | <b>0.0236</b> | <b>0.0165</b> | 0.4197 | 0.0656        | <b>0.0109</b> | 0.3313 | 0.1215        |
| Current Account Balance     | 0.732  | 0.9319        | 0.4425        | 0.2628 | 0.4425        | 0.5631        | 0.3064 | 0.585         |
| Employment MoM              | 0.6443 | 0.3327        | 0.1775        | 0.6441 | 0.3687        | 0.2355        | 0.6488 | 0.1528        |
| Employment YoY              | 0.6369 | 0.7597        | 0.8106        | 0.8043 | 0.8605        | 0.6072        | 0.8081 | 0.5227        |
| Exports                     | 0.8011 | 0.8606        | 0.9928        | 0.686  | 0.8982        | 0.9182        | 0.7198 | 0.8388        |
| GDP Annual YoY              | 0.1017 | 0.0548        | 0.3333        | 0.3333 | 0.3333        | 0.0835        | 0.0835 | 0.0835        |
| GDP SA QoQ                  | 0.6171 | 0.7552        | 0.2827        | 0.6224 | 0.2827        | 0.1135        | 0.4352 | 0.1486        |
| GDP YoY                     | 0.4371 | 0.2993        | 0.6601        | 0.6601 | 0.087         | 0.2727        | 0.487  | 0.1013        |
| Imports                     | 0.447  | 0.3042        | 0.6794        | 0.6726 | 0.2628        | 0.6076        | 0.402  | 0.1321        |
| Money Supply M3 MoM         | 0.4917 | 0.6216        | 0.7012        | 0.3649 | 0.6794        | 0.9286        | 0.4069 | 0.6261        |
| Money Supply M3 YoY         | 0.3251 | 0.6887        | 0.436         | 0.1328 | 0.1322        | 0.4549        | 0.12   | 0.347         |
| <b>PPI MoM</b>              | 0.0585 | <b>0.0268</b> | 0.228         | 0.2384 | <b>0.0238</b> | 0.1067        | 0.142  | <b>0.0231</b> |
| PPI YoY                     | 0.1712 | 0.1867        | 0.25          | 0.686  | 0.1316        | 0.0701        | 0.5461 | 0.1717        |
| Retail Sales Real YoY       | 0.5711 | 0.2449        | 0.686         | 0.992  | 0.8982        | 0.5022        | 0.9665 | 0.4132        |
| Retail Sales YoY            | 0.1662 | 0.0674        | 0.2526        | 0.8982 | 0.6794        | 0.081         | 0.6567 | 0.3498        |
| Sold Industrial Output MoM  | 0.4511 | 0.2994        | 0.4425        | 0.2509 | 0.1287        | 0.2763        | 0.5976 | 0.264         |
| Sold Industrial Output YoY  | 0.3009 | 0.2399        | 0.9024        | 0.1398 | 0.1361        | 0.6009        | 0.2947 | 0.122         |
| Trade Balance               | 0.626  | 0.3254        | 0.8982        | 0.6794 | 0.9024        | 0.8624        | 0.5034 | 0.796         |
| Unemployment Rate           | 0.9327 | 0.7941        | 0.8312        | 0.9819 | 0.8404        | 0.7847        | 0.9998 | 0.8188        |
| Unemployment Rate Quarterly | 0.9398 | 0.9368        | 0.9851        | 0.6601 | 0.3998        | 0.9932        | 0.5282 | 0.4681        |

ANOVA test seems to be more sensitive in detecting significant differences in distribution than the Kruskal-Wallis test. Results in three sub-sample periods indicate that the Anderson Darling test is superior to Kolmogorov-Smirnov test in the purpose of detecting differences in distributions. This is in line with the statistical intuition as the Anderson Darling test puts more weight into the comparison of the tail distribution.

In the next section, we first define the aggregated sentiment (AS). We also include the p-values of the Kruskal-Wallis, ANOVA, Kolmogorov-Smirnov and Anderson-Darling tests for these economies in the tables.

## 5. Empirical results – sentiment level

In order to quantitatively aggregate the impact of new market information from macroeconomic data announcements, we have suggested using the aggregated sentiment. For multiple events occurring at the same time, this indicator is also normalized by the sum of Relevance Factors of all simultaneous macroeconomic data releases. This means that the sentiment is calculated as the weighted average where the weights are based on the values of the relevance factor per each indicator.

**Definition 2** *Aggregated sentiment (AS) at the time  $t$  is the product sum of the surprise indicator (SI) and relevance factor (RF), summed through all economic releases taking place simultaneously – let us assume that they are annotated by natural numbers  $(1, \dots, n)$ :*

$$AS_t = \frac{\sum_{i=1}^n SI_{i,t} \cdot RF_{i,t}}{\sum_{i=1}^n RF_{i,t}} \quad (2)$$

**Table 7:** P-values of Kruskal-Wallis, ANOVA, Kolmogorov-Smirnov and Anderson-Darling tests for the United Kingdom

| Indicator                                | K.W           | ANOVA         | K.S_1         | K.S_2         | K.S_3         | A.D_1         | A.D_2         | A.D_3         |
|------------------------------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Average Weekly Earnings 3M/YoY           | 0.6103        | 0.3073        | 0.24          | 0.5995        | 0.9924        | 0.2353        | 0.3435        | 0.8719        |
| <b>Bank of England Bank Rate</b>         | 0.2405        | 0.3185        | 1             | 1             | 0.4678        | 0.7461        | 1             | <b>0.0337</b> |
| <b>BRC Sales Like-For-Like YoY</b>       | 0.0643        | 0.1164        | 0.1703        | 0.5455        | 0.1538        | 0.0575        | 0.5716        | <b>0.0454</b> |
| CBI Business Optimism                    | 0.3493        | 0.4249        | 0.4156        | 0.5357        | 0.6786        | 0.2748        | 0.5186        | 0.2906        |
| CBI Retailing Reported Sales             | 0.9677        | 0.7446        | 0.9024        | 0.8514        | 0.9686        | 0.887         | 0.9786        | 0.9276        |
| CBI Total Dist. Reported Sales           | 0.5722        | 0.97          | 0.6667        | 1             | 0.5714        | 0.5681        | 1             | 0.6483        |
| CBI Trends Selling Prices                | 0.5624        | 0.2396        | 0.6336        | 0.4802        | 0.5966        | 0.5261        | 0.4433        | 0.6487        |
| CBI Trends Total Orders                  | 0.2703        | 0.344         | 0.1362        | 0.449         | 0.449         | 0.1056        | 0.3097        | 0.4377        |
| Construction Output MoM                  | 0.2712        | 0.297         | 0.686         | 0.6794        | 0.0678        | 0.6846        | 0.6636        | 0.1067        |
| Construction Output YoY                  | 0.3912        | 0.4427        | 0.686         | 0.686         | 0.1398        | 0.5517        | 0.7122        | 0.1883        |
| <b>CPI Core YoY</b>                      | 0.1122        | 0.6117        | 0.0958        | <b>0.0193</b> | 0.9909        | <b>0.0229</b> | <b>0.0119</b> | 0.9874        |
| <b>CPI MoM</b>                           | 0.1638        | 0.5642        | 0.0468        | <b>0.0187</b> | 0.9924        | <b>0.0207</b> | <b>0.0162</b> | 0.8693        |
| <b>CPI YoY</b>                           | 0.1343        | 0.4897        | 0.1154        | 0.0529        | 0.9907        | <b>0.038</b>  | <b>0.0439</b> | 0.978         |
| <b>CPIH YoY</b>                          | 0.0885        | 0.3294        | <b>0.0466</b> | 0.0532        | 0.9889        | <b>0.0392</b> | <b>0.0319</b> | 0.9981        |
| Current Account Balance                  | 0.9981        | 0.9619        | 0.9801        | 0.9702        | 0.9801        | 0.773         | 0.7412        | 0.9184        |
| Employment Change 3M/3M                  | 0.8368        | 0.9336        | 0.9942        | 0.9938        | 0.7679        | 0.9552        | 0.982         | 0.8079        |
| Exports QoQ                              | 0.141         | 0.4233        | 0.2557        | 0.2942        | 0.9534        | 0.1311        | 0.0751        | 0.9659        |
| GDP QoQ                                  | 0.4975        | 0.4552        | 0.2961        | 0.4593        | 0.9112        | 0.2185        | 0.2596        | 0.8996        |
| <b>GDP YoY</b>                           | <b>0.0311</b> | 0.1026        | 0.1173        | <b>0.031</b>  | 0.2102        | <b>0.0367</b> | <b>0.0096</b> | 0.1817        |
| GfK Consumer Confidence                  | 0.4859        | 0.2556        | 0.8797        | 0.2393        | 0.4604        | 0.7948        | 0.2835        | 0.371         |
| <b>Government Spending QoQ</b>           | 0.0763        | 0.1293        | 0.0557        | 0.0815        | 0.7387        | <b>0.0397</b> | 0.0573        | 0.8355        |
| <b>Gross Fixed Capital Formation QoQ</b> | 0.5089        | <b>0.0428</b> | 0.3607        | 0.5953        | 0.4131        | 0.4583        | 0.3823        | 0.2253        |
| <b>House Price Index YoY</b>             | 0.2081        | 0.6762        | 0.3435        | <b>0.0481</b> | 0.1011        | 0.2918        | 0.0639        | 0.0944        |
| ILO Unemployment Rate 3Mths              | 0.7351        | 0.3993        | 0.1416        | 0.7478        | 0.3165        | 0.2467        | 0.4811        | 0.2421        |
| Imports QoQ                              | 0.7023        | 0.3155        | 0.2653        | 0.9038        | 0.7315        | 0.5285        | 0.6205        | 0.4653        |
| Index of Services 3M/3M                  | 0.6214        | 0.9634        | 0.3196        | 0.4497        | 0.4195        | 0.4716        | 0.3862        | 0.7146        |
| Index of Services MoM                    | 0.9474        | 0.7642        | 0.5168        | 0.9321        | 0.8982        | 0.355         | 0.7257        | 0.6031        |
| Industrial Production MoM                | 0.6693        | 0.4079        | 0.9935        | 0.6794        | 0.8916        | 0.9936        | 0.51          | 0.6169        |
| Industrial Production YoY                | 0.392         | 0.303         | 0.2576        | 0.4425        | 0.4425        | 0.1927        | 0.3492        | 0.2705        |
| Manufacturing Production MoM             | 0.465         | 0.2407        | 0.4364        | 0.6794        | 0.9024        | 0.2775        | 0.3526        | 0.5283        |
| Manufacturing Production YoY             | 0.608         | 0.4662        | 0.4425        | 0.686         | 0.6794        | 0.1672        | 0.4925        | 0.2713        |
| <b>Monthly GDP (3M/3M)</b>               | 0.0827        | 0.1153        | <b>0.0168</b> | 0.7086        | 0.3956        | <b>0.0387</b> | 0.5078        | 0.2779        |
| Monthly GDP (MoM)                        | 0.6648        | 0.5717        | 0.6056        | 0.7305        | 0.6794        | 0.4144        | 0.6306        | 0.4939        |
| Mortgage Approvals                       | 0.8066        | 0.9949        | 0.8891        | 0.8982        | 0.8946        | 0.5233        | 0.7986        | 0.6571        |
| Nationwide House PX MoM                  | 0.3041        | 0.189         | 0.2854        | 0.8728        | 0.2032        | 0.2181        | 0.9464        | 0.4242        |
| Nationwide House PX NSA YoY              | 0.1203        | 0.0845        | 0.0733        | 0.9549        | 0.0856        | 0.0751        | 0.8581        | 0.1382        |
| Net Consumer Credit                      | 0.2129        | 0.2242        | 0.9024        | 0.6691        | 0.1398        | 0.6399        | 0.593         | 0.0781        |
| Net Lending Sec. on Dwellings            | 0.4213        | 0.3822        | 0.9024        | 0.4033        | 0.4163        | 0.7698        | 0.3158        | 0.3332        |
| <b>PPI Input NSA MoM</b>                 | 0.1385        | <b>0.0493</b> | 0.256         | 0.4425        | 0.2628        | 0.1125        | 0.5957        | 0.1017        |
| <b>PPI Input NSA YoY</b>                 | 0.1442        | <b>0.0407</b> | 0.1398        | 0.693         | 0.5644        | 0.0548        | 0.5783        | 0.2578        |
| PPI Output NSA MoM                       | 0.5306        | 0.5397        | 0.4324        | 0.8828        | 0.8916        | 0.2567        | 0.9014        | 0.592         |
| PPI Output NSA YoY                       | 0.5912        | 0.8369        | 0.413         | 0.3744        | 0.1899        | 0.466         | 0.3696        | 0.3862        |
| Private Consumption QoQ                  | 0.1966        | 0.4396        | 0.1009        | 0.3447        | 0.8559        | 0.0876        | 0.2948        | 0.8097        |
| PSNB ex Banking Groups                   | 0.8869        | 0.7864        | 0.4357        | 0.449         | 0.9024        | 0.2796        | 0.4615        | 0.4898        |
| Public Sector Net Borrowing              | 0.6792        | 0.5422        | 0.9024        | 0.4089        | 0.6462        | 0.5387        | 0.6351        | 0.5494        |
| <b>Retail Price Index</b>                | <b>0.0416</b> | 0.133         | 0.129         | <b>0.011</b>  | 0.8982        | 0.105         | <b>0.0139</b> | 0.9058        |
| Retail Sales Ex Auto Fuel MoM            | 0.3642        | 0.3023        | 0.8982        | 0.686         | 0.686         | 0.6024        | 0.2237        | 0.5422        |
| Retail Sales Ex Auto Fuel YoY            | 0.4678        | 0.3525        | 0.449         | 0.2628        | 0.449         | 0.4279        | 0.3151        | 0.3832        |
| Retail Sales Inc Auto Fuel MoM           | 0.3914        | 0.409         | 0.449         | 0.1338        | 0.8982        | 0.4167        | 0.1094        | 0.8732        |
| Retail Sales Inc Auto Fuel YoY           | 0.2431        | 0.1088        | 0.449         | 0.4425        | 0.2628        | 0.3311        | 0.1212        | 0.2688        |
| <b>RICS House Price Balance</b>          | <b>0.0257</b> | 0.2031        | <b>0.0299</b> | 1             | <b>0.0299</b> | <b>0.0085</b> | 0.9998        | <b>0.0054</b> |
| RPI Ex Mort Int.Payments (YoY)           | 0.1383        | 0.4749        | 0.2546        | 0.1135        | 0.3679        | 0.0946        | 0.151         | 0.3788        |
| RPI MoM                                  | 0.079         | 0.1965        | 0.1063        | 0.1067        | 0.9877        | 0.0521        | 0.0595        | 0.9857        |
| <b>RPI YoY</b>                           | <b>0.0254</b> | 0.0639        | 0.1212        | 0.0215        | 0.9909        | <b>0.0366</b> | <b>0.0072</b> | 0.872         |
| Total Business Investment QoQ            | 0.8197        | 0.991         | 0.5882        | 0.4269        | 0.499         | 0.325         | 0.7206        | 0.2983        |
| <b>Total Business Investment YoY</b>     | 0.0771        | <b>0.023</b>  | <b>0.006</b>  | 0.7794        | 0.1429        | <b>0.0114</b> | 0.6977        | 0.1233        |
| Trade Balance GBP/Mn                     | 0.5853        | 0.2875        | 0.9942        | 0.9024        | 0.4379        | 0.6923        | 0.6858        | 0.4068        |
| Visible Trade Balance GBP/Mn             | 0.862         | 0.3787        | 0.9024        | 0.9024        | 0.9024        | 0.9255        | 0.8022        | 0.8752        |
| Weekly Earnings ex Bonus 3M/YoY          | 0.5193        | 0.4773        | 0.5757        | 0.976         | 0.6133        | 0.7922        | 0.6293        | 0.4317        |

Table 10 presents the p-values of the Kruskal-Wallis and ANOVA tests applied to the sentiment data calculated for all economies under consideration. The division of the sample

**Table 8:** P-values of Kruskal-Wallis, ANOVA, Kolmogorov-Smirnov and Anderson-Darling tests for United States (1/2)

| Indicator                                  | K.W           | ANOVA         | K.S. 1        | K.S. 2        | K.S. 3        | A.D. 1        | A.D. 2        | A.D. 3        |
|--------------------------------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| ADP Employment Change                      | 0.6999        | 0.8979        | 0.6795        | 0.6249        | 0.2694        | 0.6082        | 0.5618        | 0.2161        |
| Advance Goods Trade Balance                | 0.8299        | 0.8633        | 0.9315        | 0.8823        | 0.8982        | 0.9454        | 0.754         | 0.7363        |
| Average Hourly Earnings MoM                | 0.1764        | 0.2271        | 0.4041        | 0.2214        | 0.9847        | 0.1214        | 0.174         | 0.9696        |
| Average Hourly Earnings YoY                | 0.5612        | 0.6671        | 0.575         | 0.8253        | 0.9847        | 0.5           | 0.3599        | 0.949         |
| <b>Average Weekly Hours All Employees</b>  | <b>0.0166</b> | <b>0.0494</b> | <b>0.0003</b> | 0.1971        | 0.1004        | <b>0</b>      | 0.0546        | <b>0.0414</b> |
| Building Permits                           | 0.994         | 0.9797        | 0.9942        | 0.6794        | 0.9942        | 0.8492        | 0.735         | 0.967         |
| Building Permits MoM                       | 1             | 0.9766        | 0.9928        | 0.6726        | 0.9942        | 0.8218        | 0.6979        | 0.9873        |
| Business Inventories                       | 0.2025        | 0.2095        | 0.5315        | 0.5712        | 0.0547        | 0.6281        | 0.8064        | 0.155         |
| Cap Goods Orders Nondef Ex Air             | 0.2428        | 0.203         | 0.6455        | 0.0844        | 0.5099        | 0.4886        | 0.1625        | 0.2547        |
| Cap Goods Ship Nondef Ex Air               | 0.559         | 0.2604        | 0.2762        | 0.6326        | 0.3328        | 0.2672        | 0.6854        | 0.5332        |
| Capacity Utilization                       | 0.2794        | 0.5081        | 0.0593        | 0.8982        | 0.2413        | 0.1194        | 0.9898        | 0.3687        |
| Change in Manufact. Payrolls               | 0.5187        | 0.5237        | 0.9024        | 1             | 0.6794        | 0.55          | 0.9896        | 0.6145        |
| <b>Change in Nonfarm Payrolls</b>          | 0.1017        | 0.0876        | 0.686         | 0.1398        | 0.2584        | 0.4908        | 0.1207        | <b>0.0348</b> |
| Change in Private Payrolls                 | 0.2388        | 0.2019        | 0.9942        | 0.2576        | 0.4354        | 0.8638        | 0.2341        | 0.1771        |
| Chicago Fed Nat Activity Index             | 0.809         | 0.5306        | 0.6023        | 0.5792        | 0.5479        | 0.7402        | 0.7349        | 0.7093        |
| Conf. Board Consumer Confidence            | 0.8655        | 0.9109        | 0.9024        | 0.8982        | 0.9942        | 0.8673        | 0.9228        | 0.9648        |
| Construction Spending MoM                  | 0.5246        | 0.1743        | 0.9024        | 0.4426        | 0.9024        | 0.6774        | 0.3267        | 0.8067        |
| Consumer Credit                            | 0.936         | 0.5845        | 0.9024        | 0.8982        | 0.9024        | 0.6675        | 0.6967        | 0.8012        |
| Continuing Claims                          | 0.6419        | 0.6926        | 0.3647        | 0.3027        | 0.1404        | 0.5156        | 0.0811        | 0.1365        |
| Core PCE Price Index QoQ                   | 0.7627        | 0.8378        | 0.7145        | 0.7976        | 0.8385        | 0.4524        | 0.521         | 0.8464        |
| CPI Core Index SA                          | 0.6156        | 0.6799        | 0.8676        | 0.4272        | 0.9024        | 0.8303        | 0.3938        | 0.5571        |
| CPI Ex Food and Energy MoM                 | 0.4512        | 0.394         | 0.8191        | 0.5177        | 0.8434        | 0.3869        | 0.1178        | 0.771         |
| CPI Ex Food and Energy YoY                 | 0.6345        | 0.2384        | 0.8253        | 0.5114        | 0.575         | 0.3303        | 0.5174        | 0.385         |
| CPI Index NSA                              | 0.3665        | 0.2212        | 0.0656        | 0.6727        | 0.9024        | 0.123         | 0.4559        | 0.6542        |
| <b>CPI MoM</b>                             | 0.238         | 0.145         | 0.0756        | 0.5177        | 0.8253        | <b>0.0453</b> | 0.313         | 0.4755        |
| CPI YoY                                    | 0.3076        | 0.1449        | 0.1836        | 0.8253        | 0.6397        | 0.0678        | 0.432         | 0.385         |
| Current Account Balance                    | 0.5054        | 0.6265        | 0.9801        | 0.6601        | 0.9801        | 0.8487        | 0.3394        | 0.8638        |
| Dallas Fed Manf. Activity                  | 0.3606        | 0.6519        | 0.9942        | 0.2628        | 0.2628        | 0.7131        | 0.3266        | 0.2071        |
| Durable Goods Orders                       | 0.3953        | 0.2335        | 0.6536        | 0.1981        | 0.4279        | 0.8683        | 0.2367        | 0.4933        |
| <b>Durables Ex Transportation</b>          | <b>0.0282</b> | 0.2389        | <b>0.0113</b> | <b>0.012</b>  | 0.83          | 0.1085        | <b>0.0113</b> | 0.4914        |
| Empire Manufacturing                       | 0.5301        | 0.317         | 0.6795        | 0.1366        | 0.1398        | 0.6978        | 0.1439        | 0.1805        |
| Employment Cost Index                      | 0.3164        | 0.2179        | 0.205         | 0.5594        | 0.6224        | 0.1719        | 0.408         | 0.3789        |
| <b>Existing Home Sales</b>                 | <b>0.018</b>  | <b>0.0195</b> | <b>0.004</b>  | 0.4435        | 0.2576        | <b>0.0067</b> | 0.3638        | 0.0884        |
| <b>Existing Home Sales MoM</b>             | <b>0.0176</b> | <b>0.0213</b> | <b>0.0043</b> | 0.2628        | 0.2628        | <b>0.0066</b> | 0.2926        | 0.0924        |
| Export Price Index MoM                     | 0.2687        | 0.1254        | 0.2497        | 0.6794        | 0.6691        | 0.2375        | 0.5433        | 0.2318        |
| <b>Export Price Index YoY</b>              | 0.1845        | 0.3941        | 0.3636        | 0.9474        | <b>0.0398</b> | 0.2397        | 0.8803        | 0.0548        |
| Factory Orders                             | 0.2795        | 0.3202        | 0.2497        | 0.6475        | 0.2577        | 0.0979        | 0.3735        | 0.1026        |
| <b>FHFA House Price Index MoM</b>          | 0.1382        | 0.2466        | 0.4361        | <b>0.0113</b> | 0.449         | 0.2486        | <b>0.0382</b> | 0.6466        |
| FOMC Rate Decision (Lower Bound)           | 0.0695        | 0.068         | 0.2143        | 1             | 0.35          | 0.9944        | 0.4566        | 0.8011        |
| FOMC Rate Decision (Upper Bound)           | 0.0695        | 0.068         | 0.2143        | 1             | 0.35          | 0.9944        | 0.4566        | 0.8011        |
| GDP Annualized QoQ                         | 0.5571        | 0.3942        | 0.6444        | 0.1792        | 0.057         | 0.6381        | 0.3629        | 0.1085        |
| <b>GDP Price Index</b>                     | 0.3611        | 0.6551        | 0.2832        | <b>0.031</b>  | 0.836         | 0.2078        | <b>0.0454</b> | 0.563         |
| Housing Starts                             | 0.6112        | 0.3325        | 0.686         | 0.686         | 0.449         | 0.3605        | 0.5112        | 0.4213        |
| Housing Starts MoM                         | 0.2334        | 0.1699        | 0.686         | 0.0651        | 0.686         | 0.4059        | 0.0954        | 0.6279        |
| <b>Import Price Index ex Petroleum MoM</b> | 0.0877        | 0.0594        | 0.0657        | 0.2628        | 0.2628        | <b>0.0435</b> | 0.4252        | 0.2444        |
| Import Price Index MoM                     | 0.3341        | 0.4266        | 0.2522        | 0.9935        | 0.1398        | 0.2314        | 0.8664        | 0.1755        |
| <b>Import Price Index YoY</b>              | 0.3178        | 0.8949        | 0.4289        | 0.4309        | <b>0.0256</b> | 0.1585        | 0.7307        | <b>0.0342</b> |
| Industrial Production MoM                  | 0.9205        | 0.831         | 0.443         | 0.686         | 0.6794        | 0.4743        | 0.774         | 0.3609        |
| Initial Jobless Claims                     | 0.2653        | 0.1653        | 0.2143        | 0.918         | 0.3492        | 0.157         | 0.7839        | 0.1978        |

data is exactly the same as in the previous examinations for single macroeconomic indicators. The economies for which both p-values are smaller than or equal to 5% are (in order of significance) the United States, the Eurozone, the United Kingdom and Japan, which means that the null hypothesis about the same distribution in the three periods with respect to the COVID-19 pandemic was rejected. In the case of China no significant differences in these periods were found. Somewhat "intermediate" cases are the German and Polish economies - in these examples the ANOVA test indicates definitely insignificant differences, while the Kruskal-Wallis test is significant at the level of 10%.

**Table 9:** P-values of Kruskal-Wallis, ANOVA, Kolmogorov-Smirnov and Anderson-Darling tests for United States (2/2)

| Indicator                                  | K.W           | ANOVA         | K.S_1         | K.S_2         | K.S_3         | A.D_1         | A.D_2         | A.D_3         |
|--------------------------------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| <b>Interest on Reserve Balances Rate</b>   | 0.0824        | 0.0749        | 0.1818        | 1             | 0.1818        | <b>0.0457</b> | 1             | <b>0.0354</b> |
| ISM Employment                             | 0.6242        | 0.6886        | 0.6667        | 0.5333        | 0.5817        | 0.5681        | 0.5275        | 0.6638        |
| <b>ISM Manufacturing</b>                   | 0.1287        | 0.1295        | 0.2581        | 0.4428        | <b>0.0298</b> | 0.2989        | 0.3414        | <b>0.0229</b> |
| <b>ISM New Orders</b>                      | <b>0.0434</b> | 0.2658        | <b>0.0351</b> | <b>0.049</b>  | 0.1637        | <b>0.0129</b> | 0.0803        | 0.2332        |
| <b>ISM Prices Paid</b>                     | <b>0.0419</b> | 0.057         | 0.0678        | 0.686         | 0.0678        | 0.0767        | 0.5974        | <b>0.0254</b> |
| ISM Services Index                         | 0.1067        | 0.1221        | 0.1398        | 0.6794        | 0.1364        | 0.1382        | 0.6982        | 0.0708        |
| JOLTS Job Openings                         | 0.1918        | 0.239         | 0.0678        | 0.4426        | 0.6804        | 0.1317        | 0.664         | 0.2581        |
| <b>Kansas City Fed Manf. Activity</b>      | 0.0991        | 0.1593        | <b>0.0177</b> | 0.2695        | 0.6601        | <b>0.0186</b> | 0.1405        | 0.5798        |
| <b>Labor Force Participation Rate</b>      | 0.0521        | <b>0.0411</b> | 0.093         | 0.3505        | 0.1548        | <b>0.0321</b> | 0.3298        | 0.2098        |
| <b>Leading Index</b>                       | <b>0.007</b>  | <b>0.0072</b> | 0.3568        | 0.3175        | <b>0.0057</b> | 0.2102        | 0.0886        | <b>0.0005</b> |
| Manufacturing (SIC) Production             | 0.7954        | 0.9839        | 0.9888        | 0.6546        | 0.8916        | 0.737         | 0.5727        | 0.6412        |
| MNI Chicago PMI                            | 0.23          | 0.3279        | 0.4435        | 0.9024        | 0.2628        | 0.2532        | 0.5425        | 0.1613        |
| <b>Monthly Budget Statement</b>            | 0.0628        | 0.346         | 0.2227        | 0.4216        | 0.061         | 0.0568        | 0.4559        | <b>0.0346</b> |
| <b>NAHB Housing Market Index</b>           | 0.1201        | 0.1735        | 0.9909        | 0.2074        | 0.1236        | 0.9731        | 0.0715        | <b>0.0377</b> |
| New Home Sales                             | 0.9156        | 0.9851        | 0.6794        | 0.686         | 0.9942        | 0.8126        | 0.7561        | 0.9777        |
| New Home Sales MoM                         | 0.3053        | 0.4056        | 0.4362        | 0.2628        | 0.6794        | 0.473         | 0.1449        | 0.6292        |
| NFIB Small Business Optimism               | 0.754         | 0.742         | 0.6794        | 0.6794        | 0.5311        | 0.8121        | 0.6172        | 0.4853        |
| Nonfarm Productivity                       | 0.609         | 0.6193        | 0.8663        | 0.2677        | 0.4188        | 0.7812        | 0.4751        | 0.2879        |
| <b>PCE Core Deflator MoM</b>               | 0.1804        | 0.1583        | 0.2378        | 0.0683        | 0.7076        | <b>0.0186</b> | 0.1985        | 0.3135        |
| PCE Core Deflator YoY                      | 0.5963        | 0.9192        | 0.1275        | 0.6964        | 0.9784        | 0.0907        | 0.5426        | 0.7773        |
| PCE Deflator MoM                           | 0.7685        | 0.79          | 0.9053        | 0.5889        | 0.7193        | 0.2599        | 0.1356        | 0.8617        |
| PCE Deflator YoY                           | 0.2844        | 0.5361        | 0.1256        | 0.3634        | 0.7518        | 0.086         | 0.1695        | 0.8456        |
| Pending Home Sales MoM                     | 0.8158        | 0.6056        | 0.9024        | 0.9935        | 0.8982        | 0.6324        | 0.888         | 0.7242        |
| Pending Home Sales NSA YoY                 | 0.673         | 0.3487        | 0.4398        | 0.9087        | 0.781         | 0.3799        | 0.861         | 0.7062        |
| Personal Consumption                       | 0.1163        | 0.3203        | 0.9495        | 0.2294        | 0.1305        | 0.868         | 0.1062        | 0.0546        |
| Personal Income                            | 0.2843        | 0.3714        | 0.1129        | 0.3127        | 0.2101        | 0.0523        | 0.2707        | 0.1503        |
| Personal Spending                          | 0.678         | 0.8254        | 0.8253        | 0.3447        | 0.2258        | 0.2539        | 0.1914        | 0.1629        |
| <b>Philadelphia Fed Business Outlook</b>   | 0.0868        | <b>0.0434</b> | 0.449         | 0.2581        | 0.1398        | 0.3676        | 0.2143        | <b>0.0289</b> |
| PPI Ex Food and Energy MoM                 | 0.206         | 0.0851        | 0.1236        | 0.6208        | 0.2273        | 0.1185        | 0.4236        | 0.084         |
| PPI Ex Food and Energy YoY                 | 0.4723        | 0.1908        | 0.8916        | 0.9909        | 0.6691        | 0.3704        | 0.6944        | 0.4358        |
| PPI Final Demand MoM                       | 0.0851        | 0.0898        | 0.24          | 0.9899        | 0.2497        | 0.0665        | 0.9196        | 0.0526        |
| <b>PPI Final Demand YoY</b>                | 0.1328        | 0.235         | 0.1249        | 0.8778        | <b>0.0272</b> | 0.0775        | 0.6319        | 0.0814        |
| Real Personal Spending                     | 0.1757        | 0.6699        | 0.2503        | 0.0976        | 0.1154        | 0.1401        | 0.0755        | 0.0514        |
| Retail Inventories MoM                     | 0.4232        | 0.7639        | 0.1877        | 0.9525        | 0.1287        | 0.2583        | 0.9526        | 0.1979        |
| Retail Sales Advance MoM                   | 0.7557        | 0.4813        | 0.4425        | 0.1315        | 0.6657        | 0.6313        | 0.1568        | 0.3665        |
| Retail Sales Control Group                 | 0.3802        | 0.3369        | 0.9924        | 0.4324        | 0.449         | 0.9828        | 0.1665        | 0.305         |
| <b>Retail Sales Ex Auto and Gas</b>        | 0.0791        | <b>0.0464</b> | 0.6794        | 0.0619        | 0.2532        | 0.284         | <b>0.0202</b> | 0.2773        |
| Retail Sales Ex Auto MoM                   | 0.2886        | 0.2016        | 0.8946        | 0.1305        | 0.4301        | 0.7714        | 0.0974        | 0.4145        |
| Richmond Fed Manufact. Index               | 0.3498        | 0.3933        | 0.2524        | 0.6794        | 0.4425        | 0.1311        | 0.4946        | 0.3196        |
| <b>S&amp;P CoreLogic CS 20-City MoM SA</b> | <b>0.0402</b> | <b>0.0216</b> | 0.2456        | <b>0.0105</b> | 0.2524        | 0.1768        | <b>0.0058</b> | 0.2194        |
| S&P CoreLogic CS 20-City YoY NSA           | 0.1227        | 0.1018        | 0.2628        | 0.4425        | 0.686         | 0.0598        | 0.2211        | 0.5328        |
| S&P CoreLogic CS US HPI YoY NSA            | 0.2159        | 0.2603        | 0.1429        | 0.5714        | 0.8571        | 0.0751        | 0.448         | 0.871         |
| Trade Balance                              | 0.3588        | 0.2939        | 0.4294        | 0.686         | 0.1354        | 0.3291        | 0.6974        | 0.1359        |
| U. of Mich. Current Conditions             | 0.8699        | 0.4701        | 0.879         | 0.9904        | 0.6491        | 0.6107        | 0.9854        | 0.4734        |
| U. of Mich. Expectations                   | 0.7509        | 0.6247        | 0.7299        | 0.6478        | 0.4458        | 0.7103        | 0.7167        | 0.34          |
| U. of Mich. Sentiment                      | 0.9769        | 0.8463        | 0.8456        | 0.8457        | 0.6905        | 0.8196        | 0.7684        | 0.5082        |
| <b>Unemployment Rate</b>                   | 0.1639        | 0.1696        | <b>0.0463</b> | 0.8588        | 0.4199        | 0.171         | 0.7705        | 0.162         |
| Unit Labor Costs                           | 0.532         | 0.5395        | 0.4892        | 0.8469        | 0.2057        | 0.4438        | 0.7722        | 0.2793        |
| Wholesale Inventories MoM                  | 0.6487        | 0.4644        | 0.8787        | 0.4998        | 0.8265        | 0.6047        | 0.5891        | 0.5095        |
| Wholesale Trade Sales MoM                  | 0.5499        | 0.5503        | 0.7863        | 0.2987        | 0.6074        | 0.7363        | 0.6027        | 0.4816        |

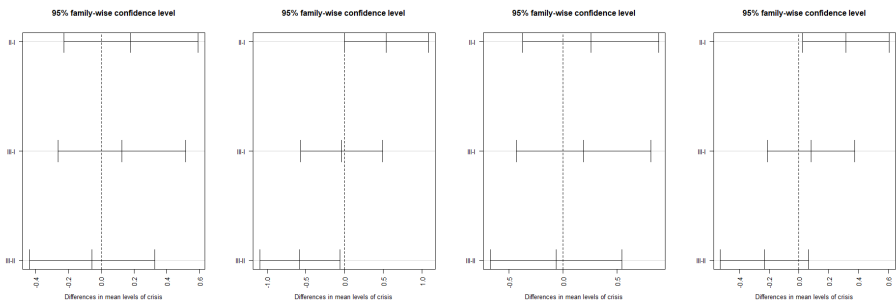
Figure 1 presents the results of the Tukey HSD test for China, the Eurozone, Germany and Japan. Analogously, Figure 2 refers to Poland, the United Kingdom and the United States. The groups have been assigned as follows: I – pre-crisis, II – crisis, III – post-crisis.

The Tukey HSD test provides more insightful information about differences in distributions than the ANOVA or Kruskal-Wallis tests. The Tukey HSD test does not only indicate whether there is a statistically significant difference between groups, but also helps to understand which pair of groups causes that result. For example, when we look at the chart for the Eurozone, we can prove that there is a statistically significant difference between

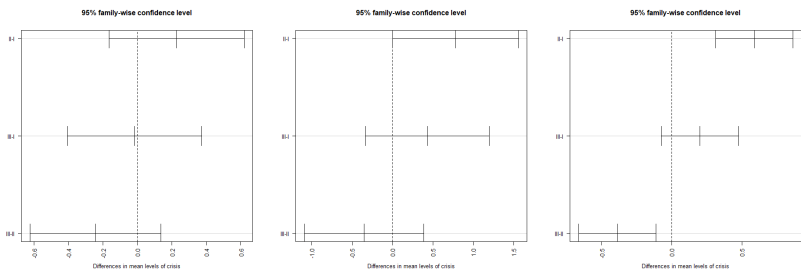
**Table 10:** P-values of Kruskal-Wallis, ANOVA, Kolmogorov-Smirnov and Anderson-Darling tests for Sentiment Indicator, per examined economies

| Country        | K.W           | ANOVA         | K.S_1         | K.S_2  | K.S_3         | A.D_1         | A.D_2         | A.D_3         |
|----------------|---------------|---------------|---------------|--------|---------------|---------------|---------------|---------------|
| China          | 0.5209        | 0.5656        | 0.6741        | 0.5824 | 0.2989        | 0.5828        | 0.5068        | 0.3246        |
| Eurozone       | <b>0.0013</b> | <b>0.0164</b> | <b>0.0393</b> | 0.7086 | <b>0.0018</b> | <b>0.006</b>  | 0.3777        | <b>0.0005</b> |
| Germany        | 0.064         | 0.6128        | <b>0.0235</b> | 0.1268 | 0.4016        | <b>0.0117</b> | <b>0.0248</b> | 0.1996        |
| Japan          | <b>0.042</b>  | <b>0.0322</b> | <b>0.0131</b> | 0.1422 | 0.2792        | <b>0.0083</b> | 0.2886        | 0.1829        |
| Poland         | 0.0746        | 0.249         | 0.0613        | 0.3991 | 0.0597        | 0.0642        | 0.2792        | 0.0527        |
| United Kingdom | <b>0.0098</b> | 0.0636        | <b>0.0252</b> | 0.1407 | 0.1595        | <b>0.0025</b> | 0.0502        | 0.0891        |
| United States  | <b>0</b>      | <b>0</b>      | <b>0</b>      | 0.3678 | <b>0.0018</b> | <b>0</b>      | 0.1575        | <b>0.0003</b> |

periods I/II and between periods II/III, while there is no evidence of a difference for pair I/III (this means that the difference in distributions of the sentiment indicator in periods I and III is statistically not significant).



**Figure 1:** Visualization of the results of the Tukey HSD test for China, Eurozone, Germany and Japan



**Figure 2:** Visualization of the results of the Tukey HSD test for Poland, the United Kingdom and United States

The interpretation of the above visualizations of the Tukey HSD test for economies under study is left to the reader.

For all economies, excluding China and Poland, we obtained significant differences between the distributions in the periods under consideration (as per Table 10). In the case

of China, the breach of 5% significance is quite large, although for Poland the differences are only slightly greater than 5%.

As can be seen from columns  $K - S_1$  and  $A - D_1$ , we should reject the null hypothesis for the same sentiment's indicator distributions before and during the crisis for the five economies considered. From the p-values in columns  $K - S_2$  and  $A - D_2$ , it follows that the sentiment's indicator distributions before and after the crisis are not significantly different (except for Germany in the Anderson-Darling test). Lastly, columns  $K - S_3$  and  $A - D_3$  indicate that the differences in distribution of the sentiment's indicator during the crisis and post-crisis time also appear, but not as significantly as in the pre-crisis versus crisis period.

Therefore, the sentiment indicator seems to be a good proxy of the state of the economy. This explanation might follow from the fact that the increased uncertainty of economic forecasts, which is an attribute of the crisis period, makes the results of analysts' projections less reliable. In other words, surprises in macroeconomic data releases follow different distributions in crisis and non-crisis periods. This conclusion is strongly supported by the p-values of the Kolmogorov-Smirnov and Anderson-Darling tests reported above for the three periods under consideration.

As observed in the previous section, the fraction of macroeconomic indicators exhibiting significant distribution differences in the periods under consideration was moderate across economies concerned. However, aggregation of individual surprises into country level sentiment makes most of the distribution differences strongly pronounced.

The next, final section summarizes the results, concludes and indicates future directions for research.

## 6. Conclusions

A striking observation based on the empirical results is the relatively small percentage of macroeconomic indicators exhibiting statistically significant differences in the distributions of the surprise indicator across all economic areas examined, taking into account the proposed division of the data sample into three sub-intervals (pre-pandemic, pandemic and post-pandemic). Strictly speaking, only 1 out of 26 indicators for China, 2 out of 26 for the Eurozone, 1 out of 33 for Germany, 4 out of 57 for Japan, 2 out of 26 for Poland, 8 out of 59 for the United Kingdom and 11 out of 101 for the United States.

However, when we consider the sentiment indicator defined in Section 5, we obtain a different picture. The economic areas for which we found a statistically significant difference with respect to the sentiment indicator in the three sub-periods are the United States, the Eurozone, the United Kingdom and Japan. Only China exhibits an insignificant difference in the sentiment indicator across these periods. In the case of Germany and Poland, the Kruskal-Wallis and ANOVA tests do not coincide, while the Kruskal-Wallis test is almost significant in both cases and ANOVA is definitely not significant. At the first glance, it might seem counter-intuitive that the aggregated approach leads to detecting more significant differences in distributions. However, in the case of the vast majority of the statistical tests, the power of the test as the function of the number of observations is strictly increasing. Furthermore, using the relevance factor as the weighting coefficient guarantees that

more important economic announcements are more impactful on the sentiment indicator's value than minor releases.

To the best of our knowledge, the methodology of the aggregated sentiment, where the relevance factors are used as the weighting coefficients has been applied for the first time. The second novelty of the paper is using the intraday data to calculate the sentiment.

The above-mentioned conclusions are also supported by the results of the Kolmogorov-Smirnov and Anderson-Darling tests, which were performed separately for individual macroeconomic indicators and aggregated sentiment. Therefore, the sentiment indicator seems to be more sensitive to the economic crisis, in comparison with the values of the surprise indicator per single category of macroeconomic data announcements.

The next observation based on the Tukey HSD test is that the pre-pandemic and post-pandemic periods with respect to the sentiment indicator are mostly convergent, while in most cases both significantly differ from the pandemic period.

We found no evidence that the importance of the macroeconomic data release, measured by the relevance indicator, impacts the distribution of the surprise indicator. Therefore, it is quite improbable that financial analysts' forecasts for the most important categories of macroeconomic indicators are of better quality than for the minor ones - neither the mean nor variance of the surprise indicator seems to be sensitive to the relevance factor.

As far as the direction of future research is concerned, we plan to examine the reaction of various asset classes (for example stocks, equity indices, bonds, foreign exchange rates, commodity prices, etc.) to macroeconomic data releases with a strong emphasis on the explanatory power of the sentiment indicator in selected periods to determine trends in prices and the volatility of securities. Intuitively, the higher the absolute value of the sentiment, the more pronounced the price, volatility and trading volume movements should be. Furthermore, the sign (positive or negative) of the sentiment indicator should explain the direction of the metric movements of the securities, mentioned above. We expect a sharper impact for negative surprises (in other words, sentiment indicator values below 0).

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