COVID-19 news announcements and the foreign exchange markets

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Abstract

This thesis entails an empirical study investigating the intraday effects of corona-virus pandemic news announcements on FX market price diffusion components, return, and volatility. The study examines explicitly the major foreign exchange market response to the COVID-19 news release, including pandemic figures related to new confirmed cases, number of deaths, progress of vaccine development and administration, government intervention measures to mitigate virus spread, and the World Health Organization senior official speech about pandemic progress. In addition, this paper investigates the context-specific effects of macroeconomic news. In other words, it examines the effects of important macroeconomic news on currency price components prior to and during the pandemic period.

The reason behind this is that the literature has reached a clear consensus about macroeconomic news's significant effects over time. The findings of this research contribute to both the empirical finance literature and the financial industry because they include insights into the behavior of foreign exchange market participants and international finance portfolio managers when analyzing the effects of unprecedented health, social and economic crises.

Previous literature shows that the stability of a country's foreign trade and its external environments impacts the exchange rate return and volatility. COVID-19 made financial markets more volatile as the pandemic increased uncertainty in foreign trade and foreign investment and intensified financial market risks. To have a clear picture of the impact of the COVID-19 pandemic on FX markets, we incorporate all the essential COVID 19 announcements in this study. Our analysis documents that COVID-19 pandemic indicators and government response policies profoundly impact FX market volatility than a return. Also, regarding vaccine development news, there is strong evidence of FX market reaction to phase 3and emergency approval news related to COVID-19 vaccine development news. There is no

evidence of market reaction to WHO official speeches about the COVID-19 pandemic in FX markets. The findings reveal that the FX market reacts to fewer macroeconomic news during the COVID-19 pandemic. However, the market reaction to US macroeconomic news is still state-dependent.

Keywords: COVID-19 announcements; FX market; macroeconomic news; exchange rate

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Table of Contents

List of Tables

List of Figures

Chapter 1 Introduction

COVID-19 caused a rapidly spreading global health emergency that made financial markets face unprecedented crises. COVID-19 disease, which started in Wuhan city in Hubei province of China in December 2019, quickly applied to almost 180 countries. The condition was declared a pandemic by the World Health Organization on March 11, 2020, and caused the death of thousands of people. However, the detrimental impact of the mentioned pandemic was not restricted to the health system and affected the global economy and financial systems as well.

Unlike the previous financial crisis of 2008 and sovereign debt crisis of 2017, COVID-19 induced shock originated outside of economic systems. The rapid spread rate of the COVID-19 pandemic and the uncertainty about treatment time and expected length of this pandemic exacerbated the situation. Induced delay in economic conditions caused a collapse in financial markets. This difference in nature of the crisis makes investigating COVID-19 pandemic indicators and pandemic-related news necessary in any study aiming to analyze the lasting effect of this pandemic on financial markets.

Investigating the process of price formation in financial markets has been one of the central questions in economics. (Anderson et al., 2007). In other words, how quickly and with what patterns general economic and financial news, including macroeconomic fundamentals, are incorporated into prices? Does the time of the news announcement matter? Is the market reaction to good and bad news similar in magnitude? Does the market react differently to the same information in different economic conditions? Make unscheduled announcements, public speeches of senior officials, and non-financial information have an essential role in price component diffusions in the financial market?

Several studies empirically investigated the price discovery process in financial markets to answer these questions.

Empirical results support a vital role of unscheduled news and macroeconomic news fundamentals on the return and volatility of the FX market (Andersen et al., 2003. Balduzzi et al., 2001. Bauwens et al., 2005. Ben Omrane & Hafner, 2014; Ben Omrane et al., 2019)

Motivated by this background, we will investigate price return and volatility reactions to COVID-19 announcements and macroeconomic news in the foreign exchange market. While exploring the impact of the COVID-19 pandemic on stock markets has been the focus of many studies, in this paper, we draw attention to its effect on exchange rate volatility and return to provide a comprehensive analysis of the impact of COVID-19. This focus on the foreign exchange market in this study is because of the profound effects of COVID-19 on the global economy and various sectors of society such as foreign trade, manufacturing, tourism, aviation, and health systems. As pointed out by previous studies, the stability of a country's business trade and external environment significantly impact exchange rate return and volatility. COVID-19 made financial markets more volatile as the pandemic increased uncertainty in foreign trade and foreign investment and intensified financial market risks.

We aim to study the effects of the COVID-19 pandemic on foreign exchange price diffusion components: return and volatility for major traded currency pairs, GBP, CAD, EURO, and Japanese Yen, all against USD. We will also study the response of these components to macroeconomic fundamentals during the pandemic period since the literature has reached a clear consensus about macroeconomic news's significant effects over time. (Ayadi et al., 2020; Ben Omrane and Savaşer, 2016, 2017; Fratzscher, 2009 amongst other).

To have a clear picture of the impact of the COVID-19 pandemic on FX markets, this paper incorporated all the essential COVID 19 announcements in this study, including COVID-19 pandemic indicators, vaccine development process news, government responses policies,

senior officials' speeches, and macroeconomic fundamentals. Considering the rapid spread of COVID-19, researchers have tried to quantify its ongoing influence on economic activities and the impact of government intervention policies such as restrictions on individual mobility and social distancing and pandemic indicators on economic activities.

Research has shown that unexpected news and information play a unique and significant role in exchange rate movements as a response to the rapid spread of COVID-19 various countries implemented measures to control transportation and individual movements that made international trade and the economy more unpredictable, which can have a considerable impact on exchange rate fluctuation.

In this study, we focus on several questions. Can pandemic indicators explain price component diffusions in foreign exchange markets during the COVID-19 pandemic? Does unscheduled news related to vaccine process development affect primary currency return and volatility? Do government intervention policies and World Health Organization senior officials' speeches significantly impact FX market price return and volatility. Are some pandemic news indicators more prominent than others? Is there any state-contingent effect? In other words, are FX return and volatility responses to macroeconomic news changing over time and, more specifically, during the COVID-19 pandemic? Specifically, the objective of this paper is as follows:

(1) Examine the importance of economic conditions during the pandemic by analyzing the effects of pandemic indicators such as the number of COVID-19 confirmed cases, deaths, and vaccination rate on the foreign exchange market.

(2) Quantify the pandemic-related news, including the vaccine development, for major vaccine-producing companies, including Pfizer, Moderna, Novavax, Johnson & Johnson, and Oxford-AstraZeneca, and analyze their effects on foreign exchange price diffusion components.

(3) Investigating the impact of government intervention policies and World Health Organization senior officials' speeches on foreign exchange price return and volatility.

(4) Investigate the impact of macroeconomic news announcements on the foreign exchange market.

(5) Examine macroeconomic news context-specific effects by comparing macroeconomic news effects before and during the COVID-19 pandemic.

To analyze the potential link between each price diffusion component with the pandemic announcements and macroeconomic news fundamentals, we estimate the conditional mean response and volatility adjustment of 5-min returns to those factors following the framework suggested in Andersen et al. (2003) and recently implemented by Ben Omrane & Savaşer (2016) among others.

To conduct the empirical analysis, we use a high-frequency 5-min intraday exchange rate dataset purchased from Olsen & Associates, consisting of the Euro, British pound, Canadian dollar, and Japanese yen, all quoted against the US dollar. The reason to implement high-frequency data is that the literature shows that intraday data are more appropriate for studying macroeconomic news effects in currency markets; lower frequency data may not capture all the variation in price components. The data spans January 1, 2017, to June 30, 2021. This paper uses tradable quotes for the bid and ask spot exchange rates, and the midpoint price is computed by taking the average offer and ask prices.

We collect the most prominent COVID-19 pandemic indicators from the Bloomberg service. COVID-19 pandemic indicators could be considered proxies indicating how severe the pandemic spread hits a country. Our sample consists of the number of confirmed COVID-19 cases, the number of COVID-19 related deaths, and COVID-19 vaccine doses administrated in the US, Great Britain, Japan, Canada, and Germany.

We also include all news related to three main phases of the vaccine development process (phase 1, phase 2, and phase 3 according to the verified vaccine development process, and the FDA[1], EMA[2], and WHO[3] emergency approval news for major pharma companies, including Pfizer, Moderna, Novavax, Johnson & Johnson, and Oxford-AstraZeneca. Also, WHO senior officials' speeches related to the COVID-19 pandemic are included in this study. We gathered COVID-19 vaccine news headlines and WHO speeches from the FACTIVA global news monitoring and search engine, using the Reuters news agency as the source of the news release from January 1, 2020, to June 30, 2021, which includes the entire pandemic period composing this study. The Oxford COVID-19 Government Response Tracker panel database provides government response policies data. We implement COVID-19 vaccine development news published on Reuter's service in our study in addition to the most prevalent pandemic indicators.

Macroeconomic news data will include major macroeconomic news announcements related to the US, Canada, UK, Germany, and Japan. These figures will be linked to actual economic activity, employment, prices, production, monetary policy, and other vital indicators.

The novelty of our study stems from the fact that we analyze the impact of disease outbreak indicators and news, which may have valuable information about possible pandemic effects on exchange rate price movements in conjunction with a broad number of indicators, COVID-19 health news, and currency pairs.

There is growing literature investigating the effects of pandemic factors on stock markets, bond markets, and foreign exchange markets during the COVID-19 pandemic. Most of them only used a limited number of pandemic indicators such as infection numbers or the number of deaths as their proxy for the effects of the pandemic. Although some studies investigated the

[1] The United States Food and Drug Administration
[2] European Medicines Agency
[3] World Health Organization

impact of pandemic-related news, such as panic index, Google search volume, and government response policies on stock and bond markets, studying the effect of COVID-19 pandemic indicators and information on the FX market is sparse and not conclusive. To bridge the gap, we incorporated broad categories of news and pandemic indicators in this study to have a clearer image of the impact of the pandemic on the foreign exchange market. At the time of this work, we have not found any study that has implemented vaccine development, pandemic indicators, and macroeconomic news to study the reaction of price diffusion components in the foreign exchange markets. We also extend previous research relating context-specific effects (state-dependent) of macroeconomic information to the pandemic. Papers showing macro news announcements are state dependent include Ayadi et al. (2020), Bacchetta et al. (2013), Ben Omrane & Savaşer (2016, 2017), and Charles et al. (2012).

The remainder of this thesis is organized as follows. Section 2 reviews the relevant literature. Section 3 provides information about the COVID-19 pandemic factors and foreign exchange data. Section 4 describes the methodology, section 5 explains empirical results, and the last section concludes the paper.

Chapter 2 Literature review

Due to panic induced by COVID-19 pandemic and the resulting deterioration of economic conditions, investors changed their investing patterns, which, combined with a change in consumption expenditure, led to more volatile financial markets during the pandemic (Sharma et al., 2019). Foreign exchange markets have been exposed to this situation, and COVID-19 had a substantial and positive impact on the volatility of exchange rates (Corbet et al., 2020). There is growing literature investigating the effects of COVID-19 induced shocks on foreign exchange markets**.** One branch of studies compared the return and volatility of the foreign exchange market before and during COVID-19 periods (Bartsch, 2019; Ilzetzki et al., 2020; Konstantakis et al., 2021; Narayan et al., 2020).

Some studies show that COVID-19 doubled the duration of the high volatility state in comparison with the pre-COVID-19 era. Moreover, the volatility range is statistically significantly higher in the high volatility state in this period (Konstantakis et al., 2021). In another study, Ilzetzki et al. (2020) claim exchange rate volatility has been trending downwards since 2014. Even during the COVID-19 period, this trend remained stable, and he described this result as unusual because exchange rate volatility increases during US recessions. They attribute this result to the convergence in monetary policy, reflected in a sharp reduction of inflation and short and long-term interest rate differentials, and consider the shutdown of financial volatility as the leading explanation.

Many empirical papers have documented the relation between macroeconomic news and asset price movements. (Andersen et al., 2003; Balduzzi et al., 2001; Bauwens et al., 2005; Ben Omrane & Hafner, 2014; Ben Omrane et al., 2019; Faust et al., 2007; Han et al., 2008). Convincing evidence links high-frequency exchange rate dynamics and fundamentals by

showing that macroeconomic announcement surprises produce conditional mean jumps in US dollar spot exchange rates in several foreign currencies (Andersen et al., 2003).

Bauwens et al. (2005) investigate the effect of a broad category of scheduled and unscheduled news announcements on the euro/dollar return volatility. They suggest pre-announcement, contemporaneous, and post-announcement reactions by distinguishing between the impact on the volatility of scheduled and unscheduled news. The document increased volatility before the expected announcement in the pre-announcement era.

Although earlier studies in this area focused on the impact of macroeconomic fundamentals on currency market components, recent studies investigate the context-specific effect of that news. State dependency on the impacts of macroeconomic information on the foreign exchange market has been found in several studies. Ben Omrane et al. (2019) documents the effect of 70 US and EU (European Union) macroeconomic news announcements on euro/dollar return and volatility over ten years, including the US mortgage crisis and EU sovereign debt crisis. They demonstrate an asymmetrical effect between recessions and expansions for both news categories, while US news had twice as significant impacts as EU announcements. In another study, Ben Omrane & Savaşer (2017) study the volatility reaction of major currency markets to US macroeconomic news in the 2008 global financial crisis. They that forex volatility responds to most news categories in an expansion period while the response to Fed funds rate and new home sales depends on the state of the economy, attributed to context-specific relevance of those indicators in the 2008 global financial crisis. In a comprehensive study of the impact of many US and EU macroeconomic news announcements on euro/dollar return and volatility, Ben Omrane et al. (2019) show that most news is unstable in different economic states. Their study period includes the US mortgage crisis and the EU sovereign debt crisis. Similarly, Cheung et al. (2019) study the state-dependent impact of the US and Japanese macro news before and after the financial crisis on the JPY/USD. Their study suggests that while US

macro news is more important during regular times than a crisis, Japanese macro information is almost irrelevant.

As COVID-19 has a significant impact on financial markets, the reaction of market components to macroeconomic fundamentals might be different in this era. This paper aims to complete the state-dependent news effects documented in the studies in the COVID-19 age by demonstrating evidence from the most traded currency pairs.

Another branch of studies in COVID-19 literature focuses on the impact of pandemic news and indicators on volatility, return, and adjustments of foreign exchange markets during a pandemic. This paper contributes to this second strand of literature and investigates intraday return and volatility reaction to pandemic indicators and news.

Several studies document meaningful support for the role of news in predicting exchange rate volatility and return. For instance, previous global financial crises, global or regional health problems, terrorist attacks, and government shutdowns contain valuable exchange rate volatility and return prediction information. (Ben Omrane & Savaşer, 2017; Chen et al., 2007; John & Li,2021; Narayan et al., 2017; Sharma et al., 2019).

As mentioned earlier, the significant role of news, both scheduled and non-scheduled news, cannot be ignored when studying the movements in financial or economic variables. Previous studies examined the effects of unscheduled information on foreign exchange components during the financial crisis. For instance, Melvin et al. (2009) provides an overview of the remarkable events of the 2008-2009 global financial crisis and their implications for the foreign exchange market dynamics. They developed a financial stress index to depict the nature of the crisis and showed that this index has potential value in hedging portfolios against loss during stressful periods.

Naderi Semiromi et al. (2020) study the role of news story events in the economic calendar on predicting intraday directional movements of currency pairs. They documented news's significant role in increasing forecast accuracy in foreign exchange markets. Their results emphasize news-based trading behavior. In a recent study, Umar & Gubareva (2020) examined the impact of the COVID-19 induced pandemic on primary currency and cryptocurrency markets using the panic index. They argue that cross-currency hedge strategies, which work under normal conditions, are likely to fail during a global crisis such as the COVID-19 pandemic.

Related to government policies' impact on foreign exchange markets, Feng et al. (2021) explore the effect of the COVID-19 pandemic and government policy responses on the exchange rate volatility of 20 countries during a current pandemic. The paper suggests that increased confirmed cases and government policies such as restrictions on internal movement, closing schools, and public information campaigns induce exchange rate volatility. In contrast, economic response policies such as income support have a restraining effect on exchange rate volatility. Haroon et al. (2020) also studied the relation between COVID-19 media coverage and financial market behavior. Their results suggest that panic generated by the news is significantly associated with equity market volatility.

Motivated by this background, we investigate the relationship of unanticipated events with understanding exchange rate movements during COVID-19. Not only are disease outbreaks unexpected, but the magnitude of their impact cannot be predicted, which indicators of the disease are more important than others.

The novelty of this study stems from analyzing the impact of several disease outbreak indicators and COVID health news on exchange rate price movements on several currency pairs. Although some studies investigated the effect of pandemic-related news such as panic

index, Google search volume, and government response policies on stock and bond markets, studying the impact of COVID-19-related information on the FX literature is sparse inconclusive. To bridge the gap, we implement COVID-19 vaccine development news published on Reuter's service in our study, in addition to the most prevalent pandemic indicators. This choice is that we believe sophisticated investors such as those operating in the FX market rely primarily on professional news services such as Bloomberg and Reuters as their source for acquiring information. In contrast, retail investors who are especially active in stock markets are usually affected by news from Google searches and Twitter (Deb, 2021). We have not found any study that has used vaccine development and pandemic indicators to gauge the reaction of forex market components. We also extend the analysis to a broader number of indicators and news for major currency pairs, which permits a more comprehensive study of the impact of a pandemic on the foreign exchange market.

Chapter 3 Data

Our dataset spans from January 1, 2017, to June 30, 2021. The dataset includes five types of data: (i) Five-minute spot exchange rate of return for four currencies pairs, EUR/USD, GBP/USD, JPY/USD, and CAD/USD, (ii) COVID-19 pandemic indicators, (iii) COVID-19 vaccine development process news, and (iv) Government response policies and WHO official's speeches and (v) Macroeconomic news data of the US, UK, Germany, Canada, and Japan. In the following sections, each data category is described in more detail.

3.1 Exchange rate dataset

This paper uses a high-frequency 5-minute intraday exchange rate dataset provided by Olsen & Associates LLC, which consists of the Euro, British pound, Canadian dollar, and Japanese yen, all quoted against the US dollar. The data corresponds to Eastern Standard Time (EST) from January 1, 2017, to June 30, 2021. The trading day starts at 00:00 EST and ends at 23:55. There are 288 5-minute intervals every 24 hours. We use tradable bid and ask spot exchange prices, and the midpoint price is calculated by taking the average bid and ask prices. The percentage returns ($R_{t,n}$), at time interval n on date t, is calculated as the difference between the natural logarithms of the prices at time n-1 and n, which then is multiplied by 100, and volatility at time t, volatility is the absolute value of the intraday return ($R_{t,n}$).

The reason to use the intraday return to analyze return and volatility reaction to the news is that the price adjustment to the information in the FX market usually happens very quickly, and daily returns may lose the variation in coefficients that capture the response to news (Omrane & Savaşer, 2017). Therefore, where return reaction to announcements is rapid, the use of more expansive windows may contaminate announcement effects as longer intervals might incorporate results from other events, which would lead to a biased estimated coefficient.

We exclude weekends and US statutory holidays following the literature to filter returns from price anomalies.[4]And the first interval of Monday and those after 21:00 on Friday because of low trading activity (Ben Omrane et al., 2019).

Table 1 presents the summary statistics of 5-min exchange rate returns between January 1, 2017, and June 30, 2021, for all the currency pairs in this study.

[insert Table 1 here]

3.2 COVID-19 Pandemic indicators dataset

We collect the most prominent COVID-19 pandemic indicators from the Bloomberg economic calendar service. COVID-19 pandemic indicators could be considered proxies showing how severe a country is affected by the spread of COVID-19. The sample includes data for the number of confirmed COVID-19 cases, the number of COVID-19 related deaths, and COVID-19 vaccine doses administrated in the US, Great Britain, Japan, Canada, and Germany. We have 527 observations for each of the "number of confirmed cases" and "number of deaths" pandemic indicators for all the countries in our sample. However, as governments started COVID-19 vaccination at various times, we have 199, 192, 186, 192, and 133 observations for the US, UK, Germany, Canada, and Japan. COVID-19 was declared a pandemic by WHO on March 11, 2020; however, countries started reporting COVID-19-related statistics from January 22, 2020, as the disease spread globally. To avoid missing the

[4] The 10 US statutory holidays deleted are New Year's Day, Martin Luther King's Day, Presidents Day, Memorial Day, Independence Day, Labor Day, Columbus Day, Veterans Day, Thanksgiving Day, and Christmas Day.

possible impact of COVID-19 on FX markets, we collect pandemic-related data from January 22, 2020[5]For each country.

The numbers of confirmed cases and deaths in most countries have increased exponentially. The number of confirmed deaths in some countries within a period is 0, and the total population of each country is different. Therefore, to have smooth explanatory variables for each pandemic indicator, we divided daily changes over its 7-day moving average to measure the slowdown or development of the COVID-19 pandemic.

Fig. 2,3, and 4 show the growth trend of confirmed cases, deaths, and vaccination rates for each country in the sample.

3.3 COVID-19 vaccine news dataset

I include COVID-19 vaccine development news related to major vaccine-producing companies (Pfizer, Moderna, Novavax, Johnson & Johnson, and Oxford-AstraZeneca) as unscheduled news events for the COVID-19 vaccine development process over the sample period. An indicator variable is defined that takes the value "1" on the interval when there is essential vaccine development news and "0" else. I include all the information related to the vaccine development process (phase 1, phase 2, phase 3 according to the verified vaccine development process of the World Health Organization), and FDA, EMA,[6], and WHO[7] Emergency approval news. In more detail, our sample consists of all the headlines related to enrolment, initiation, pauses, and resumptions of trial studies of each phase, interim, final, and revisions of results related to each step, and companies' decisions to file for approvals, updates about approval decision progress and official emergency approval news for all the companies in my sample. I

[5] Since January 1, 2020, the novel coronavirus, known as COVID-19, has spread from the People's Republic of China to 20 other countries. On January 30, 2020, following the recommendations of the Emergency Committee, the WHO Director-General declared that the COVID-19 outbreak constitutes a Public Health Emergency of International Concern (PHEIC).
[6] European Medicines Agency.
[7] World Health Organization.

gather COVID-19 vaccine news headlines from the FACTIVA global news monitoring and search engine, using the Reuters news agency as the source of the news release from January 1, 2020, to June 30, 2021. Then, by investigating the content of each news release, the most prominent headlines related to each category of vaccine development for each vaccine producing company (Pfizer, Moderna, Novavax, Johnson & Johnson, and Oxford-AstraZeneca) are selected based on a related keyword. There are 200 COVID-19 vaccine development news headlines used in this study.

Table 2 summarizes the number of headlines related to each category of vaccine development news for each company.

[insert Table 2 here]

3.*4 Government response policies and WHO officials' speeches*

Control measures and the timeline of implementing government policy responses adopted by each country for controlling the spread of the COVID-19 pandemic and its detrimental effects on the economy are different. There are several types of policies, such as lockdowns, international border closure, school and workplace closing, and economic support initiatives, that different countries have adopted during the global pandemic of COVID-19. To have a measure to control the impacts of these policies on price variations in FX markets, following Feng et al. (2021), this paper uses the (OxCGRT)[8]A database provided by Oxford University records all categories of government response policies for each country to evaluate how the government's response changes over time. To be more precise, OxCGRT categorizes the pandemic prevention measures taken by each government and classifies them into 17 variables

[8] Oxford COVID-19 Government Response Tracker

and three groups: Containment and closure, economic response, and health systems.[9]. Each of these groups is as follows:

Containment and closure include school closings (C1), workplace closings (C2), canceling public events (C3), restrictions on gathering size (C4), public transport closure (C5), stay at home requirements (C6), rules on internal movement (C7), and restrictions on international travel (C8).

The economic response category contains four indicators: income support (E1), debt/contract relief for households (E2), fiscal measures (E3), and giving international support (E4).

The last item is health systems, covering public information campaign (H1), testing policy (H2), contact tracing (H3), emergency investment in health care (H4), and investment in COVID-19 vaccines (H5). (Hale et al., 2021) The indicators mentioned above are of two types: Ordinal and numeric.[10] Four indices in the OxCGRT tracker database are calculated based on different variables in each of the main categories mentioned above. To have a comprehensive set of indicators in this study, I include the overall government response index (GR), and the simple averages of the individual component indicators.[11] The way each index is calculated is presented in Table 3. For example, the stringency index, ST, combines nine response indicators, containing all indicators under the Containment and closure category and the H1 indicator, which belongs to the health systems category. The score ranges from 0 to 100, and the higher the score is, the more stringent the government response is to the COVID-19 pandemic (Feng et al., 2021). To smooth government response policy variables, we calculated each variable as the difference between the announced value of each variable and its average divided by standard deviation of difference.

[9] See the Appendix for more.
[10] 5 Among the 17 specific indicators, E3, E4, H4, and H5, are measured by number. The remaining indicators measure policies on a simple scale of severity/intensity.
[11] See the Appendix for specific classification and composition.

Table 3 shows the composition of each government response index, and Table 4 presents a definition of each component.

[insert Tables 3 and 4 here]

Another type of unscheduled news that we use in this study is World Health Organization officials' speeches collected from the FACTIVA news service. This dataset includes 93 news headlines related to the worldwide situation of the COVID-19 pandemic addressed by World Health Organization senior officials.

Table 5 shows the name and position of each speaker and the number of news headlines for each of them used in this study.

[insert Table 5 here]

3.5 Macroeconomic news dataset

The macroeconomic news dataset is collected from the Bloomberg economic calendar and includes released and traders' forecasts values of macroeconomic fundamentals from the US, Germany, UK, Canada, and Japan. Some US macroeconomic news, such as Nonfarm Payrolls, Consumer Confidence Index, and New Home Sales, are monthly. However, some other types, such as news releases related to GDP, are announced quarterly. Most US and Canadian announcements occur at 8:30 am, and 10:00 am EST. Most European news is announced at 2:00 and 5:00 am EST. The sample period starts from January 1, 2017, to June 30, 2021. Following the literature, this paper uses the surprise value of each macroeconomic news indicator. The surprise component of each macroeconomic news is calculated as the difference between the announced value of the indicator and its median forecast from the MMS survey, which is divided by the sample standard deviation of this difference (Balduzzi et al., 2001).

This thesis considers the most relevant macroeconomic announcements in the currency market following Andersen et al. (2003, 2007), Ben Omrane & Savaşer (2017), and the related literature. As there is strong support for the role of US macroeconomic news impact on FX markets, we use both US and country-specific macroeconomic announcements for each currency pair.

Table 6 summarizes scheduled macroeconomic news announcement groups for the US, Japan, Germany, Canada, and the UK from January 1, 2017, to June 30, 2021.

[insert Table 6 here]

Chapter 4 Methodology

To analyze the impact of macroeconomic news announcements, COVID-19 pandemic indicators, COVID-19 vaccine development process news, and government response policies on the return and volatility of the currency market. I follow the framework suggested by Andersen et al. (2003) and recently implemented by Ben Omrane et al. (2019). Following Andersen et al. (2003), we model intraday return ($R_{t,n}$) accurately as a linear function of lagged values, macroeconomic announcements, COVID-19 pandemic announcements, and the World Health Organization public communication.

I first estimate the conditional mean of the 5-minute returns ($R_{t,n}$). According to the literature, conditional mean adjustments of exchange rates to macroeconomic announcements occur within a few minutes of the news release (Andersen et al., 2003, 2007). The return responses are modeled as follows:

$$R_{t,n} = \varphi_0 + \varphi_1 R_{t,n-1} + \sum_{m=1}^{M} \alpha_{1,m} Unsch_{m,t,n-1} + \alpha_2 \text{Cases}_{t,n-1} + \alpha_3 \text{Vaccination}_{t,n-1} + \alpha_4 \text{GR}_{t,n-1} + \alpha_5 \text{W}_{t,n-1} + \sum_{i=1}^{I} \sum_{k=1}^{K} \beta_{1,i,k} News_{k,t,n-1} PAND + \sum_{i=1}^{I} \sum_{k=1}^{K} \beta_{2,i,k} News_{k,t,n-1} NOPAND + \varepsilon_{t,n} \quad (1)$$

Where $R_{t,n}$ represents a 5-minute return in day t and time intervals n and $\varphi_0$is the intercept. $R_{t,n-1}$ is the lagged return with coefficient φ_1. $Unsch_{e,t,n-1}$ denotes the vaccine-producing development variable, and *m* represents the vaccine news announcement type *m* at day t and interval n-1. Here M=30 as I consider five vaccine-producing companies (Pfizer, Moderna,

Novavax, Johnson & Johnson, and Oxford-AstraZeneca) and six categories of news announcements (Phase1, Phase2. Phase 3, WHO, EMA, and FDA approval). The dummy variable takes the value of 1 if there is a news headline related to the COVID-19 vaccine-producing process and zero otherwise. Therefore, the total number of vaccine development news can be obtained by summing the dummies for all companies and categories of news. $\text{Cases}_{,n-1}$ represents smoothed COVID-19 confirmed cases, a difference between changes in the daily number of COVID-19 confirmed cases minus its sample average divided by its standard deviation for each country at date t and time interval $n-1$.

Moreover, COVID-19 vaccine doses administrated in each country, $\text{Vaccination}_{s,n-1}$ shows smoothed variable for vaccination rate at date t and time interval $n-1$and $\alpha_2.\alpha_3$, represent their coefficients respectively. To measure the impact of all the government response policies on the return of the FX market for each currency pair, this paper implements the overall government response index (the $\text{GR}_{t,n-1}$), which is the simple average of the individual component indicators at day t and interval n-1 where α_4 is its coefficients. We smoothed this variable by taking out its average and dividing the difference by its standard deviation. Finally, $\text{W}_{t.nthe-1}$ represents a dummy variable for WHO officials' speeches. It takes value one if there is a headline on day t and time interval n-1 and 0 otherwise, and $\alpha_5$is the coefficient.

To interpret the conditional mean adjustment of exchange rates to macroeconomic announcements during the COVID-19 pandemic period and examine the state-dependency of the FX market on macroeconomic announcements, I split the sample period into PAND, and NOPAND, which are the predefined dummies representing the COVID-19 pandemic and pre-pandemic periods. $News_{,t,n-1}$ represents the macroeconomic news surprise component k on day t for country i. Due to the importance of US macroeconomic news, I consider US macroeconomic announcements while studying all the currency pairs in addition to country-

specific macroeconomic announcements. Here, $\beta_{1,i,k}$ and $\beta_{2,i,k}$ represent coefficients for pandemic and pre-pandemic periods, respectively. To be consistent with the literature, the news surprise component is calculated as the difference between actual and forecasted values divided by the standard deviation of its difference. To be more precise, $S_{k,t}=\frac{A_{k,t}-F_{k,t}}{\hat{\sigma}_k}$, where $A_{k,t}$is the actual or released value of news k at time t, $F_{k,t}$ denotes the forecasted news figure, $\hat{\sigma}_k$is the standard deviation of difference for news k, and $\varepsilon_{t,n}$ is the residual term which is conditionally heteroskedastic. The error term distribution ($\varepsilon_{t,n}$) is normal with a 0 mean, i.e., $\varepsilon_{t,n}\sim N(0, \sigma 2)$.

Equation (2) is estimated using a 2 step least square. First, we estimate Equation (1) then we use absolute values of the residuals from Equation (1) as a measure of volatility to estimate Equation (2). We approximate the volatility using the following model:

$$
\begin{aligned}
|\varepsilon_{t,n}| = \omega_0 + \sum_{m=1}^{M} \alpha_{1,m}\, Unsch_{m,t,n-1} + \alpha_2\, \mathrm{Cases}_{t,n-1}\, \mathrm{Vaccination}_{t,n-1} \quad + \alpha_3 \mathrm{W}_{t,n-1} \\
+ \alpha_4 \mathrm{GR}_{t,n-1} + \sum_{i=1}^{I} \sum_{k=1}^{K} \upsilon_{1,i,k}\, |News_{k,t,n-1}|\, PAND \\
+ \sum_{i=1}^{I} \sum_{k=1}^{K} \upsilon_{2,i,k}\, |News_{k,t,n-1}|\; NOPAND + \delta_1 n + \delta_2 n^2 \\
+ \sum_{d=1}^{D} \lambda_d\, DW_{d,t} + \sum_{p=1}^{P} (\delta_{c,p} \cos\, (\frac{2\pi p}{N} n) \; + \delta_{s,p} \sin(\frac{2\pi p}{N} n)) \; + \; e_{t,n}
\end{aligned}
\tag{2}
$$

The volatility $|\varepsilon_{t.n}|$ is estimated from the absolute value of the residual term from Equation (1). The right-hand side of Equation (2) includes five components: COVID-19 vaccine news dummy variables, COVID-19 pandemic indicators, government response policies and officials' speeches, macroeconomic news surprises, and seasonality controlling elements. The first component involves vaccine news dummy variable $Unsch_{m,t,n-1}$and the

COVID-19 pandemic indicators. Government response policies indicator $\mathrm{GR}_{t,n-1}$, and $\mathrm{W}_{t,n-1}$ are WHO officials' speeches variables, all described in Equation 1. The absolute value of macroeconomic news surprise element $|News_{k,t,n-1}|$ is multiplied by the COVID-19 pandemic state dummies ($PAND$, $NOPAND$), and $\upsilon_{1,i,k}, \upsilon_{2,i,k}$ are their coefficients, respectively.

Due to different trading times during the 24 hours in the global foreign exchange markets, there is a strong seasonality pattern while using intraday 5-minute return data. We have a new set of dummy variables $DW_{d,t}$ to obtain day-of-the-week effects, which control varying trading volumes over the week. This paper uses a Fourier flexible Form of order 4 for the calendar-effect pattern following the literature. Because of the 24-hour trading in currency markets, 5-minute returns display intraday seasonality patterns that require control. I control the cyclical seasonality pattern using the Flexible Fourier Form or FFF (the sum of sine and cosine terms). Laakkonen (2013) compares different methods to capture intraday seasonality and suggests that the FFF method is the best tool for controlling seasonality.

The use of the FFF method imposes a polynomial function for the response pattern to ensure that all the response patterns are fully incorporated within the response window. This model includes $\cos(\frac{2\pi p}{N} n)$ and $\sin(\frac{2\pi p}{N}\ n)$ with coefficient $\delta_{c,p}$ and $\delta_{,s,p}$. The value of p is determined according to the Schwarz and Akaike information criteria and is set to 5. The n and n^2 are divided by normalizing factors n_1, $n\ _2$, which are calculated as $n_1 = \frac{N+1}{2}$ and $n_2 = \frac{(N+1)(N+2)}{6}$ (Andersen & Bollerslev, 1997).

The results of conducting equations (1) and (2) would allow me to answer the questions of my study and deduce whether COVID-19 pandemic indicators and vaccine development news can explain movements in foreign exchange markets during the pandemic. Also, I would be

able to examine the context-specific effects of macroeconomic information during the pandemic.

Chapter 5 Empirical analysis and discussion of results

5.1 Preliminary analysis

Before conducting the primary analysis, we perform the following steps to better understand the relationship between macroeconomic news, covid-19, and price diffusion components (return and volatility). First, we compute the volatility in FX markets before and during COVID-19 pandemic periods and macroeconomic news days, COVID-19 news days, and non-news days. (Table 7). Then, we run a contemporary equation for return and volatility on covid-19 variables (confirmed cases, deaths, and vaccination rate) to better observe the link between COVID-19 pandemic indicators and price components diffusion during the pandemic period. Results of this preliminary analysis are provided in Tables 8 and 9. Table 9 shows a significant impact of COVID-19 pandemic indicators on all currency pairs' foreign exchange market volatility. All the coefficients are statistically significant for all variables for each currency pair except the JPY/USD. In contrast to volatility, COVID-19 pandemic indicators cannot explain FX returns.

However, instead of using all the COVID-19 announcements, including COVID-19 pandemic indicators and governments response policies, in one model, we use them independently in each Equation to determine each variable's impact exclusively. We consider a set of alternative indicators suggested by the existing literature. The correlation matrix is provided in Table 10, where there is a medium to strong correlation between the COVID-19 pandemic indicators variable category and government response policies variables and between variables in each category. Also, COVID-19 demonstrated that issues are highly correlated with deaths related to COVID-19. This high correlation between COVID-19 announcements is not surprising as government response policies to control the COVID-19 spread can affect

COVID-19 confirmed cases in each country, which subsequently impact COVID-19 deaths. Therefore, using all these variables in one Equation simultaneously can reduce the precision of the estimated coefficients and lessen the validity of the results. Therefore, as described in detail in the methodology section, we use COVID-19 confirmed cases, COVID-19 vaccine doses administrated, and the overall government response policy for each country in the main equations. Then, for a robustness check of the results of the study, we alter COVID-19 confirmed cases with COVID-19 deaths and the overall government response policy with the stringency index. We discuss the empirical results of each Equation in subsequent sections.

[Insert tables 7,8, 9, and 10 here]

5.2 Main equations results

This section presents and discusses the empirical results of our analysis. In the first part, I present the estimated results from the conditional mean model (Eq. (1)) for COVID-19 announcements to determine the impact of the COVID-19 pandemic on FX market return over our sample period. In the second part, I investigate whether there is a systematic change in the volatility reaction of exchange rates to COVID-19 announcements.

5.2.1 Results from conditional mean model

First, we discuss the estimated parameters from Equation (1) which employs COVID-19 pandemic announcements (daily new cases and vaccine doses administrated) impact on returns in the foreign exchange market.

As documented in Tables 11,12,13 and 14, when investigating the impact of COVID-19 vaccine development news from the major pharma companies on foreign exchange market returns, we observe that information related to the announcement of EMA emergency approval

for the Moderna vaccine caused a negative movement in return of the euro against the US dollar. We can attribute this result to the appreciation of the dollar because of the positive news for a US-based COVID-19 vaccine.

We can observe a similar negative impact for news related to phase 1 of AstraZeneca and Moderna on the return of GBP/USD. Also, phase 1 and EMA emergency approval of Moderna; and phase 1 studies of Moderna had a negative impact on the relation of CAD, and JPY all against the US dollar respectively. However, the EMA emergency approval of Pfizer has a positive impact on the return of the Canadian dollar against the US dollar.

Empirical results show that COVID-19 pandemic indicators such as daily new COVID-19 confirmed cases and COVID-19 vaccine doses administrated in each country, do not have a significant impact on the return of currency pairs in this study.

Also, when interpreting results for the impact of government response policies on the return of the FX market during the COVID-19 pandemic, we can observe that the overall government response index for the UK as a proxy for government intervention policies has a positive impact on the return of GBP against USD. However, there are no similar impacts for the other currency pairs. The statistical significance of coefficients for government response indices can be attributed to the effectiveness of governments' reaction to controlling the detrimental impacts of the pandemic. Finally, there is no evidence of the FX market reaction to WHO official speeches about the COVID-19 pandemic.

The results reported in Tables 11,12,13 and 14 show that there are some news types that are important during the pandemic period but do not have a significant impact before the COVID-19 pandemic. For instance, US macroeconomic news announcements, the Unemployment Rate, and Trade Balance had a prominent impact on the return of the EURO/USD, GBP/USD, and JPY/USD during the pandemic period but did not have a significant impact before the COVID-19 pandemic. For instance, a one standard deviation increase in the US unemployment

rate surprise increases the return of the euro against the dollar by 0.0409 basis points (Table 11) and 0.0323, 0.0481 for GBP and JPY respectively. This is an economically and statistically significant effect showing that an increase in the unemployment rate in the US during the COVID-19 pandemic, makes the US dollar depreciates against the other currencies. These results are intuitive as the slowdown in the economy because of the COVID-19 pandemic caused restrictions in international trade, and demands in the labor market, and these macroeconomic news figures could signal the severity of the impact of the COVID-19 pandemic on the US economy. Therefore, FX market participants naturally pay more attention to these news types during the pandemic.

However, macroeconomic news categories such as ISM Manufacturing, CPI MoM, and FOMC Rate Decision (Lower Bound) are significant in both states.

[Insert Tables 11, 12, 13, and 14 here]

Overall, our results show that all currency pairs react significantly to fewer US macroeconomic news during the COVID-19 pandemic than in the pre-COVID-19 period. For instance, all currency pairs respond to a maximum number of 7 US announcements during a pandemic, whereas a minimum number of 8 before the pandemic.

Our estimation suggests that four types of US macroeconomic announcements appear to move all the currency pairs in the COVID-19 pandemic - the unemployment rate, Factory Orders, ISM Manufacturing, and consumer price index. While the macroeconomic news announcement types, Changes in Nonfarm Payrolls, Retail Sales MoM, New Home Sales, Durable Goods Orders, and Capacity Utilization have a significant impact on the return of the all-currency pairs against the US dollar before the pandemic, their coefficients are not statistically significant during the COVID-19 pandemic.

Empirical results suggest that there is a context-specific impact of macroeconomic news for some news categories. Standard models of exchange rate determination predict that more substantial than expected economic activity news tends to appreciate a country's currency and results would be reverse for an increase in undesirable economic index. (Ben Omrane and Savaşer, 2017). Financial crises, business cycles, global health crises, terrorist attacks, sharp fluctuations in risk conditions, and central bank policies can generate time-variant news effects in currency markets. Our analysis, which focuses on the 5-min conditional mean adjustment of currency returns over the period, confirms this finding (Eq. (1)). In the estimated regression model, the pandemic coefficient represents the effect of the news indicator during the COVID-19 pandemic period, while the no-pandemic coefficient captures the impact of the news indicator before the COVID-19 pandemic period. When the difference between estimated coefficients before and during the pandemic is significantly different from zero, we conclude that the return response to macroeconomic news is state-dependent.

For instance, purchasing price index (PPI) had a negative impact (-0.0525bps) on the return of the euro against the US dollar before the pandemic but its coefficient was not statistically significant during the pandemic.

Our results reveal that the impact of at least five types of US announcements depends on the state of the economy. For instance, the significant figures related to, PPI MoM, Retail Sales MoM, New Home Sales, Consumer Confidence Index, and CPI MoM, vary significantly before and during the COVID-19 pandemic, either they are not significant in one state or the magnitude of their impact changes significantly over time.

Regarding Country-specific news announcements, we can observe that the number of important announcements is less than US news announcements, suggesting that market participants pay more attention to US macroeconomic news. For instance, only 1(3,5) type of German (UK, Canadian) news caused movement in the euro's value (pound, Canadian dollar,

respectively) against the US dollar during the pandemic. In contrast, at least three types of news have a significant impact before the pandemic. None of the Japanese macroeconomic news has a significant effect on the return of JPY/USD in neither the pandemic nor before the pandemic periods.

5.2.2 Results from conditional variance (volatility) model

We examine the impact of COVID-19 announcement and macroeconomic news on the volatility of FX markets and possible state-dependent pattern by estimating the volatility response to the individual news announcements across different sample periods. Tables 15, 16, 17, and 18 present the volatility response coefficients based on the estimation of Equation (2). In this specification, pandemic represents the volatility response coefficient in the pandemic period, and no-pandemic represents the corresponding coefficient before the pandemic period.

[Insert Tables 15, 16, 17, and 18 here]

The results of the study provide evidence for the significant impact of COVID-19 pandemic indicators, daily new cases, and COVID-19 vaccination on the volatility of the FX market. For instance, a 1 unit increase in daily news COVID-19 cases decreases volatility by 0.0014, 0.0009,0.0002, 0.0025 bps in euro, pound, Canadian dollar, and Japanese yen markets against the US dollar, respectively. These results might seem counter-intuitive at first glance as we might expect that increase in COVID-19 confirmed cases should increase the volatility in the FX market. However, this decrease in volatility might be the result of a decrease in the likelihood of going back to normal economic and social conditions, which consequently makes market participants have a similar evaluation of the state of the economy and the result would be a negative impact on volatility.

On the other hand, an increase in vaccine doses administrated in each country negatively affects the volatility, as shown in Tables 15, 16, 17, and 18. For instance, 1unit increase in vaccine doses administrated decreases volatility by 0.0014, 0.0045, 0.001, and 0.0009 for the euro, pound, Canadian dollar, and yen, all against the US dollar respectively. We can assume that increase in vaccination rate triggers the hope FX market which as result decreases volatility.

Regarding COVID-19 vaccine development news, news related to the Moderna COVID-19 vaccine has a prominent impact on the volatility of the FX market. To be more precise, headlines related to EMA emergency approval for the Moderna vaccine have a significant impact on 3 of 4 currency pairs. It has a positive impact on the volatility of the euro and Canadian dollar against the US dollar (0.0186 and 0.015 basis points respectively) while having a negative impact on the volatility of the British pound against the USD by -0.0173 bps for the 5-minute interval following the release. Also, news related to phase 1 and phase 3 trial studies of Moderna has a positive impact on the volatility of GBP/USD and JPY/USD respectively.

Also, the government response policy index has a positive impact on the volatility of the foreign exchange market for all currency pairs. it increases volatility by 0.0015, 0.0016, 0.003, and 0.0005 basis points for the euro, British pound, Canadian dollar, and Japanese yen all against the US dollar. We can attribute these results to the fact that growth in government intervention indicators signals the worsening condition related to the COVID-19 pandemic which makes the market more volatile. This result is line with the literature including Feng et al. (2021).

Like return reaction to World Health Organization official speeches, there is no evidence of market reaction to WHO official speeches about the COVID-19 pandemic in FX markets.

For the impact of US macroeconomic news on the volatility of the foreign exchange market, this paper documents that for the euro market (pound, Canadian dollar, and yen), 3 (5, 8, and

6, respectively) out of the total of 27 US macroeconomic news items are associated with a volatility response during the COVID-19 pandemic. The correspondent figures are 11, 13, 16, and 14 for the euro, pound, Canadian dollar, and yen, respectively, before the pandemic.

The coefficients associated with 11, 8, 10, 11 of news items for EURO/USD, GBP/USD, CAD/USD, and JPY/USD reveal that the volatility response to the US macroeconomic news announcements depends on the state of the economy. When there are differences in volatility reaction across different economic states, these differences are economically meaningful.

For instance, in the euro-dollar market, a one standard deviation increase in the unanticipated component of the Change in Nonfarm Payrolls announcement leads to an -0.0020 basis points decrease in volatility during the pandemic; in contrast, the same increase in the announcement surprise is associated with a -0.0289-basis point decrease before the pandemic period; this difference is statistically significant at the 5% level (Table 15). As it is evident, the magnitude of the unemployment rate coefficient was smaller during the COVID-19 pandemic period. Generally, the Change in Non-farm payroll is highly correlated with the confidence of the public and businesses toward the prosperity of the national economy. However, if the economy is unstable, businesses would aim to maintain their current operation level and refrain from making new investments in their business. In times of crisis like COVID-19 pandemics, however, the primary purpose would be to ensure the company's survival and mostly keep the minimum operation level and job cuts would be expected. We can argue that FX market participants expected the direction of the macroeconomic releases such as Changes in Nonfarm Payrolls, Retail Sales MoM, and New Home Sales during the current COVID-19 pandemic and these expectations were reflected in prices even before official macroeconomic announcements. Therefore, the volatility reacted with the same degree(direction) but with less magnitude to the Change in Nonfarm Payrolls. On the other hand, the magnitude of coefficients to macro news such as purchasing price index,

Our findings confirm the time-varying nature of the exchange-rate reaction to the news. Specifically, we show that the magnitude of the news effect coefficients varies over time.

5.2.3 Robustness

To test that the validity of our main results is robust to the choice of pandemic indicator and the government response variable, we consider various alternative measures of COVID-19 announcements to analyze the impact of this ongoing pandemic on foreign exchange markets. First, we estimated conditional mean and volatility equations using the daily COVID-19 number of deaths instead of confirmed cases as the pandemic indicators. Then, I alternate the overall government response policy index with the stringency index. The results show that the main results remain unchanged when we use different indicators for all currency pairs.

[Insert Tables 23, 24, 25, and 26 here]

Chapter 6 Conclusion

In this thesis, I investigated the return and volatility reaction to the COVID-19 announcement and macroeconomic news in the euro, pound, Canadian dollar, and yen markets during the COVID-19 pandemic period. Also, I compared the impacts of macroeconomic news on the foreign exchange market before and during the COVID-19 pandemic. Unlike the recent studies regarding the impact of the COVID-19 pandemic, which used a limited set of COVID-19 pandemic-related variables and did not implement macroeconomic news as the primary control variable, this paper investigates the impacts of all the potentially prominent variables on price component diffusions return and volatility for major currency pairs in more detail.

Our analysis documents that COVID-19 pandemic indicators and government response policies impact FX market volatility more profoundly than a return. We attribute this result to induced uncertainty in the FX market stemming from the COVID-19 disease spread and the ability of governments to control its impact on the economy. Also, regarding COVID-19 vaccine development news, there is evidence of the pound and Canadian dollar markets' significant reactions to phase 3 (final stage trial studies) of the Pfizer COVID-19 vaccines. It seems that these results triggered hope in financial markets due to successful COVID-19 vaccine trial studies. There is no evidence of market reaction to WHO officials' speeches about FX markets.

I contribute to the literature by examining context-specific macroeconomic information during the pandemic as the macroeconomic announcement has been demonstrated to be state-dependent. This study shows that a particular news announcement can have asymmetric impacts on FX return and volatility in this unusual period. In other words, the same announcement is context-specific as its effect is contingent on the economic state. The findings

reveal that the FX market reacts to fewer macroeconomic news during the COVID-19 pandemic.

This variability in exchange rate response during global pandemics such as the current COVID-19 pandemic raises significant concerns over currency exposure, which corporations involved in international trade must manage effectively. This implies that asset managers whose portfolios include global assets should also consider the time-varying impact of macroeconomic news on exchange rate return and volatility when designing strategies to improve the risk management and return performance associated with their international transactions.

Also, in response to the rapid spread of COVID-19, various countries implemented measures to control transportation and individual movements that made international trade and their economies more unpredictable, impacting exchange rate fluctuation.

The novelty of my study stems from the fact that I analyze the impact of a wide range of disease outbreak indicators and health news which could have valuable information about the pandemic on exchange rate price movements on several major currency pairs.

Bibliography

Andersen, T. G., & Bollerslev, T. (1997). Intraday periodicity and volatility persistence in financial markets. *Journal of Empirical Finance, 4*(2-3), 115–158. https://doi.org/10.1016/s0927-5398(97)00004-2

Andersen, T., Bollerslev, T., Diebold, F., & Vega, C., (2003). "Micro effects of macro announcements: Real-time price discovery in foreign exchange", American Economic Review, 93(1), 38–62.

Andersen, T., Bollerslev, T., Diebold, F., & Vega, C., (2007). "Real-time price discovery in global stock, bond and foreign exchange markets", Journal of International Economics, 73(2), 251–277.

Ayadi, M. A., Ben Omrane, W., Wang, J., & Welch, R. (2020). Macroeconomic news, public communications, and foreign exchange jumps around U.S. and European financial crises. *International Journal of Finance & Economics*, *25*(2), 197-227. https://doi.org/10.1002/ijfe.1747

Bacchetta, P., & Van Wincoop, E. (2013). On the unstable relationship between exchange rates and macroeconomic fundamentals. *Journal of International Economics*, *91*(1), 18-26. https://doi.org/10.1016/j.jinteco.2013.06.001

Balduzzi, P., Elton, E. J., & Green, T. C. (2001). Economic news and bond prices: Evidence from the U.S. treasury market. *The Journal of Financial and Quantitative Analysis*, *36*(4), 523. https://doi.org/10.2307/2676223

Bartsch, Z. (2019). Economic policy uncertainty and dollar-pound exchange rate return volatility. Journal of International Money and Finance, 98, 102067. https://doi.org/10.1016/j.jimonfin.2019.102067

Bauwens, L., Ben Omrane, W., & Giot, P. (2005). News announcements, market activity and volatility in the euro/dollar foreign exchange market. *Journal of International Money and Finance, 24*(7), 1108-1125. https://doi.org/10.1016/j.jimonfin.2005.08.008

Ben Omrane, W., & Hafner, C. (2014). Macroeconomic news surprises and volatility spillover in foreign exchange markets. *Empirical Economics, 48*(2), 577-607. https://doi.org/10.1007/s00181-013-0792-4

Ben Omrane, W., & Savaşer, T. (2016). The sign switch effect of macroeconomic news in foreign exchange markets. *Journal of International Financial Markets, Institutions and Money, 45*, 96-114. https://doi.org/10.1016/j.intfin.2016.07.002

Ben Omrane, W., & Savaşer, T. (2017). Exchange rate volatility response to macroeconomic news during the global financial crisis. *International Review of Financial Analysis, 52*, 130-143. https://doi.org/10.1016/j.irfa.2017.05.006

Ben Omrane, W., Welch, R., & Zhou, X. (2019). The dynamic effect of macroeconomic news on the euro/US dollar exchange rate. *Journal of Forecasting, 39*(1), 84-103. https://doi.org/10.1002/for.2615

Charles, A., Darné, O., & Kim, J. H. (2012). Exchange-rate return predictability and the adaptive markets hypothesis: Evidence from major foreign exchange rates. *Journal of International Money and Finance, 31*(6), 1607-1626. https://doi.org/10.1016/j.jimonfin.2012.03.003

Chen, M., Jang, S. (., & Kim, W. G. (2007). The impact of the SARS outbreak on Taiwanese hotel stock performance: An event-study approach. *International Journal of Hospitality Management, 26*(1), 200-212. https://doi.org/10.1016/j.ijhm.2005.11.004

Cheung, Y., Fatum, R., & Yamamoto, Y. (2019). The exchange rate effects of macro news after the global financial crisis. *Journal of International Money and Finance, 95*, 424-443. https://doi.org/10.1016/j.jimonfin.2018.03.009

Corbet, S., Hou, Y. (., Hu, Y., Oxley, L., & Xu, D. (2021). Pandemic-related financial market volatility spillovers: Evidence from the Chinese COVID-19 epicentre. *International Review of Economics & Finance*, *71*, 55-81. https://doi.org/10.1016/j.iref.2020.06.022

Faust, J., Rogers, J. H., Wang, S. B., & Wright, J. H. (2007). The high-frequency response of exchange rates and interest rates to macroeconomic announcements. Journal of Monetary Economics, 54(4), 1051-1068. https://doi.org/10.1016/j.jmoneco.2006.05.015

Feng, G., Yang, H., Gong, Q., & Chang, C. (2021). What is the exchange rate volatility response to COVID-19 and government interventions? *Economic Analysis and Policy*, *69*, 705-719. https://doi.org/10.1016/j.eap.2021.01.018

Fratzscher, M., (2008). "Communication and exchange rate policy", Journal of Macroeconomics, 30(4), 1651–1672.

Hale, T., Angrist, N., Goldszmidt, R., Kira, B., Petherick, A., Phillips, T., Webster, S., Cameron-Blake, E., Hallas, L., Majumdar, S., & Tatlow, H. (2021). A global panel database of pandemic policies (Oxford Covid-19 Government response tracker). *Nature Human Behaviour*, *5*(4), 529–538. https://doi.org/10.1038/s41562-021-01079-8

Han, Y. W. (2008). Intraday effects of macroeconomic shocks on the US dollar–euro exchange rates. *Japan and the World Economy*, *20*(4), 585-600. https://doi.org/10.1016/j.japwor.2007.03.004

Haroon, O., & Rizvi, S. A. (2020). COVID-19: Media coverage and financial markets behavior—A sectoral inquiry. *Journal of Behavioral and Experimental Finance*, *27*, 100343. https://doi.org/10.1016/j.jbef.2020.100343

Ilzetzki, E., Reinhart, C., & Rogoff, K. (2020). Will the secular decline in exchange rate and inflation volatility survive COVID-19? https://doi.org/10.3386/w28108

John, K., & Li, J. (2021). COVID-19, volatility dynamics, and sentiment trading. *Journal of Banking & Finance*, 106162. https://doi.org/10.1016/j.jbankfin.2021.106162

Konstantakis, K. N., Melissaropoulos, I. G., Daglis, T., & Michaelides, P. G. (2021). The euro to dollar exchange rate in the covid-19 era: Evidence from spectral causality and Markov-switching estimation. *International Journal of Finance & Economics*. https://doi.org/10.1002/ijfe.2524

Laakkonen, H. (2013). Exchange rate volatility, macroeconomic announcements and the choice of intraday periodicity filtering method. *Quantitative Finance, 14*(12), 2093-2104. https://doi.org/10.1080/14697688.2012.739727

Melvin, M., & Taylor, M. P. (2009). The crisis in the foreign exchange market. *Journal of International Money and Finance, 28*(8), 1317-1330. https://doi.org/10.1016/j.jimonfin.2009.08.006

Naderi Semiromi, H., Lessmann, S., & Peters, W. (2020). News will tell: Forecasting foreign exchange rates based on news story events in the economy calendar. *The North American Journal of Economics and Finance, 52*, 101181. https://doi.org/10.1016/j.najef.2020.101181

Narayan, P. K., Devpura, N., & Wang, H. (2020). Japanese currency and stock market—What happened during the COVID-19 pandemic? *Economic Analysis and Policy, 68*, 191-198. https://doi.org/10.1016/j.eap.2020.09.014

Narayan, P. K., Narayan, S., Khademalomoom, S., & Phan, D. H. (2017). Do terrorist attacks impact exchange rate behavior? New international evidence. *Economic Inquiry, 56*(1), 547-561. https://doi.org/10.1111/ecin.12447

Sharma, S. S., Bach Phan, D. H., & Narayan, P. K. (2019). undefined. *Emerging Markets Review, 40*, 100626. https://doi.org/10.1016/j.ememar.2019.100626

Umar, Z., & Gubareva, M. (2020). A time–frequency analysis of the impact of the COVID-19 induced panic on the volatility of currency and cryptocurrency markets. Journal of Behavioral and Experimental Finance, 28, 100404. https://doi.org/10.1016/j.jbef.2020.100404

Appendices

Table 1: Descriptive statistics of exchange rates data

5-minute return	EUR/USD	GBP/USD	CAD/USD	JPY/USD
Mean	0.0000	0.0000	0.0000	0.0000
Standard deviation	0.03	0.04	0.03	0.03
Min	-0.73	-1.77	-0.78	-1.33
Max	0.79	2.03	1.39	2.86
Skewness	0.15	0.27	0.62	3.28
Kurtosis	23.96	86.37	61.70	417.29
Number of observations	308,314	308,031	308,726	307,988

Note. This table presents the summary statistics of 5-minute exchange rate returns between January 1, 2017, and June 30, 2021. The dataset is provided by Olsen & Associates and contains tradable bid-ask prices. The 5-minute return at time t is calculated as the difference between the logarithms of the midpoint prices at times t-1 and t, multiplied by 100. Trading days start at 00:00 EST and end at 23:55 EST. I exclude weekends, US statutory holidays, and the first interval of each day and those after 21:00 on Friday because of low trading activity.

Table 2: COVID-19 Vaccine development process news

Company name	Phase 1	Phase 2	Phase 3	WHO Approval	FDA Approval	EMA Approval	Total
Pfizer	5	7	6	3	6	28	55
Moderna	4	3	3	48	4	9	71
AstraZeneca	3	2	7	8	3	19	42
Novavax	3	0	11	0	0	0	14
Johnson and Johnson	1	2	4	2	2	7	18
Total	**16**	**14**	**31**	**59**	**15**	**63**	**200**

Note. This table shows several headlines related to enrolment, initiation, and pauses. Resumptions, and resumptions of trial studies, interim, final, and revisions of results related to each of the 3 phases, companies' decisions to file for approvals, updates about approval decision progress, and official emergency approval news for all the companies in our sample.

Table 3: Composition of government response policies indices

Index	K	C1	C2	C3	C4	C5	C6	C7	C8	E1	E2	H1	H2	H3
Government response	13	*	*	*	*	*	*	*	*	*	*	*	*	*
Containment and health	11	*	*	*	*	*	*	*	*			*	*	*
Stringency index	9	*	*	*	*	*	*	*	*			*		
Economic support index	2									*	*			

Note. This table shows the indices used in the study according to OxCGRT classification. It is worth mentioning indicators E3, E4, H4, and H5 were not used in the comprehensive index.

Table 4: Government response variables definition

Containment and closure	
C1	School closure
C2	Workplace closure
C3	Cancel public events
C4	Restrictions on gathering size
C5	Public transport closure
C6	Stay at home requirements.
C7	Restrictions on interval movements
C8	Restrictions on international travel
Economic response	
E1	Income support
E2	Debt relief for households
E3	Fiscal measures
E4	Giving international support
Health system	
H1	Public information campaign
H2	Testing policy
H3	Contact tracing
H4	Emergency investment in healthcare
H5	Investment in COVID-19 vaccine

Note. This table shows indicators and components of each according to OxCGRT database.

Table 5:Who official speeches

Name of speaker	**Position**	**Number of news**
Tedros Adhanom Ghebreyesus	WHO director-general	51
Mike Ryan	Head of WHO's emergencies program	11
Carissa Etienne	World Health Organization's director for the Americas	6
Hans Kluge	WHO Regional Director for Europe,	4
Soumya Swaminathan	WHO chief scientist	3
Margaret Harris	Spokesperson	2
Dominic Dwyer	Member of the World Health Organization-led team	2
Matshidiso Moeti	WHO regional director for Africa	1
Tarik Jasarevic	WHO spokesperson	1
Christian Lindmeier	WHO spokesperson	1
Alejandro Cravioto	Chairman of WHO's Strategic Advisory Group	1
Bernardo Mariano	Chief information officer	1
Bruce Aylward	A senior adviser to the WHO director-general	2
Christian Lindmeier	Spokesperson	1
Dr. Marie-Paule Kieny	Co-chair of a World Health Organization (WHO)	1
Janet Diaz	Top WHO official for clinical care response	1
Maria van Kerkhove	WHO epidemiologist and technical lead	2
Paul Molinaro	Chief of WHO operations support and logistics	1
	Total	**92**

Note. This table presents the name, position, several public speeches of WHO officials related to the COVID-19pandemic.

Table 6: Macroeconomic news announcements

Announcement	US	UK	GE	CA	JP
			Obs		
GDP Annualized QoQ—Advance		18			
GDP Annualized QoQ—Preliminary		18			
GDP Final		17			
Change in Nonfarm Payrolls		54			
Nonfarm Productivity		35			
PPI MoM		54			
Unemployment Rate		54			42
Retail Sales MoM		54		54	42
Industrial Production MoM		54	54	54	43
Personal Income		53			
Consumer Credit		54	29		
New Home Sales		54			
Personal Consumption		53			
Factory Orders		54			
Construction Spending MoM		54			
Business Inventories		54			
Monthly Budget Statement		54			
Trade Balance		54		54	84
CPI MoM		54	54		
Consumer Confidence Index		54			
ISM Manufacturing		54			
Housing Starts		54			42
Leading Index		54			
Capacity Utilization		54			14
FOMC Rate Decision (Upper Bound)		36			
FOMC Rate Decision (Lower Bound)		36			
Current Account Balance			18	52	14
GfK Consumer Confidence			58	54	
Net Consumer Credit			55		
Employment Change 3M/3M			54		
Manufacturing Production MoM			54		
Trade Balance GBP/Mn			54		
GDP QoQ			42		
Bank of England Bank Rate			38		
Monthly GDP (MoM)			36		42
Total Business Investment QoQ			36		
Industrial Product Price MoM					43
Consumer Price Index					42
GDP MoM					42
Manufacturing Sales MoM					42
Bank of Canada Rate Decision					30
Capacity Utilization Rate					14
Building Permits MoM					42
Raw Materials Price Index MoM					43
GDP SA QoQ				36	
Unemployment Change (000's)				55	
Unemployment Claims Rate SA				55	
Industrial Production SA MoM				55	
Import Price Index MoM				53	
IFO Business Climate				53	
ZEW Survey Current Situation				54	
Markit/BME Germany Manufacturing				35	
Tankan					14
Current Account					42
GDP					29
Retail sales					42
PPI					84
Imports YoY					42
Exports YoY					42
Housing Starts YoY					42
Industrial Production					42

Note. This table shows scheduled macroeconomic news announcement groups for the US, Japan, Germany, Canada, and the UK from January 1, 2017, to June 30, 2021. YoY, QoQ, and MoM stand for year over year, quarter over quarter, and month over month figures. News with SA and NSA suffix denote seasonally and not seasonally adjusted figures. Obs is the abbreviation for observations. News categories are based on Andersen et al. (2003), Ben Omrane & Savaşer (2017), and other related papers.

Table 7: Volatility of currency pairs before and during COVID-19 pandemic

Currency pairs	Whole sample			Macroeconomic news days			Non-macroeconomic news days		
	Before pandemic	During pandemic	*p*-value	Before pandemic	During pandemic	*p*-value	Before pandemic	During pandemic	*p*-value
Panel A: EUR-USD									
Return	0.0000	0.0001	0.86	0.0006	0.0005	0.95	0.0000	0.0001	0.86
Volatility	0.0167	0.0191	0.00	0.0205	0.0222	0.06	0.0167	0.0191	0.00
Panel B: GBP-USD									
Return	0.0000	0.0001	0.95	0.0023	0.0022	0.96	0.0000	0.0000	0.94
Volatility	0.0207	0.0252	0.00	0.0309	0.0285	0.09	0.0206	0.0252	0.00
Panel C: CAD-USD									
Return	0.0000	0.0001	0.48	0.0004	0.0028	0.16	0.0000	0.0001	0.56
Volatility	0.0163	0.0204	0.00	0.0241	0.025	0.42	0.0163	0.0203	0.00
Panel D: JPY-USD									
Return	0.0000	-0.0001	0.28	-0.0020	-0.0006	0.35	0.0000	-0.0001	0.25
Volatility	0.0175	0.017	0.00	0.0209	0.0196	0.19	0.0175	0.017	0.00

Note. This table compares the mean and volatility he each currency pair during and before the COVID-19 pandemic period for the whole sample, during the days with macroeconomic news announcements and, days without macroeconomic news releases. The *p*-value for each sub-sample reports the t-test result for the equality test.

Table 8: Preliminary analysis, the impact of COVID-19 indicators on return

Currency pairs	COVID-19 cases		COVID-19 deaths		COVID-19 vaccine doses	
	Coef.	*p*-value	Coef.	*p*-value	Coef.	*p*-value
EUR-USD	-0.0002	0.19	0.0001	0.46	-0.0002	0.19
GBP-USD	-0.0003	0.22	0.0000	0.81	0.0000	0.96
CAD-USD	0.0000	0.95	-0.0002	0.14	0.0001	0.48
JPY-USD	0.0003	0.14	0.0001	0.20	0.0000	0.80

Note. This table shows estimation results from regressing returns on COVID-19 pandemic indicators. For each variable, the first column lists the return response coefficient associated with each currency pair in the COVID-19 period, and the second column reports the corresponding p-value. * Denotes statistical significance at the 5% level.

Table 9: Preliminary analysis, the impact of COVID-19 indicators on volatility

Currency pairs	COVID-19 cases		COVID-19 deaths		COVID-19 vaccine doses	
	Coef.	*p*-value	Coef.	*p*-value	Coef.	*p*-value
EUR-USD	0.0010	0.00	0.0031	0.00	-0.0034	0.00
GBP-USD	0.0033	0.00	0.0052	0.00	-0.0026	0.00
CAD-USD	0.0021	0.00	0.0031	0.00	-0.0019	0.00
JPY-USD	0.0000	0.78	0.0010	0.00	-0.0016	0.00

Note. This table shows estimation results from regressing volatility on COVID-19 pandemic indicators. For each variable, the first column lists the return response coefficient associated with each currency pair in the COVID-19 period, and the second column reports the corresponding p-value. * Denotes statistical significance at the 5% level.

Table 10: Correlation matrix, COVID-19 announcement news variables

Variable	COVID-19 Cases	COVID19- Death	COVID19- Vaccine	Government response index	Economic support index	Stringency index
Panel A- EUR/USD						
COVID-19 Cases	1					
COVID19- Death	0.66	1				
COVID19- Vaccine	0.33	0.04	1			
Government response index	0.03	0.26	0.37	1		
Economic support index	-0.6	-0.43	-0.32	0.50	1	
Stringency index	0.15	0.38	0.48	0.95	-0.33	1
Containment health index	0.16	0.38	0.47	0.98	0.34	0.96
Panel B- GBP/USD						
COVID-19 Cases	1					
COVID19- Death	0.68	1				
COVID19- Vaccine	0.3	0.3	1			
Government response index	0.2	0.4	0.36	1		
Economic support index	0.4	0.6	0.35	0.92	1	
Stringency index	0.16	0.4	0.3	0.96	0.80	1
Containment health index	0.13	0.3	0.35	0.99	0.90	0.96
Panel C- CAD/USD						
COVID-19 Cases	1					
COVID19- Death	0.75	1				
COVID19- Vaccine	0.35	0.37	1			
Government response index	0.17	0.34	0.37	1		
Economic support index	-0.12	0.08	0.09	0.92	1	
Stringency index	0.25	0.41	0.37	0.98	0.88	1
Containment health index	0.21	0.38	0.4	0.99	0.89	0.98
Panel D- JPY/USD						
COVID-19 Cases	1					
COVID19- Death	0.7	1				
COVID19- Vaccine	0.3	0.24	1			
Government response index	-0.34	-0.21	0.11	1		
Economic support index	0.41	0.36	0.38	0.45	1	
Stringency index	-0.6	-0.4	-0.04	0.9	0.02	1
Containment health index	-0.52	-0.35	0.003	0.95	0.18	0.98

Note. This table shows the correlation matrix for COVID-19 announcement variables. COVID-19 Cases, COVID19- Death, COVID-19 Vaccine doses administrated are categorized as COVID-19 pandemic indicators, and the last four rows are government response policies indices.

Table 11: Return response to COVID-19 pandemic indicators, EUR/USD

News Category	During Pandemic		Before Pandemic		
	Coeff.	*p*-value	Coeff.	*p*-value	*p*-diff.
Panel A: US Macroeconomic News					
GDP Annualized QoQ—Advance	-0.0002	0.98	0.0008	0.92	0.93
GDP Annualized QoQ—Preliminary	0.0019	0.86	-0.0046	0.57	0.63
GDP Final	0.0072	0.51	-0.0177*	0.02	0.06
Change in Nonfarm Payrolls	0.0045	0.22	0.2582*	0.01	0.00*
Nonfarm Productivity	-0.0035	0.46	-0.0077	0.59	0.77
PPI MoM	0.0019	0.67	-0.0525*	0.00	0.00*
Unemployment Rate	0.0409*	0.00	0.0245	0.47	0.63
Retail Sales MoM	0.0042	0.52	-0.0265*	0.00	0.00*
Consumer Credit	-0.0009	0.83	-0.0037	0.67	0.77
New Home Sales	0.0063	0.16	-0.0239*	0.00	0.00*
Personal Consumption	-0.0014	0.71	-0.3664*	0.04	0.04*
Durable Goods Orders	-0.0010	0.83	0.0098*	0.00	0.05
Factory Orders	0.0237*	0.00	0.0139*	0.00	0.01*
Construction Spending MoM	-0.0101*	0.02	-0.0009	0.89	0.23
Business Inventories	-0.0020	0.76	-0.0021	0.64	0.99
Monthly Budget Statement	0.0024	0.55	-0.0014	0.88	0.70
Trade Balance	-0.0344*	0.00	-0.0095*	0.03	0.00*
CPI MoM	-0.0350*	0.00	-0.1416*	0.00	0.00*
Consumer Confidence Index	0.0019	0.72	-0.0328*	0.00	0.00*
ISM Manufacturing	-0.0105*	0.03	-0.1071*	0.00	0.00*
Housing Starts	0.0039	0.41	-0.0371*	0.00	0.00*
Leading Index	-0.0080	0.06	-0.0083	0.17	0.97
Capacity Utilization	-0.0064	0.12	-0.0367*	0.00	0.00*
FOMC Rate Decision (Upper Bound)	0.0146	0.06	0.0023	0.67	0.19
FOMC Rate Decision (Lower Bound)	0.0300*	0.00	0.0549*	0.00	0.01*
Panel B: Germany Macroeconomic News					
GDP SA QoQ	0.0049	0.55	-0.0070	0.21	0.05
Unemployment Change (000's)	-0.0030	0.43	0.0108	0.43	0.33
Unemployment Claims Rate SA	0.0032	0.41	0.0160	0.11	0.24
Retail Sales MoM	-0.0011	0.77	0.4802	0.36	0.36
Industrial Production SA MoM	0.0098*	0.01	0.2837*	0.00	0.00*
Trade Balance	0.0082	0.15	0.0023	0.64	0.43
Current Account Balance	0.0028	0.61	0.0074	0.14	0.54
GfK Consumer Confidence	0.0001	0.98	-0.2143*	0.01	0.01*
Import Price Index MoM	-0.0023	0.72	-0.0023	0.61	0.05
IFO Business Climate	-0.0044	0.50	0.0151*	0.00	0.21
ZEW Survey Current Situation	-0.0038	0.42	-0.0015	0.79	0.75
Markit/BME Germany Manufacturing	0.0095	0.09	0.0071	0.40	0.81
Panel C: Germany COVID-19 News					
COVID-19 - Daily New cases	0.0001	0.15			
COVID-19 - Daily Vaccine doses	-0.0003*	0.01			
Panel D: Unscheduled COVID-19 news					
The overall Government response index	0.0002	0.07			
WHO Officials' Speeches	-0.0013	0.65			
Panel E: Vaccine Development News					
Johnson & Johnson Phase 1	0.0144	0.59			
Johnson & Johnson Phase 2	-0.0046	0.81			
Johnson & Johnson Phase 3	-0.0081	0.55			
Johnson & Johnson FDA Approval	0.0091	0.56			
Johnson & Johnson EMA Approval	0.0041	0.68			
Johnson & Johnson WHO Approval	0.0098	0.61			
Pfizer Phase 1	0.0180	0.14			
Pfizer Phase 2	0.0064	0.58			
Pfizer Phase 3	0.0067	0.54			
Pfizer FDA Approval	0.0025	0.82			
Pfizer EMA Approval	0.0049	0.34			
Pfizer WHO Approval	0.0057	0.72			
Novavax Phase 1	0.0088	0.64			
Novavax Phase 3	-0.0013	0.87			
AstraZeneca Phase 1	-0.0095	0.54			
AstraZeneca Phase 2	-0.0150	0.48			
AstraZeneca Phase 3	0.0012	0.91			
AstraZeneca FDA Approval	0.0064	0.68			
AstraZeneca EMA Approval	-0.0029	0.65			
AstraZeneca WHO Approval	-0.0029	0.78			
Moderna Phase 1	-0.0095	0.48			
Moderna Phase 2	0.0240	0.16			
Moderna Phase 3	-0.0500	0.01			
Moderna FDA Approval	0.0215	0.11			
Moderna EMA Approval	-0.0306*	0.00			
Moderna WHO Approval	0.0042	0.31			

Note. This table shows macroeconomic news and COVID-19 announcement's effects on EUR/USD returns before and during the COVID-19 pandemic (Estimated using Eq. (1) regression model). For each period, the first column lists the return response coefficient associated with individual news announcements, and the second column reports the corresponding p-value. The last column, p-diff, represents the p-value corresponding to a Wald test for the difference between during and before pandemic estimated coefficients. * Denotes statistical significance at the 5% level.

Table 12: Return response to COVID-19 pandemic indicators, GBP/USD

News Category	During Pandemic		Before Pandemic		
	Coeff.	*p*-value	Coeff.	*p*-value	*p*-diff.
Panel A: US Macroeconomic News					
GDP Annualized QoQ—Advance	-0.0056	0.70	0.0035	0.73	0.12
GDP Annualized QoQ—Preliminary	0.0022	0.88	-0.0039	0.71	0.83
GDP Final	0.0123	0.39	0.0048	0.63	0.05
Change in Nonfarm Payrolls	0.0060	0.21	0.1652	0.18	0.19
Nonfarm Productivity	0.0045	0.46	-0.0157	0.40	0.30
PPI MoM	0.0137*	0.02	-0.0398*	0.00	0.00*
Unemployment Rate	0.0323*	0.00	0.0779	0.08	0.30
Retail Sales MoM	0.0087	0.31	-0.0190*	0.00	0.00*
Personal Income	0.0007	0.88	-0.4181	0.42	0.42
Consumer Credit	0.0004	0.94	0.0021	0.85	0.89
New Home Sales	-0.0024	0.68	-0.0285*	0.00	0.01*
Personal Consumption	0.0015	0.75	-0.4546	0.05	0.04*
Durable Goods Orders	0.0064	0.28	0.0072	0.11	0.90
Factory Orders	0.0293*	0.00	0.0029	0.61	0.00*
Construction Spending MoM	-0.0081	0.16	0.0099	0.23	0.07
Business Inventories	-0.0221*	0.01	0.0010	0.86	0.02*
Monthly Budget Statement	0.0008	0.88	-0.0039	0.73	0.70
Trade Balance	-0.0266*	0.00	-0.0078	0.17	0.07
CPI MoM	-0.0335*	0.00	-0.1087*	0.00	0.00*
Consumer Confidence Index	0.0021	0.76	-0.0354*	0.00	0.00*
ISM Manufacturing	-0.0158*	0.01	-0.0736*	0.00	0.00*
Housing Starts	0.0067	0.28	-0.0308*	0.00	0.00*
Leading Index	-0.0034	0.54	0.0125	0.12	0.10
Capacity Utilization	-0.0108*	0.04	-0.0227*	0.03	0.30
FOMC Rate Decision (Upper Bound)	0.0095	0.35	0.0057	0.43	0.76
FOMC Rate Decision (Lower Bound)	0.0183	0.07	0.0306*	0.00	0.31
Panel B: UK Macroeconomic News					
CPI MoM	0.0044	0.49	0.0122	0.10	0.41
Industrial Production MoM	0.0048	0.57	0.0019	0.74	0.04*
Current Account Balance	0.0119	0.34	-0.0068	0.55	0.26
GfK Consumer Confidence	0.0024	0.76	-0.0037	0.53	0.78
Net Consumer Credit	-0.0160*	0.00	0.0535*	0.00	0.00*
Employment Change 3M/3M	0.0107	0.07	0.0590*	0.00	0.00*
Retail Price Index	0.0107	0.09	0.1194*	0.00	0.00*
Trade Balance GBP/Mn	0.0032	0.59	0.0420*	0.00	0.00*
GDP QoQ	0.0003	0.98	0.0045	0.50	0.00*
Bank of England Bank Rate	0.0494*	0.00	0.0174*	0.02	0.50
Monthly GDP (MoM)	-0.0068	0.43	-0.0229*	0.01	0.04 *
Panel C: UK COVID-19 News					
COVID-19 - Daily New cases	-0.0001	0.23			
COVID-19 - Daily Vaccine doses	-0.0001	0.44			
Panel D: Unscheduled COVID-19 news					
The overall Government response index	0.0003*	0.00			
WHO Officials' Speeches	-0.0027	0.47			
Panel E: Vaccine Development News					
Johnson & Johnson Phase 1	0.0002	0.99			
Johnson & Johnson Phase 2	-0.0045	0.86			
Johnson & Johnson Phase 3	-0.0026	0.88			
Johnson & Johnson FDA Approval	0.0140	0.49			
Johnson & Johnson EMA Approval	0.0107	0.42			
Johnson & Johnson WHO Approval	0.0021	0.93			
Pfizer Phase 1	0.0093	0.55			
Pfizer Phase 2	0.0282	0.06			
Pfizer Phase 3	0.0038	0.79			
Pfizer FDA Approval	-0.0125	0.38			
Pfizer EMA Approval	0.0079	0.24			
Pfizer WHO Approval	0.0307	0.14			
Novavax Phase 1	0.0167	0.50			
Novavax Phase 3	-0.0121	0.25			
AstraZeneca Phase 1	-0.0819*	0.00			
AstraZeneca Phase 2	-0.0147	0.60			
AstraZeneca Phase 3	0.0223	0.09			
AstraZeneca FDA Approval	0.0137	0.50			
AstraZeneca EMA Approval	0.0012	0.89			
AstraZeneca WHO Approval	-0.0210	0.12			
Moderna Phase 1	-0.0620*	0.00			
Moderna Phase 2	0.0383	0.09			
Moderna Phase 3	-0.0360	0.15			
Moderna FDA Approval	0.0032	0.86			
Moderna EMA Approval	-0.0030	0.79			
Moderna WHO Approval	0.0003	0.96			

Note. This table shows macroeconomic news and COVID-19 announcement's effects on EUR/USD returns before and during the COVID-19 pandemic (Estimated using Eq. (1) regression model). For each period, the first column lists the return response coefficient associated with individual news announcements, and the second column reports the corresponding p-value. The last column, p-diff, represents the p-value corresponding to a Wald test for the difference between during and before pandemic estimated coefficients. * Denotes statistical significance at the 5% level.

Table 13: Return response to COVID-19 pandemic indicators, CAD/USD

News Category	During Pandemic		Before Pandemic		
	Coeff.	*p*-value	Coeff.	*p*-value	*p*-diff.
Panel A: US Macroeconomic News					
GDP Annualized QoQ—Advance	0.0282*	0.01	0.0134	0.10	0.00*
GDP Annualized QoQ—Preliminary	-0.0010	0.93	-0.0019	0.82	0.16
GDP Final	-0.0054	0.63	0.0196	0.01	0.04
Change in Nonfarm Payrolls	-0.0024	0.55	0.1553	0.11	0.10
Nonfarm Productivity	-0.0022	0.65	0.0126	0.39	0.42
PPI MoM	0.0258*	0.00	-0.0329*	0.00	0.00*
Unemployment Rate	-0.0162*	0.00	0.1270*	0.00	0.00*
Retail Sales MoM	-0.0014	0.85	-0.0421*	0.00	0.00*
Consumer Credit	0.0013	0.75	-0.0083	0.36	0.33
New Home Sales	0.0029	0.54	-0.1168*	0.00	0.00*
Personal Consumption	0.0046	0.23	-0.1689	0.33	0.00*
Durable Goods Orders	0.0068	0.14	-0.0037	0.29	0.07
Factory Orders	0.0165*	0.01	-0.0075	0.10	0.05
Construction Spending MoM	-0.0045	0.33	0.0081	0.21	0.11
Business Inventories	-0.0132	0.05	0.0020	0.67	0.05
Monthly Budget Statement	0.0053	0.20	-0.0038	0.67	0.35
Trade Balance	0.0073	0.30	-0.0136*	0.00	0.04*
CPI MoM	-0.0403*	0.00	-0.1158*	0.00	0.00*
Consumer Confidence Index	-0.0031	0.57	-0.0049	0.32	0.79
ISM Manufacturing	-0.0188*	0.00	-0.0474*	0.00	0.00*
Housing Starts	-0.0048	0.32	-0.0240*	0.00	0.36
Leading Index	-0.0033	0.45	-0.0040	0.52	0.92
Capacity Utilization	0.0007	0.87	-0.0011	0.89	0.84
FOMC Rate Decision (Upper Bound)	0.0071	0.37	0.0082	0.14	0.90
FOMC Rate Decision (Lower Bound)	0.0144	0.07	0.0522*	0.00	0.00*
Panel B: Canada Macroeconomic News					
Housing Starts	0.0012	0.81	0.0013	0.85	0.98
Retail Sales MoM	-0.0063	0.33	-0.0327*	0.00	0.00*
Unemployment Rate	-0.0127*	0.00	-0.3097*	0.00	0.00*
Current Account Balance	0.0034	0.70	0.0059	0.49	0.17
Industrial Product Price MoM	-0.0008	0.90	0.0139*	0.01	0.07
Consumer Price Index	-0.0402*	0.00	0.0729*	0.00	0.00*
GDP MoM	-0.0129	0.04	0.0611*	0.00	0.00*
Manufacturing Sales MoM	0.0159*	0.03	0.0056	0.31	0.00*
Bank of Canada Rate Decision	0.0507*	0.00	0.0015	0.81	0.00*
Capacity Utilization Rate	0.0249*	0.03	0.1482*	0.00	0.00*
Building Permits MoM	-0.0057	0.44	-0.0025	0.66	0.91
Raw Materials Price Index MoM	0.0096	0.11	0.0540*	0.00	0.00*
Panel C: Canada COVID-19 News					
COVID-19 - Daily New cases	0.0000	0.84			
COVID-19 - Daily Vaccine doses	0.0000	0.92			
Panel D: Unscheduled COVID-19 news					
The overall Government response index	0.0002*	0.04			
WHO Officials' Speeches	-0.0067*	0.02			
Panel E: Vaccine Development News					
Johnson & Johnson Phase 1	-0.0104	0.70			
Johnson & Johnson Phase 2	-0.0012	0.95			
Johnson & Johnson Phase 3	0.0050	0.72			
Johnson & Johnson FDA Approval	0.0214	0.18			
Johnson & Johnson EMA Approval	0.0165	0.11			
Johnson & Johnson WHO Approval	0.0243	0.21			
Pfizer Phase 1	0.0135	0.28			
Pfizer Phase 2	0.0065	0.58			
Pfizer Phase 3	-0.0019	0.86			
Pfizer FDA Approval	0.0048	0.67			
Pfizer EMA Approval	0.0111*	0.03			
Pfizer WHO Approval	0.0195	0.23			
Novavax Phase 1	0.0276	0.16			
Novavax Phase 3	-0.0066	0.43			
AstraZeneca Phase 1	-0.0125	0.43			
AstraZeneca Phase 2	-0.0016	0.94			
AstraZeneca Phase 3	0.0079	0.45			
AstraZeneca FDA Approval	0.0173	0.28			
AstraZeneca EMA Approval	-0.0060	0.37			
AstraZeneca WHO Approval	-0.0120	0.26			
Moderna Phase 1	-0.0318	0.02			
Moderna Phase 2	0.0062	0.72			
Moderna Phase 3	0.0057	0.77			
Moderna FDA Approval	0.0262	0.06			
Moderna EMA Approval	-0.0217*	0.02			
Moderna WHO Approval	-0.0010	0.82			

Note. This table shows macroeconomic news and COVID-19 announcement's effects on EUR/USD returns before and during the COVID-19 pandemic (Estimated using Eq. (1) regression model). For each period, the first column lists the return response coefficient associated with individual news announcements, and the second column reports the corresponding p-value. The last column, p-diff, represents the p-value corresponding to a Wald test for the difference between during and before pandemic estimated coefficients. * Denotes statistical significance at the 5% level.

Table 14: Return response to COVID-19 pandemic indicators, JPY/USD

News Category	During Pandemic		Before Pandemic		
	Coeff.	*p*-value	Coeff.	*p*-value	*p*-diff.
Panel A: US Macroeconomic News					
GDP Annualized QoQ—Advance	-0.0180	0.11	-0.0053	0.51	0.88
GDP Annualized QoQ—Preliminary	0.0069	0.54	-0.0121	0.14	0.92
GDP Final	0.0040	0.72	0.0022	0.78	0.79
Change in Nonfarm Payrolls	-0.0079*	0.03	0.1649	0.09	0.07
Nonfarm Productivity	0.0006	0.90	-0.0197	0.18	0.18
PPI MoM	0.0087	0.05	-0.0628*	0.00	0.00*
Unemployment Rate	0.0481*	0.00	0.1226*	0.00	0.03*
Retail Sales MoM	0.0142*	0.03	-0.0310*	0.00	0.00*
Consumer Credit	0.0002	0.96	0.0029	0.74	0.78
New Home Sales	-0.0087	0.06	-0.0333*	0.00	0.00*
Personal Consumption	0.0019	0.61	0.1615	0.36	0.37
Durable Goods Orders	-0.0007	0.88	0.0076*	0.03	0.15
Factory Orders	0.0132	0.05	0.0266*	0.00	0.03*
Construction Spending MoM	-0.0113*	0.01	0.0020	0.75	0.08
Business Inventories	-0.0024	0.72	0.0040	0.39	0.43
Monthly Budget Statement	-0.0004	0.92	0.0050	0.58	0.58
Trade Balance	-0.0041	0.56	-0.0314*	0.00	0.00*
CPI MoM	-0.0484*	0.00	-0.1408*	0.00	0.00*
Consumer Confidence Index	-0.0084	0.12	-0.0378*	0.00	0.00*
ISM Manufacturing	-0.0204*	0.00	-0.1597*	0.00	0.00*
Housing Starts	-0.0075	0.12	-0.0388*	0.00	0.00*
Leading Index	-0.0036	0.41	-0.0014	0.82	0.78
Capacity Utilization	-0.0111*	0.01	-0.0443*	0.00	0.00*
FOMC Rate Decision (Upper Bound)	0.0002	0.98	-0.0048	0.40	0.61
FOMC Rate Decision (Lower Bound)	-0.0241*	0.00	0.0324*	0.00	0.00*
Panel B: Japan Macroeconomic News					
Tankan	0.0071	0.53	0.0166	0.34	0.76
Current Account	-0.0079	0.22	0.0029	0.71	0.17
GDP	0.0011	0.87	0.0241	0.29	0.46
Trade Balance	0.0038	0.41	0.0076	0.19	0.92
Retail sales	-0.0331	0.88	0.0033	0.44	0.87
PPI	0.0025	0.62	0.0018	0.74	0.94
Imports YoY	-0.0020	0.65	0.0049	0.88	0.70
Exports YoY	0.0219	0.31	0.0011	0.88	0.34
Housing Starts YoY	-0.0043	0.37	-0.0005	0.95	0.90
Industrial Production	-0.0004	0.94	-0.0058	0.56	0.24
Panel C: Japan COVID-19 News					
COVID-19 - Daily New cases	0.0000	0.88			
COVID-19 - Daily Vaccine doses	0.0000	0.70			
Panel D: Unscheduled COVID-19 news					
The overall Government response index	0.0001	0.58			
WHO Officials' Speeches	0.0006	0.84			
Panel E: Vaccine Development News					
Johnson & Johnson Phase 1	-0.0026	0.92			
Johnson & Johnson Phase 2	0.0020	0.92			
Johnson & Johnson Phase 3	0.0016	0.91			
Johnson & Johnson FDA Approval	0.0105	0.51			
Johnson & Johnson EMA Approval	0.0028	0.79			
Johnson & Johnson WHO Approval	-0.0106	0.58			
Pfizer Phase 1	0.0030	0.81			
Pfizer Phase 2	0.0049	0.68			
Pfizer Phase 3	-0.0115	0.30			
Pfizer FDA Approval	0.0050	0.65			
Pfizer EMA Approval	0.0050	0.34			
Pfizer WHO Approval	0.0020	0.90			
Novavax Phase 1	-0.0045	0.82			
Novavax Phase 3	-0.0042	0.61			
AstraZeneca Phase 1	0.0097	0.54			
AstraZeneca Phase 2	-0.0029	0.89			
AstraZeneca Phase 3	0.0016	0.88			
AstraZeneca FDA Approval	0.0044	0.78			
AstraZeneca EMA Approval	-0.0058	0.39			
AstraZeneca WHO Approval	-0.0002	0.98			
Moderna Phase 1	-0.0012	0.93			
Moderna Phase 2	0.0162	0.35			
Moderna Phase 3	-0.1408*	0.00			
Moderna FDA Approval	0.0024	0.86			
Moderna EMA Approval	-0.0058	0.53			
Moderna WHO Approval	-0.0001	0.99			

Note. This table shows macroeconomic news and COVID-19 announcement's effects on EUR/USD returns before and during the COVID-19 pandemic (Estimated using Eq. (1) regression model). For each period, the first column lists the return response coefficient associated with individual news announcements, and the second column reports the corresponding p-value. The last column, p-diff, represents the p-value corresponding to a Wald test for the difference between during and before pandemic estimated coefficients. * Denotes statistical significance at the 5% level.

Table 15: Volatility response to COVID-19 pandemic indicators, EUR/USD

News Category	During Pandemic		Before Pandemic		
	Coeff.	*p*-value	Coeff.	*p*-value	*p*-diff.
Panel A: US Macroeconomic News					
GDP Annualized QoQ—Advance	-0.0142	0.07	-0.0080	0.15	0.70
GDP Annualized QoQ—Preliminary	-0.0167*	0.03	-0.0094	0.11	0.72
GDP Final	-0.0115	0.14	0.0013	0.81	0.02
Change in Nonfarm Payrolls	-0.0022	0.39	-0.0180	0.79	0.00*
Nonfarm Productivity	-0.0039	0.24	0.0015	0.88	0.78
PPI MoM	-0.0020	0.52	0.0000	1.00	0.00*
Unemployment Rate	0.0087*	0.00	0.6134*	0.00	0.63
Retail Sales MoM	0.0112*	0.02	0.0524*	0.00	0.00*
Consumer Credit	-0.0038	0.18	0.0034	0.59	0.77
New Home Sales	0.0007	0.83	0.0153*	0.00	0.00*
Personal Consumption	-0.0044	0.09	0.3404*	0.01	0.04
Durable Goods Orders	-0.0004	0.91	0.0114*	0.00	0.01
Factory Orders	-0.0058	0.21	0.0144*	0.00	0.01
Construction Spending MoM	0.0053	0.09	0.0014	0.76	0.23
Business Inventories	-0.0058	0.21	0.0027	0.40	0.99
Monthly Budget Statement	-0.0011	0.71	0.0118	0.06	0.70
Trade Balance	0.0116*	0.02	0.0217*	0.00	0.00*
CPI MoM	0.0182*	0.00	0.0989*	0.00	0.00*
Consumer Confidence Index	0.0045	0.23	0.0096*	0.01	0.00*
ISM Manufacturing	0.0089*	0.01	0.0396*	0.00	0.00*
Housing Starts	0.0073*	0.03	0.0113*	0.00	0.00*
Leading Index	-0.0019*	0.53	-0.0002	0.96	0.97
Capacity Utilization	-0.0020	0.50	0.0060	0.30	0.00*
FOMC Rate Decision (Upper Bound)	0.0002	0.97	0.0069	0.08	0.19
FOMC Rate Decision (Lower Bound)	0.1076*	0.00	0.1758*	0.00	0.01*
Panel B: Germany Macroeconomic News					
GDP SA QoQ	-0.0064	0.27	0.0020	0.62	0.05
Unemployment Change (000's)	-0.0027	0.31	-0.0117	0.23	0.33
Unemployment Claims Rate SA	-0.0002	0.94	0.0136	0.06	0.24
Retail Sales MoM	-0.0026	0.32	-0.1849	0.63	0.36
Industrial Production SA MoM	-0.0021	0.42	0.1723*	0.00	0.00*
Trade Balance	0.0005	0.90	-0.0038	0.27	0.43
Current Account Balance	-0.0016	0.67	0.0075*	0.04	0.54
GfK Consumer Confidence	0.0008	0.75	0.1316*	0.03	0.01*
Import Price Index MoM	-0.0002	0.96	0.0093*	0.00	0.05
IFO Business Climate	0.0158*	0.00	0.0200*	0.00	0.21
ZEW Survey Current Situation	0.0044	0.19	0.0216*	0.00	0.75
Markit/BME Germany Manufacturing	0.0011	0.77	-0.0034	0.57	0.81
Panel C: Germany COVID-19 News					
COVID-19 - Daily New cases	0.0025*	0.00			
COVID-19 - Daily Vaccine doses	-0.0032*	0.00			
Panel D: Unscheduled COVID-19 news					
The overall Government response index	0.0013*	0.00			
WHO Officials' Speeches	0.0013	0.52			
Panel E: Vaccine Development News					
Johnson & Johnson Phase 1	-0.0062	0.75			
Johnson & Johnson Phase 2	-0.0178	0.19			
Johnson & Johnson Phase 3	-0.0070	0.46			
Johnson & Johnson FDA Approval	-0.0109	0.32			
Johnson & Johnson EMA Approval	-0.0002	0.98			
Johnson & Johnson WHO Approval	-0.0122	0.37			
Pfizer Phase 1	0.0106	0.22			
Pfizer Phase 2	-0.0078	0.35			
Pfizer Phase 3	-0.0051	0.52			
Pfizer FDA Approval	-0.0043	0.58			
Pfizer EMA Approval	0.0016	0.65			
Pfizer WHO Approval	-0.0013	0.91			
Novavax Phase 1	-0.0002	0.99			
Novavax Phase 3	-0.0080	0.17			
AstraZeneca Phase 1	0.0083	0.45			
AstraZeneca Phase 2	0.0086	0.57			
AstraZeneca Phase 3	-0.0066	0.36			
AstraZeneca FDA Approval	-0.0020	0.85			
AstraZeneca EMA Approval	-0.0001	0.98			
AstraZeneca WHO Approval	-0.0065	0.38			
Moderna Phase 1	-0.0103	0.28			
Moderna Phase 2	-0.0038	0.76			
Moderna Phase 3	-0.0197	0.15			
Moderna FDA Approval	-0.0187	0.05			
Moderna EMA Approval	0.0158*	0.01			
Moderna WHO Approval	-0.0018	0.54			

Note. This table shows macroeconomic news and COVID-19 announcement's effects on EUR/USD returns before and during the COVID-19 pandemic (Estimated using Eq. (1) regression model). For each period, the first column lists the return response coefficient associated with individual news announcements, and the second column reports the corresponding p-value. The last column, p-diff, represents the p-value corresponding to a Wald test for the difference between during and before pandemic estimated coefficients. * Denotes statistical significance at the 5% level.

Table 16: Volatility response to COVID-19 pandemic indicators, GBP/USD

News Category	During Pandemic		Before Pandemic		
	Coeff.	*p*-value	Coeff.	*p*-value	*p*-diff.
Panel A: US Macroeconomic News					
GDP Annualized QoQ—Advance	-0.0002	0.98	0.0008	0.92	0.12
GDP Annualized QoQ—Preliminary	0.0020	0.85	-0.0046	0.57	0.83
GDP Final	0.0073	0.51	-0.0177	0.02	0.05
Change in Nonfarm Payrolls	0.0045	0.22	0.2582*	0.01	0.19
Nonfarm Productivity	-0.0034	0.46	-0.0077	0.59	0.30
PPI MoM	0.0019	0.67	-0.0525*	0.00	0.00*
Unemployment Rate	0.0409*	0.00	0.0245	0.47	0.30
Retail Sales MoM	0.0043	0.51	-0.0265*	0.00	0.00*
Consumer Credit	-0.0009	0.82	-0.0037	0.67	0.89
New Home Sales	0.0063	0.16	-0.0239*	0.00	0.01*
Personal Consumption	-0.0014	0.71	-0.3664*	0.04	0.04
Durable Goods Orders	-0.0009	0.84	0.0098*	0.00	0.92
Factory Orders	0.0237*	0.00	0.0139*	0.00	0.00*
Construction Spending MoM	-0.0101	0.02	-0.0009	0.89	0.07
Business Inventories	-0.0020	0.75	-0.0021	0.64	0.02
Monthly Budget Statement	0.0024	0.55	-0.0014	0.88	0.70
Trade Balance	-0.0344*	0.00	-0.0095	0.03	0.07
CPI MoM	-0.0350*	0.00	-0.1416*	0.00	0.00*
Consumer Confidence Index	0.0019	0.72	-0.0328*	0.00	0.00*
ISM Manufacturing	-0.0105*	0.03	-0.1071*	0.00	0.00*
Housing Starts	0.0039	0.41	-0.0371*	0.00	0.00*
Leading Index	-0.0080	0.06	-0.0083	0.17	0.10
Capacity Utilization	-0.0064	0.12	-0.0367*	0.00	0.30
FOMC Rate Decision (Upper Bound)	0.0146	0.06	0.0023	0.67	0.76
FOMC Rate Decision (Lower Bound)	0.0300*	0.00	0.0549*	0.00	0.31
Panel B: UK Macroeconomic News					
CPI MoM	0.0049	0.54	-0.0070	0.21	0.41
Industrial Production MoM	-0.0030	0.43	0.0108	0.43	0.04
Current Account Balance	0.0032	0.40	0.0160	0.11	0.26
GfK Consumer Confidence	-0.0011	0.77	0.4797	0.37	0.78
Net Consumer Credit	0.0098*	0.01	0.2837*	0.00	0.00*
Employment Change 3M/3M	0.0082	0.14	0.0023	0.64	0.00*
Retail Price Index	0.0001	0.98	-0.2143*	0.01	0.00*
Trade Balance GBP/Mn	-0.0022	0.72	-0.0023	0.61	0.00*
GDP QoQ	-0.0044	0.50	0.0151*	0.00	0.00*
Bank of England Bank Rate	-0.0038	0.41	-0.0015	0.79	0.50
Monthly GDP (MoM)	0.0095	0.09	0.0071	0.40	0.04
Panel C: UK COVID-19 News					
COVID-19 - Daily New cases	0.0000	0.83			
COVID-19 - Daily Vaccine doses	-0.0001	0.10			
Panel D: Unscheduled COVID-19 news					
The overall Government response index	0.0001	0.21			
WHO Officials' Speeches	-0.0012	0.66			
Panel E: Vaccine Development News					
Johnson & Johnson Phase 1	0.0141	0.60			
Johnson & Johnson Phase 2	-0.0046	0.81			
Johnson & Johnson Phase 3	-0.0080	0.55			
Johnson & Johnson FDA Approval	0.0089	0.56			
Johnson & Johnson EMA Approval	0.0040	0.69			
Johnson & Johnson WHO Approval	0.0096	0.61			
Pfizer Phase 1	0.0180	0.14			
Pfizer Phase 2	0.0064	0.58			
Pfizer Phase 3	0.0068	0.54			
Pfizer FDA Approval	0.0025	0.82			
Pfizer EMA Approval	0.0048	0.35			
Pfizer WHO Approval	0.0058	0.71			
Novavax Phase 1	0.0089	0.64			
Novavax Phase 3	-0.0014	0.86			
AstraZeneca Phase 1	-0.0094	0.54			
AstraZeneca Phase 2	-0.0149	0.48			
AstraZeneca Phase 3	0.0012	0.91			
AstraZeneca FDA Approval	0.0061	0.69			
AstraZeneca EMA Approval	-0.0033	0.61			
AstraZeneca WHO Approval	-0.0031	0.77			
Moderna Phase 1	-0.0096	0.48			
Moderna Phase 2	0.0240	0.16			
Moderna Phase 3	-0.0500*	0.01			
Moderna FDA Approval	0.0216	0.11			
Moderna EMA Approval	-0.0306*	0.00			
Moderna WHO Approval	0.0041	0.32			

Note. This table shows macroeconomic news and COVID-19 announcement's effects on EUR/USD returns before and during the COVID-19 pandemic (Estimated using Eq. (1) regression model). For each period, the first column lists the return response coefficient associated with individual news announcements, and the second column reports the corresponding p-value. The last column, p-diff, represents the p-value corresponding to a Wald test for the difference between during and before pandemic estimated coefficients. * Denotes statistical significance at the 5% level.

Table 17: Volatility response to COVID-19 pandemic indicators, CAD/USD

News Category	During Pandemic		Before Pandemic		
	Coeff.	*p*-value	Coeff.	*p*-value	*p*-diff.
Panel A: US Macroeconomic News					
GDP Annualized QoQ—Advance	-0.0089	0.26	-0.0145*	0.01	0.00*
GDP Annualized QoQ—Preliminary	-0.0076	0.37	-0.0002	0.98	0.17
GDP Final	-0.0062	0.44	-0.0250*	0.00	0.04
Change in Nonfarm Payrolls	-0.0050	0.08	-0.2087*	0.00	0.10
Nonfarm Productivity	0.0034	0.32	-0.0078	0.46	0.42
PPI MoM	0.0145*	0.00	0.0039	0.42	0.00*
Unemployment Rate	0.0012	0.65	0.7470*	0.00	0.00*
Retail Sales MoM	0.0136*	0.01	0.0176*	0.00	0.00*
Consumer Credit	-0.0012	0.68	0.0073	0.26	0.34
New Home Sales	-0.0036	0.27	0.1063*	0.00	0.00*
Personal Consumption	-0.0051	0.06	0.0795	0.52	0.01*
Durable Goods Orders	-0.0068*	0.04	0.0191*	0.00	0.00*
Factory Orders	0.0050	0.29	0.0025	0.43	0.05
Construction Spending MoM	-0.0005	0.88	-0.0141*	0.00	0.11
Business Inventories	-0.0124*	0.01	0.0041	0.20	0.06
Monthly Budget Statement	0.0059*	0.04	-0.0108	0.09	0.35
Trade Balance	0.0223*	0.00	0.0320*	0.00	0.05
CPI MoM	0.0173*	0.00	0.0955*	0.00	0.00*
Consumer Confidence Index	0.0034	0.37	-0.0008	0.81	0.80
ISM Manufacturing	0.0101*	0.00	0.0224*	0.00	0.00*
Housing Starts	-0.0015	0.68	0.0112*	0.00	0.37
Leading Index	-0.0014	0.64	-0.0088	0.05	0.92
Capacity Utilization	-0.0032	0.28	-0.0038	0.51	0.84
FOMC Rate Decision (Upper Bound)	0.0007	0.90	0.0161*	0.00	0.91
FOMC Rate Decision (Lower Bound)	0.0811*	0.00	0.1705*	0.00	0.00*
Panel B: Canada Macroeconomic News					
Housing Starts	0.0001	0.98	-0.0045	0.36	0.98
Retail Sales MoM	0.0047	0.30	0.1240*	0.00	0.00*
Unemployment Rate	0.0102*	0.00	0.4029*	0.00	0.00*
Current Account Balance	-0.0009	0.90	0.0063	0.30	0.17
Industrial Product Price MoM	0.0006	0.89	0.0066	0.10	0.07
Consumer Price Index	0.0062	0.20	0.1433*	0.00	0.00*
GDP MoM	0.0033	0.46	0.1294*	0.00	0.00*
Manufacturing Sales MoM	-0.0033	0.52	0.0187*	0.00	0.00*
Bank of Canada Rate Decision	0.1620*	0.00	0.3620*	0.00	0.00*
Capacity Utilization Rate	0.0193*	0.02	0.0924*	0.00	0.00*
Building Permits MoM	0.0059	0.26	0.0367*	0.00	0.91
Raw Materials Price Index MoM	-0.0051	0.23	0.1098*	0.00	0.00*
Panel C: Canada COVID-19 News					
COVID-19 - Daily New cases	0.0041*	0.00			
COVID-19 - Daily Vaccine doses	-0.0023*	0.00			
Panel D: Unscheduled COVID-19 news					
The overall Government response index	0.0016*	0.00			
WHO Officials' Speeches	0.0022	0.28			
Panel E: Vaccine Development News					
Johnson & Johnson Phase 1	-0.0130	0.50			
Johnson & Johnson Phase 2	0.0002	0.99			
Johnson & Johnson Phase 3	-0.0147	0.13			
Johnson & Johnson FDA Approval	-0.0125	0.27			
Johnson & Johnson EMA Approval	-0.0069	0.35			
Johnson & Johnson WHO Approval	0.0109	0.43			
Pfizer Phase 1	-0.0095	0.28			
Pfizer Phase 2	0.0008	0.93			
Pfizer Phase 3	-0.0109	0.17			
Pfizer FDA Approval	-0.0154	0.05			
Pfizer EMA Approval	0.0037	0.31			
Pfizer WHO Approval	-0.0168	0.14			
Novavax Phase 1	0.0019	0.89			
Novavax Phase 3	-0.0021	0.72			
AstraZeneca Phase 1	-0.0170	0.13			
AstraZeneca Phase 2	-0.0100	0.52			
AstraZeneca Phase 3	0.0046	0.53			
AstraZeneca FDA Approval	-0.0013	0.91			
AstraZeneca EMA Approval	0.0001	0.99			
AstraZeneca WHO Approval	0.0034	0.65			
Moderna Phase 1	-0.0064	0.51			
Moderna Phase 2	-0.0112	0.37			
Moderna Phase 3	-0.0155	0.26			
Moderna FDA Approval	0.0045	0.64			
Moderna EMA Approval	0.0139*	0.03			
Moderna WHO Approval	0.0039	0.19			

Note. This table shows macroeconomic news and COVID-19 announcement's effects on EUR/USD returns before and during the COVID-19 pandemic (Estimated using Eq. (1) regression model). For each period, the first column lists the return response coefficient associated with individual news announcements, and the second column reports the corresponding p-value. The last column, p-diff, represents the p-value corresponding to a Wald test for the difference between during and before pandemic estimated coefficients. * Denotes statistical significance at the 5% level.

Table 18: Volatility response to COVID-19 pandemic indicators, JPY/USD

News Category	During Pandemic		Before Pandemic		
	Coeff.	*p*-value	Coeff.	*p*-value	*p*-diff.
Panel A: US Macroeconomic News					
GDP Annualized QoQ—Advance	0.0183*	0.03	-0.0022	0.72	0.88
GDP Annualized QoQ—Preliminary	-0.0062	0.46	-0.0074	0.24	0.92
GDP Final	-0.0008	0.93	-0.0056	0.35	0.79
Change in Nonfarm Payrolls	-0.0014	0.62	0.0473	0.52	0.07
Nonfarm Productivity	-0.0034	0.34	0.0014	0.90	0.18
PPI MoM	0.0117*	0.00	0.0173*	0.00	0.00*
Unemployment Rate	0.0097*	0.00	0.6391*	0.00	0.03
Retail Sales MoM	0.0073	0.15	0.0573*	0.00	0.00*
Consumer Credit	0.0001	0.98	0.0033	0.63	0.78
New Home Sales	0.0041	0.23	0.0097	0.05	0.00*
Personal Consumption	-0.0027	0.34	1.2197*	0.00	0.37
Durable Goods Orders	-0.0014	0.69	0.0140*	0.00	0.00*
Factory Orders	0.0064	0.20	0.0328*	0.00	0.03
Construction Spending MoM	0.0061	0.08	0.0108*	0.03	0.08
Business Inventories	0.0007	0.90	-0.0030	0.38	0.43
Monthly Budget Statement	-0.0030	0.33	0.0113	0.10	0.58
Trade Balance	0.0109*	0.04	0.0351*	0.00	0.00*
CPI MoM	0.0241*	0.00	0.0873*	0.00	0.00*
Consumer Confidence Index	-0.0076	0.06	0.0054	0.15	0.00*
ISM Manufacturing	0.0187*	0.00	0.0692*	0.00	0.00*
Housing Starts	0.0013	0.72	0.0197*	0.00	0.00*
Leading Index	0.0012	0.72	0.0161*	0.00	0.78
Capacity Utilization	-0.0024	0.44	0.0108	0.08	0.00*
FOMC Rate Decision (Upper Bound)	-0.0029	0.62	0.0092*	0.03	0.61
FOMC Rate Decision (Lower Bound)	0.0601*	0.00	0.1482*	0.00	0.00*
Panel B: Japan Macroeconomic News					
Tankan	-0.0067	0.44	0.0045	0.74	0.76
Current Account	0.0056	0.25	-0.0014	0.82	0.17
GDP	0.0010	0.85	-0.0064	0.71	0.46
Trade Balance	0.0027	0.43	0.0006	0.89	0.92
Retail sales	-0.1231	0.48	-0.0022	0.48	0.87
PPI	-0.0021	0.59	0.0001	0.99	0.94
Imports YoY	0.0008	0.82	-0.0215	0.37	0.70
Exports YoY	-0.0055	0.74	-0.0045	0.38	0.34
Housing Starts YoY	-0.0003	0.93	-0.0048	0.50	0.90
Industrial Production	-0.0044	0.29	-0.0035	0.64	0.24
Panel C: Japan COVID-19 News					
COVID-19 - Daily New cases	-0.0003*	0.00			
COVID-19 - Daily Vaccine doses	-0.0013*	0.00			
Panel D: Unscheduled COVID-19 news					
The overall Government response index	-0.0008*	0.00			
WHO Officials' Speeches	0.0030	0.16			
Panel E: Vaccine Development News					
Johnson & Johnson Phase 1	-0.0115	0.58			
Johnson & Johnson Phase 2	-0.0128	0.38			
Johnson & Johnson Phase 3	-0.0121	0.24			
Johnson & Johnson FDA Approval	-0.0111	0.35			
Johnson & Johnson EMA Approval	-0.0138	0.08			
Johnson & Johnson WHO Approval	-0.0137	0.35			
Pfizer Phase 1	-0.0020	0.83			
Pfizer Phase 2	-0.0026	0.77			
Pfizer Phase 3	0.0014	0.87			
Pfizer FDA Approval	-0.0046	0.58			
Pfizer EMA Approval	0.0008	0.84			
Pfizer WHO Approval	-0.0085	0.49			
Novavax Phase 1	-0.0085	0.56			
Novavax Phase 3	-0.0051	0.41			
AstraZeneca Phase 1	-0.0031	0.79			
AstraZeneca Phase 2	0.0007	0.97			
AstraZeneca Phase 3	-0.0032	0.68			
AstraZeneca FDA Approval	-0.0126	0.29			
AstraZeneca EMA Approval	-0.0056	0.27			
AstraZeneca WHO Approval	-0.0047	0.56			
Moderna Phase 1	-0.0060	0.57			
Moderna Phase 2	-0.0074	0.57			
Moderna Phase 3	0.0961*	0.00			
Moderna FDA Approval	-0.0147	0.16			
Moderna EMA Approval	-0.0104	0.13			
Moderna WHO Approval	-0.0048	0.13			

Note. This table shows macroeconomic news and COVID-19 announcement's effects on EUR/USD returns before and during the COVID-19 pandemic (Estimated using Eq. (1) regression model). For each period, the first column lists the return response coefficient associated with individual news announcements, and the second column reports the corresponding p-value. The last column, p-diff, represents the p-value corresponding to a Wald test for the difference between during and before pandemic estimated coefficients. * Denotes statistical significance at the 5% level.

Table 19: Robustness check- Return response to COVID-19 pandemic indicators, EUR/USD

News Category	During Pandemic		Before Pandemic		
	Coeff.	*p*-value	Coeff.	*p*-value	*p*-diff.
Panel A: US Macroeconomic News					
GDP Annualized QoQ—Advance	-0.0001	0.99	0.0007	0.92	0.71
GDP Annualized QoQ—Preliminary	0.0021	0.85	-0.0046	0.57	0.73
GDP Final	0.0073	0.51	-0.0178*	0.02	0.02
Change in Nonfarm Payrolls	0.0045	0.22	0.2582*	0.01	0.01*
Nonfarm Productivity	-0.0034	0.46	-0.0077	0.59	0.78
PPI MoM	0.0019	0.67	-0.0525*	0.00	0.00*
Unemployment Rate	0.0409*	0.00	0.0246	0.47	0.63
Retail Sales MoM	0.0043	0.51	-0.0266*	0.00	0.00*
Consumer Credit	-0.0009	0.82	-0.0037	0.67	0.77
New Home Sales	0.0063	0.16	-0.0239*	0.00	0.00*
Personal Consumption	-0.0013	0.71	-0.3668*	0.03	0.04
Durable Goods Orders	-0.0009	0.85	0.0098*	0.00	0.43
Factory Orders	0.0238*	0.00	0.0138*	0.00	0.01*
Construction Spending MoM	-0.0101*	0.02	-0.0008	0.89	0.23
Business Inventories	-0.0020	0.75	-0.0021	0.64	0.99
Monthly Budget Statement	0.0024	0.55	-0.0014	0.88	0.70
Trade Balance	-0.0344*	0.00	-0.0096*	0.03	0.00*
CPI MoM	-0.0350*	0.00	-0.1416*	0.00	0.00*
Consumer Confidence Index	0.0019	0.72	-0.0328*	0.00	0.00*
ISM Manufacturing	-0.0105*	0.03	-0.1071*	0.00	0.00*
Housing Starts	0.0039	0.41	-0.0371*	0.00	0.00*
Leading Index	-0.0080	0.06	-0.0083	0.17	0.97
Capacity Utilization	-0.0064	0.12	-0.0367*	0.00	0.00*
FOMC Rate Decision (Upper Bound)	0.0147	0.06	0.0023	0.67	0.19
FOMC Rate Decision (Lower Bound)	0.0300*	0.00	0.0549*	0.00	0.01*
Panel B: Germany Macroeconomic News					
GDP SA QoQ	0.0050	0.54	-0.0070	0.21	0.05
Unemployment Change (000's)	-0.0030	0.43	0.0108	0.43	0.33
Unemployment Claims Rate SA	0.0032	0.41	0.0160	0.11	0.24
Retail Sales MoM	-0.0010	0.77	0.4811	0.36	0.36
Industrial Production SA MoM	0.0098*	0.01	0.2839*	0.00	0.00*
Trade Balance	0.0081	0.15	0.0023	0.64	0.43
Current Account Balance	0.0028	0.60	0.0074	0.15	0.54
GfK Consumer Confidence	0.0001	0.98	-0.2144*	0.01	0.01*
Import Price Index MoM	-0.0022	0.73	-0.0023	0.61	0.05
IFO Business Climate	-0.0044	0.50	0.0151*	0.00	0.21
ZEW Survey Current Situation	-0.0038	0.41	-0.0015	0.79	0.75
Markit/BME Germany Manufacturing	0.0095	0.09	0.0071	0.40	0.81
Panel C: Germany COVID-19 News					
COVID-19 - Daily New deaths	0.0000	0.56			
COVID-19 - Daily Vaccine doses	-0.0003	0.05			
Panel D: Unscheduled COVID-19 news					
Stringency index	0.0002	0.07			
WHO Officials' Speeches	-0.0012	0.68			
Panel E: Vaccine Development News					
Johnson & Johnson Phase 1	0.0143	0.60			
Johnson & Johnson Phase 2	-0.0046	0.81			
Johnson & Johnson Phase 3	-0.0080	0.55			
Johnson & Johnson FDA Approval	0.0091	0.56			
Johnson & Johnson EMA Approval	0.0041	0.68			
Johnson & Johnson WHO Approval	0.0098	0.61			
Pfizer Phase 1	0.0180	0.13			
Pfizer Phase 2	0.0065	0.57			
Pfizer Phase 3	0.0068	0.53			
Pfizer FDA Approval	0.0026	0.82			
Pfizer EMA Approval	0.0049	0.34			
Pfizer WHO Approval	0.0058	0.72			
Novavax Phase 1	0.0090	0.64			
Novavax Phase 3	-0.0013	0.87			
AstraZeneca Phase 1	0.0093	0.55			
AstraZeneca Phase 2	-0.0094	0.54			
AstraZeneca Phase 3	-0.0149	0.48			
AstraZeneca FDA Approval	0.0013	0.90			
AstraZeneca EMA Approval	0.0063	0.68			
AstraZeneca WHO Approval	-0.0030	0.65			
Moderna Phase 1	-0.0029	0.78			
Moderna Phase 2	-0.0094	0.48			
Moderna Phase 3	0.0240	0.16			
Moderna FDA Approval	-0.0499*	0.01			
Moderna EMA Approval	0.0216	0.11			
Moderna WHO Approval	-0.0305*	0.00			

Note. This table shows macroeconomic news and COVID-19 announcement's effects on EUR/USD returns before and during the COVID-19 pandemic (Estimated using Eq. (1) regression model). For each period, the first column lists the return response coefficient associated with individual news announcements, and the second column reports the corresponding p-value. The last column, p-diff, represents the p-value corresponding to a Wald test for the difference between during and before pandemic estimated coefficients. * Denotes statistical significance at the 5% level.

Table 20: Robustness check- Return response to COVID-19 pandemic indicators, GBP/USD

News Category	During Pandemic		Before Pandemic		
	Coeff.	*p*-value	Coeff.	*p*-value	*p*-diff.
Panel A: US Macroeconomic News					
GDP Annualized QoQ—Advance	-0.0056	0.69	0.0035	0.73	0.12
GDP Annualized QoQ—Preliminary	0.0021	0.88	-0.0039	0.71	0.83
GDP Final	0.0124	0.39	0.0048	0.63	0.05
Change in Nonfarm Payrolls	0.0060	0.20	0.1652	0.18	0.19
Nonfarm Productivity	0.0045	0.46	-0.0157	0.40	0.30
PPI MoM	0.0138	0.02	-0.0398*	0.00	0.00*
Unemployment Rate	0.0323*	0.00	0.0779	0.08	0.30
Retail Sales MoM	0.0087	0.31	-0.0190*	0.00	0.00*
Consumer Credit	0.0004	0.94	0.0021	0.85	0.89
New Home Sales	-0.0024	0.68	-0.0285*	0.00	0.01*
Personal Consumption	0.0015	0.75	-0.4547	0.05	0.04
Durable Goods Orders	0.0064	0.28	0.0072	0.11	0.12
Factory Orders	0.0293*	0.00	0.0029	0.61	0.00*
Construction Spending MoM	-0.0081	0.16	0.0099	0.23	0.07
Business Inventories	-0.0221*	0.01	0.0010	0.86	0.02
Monthly Budget Statement	0.0008	0.88	-0.0039	0.73	0.70
Trade Balance	-0.0266*	0.00	-0.0078	0.17	0.07
CPI MoM	-0.0335*	0.00	-0.1087*	0.00	0.00*
Consumer Confidence Index	0.0021	0.76	-0.0354*	0.00	0.00*
ISM Manufacturing	-0.0159*	0.01	-0.0736*	0.00	0.00*
Housing Starts	0.0067	0.28	-0.0308*	0.00	0.00*
Leading Index	-0.0034	0.54	0.0125	0.12	0.10
Capacity Utilization	-0.0108*	0.04	-0.0227*	0.03	0.30
FOMC Rate Decision (Upper Bound)	0.0095	0.35	0.0057	0.43	0.76
FOMC Rate Decision (Lower Bound)	0.0183	0.07	0.0306*	0.00	0.31
Panel B: UK Macroeconomic News					
CPI MoM	0.0044	0.48	0.0122	0.10	0.41
Industrial Production MoM	0.0048	0.57	0.0019	0.74	0.04
Current Account Balance	0.0119	0.35	-0.0068	0.55	0.26
GfK Consumer Confidence	0.0024	0.76	-0.0037	0.53	0.78
Net Consumer Credit	-0.0159*	0.00	0.0535*	0.00	0.00*
Employment Change 3M/3M	0.0107	0.07	0.0590*	0.00	0.00*
Retail Price Index	0.0107	0.09	0.1194*	0.00	0.00*
Trade Balance GBP/Mn	0.0032	0.59	0.0420*	0.00	0.00*
GDP QoQ	0.0003	0.98	0.0045	0.50	0.00*
Bank of England Bank Rate	0.0493*	0.00	0.0174*	0.02	0.50
Monthly GDP (MoM)	-0.0068	0.43	-0.0230*	0.01	0.04
Panel C: UK COVID-19 News					
COVID-19 - Daily New deaths	-0.0002	0.17			
COVID-19 - Daily Vaccine doses	-0.0001	0.62			
Panel D: Unscheduled COVID-19 news					
Stringency index	0.0004*	0.00			
WHO Officials' Speeches	-0.0027	0.46			
Panel E: Vaccine Development News					
Johnson & Johnson Phase 1	0.0002	0.99			
Johnson & Johnson Phase 2	-0.0044	0.86			
Johnson & Johnson Phase 3	-0.0025	0.88			
Johnson & Johnson FDA Approval	0.0140	0.49			
Johnson & Johnson EMA Approval	0.0107	0.42			
Johnson & Johnson WHO Approval	0.0021	0.93			
Pfizer Phase 1	0.0093	0.55			
Pfizer Phase 2	0.0283	0.06			
Pfizer Phase 3	0.0039	0.78			
Pfizer FDA Approval	-0.0124	0.39			
Pfizer EMA Approval	0.0079	0.24			
Pfizer WHO Approval	0.0309	0.14			
Novavax Phase 1	0.0169	0.50			
Novavax Phase 3	-0.0121	0.25			
AstraZeneca Phase 1	-0.0131	0.52			
AstraZeneca Phase 2	-0.0818*	0.00			
AstraZeneca Phase 3	-0.0147	0.60			
AstraZeneca FDA Approval	0.0224	0.09			
AstraZeneca EMA Approval	0.0136	0.50			
AstraZeneca WHO Approval	0.0011	0.89			
Moderna Phase 1	-0.0210	0.12			
Moderna Phase 2	-0.0620*	0.00			
Moderna Phase 3	0.0383	0.09			
Moderna FDA Approval	-0.0360	0.15			
Moderna EMA Approval	0.0032	0.85			
Moderna WHO Approval	-0.0029	0.80			

Note. This table shows macroeconomic news and COVID-19 announcement's effects on EUR/USD returns before and during the COVID-19 pandemic (Estimated using Eq. (1) regression model). For each period, the first column lists the return response coefficient associated with individual news announcements, and the second column reports the corresponding p-value. The last column, p-diff, represents the p-value corresponding to a Wald test for the difference between during and before pandemic estimated coefficients. * Denotes statistical significance at the 5% level.

Table 21: Robustness check- Return response to COVID-19 pandemic indicators, CAD/USD

News Category	During Pandemic		Before Pandemic		
	Coeff.	*p*-value	Coeff.	*p*-value	*p*-diff.
Panel A: US Macroeconomic News					
GDP Annualized QoQ—Advance	0.0283*	0.01	0.0134	0.10	0.00*
GDP Annualized QoQ—Preliminary	-0.0010	0.93	-0.0020	0.82	0.16
GDP Final	-0.0054	0.63	0.0196*	0.01	0.04
Change in Nonfarm Payrolls	-0.0024	0.54	0.1553	0.11	0.10
Nonfarm Productivity	-0.0022	0.65	0.0126	0.39	0.42
PPI MoM	0.0258*	0.00	-0.0329*	0.00	0.00*
Unemployment Rate	-0.0162*	0.00	0.1270*	0.00	0.00*
Retail Sales MoM	-0.0013	0.85	-0.0421*	0.00	0.00*
Consumer Credit	0.0013	0.75	-0.0083	0.36	0.33
New Home Sales	0.0029	0.54	-0.1168*	0.00	0.00*
Personal Consumption	0.0046	0.23	-0.1692	0.33	0.00*
Durable Goods Orders	0.0069	0.14	-0.0038	0.29	0.84
Factory Orders	0.0166*	0.01	-0.0075	0.10	0.05
Construction Spending MoM	-0.0045	0.33	0.0081	0.21	0.11
Business Inventories	-0.0132	0.05	0.0020	0.67	0.05
Monthly Budget Statement	0.0053	0.20	-0.0038	0.67	0.35
Trade Balance	0.0073	0.31	-0.0136*	0.00	0.04
CPI MoM	-0.0402*	0.00	-0.1158*	0.00	0.00*
Consumer Confidence Index	-0.0030	0.58	-0.0049	0.32	0.79
ISM Manufacturing	-0.0188*	0.00	-0.0474*	0.00	0.00*
Housing Starts	-0.0048	0.32	-0.0240*	0.00	0.36
Leading Index	-0.0033	0.45	-0.0040	0.52	0.92
Capacity Utilization	0.0007	0.87	-0.0011	0.89	0.84
FOMC Rate Decision (Upper Bound)	0.0072	0.37	0.0082	0.15	0.90
FOMC Rate Decision (Lower Bound)	0.0145	0.07	0.0522*	0.00	0.00*
Panel B: Canada Macroeconomic News					
Housing Starts	0.0012	0.80	0.0013	0.85	0.98
Retail Sales MoM	-0.0062	0.34	-0.0327*	0.00	0.00*
Unemployment Rate	-0.0127*	0.00	-0.3097*	0.00	0.00*
Current Account Balance	0.0035	0.69	0.0059	0.49	0.17
Industrial Product Price MoM	-0.0009	0.90	0.0139*	0.01	0.07
Consumer Price Index	-0.0402*	0.00	0.0729*	0.00	0.00*
GDP MoM	-0.0129	0.04	0.0610*	0.00	0.00*
Manufacturing Sales MoM	0.0160*	0.02	0.0055	0.31	0.00*
Bank of Canada Rate Decision	0.0508	0.00	0.0015	0.82	0.00*
Capacity Utilization Rate	0.0249*	0.03	0.1482*	0.00	0.00*
Building Permits MoM	-0.0055	0.46	-0.0025	0.65	0.91
Raw Materials Price Index MoM	0.0095	0.11	0.0540*	0.00	0.00*
Panel C: Canada COVID-19 News					
COVID-19 - Daily New deaths	-0.0001	0.10			
COVID-19 - Daily Vaccine doses	0.0000	0.77			
Panel D: Unscheduled COVID-19 news					
Stringency index	0.0003*	0.01			
WHO Officials' Speeches	-0.0066*	0.02			
Panel E: Vaccine Development News					
Johnson & Johnson Phase 1	-0.0105	0.70			
Johnson & Johnson Phase 2	-0.0012	0.95			
Johnson & Johnson Phase 3	0.0050	0.71			
Johnson & Johnson FDA Approval	0.0213	0.18			
Johnson & Johnson EMA Approval	0.0165	0.11			
Johnson & Johnson WHO Approval	0.0243	0.21			
Pfizer Phase 1	0.0136	0.27			
Pfizer Phase 2	0.0065	0.58			
Pfizer Phase 3	-0.0019	0.87			
Pfizer FDA Approval	0.0049	0.67			
Pfizer EMA Approval	0.0112*	0.03			
Pfizer WHO Approval	0.0196	0.23			
Novavax Phase 1	0.0277	0.15			
Novavax Phase 3	-0.0065	0.43			
AstraZeneca Phase 1	-0.0089	0.57			
AstraZeneca Phase 2	-0.0122	0.44			
AstraZeneca Phase 3	-0.0016	0.94			
AstraZeneca FDA Approval	0.0080	0.44			
AstraZeneca EMA Approval	0.0174	0.27			
AstraZeneca WHO Approval	-0.0060	0.37			
Moderna Phase 1	-0.0120	0.26			
Moderna Phase 2	-0.0315	0.02			
Moderna Phase 3	0.0062	0.72			
Moderna FDA Approval	0.0058	0.77			
Moderna EMA Approval	0.0263	0.06			
Moderna WHO Approval	-0.0217*	0.02			

Note. This table shows macroeconomic news and COVID-19 announcement's effects on EUR/USD returns before and during the COVID-19 pandemic (Estimated using Eq. (1) regression model). For each period, the first column lists the return response coefficient associated with individual news announcements, and the second column reports the corresponding p-value. The last column, p-diff, represents the p-value corresponding to a Wald test for the difference between during and before pandemic estimated coefficients. * Denotes statistical significance at the 5% level.

Table 22: Robustness check- Return response to COVID-19 pandemic indicators, JPY/USD

News Category	During Pandemic		Before Pandemic		
	Coeff.	*p*-value	Coeff.	*p*-value	*p*-diff.
Panel A: US Macroeconomic News					
GDP Annualized QoQ—Advance	-0.0180	0.11	-0.0053	0.51	0.88
GDP Annualized QoQ—Preliminary	0.0069	0.54	-0.0121	0.14	0.92
GDP Final	0.0040	0.72	0.0022	0.78	0.79
Change in Nonfarm Payrolls	-0.0079*	0.03	0.1649	0.09	0.07
Nonfarm Productivity	0.0006	0.90	-0.0197	0.18	0.18
PPI MoM	0.0088	0.05	-0.0628*	0.00	0.00*
Unemployment Rate	0.0481*	0.00	0.1225*	0.00	0.03
Retail Sales MoM	0.0142*	0.03	-0.0310*	0.00	0.00*
Consumer Credit	0.0002	0.96	0.0029	0.74	0.78
New Home Sales	-0.0087	0.06	-0.0333*	0.00	0.00*
Personal Consumption	0.0019	0.61	0.1615	0.36	0.37
Durable Goods Orders	-0.0007	0.88	0.0076*	0.03	0.42
Factory Orders	0.0132	0.05	0.0266*	0.00	0.03
Construction Spending MoM	-0.0113*	0.01	0.0020	0.75	0.08
Business Inventories	-0.0024	0.72	0.0040	0.39	0.43
Monthly Budget Statement	-0.0004	0.92	0.0050	0.58	0.58
Trade Balance	-0.0041	0.56	-0.0314*	0.00	0.00*
CPI MoM	-0.0484*	0.00	-0.1408*	0.00	0.00*
Consumer Confidence Index	-0.0084	0.12	-0.0378*	0.00	0.00*
ISM Manufacturing	-0.0204*	0.00	-0.1597*	0.00	0.00*
Housing Starts	-0.0075	0.12	-0.0388*	0.00	0.00*
Leading Index	-0.0036	0.41	-0.0014	0.82	0.78
Capacity Utilization	-0.0111*	0.01	-0.0443*	0.00	0.00*
FOMC Rate Decision (Upper Bound)	0.0002	0.98	-0.0048	0.40	0.61
FOMC Rate Decision (Lower Bound)	-0.0241*	0.00	0.0324*	0.00	0.00*
Panel B: Japan Macroeconomic News					
Tankan	0.0071	0.53	0.0166	0.34	0.76
Current Account	-0.0079	0.22	0.0029	0.71	0.17
GDP	0.0011	0.87	0.0241	0.29	0.46
Trade Balance	0.0038	0.41	0.0076	0.19	0.92
Retail sales	-0.0329	0.89	0.0033	0.44	0.87
PPI	0.0025	0.61	0.0018	0.74	0.94
Imports YoY	-0.0020	0.65	0.0049	0.88	0.70
Exports YoY	0.0219	0.31	0.0011	0.88	0.34
Housing Starts YoY	-0.0043	0.37	-0.0005	0.95	0.90
Industrial Production	-0.0004	0.94	-0.0058	0.56	0.24
Panel C: Japan COVID-19 News					
COVID-19 - Daily New deaths	0.0000	0.63			
COVID-19 - Daily Vaccine doses	0.0000	0.69			
Panel D: Unscheduled COVID-19 news					
Stringency index	0.0001	0.55			
WHO Officials' Speeches	0.0006	0.84			
Panel E: Vaccine Development News					
Johnson & Johnson Phase 1	-0.0026	0.92			
Johnson & Johnson Phase 2	0.0020	0.92			
Johnson & Johnson Phase 3	0.0016	0.91			
Johnson & Johnson FDA Approval	0.0105	0.51			
Johnson & Johnson EMA Approval	0.0028	0.79			
Johnson & Johnson WHO Approval	-0.0106	0.58			
Pfizer Phase 1	0.0030	0.81			
Pfizer Phase 2	0.0049	0.68			
Pfizer Phase 3	-0.0115	0.30			
Pfizer FDA Approval	0.0050	0.65			
Pfizer EMA Approval	0.0050	0.34			
Pfizer WHO Approval	0.0020	0.90			
Novavax Phase 1	-0.0045	0.82			
Novavax Phase 3	-0.0042	0.61			
AstraZeneca Phase 1	0.0165	0.30			
AstraZeneca Phase 2	0.0097	0.54			
AstraZeneca Phase 3	-0.0029	0.89			
AstraZeneca FDA Approval	0.0016	0.88			
AstraZeneca EMA Approval	0.0044	0.78			
AstraZeneca WHO Approval	-0.0058	0.39			
Moderna Phase 1	-0.0002	0.98			
Moderna Phase 2	-0.0012	0.93			
Moderna Phase 3	0.0162	0.35			
Moderna FDA Approval	-0.1408*	0.00			
Moderna EMA Approval	0.0024	0.86			
Moderna WHO Approval	-0.0058	0.53			

Note. This table shows macroeconomic news and COVID-19 announcement's effects on EUR/USD returns before and during the COVID-19 pandemic (Estimated using Eq. (1) regression model). For each period, the first column lists the return response coefficient associated with individual news announcements, and the second column reports the corresponding p-value. The last column, p-diff, represents the p-value corresponding to a Wald test for the difference between during and before pandemic estimated coefficients. * Denotes statistical significance at the 5% level.

Table 23: Robustness check- Volatility response to COVID-19 pandemic indicators, EUR/USD

News Category	During Pandemic		Before Pandemic		
	Coeff.	*p*-value	Coeff.	*p*-value	*p*-diff.
Panel A: US Macroeconomic News					
GDP Annualized QoQ—Advance	-0.0148	0.06	-0.0079	0.15	0.71
GDP Annualized QoQ—Preliminary	-0.0152	0.05	-0.0092	0.11	0.73
GDP Final	-0.0121	0.12	0.0014	0.80	0.02*
Change in Nonfarm Payrolls	-0.0021	0.41	-0.0171	0.80	0.01*
Nonfarm Productivity	-0.0044	0.19	0.0018	0.86	0.78
PPI MoM	-0.0024	0.45	0.0003	0.95	0.00*
Unemployment Rate	0.0088*	0.00	0.6138*	0.00	0.63
Retail Sales MoM	0.0105*	0.02	0.0525*	0.00	0.00*
Consumer Credit	-0.0040	0.17	0.0037	0.56	0.77
New Home Sales	0.0007	0.83	0.0156*	0.00	0.00*
Personal Consumption	-0.0045	0.09	0.3449*	0.01	0.04
Durable Goods Orders	-0.0003	0.93	0.0116*	0.00	0.00*
Factory Orders	-0.0064	0.17	0.0146*	0.00	0.01
Construction Spending MoM	0.0054	0.09	0.0016	0.72	0.23
Business Inventories	-0.0055	0.23	0.0028	0.38	0.99
Monthly Budget Statement	-0.0012	0.68	0.0121	0.06	0.70
Trade Balance	0.0125*	0.01	0.0219*	0.00	0.00*
CPI MoM	0.0184*	0.00	0.0990*	0.00	0.00*
Consumer Confidence Index	0.0044	0.25	0.0101*	0.00	0.00*
ISM Manufacturing	0.0083*	0.01	0.0398*	0.00	0.00*
Housing Starts	0.0070*	0.04	0.0114*	0.00	0.00*
Leading Index	-0.0024	0.44	-0.0001	0.98	0.97
Capacity Utilization	-0.0021	0.47	0.0062	0.28	0.00*
FOMC Rate Decision (Upper Bound)	0.0002	0.96	0.0071	0.07	0.19
FOMC Rate Decision (Lower Bound)	0.1078*	0.00	0.1762*	0.00	0.01
Panel B: Germany Macroeconomic News					
GDP SA QoQ	-0.0054	0.35	0.0022	0.58	0.05
Unemployment Change (000's)	-0.0031	0.25	-0.0114	0.24	0.33
Unemployment Claims Rate SA	-0.0006	0.82	0.0138	0.06	0.24
Retail Sales MoM	-0.0024	0.36	-0.1716	0.65	0.36
Industrial Production SA MoM	-0.0020	0.44	0.1743*	0.00	0.00*
Trade Balance	-0.0006	0.89	-0.0037	0.29	0.43
Current Account Balance	-0.0022	0.57	0.0077*	0.03	0.54
GfK Consumer Confidence	0.0005	0.84	0.1345*	0.02	0.01*
Import Price Index MoM	-0.0005	0.92	0.0095*	0.00	0.05
IFO Business Climate	0.0157*	0.00	0.0202*	0.00	0.21
ZEW Survey Current Situation	0.0041	0.21	0.0219*	0.00	0.75
Markit/BME Germany Manufacturing	0.0015	0.70	-0.0034	0.57	0.81
Panel C: Germany COVID-19 News					
COVID-19 - Daily New deaths	0.0032*	0.00			
COVID-19 - Daily Vaccine doses	-0.0039*	0.00			
Panel D: Unscheduled COVID-19 news					
Stringency index	0.0010*	0.00			
WHO Officials' Speeches	0.0009	0.65			
Panel E: Vaccine Development News					
Johnson & Johnson Phase 1	-0.0068	0.72			
Johnson & Johnson Phase 2	-0.0162	0.23			
Johnson & Johnson Phase 3	-0.0071	0.46			
Johnson & Johnson FDA Approval	-0.0113	0.31			
Johnson & Johnson EMA Approval	-0.0010	0.89			
Johnson & Johnson WHO Approval	-0.0138	0.31			
Pfizer Phase 1	0.0087	0.31			
Pfizer Phase 2	-0.0086	0.29			
Pfizer Phase 3	-0.0053	0.50			
Pfizer FDA Approval	-0.0058	0.46			
Pfizer EMA Approval	0.0011	0.77			
Pfizer WHO Approval	-0.0020	0.86			
Novavax Phase 1	-0.0049	0.72			
Novavax Phase 3	-0.0087	0.13			
AstraZeneca Phase 1	-0.0112	0.31			
AstraZeneca Phase 2	0.0098	0.37			
AstraZeneca Phase 3	0.0097	0.52			
AstraZeneca FDA Approval	-0.0068	0.35			
AstraZeneca EMA Approval	-0.0021	0.85			
AstraZeneca WHO Approval	0.0005	0.92			
Moderna Phase 1	-0.0075	0.31			
Moderna Phase 2	-0.0114	0.23			
Moderna Phase 3	-0.0048	0.69			
Moderna FDA Approval	-0.0218	0.11			
Moderna EMA Approval	-0.0198*	0.04			
Moderna WHO Approval	0.0157*	0.01			

Note. This table shows macroeconomic news and COVID-19 announcement's effects on EUR/USD returns before and during the COVID-19 pandemic (Estimated using Eq. (1) regression model). For each period, the first column lists the return response coefficient associated with individual news announcements, and the second column reports the corresponding p-value. The last column, p-diff, represents the p-value corresponding to a Wald test for the difference between during and before pandemic estimated coefficients. * Denotes statistical significance at the 5% level.

Table 24: Robustness check- Volatility response to COVID-19 pandemic indicators, GBP/USD

News Category	During Pandemic		Before Pandemic		
	Coeff.	*p*-value	Coeff.	*p*-value	*p*-diff.
Panel A: US Macroeconomic News					
GDP Annualized QoQ—Advance	-0.0254*	0.01	-0.0011	0.88	0.12
GDP Annualized QoQ—Preliminary	-0.0096	0.36	-0.0026	0.74	0.83
GDP Final	-0.0133	0.20	0.0192*	0.01	0.05
Change in Nonfarm Payrolls	-0.0035	0.31	0.1769	0.05	0.19
Nonfarm Productivity	-0.0030	0.50	-0.0149	0.27	0.30
PPI MoM	0.0105*	0.01	-0.0129*	0.04	0.00*
Unemployment Rate	0.0069*	0.04	0.3721*	0.00	0.30
Retail Sales MoM	0.0090	0.14	0.0398*	0.00	0.00*
Consumer Credit	-0.0010	0.79	-0.0075	0.37	0.89
New Home Sales	-0.0020	0.63	0.0029	0.63	0.01*
Personal Consumption	-0.0043	0.22	0.6169*	0.00	0.04
Durable Goods Orders	-0.0021	0.63	0.0022	0.51	0.74
Factory Orders	-0.0118	0.06	0.0099*	0.02	0.00*
Construction Spending MoM	-0.0015	0.72	-0.0032	0.60	0.07
Business Inventories	-0.0059	0.34	0.0098*	0.02	0.02
Monthly Budget Statement	0.0006	0.88	0.0060	0.48	0.70
Trade Balance	0.0039	0.55	0.0134*	0.00	0.07
CPI MoM	0.0127*	0.01	0.0640*	0.00	0.00*
Consumer Confidence Index	-0.0015	0.76	0.0074	0.11	0.00*
ISM Manufacturing	0.0030	0.51	0.0155*	0.00	0.00*
Housing Starts	-0.0046	0.31	0.0117*	0.01	0.00*
Leading Index	0.0026	0.51	-0.0088	0.13	0.10
Capacity Utilization	0.0005	0.91	-0.0067	0.37	0.30
FOMC Rate Decision (Upper Bound)	0.0047	0.52	0.0183*	0.00	0.76
FOMC Rate Decision (Lower Bound)	0.0817*	0.00	0.1462*	0.00	0.31
Panel B: UK Macroeconomic News					
CPI MoM	-0.0004	0.94	0.0035	0.52	0.41
Industrial Production MoM	-0.0010	0.87	0.0037	0.39	0.04
Current Account Balance	-0.0068	0.46	0.0135	0.10	0.26
GfK Consumer Confidence	-0.0003	0.96	0.0002	0.96	0.78
Net Consumer Credit	-0.0007	0.85	0.0766*	0.00	0.00*
Employment Change 3M/3M	0.0061	0.16	0.0462*	0.00	0.00*
Retail Price Index	0.0163*	0.00	0.1255*	0.00	0.00*
Trade Balance GBP/Mn	0.0009	0.84	0.0455*	0.00	0.00*
GDP QoQ	-0.0065	0.38	0.0467*	0.00	0.00*
Bank of England Bank Rate	0.2033*	0.00	0.2755*	0.00	0.50
Monthly GDP (MoM)	-0.0020	0.75	0.0337*	0.00	0.04
Panel C: UK COVID-19 News					
COVID-19 - Daily New deaths	0.0052*	0.00			
COVID-19 - Daily Vaccine doses	-0.0029*	0.00			
Panel D: Unscheduled COVID-19 news					
Stringency index	0.0002	0.05			
WHO Officials' Speeches	0.0033	0.22			
Panel E: Vaccine Development News					
Johnson & Johnson Phase 1	-0.0133	0.60			
Johnson & Johnson Phase 2	-0.0063	0.73			
Johnson & Johnson Phase 3	-0.0154	0.23			
Johnson & Johnson FDA Approval	-0.0109	0.46			
Johnson & Johnson EMA Approval	-0.0134	0.16			
Johnson & Johnson WHO Approval	-0.0064	0.72			
Pfizer Phase 1	-0.0190	0.10			
Pfizer Phase 2	0.0167	0.13			
Pfizer Phase 3	-0.0168	0.11			
Pfizer FDA Approval	-0.0039	0.71			
Pfizer EMA Approval	-0.0002	0.96			
Pfizer WHO Approval	-0.0214	0.16			
Novavax Phase 1	-0.0167	0.35			
Novavax Phase 3	0.0007	0.93			
AstraZeneca Phase 1	-0.0206	0.16			
AstraZeneca Phase 2	0.0173	0.24			
AstraZeneca Phase 3	-0.0265	0.19			
AstraZeneca FDA Approval	0.0144	0.13			
AstraZeneca EMA Approval	-0.0145	0.33			
AstraZeneca WHO Approval	-0.0067	0.28			
Moderna Phase 1	0.0041	0.68			
Moderna Phase 2	0.0312*	0.01			
Moderna Phase 3	-0.0082	0.61			
Moderna FDA Approval	-0.0175	0.33			
Moderna EMA Approval	-0.0143	0.26			
Moderna WHO Approval	-0.0231*	0.01			

Note. This table shows macroeconomic news and COVID-19 announcement's effects on EUR/USD returns before and during the COVID-19 pandemic (Estimated using Eq. (1) regression model). For each period, the first column lists the return response coefficient associated with individual news announcements, and the second column reports the corresponding p-value. The last column, p-diff, represents the p-value corresponding to a Wald test for the difference between during and before pandemic estimated coefficients. * Denotes statistical significance at the 5% level.

Table 25: Robustness check- Volatility response to COVID-19 pandemic indicators, CAD/USD

News Category	During Pandemic		Before Pandemic		
	Coeff.	*p*-value	Coeff.	*p*-value	*p*-diff.
Panel A: US Macroeconomic News					
GDP Annualized QoQ—Advance	-0.0109	0.17	-0.0148*	0.01	0.88
GDP Annualized QoQ—Preliminary	-0.0062	0.46	-0.0003	0.96	0.92
GDP Final	-0.0056	0.48	-0.0250*	0.00	0.79
Change in Nonfarm Payrolls	-0.0049	0.08	-0.2139*	0.00	0.07
Nonfarm Productivity	0.0037	0.28	-0.0073	0.48	0.18
PPI MoM	0.0147*	0.00	0.0041	0.39	0.00*
Unemployment Rate	0.0015	0.58	0.7452*	0.00	0.03
Retail Sales MoM	0.0136*	0.01	0.0175*	0.00	0.00*
Consumer Credit	-0.0006	0.85	0.0070	0.27	0.78
New Home Sales	-0.0034	0.29	0.1063*	0.00	0.00*
Personal Consumption	-0.0049	0.07	0.0793	0.52	0.37
Durable Goods Orders	-0.0065	0.05	0.0190*	0.00	0.34
Factory Orders	0.0046	0.33	0.0025	0.43	0.03
Construction Spending MoM	-0.0005	0.87	-0.0142*	0.00	0.08
Business Inventories	-0.0125*	0.01	0.0041	0.20	0.43
Monthly Budget Statement	0.0058*	0.04	-0.0107	0.09	0.58
Trade Balance	0.0230*	0.00	0.0321*	0.00	0.00*
CPI MoM	0.0171*	0.00	0.0955*	0.00	0.00*
Consumer Confidence Index	0.0034	0.38	-0.0007	0.85	0.00*
ISM Manufacturing	0.0100*	0.00	0.0223*	0.00	0.00*
Housing Starts	-0.0012	0.74	0.0112*	0.00	0.00*
Leading Index	-0.0013	0.68	-0.0085	0.05	0.78
Capacity Utilization	-0.0034	0.26	-0.0041	0.48	0.00*
FOMC Rate Decision (Upper Bound)	0.0007	0.90	0.0161*	0.00	0.61
FOMC Rate Decision (Lower Bound)	0.0814*	0.00	0.1709*	0.01	0.00*
Panel B: Canada Macroeconomic News					
Housing Starts	0.0004	0.91	-0.0046	0.34	0.76
Retail Sales MoM	0.0051	0.27	0.1239*	0.00	0.87
Unemployment Rate	0.0102*	0.00	0.4017*	0.00	0.34
Current Account Balance	-0.0005	0.94	0.0065	0.28	0.17
Industrial Product Price MoM	0.0004	0.94	0.0065	0.10	0.46
Consumer Price Index	0.0058	0.23	0.1433*	0.00	0.92
GDP MoM	0.0042	0.35	0.1293*	0.00	0.87
Manufacturing Sales MoM	-0.0035	0.49	0.0188*	0.00	0.94
Bank of Canada Rate Decision	0.1620*	0.00	0.3620*	0.00	0.70
Capacity Utilization Rate	0.0216*	0.01	0.0922*	0.00	0.34
Building Permits MoM	0.0026	0.63	0.0367*	0.00	0.90
Raw Materials Price Index MoM	-0.0055	0.19	0.1099*	0.00	0.24
Panel C: Canada COVID-19 News					
COVID-19 - Daily New deaths	0.0039*	0.00			
COVID-19 - Daily Vaccine doses	-0.0022*	0.00			
Panel D: Unscheduled COVID-19 news					
Stringency index	0.0013*	0.00			
WHO Officials' Speeches	0.0028	0.17			
Panel E: Vaccine Development News					
Johnson & Johnson Phase 1	-0.0134	0.49			
Johnson & Johnson Phase 2	0.0009	0.95			
Johnson & Johnson Phase 3	-0.0150	0.12			
Johnson & Johnson FDA Approval	-0.0105	0.35			
Johnson & Johnson EMA Approval	-0.0068	0.36			
Johnson & Johnson WHO Approval	0.0115	0.40			
Pfizer Phase 1	-0.0098	0.26			
Pfizer Phase 2	0.0017	0.84			
Pfizer Phase 3	-0.0113	0.16			
Pfizer FDA Approval	-0.0161*	0.04			
Pfizer EMA Approval	0.0037	0.32			
Pfizer WHO Approval	-0.0169	0.14			
Novavax Phase 1	0.0039	0.78			
Novavax Phase 3	-0.0028	0.63			
AstraZeneca Phase 1	-0.0125	0.27			
AstraZeneca Phase 2	-0.0196	0.08			
AstraZeneca Phase 3	-0.0102	0.51			
AstraZeneca FDA Approval	0.0045	0.54			
AstraZeneca EMA Approval	-0.0010	0.93			
AstraZeneca WHO Approval	0.0005	0.91			
Moderna Phase 1	0.0035	0.64			
Moderna Phase 2	-0.0055	0.57			
Moderna Phase 3	-0.0118	0.34			
Moderna FDA Approval	-0.0149	0.28			
Moderna EMA Approval	0.0047	0.63			
Moderna WHO Approval	0.0149*	0.02			

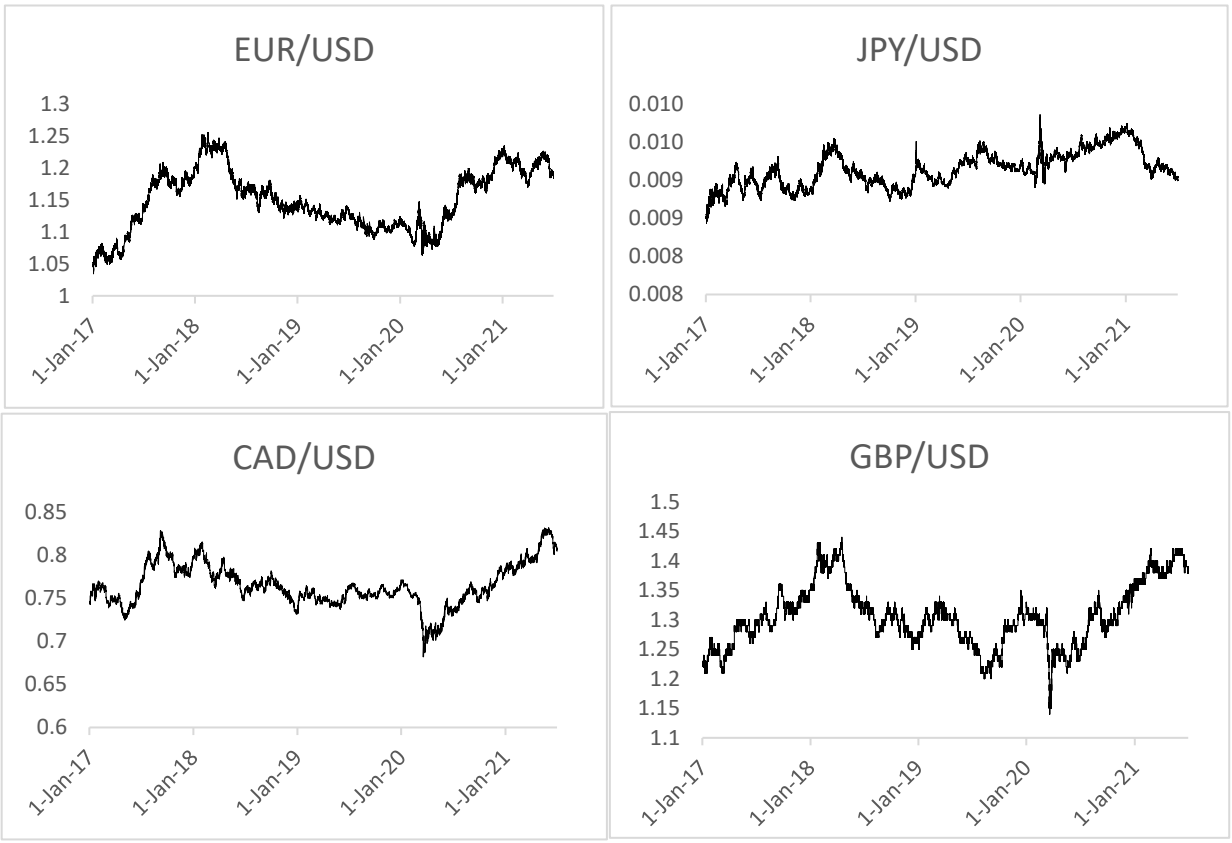
Note. This table shows macroeconomic news and COVID-19 announcement's effects on EUR/USD returns before and during the COVID-19 pandemic (Estimated using Eq. (1) regression model). For each period, the first column lists the return response coefficient associated with individual news announcements, and the second column reports the corresponding p-value. The last column, p-diff, represents the p-value corresponding to a Wald test for the difference between during and before pandemic estimated coefficients. * Denotes statistical significance at the 5% level.

Table 26: Robustness check- Volatility response to COVID-19 pandemic indicators, JPY/USD

News Category	During Pandemic		Before Pandemic		
	Coeff.	*p*-value	Coeff.	*p*-value	*p*-diff.
Panel A: US Macroeconomic News					
GDP Annualized QoQ—Advance	0.0180*	0.03	-0.0024	0.69	0.88
GDP Annualized QoQ—Preliminary	-0.0069	0.42	-0.0075	0.23	0.92
GDP Final	-0.0006	0.94	-0.0058	0.34	0.79
Change in Nonfarm Payrolls	-0.0012	0.66	0.0449	0.54	0.07
Nonfarm Productivity	-0.0034	0.35	0.0012	0.91	0.18
PPI MoM	0.0119*	0.00	0.0173*	0.00	0.00*
Unemployment Rate	0.0098*	0.00	0.6380*	0.00	0.03
Retail Sales MoM	0.0072	0.15	0.0573*	0.00	0.00*
Consumer Credit	0.0002	0.95	0.0032	0.64	0.78
New Home Sales	0.0039	0.26	0.0096	0.05	0.00*
Personal Consumption	-0.0026	0.36	1.2156*	0.00	0.37
Durable Goods Orders	-0.0013	0.72	0.0139*	0.00	0.78
Factory Orders	0.0065	0.19	0.0328*	0.00	0.03
Construction Spending MoM	0.0061	0.07	0.0106*	0.03	0.08
Business Inventories	0.0002	0.96	-0.0031	0.37	0.43
Monthly Budget Statement	-0.0029	0.34	0.0112	0.10	0.58
Trade Balance	0.0112*	0.04	0.0351*	0.00	0.00*
CPI MoM	0.0238*	0.00	0.0874*	0.00	0.00*
Consumer Confidence Index	-0.0074	0.07	0.0053	0.16	0.00*
ISM Manufacturing	0.0187*	0.00	0.0692*	0.00	0.00*
Housing Starts	0.0014	0.71	0.0201*	0.00	0.00*
Leading Index	0.0014	0.66	0.0161*	0.00	0.78
Capacity Utilization	-0.0025	0.42	0.0106	0.08	0.00*
FOMC Rate Decision (Upper Bound)	-0.0024	0.69	0.0090*	0.03	0.61
FOMC Rate Decision (Lower Bound)	0.0607*	0.00	0.1481*	0.00	0.00*
Panel B: Japan Macroeconomic News					
Tankan	-0.0064	0.45	0.0043	0.75	0.76
Current Account	0.0054	0.27	-0.0015	0.80	0.17
GDP	0.0010	0.84	-0.0067	0.70	0.46
Trade Balance	0.0028	0.43	0.0006	0.89	0.92
Retail sales	-0.1071	0.53	-0.0023	0.48	0.87
PPI	-0.0019	0.61	-0.0001	0.98	0.94
Imports YoY	0.0007	0.84	-0.0217	0.36	0.70
Exports YoY	-0.0057	0.73	-0.0045	0.37	0.34
Housing Starts YoY	0.0003	0.93	-0.0048	0.49	0.90
Industrial Production	-0.0046	0.27	-0.0037	0.62	0.24
Panel C: Japan COVID-19 News					
COVID-19 - Daily New deaths	0.0010*	0.00			
COVID-19 - Daily Vaccine doses	-0.0017*	0.00			
Panel D: Unscheduled COVID-19 news					
Stringency index	0.0017*	0.00			
WHO Officials' Speeches	0.0033	0.13			
Panel E: Vaccine Development News					
Johnson & Johnson Phase 1	-0.0129	0.53			
Johnson & Johnson Phase 2	-0.0122	0.40			
Johnson & Johnson Phase 3	-0.0127	0.22			
Johnson & Johnson FDA Approval	-0.0117	0.33			
Johnson & Johnson EMA Approval	-0.0149	0.06			
Johnson & Johnson WHO Approval	-0.0139	0.34			
Pfizer Phase 1	-0.0028	0.76			
Pfizer Phase 2	-0.0027	0.77			
Pfizer Phase 3	0.0012	0.89			
Pfizer FDA Approval	-0.0053	0.53			
Pfizer EMA Approval	0.0002	0.96			
Pfizer WHO Approval	-0.0090	0.46			
Novavax Phase 1	-0.0083	0.57			
Novavax Phase 3	-0.0055	0.38			
AstraZeneca Phase 1	-0.0020	0.87			
AstraZeneca Phase 2	-0.0029	0.81			
AstraZeneca Phase 3	0.0004	0.98			
AstraZeneca FDA Approval	-0.0031	0.69			
AstraZeneca EMA Approval	-0.0124	0.30			
AstraZeneca WHO Approval	-0.0060	0.23			
Moderna Phase 1	-0.0056	0.49			
Moderna Phase 2	-0.0053	0.61			
Moderna Phase 3	-0.0076	0.57			
Moderna FDA Approval	0.0960*	0.00			
Moderna EMA Approval	-0.0156	0.13			
Moderna WHO Approval	-0.0112	0.10			

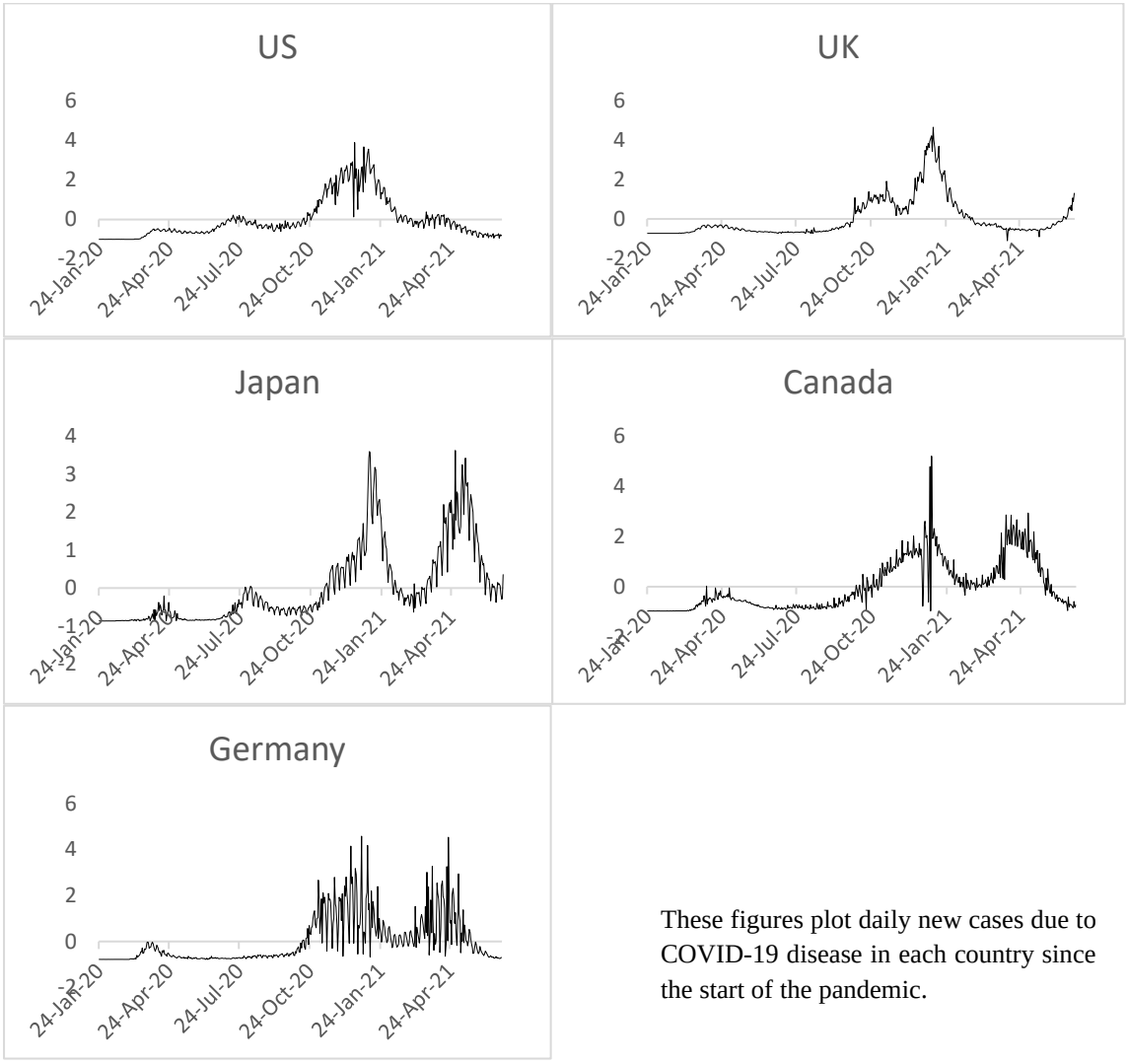
Note. This table shows macroeconomic news and COVID-19 announcement's effects on EUR/USD returns before and during the COVID-19 pandemic (Estimated using Eq. (1) regression model). For each period, the first column lists the return response coefficient associated with individual news announcements, and the second column reports the corresponding p-value. The last column, p-diff, represents the p-value corresponding to a Wald test for the difference between during and before pandemic estimated coefficients. * Denotes statistical significance at the 5% level.

Figure 1: Currency pairs historical prices



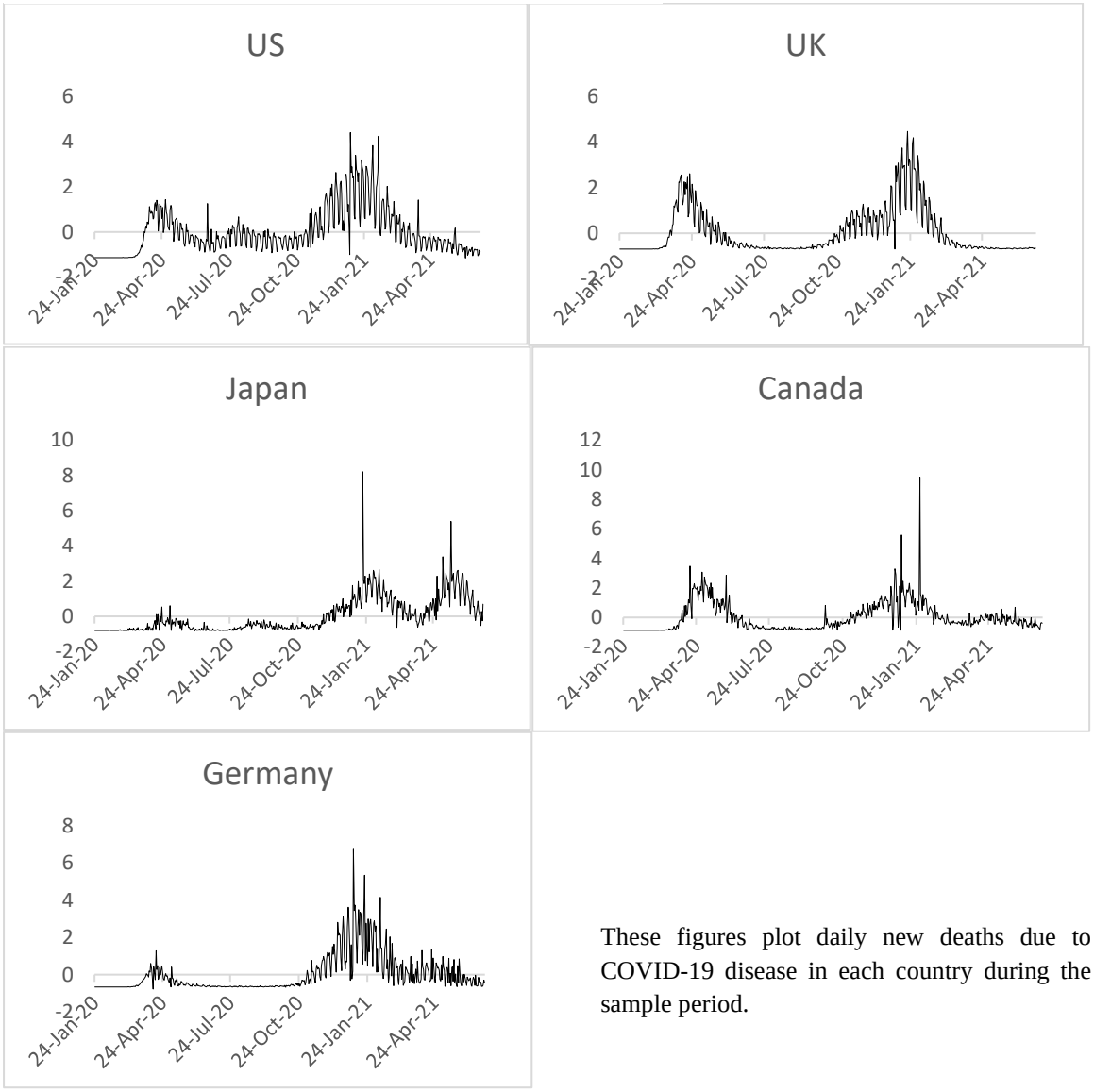
These figures show historical mid-point prices of EUR/USD, JPY/USD, CAD/USD, and GBP/USD since January 1, 2017 to June 30, 2021. Mid-point price is calculated as average of bid and ask prices for each 5-minute intervals.

Figure 2: COVID-19 overview-Daily new cases



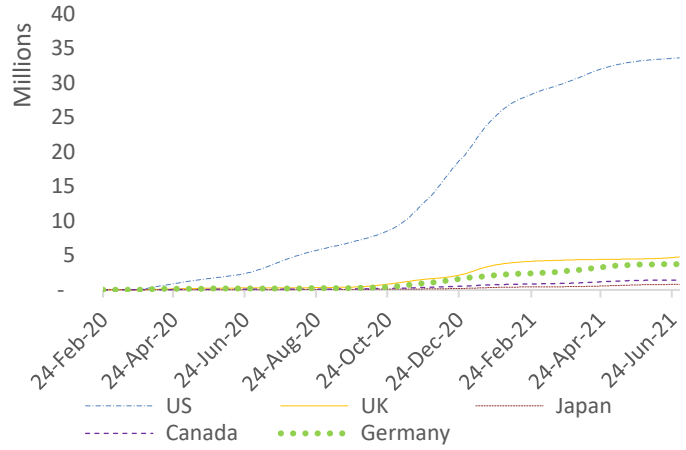
These figures plot daily new cases due to COVID-19 disease in each country since the start of the pandemic.

Figure 3: COVID-19 overview-Daily new deaths



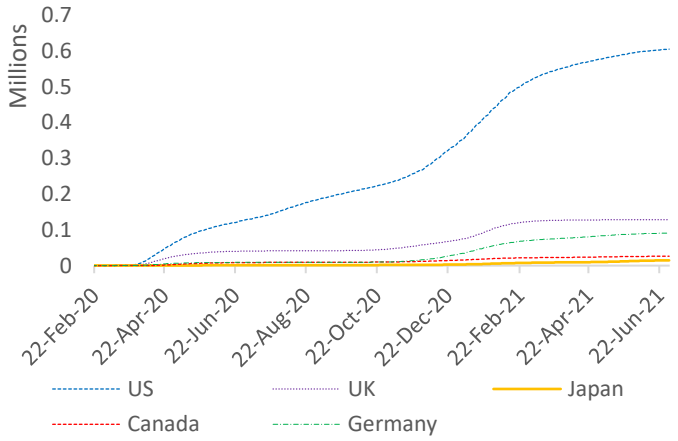
These figures plot daily new deaths due to COVID-19 disease in each country during the sample period.

Figure 4: COVID-19 overview-Cumulative number of confirmed cases



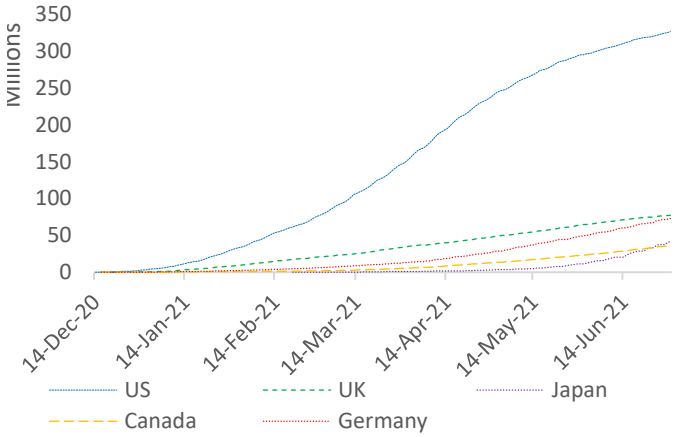
This figure presents cumulative number of confirmed cases due to COVID-19 since start of pandemic for US, UK, Germany, Canada, and Japan.

Figure 5: COVID-19 overview-Cumulative number of deaths



This figure presents cumulative number of deaths due to COVID-19 since start of pandemic for US, UK, Germany, Canada, and Japan

Figure 6: COVID-19 overview-Cumulative number of vaccine doses administrated



This figure plots cumulative number of vaccine dose administrated in US, UK, Germany, Canada, and Japan since start of vaccination.

Figure 7: Timeline of COVID-19 vaccine development news

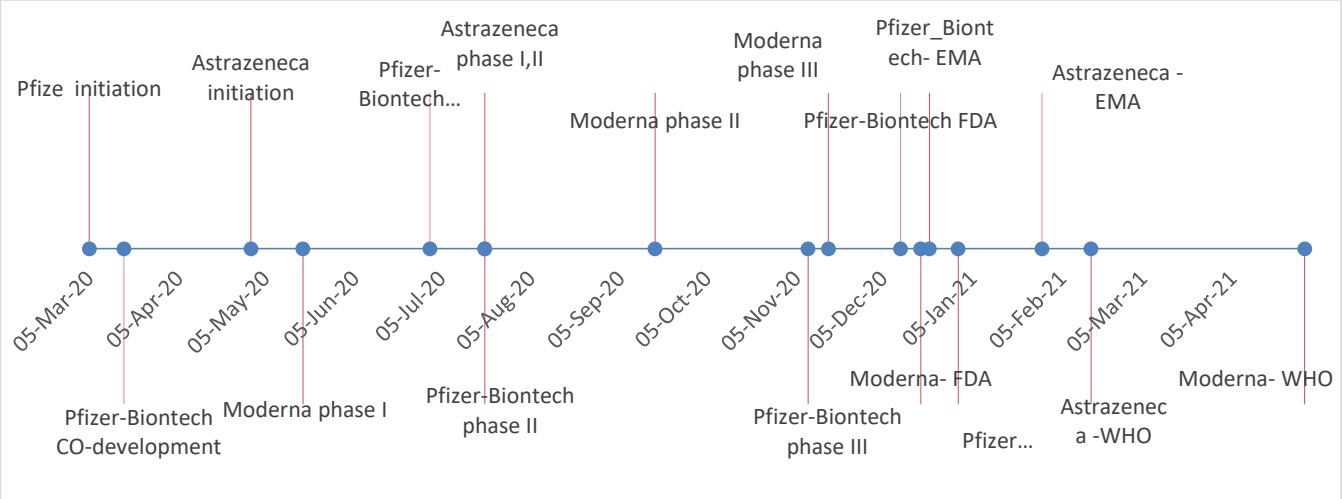


Figure 8: Total number of COVID-19 vaccine development news for each company