Global Market's Diagnosis on Coronavirus : A Tug of War between Hope and Fear

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Abstract : The increasing propagation of the coronavirus pushes to urgently rethink the possible consequences for the global markets. The coronavirus combines demand, supply and uncertainty shocks, that would be harmful to the real economy mainly owing to the shutdown of factories and offices and travel restrictions. This would generate international spillover effects. In this article, we provide a first analysis of the stock price responses to the outbreak of COVID-19. To this end, we use an improved event study methodology to test how G7 (Canada, France, Germany, Italy, Japan, the United Kingdom and the United States) stock markets react to the rapid emergence of the novel epidemic.Then, we employ the volatility spillover procedure of Diebold and Yilmaz's (2012) to discern to what extent can China be a risk exporter to the G7 countries. Our results reveal that all the G7 stock markets are suffering from uncertainty caused by the COVID-19, but the responses to this shock differ from country to country. Difficulties in trade and travel interrupted the flow of goods and services, with cascading impacts on industries where supply chains depend hugely on supplies from China. In the current uncertain times, China is likely to be the major volatility transmitter (followed by the United States), whereas Japan, Germany, France and Italy are likely to be volatility receivers. The global spread of coronavirus may be an occasion for global value chains to rethink their global strategies.

Keywords : Coronavirus ; G7 stock markets ; abnormal returns ; systematic risks ; risk spillovers.

***JEL codes* :** F65 ; G14 ; G15.

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1. Introduction

As of March 3, 2020, the coronavirus outbreak has killed more than 3,100 people and infected over 90,000 (see Figure A1, Appendix). Even though the coronavirus outbreak may be stabilizing in China, it is spreading promptly in other countries. As of the end of February, 2020, more than thirty-three countries have reported confirmed cases. The major issue is not just the number of infected persons, but also the huge level of disruption to economies from the conducted containment measures. The COVID-19 outbreak has yielded major international institutions and banks to cut their growth forecasts (see Figure A2). The manufacturing sector in major economies has been harmed by the coronavirus (see Figure A3) due to supply chain distruption, the shutdown of factories and offices and travel restrictions. The new deadly virus has also exerted an adverse impact on services industry (see Figure A4) as a decline in consumer spending would have negative impact on retail stores, restaurants and air transport, among others. With the wide-scale transmission of the coronavirus, all economic players (consumers, suppliers, financial intermediaries ect) are facing an unprecedented crisis, which requires coordinated responses from all countries. And especially in the case of the European Union which became biggest cluster of coronavirus cases.[2] There are uncoordinated responses from different countries. This lack of coordination and solidarity rises the anxiety of citizens who lose confidence in the authorities' ability to appropriately deal with the crisis. The financial

2 One can cite the case of Italy, which was abandoned by the European Union (EU) in this time of need . It was left alone in the face of this deadly virus. Countries in the EU have failed to give medical assistance and supplies to Italy during an outbreak.No aid was given to this country from the EU members who are themselves engulfed in their own problems.

markets, known for their exuberance and excessive reactions (see Figure A5), will exacerbate the general panic.

The detrimental economic effects of these developments for other countries are significant, due to the disruption to global supply chains, a decline in demand for imported goods and services as well as the marked decrease in international tourism and business travel. Relative to the SARS outbreak in 2003, the global economy has become much more integrated, and China (the origin of this outbeark) plays now a much more pronounced role in global GDP, industry, trade, tourism and FDI (see Figure A6). China is a trading giant and a manufacturing superpower. China is regarded as the factory of the world. This would undoubtedly intensify the economic spillovers to other countries from a negative shock in China.

The recent history suggests that when a disease emerges, it will generally promptly be contained. The economic effects will be modest and the stock markets will be moderately impacted. For instance, the SARS virus occuring in China in 2003 was rapidly contained and the stock market rose by about 20 percent that year. Nonetheless, things seem so different with the coronavirus. The global economy seems very fragile and an extended disease outbreak might tip the contemporanuous aging business cycle into a global recession. The coronavirus intensifies the anxiety over the global economic outlook. The coronavirus is still spreading rapidly and has attained 76 countries and territories as of March 03, 2020. It must be pointed out at this stage that Coronavirus cases in China overtake SARS and the effects could be much more harmful for the global economy and for investors alike (see Bouoiyour and Selmi 2020). We can have information regarding the economic exposure of different stock markets to China's economy, based on sources of firms' revenues. Using the

MSCI Economic Exposure database, Figure A7 describes the effect of coronavirus on some developed stock markets. The impact of the virus on markets, and in turn on global growth depends on the duration and spread of the outbreak and policy responses by governments and major central banks. There is a beginning of anxiety on the financial markets because of the development of virus. If a remedy is not found promptly, the panic would have a substantial impact on the global market. Since the beginning of March 2020, we note a marked decline in stock markets. This sharp collapse starts following news on the international propagation and other news against a background of hopeful developments in China with respect a drop in new cases and the gradual resumption of production. This can explain the improved performances of Chinese shares in March compared to the equities Europe and the United States. With the propagation of the virus, there is a sharp decrease of risk appetite. The dollar is losing its appeal as a safe haven, whereas investors are responding to the spread of the coronavirus by betting on several rate cuts from the Fed.[3]

The objectives of this paper are two-fold : (i) To address How does coronavirus affect the performances of G7 stock markets ? To this end, we use an improved event study methodology to assess the abnormal returns behaviors for distinct industries of the G7 stock markets around the day of the announcement of the emergence of new deadly virus, namely coronavirus. An event study methodology looks at the sharp changes in the stock prices following an unforseen event. According to the modern financial theory, the stock price accounts for all available information and expectations

[3] It should be remembered that the European Central Bank's interest rates have been blocked at 0% since 2016, and are even negative in certain countries, such as Japan, Switzerland or Denmark. A fall in the interest rate aims to revive economic activity but also to make the concerned currency less remunerative, and therefore less attractive to Forex traders.

about the future. The present research differentiates between abnormal retrurns (ARs) and cumulative abnormal returns (CARs) following the occurence of coronavirus outbreak. And (ii) to employ the volatility spillover procedure of Diebold and Yilmaz's (2012) to discern especially if China can be considered a risk exporter to the rest of the G7 countries. During times of heightened uncertainty surrounding an unforessen event a prominent topic discussed by academics, regulators and market participants in general is that of volatility transmission. To offer reliable information regarding stock market risk spillovers, there is a need for effective measures. This study conducts a generalized VAR in variance decomposition developed by Diebold and Yilamz (2012) to measure the total volatility spillover effects, and to shed some light on the net directional spillovers across China and G7 markets. Understanding the transmission process between markets is critical for risk management and economic policy. Such information can help policy makers in undertaking decoupling policies to insulate the economy from risk spillovers effects, to lighten the spread of the damage done by coronavirus, and to preserve the stability of financial system.

Our findings indicate that all G7 stock markets face increasing uncertainty, though with varying sensitivities. Specifically, the stock market responses of U.S., Japan and Germany were even more severe than the reactions of Italy, France, United Kingdom, and Canada. Not surprisingly, the major trading partners witness a sharp decline in exports to the virus-hit country and supply chain disruption would accordingly lead to a drop in production. Besides, we show that the uncertainty over the coronavirus spread resulted in significant volatility spillover effects across China and G7 stock markets. China and the United States are the stress volatility exporters, while Japan, Germany, France and Italy are the net receivers of volatility spillovers..

The rest of the paper is organized as follows. Section 2 presents some basic insights into the event study methodology procedure. Section 3 reports the main findings. Section 4 discusses the results and concludes.

2. Methodology and data

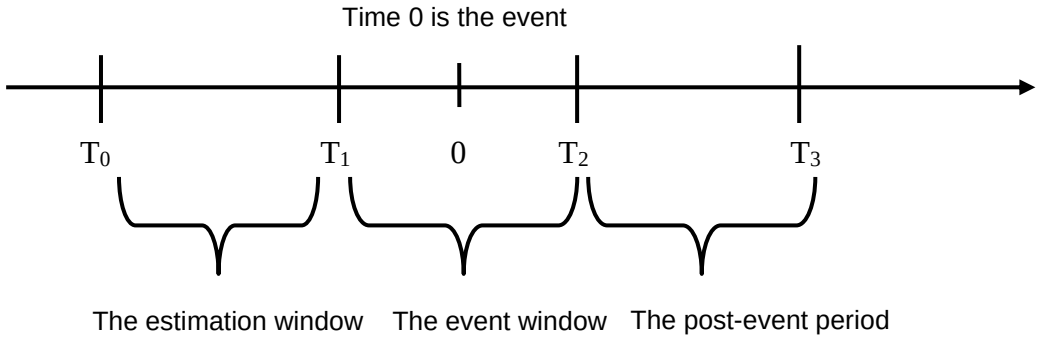
Amid worries over a global economic slowdown from the deepening coronavirus outbreak, many analysts have warned that uncertainty about the coronavirus is the widest immediate risk facing global financial markets. Accordingly, throughout this study, we examine the responses of G7 stock markets to coronavirus (i.e., whether there are abnormal returns due to this event). This study is the first, to our best knowledge, to assess some of the financial consequences of coronavirus. More interestingly, we investigate volatility linkages between China and G7 stock markets, which remain up to now not researched in current times of growing anxiety over coronavirus oubreak. To determine the abnormal returns and to analyze the risk spillovers across the stock markets, we need information about G7 stock prices. We collected daily time series data for stock prices of France (CAC40) , Germany (DAX30), Japan (Nikkei 225), the United Kingdom (FTSE 100), the United States (S&P500), Italy (MIB 30) and Canada (SP-TSX) from DataStream covering the period from January 01, 2018 to March 03, 2019.

2.1. Detecting abnormal returns and systematic analysis of risks

To analyze the reactions of G7 stock markets to the uncertainty surrounding the spread of coronavirus, we apply a market model event study methodology as outlined by Dodd and Warner (1983) and Brown and Warner (1985). This methodology has been successfully carried out to several events (Benninga, 2008). We define day “0” as the announcement day of the emergence of the new deadly virus. Thereafter, the

estimation and event windows can be determined (see Figure 1). The interval T0-T1 is the estimation window which provides the information needed to specify the normal return (i.e., prior to the occurrence of the event). The interval T2-T1+1is the event window, and the interval T3-T2 is the post event window which is used to appropriately evaluate the behavior of the G7 stock markets following the occurrence of coronavirus. We considered a window of 260 days, consisting of 239 days before the event day and 20 days after the event as well as the event day.[4]Throughout the rest of our analysis, we allow for the possible overreaction or under-reaction to the first announcement of the emergence of coronavirus whereby markets have a tendency to correct their mistakes in subsequent periods.

Figure 1. Data structure of an event study



Based on the selected return model, event studies consist of applying an event window only (e.g., the market-adjusted model) or an event and an estimation window (e.g., the market model) to the sample data. The market model is the most commonly used model in the literature. It predicts normal returns by adjusting daily returns to

[4] Note that there is no consensus among academics on the most appropriate length of the estimation period, but MacKinlay (1997) recommended to utilize an estimation period of 260 trading days.

obtain the ex-post-abnormal returns[5] where adjustment is approximated by the Capital Asset Pricing Model. The abnormal returns are grouped across different countries in order to determine the country-specific average (*C*) at time *t*, (ARC_t) expressed as follows:

$$ARC_{it} = {}^{1}\!/_{n} \sum_{i=1}^{n} \ln\left({}^{P_{it}}\!/_{P_{it-1}} \right) - E(R_{it}) \quad (1)$$

Where $E(R_{it})$ is determined via this equation :

$$E(R_{it}) = \beta_{0_{it}} + \beta_{1_{it}} (\tilde{r}_{m,it} - \tilde{r}_{f_{t_{US}}}) \qquad (2)$$

With P_{it} is the adjusted stock price of each country*j* at time *t,* $E(R_{it})$ is the expected returnat time *t*, $\tilde{r}_{m,it}$ is the return of stock markets understudy, and $\tilde{r}_{f,it}$ corresponds to the three-month Treasury Bill of each country employed as the risk-free rate for investors.

We estimate the cumulative abnormal returns (CARs) for each country i during the event window [$\tau_1; \tau_2$] surrounding the event day t = 0, where [$\tau_1; \tau_2$] = ∈ [−2;+2], [−5;+5],[−10;+10], [−15;+15], and [-20; +20].

We thereafter investigate the immediate change in systematic risk. To do so, we adjust the CAPM by incorporating an interaction variable. The immediate risk is determined by the average change in risk resulting from the event. A dummy variable (*DV*) -which takes the value of one on the first day of trading after Wuhan was placed under quarantine on January 23, 2020, and zero otherwise- is created in an attempt to

[5] For detailed information regarding the event study methodology procedure, readers can refer to Dodd and Warner (1983) Brown and Warner (1985).

properly depict the instantaneous changes in systematic risk. According to Ramiah et al. (2016) and Selmi and Bouoiyour (2019), the model to be estimated is denoted as

$$\tilde{r}_{it} - \tilde{r}_{ft} = \beta_i^0 + \beta_i^1\left[\tilde{r}_{mt} - \tilde{r}_{ft}\right] + \beta_i^2\left[\tilde{r}_{mt} - \tilde{r}_{ft}\right] * DV + \beta_i^3 DV + \tilde{\varepsilon}_{it} \quad (3)$$

where $\tilde{r}_{it}$ is the country-specific *i*'s return at time t, $\tilde{r}_{ft}$ is the risk free rate at time t, $\tilde{r}_{mt}$ is the returns of stocks within each country at time *t*, β_i^0 is the intercept term, β_i^1 refers to the average short-run systematic risk of each G7 country, β_i^2 corresponds to the change in the risk for each considered country, β_i^3 refers to the shift in market returns caused by the event date, $\tilde{\varepsilon}_{it}$ is the error term.

2.2. Measuring risk spillovers

After assessing the responses of G7 stock markets to the emergence of coronavirus, we now focus on the extent of volatility transmission across China and these countries in the same period. For this purpose, we incorporate the conditional volatility series[6] to a generalized VAR framework (Diebold and Yilmaz, 2012). Because we haven't enough of data to measure the volatility transmission after the emergence of coronavirus, we will compare two main periods : Period 1 (prior to the emergence of coronavirus, from January 01, 2018 till January 22, 2020) and Period 2 (extended period that accounts for post-coronavirus spread period, from January 01, 2018 to March 03, 2020).

This volatility transmission investigation covers the following aspects.

First, we calculate the total volatility spillover index which refers to the proportion of the volatility forecast error variances comes from spillovers. Let:

[6] The conditional volatility of each G7 stock market index is determined through an Exponential-GARCH model. The detailed results about the volatility of each market will be available upon request.

$$x_t = \phi x_{t-1} + \varepsilon_t \qquad (4)$$

where $x_t = (x_{1,t}, x_{2,t})$ and ϕ is a 2*2 parameter matrix; *x* will be considered as a vector of the considered stock volatilities.

By covariance stationarity, the moving average representation of the VAR is denoted:

$$x_t = \Theta(L)\varepsilon_t \qquad (5)$$

where $\Theta(L) = (I - \phi L)^{-1}$

Second, we consider 1-step-ahead forecasting. The optimal forecast is given by:

$$x_{t+1,t} = \phi x_t \qquad (6)$$

with corresponding 1-step-ahead error vector:

$$e_{t+1} = x_{t+1} - x_{t+1,t} = A_0 \mu_{t+1} = \begin{bmatrix} a_{0,11} & a_{0,12} \\ a_{0,21} & a_{0,22} \end{bmatrix} \begin{bmatrix} \mu_{1,t+1} \\ \mu_{2,t+1} \end{bmatrix} \qquad (7)$$

Specifically, the variance of the 1-step-ahead error in forecasting $x_{1,t}$ is $a_{0,11}^2 + a_{0,12}^2$, and the variance of the 1-step-ahead error in forecasting $x_{2,t}$ is $a_{0,21}^2 + a_{0,22}^2$. There exist two possible spillovers in our example: x_{1t} shocks that exert influence on the forecast error variance of x_{2t} (with contribution $a_{0,21}^2$), and x_{2t} shocks that affect the forecast error variance of x_{1t} (with contribution $a_{0,12}^2$). Hence the total spillover effect is equal to $a_{0,12}^2 + a_{0,21}^2$. Having outlined the Spillover Index in a first-order two-variable VAR, it is easier to generalize this to a dynamic framework for a p[th]-order N-variable case.

Third, we quantify the net directional volatility spillovers for stock indices in an attempt to determine which of the considered countries are net volatility importers, and which of them are the major stress volatility exporters. In this step, we disentangle the total

spillover index for stock volatilities into all of the forecast error variance components for variable *i* coming from shocks to variable *j*, for all *i* and *j*.

3. Results and discussion

3.1. Event study methodology findings

Table 1 summarizes the abnormal returns and cumulative abnormal returns prior to the emergence of coronavirus (-239 days) and those after the event day (+2, +5, +10 and +20 days). Our results reveal that all the G7 stock markets have been adversely affected by the coronavirus. Some countries responded more intensely to the coronavirus spread, especially Japan, Germany and the United States. Given the leading role of China in the world economy, the fact that China's economy shows signs of sharp slowing due to growing vulnerability to interruptions of international trade and travel since the emergence of coronavirus would hinder its imports and deteriorate the current account position of exporters.

The sharp heterogeneity in the responses of G7 stock returns can be attributed the level of dependency to China. But if we follow this assumption, one can expect that the current coronavirus spread would affect the United States most (US$479.7 billion or 19.2% of total Chinese exports in 2019) followed by Japan (US$147.2 billion or 5.9%), Germany (US$77.9 billion or 3.1%). However, our findings are not consistent with this hierarchy: Japan, Germany, United States and Italy suffered the most from worries over coronavirus. The fact Germany is the most affected in Europe is not surprising considering its position as European largest exporter. It is also the biggest importer of Chinese goods absorbing more than 20 percent of the European imports from China, and has also been one of the most active European countries in investing in China. investing in China. Italy is the Chinese fourth largest trading partner in the European Union and share a history of friendly exchanges with it. Whilst the

development of China-Italy links has been steady, Italy has lacked the capacity to exploit the opportunities provided by Chinese economy. Specifically, the Italian entrepreneurial and institutional systems appear less than dynamic regarding the agility to various opportunities. Italy's lack of distribution channels, underdeveloped market and the unsystematic operation of corporate sector over a tightly-knit institutional setup have harmed the cooperation. Also, Canada is likely to be significantly affected. The energy sector is the major game changer for the bilateral link between Canada and China (Dobson and Evans 2015). For the United Kingdom, despite the harmful consequences of the European economic crisis, it has not been receiving investments from China. This can explain the moderate response of United Kingdom to this event compared to the rest of European countries. Moreover, China is the world's largest recipient of foreign direct investment (FDI). According to the 2019 World Investment Report , China was ranked the world's second largest FDI recipient China, by attracting 139 billion U.S. dollars, after United States. If we consider for example the period 2017-2019, China's economy was ranked the second most attractive to multinational companies, only behind the United States. Without going into details, we can notice that during the same period (i.e., between 2017-2019) FDI inflows continued to rise from USD 136 billion to 139 billion (i.e., an increase by 3.7%). This growth is dominantly attributed to trade liberalization plans and the rapid development of the high-tech sector. Regardless of the trade war with the United States, more than 60,000 companies were established by foreign investors in 2018, an increase by about 70% compared to 2017. China continued absorbing FDI flows from Asian countries and developed countries (with large extent, Germany), thanks to Mergers and acquisitions (M&A) deals.

Despite the heterogeneous responses of the different markets under study, the coronavirus crisis marks a turning point. It challenges us about the ways in which globalization and the economy in general work.The globalism is likely to be the major victim of coronavirus spread. This epidemic comes to recall us that a highly connected global economy not only eases the spread of the coronavirus, but also intensifies the detrimental economic consequences. Open economies are hugely vulnerable to economic shocks linked to an epidemic. If the virus persists in affected economies and disrupts global production lines, the increased risk profile in doing business there would decrease foreign investment and exports in those countries. Accordingly, the economic losses will reinforce protectionism and isolationism. One can therefore expect that due to the shortened supply chain, production worldwide may become more localized or regionalized.

Table 1. The reactions of G7 stock markets to coronavirus spread (Daily data)

Country	AR	CAR (-239)	CAR2	CAR5	CAR10	CAR15	CAR20
Canada	-0.03* (-1.82)	0.41** (2.24)	-0.04* (-1.90)	-0.06* (-1.88)	-0.03*** (-3.38)	-0.07*** (-3.41)	-0.11** (-2.72)
France	-0.11*** (-3.32)	0.39** (2.81)	-0.05* (-1.89)	-0.09** (2.43)	-0.14* (-3.46)	-0.15*** (-3.62)	-0.17*** (-4.18)
Germany	-0.58*** (-4.91)	0.86*** (3.83)	-0.08* (-1.69)	-0.16** (-2.31)	-0.34*** (-5.11)	-0.41*** (-3.42)	-0.52** (-2.81)
Italy	-0.16** (-2.83)	0.42** (2.53)	-0.02*** (-3.89)	-0.10* (-1.82)	-0.18** (-1.91)	-0.21*** (-4.37)	-0.25*** (-3.81)
Japan	-0.76*** (-4.55)	1.11*** (3.81)	-0.04 (-1.49)	-0.19** (-2.83)	-0.24*** (-3.76)	-0.63** (-2.74)	-0.77*** (-4.69)
The United Kingdom	-0.08* (-1.96)	0.21*** (4.52)	-0.04* (-2.88)	0.03 (1.24)	-0.06** (-2.81)	-0.05*** (-3.21)	-0.07*** (-3.61)
The United States	-0.68** (-2.44)	0.43** (1.99)	-0.09*** (-4.11)	-0.11** (-2.72)	-0.19*** (-3.38)	-0.21*** (-4.09)	-0.23*** (-3.62)

Notes: AR: Abnormal returns; CAR: Cumulative abnormal returns; ∗, ∗∗, ∗∗∗ denote statistical significance at the 10%, 5% and 1% levels, respectively.

After determining the abnormal returns and cumulative abnormal returns of G7 stock markets due to the spread of coronavirus, the changes in the short-term systematic risk following the emergence of coronavirus are reported in Table 2. It is

a common practice in finance to calculate changes in systematic risk through Beta. We show that the increased uncertainty has yielded toa sharp rise in systematic risk for all the G7 countries, with large extent for Japan, the United States and Germany. These results are in line with those of Table 1.

Table 2. Changes in short-term systematic risk of the G7 stock markets following the coronavirus (Daily data)

Country	Beta prior to the emergence of coronavirus	Immediate risk	Beta post- the emergence of coronavirus
Canada	0.06** (2.71)	0.14*** (4.39)	0.21** (2.63)
France	0.10*** (3.42)	0.17** (2.67)	0.28*** (3.54)
Germany	0.12** (2.64)	0.23** (2.76)	0.51*** (4.36)
Italy	0.09*** (3.81)	0.17*** (3.92)	0.29*** (3.77)
Japan	0.18** (2.26)	0.31* (1.82)	0.61*** (3.62)
The United Kingdom	0.07* (1.92)	0.08*** (3.27)	0.10** (2.68)
The United States	0.19** (2.59)	0.22** (2.62)	0.44*** (3.52)

Notes: *, **, *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Due to the restricted period of our analysis, the robustness to data frequency was assessed by resorting to weekly data. Weekly data have been identified as being helpful in detecting the direction of temporal relationships following increased volatility and the transmission of shocks to other markets (Garderbroek et al. 2014).The abnormal returns and cumulative abnormal returns of G7 stock markets are reported in Table 3, while the changes in short-term systematic risk of the G7 stock markets are displayed in Table 4. All the G7 countries reacted negatively to this event, but some markets reacted more strongly than others. The most affected markets are, respectively, Japan, the United States, Germany and Italy (see Tables 3 and 4). For investors who choose to use the hedging characteristics of G7 stock returns to protect

against rising uncertainty surrounding coronavirus, it appears prominent to discover whether the effect of coronavirus is consistent over various window events (i.e., prior to the announcement of the emergence of the new virus, immediately and post the announcement date).

Table 3. The reactions of G7 stock markets to coronavirus spread (weekly data)

Country	AR	CAR (-239)	CAR2	CAR5	CAR10	CAR15	CAR20
Canada	-0.08*** (-3.24)	0.36*** (4.51)	-0.08** (-2.68)	-0.10** (-2.76)	-0.12** (-2.43)	-0.09* (-1.79)	-0.14*** (-3.61)
France	-0.12*** (-4.61)	0.25*** (3.64)	-0.07** (-2.41)	-0.13* (1.91)	-0.16* (-1.76)	-0.12** (-2.31)	-0.15** (-2.49)
Germany	-0.48*** (-3.61)	0.61** (2.54)	-0.06** (-2.39)	-0.14** (-2.74)	-0.26** (-2.69)	-0.38*** (-3.72)	-0.49** (-2.90)
Italy	-0.21*** (-3.62)	0.38*** (4.29)	-0.04** (-2.73)	-0.13** (-2.41)	-0.17*** (-3.82)	-0.23*** (-5.09)	-0.25*** (-4.27)
Japan	-0.69** (-2.61)	0.71*** (3.42)	-0.11** (-2.45)	-0.19** (-2.81)	-0.24*** (-3.43)	-0.43*** (-3.81)	-0.61*** (-3.81)
The United Kingdom	-0.03** (-2.63)	0.14*** (4.15)	-0.06 (-1.26)	-0.08 (-1.19)	-0.03*** (-4.10)	-0.02*** (-3.72)	-0.04** (-2.85)
The United States	-0.43*** (-3.72)	0.51*** (3.42)	-0.04* (-1.97)	-0.07** (-2.39)	-0.16*** (-3.77)	-0.23*** (-4.28)	-0.30** (-2.57)

Notes: AR: Abnormal returns; CAR: Cumulative abnormal returns; ∗, ∗∗, ∗∗∗ denote statistical significance at the 10%, 5% and 1% levels, respectively.

Table 4. Changes in short-term systematic risk of the G7 stock markets following the coronavirus (weekly data)

Country	Beta prior to the emergence of coronavirus	Immediate risk	Beta post- the emergence of coronavirus
Canada	0.07** (2.76)	0.14*** (3.81)	0.21*** (4.59)
France	0.11*** (3.85)	0.16*** (4.09)	0.18*** (3.72)
Germany	0.11*** (3.65)	0.16*** (4.17)	0.48*** (4.23)
Italy	0.08*** (3.81)	0.17*** (5.16)	0.24*** (3.81)
Japan	0.14*** (3.92)	0.23*** (3.41)	0.41*** (3.81)
The United Kingdom	0.07** (2.68)	0.10* (3.27)	0.12*** (4.28)
The United States	0.16* (1.89)	0.22** (2.72)	0.34*** (3.89)

Notes: ∗, ∗∗, ∗∗∗ denote statistical significance at the 10%, 5% and 1% levels, respectively.

3.2. Volatility spillovers across China and G7 stock markets

In the following, we examine the financial spillover effect of coronavirus spread on G7 stock markets. As mentioned above, since we haven't enough of data to effectively determine the risk spillovers across G7 markets after the emergence of coronavirus, we compare two periods : Period 1 (before the start of coronavirus, i.e., January 01, 2018 to January 22, 2020) and Period 2 (considering the period post-coronavirus, i.e., from January 01, 2018 to March 03, 2020).

Table 4 displays an approximate "input-output" decomposition of the total volatility spillover index. In particular, based on the study of Diebold and Yilmaz (2012), we disentangle the spillover index into all of the forecast error variance components for variable *i* coming from shocks to variable *j*, for all *i* and *j.* The ij^{th} entry is the estimated contribution to the forecast variance of market *i*, resulting from innovations to market *j*. The sum of variances in a row (column), excluding the contribution to its own volatilities (diagonal variances) represents the impact on the volatilities of other stock markets. The last row in the table is the contribution to the volatilities of all markets from this particular market.

Our findings indicate that for total volatility spillovers to others is stronger than total volatility spillovers from others for the two periods under consideration. For both periods, the contribution to others is more pronounced than the contribution from others for China and the United States; inversely for Canada, Germany, France, Italy and the United Kingdom. The risk spillovers to others and from others seem stronger for the Period2 than Period1, highlighting the role of coronavirus in exacerbating the volatility spillovers across China and G7 stock markets.

Table 4. Volatility spillovers across G7 stock markets

	China	Canada	France	Germany	Italy	Japan	U.K	U.S.	Contribution from others
Period1: From January 01, 2018 to January 22, 2020									
China	52.4	8.6	15.6	12.7	4.2	47.3	0.9	44.3	9.1
Canada	9.8	42.3	8.7	5.9	3.4	9.4	12.7	15.9	12.5
France	17.2	6.4	61.2	13.4	1.9	12.6	13.1	12.2	34.6
Germany	18.3	4.5	7.3	55.9	1.3	3.8	14.2	13.4	32.8
Italy	1.4	6.0	11.9	9.3	61.5	1.4	8.8	14.8	16.7
Japan	0.8	3.1	4.4	1.9	2.6	69.1	10.6	9.7	14.1
U.K.	0.3	11.7	13.4	12.5	9.3	4.8	6.9	6.2	12.9
U.S.	41.6	10.9	18.3	24.6	14.8	2.5	11.8	72.4	6.8
Contribution to others	51.6	10.9	28.3	24.6	8.8	12.5	9.4	43.2	180.3
Period2: from January 01, 2018 to March 03, 2020									
China	61.7	13.2	17.2	19.8	18.6	59.8	0.8	48.1	10.2
Canada	12.4	45.1	9.3	6.2	5.8	10.6	11.9	12.9	15.7
France	19.5	6.9	62.8	14.1	2.6	13.9	14.5	13.1	36.4
Germany	21.3	4.8	10.4	56.7	1.8	4.1	15.3	14.4	35.1
Italy	3.7	5.1	15.2	11.4	63.4	1.8	9.4	15.6	18.1
Japan	1.6	4.2	6.2	2.9	3.8	69.6	11.2	10.8	20.2
U.K.	0.9	12.6	12.7	13.1	10.0	5.1	7.8	7.9	13.1
U.S.	44.1	11.5	22.0	24.8	15.1	3.9	12.3	73.6	5.9
Contribution to others	62.3	11.3	17.4	19.2	9.6	13.4	11.1	52.4	196.7

Notes: The values are calculated from variance decompositions based on 1-step-ahead forecasts. The optimal lag length for the VAR models is 3 for the two periods under study, determined by the Akaike Information Criterion.

Then, we measure the average net directional spillovers, which refers to the difference between the “contribution to others” and the “contribution from others”. This exercise allows to determine which from China and the G7 stock markets is the most important volatility exporter to the rest of countries. The results are summarized n Table 5. China and the United States are regarded to be the volatility transmitters, whereas Canada, Germany, France, Italy and the United Kingdom are likely to be volatility receivers. These findings are of particular interest of both regulators and investors. Investors can enhance their hedging and portfolio diversification by exploiting their knowledge with respect the way the G7 stock risks over coronavirus fears can be transmitted from one market to another. The information drawn from our analysis is important for policy-makers in the sample countries for understanding the

markets' co-movements and designing appropriate policies to locate possible sources of imbalances and propagation channels in the financial system. In other words, accurate insights about the major volatility transmitters and receivers can help them in undertaking decoupling policies to (1) insulate the economy from high risk spillovers effects, (2) lighten the spread of the damage done by this new virus, and (3) preserve the stability of financial system.

For robustness, as previously we used weekly data instead of daily data. In doing so, slight changes are found but the results do not change fundamentally.[7] We often find that China and the United States are the risk exporters, while the rest of G7 countries are the volatility importers.

Table 5. The average net directional volatility spillovers across G7 stock markets

	Contribution from others	Contribution to others	Average net directional spillover
Period1: From January 01, 2018 to January 22, 2020			
China	9.1	51.6	42.5
Canada	12.5	10.9	-1.6
France	34.6	28.3	-6.3
Germany	32.8	24.6	-8.2
Italy	16.7	8.8	-7.9
Japan	14.1	12.5	-1.6
U.K.	12.9	9.4	-3.5
U.S.	6.8	43.2	36.4
Period2: from January 01, 2018 to March 03, 2020			
China	10.2	62.3	52.1
Canada	15.7	11.3	-4.4
France	36.4	17.4	-19.0
Germany	35.1	19.2	-15.9
Italy	18.1	9.6	-8.5
Japan	20.2	13.4	-6.8
U.K.	13.1	11.1	-2.0
U.S.	5.9	52.4	46.5

[7] To keep the clarity of our presentation, detailed findings will be available for interested readers upon request.

4. Discussion of results and conclusions

Given the massive impacts of the coronavirus on public physical and psychological health, the economic and financial effects may appear secondary. In this article, we focus on which G7 stock markets seem most vulnerable to a disruption of global supply chains caused by the coronavirus. Our results reveal that all G7 stock markets suffered markedly from the rising uncertainty over the coronavirus spread, though with distinct extent. In particular, the stock market reactions of U.S., Japan and Germany were stronger than those of Italy, France, United Kingdom, and Canada. We also find that the propagation of coronavirus caused high risk spillovers across China and G7 stock markets. China and the United States are the volatility tramsitters, whereas Japan, Germany, France and Italy are the the volatility receivers. These outcomes inform policymakers, investors, and businesses in their possible reactions to the emergency, and hopefully allow to effectively prepare for possible future emergencies.

Beyond the obtained empirical findings, we want through the present research paper, to draw attention to the lessons to be learned from this unprecedented crisis. Indeed, there are many lessons to be learned, right now, from the coronavirus crisis in order to better overcome it and try to predict possible following crises. The virus is not the main cause of the current crisis, which is a crisis of globalization and the way our economic system as a whole works. It is a catalyst, highlighting the intrinsic inconsistencies and dysfunctions of the production system.

Even before Coronavirus, we have already witnessed amarked slowdown in economic growth in most developed countries (including our G7 sample). This slowdown has not been sufficiently taken into account by the financial markets, which

have continued to rise, encouraged by the accomodative monetary policies[8] of major central banks. However, the causes behind this sharp decline in growth are well known and are mostly objective. These include among others the decreasing Chinese imports, the heightened US-China trade war, Brexit, tensions between Iran and the United States and tensions in the Middle East region and other parts of the world. All of this has created situations of growing uncertainty. In other words, the ingredients for a major crisis are still there. The coronavirus is the spark that exploded this crisis.

The Coronavirus did not create this high uncertainty that we have known for a number of years, but it has accentuated, exacerbated and multiplied it. The panic generated by this pandemic is mainly due to the fact that little is known about the virus. If we know its mode of dissemination in general, appropriate infection prevention and control measures, we do not know its morbidity. We do not know especially if it will mutate into a more spreading form, as was the case of the Spanish flu which killed more than 50 million between 1918 and 1919.

The unbridled pursuit of profit has led multinational companies to create a complex and fragmented value chain system, which does not take into account the carbon footprints and the working conditions, which are very often difficult, in developing countries. Not to mention the over-reliance on world's workshop, i.e., China. Strategic products and essential inputs for society are produced in subcontracting basis in this country, which can be problematic when a production breakdown occurs, as is the case with the current crisis. Today, the debt ratios of the countries studied in our sample are very high (see Figure A8). The margins of

[8] An accommodative monetary policy happens when a central bank expands the overall money supply to boost the economy when growth is declining (as measured by GDP).

maneuver of these states are consequently reduced (if we compare them compared to that of 2008 and the subprime crisis for example). This would not give these countries the flexibility they needs to effectively respond to changing economic circumstances. When we look at central banks, the situation seems not much better. Indeed, interest rates in most of the concerned countries are around 0%. Even if the situation on the United States is different due to the fact that the dollar plays the role of reserve currency, but we shouldn't ignore that the shrinking of the Federal Reserve's (Fed) balance sheet - so-called quantitative tightening[9] -is very worrying.

There remains the pursuit, but this time on a larger scale, of conventional policies, of buy-back securities of companies to provide them with liquidity, well known as 'quantitative easing'. However, there is the question of the effectiveness of these central bank policies. It is obvious that much of this cash is not going to the real economy. Banks do not direct these colossal amounts of money to small and medium-sized businesses. With the disruptive coronavirus crisis, it may be time to rethink their use and redirect them towards the financing of small and medium-sized businesses, or those that create long-term jobs that protect the environment. Not to mention a massive investment in the health sector. The World Health Organization (WHO) must have more human and material resources and a coercive policy for more efficiency. It is abnormal that this organization is endowed with less power than the International Federation of Association Football (in the sport field) for example.

It should not be forgotten that the current crisis is linked to hygiene problems (a wholesale market in Wuhan). It is therefore time to take this issue seriously. Indeed, almost half of the world's population does not have access to effective hygiene

[9] Quantitative tightening is monetary policy applied by a central bank to reduce the amount of liquidity within the economy.

services, which would have an adverse impact on health and, ultimately, on economic growth. Investing in health and the environment is the main lever to restore the confidence currently lacking on financial markets and economic players (companies, citizens, NGO, etc.).

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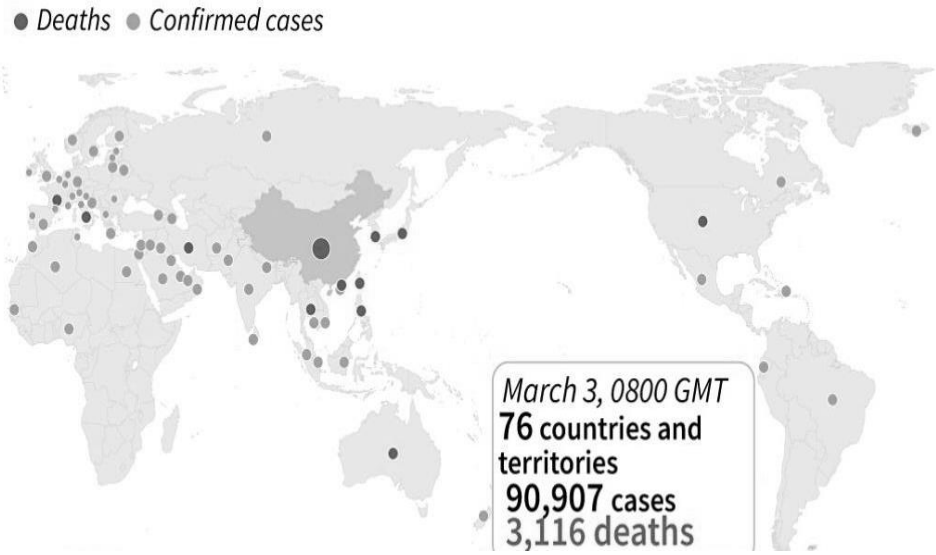
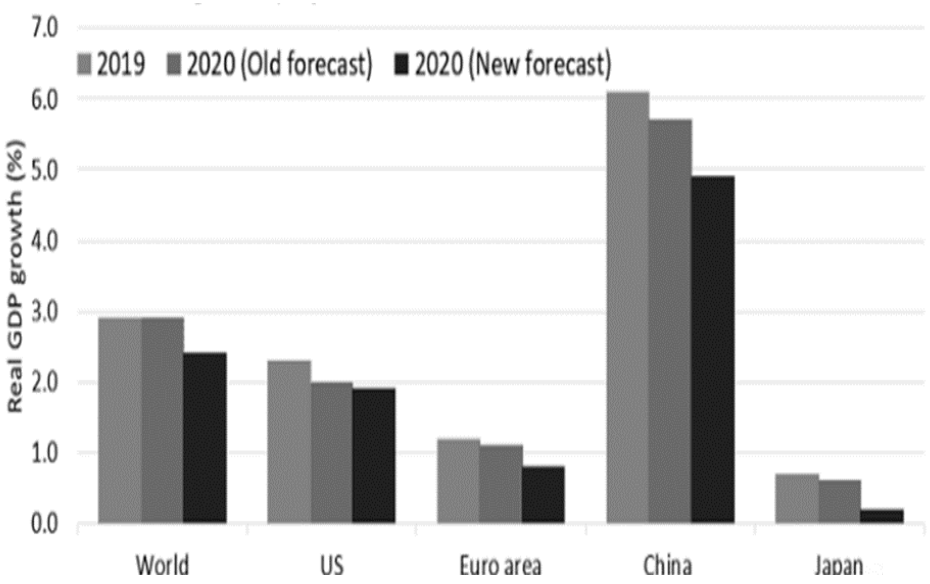
Appendix

Figure A1. Global spreads of the coronavirus



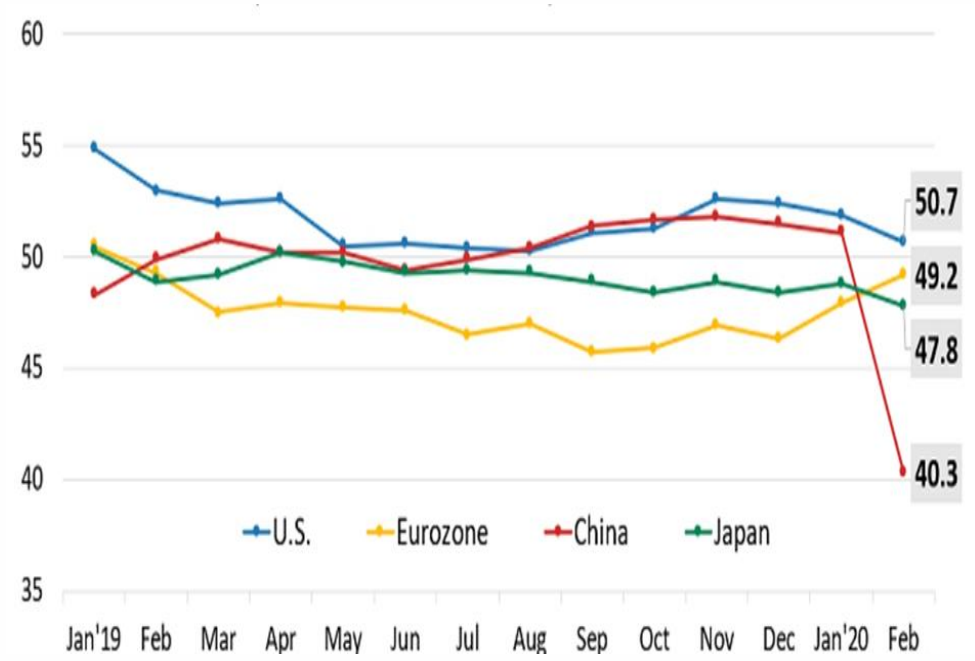
SOURCE : For more details about the number of conformed cases and deaths by country, you can refer to this link : https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6

Figure A2. Forecasts of global economy after the COVID-19 outbreak



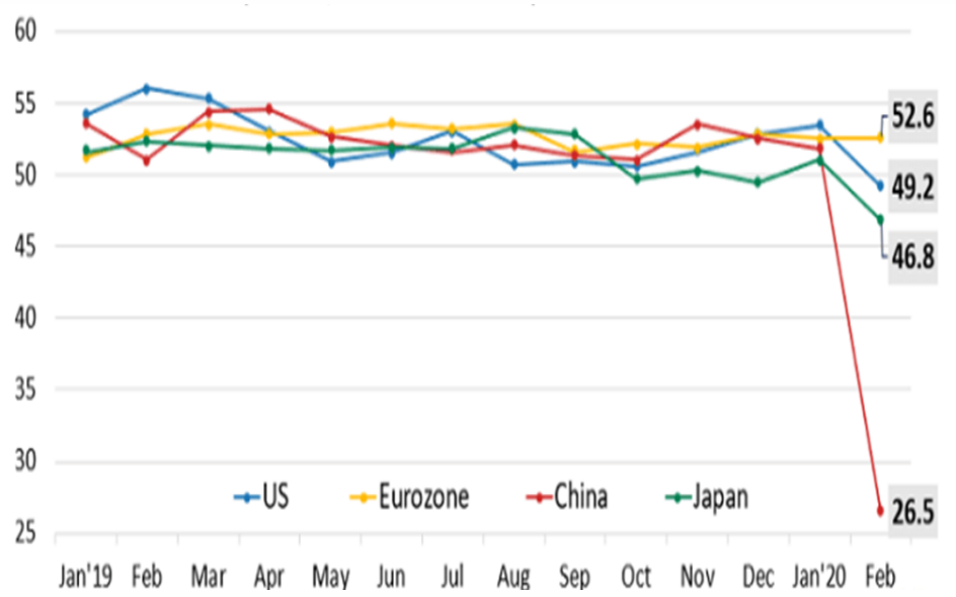
SOURCE : OECD Economic Outlook Report (2020).

Figure A3. The performance of the manufacturing sector in major economies after the emergence of COVID-19



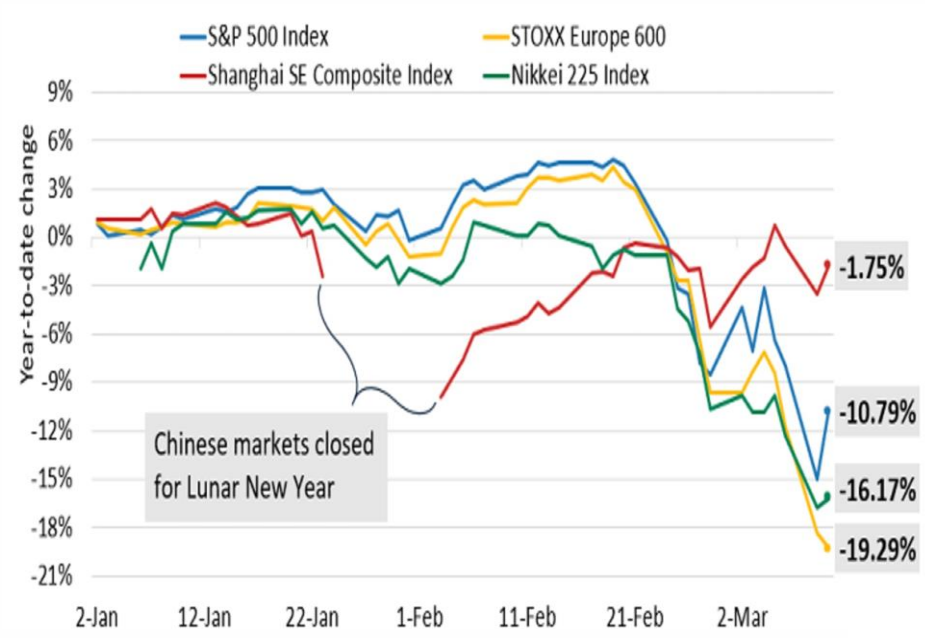
SOURCE : Refinitiv (https://www.refinitiv.com/en/about-us)

Figure A4. Services activity in major economies after the emergence of COVID-19



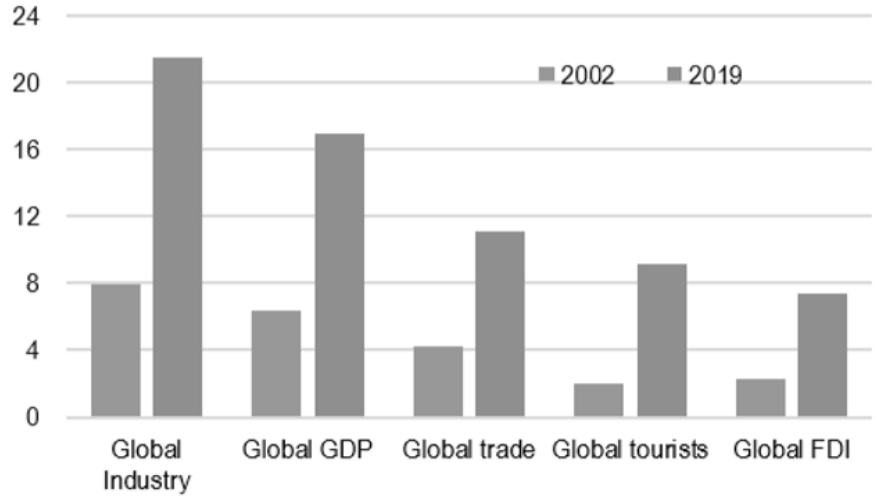
SOURCE : Refinitiv (https://www.refinitiv.com/en/about-us)

Figure A5. Responses of major stock prices to the emergence of COVID-19



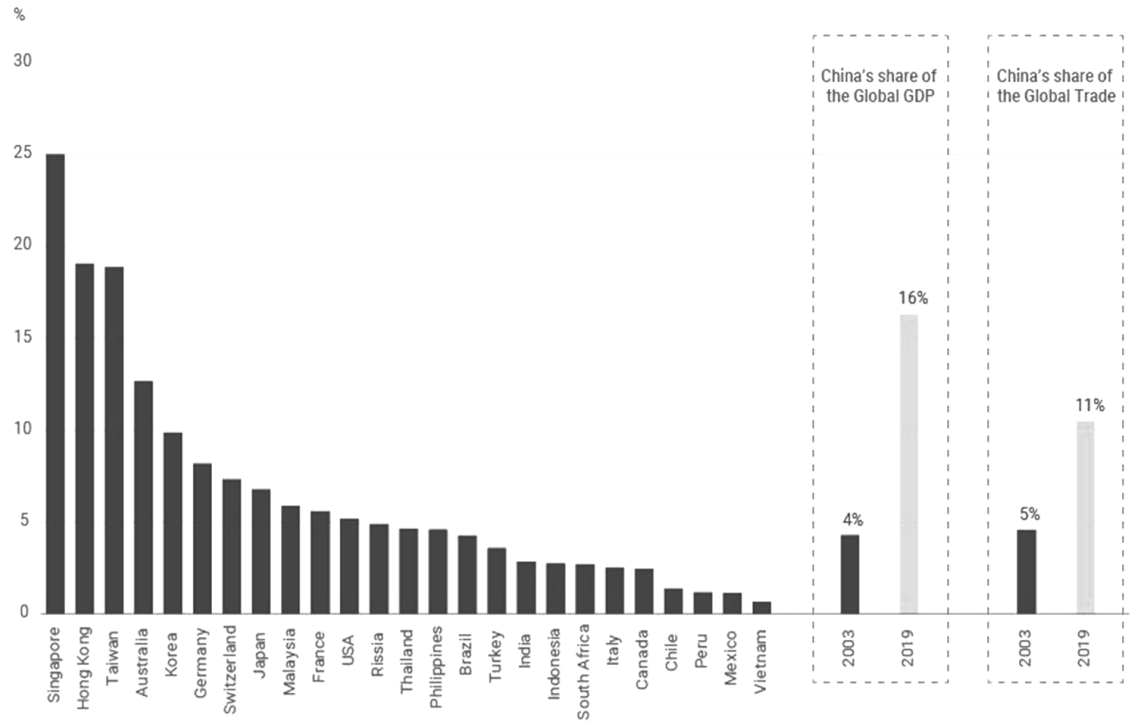
SOURCE : Refinitiv (https://www.refinitiv.com/en/about-us)

Figure A6. China's global integration (in % of world) : 2002 vs 2019



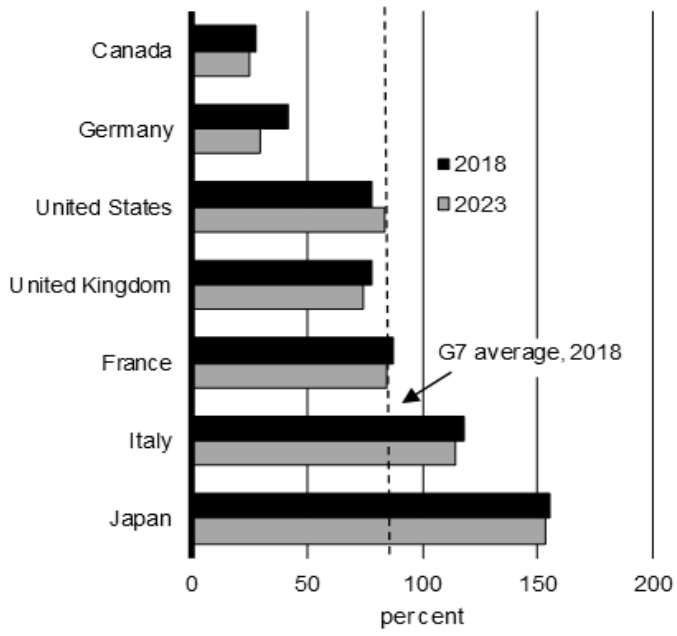
SOURCE : OECD Economic Outlook Report (2020).

Figure A7. The reactions of global markets to coronavirus : A comparison with SARS



Source: MSCI Economics Exposure Database, IMF World Economic Outlook, World Bank.

Figure A8. G7 Debt-to-GDP Ratio



SOURCE: OECD.