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Sherif M. Hassan and John Riveros

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M&S Research Hub institute
Carlo Mierendorff Str. 43, 34132 Kassel, Germany
Telephone +49 (0)56149941680,
Email: info@ms-researchhub.com,
Web: www.ms-researchhub.com

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First to React Is the Last to Forgive: Evidence from the Stock Market Impact of COVID 19

Sherif.M. Hassan.[ab] and John Riveros [ac]

[a] M&S Research Hub, Kassel-Germany
[b] ERF, Cairo-Egypt
[c] Estudios y Evaluación de la Gestión Pública Colombian, Colombia

Corresponding author: John Riveros
Contact: Hassan@ms-researchhub.com / riveros@ms-researchhub.com

Abstract

COVID 19 has had parallel and uneven economic shocks across countries since its outbreak in December 2019. Stock markets as usual were the first to react, with drop rates as much as the Global Financial crises of 2008. This study uses daily data to model the dynamic impact of COVID 19 pandemic on returns of selected stock market indices and globally-traded commodities. The overall panel least squares VAR estimation results indicate a negative short termed impact of 2.3% on the performances of the stock markets when the spread rate of coronavirus increases by 1% across countries ceteris paribus. While The COVID 19 contamination rate is not statistically significant to explain the changes in the exchange rate and gold prices in the countries of analysis, yet the virus spread rate is found to be significant in steering prices of platinum, silver, WTI, and Brent crude oil.

Keywords: Panel VAR, Stock Market Indices, COVID 19

JEL codes: G01; I15; H12; G15

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1. Background

As the world was ready to enter the new year, health authorities in Wuhan, China has reported to the World Health Organization (WHO) the outbreak of unknown clusters of viral pneumonia cases on the last day of December 2019. After a formal investigation of these cases by the beginning of 2020, the world witnessed the birth of the SARS-CoV-2 (COVID 19) virus. As of 30 June, More than 12 million infection cases and more than 500,000 deaths have been globally declared to be associated with COVID 19 pandemic (World Health Organization [WHO], 2020). COVID 19 is the fifth in the 21st-century list of pandemics, after Influenza H1N1, Coronavirus (Bats), Ebolavirus, Coronavirus (Camels), where the furriest among the list H1N1 was estimated to be associated with 151,700 to 575,400 deaths worldwide (Center for Disease Control and Prevention [CDC], 2019).

While the exact global economic impacts of COVID 19 are not yet clear, it is considered deadlier than the other two Coronaviruses and has affected a massively larger number of people over a shorter period. MARS and SERS have affected respectively, 8437 and 2499 cases, and with 813 and 816 associated deaths (WHO, 2012; CDC, 2004). This study contributes to the newly developed COVID 19 empirical research by examining the impact of its contamination rate on returns of stock market indices and selected globally trade commodities, namely gold, platinum, silver, WTI and Brent oil. We utilize daily data of selected stock markets from the firstly affected countries, China, the USA, Spain, Italy, South Korea, and Japan. The methodology adopted is a k-variate panel VAR of order p. .

The overall panel least squares VAR estimation indicates a negative short termed impact of 2.3% on the performances of the stock markets when the spread rate of coronavirus increases by 1% across countries ceteris paribus. The coronavirus contamination rate is not statistically significant to explain changes in the exchange rate and gold prices, yet the virus spread rate significantly steer prices of platinum, silver, WTI, and Brent crude oil. According to the Driscoll-Kraay approach, we found that the exchange rate, platinum, and gold are the main drivers for stock market movements.

Global stock markets reacted strongly and wildly to the COVID 19 pandemic, in March 2020, the US stock market hit the circuit breaker mechanism four times in ten days. Since its inception in 1987, the breaker has only ever been triggered once, in 1997. Stock markets in Europe and Asia have also dramatically reacted. FTSE of the UK has dropped on 12th of March more than 10% on its worst day since 1987 and the stock market in Japan has lost more than 20% from its highest position at the end of 2019 (Zhang et al. 2020). Gormsen and Koijen (2020) showed that stock markets have dropped in response to COVID 19 as much as the global financial crises of 2008, yet the markets during the pandemic have recovered quicker especially in Europe.

The pandemic severity varies across countries hence begetting non-uniform individual stock markets reactions, Capelle-Blancard and Desroziers (2020) have accounted for such heterogeneity across 74 countries and found that the number of infected people in each country was the primary driver for stock market reactions, and volatility heaved as concerns about the pandemic grew. Their results also showed that the number of COVID 19 infection cases in wealthy neighboring countries has affected investors' decisions. He, et. al (2020) used conventional t-tests and non-parametric Mann–Whitney tests to analyze the impact of COVID 19 on selected stock markets in Asia and Europe. They found that COVID 19 has a negative, bidirectional, and short-termed impact on stock markets between Asian, American, and European stock markets, yet the impact tends to intensify as the virus spreads.

Examining a different perspective of heterogeneity, Albuquerque, et. al (2020) argued that COVID 19 have triggered unparalleled shocks to stocks, those with higher environmental, social and governance activities (ESG) rating have shown more resilience, maintained higher returns and higher operating profit margins relative to their counterparts during the first quarter of 2020. The logic here follows Albuquerque, et. al (2019) model that investing in ESG policies feeds into the customers' loyalty and reduces price elasticity of demand for the firm products.

2. Literature Review

Studies of the macroeconomic impact of past pandemics have mainly aimed to quantify the effects in terms of lost output and growth, however firm conclusions about the pandemics' long-run economic effects have not been well researched (Bell and Lewis, 2004). Studies of such a scope usually study the short term economic effects of pandemics through their impact on supply and demand, stock market, fertility rate, trade, labor inputs, and tourism (Jonung and Roeger, 2006).

One of the few studies on the economic effects of Spanish influenza between 1918-19, suggested that this pandemic has simulated growth of the US economy post the pandemic years in the 1920s (Brainerd and Siegler, 2003), in contrary to Correia et al. (2020) who showed that a sharp decline in economic activity has persisted until at least 1923. Comparing the Spanish flu effects across 43 countries between 1918 and 1920, Barro et al. (2020) concluded that the flu-associated death rates caused declines in GDP and consumption of about 6%. Karlsson, et al. (2014) found no discernible effect of the 1918 influenza pandemic on earnings in Sweden. The state of the economy during pandemic defines extensively the speed and severity of the ensued economic effects. Benmelech and Frydmann (2020) argued that the increase in the government's demand for World War 1-related products during the 1918' influenza pandemic has made up for the contraction in consumer spending and private investment, leaving only modest and short-termed effects on US and Europe economies. It is generally perceived also that during pandemics, regions with a higher degree of global exposure and economic integration are affected more sturdily than less integrated regions (Verikios, et al. 2012).

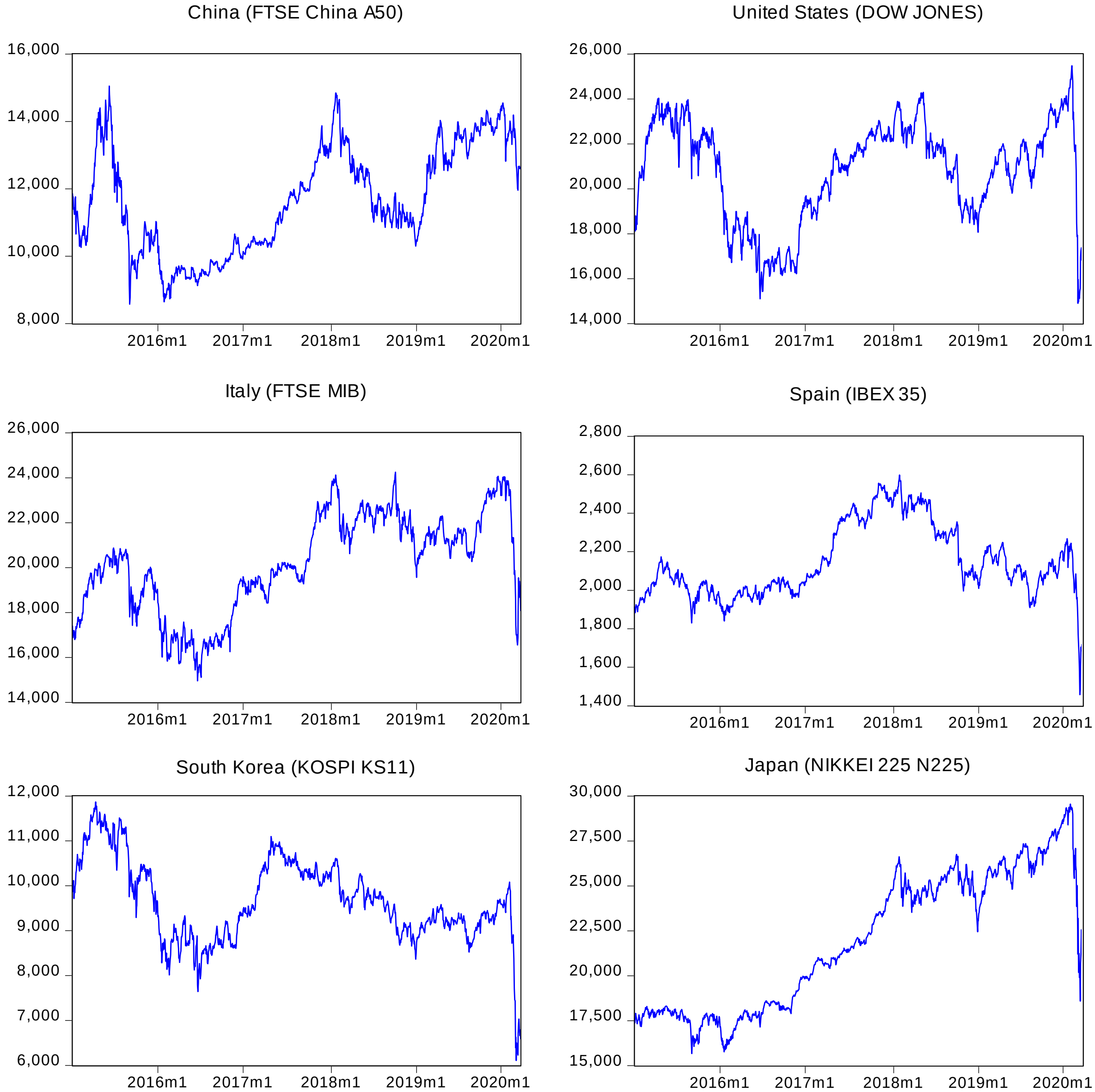
May 2009 has witnessed the emergence of a new H1N1 commonly known as “swine flu” due to its close association with North American and Eurasian pig influenza. Verikios, et al. (2012) is one of the few studies that investigated the economic effects of the H1N1 epidemic, by applying to Australia. Their MONASH-Health model simulation results showed that the epidemic was associated with significant short-termed adverse macroeconomic effects that extended only within two or four quarters then the economy reverted to normal rates. The preceded contractionary effect would reduce tourism, household demands for international travel and industries would face increased costs via absenteeism and loss of labor force (Verikios, et al. 2012).

As we move forward in time and from north to south on the map, Young (2005) projected an increasing trend in per capita consumption post the AIDS epidemic in South Africa. The widespread community infection measures during the epidemic have lowered national fertility rates, both through reducing the willingness to engage in unprotected sexual activity and increasing the scarcity of labor and the value of a woman's time. On the contrary, World Bank (2016) postulated that the recent Ebola epidemic in West Africa during 2014-2015 has had severe and adverse shocks to the private sector as well as has posed threats to national food security due to the decline in agricultural production.

3. Stylized Facts

Graph 1 shows the reaction of selected stock markets of the firstly affected countries to the COVID 19 pandemic. Starting from January 2020, a persistent and sharp decrease in stock prices is observed. This decrease has been consistent with an increase in the overall number of people contaminated per day by each country, where the first transmission pattern is appointed to the factor of close contact with infected individuals.

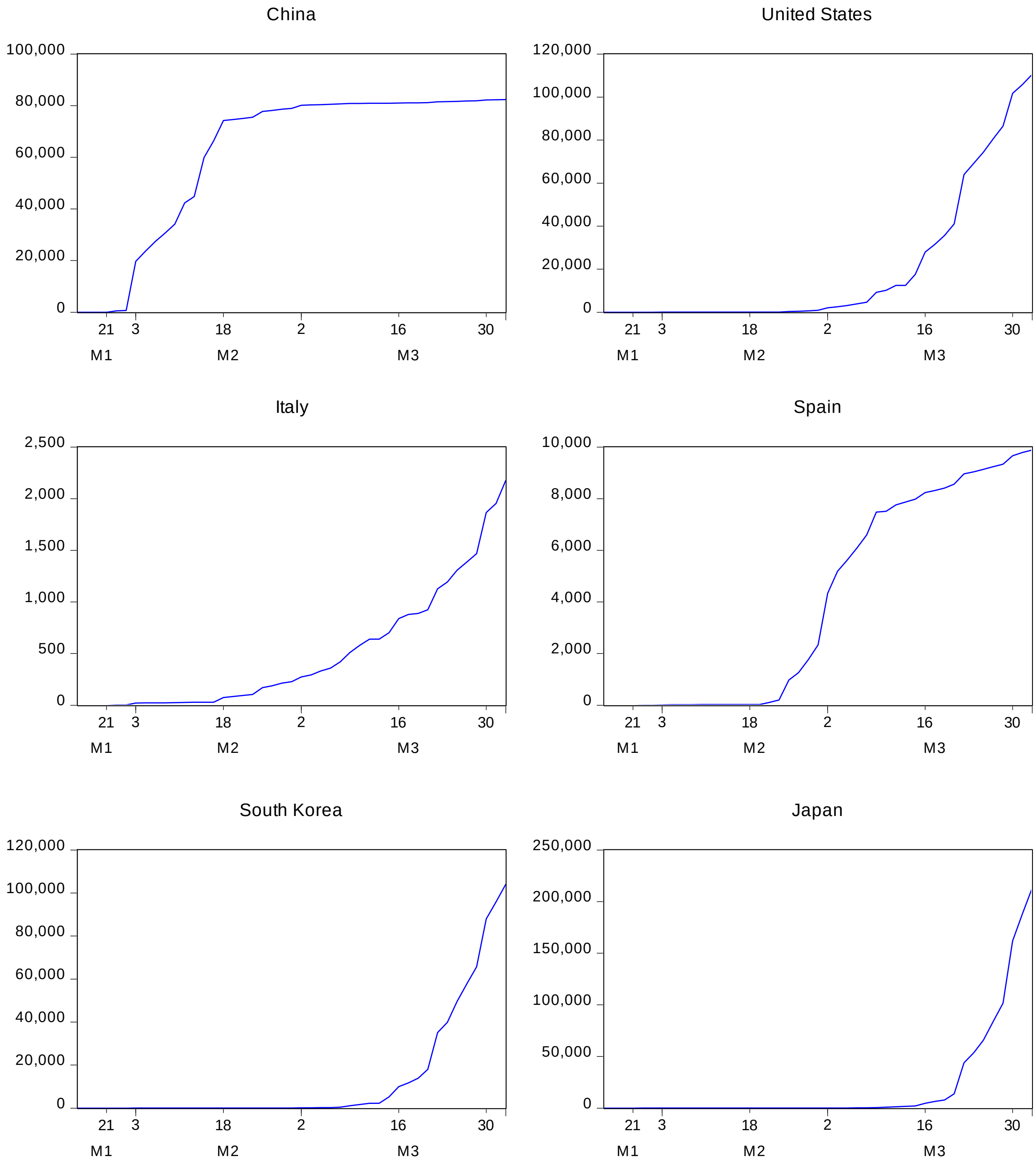
Graph 1 Prices of Stock Markets in Local Currencies



Source: Data Stream (2020)

In this concern, the number of people contaminated per day is shown in Graph 2. The steeply-increasing contamination rate is also evident across all countries, yet China was able to control the spread rate and flatten the curve better than other countries. Japan and the United States have the highest and steepest contamination rate among other countries although the outbreak on a large scale in both countries started in February.

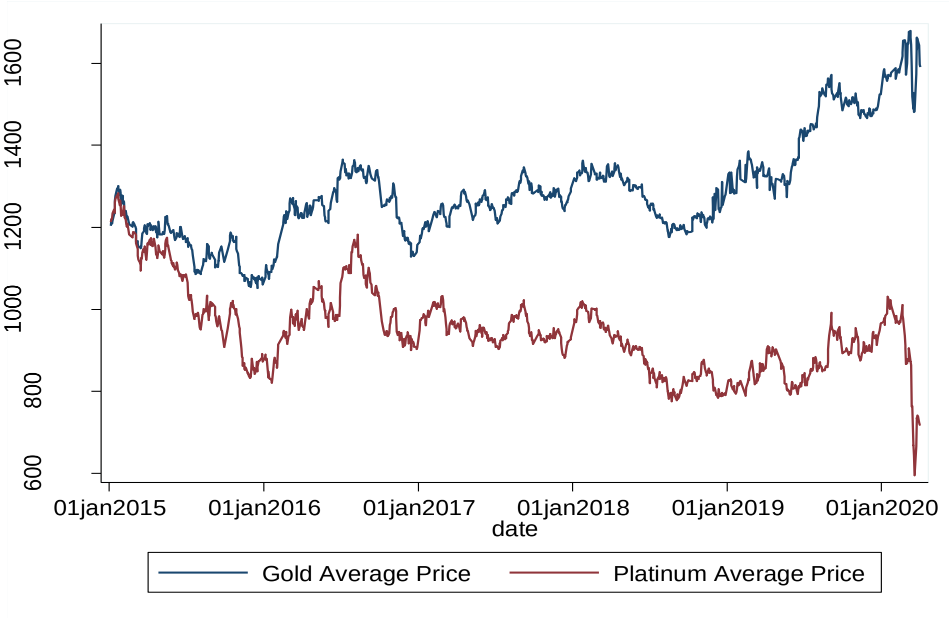
Graph 2 People Infected per day with COVID 19

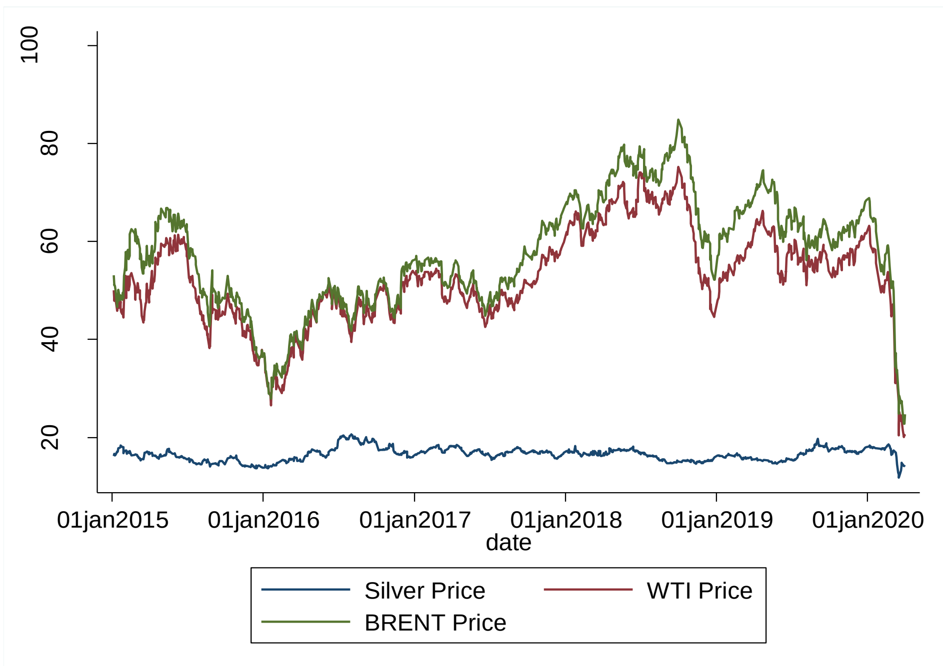


Note: M1 to M3 represents the months from January to March of 2020. The numbers in the X-axis covers the days within the months. Source: CSSE (2020)

Commodities and financial markets are closely connected; from this, we observe a clear bi-directional feedback effect of COVID 19 pandemic on prices of global commodities. As the scale of the pandemic and its economic impact started to emerge, the prices of gold, platinum (measured in 1 troy ounce), Brent and WTI crude oil (measured in 1 barrel of oil) have reacted on spot by a severe cut-down. Only gold and platinum prices started to noticeably revert reflecting the stability of these metals' values during times of uncertainty and economic recessions.

Graph 3 Commodity Price Behavior





Source: Data Stream (2020)

Table 1 reports the correlation analysis between the growth rates of these variables[1] and the contamination growth rate of COVID 19. The results suggest that COVID 19 contamination is statistically significant and negatively correlated with stock market returns. The exchange rate and gold prices are not statistically affected by the pandemic yet for the remaining commodities, the negative relationship is significant.

Table 1 Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Stock Market Performance	1.000							
(2) Contamination G. R.	-0.120***	1.000						
(3) Exchange Rate G. R.	-0.002	0.002	1.000					
(4) Gold Price G. R.	-0.060***	0.004	0.120***	1.000				
(5) Silver Price G. R	0.093***	-0.087***	0.099***	0.571***	1.000			
(6) Platinum Price G. R	0.197***	-0.058***	0.131***	0.488***	0.527***	1.000		
(7) WTI Price G. R	0.232***	-0.085***	0.034***	0.049***	0.206***	0.214***	1.000	
(8) BRENT Change	0.247***	-0.124***	0.028**	0.027**	0.196***	0.228***	0.915***	1.000

Note: Pair-wise correlation coefficients are presented in the table. Source: authors' calculation

Table 2 Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
Stock Market Performance	6798	.0001105	.013	-.169	.114
Number of People contaminated per day	6798	797.0981	8118.323	0	213372
Exchange Rate G. R.	6798	.0000168	.008	-.111	.125
Gold Price G. R	6798	.0001613	.01	-.046	.058
Silver Price G. R	6798	.0012936	.018	-.136	.076
Platinum Price G. R	6798	-.0001951	.014	-.121	.104
WTI Price G. R	6798	-.0002151	.027	-.246	.238
BRENT Change	6798	-.0001893	.025	-.241	.144

Source: authors' calculation

We use daily data from January 1st 2015 to April 1st 2020 for China, United States, Italy, Spain, South Korea, and Japan. The average number of people contaminated per day is 797 for all countries. The prices of gold and silver have an average growth rate of 0.016% and 0.129% respectively. The highest volatility is observed in Brent oil prices, while exchange rates have the lowest standard deviation.

[1] Growth rates are used to override potential inertial effects of the time series and provide a non-spurious correlation. The exchange rate of local currencies against USD is used.

Table 3 Basic Statistics by Country

Country	Statistic	Number of people Contaminated Per Day	Stock Market Performance (Returns)	Exchange Rate G.R.
China	Mean	2426.472	0.0003436	-0.0001023
	Minimum	0	-0.0899	-0.018
	Maximum	82361	0.0707	0.0111
	Std. Dev.	13322.93	.015367	.0024559
Italy	Mean	802.5702	0.0000781	-0.0000218
	Minimum	0	-0.1692	-0.0239
	Maximum	110574	0.0893	0.0307
	Std. Dev.	7694.682	.0152327	.0054836
Japan	Mean	19.54369	0.0001076	0.0001546
	Minimum	0	-0.0792	-0.0318
	Maximum	2178	0.0804	0.0333
	Std. Dev.	151.2382	.0129665	.0062192
South Korea	Mean	160.5596	0.0000217	0.0000414
	Minimum	0	-0.0839	-0.1111
	Maximum	9887	0.086	0.125
	Std. Dev.	1121.529	.009589	.0158595
Spain	Mean	532.5755	-0.0001861	-0.0000218
	Minimum	0	-0.1406	-0.0239
	Maximum	104118	0.0782	0.0307
	Std. Dev.	6031.944	.0130819	.0054836
USA	Mean	840.8676	0.0002982	0.0000507
	Minimum	0	-0.1293	-0.0295
	Maximum	213372	0.1137	0.0246
	Std. Dev.	10845.3	.0121533	.0054717
Total	Mean	797.0981	0.0001105	0.0000168
	Minimum	0	-0.1692	-0.1111
	Maximum	213372	0.1137	0.125
	Std. Dev.	8118.323	.0132068	.0080215

Note: All nominal exchange rates are measured vis.a.vis USD, in the case of USA exchange rate, it is measured relative to the euro. Source: auhors' calculation

Stock markets of all countries exhibit on average positive returns throughout the study duration, except for Spain that was adversely affected by the European multi debt crisis since the end of 2009. China's FTSE has a higher return on average than the USA's Dow Jones, reflecting China's unprecedentedly rapid growth over the last decade.

4. Methodology

To investigate the impact of the contamination rate of COVID 19 on stock market returns of the firstly affected countries and selected globally-traded commodities, we utilize a k-variate panel VAR of order p following Abrigo & Love (2016). The basic specification is as follows:

$$\mathbf{Y}_{it} = \sum_{\gamma=1}^{p} \mathbf{Y}_{it-\gamma}\boldsymbol{A}_{\gamma} + \mathbf{X}_{it}\mathbf{B} + \mathbf{u}_i + \boldsymbol{e}_{it} \qquad (1)$$

$$i \in \{1, 2, \dots, N\}, \quad t \in \{1, 2, \dots, T_i\}$$

Where $\mathbf{Y}_{it}$ is a (1 x k) vector of the dependent stationary variables, which includes the performance of the stock market of country *i* at time *t* as the main variable of interest. Other endogenous regressors in the model are the growth rate of the current exchange rates of country *i* at time *t* and the growth rate of the prices of commodities of gold, platinum, silver, WTI & BRENT oil. We assume parameter homogeneity for $\boldsymbol{A}_{\gamma}(k \text{ x } k)$ and $\boldsymbol{B}$ which is a matrix of $(l \text{ x } k)$ of parameters.

$\mathbf{X}_{it}$ is the (1 x l) vector of exogenous covariates in which we're going to allocate the growth rate of contagious per day of COVID 19[2]. Fixed effects are captured in $\boldsymbol{u}_i$. The performance (or returns) of the stock market is estimated using the following formula:

$$r = \frac{s_{it+1} - s_{it}}{s_{it}} \approx \ln\left(\frac{s_{it+1}}{s_{it}}\right) \qquad (2)$$

Where for country *i* at day *t* the closing stock price is represented in s, which is the growth rate of the latest stock price registered in the stock market, this should be equivalent to the difference in natural logarithms. The growth rates of the exchange rate and commodities' prices are estimated using the same Formula.

The selected stock markets by country are presented in Table 4:

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[2] For obvious reasons, the contamination rate of COVID 19 is exogenous and cannot be correlated in a causal sense with the set endogenous regressors mentioned, this is due to the fact that financial movement and dynamics of the stock markets doesn't imply the direct or physical contact between individuals which might transmit or be correlated with the contamination of the virus.

Table 4 Identification of Countries and the Stock Markets used

ID	Country of Analysis	Stock Market
1	China	FTSE China A50
2	United States	DOW JONES
3	Italy	FTSE MIB
4	Spain	IBEX 35
5	South Korea	KOSPI KS11
6	Japan	NIKKEI 225 (N225)

Source: Own Elaboration

Daily data about the number of infection cases in each country is sourced from the Center for Systems Science and Engineering -CSSE- of the John Hopkins Whiting School of Engineering (CSSE, 2020). This source provides well-documented data of the positive cases in absolute values of the population contaminated[3].

To account for the issues of serial correlation and heteroskedasticity that is associated with financial data, we estimate the overall panel VAR using panel least squares while using the White-Arellano estimator (White, 1980: 1984: Arellano, 1987) with cross-section weights that account for heteroskedasticity and serially correlated errors[4]. We also utilize Driscoll-Kraay (2006) standard errors that are robust to heteroskedasticity and serial correlation. These robust standard errors are proper for the context of large panels ($T>N$) similar to our data structure (Hoechle, 2007)[5].

VAR model is in essence a Seemly Unrelated Regression (SUR) model (Triacca, 2014). Accordingly, we follow Wooldridge's (2002) suggestion to use the Generalized Least Square (GLS) method to estimate Equation (1). This method possesses some advantages in reducing the trade-off between efficiency and robustness, it also allows using Breusch and Pagan Lagrange multiplier to test possible correlations between the errors of the VAR equations. De Hoyos & Sarafidis (2006) recommend this test to confirm the presence of cross-sectional dependence in the context of large panels (T > N).

[3] A normalization has been imposed from this approach, where before the first detected case of all countries, the number of people positive of COVID 19 was normalized to 0. With this, the past information of financial data can be used to compare the change produced in average by the rate of the contamination as soon as it started to growth in each country.

[4] Arellano (1987) stated that this period estimator is not suitable when T is large for fixed N, however, some new empirical evidence from Moundigbaye, Rea, & Reed (2018) tends to suggest that the White estimator with cross-section weights can perform well for T>N and it's more appropriate in comparison to the ordinary least squares estimator.

[5] The lag length proposed to be considered in the autocorrelation structure is defined by $m(T) = floor\left[4\left(T/_{100}\right)^{2/9}\right]$ following Hoeckle (2017).

We start our empirical analysis by confirming the variables' stationarity using the first generation of panel unit-roots, namely Levin, Lin & Chu (2002). The second generation and Fisher-type unit-root test are also performed as proposed by Im, Pesaran & Shin (2003) and the (Choi, 2001). For Equation (1) panel VAR with the generalized method of moments -GMM- becomes unfeasible for the scale of T[6]. Nevertheless, the approximation in (1) has the same structure compared with the original panel VAR model as proposed by Abrigo & Love (2016). Our estimations also account for unobserved countries' heterogeneity by using the fixed effects estimator.

The lag selection for p in Equation (1) is problematic since the literature does not define a clear benchmark. Accordingly are unable to perform the optimal moment and model selection criteria (MMSC) of Andrews & Lu (2001). The number of lags in p is selected to satisfy two criteria, first, they are sufficient to capture the persistent time serial correlation, and second to maintain the model stability regarding the autoregressive coefficients.

An advantage for the current structure of the data is that the endogeneity bias -which emerges due to the correlation of the unobserved heterogeneity and the lagged values of the dependent variable- can be corrected by accounting for the fixed effects. As suggested by Beck & Katz (1995), as soon as $T \to \infty$, the average error term minimizes to zero and the bias of the dynamic panel models is eliminated.

[6] Abrigo & Love (2016, p. 780) and Arellano (1987) state that GMM estimators can be consistent if the ratio T/N remains as a positive constant lesser or equal to 2, however this is not the case, since the dataset is composed from daily data between 2015 and 2020, which violates this ratio and would lead to inconsistent results.

5. Results

The first and second generation of panel unit-root tests confirms that the variables of the stock market performance, the growth rates of the exchange rate, the growth in the commodity prices of gold, platinum, silver, WTI, and Brent are stationary (see Appendix A). The lags are selected based on the AIC, BIC, FPS & Hannan-Quinn information criteria tests of the VAR model[7].

The panel least squares VAR estimation shows that an increase of 1% at the growth rate of coronavirus contamination reduces the stock markets' returns by 2.3% at the 1% significance level. The model stability is satisfactory but the Breush-Pagan Lagrange Multiplier test shows the presence of autocorrelation in the residuals. To account for this problem, we re-estimate the model using the White-Arellano period estimator with cross-sectional weights, SUR, and the Driscoll-Kraay approach. In the SUR model, the null hypothesis of the Breusch-Pagan test of independence is rejected, indicating the presence of cross-sectional dependence in Equation (1), therefore, Driscoll-Kraay approach provides the most robust results as it accounts for the problems of serial correlation, heteroskedasticity, and cross-sectional dependence. The results are robust across all specification and the negative impact of COVID 19 contamination on stock market daily returns is confirmed, yet a slight change in the magnitude from 2.3% to 2.1% is observed in the White-Arellano model (regression tables are presented in Appendix B).

The contamination rate of COVID 19 is not statistically significant to explain the changes in the exchange rate and gold prices. Yet COVID 19 at the 10% level of significance explains the changes in prices of platinum, silver, WTI, and Brent crude oil. A 1% increase of the COVID 19 spread rate causes a reduction of 1.1%, 1.6%, 3.26%, and 4.08% in the prices of platinum, silver, and Brent respectively.

5-1. Granger causality

Empirical findings regarding the Granger-causality tests based on Driscoll-Kraay approach are presented in Appendix C. Their main findings are as follows: Exchange rate, platinum,

[7] We run unit root tests using 16 lags based on the selection criteria tables in Appendix A. Using this particular lag length confirmed that the inverse roots of the AR polynomial characteristic are stable.

and gold granger cause stock market returns at the 10% significance level. Stock market returns and platinum granger causes the exchange rate at the 5% significance level. WTI oil price granger causes gold at the 5% level of significance. At the 10% significance level, the exchange rate and Brent oil price grange-causes gold. Brent, WTI, and the gold granger cause platinum at the 5% level of significance. All variable granger causes silver at the 1% level of significance. Silver alone granger causes WTI prices, while Brent is granger-caused at by the exchange rate at the 5% significance level.

5-2. Impulse responses

The impulse response function of the panel VAR model is presented in Appendix D. It indicates that after one Cholesky standard deviation shock, for each variable considering the response for its own, there's a decreasing but significant effect that tends to disappear after 8-10 days.

Gold prices react positively to a shock of stock market returns, however, this positive effect is not permanent. The platinum and silver commodities tend to behave similarly yet for a longer period (response fades away usually after 4 days). A shock in stock market return triggers short-termed positive response also at WTI and Brent oil prices.

A positive shock in the WTI prices creates a stabilization process for the same variable in the short term, while the same shock triggers a positive response by Brent oil prices. Finally, silver responses positively to a shock in stock market return, however, after a few days the response turns negative.

6. Conclusion

This research contributes to the emerging COVID 19 economic literature by investigating the impact of the pandemic contamination rate on daily stock market returns in the first affected countries and prices of global commodities. Daily data from January 1^{st,} 2015 to April 1st 2020 for China, United States, Italy, Spain, South Korea, and Japan are used to estimate a k-variate panel VAR of order p. Basic regression results are obtained first using the OLS estimator of panel VAR then the results are checked against other robustness approaches. White-Arellano estimator and Driscoll-Kraay standard errors are utilized to account for the issues of serial correlation and heteroskedasticity.

Results confirm the negative impact of the pandemic on stock market returns. As the pandemic spread rate increases by 1%, the stock market returns decrease on average by 2.3%. The negative impact of the pandemic extends to affect also prices of selected global commodities, Brent and WTI oil price, gold, silver, and platinum. WTI hit the biggest decline in response to COVID 19, with an average price decrease of 4.08% with every 1% increase in the pandemic contamination cases. Worth mentioning that COVID 19 pandemic might not be the sole driver of the fall in oil prices, the Russian and Saudi Arabian oil price war since March 2020 has also contributed to bringing down oil prices (Cohen, 2020).

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Appendix A

Table 5 Panel unit-root Summary

	Method	Statistic	Prob.**	sections	Obs
Stock Market Performance	Null: Unit root (assumes common unit root process)				
	Levin, Lin & Chu t*	-80.0007	0.0000	6	6789
	Null: Unit root (assumes individual unit root process)				
	Im, Pesaran and Shin W-stat	-76.1168	0.0000	6	6789
	ADF - Fisher Chi-square	985.949	0.0000	6	6789
	PP - Fisher Chi-square	653.088	0.0000	6	6792
Exchange Rate G.R.	Method	Statistic	Prob.**	sections	Obs
	Null: Unit root (assumes common unit root process)				
	Levin, Lin & Chu t*	-103.273	0.0000	6	6782
	Null: Unit root (assumes individual unit root process)				
	Im, Pesaran and Shin W-stat	-83.9082	0.0000	6	6789
	ADF - Fisher Chi-square	701.022	0.0000	6	6789
	PP - Fisher Chi-square	578.435	0.0000	6	6792
Gold Price G. R.	Method	Statistic	Prob.**	sections	Obs
	Levin, Lin & Chu t*	-121.806	0.0000	6	6792
	Im, Pesaran and Shin W-stat	-102.359	0.0000	6	6792
	ADF - Fisher Chi-square	447.574	0.0000	6	6792
	PP - Fisher Chi-square	361.517	0.0000	6	6792
	Method	Statistic	Prob.**	sections	Obs
	Levin, Lin & Chu t*	-105.714	0.0000	6	6792
	Null: Unit root (assumes individual unit root process)				
	Im, Pesaran and Shin W-stat	-89.7777	0.0000	6	6792
	ADF - Fisher Chi-square	806.674	0.0000	6	6792
	PP - Fisher Chi-square	807.046	0.0000	6	6792
Silver Price G.R.	Method	Statistic	Prob.**	sections	Obs
	Null: Unit root (assumes individual unit root process)				
	Levin, Lin & Chu t*	-63.277	0.0000	6	6792
	Null: Unit root (assumes individual unit root process)				
	Im, Pesaran and Shin W-stat	-56.2231	0.0000	6	6792
	ADF - Fisher Chi-square	1192.89	0.0000	6	6792
	PP - Fisher Chi-square	830.539	0.0000	6	6792
WTI Price G.R.	Method	Statistic	Prob.**	sections	Obs

	Null: Unit root (assumes individual unit root process)				
	Levin, Lin & Chu t*	-115.783	0.0000	6	6792
	Null: Unit root (assumes individual unit root process)				
	Im, Pesaran and Shin W-stat	-99.7131	0.0000	6	6792
	ADF - Fisher Chi-square	524.310	0.0000	6	6792
	PP - Fisher Chi-square	521.845	0.0000	6	6792
	Method	Statistic	Prob.**	sections	Obs
	Null: Unit root (assumes individual unit root process)				
	Levin, Lin & Chu t*	-115.783	0.0000	6	6792
Brent Price G. R.	Null: Unit root (assumes individual unit root process)				
	Im, Pesaran and Shin W-stat	-99.7131	0.0000	6	6792
	ADF - Fisher Chi-square	524.310	0.0000	6	6792
	PP - Fisher Chi-square	521.845	0.0000	6	6792

Note: The G.R. for each variable corresponds to Growth Rate. ** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality. Newey-West automatic bandwidth selection and Bartlett kernel. Automatic lag length selection based on SIC. Exogenous variables: Individual effects. Program EVIEWS 11. Source: Own Elaboration.

Table 6 VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	139820.8	NA	1.81e-27	-41.71047	-41.66068	-41.69328
1	140370.3	1096.641	1.56e-27	-41.85982	-41.76024	-41.82543
2	140630.9	519.6635	1.46e-27	-41.92298	-41.77361	-41.87140
3	140933.6	602.8360	1.36e-27	-41.99868	-41.79952	-41.92991
4	141217.3	564.4791	1.27e-27	-42.06873	-41.81978	-41.98276
5	141618.7	797.8281	1.14e-27	-42.17390	-41.87516	-42.07073
6	141850.4	459.9617	1.08e-27	-42.22841	-41.87988*	-42.10805
7	142066.0	427.6215	1.03e-27	-42.27813	-41.87981	-42.14058
8	142243.4	351.5039	9.88e-28	-42.31646	-41.86834	-42.16171
9	142444.2	397.2597	9.45e-28	-42.36174	-41.86383	-42.18979
10	142598.3	304.7930	9.15e-28	-42.39312	-41.84542	-42.20398
11	142794.9	388.1012	8.76e-28	-42.43714	-41.83965	-42.23080
12	142980.0	365.2942	8.41e-28	-42.47777	-41.83049	-42.25424
13	143121.4	278.5869	8.18e-28	-42.50534	-41.80826	-42.26461
14	143308.8	368.9929	7.85e-28	-42.54665	-41.79978	-42.28873
15	143424.3	227.0749	7.70e-28	-42.56648	-41.76983	-42.29137
16	143567.9	282.0778*	7.48e-28*	-42.59471*	-41.74826	-42.30240*
18	143424.3	227.0749	7.70e-25	-42.56647	-41.76986	-42.29137

Note: VAR Lag Order Selection Criteria Endogenous variables: Stock Market Performance, Exchange Rate G.R. Gold Price G.R. Platinum Price G.R. Silver Price G.R. WTI Price G.R. Brent Price G.R. Exogenous variables: C COUNTRY_1 COUNTRY_2 COUNTRY_3 COUNTRY_4 COUNTRY_6 Contamination Growth Rate. Sample: 1/05/2015 4/01/2020. Included observations: 6702. * indicates lag order selected by the criterion. Source: Own Elaboration.

Appendix B

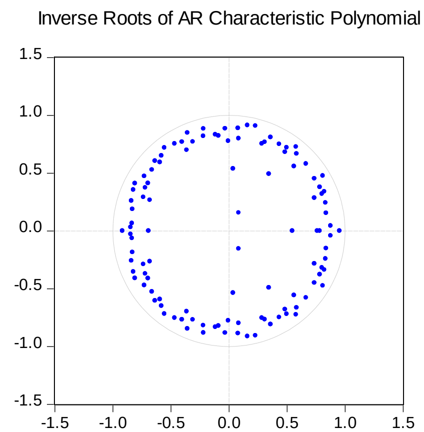
Table 7 Panel LS VAR Regression

	Stock market performance	Exchange rate G.R	Gold G. R.	Platinum G. R.	Silver G. R.	WTI G. R.	BRENT G. R.
Stock Market Performance (-1)	-0.087550	-0.000719	-0.022080	0.009438	0.050663	-0.023967	0.024816
	(0.01300)	(0.00800)	(0.00970)	(0.01322)	(0.01653)	(0.02595)	(0.02386)
	[-6.73656]	[-0.08983]	[-2.27582]	[0.71409]	[3.06404]	[-0.92354]	[1.04020]
Exchange Rate G.R (-1)	-0.028832	-0.170830	0.016319	-0.003858	0.006100	0.017308	0.008774
	(0.02022)	(0.01244)	(0.01509)	(0.02056)	(0.02572)	(0.04037)	(0.03711)
	[-1.42612]	[-13.7283]	[1.08127]	[-0.18763]	[0.23714]	[0.42875]	[0.23643]
Gold G. R. (-1)	-0.047745	-0.001082	-0.213655	-0.059978	0.030517	-0.050640	-0.041272
	(0.02160)	(0.01329)	(0.01612)	(0.02197)	(0.02748)	(0.04313)	(0.03965)
	[-2.21061]	[-0.08142]	[-13.2513]	[-2.73061]	[1.11058]	[-1.17420]	[-1.04096]
Platinum G. R. (-1)	0.062698	0.016599	0.058177	-0.049906	0.129788	-0.109377	-0.114867
	(0.01528)	(0.00940)	(0.01141)	(0.01554)	(0.01944)	(0.03051)	(0.02805)
	[4.10371]	[1.76505]	[5.10077]	[-3.21185]	[6.67695]	[-3.58519]	[-4.09555]
Silver G. R. (-1)	0.023371	0.001179	0.028556	0.091342	-0.103903	-0.006143	-0.000438
	(0.01298)	(0.00799)	(0.00969)	(0.01320)	(0.01652)	(0.02592)	(0.02383)
	[1.80029]	[0.14757]	[2.94660]	[6.91852]	[-6.29090]	[-0.23699]	[-0.01836]
WTI G. R. (-1)	0.090126	0.007082	-0.023384	0.060967	0.006428	-0.062076	-0.006389
	(0.01624)	(0.01000)	(0.01212)	(0.01652)	(0.02066)	(0.03243)	(0.02982)
	[5.54895]	[0.70841]	[-1.92861]	[3.69088]	[0.31109]	[-1.91402]	[-0.21428]
Brent G. R. (-1)	-0.076179	0.000374	0.037715	-0.024965	0.025714	0.006755	-0.036970
	(0.01786)	(0.01099)	(0.01333)	(0.01817)	(0.02273)	(0.03567)	(0.03279)
	[-4.26474]	[0.03399]	[2.82838]	[-1.37425]	[1.13150]	[0.18937]	[-1.12746]
Constant	0.000146	7.61E-05	0.000188	-0.000188	0.000707	0.000136	0.000302
	(0.00038)	(0.00024)	(0.00029)	(0.00039)	(0.00049)	(0.00076)	(0.00070)
	[0.38268]	[0.32333]	[0.65774]	[-0.48334]	[1.45150]	[0.17839]	[0.42931]
Contamination Growth	-0.023273	0.000844	-0.000837	-0.011122	-0.016373	-0.032591	-0.040791
	(0.00242)	(0.00149)	(0.00180)	(0.00246)	(0.00308)	(0.00483)	(0.00444)
	[-9.62805]	[0.56736]	[-0.46386]	[-4.52436]	[-5.32400]	[-6.75226]	[-9.19287]
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.094149	0.078562	0.161285	0.186314	0.173773	0.148889	0.132859
Adj. R-squared	0.077912	0.062045	0.146251	0.171729	0.158963	0.133633	0.117315
S.E. equation	0.012633	0.007776	0.009431	0.012848	0.016073	0.025226	0.023191
F-statistic	5.798300	4.756489	10.72803	12.77412	11.73346	9.759309	8.547567

Note: The number of lags used in the estimation was 16 for each variable. Due to the matter of size, only the first lag coefficient was reported in the VAR output. Standard errors in ( ) & t-statistics in [ ]. . The (-1) indicates the lag associated to the variable. Country Fixed Effects were calculated with dummy variables for the countries of Japan, United

States, China, Italy & Spain, the reference country is South Korea, although the dummy variables for the fixed effects of the countries were not statistically significant in the regression. Source: Own Elaboration.

Figure 1 Stability test of the VAR Model



Note: All the inverse roots presented in the graph correspond to the panel VAR model with least squares, the model is stable with 16 lags. Source: Own Elaboration.

Table 8 VAR Residual Serial Correlation LM Tests

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	317.1990	49	0.0000	6.499722	(49, 33359.2)	0.0000
2	239.4148	49	0.0000	4.900126	(49, 33359.2)	0.0000
3	331.5232	49	0.0000	6.794700	(49, 33359.2)	0.0000
4	309.2042	49	0.0000	6.335141	(49, 33359.2)	0.0000
5	249.4553	49	0.0000	5.106395	(49, 33359.2)	0.0000
6	188.5041	49	0.0000	3.855189	(49, 33359.2)	0.0000
7	267.5700	49	0.0000	5.478695	(49, 33359.2)	0.0000
8	295.6340	49	0.0000	6.055875	(49, 33359.2)	0.0000
9	345.0118	49	0.0000	7.072586	(49, 33359.2)	0.0000
10	361.7603	49	0.0000	7.417786	(49, 33359.2)	0.0000
11	237.6562	49	0.0000	4.864006	(49, 33359.2)	0.0000
12	258.2338	49	0.0000	5.286789	(49, 33359.2)	0.0000
13	410.9803	49	0.0000	8.433254	(49, 33359.2)	0.0000
14	238.3621	49	0.0000	4.878504	(49, 33359.2)	0.0000
15	244.0089	49	0.0000	4.994500	(49, 33359.2)	0.0000
16	169.7301	49	0.0000	3.470255	(49, 33359.2)	0.0000

Note: Null hypothesis: No serial correlation at lag h. Sample: 1/05/2015 4/01/2020. Included observations: 6702. Source: Own Elaboration.

Table 9 Panel Regression with White-Arellano Period Estimator using Cross Section Weights

	Stock market performance	Exchange rate G.R	Gold G. R.	Platinum G. R.	Silver G. R.	WTI G. R.	BRENT G. R.
Stock Market Performance (-1)	-0.086094	-0.002285	-0.02217	0.009351	0.050746	-0.0245	0.024586
	(0.040855)	(0.003473)	(0.004729)	(0.01326)	(0.005208)	(0.019968)	(0.022109)
	[-2.107312]	[-0.658031]	[-4.687863]	[0.705256]	[9.744536]	[-1.226992]	[1.11203]
Exchange Rate G.R (-1)	-0.00242	-0.070823	0.016646	-0.003583	0.006218	0.017088	0.008656
	(0.057852)	(0.036129)	(0.023063)	(0.01008)	(0.009465)	(0.027836)	(0.019681)
	[-0.041837]	[-1.960297]	[0.721738]	[-0.355462]	[0.656965]	[0.613881]	[0.439829]
Gold G. R.(-1)	-0.050012	-0.008344	-0.213726	-0.060047	0.030593	-0.050836	-0.041396
	(0.030091)	(0.006924)	(0.003373)	(0.003522)	(0.00595)	(0.007392)	(0.007508)
	[-1.662045]	[-1.20517]	[-63.36627]	[-17.05055]	[5.142054]	[-6.877304]	[-5.513285]
Platinum G. R.(-1)	0.066809	0.00613	0.058167	-0.049964	0.129663	-0.109381	-0.11494
	(0.021934)	(0.002348)	(0.002558)	(0.003163)	(0.005046)	(0.004776)	(0.004885)
	[3.045838]	[2.611309]	[22.73915]	[-15.79721]	[25.69414]	[-22.90227]	[-23.53079]
Silver G. R.(-1)	0.026228	0.00638	0.028515	0.091256	-0.103978	-0.006238	-0.000435
	(0.011598)	(0.003305)	(0.001815)	(0.002725)	(0.003861)	(0.004464)	(0.003347)
	[2.261502]	[1.930138]	[15.70984]	[33.48252]	[-26.92686]	[-1.397275]	[-0.129917]
Wti G. R.(-1)	0.091272	0.003983	-0.023407	0.060958	0.00643	-0.061904	-0.006324
	(0.012644)	(0.006781)	(0.001255)	(0.001731)	(0.00225)	(0.009037)	(0.008152)
	[7.21853]	[0.587473]	[-18.65101]	[35.20777]	[2.858301]	[-6.850338]	[-0.775746]
Brent G. R.(-1)	-0.076171	0.002585	0.037766	-0.024975	0.025678	0.006613	-0.037039
	(0.013656)	(0.010189)	(0.002018)	(0.002262)	(0.003862)	(0.008508)	(0.008383)
	[-5.577658]	[0.253714]	[18.71311]	[-11.03856]	[6.649098]	[0.777319]	[-4.418422]
C	0.000118	0.000105	0.000188	-0.000187	0.000707	0.000138	0.000303
	(0.0000468)	(0.0000279)	(0.0000188)	(0.0000437)	(0.0000419)	(0.000077)	(0.0000828)
	[2.533453]	[3.76805]	[10.00332]	[-4.273075]	[16.88971]	[1.792407]	[3.657534]
Contamination Growth	-0.021271	-0.001656	-0.00085	-0.011251	-0.016458	-0.032763	-0.040896
	(0.003872)	(0.001741)	(0.001889)	(0.004233)	(0.004318)	(0.007899)	(0.007929)
	[-5.493094]	[-0.951025]	[-0.45024]	[-2.658056]	[-3.811739]	[-4.147823]	[-5.157791]
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.100755	0.036377	0.161446	0.186464	0.173877	0.14905	0.132937
Adjusted R-squared	0.084636	0.019104	0.146415	0.171881	0.159069	0.133797	0.117395
S.E. of regression	0.012615	0.007594	0.009431	0.012848	0.016073	0.025226	0.023191
F-statistic	6.25072	2.105986	10.74082	12.78671	11.74192	9.7717	8.553398
Prob(F-statistic)	0	0	0	0	0	0	0

Note: The number of lags used in the estimation was 16 for each variable. Due to the matter of size, only the first lag coefficient was reported. Standard errors in ( ) & t-statistics in [ ]. Country Fixed Effects were calculated with dummy variables for the countries of Japan, United States, China, Italy and South Korea, the reference country is South Korea.
Source: Own Elaboration.

Table 10 Regression with Driscoll-Kraay robust standard errors to autocorrelation, HT and cross-sectional dependence.

VARIABLES	Stock Market Performance	Exchange Rate G. R	Gold G. R.	Platinum G. R.	Silver G. R.	WTI G. R.	BRENT G. R.
Stock Market Performance (-1)	-0.0875**	-0.000719	-0.0221	0.00944	0.0507	-0.0240	0.0248
	(0.0374)	(0.00729)	(0.0198)	(0.0205)	(0.0295)	(0.0516)	(0.0434)
Exchange Rate G.R (-1)	-0.0288	-0.171**	0.0163	-0.00386	0.00610	0.0173	0.00877
	(0.0177)	(0.0746)	(0.0153)	(0.0193)	(0.0220)	(0.0311)	(0.0290)
GOLD G. R. (-1)	-0.0477	-0.00108	-0.214***	-0.0600	0.0305	-0.0506	-0.0413
	(0.0389)	(0.0118)	(0.0660)	(0.0596)	(0.0677)	(0.130)	(0.103)
PLATINUM G. R. (-1)	0.0627**	0.0166**	0.0582*	-0.0499	0.130***	-0.109	-0.115
	(0.0319)	(0.00795)	(0.0310)	(0.0489)	(0.0445)	(0.0906)	(0.0888)
SILVER G. R. (-1)	0.0234	0.00118	0.0286	0.0913**	-0.104**	-0.00614	-0.000438
	(0.0201)	(0.00774)	(0.0254)	(0.0368)	(0.0472)	(0.0742)	(0.0626)
WTI G. R. (-1)	0.0901**	0.00708	-0.0234	0.0610	0.00643	-0.0621	-0.00639
	(0.0361)	(0.00997)	(0.0392)	(0.0669)	(0.0571)	(0.104)	(0.0890)
BRENT G. R. (-1)	-0.0762*	0.000374	0.0377	-0.0250	0.0257	0.00675	-0.0370
	(0.0389)	(0.00954)	(0.0375)	(0.0623)	(0.0560)	(0.111)	(0.0980)
Country 1 (China)	0.000450	-0.000226	1.14e-05	-9.07e-05	-8.74e-05	-0.000301	-0.000287
	(0.000473)	(0.000191)	(6.17e-05)	(0.000143)	(0.000205)	(0.000319)	(0.000345)
country_2 (Italy)	0.000217	-1.65e-05	3.44e-06	-3.69e-05	-3.44e-05	-0.000133	-0.000127
	(0.000219)	(1.34e-05)	(2.63e-05)	(4.83e-05)	(7.55e-05)	(0.000116)	(0.000124)
country_3 (Japan)	0.000245	0.000154	-1.80e-05	-8.81e-05	-0.000114	-0.000253	-0.000264
	(0.000299)	(0.000215)	(4.18e-05)	(8.78e-05)	(0.000126)	(0.000219)	(0.000232)
country_4 (South Korea)	0.000132	4.78e-06	-8.72e-06	-7.73e-05	-0.000100	-0.000226	-0.000231
	(0.000355)	(0.000420)	(4.22e-05)	(8.82e-05)	(0.000134)	(0.000222)	(0.000240)
country_6 (USA)	0.000587*	-8.10e-05	5.50e-07	-5.53e-05	-4.38e-05	-0.000167	-0.000126
	(0.000314)	(0.000374)	(4.99e-05)	(8.67e-05)	(0.000127)	(0.000165)	(0.000169)
Contamination Growth	-0.0233***	0.000844	-0.000837	-0.0111*	-0.0164***	-0.0326*	-0.0408**
	(0.00679)	(0.00240)	(0.00268)	(0.00608)	(0.00629)	(0.0179)	(0.0170)
Constant	0.000146	7.61e-05	0.000188	-0.000188	0.000707	0.000136	0.000302
	(0.000359)	(0.000186)	(0.000282)	(0.000384)	(0.000470)	(0.000766)	(0.000699)
Prob > F	0	0	0	0	0	0	0
Observations	6,702	6,702	6,702	6,702	6,702	6,702	6,702
R-squared	0.094	0.079	0.161	0.186	0.174	0.149	0.133
Number of groups	6	6	6	6	6	6	6

Note: Standard errors in parentheses. Statistically significant coefficient different from 0 at p-values *** p<0.01, ** p<0.05, * p<0.1 significance levels. Due to the matter of size, only the first lag coefficient was reported. The (-1) indicates the lag associated to the variable. The assumed serial correlation of the errors was defined as $m(T) = floor\left[4(T/_{100})^{2/9}\right]$ in the estimators, with T=1133 time points. Source: Own Elaboration.

Table 11 SUR (FGLS) Regression

VARIABLES	Stock Market Performance	Exchange Rate G.R	Gold G. R.	Platinum G. R.	Silver G. R.	WTI G. R.	BRENT G. R.
Stock Market Performance (-1)	-0.0875***	-0.000719	-0.0221**	0.00944	0.0507***	-0.0240	0.0248
	(0.0129)	(0.00793)	(0.00962)	(0.0131)	(0.0164)	(0.0257)	(0.0236)
Exchange Rate G.R (-1)	-0.0288	-0.171***	0.0163	-0.00386	0.00610	0.0173	0.00877
	(0.0200)	(0.0123)	(0.0150)	(0.0204)	(0.0255)	(0.0400)	(0.0368)
GOLD G. R. (-1)	-0.0477**	-0.00108	-0.214***	-0.0600***	0.0305	-0.0506	-0.0413
	(0.0214)	(0.0132)	(0.0160)	(0.0218)	(0.0272)	(0.0427)	(0.0393)
PLATINUM G. R. (-1)	0.0627***	0.0166*	0.0582***	-0.0499***	0.130***	-0.109***	-0.115***
	(0.0151)	(0.00932)	(0.0113)	(0.0154)	(0.0193)	(0.0302)	(0.0278)
SILVER G. R. (-1)	0.0234*	0.00118	0.0286***	0.0913***	-0.104***	-0.00614	-0.000438
	(0.0129)	(0.00792)	(0.00960)	(0.0131)	(0.0164)	(0.0257)	(0.0236)
WTI G. R. (-1)	0.0901***	0.00708	-0.0234*	0.0610***	0.00643	-0.0621*	-0.00639
	(0.0161)	(0.00991)	(0.0120)	(0.0164)	(0.0205)	(0.0321)	(0.0295)
BRENT G. R. (-1)	-0.0762***	0.000374	0.0377***	-0.0250	0.0257	0.00675	-0.0370
	(0.0177)	(0.0109)	(0.0132)	(0.0180)	(0.0225)	(0.0353)	(0.0325)
country_1	0.000450	-0.000226	1.14e-05	-9.07e-05	-8.74e-05	-0.000301	-0.000287
	(0.000531)	(0.000327)	(0.000396)	(0.000540)	(0.000675)	(0.00106)	(0.000975)
country_2	0.000217	-1.65e-05	3.44e-06	-3.69e-05	-3.44e-05	-0.000133	-0.000127
	(0.000530)	(0.000326)	(0.000396)	(0.000539)	(0.000674)	(0.00106)	(0.000973)
country_3	0.000245	0.000154	-1.80e-05	-8.81e-05	-0.000114	-0.000253	-0.000264
	(0.000531)	(0.000327)	(0.000396)	(0.000540)	(0.000675)	(0.00106)	(0.000974)
country_4	0.000132	4.78e-06	-8.72e-06	-7.73e-05	-0.000100	-0.000226	-0.000231
	(0.000530)	(0.000326)	(0.000396)	(0.000539)	(0.000674)	(0.00106)	(0.000973)
country_6	0.000587	-8.10e-05	5.50e-07	-5.53e-05	-4.38e-05	-0.000167	-0.000126
	(0.000531)	(0.000327)	(0.000396)	(0.000540)	(0.000675)	(0.00106)	(0.000974)
Contamination Growth	-0.0233***	0.000844	-0.000837	-0.0111***	-0.0164***	-0.0326***	-0.0408***
	(0.00240)	(0.00147)	(0.00179)	(0.00244)	(0.00305)	(0.00478)	(0.00440)
Constant	0.000146	7.61e-05	0.000188	-0.000188	0.000707	0.000136	0.000302
	(0.000379)	(0.000233)	(0.000283)	(0.000386)	(0.000482)	(0.000757)	(0.000696)
Observations	6,702	6,702	6,702	6,702	6,702	6,702	6,702
R-squared	0.094	0.079	0.161	0.186	0.174	0.149	0.133

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Source: Own Elaboration

Table 12 Breusch-Pagan test of independence:

chi2 (21) =	14037.690
Prob>chi2	0.0000

Note: Null hypothesis is independence between the error terms for each of the equations. Source: Own Elaboration

Appendix C.

Table 13 Granger Causality test related to the Stock Market Performance (Results from the Regression with Driscoll-Kraay Approach).

Excluded Variable (X)	Hypothesis.	F- Statistic	Prob > F
Exchange Rate G. R	Does not Granger Cause the Stock Market Performance	1.58	0.0664
BRENT_Change	Does not Granger Cause the Stock Market Performance	1.16	0.2906
WTI_Change	Does not Granger Cause the Stock Market Performance	0.77	0.7195
PLATINUM_Change	Does not Granger Cause the Stock Market Performance	1.86	0.0202
GOLD_Change	Does not Granger Cause the Stock Market Performance	1.50	0.0916
SILVER_Change	Does not Granger Cause the Stock Market Performance	1.35	0.1571

Note: H0: X variable does not Granger-Cause the Stock Market Performance.

Table 14 Granger Causality test related to the Exchange Rate G. R (Regression with Driscoll-Kraay Approach).

Excluded Variable (X)	Hypothesis.	F- Statistic	Prob > F
Stock Market Performance	Does not Granger Cause the Exchange Rate G. R	1.82	0.0248
BRENT_Change	Does not Granger Cause the Exchange Rate G. R	1.16	0.2906
WTI_Change	Does not Granger Cause the Exchange Rate G. R	0.77	0.7195
PLATINUM_Change	Does not Granger Cause the Exchange Rate G. R	1.86	0.0202
GOLD_Change	Does not Granger Cause the Exchange Rate G. R	1.50	0.0916
SILVER_Change	Does not Granger Cause the Exchange Rate G. R	1.35	0.1571

Note: H0: X variable does not Granger-Cause the Stock Market Performance.

Table 15 Granger Causality test related to the Gold Price G. R (Regression with Driscoll-Kraay Approach).

Excluded Variable (X)	Hypothesis.	F- Statistic	Prob > F
Stock Market Performance	Does not Granger Cause the Gold Price G. R	1.34	0.1637
Exchange Rate G. R	Does not Granger Cause the Gold Price G. R	1.62	0.0573
BRENT_Change	Does not Granger Cause the Gold Price G. R	1.49	0.0942
WTI_Change	Does not Granger Cause the Gold Price G. R	1.79	0.0275
PLATINUM_Change	Does not Granger Cause the Gold Price G. R	1.15	0.2996
	Does not Granger Cause the		

	Gold Price G. R		
SILVER_Change	Does not Granger Cause the Gold Price G. R	1.71	0.0393

Note: H0: X variable does not Granger-Cause the Stock Market Performance.

Table 16 Granger Causality test related to the Platinum Price G. R (Regression with Driscoll-Kraay Approach).

Excluded Variable (X)	Hypothesis.	F- Statistic	Prob > F
Stock Market Performance	Does not Granger Cause the Platinum Price G. R	1.05	0.4008
Exchange Rate G. R	Does not Granger Cause the Platinum Price G. R	1.39	0.1389
BRENT_Change	Does not Granger Cause the Platinum Price G. R	2.38	0.0017
WTI_Change	Does not Granger Cause the Platinum Price G. R	1.80	0.0266
GOLD_Change	Does not Granger Cause the Platinum Price G. R	3.46	0.0000
SILVER_Change	Does not Granger Cause the Platinum Price G. R	1.55	0.0760

Note: H0: X variable does not Granger-Cause the Stock Market Performance.

Table 17 Granger Causality test related to the Silver Price G. R (Regression with Driscoll-Kraay Approach).

Excluded Variable (X)	Hypothesis.	F- Statistic	Prob > F
Stock Market Performance	Does not Granger Cause the Silver Price G. R	2.29	0.0026
Exchange Rate G. R	Does not Granger Cause the Silver Price G. R	2.25	0.0033
BRENT_Change	Does not Granger Cause the Silver Price G. R	2.36	0.0019
WTI_Change	Does not Granger Cause the Silver Price G. R	2.07	0.0078
GOLD_Change	Does not Granger Cause the Silver Price G. R	4.01	0.0000
PLATINUM_Change	Does not Granger Cause the Silver Price G. R	2.36	0.0019

Note: H0: X variable does not Granger-Cause the Stock Market Performance.

Table 18 Granger Causality test related to the WTI Price G. R (Regression with Driscoll-Kraay Approach).

Excluded Variable (X)	Hypothesis.	F- Statistic	Prob > F
Stock Market Performance	Does not Granger Cause the WTI Price G. R	1.00	0.4585
Exchange Rate G. R	Does not Granger Cause the WTI Price G. R	1.07	0.3835
BRENT_Change	Does not Granger Cause the WTI Price G. R	0.91	0.5585
SILVER_Change	Does not Granger Cause the WTI Price G. R	1.75	0.0326
GOLD_Change	Does not Granger Cause the WTI Price G. R	1.01	0.4480
PLATINUM_Change	Does not Granger Cause the WTI Price G. R	1.00	0.4579

Note: H0: X variable does not Granger-Cause the Stock Market Performance.

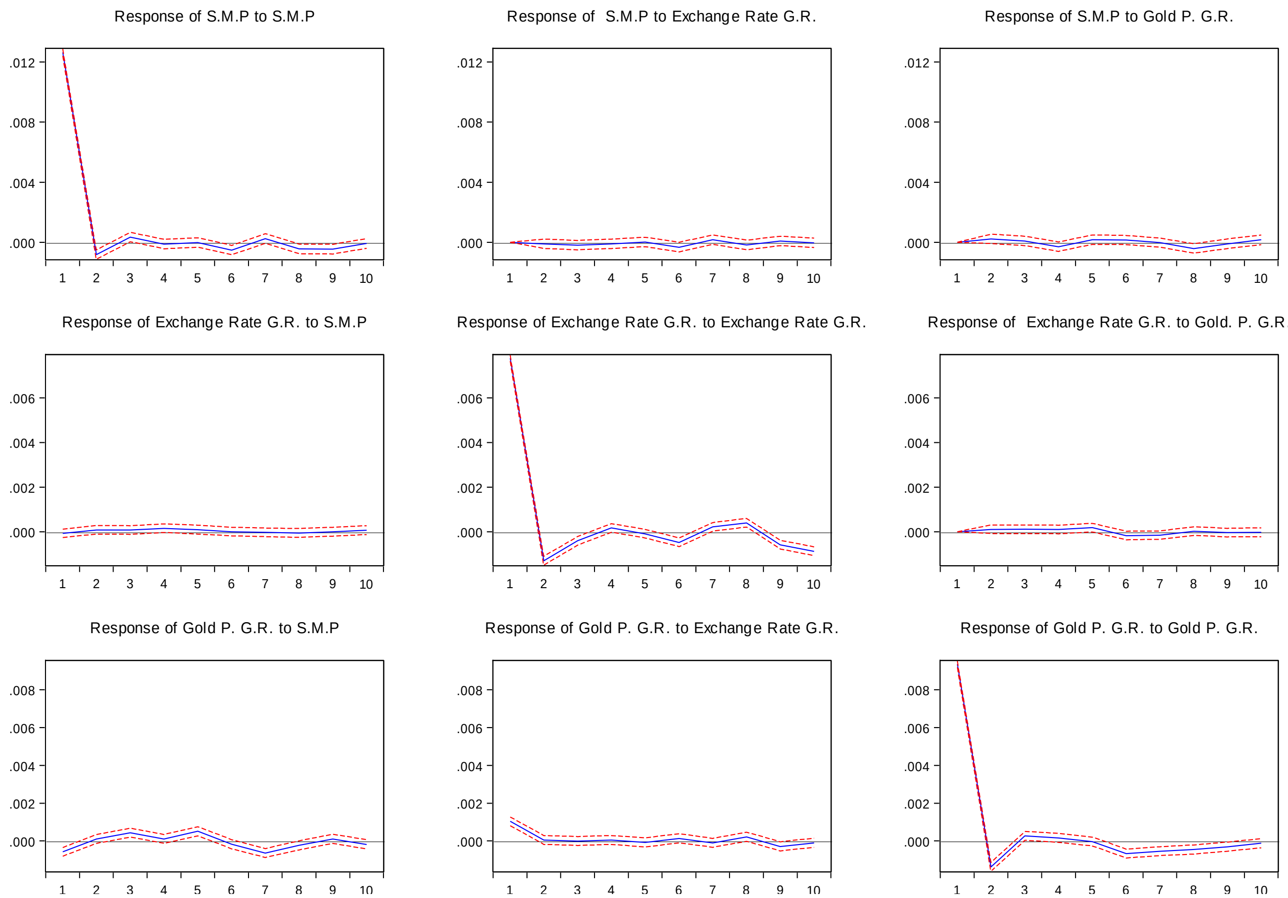
Table 19 Granger Causality test related to the BRENT Price G. R (Regression with Driscoll-Kraay Approach).

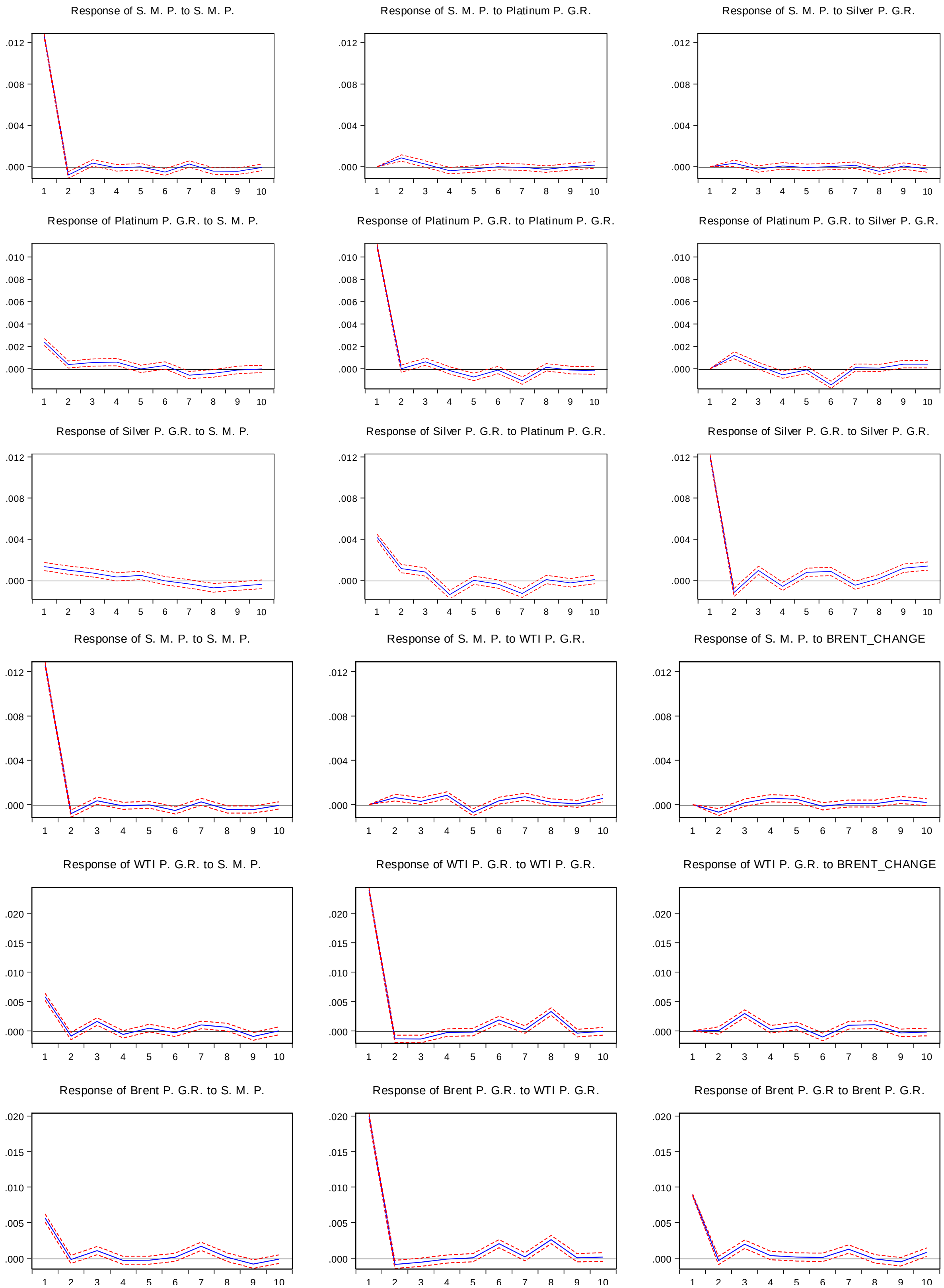
Excluded Variable (X)	Hypothesis.	F- Statistic	Prob > F
Stock Market Performance	Does not Granger Cause the BRENT Price G. R	1.28	0.2017
Exchange Rate G. R	Does not Granger Cause the BRENT Price G. R	1.84	0.0224
WTI_Change	Does not Granger Cause the BRENT Price G. R	1.42	0.1246
SILVER_Change	Does not Granger Cause the BRENT Price G. R	1.48	0.1000
GOLD_Change	Does not Granger Cause the BRENT Price G. R	1.08	0.3652
PLATINUM_Change	Does not Granger Cause the BRENT Price G. R	1.06	0.3869

Note: H0: X variable does not Granger-Cause the Stock Market Performance.

Appendix D.

Graph 4 Estimated Impulse-Response Function





Note: Response to Cholesky One S.D. (d.f. adjusted) innovations +- 2 S. E. Source: Own Elaboration.