The Relationship Between Stock Market Index Returns and Gold Returns during the First Year of the Coronavirus Pandemic: An Asymmetric Causality Test

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Abstract

The Coronavirus is one of the most influential infectious diseases of the 21st century. This study investigates the relationship between stock market returns and gold market returns for five of the most affected countries between January 02, 2020, and December 31, 2020, by using the Hatemi-J Asymmetric Causality Test. The results show that because of the demand for liquidity, the atmosphere of panic, and the perception of gold as a safe-haven, the causal relationship is not strong for each country.

Keywords: COVID-19, Stock Exchange Markets, Gold

JEL Codes: G15, O16

Koronavirüs Pandemisinin İlk Yılında Borsa Endeks Getirileri ile Altın Getirileri Arasındaki İlişki: Asimetrik Bir Nedensellik Testi

Öz

Coronavirüs 21. yüzyılın en etkili bulaşıcı hastalıklarından biridir. Bu çalışma, 02 Ocak 2020 ile 31 Aralık 2020 tarihleri arasında en çok etkilenen ülkelerden beşi için borsa getirileri ile altın piyasası getirileri arasındaki ilişki

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Hatemi-J Asimetrik Nedensellik testi ile incelemektedir. Elde edilen bulgular nakit talebi, panik ortamı ve altının güvenli liman olarak algılanması nedenleriyle nedensellik ilişkisinin her ülke için güçlü olmadığını göstermektedir.

Anahtar Kelimeler: COVID-19, Borsa, Altın

JEL Kodları: G15, O16

1. Introduction

Throughout human history, many infectious diseases have brought crisis and tragedy into local or global communities. Some diseases like malaria and tuberculosis were endemic and limited to particular areas. However, some contagious diseases were epidemic or pandemic such as SARS, Zika, yellow fever, Ebola, and many more. Currently, a prominent disease continues to spread around the world known as the Coronavirus or 2019-nCoV (hereafter COVID-19).

On December 31, 2019, the China National Office of the World Health Organization (WHO) was notified of cases of pneumonia from an unknown source detected in Wuhan City. Over the next four days, a total of 44 case patients with pneumonia were reported to the WHO by the national authorities in that country. The Chinese authorities identified a new type of Coronavirus, which was isolated on January 07, 2020. In the next seven days, the authorities in Thailand, Japan, and the Korean Republic reported their first cases. A week later, six deaths were reported on January 20, 2020 (WHO, 2020a). As the reach of the virus expanded, the WHO declared the health crisis a pandemic on March 11, 2020 (WHO, 2020b). The WHO has reported data that shows 808,984 confirmed cases and 38,766 deaths by the end of March 2020. By June, 10,290,089 confirmed cases and 502,129 deaths were reported and at the end of the summer, there were 33,777,698 confirmed cases and 1,009,095 deaths. Ultimately, by the end of 2020, 83,488,443 confirmed cases and 1,818,336 deaths were announced (ourworldindata.org, 21.01.2021).

In ordinary daily life, people face a variety of risks related to health, life, income, financial assets, etc. Diseases, in particular, can often affect small groups or certain kinds of people or sometimes entire regions and countries. However, some dangerous diseases have spread beyond national borders and affected people on a continent-wide or global scale. On an economic level, OECD has designated five essential risk categories for the 21st century: Natural disasters, industrial accidents, infectious diseases, terrorism, and food safety (OECD, 2003, p.9). There are two predominant categories of risk defined by

finance theory regarding capital markets: systematic and non-systematic risks. Systematic risks are outside the level of control for businesses and firms such as natural disasters, war, political crises, or infectious diseases. In most cases, these kinds of risks influence an entire economy, but the hits are especially severe for the financial market.

In the late 1900s, approximately thirteen million people were dying from infectious diseases per year. Today, developing countries in Asia and Africa, which continually experience health challenges, contain the majority of victims of disease and contain the highest number of at-risk groups. However, other countries such as OECD members, also carry significant risks of encountering pandemics as viruses and bacteria continue to evolve (OECD, 2003, p.36).

Pandemics of influenza have also brought considerable costs to national economies, particularly the impact on income. Moreover, unexpected deaths and absenteeism from illness negatively affect the labor force and overall production (Fan et al., 2016, p.3). Precautions taken to prevent the spread of the disease leads to social distancing procedures, and as seen during the COVID-19 pandemic, these precautions can also lead to school closures along with limits on services like transportation, leisure and tourism, and commercial production (Bloom et al., 2018, p.46). In addition, national budget deficits have grown with increasing health expenditures.

To sum up, the adverse effects of COVID-19 in the various economic sectors have dramatically damaged the financial sector and the stock markets. The first half of 2020 saw a dramatic fall in the balance sheets and income statements of publicly traded companies. Throughout 2020, as the world faced the effects of the pandemic, capital markets responded with a sharp downward trend. Along with the increasing number of deaths and projections of economic slowdowns around the world during the first economic shock wave, the projections for the stock exchange market continued to remain bleak.

This study aims to analyze the causal relationship between the returns in the stock market indices and gold during the first year of COVID-19.

The unique research contributions to the literature are as follows:

- This study primarily investigates the causality relationship between the stock market returns and the returns for gold investments. The research was conducted during the COVID-19 outbreak, with its effects and influences still present in daily life. Naturally, the first few

months of the epidemic caused a measure of panic and instinctual survival responses. However, as it continued, people began to adapt to a new normal way of living and started to search for ways to stabilize their financial situation, particularly related to their wages and investments, which are essential for the future. In this context, this study intends to show the reactions from financial markets during this period of crisis. 2020 was a year full of frightening and panic both of daily life and markets (manufactural or financial). But the following months, the panic atmosphere was replaced by a "new normal", despite new waves of variations of COVID-19. Because of this the study includes only the first year of the pandemic.

- The countries that were chosen for the analysis were the countries with the highest total cases around the world at the time of the study. These countries are Brazil, India, France, Russia, and the US. Each country that was examined also plays a critical role in the regional and international financial markets. Therefore, an economic crisis in these countries tends to quickly affect the economies and markets in other countries. An additional feature that this study offers is a multinational type of analysis, so the economic effects of the virus on the global financial markets can be better understood in the countries that are the most affected.
- The analysis covers the entire year from January 02, 2020, to December 31, 2020. Although the virus was identified on December 31, 2019, the first quarter of 2020 was a situation where the health crisis evolved from a local outbreak to a global pandemic. Thus, in the months that followed, the effects of COVID-19 caused significant loss in the real economy and the financial markets. Unfortunately, since the economic effects of the virus are continuing and are even deteriorating in some places, an analysis at this stage will not have the benefits of being from an outside perspective.
- Even with less than comprehensive economic data and while an investigation of the causality relation between the variables continues, the time dimension of this study is limited (t=261). Nevertheless, considerable care was taken to correctly determine the technique for assessing the relationship in the financial market. Typically, in the literature of symmetric causality analyses, all the effects of positive and negative shocks are usually considered and assessed together, as is the case in Toda-Yamamoto (1995) and

Hacker-Hatemi-J (2006). However, the causality test developed later by Hatemi-J (2012) considers the potential effects of positive and negative shocks separately. This study prefers using the causality test developed by Hatemi-J (2012) because of the advantages of separating the asymmetric switches and having the possibility of using a certain level of the series.

- Another unique contribution of this study is that it enables a comparative analysis of the results for the countries whose gold returns and stock market returns were the most affected. Interestingly, during the time when many countries implemented restrictions in the fight against COVID-19, many countries were somehow able to produce positive results in comparison to the top five countries that have had considerable challenges managing the pandemic. As a result, many people in this chaotic environment had difficulty maintaining rational and careful investment behavior. This study examines the decisions of the investors regarding these two financial assets as the crisis unfolded during this period. Furthermore, all variables used to calculate the returns of these investments were in the local currency to retain a more balanced assessment of the real financial situation in each country. Therefore, the study focuses more on the characteristics and decisions of the local investors in each country.
- The primary motivation for a study of this nature is the limited availability of studies about infectious diseases and their effects on financial markets. Consequently, along with the reasons given above, this study, which examines these effects, has the potential to offer a unique contribution to the academic literature.

The study is organized as follows: Section 2 presents a brief history of the most infectious diseases from the ancient period until the present day. Also, it has a literature review about the research related to how disease outbreaks affect an economy. Section 3 presents the current and expected economic impacts of COVID-19. The following section outlines the data and methodology and then the study concludes with an outline of the findings and general conclusion.

2. A Brief History and Literature Review of Epidemics and Pandemics

Fatal diseases have always been a serious danger to humanity throughout history. With the discovery of the American continent, different colonies and trade routes were established and interactions between different civilizations,

cultures and even animals increased. At the same time, cities also became more crowded in ways that increased human connections. As a result, both these situations accelerated the chances of large epidemic health problems (weforum.org, 2020). Undoubtedly, globalization and urbanization are not the only causes of epidemic disease. Throughout history, there have been millions of deaths related to epidemics or pandemics. Some of them originated from animals, but some were infections spread from human to human. Table 1 shows the top 5 deadliest historical diseases and the top 5 deadliest diseases in the last 100 years, excluding COVID-19.

Table 1. The Deadliest Diseases in Recorded History

Top 5 in History			Top 5 in the Last 100 Years*		
Name of Disease	**Years (CE)**	**# of Deaths**	**Name of Disease**	**Years**	**# of Deaths**
Black Death	1347-1351	200 million	HIV – AIDS	1981- current	25-35 million
Smallpox	1520	56 million	Asian Flu	1957-1958	1.1 million
Spanish Flu	1918-1919	40-50 million	Hong Kong Flu	1968-1970	1 million
Plague of Justinian	541-542	30-50 million	Swine Flu	2009-2010	200 thousand
The Third Plague	1855	12 million	Ebola	2014-2016	11.3 thousand

* COVID-19 is excluded.

Source: https://www.weforum.org/agenda/2020/03/a-visual-history-of-pandemics/, Date of Access: 22.03.2020

In the ancient world, plagues and diseases were frequent, according to the historical writings we have. In that period, unfortunately, mortality rates relative to the population were massive. During the Peloponnesian War (430-425 BC), for example, the plague caused a decrease of around 10% of the Attica population. In Italy, a smallpox epidemic tragically killed 20-25% of the total population (Boroda, 2008, p.49). In fact, what is called the Plague of Justinian caused the death of approximately 57% of the population in Constantinople (Allen, 1979, p.11).

Major pandemics and disease remained limited in Europe until the 14th century when the arrival of the Black Death struck Europe. It started in Central Asia and then reached China and East Anatolia within thirty years. It is possible that merchants carried the disease to Italy, and then its disastrous effects spread throughout Europe. During the years of 1347-1351, some European regions lost approximately 50-60% of their population (Boroda, 2008, p.49-51).

The discovery of the New World, not only opened doors for Europeans to expand their economic influence, but they also infected the native

populations of the new continent with deadly diseases. The first epidemic disease, which was introduced to the American continent was smallpox. In 1520, approximately one-third to one-half of the native Aztec people in what is now central Mexico died from smallpox (McCaa, 1995, p.397).

The most catastrophic infectious disease in recent history broke out in 1918. It is commonly called the "Spanish Flu" or the "Spanish Lady" because it was first spotted in Madrid. The flu's effects were so devastating in Spain that the growth rate of the population turned negative in 1918 (Trilla et al., 2008, p.668-672).

Even though medical science had continuously improved over the decades since that period, fatal diseases still continued in the 20th and 21st centuries. Although the death rates of diseases in the modern period are comparably lower, their impact on local and global economies, as well as daily life, is equally severe. One of the deadliest diseases in the modern period is HIV-AIDS, which was first recognized in 1981 (Lewthwaite and Wilkins, 2009, p.333). Approximately 38 million people around the world have contracted HIV, according to WHO, and over two-thirds of the cases have occurred in Africa (WHO, 2019).

In recent years, the number of flu infection cases has escalated. One of the most lethal outbreaks of the flu was the Asian flu that occurred between 1957-1958. Swine Flu (or A (H1N1)) spread in Mexico and the United States in April 2009, and it was announced as a pandemic in June 2009 by WHO (WHO, 2012, p. 3-4). Ebola is also considered a serious and fatal disease since it first appeared in the rainforest areas of Central Africa in 1976. The most serious and complex outbreak of Ebola was in 2014-2016 in West Africa (WHO, 2020c).

Finally, COVID-19 became a member of the top deadliest diseases by the end of 2020. At that time, there were close to 2 million deaths and more than 80 million confirmed cases globally according to WHO (https://covid19.who.int/, 13.01.2021).

The literature is growing since the onset of the COVID-19 pandemic regarding the effects and costs of epidemic viruses on economic life and the financial markets. There are several studies that examine the role of epidemics and pandemics on the markets that were researched using historical examples. Other research examines the effects of pandemics before the COVID-19 era and others make economic projections for a post-COVID-19 era.

There have been several studies that address the costs of epidemics and pandemics, both in terms of the costs of past pandemics or in modeling potential costs for possible pandemics in the future (see Burns et al., 2006; McKibbin and Sidorenko, 2006; Jonung and Roeger, 2006; Fan et al., 2016; Prager et al., 2016; Jordá et al 2020). These kinds of projections generally model the macroeconomic effects on income or the share of GDP.

Several studies have examined the effects of epidemics or pandemics on the economy or financial markets (see Granger et al., 2000; Nippani and Washer, 2004; Jiang et al., 2017). The analyses of these studies have summarized the economic effects of Asian flu, avian influenzas, SARS, Ebola, and Zika.

The effects of the COVID-19 pandemic on the market performance and value of commodities (especially oil and gold) have been researched broadly (See Bakas and Triantafyllou, 2020). Outside of commodities, there are additional studies about stock market performance and volatility that focus on emerging markets, developed markets, or both of them (see Ashraf, 2020; Salisu et al., 2020; Albulescu, 2020; Kartal et al., 2020a; Kartal et al., 2020b). Most of these studies examined a range of market responses and developments from stock market indices to debt-notes, cryptocurrencies, and the role of political uncertainties, etc. (see Ali et al., 2020; Sharif et al., 2020; Corbet et al., 2020; Conlon and McGee, 2020). There are also limited studies that analyze the stock performance of a firm or group of firms in the market (see De Vito and Gómez, 2020; Al-Awadhi et al., 2020; Shen et al., 2020).

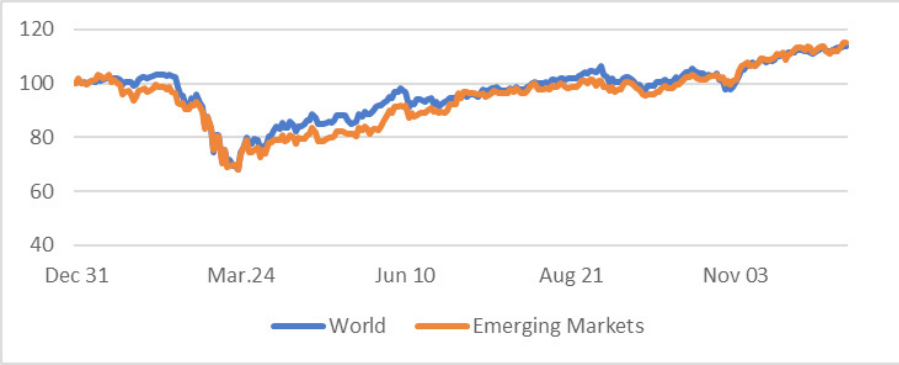
3. The Impact of COVID-19 on Capital Markets

Outbreaks of infectious diseases can have a massive impact on living standards, and unfortunately, in these situations, the economic and financial effects are often not given adequate concern. But, of course, individuals and communities need to work to survive, and the economic environment affects life and sustainable working situations directly. This section includes some of the financial situations affected from both a micro and macro perspective.

The adverse effects of the COVID-19 crisis on the global stock markets were sharp and abrupt, especially in the first few months of 2020. In January 2020, when the health problems were mostly limited to regional areas, significant indices were not yet severely impacted, except for the Shanghai Composite Index. For around 25-40 days following the initial outbreak in China, some indices actually showed positive growth. However, immediately afterward, the stock markets began to plunge for the next 4 weeks. In the last part of the first quarter of 2020, stock markets leveled off and even regained

some losses, but a full rebound of the total earnings lost did not come until later in the summer. Figure 1 shows the index changes of the MSCI World and MSCI Emerging Markets ETFs for 2020.

Figure 1. MSCI Stock Market Indices Daily-Cumulative Return/Loss During 2020



Source: www.investing.com and our own calculations.

Throughout the year, financial markets at times showed an overreaction to the news reported about the health crisis. Table 2 shows the date and rate of the most critical return drop for the countries most affected by the virus as well as other important markets.

Table 2. The Largest Daily Drop in the Stock Exchange Markets During the COVID-19 Health Crisis in 2020

Most Affected Countries			Important Markets		
Country (Index)	**Date**	**Rate**	**Country (Index)**	**Date**	**Rate**
USA (S&P500)	March 16	-11.98%	Germany (DAX)	March 12	-12,24%
India (NIFTY50)	March 23	-12.98%	Italy (MIB)	March 12	-16.92%
Brazil (BOVESPA)	March 12	-14.78%	England (FTSE100)	March 12	-10.87%
Russia (MOEX)	March 12	-8.28%	China (SSE)	February 03	-7.72%
France (CAC40)	March 12	-12.28	Japan (NIKKEI225)	March 13	-6.08%

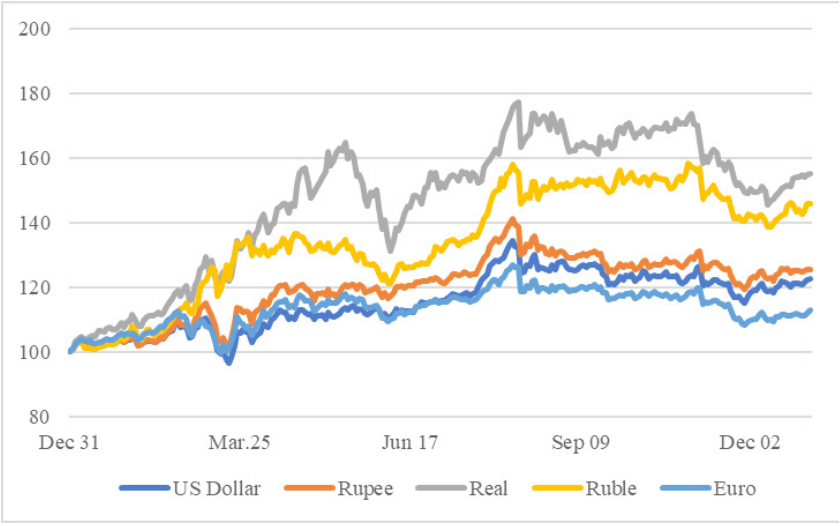
Source: www.investing.com and our calculations

The first shock to the market was seen in China, the Shanghai Stock Market was on February 3, 2020. The index fell -7.72% in one day and shortly afterward other markets started to drop with news of the virus spreading in China. However, the most difficult period for the equity markets around the world was between March 9-18. The MSCI World Index fell –10.43% and –11.38% on March 12 and March 16, respectively.

In contrast to the stock markets, the gold markets did not face a bear market problem relatively speaking. In fact, the gold markets showed

a positive trend until the last week of February. The quick response from the central banks and especially the Federal Reserve's unlimited quantities easing plan enabled gold to remain relatively strong. During the COVID-19 outbreak, investors and traders faced high risks. As a result, holding gold yielded no losses in opportunity costs in this kind of volatile environment. Furthermore, gold markets had the advantage of being a safe-haven and a liquid asset throughout the economic crisis (Kitco, 2020). Figure 2 shows the fluctuations and trends of gold in local currencies for 2020.

Figure 2. Gold Market Indices Daily-Cumulative Return/Loss During 2020



Source: www.investing.com and our calculations

During the first quarter of 2020, only the cumulative gold returns in terms of US dollars and euros had negative values. While other markets recorded losses in the third week of March, which was the most economically catastrophic period of the outbreak, but because of currency rates, the cumulative returns of gold in these countries during the first quarter did not stay negative.

4. Data and Methodology

This analysis includes data from five of the most affected countries by total new cases of COVID-19 at the end of 2020. Thus, the study asymmetrically shows changes in how the financial markets were affected via shocks in the returns of these assets. The countries that were part of the analysis are Brazil, India, France, Russia, and the United States. The range

of the dataset is weekdays between January 2 – December 31 since the limits of the study start when the initial economic effects of the virus impact the financial markets. The data for each day were collected from www.investing.com.

In this study, the daily rate of return for each index was examined and the details of the data from the variables are shown in Table 3. The returns were obtained as follows;

$$R = \ln(\frac{X_t}{X_{t-1}}) \quad (1)$$

where x_t refers to the asset price in period *t*.

Table 3: Definition of Variables

Variable	Definition
r_brazil	Returns of BOVESPA
r_france	Returns of CAC40
r_india	Returns of NIFTY50
r_russia	Returns of MOEX
r_usa	Returns of S&P500
r_xaubrl	Returns of Spot Gold in terms of Brazilian Real
r_xaueur	Returns of Spot Gold in terms of Euro
r_xauinr	Returns of Spot Gold in terms of Indian Rupee
r_xaurub	Returns of Spot Gold in terms of Russian Ruble
r_xauusd	Returns of Spot Gold in terms of USD

Note: Spot gold prices (except in terms of USD) are calculated as follows: Currency pairs against USD multiplied by the spot gold in terms of USD.

As seen in Table 3, there are two variables used to calculate returns in these five countries. One of the variables is the stock market index for each country in its local currency. Stock markets are used as a barometer of the economy because it reacts quickly to positive or negative shocks. Unlike macroeconomic data that were announced weeks after the end of the period (such as capacity utilization rate, industrial production index, GDP, etc.), stock markets buy or sell rapidly based on market expectations. In this way, focusing on the financial market reactions helps highlight the real economic perceptions during that period. The second variable is gold in its local currency. There are some studies have used gold prices in the local currency such as Baur and Lucey (2010) and Beckmann et al. (2014). Although the price of gold is typically valued in US dollars, choosing to assess gold prices in the local currency can account for the effects of exchange rates relative to the US dollar. As Beckmann et al. (2014) indicate, the relationship between stock market indices and gold prices could be assessed in terms of the US dollar exchange rate. Correlations between the stock market and gold market

generally occur when economic shocks affect both the domestic exchange rate and stock markets (via interest rates, etc.). Therefore, there is no direct need to correct for the exchange rate effects for the time series estimates related to gold prices and the stock market (Beckmann, et al. 2014). Gold returns were chosen as a variable because of their perception by many investors as a safe-haven in financial markets. Gold is also considered to be a significant hedge instrument against stocks (see Hillier et al. (2006) for abnormal stock market volatility). There are other advantages of using gold as a variable. When situations cause economic uncertainty and risk to increase, gold assets have historically shown more positive and stable reactions while many other financial assets have fallen. Especially during times of financial or economic crisis, analyzing the distinct movements of gold and various stocks can be very profitable (see in more details Baur and Lucey, 2010, p.218, Beckmann, et al., 2015, p.16, Gurgun and Unalmis, 2014, p.342). Aside from these, as Beckmann et al. (2015) also indicate, many studies show the effectiveness of gold as a hedge against inflation. Table 4 summarises the descriptive statistics for each variable.

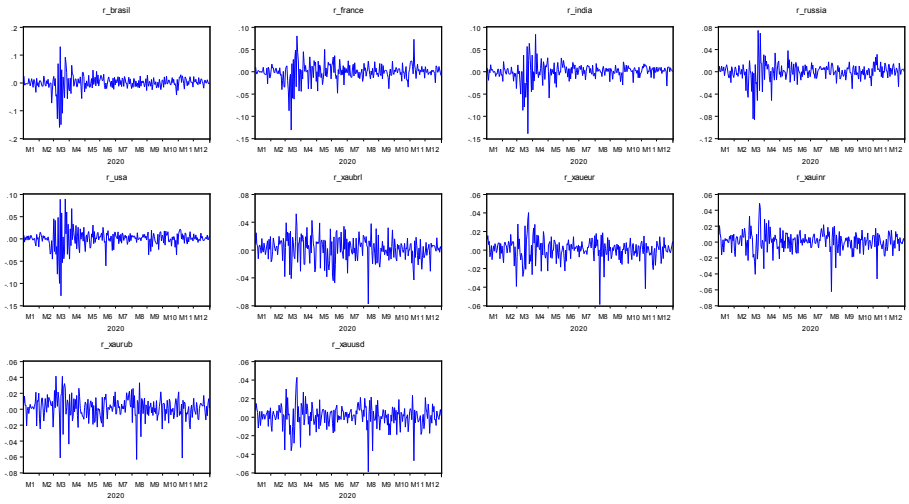
Table 4. Descriptive Statistics of the Variables

	r_brazil	r_france	r_india	r_russia	r_usa
Mean	0.000110	-0.000284	0.000528	0.000294	0.000577
Median	0.000000	0.000076	0.001869	0.001293	0.001842
Maximum	0.130228	0.080561	0.084003	0.074349	0.089683
Minimum	-0.159938	-0.130983	-0.139038	-0.086460	-0.127652
Standard Deviation	0.027915	0.020421	0.019615	0.016194	0.021512
Skewness	-1.443034	-1.128567	-1.779687	-0.871947	-0.877124
Kurtosis	13.778750	11.491380	16.056940	11.311420	11.867210
Jarque-Bera	1354.055000	839.531200	1991.788000	784.315200	888.539700
Probability	0.000***	0.000***	0.000***	0.000***	0.000***
Observations	261	261	261	261	261
	r_xaubrl	r_xaueur	r_xauinr	r_xaurub	r_xauusd
Mean	0.001836	0.000529	0.000951	0.001555	0.000855
Median	0.003557	0.001616	0.002339	0.002428	0.002193
Maximum	0.052210	0.040436	0.048770	0.041756	0.042968
Minimum	-0.077563	-0.058753	-0.062406	-0.063240	-0.058928
Standard Deviation	0.017357	0.011282	0.012341	0.014306	0.011944
Skewness	-0.611662	-0.825881	-0.615071	-0.998775	-0.868418
Kurtosis	4.621462	7.131717	7.241967	6.801111	7.027369
Jarque-Bera	44.86656	215.3185	212.1444	200.5203	209.1948
Probability	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Observations	261	261	261	261	261

Note: The symbols *, **, and *** show the significance level at 10%, 5% and 1%, respectively.

All the variables in the analysis have a total of 261 observations. All stock market returns have a positive mean (except France), and mean gold returns are also positive. Surprisingly, the average daily performance of the stock market in France has the lowest rate, while India and the US have the highest average. The highest standard deviation is the returns from the stock market in Brazil (0.027915). Figure 3 includes graphs for each variable individually.

Figure 3. Graphs for Variables



The causality relationship between the returns of the stock market and the returns of gold was analyzed by using the causality analysis by Hatemi-J (2012). The classic causality tests do not consider the impact of negative and positive shocks. However, the economic variables show how different reactions to some shocks affect the economy, such as diseases or crises. When this kind of collapse in financial markets occurs, the results of the analysis tend to be more reliable and correct. In the financial markets, agents also tend to react differently to a negative price shock compared to positive ones. There are various studies such as Hatemi-J (2012) that outline the asymmetric characteristics of the financial markets and market returns (Longin and Solnik (2001), Ang and Chen (2002), Alvarez-Ramirez et al. (2009)). Investors tend to react more strongly to negative news than positive news (Hatemi-J, 2012). When COVID-19 began to transition into a global health crisis, financial markets reacted dramatically in a strong bear market trend. Whereas the recovery process was relatively gradual and the market did not fully recover until the end of the first half of 2020. The second half of 2020 reported record

rebounds in the stock markets as health developments and other economic indicators showed positive signs. For this reason, an asymmetric causality analysis by Hatemi-J (2012) was preferred.

The foundation of Hatemi-J's analysis is based on the studies of Granger and Yoon (2002) and Toda-Yamamoto (1995). Hatemi-J (2012) defined the integrated variables (y_{1t} and y_{2t}), as the random walk processes as shown in Equation (2):

$$y_{1t} = y_{1t-1} + \varepsilon_{1t} = y_{10} + \sum_{i=1}^{t} \varepsilon_{1i}$$
$$y_{2t} = y_{2t-1} + \varepsilon_{2t} = y_{20} + \sum_{i=1}^{t} \varepsilon_{2i} \quad (2)$$

The constant terms ($y_{1,0}$ and $y_{2,0}$) are the initials, e_{1i}, e_{2i} are the error terms, and t=1,2,3…T. While $e_{1i}^{+}=\max(e_{1i},0)$ and $e_{2i}^{+}=\max(e_{2i},0)$ represent positive shocks, $e_{1i}^{-}=\min(e_{1i},0)$ and $e_{2i}^{-}=\min(e_{2i}, 0)$ represent the negative shocks. They are shown in Equation (3) in the asymmetric form:

$$y_{1t} = y_{1t-1} + \varepsilon_{1t} = y_{1,0} + \sum_{i=1}^{t} \varepsilon_{1i}^{+} + \sum_{i=1}^{t} \varepsilon_{1i}^{-}$$
$$y_{2t} = y_{2t-1} + \varepsilon_{2t} = y_{2,0} + \sum_{i=1}^{t} \varepsilon_{2i}^{+} + \sum_{i=1}^{t} \varepsilon_{2i}^{-} \quad (3)$$

Both positive and negative shocks for every single variable could be defined in a cumulative form as:

$y_{1t}^{+} = \sum_{i=1}^{t} \varepsilon_{1i}^{+}$, $y_{1t}^{-} = \sum_{i=1}^{t} \varepsilon_{1i}^{-}$, $y_{2t}^{+} = \sum_{i=1}^{t} \varepsilon_{2i}^{+}$, $y_{2t}^{-} = \sum_{i=1}^{t} \varepsilon_{2i}^{-}$. The test for the causality of the positive and negative shocks can be implemented by the p^{th} order Vector Auto-Regressive Model (VAR(p)).

The optimal lag length may be selected in a way suggested by Hatemi-J (2003). This way is more robust in the ARCH model, and it also has a good performance when the VAR model is used for estimates. The optimal lag order (p) selection criteria are shown in Equation (4):

$$HJC = \ln\left(\left|\hat{\Omega}_j\right| + j\left(\frac{n^2 lnT + 2n^2 \ln(lnT)}{2T}\right), j = 0,1,2 \ldots . p \quad (4)$$

In Equation (4) the determinant of the estimated variance-covariance matrix of the error terms in the vector autoregressive model which is based on

j^{th} lag order is $|\hat{\Omega}_j|$. The number of equations in the VAR model is n and the number of observations is T. The null hypothesis which is the k_{th} element of y_t^+ for positive shocks and the m_{th} element of y_t^- for negative shocks does not Granger cause the ω_{th} element of y_t^+ and the φth element of y_t^-, respectively. To solve the financial data which usually does not follow a normal distribution, Hatemi-J (2012) makes use of the bootstrapping simulation technique. The hypothesis of the criteria test is based on the Wald Test (Hatemi-J, 2012).

5. Findings

In our study, an analysis of the causality relationship between stock market returns and gold returns in the local currency was conducted for the countries most affected by COVID-19. Since the relationship between the positive and negative shocks has to take into consideration the data from the financial markets, the Hatemi-J Asymmetric Causality Test was used in this study. The advantages of this test are the ways it examines the causality relation between positive and negative shocks with the variables as well as the way it performs with stationary or non-stationary datasets (Hatemi-J, 2012, p.448). The results of the Hatemi-J (2012) Asymmetric Causality Test results are presented in Table 5.

Table 5. The results of the Hatemi-J Asymmetric Causality Tests

Null hypothesis	Test statistic	HJC	Bootstrap CV at 1%	Bootstrap CV at 5%	Bootstrap CV at 10%
r_brasil$^+$ ⇏ r_xaubrl$^+$	8.599*	2	14.545	9.937	7.947
r_brasil$^-$ ⇏ r_xaubrl$^-$	21.101***	6	16.054	11.629	9.582
r_xaubrl$^+$ ⇏ r_brazil$^+$	18.316***	5	14.883	10.091	8.017
r_xaubrl$^-$ ⇏ r_brazil$^-$	37.853***	6	16.295	11.480	9.491
r_france$^+$ ⇏ r_xaueur$^+$	19.815***	4	13.772	8.513	6.618
r_france$^-$ ⇏ r_xaueur$^-$	11.673**	4	13.143	8.291	6.448
r_xaueur$^+$ ⇏ r_france$^+$	6.903*	4	13.308	8.220	6.400
r_xaueur$^-$ ⇏ r_france$^-$	7.534*	4	13.403	8.395	6.510
r_india$^+$ ⇏ r_xauinr$^+$	5.869**	2	8.825	4.019	2.651
r_india$^-$ ⇏ r_xauinr$^-$	32.454***	4	14.592	8.380	6.401
r_xauinr$^+$ ⇏ r_india$^+$	2.150	2	8.527	3.995	2.655
r_xauinr$^-$ ⇏ r_india$^-$	8.842**	4	14.466	8.661	6.474
r_russia$^+$ ⇏ r_xaurub$^+$	40.691***	6	16.803	11.551	9.449
r_russia$^-$ ⇏ r_xaurub$^-$	23.240***	4	11.763	7.919	6.320
r_xaurub$^+$ ⇏ r_russia$^+$	5.790	6	17.276	11.915	9.693
r_xaurub$^-$ ⇏ r_russia$^-$	9.282**	4	12.374	8.282	6.427
r_usa$^+$ ⇏ r_xauusd$^+$	7.999	5	14.899	9.992	8.073
r_usa$^-$ ⇏ r_xauusd$^-$	8.878*	5	14.961	9.859	7.959
r_xauusd$^+$ ⇏ r_usa$^+$	1.781	5	15.687	10.482	8.253
r_xauusd$^-$ ⇏ r_usa$^-$	7.688	5	15.254	10.035	7.957

Notes: The denotation A ⇏ B means that variable A does not cause variable B.
The symbols *, **, and *** show the significance level at 10%, 5%, and 1%, respectively.
CV stands for critical value. Hatemi-J Criterion (HJC) is used.

The results of the Hatemi-J Asymmetric Causality Test show that four out of the five countries (excluding the US) have a two-way causality during the negative shock. However, there is not any two-way causality relation for positive shocks. From observations of positive shocks, there is a one-way causality relationship from gold prices to the stock market index only for Brazil. And inversely, a one-way causality was found for India and Russia from the stock market index to gold prices during the positive shocks in the market. Causality between these variables was not found during positive shocks for France and the US. According to these results, during 2020, negative shocks created more causal effects between the variables than positive shocks. For the US, the impact of negative shocks is almost negligible because the one-way causality is only valid at a 10% significance level.

The volatility of panic in the markets makes investment decisions difficult and risky. Investors often turn to gold as a traditional and safe option for their investment during times of high volatility. As a result, during these periods, high levels of uncertainty in stock market returns can influence the demand for gold, and thus turbulent markets can have a causal connection with gold prices. Gold prices and stocks are often considered substitutes for each other. In other words, there is observed to be a reverse relationship between gold and stock prices such that when gold prices fall, investors tend to reallocate their investments toward the stock market and vice versa (Smith, 2001; Levin & Wright, 2006; Toraman et al., 2011).

According to Gaur and Bansal (2010), in the duration of a crisis, a slumping stock market always results in gold rates climbing. Similarly, Le and Chang (2012) found that a strong relationship exists between stock market prices and gold prices and observed how declines in the stock market are reasons for increases in the gold rate. Gilmore et al. (2009) used a daily time series for a sampling period between 1996-2007 and found that the stock market index was linked with the price index of gold mining companies in the long run and that both variables influence each other in the short run. Therefore, there is clear evidence that during turbulent periods of economic uncertainty, as prices in equity markets fall, gold prices rise and attention quickly shifts toward gold as a safe-haven.

In line with the traditional view about gold being a safe-haven during a financial crisis, this study continues to show a causality relation between gold and the stock exchange markets in each of the countries analyzed. However, on the whole, the stock market's sensitivity to economic and political indicators is high. For the countries which have suffered the highest number

of COVID-19 cases, the effects of sudden and considerable economic losses may be expected to be reflected spontaneously in the financial markets (Jiang et al., 2017).

6. Conclusion

The initial outbreak of COVID-19 began toward the end of December 2019 in a local province in China. In only ten weeks, it quickly spread across the world and turned into a global pandemic.

Pandemic influenza viruses have significant effects on national economies. In 2020, situations such as death and absenteeism related to the illness, new social distancing requirements, the closures of businesses and public offices have naturally affected daily life and affected the economic markets negatively. Stock markets reported sharp declines during the first spike of global cases of the virus. The primary aim of the present study is to examine the short-term causality relationship between stock market returns and gold returns during this type of health crisis.

The analysis covers a period between January 2, 2020, to December 31, 2020, and data from the stock market indices and the gold rates were collected from the top five countries most affected by the virus by the end of 2020 (Brazil, India, France, Russia, and the US). In particular, the data related to the returns from these variables were used. Due to the effects of the virus and the news surrounding it, the reactions from stock markets shifted sharply in both negative and positive directions. As a result, an asymmetric causality test developed by Hatemi-J to measure these dynamics was preferred.

The results of the asymmetric causality tests show that there is no two-way causality relation for Brazil, India, France, Russia, and the US during positive economic shocks. In contrast, during the negative shock of the COVID-19 crisis, Brazil, India, Russia, and France were observed to have a two-way causal relationship. During the positive shocks, Brazil was found to have only a one-way causal relationship from gold prices to the stock market, whereas India and Russia had a one-way causal relationship in the other direction (from the stock market index to gold prices). For the US, during the negative shock of 2020, the causal link is very weak. Despite the rebound in the financial markets, gold is still seen as a safe-haven type of investment, particularly during times of economic crisis. Many investors, and even speculators, want to maintain high liquidity, so this will contribute to bear-market types of trends. However, of course, gold (or precious metals) is not the only alternative. The decision-making bodies of national governments acted quickly with expansionary fiscal and monetary policies such as the

postponement of taxes, subsidy and grant options, reductions in interest rates, etc. These fiscal and monetary policies created a large playground for financial markets, so the traditional sharp relationship between gold and stock markets was softened. This means that the returns of the stock market and the gold market acted more independently in this situation.

In sum, the negative shock experienced in the stock exchange markets contributed to a rapid sell-off and investors were hesitant to buy back their assets, especially in the first half of 2020. During the initial stages of the COVID-19 pandemic and the negative economic shock, it was shown that the variables maintained a stronger causal relationship in the most affected countries. Additional developments also contributed to the economic downturn such as social distancing policies and mandatory business closures. But the second half of the year was different for the financial markets. Stock markets regained their previous losses and as positive news came out later in the year about vaccines and other macroeconomic recovery packages, there was a strong upward bull market trend.

The study focuses on the relationship between returns in gold and the stock market during the COVID-19 pandemic. There are several layers of connections between assets in the financial markets and, as is generally characteristic of markets, every economic crisis has different results with different causal relationships. The results of this study correspond with other findings in the literature. In a period of economic panic or crisis, demand for gold increases, and gold returns increase while stock markets are frantically selling. An asymmetric testing process for stock market returns and gold returns in terms of the local currency was not found, but traditional causality tests generally showed the same results, as was discussed in previous sections.

This study aims to provide a meaningful contribution to future research about the effects of pandemic disease on financial markets.

Authors' contributions

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Availability of data and materials

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Competing interests

The authors declare that they have no competing interests.

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