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Contagion effect of the corona virus: Evidence of China, Italy and USA

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Abstract: The contribution of this research to give readers in the first time a clear understanding of the analysis of the economic impact of COVID-19 on three countries, mainly, the United States, China and Italy .Also this paper investigates the contagious epidemic in a multivariate time-varying asymmetric framework, focusing on these countries (USA ,China and Italy) during the epidemic corona virus.

Methods: Specifically, both a multivariate Gaussian copula model and the dynamic conditional correlation (DCC) approach are used to capture china, USA, Italy non-linear correlation dynamics during the period January 22, 2020–March 23, 2020. The empirical evidence confirms the spread of the epidemic from one country to all others.
Results: The results also suggest that China is more prone to epidemic contagion while the numbers of deaths has a larger impact than country-specific epidemic corona virus.

Keywords: Coronavirus, China, the dynamic conditional correlation.

Introduction

COVID-19 was identified in Wuhan (China) in December 2019 it gave rise to a pandemic all over the world. COVID-19 is a new type of pneumonia caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) infection. COVID-19 is affecting millions of people in the word, where the number of infected people is constantly increasing. The SARS-CoV-2 disease is highly infectious that created severe health problems all over the world, and caused the death of millions of people.

In fact, in late January 2020, the World Health Organization declared the novel coronavirus (COVID-19) as a potential health peril just a few weeks, before declaring a global health emergency (Ghebreyesuss, 2020). In fact, the first COVID-19 case that appeared in the United States was in

January (2020). As of 3 March 2020, According to World Health Organization's (WHO) statistics, the mortality rate was 3.4%. According to World meter, on 22 may, 2020, the mortality rate reached nearly 5.9% while in Italy, it was more than 13%. By mid-March, most states in the United States had declared a state of disaster, and the stock market plunged (Mazur, Dang, & Vega, 2020).

According to Centers for Disease Control and Prevention [CDC], 2020a, 2020b) COVID-19 cases continued to rise at worrying pace and over 200,000 individuals in the United States died from the disease. To decrease the spread of COVID-19 pandemic, the majority of countries around the world were forced to "lockdown" in an ultimate effort to reduce exponential growth in transmission rates. Among other actions, this has involved closing schools, businesses with perceived high risk of transmissions sports activities, large social gatherings and travel routes, effectively shutting down entire societies. Indeed, what firstly instigated as natural catastrophes in the form of a pandemic gave rise to two simultaneous crises: economic and public health.

In this direction, among the many studies that have focused on the economic impact of covid-19 we can mention those of Weder M., (2020), Boone L. et al.,(2020), McKibbin W. et Fernando R., (2020), Arezki R. et Nguyen H., (2020), Baldwin R. et Tomiura E., (2020), Beck T., 2020 ; Cecchetti G. et Schoenholtz L., (2020), Mann C., 2020 ; Meninno R. et Wolff G., (2020), Voth J., (2020), Cochrane J., (2020), Wren-Lewis S., (2020),Wyplosz C., (2020), Baker S. et al., (2020), Tobias A. et Aditya N., (2020), Albulescu C., -2020a, 2020b et 2020), FMI, (2020b). They have shown that covid-19 has destabilized the world economy by reducing production, lowering tax revenues, increasing the spending on screening, health care, etc. and increasing assistance to households, transfers, unemployment benefits, wage subsidies, deferral of tax payments, etc.).

Other several studies on economic crises and disasters, such as those of Chan &Mak, (2014), Sirola&Pietsa, (2017), respectively, identified helping behaviors, such as social and cooperative behavior that facilitates goal attainment for another party, Chan &Mak, (2014), Sirola&Pietsa, (2017)), as crucial for recovery from disasters and the success of businesses and economies during tough economic times (Aldrich & Meyer, (2015), Doerfel, Lai, &Chewning, (2010), Podsakoff, Whiting, Podsakoff, &Blume, (2009), Sirola, (2020)

When dealing with traditional asset markets (e.g., stocks, bonds, foreign exchange, commodities) or even gold Exchange-Traded Funds, " (Buraschi et al.2014) in the cross-section of returns

Figure 6 shows an unprecedented high level of correlation across worldwide stocks, with a peak of 88.93 percent in April 2020, reinforcing the contagion scenario. Correlation analysis progresses from (1) in blue to (+1) in red, depending on the construction. When the blue color is present, there are prospects for uncorrelated investment for the asset manager (which is what he is looking for according to Markowitz portfolio theory). In the current situation, only linked market fluctuations exist, implying that the asset manager has no way to transfer his funds.

Regarding the effects of the Covid-19 crisis on the banking or financial system, most of researchers agree on the possibility of financial instability over time, in the absence of effective measures, (Albulescu C., (2020b) and (2020c) Mann C., (2020), Baker S. et al., (2020) the absence of clear and honest communication from the authorities about the pandemic (Weder M., 2020; Ceccheti G., 2020), the lack of communication between the supervisory bodies and banks (Tobias A. and Aditya N , (2020), the

lack of liquidity (Weder M., (2020), Beck T.,(2020); Tobias A. and Aditya N., (2020), the non-assistance of vulnerable firms and households (Boone L., (2020), Wren-Lewis S., (2020), inadequate response measures (Beck T., (2020), solvency problems both for firms or households and for banks resulting in an increase in non-performing loans (Beck T. , (2020), the contagion effects following the interconnection of banks (Ceccheti G., 2020), mis-management of credit risk (Tobias A. and Aditya N., (2020), the lack of international collaboration of national regulations (Tobias A. and Aditya N., (2020), Beck T., (2020).

Economic impact of the COVID-19 pandemic

The COVID-19 pandemic, which has had far-reaching economic consequences beyond its spreading.,[1]the pandemic caused the largest global recession in history, with more than a third of the global population being placed at the same time under lockdown.[2]

24 February, 2020, Global stock markets fell due to a significant rise in the number of COVID-19 cases outside the mainland of China. In fact,[3]By 28 February, 2020, stock markets worldwide saw their largest single-week declines since the crisis. Global stock markets crashed in March 2020, with falls of several percent in the world's major indices.

The pandemic has forced to switch the plans globally. All cultural, sport, and technological events have been canceled or moved online.[4]While the monetary impact on the travel and trade industry, which has not yet been estimated, is likely to be in billions of dollars and continues to increase. In this section, we will present the impact of covid-19 in China, the United States and Italy.

Akhtar Uzzaman et al. (2020) Examines the contagion impacts occurring on both financial as well no financial firms in China, Italy and USA during Covid-19 period.Ashraf (2020) find that an increase in the Covid-19 cases cause decline in the Stock Returns. The Social distancing and the restrictions of the government on various commercial activities are the major reasons for reduction in stock market returns.

Al-Awadhi et al.(2020) examines that on the Chinese stock market that daily increasing in covid-19 cases and death both have significant negative effect on stock returns. Papadamou et al.(2020) suggest that Google-based anxiety regarding COVID-19 contagion effects leads to elevated risk-aversion in stock markets. Sharif2020b) Examines the ration among covid-19,economic policy uncertainty oil price volatility and geopolitical risk in the US within a time framework.

Several studies have examined financial contagion (Eichengreen et al., 1996; Forbes & Rigobon, 2002; Dungey & Fry, 2009; Kenourgios et al., 2013; Kenourgios & Dimitriou, 2015; El Ghini & Saidi, 2015; Zorgati et al., 2019; Akhtar uzzaman et al., 2020). Indeed, Kenourgios et al. (2013) investigate financial contagion as a mechanism of asymmetric propagation in equity and change markets. They use an asymmetric generalized dynamic conditional correlation (AG-DCC)

model and find that conditional correlations between stock markets increase significantly during a crisis period, supporting the presence of financial contagion. Zorgati et al. (2019) finds the presence of the Economic contagion phenomenon with the copulas approach. They shows the present of contagion effect among the U.S. and all other American countries as well as the Australian, Indian, Malaysian, Indonesian, Singaporean, and Chinese ones

Economic impact of covid-19 in China

On January 11th, 2020, the Chinese media reported the first death case from the novel coronavirus. On March 11th, 2020, the World Health Organization (WHO) officially declared the COVID-19 a pandemic. Naturally, the effects of this global pandemic would be devastating on the Chinese economy and the global economy. In fact, according to Shen Ling, economics professor and macroeconomist at the Faculty of Business Administration said that this has two main aspects. On the one hand, the spread of the epidemic means that every economy should invest more resources to combat the epidemic. The second argument revealed by Shen Ling is that other countries around the world had imposed flight control and entry restrictions on China since the outbreak of the virus in China. This means that after the epidemic spread, the exchange of normal staff and goods would be further restricted, which would have a major impact on the already globalized Chinese economy.

Moreover, for the first time in history, on 22 May, 22020, the Chinese Premier, Li Keqiang, announced that the central government wouldn't set an economic growth target for 2020, with the economy having contracted by 6.8% compared to 2019 and that China was facing an "unpredictable" time.

Zooming on China, the data released by the National Bureau of Statistics of China, in January and February, showed that the pandemic had a huge impact on its economy in the short and medium run owing to the impact the pandemic .On the net exports stemming from a likely marked global slowdown. According to the same source, the value-added of the industry above the designated size[5] , investments, and retail sales fell by 13.5%, 24.5%, and 20.5%, respectively compared to the same period of the previous year, and the unemployment rate reached 6.2%.during the imposed, restriction measures. In fact, the Chinese enterprises faced challenges, which restricted their production and operation activities and posed risks to operations in the short term.

Economic impact of covid- 19 Italy

During the initial stages of the pandemic, all the regions in Italy had been divided in a color-coded system ranging from white (very low risk) yellow (low risk), orange (high risk) and red (very high risk) depending on the pandemic transmission rates, availability of hospitals and ICU beds, and other parameters. Then, different restrictive measures were applied to each zone. After a few days of the spread of covid-19, Italy entered a strict three-day lockdown to try to prevent a further spread of the epidemic over Easter and stop the extension of the red zone (the highest tier of restrictions).

In fact, during the virus spread period, hospitals and retirement homes were more severely affected by the virus. Hospitals were perplexed with a huge number of infected cases received daily. However, due to the shortage of masks and other protective clothing, nurses and hospital staff, who were essentially

the front line workers, continued to help patients without adequate protection. Moreover, what worsened the situation is that people were not accustomed to social distancing, which accelerated the spread of the virus.

On the other hand, on the economic front, Italy was heavily impacted by the COVID-19 pandemic, as the country was the first in Europe to be struck by the pandemic. In fact, the IMF declared that GDP dropped by 10.5% in 2020 after real output contraction by 18% in the first half of the year. In fact, according to the FMI, the country's primary budget is structurally positive, however, the interest cost on government's debt weighs heavily on Italy's accounts, with the general government budget being structurally in deficit. Moreover, the economic crisis caused by the COVID-19, has resulted in reduced revenue from direct and indirect taxes, as well as by increased government expenditure (that had a budgetary impact of about 5.5% of the GDP), causing the budget deficit to reach 3.8% of the in 2020. On the other hand, in 2020, the historically-high debt-to- the GDP ratio spiked to a worrying figure of 161.8 whereas inflation stagnated at (0.1%) due to a downward pressure from oil prices and private consumption, and was likely to remain subdued in 2021 at 0.6%, (IMF). The unemployment rate rose to 11.8% in 2021, with consequent job losses among the service-sector workers. According to the Italian National Institute of Statistics (ISTAT), in Sept. 2020, Italy had a high rate of youth unemployment with 31.1% and regional inequalities between the highly industrialized and dynamic North and the poor rural southern "Mezzogiorno" areas,, where the unemployment is still high beside the existence of organized crime and black economy remaining an important open issue.

The economic impact of the covid19 in the United States

In January 2020, the COVID-19 reached the United States then, by mid-March, most states in the United States had declared a state of disaster and the stock market plunged (Mazur, Dang, & Vega, 2020). The COVID-19 cases continued to rise at higher speed where over 200,000 individuals in the United States died from the disease (Centers for Disease Control and Prevention [CDC], 2020a, 2020b). In fact, there were several reasons for the tremendous rise of the number of COVID-19 cases in the United States. Firstly the U.S. government initially failed to understand the severity of the pandemic therefore; they did not isolate individuals who displayed the COVID-19 symptoms. Moreover, the President of the United States of America initially did not make the country ready to fight the pandemic even after repeated warnings by healthcare officials, secondly, the government did not urge people to wear face masks and use hand sanitizers. It is because of these reasons that there was an explosion of the number of COVID-19 cases in the U.S

On the other hand, on February 27, the US stocks suffered the biggest loss in a week since 2008 besides, the Dow Jones Industrial Average fell by 1190 points in one day then, and on 28 February it dropped below 25000 and ended the week down at 12.4 percent. Moreover, the S&P500 Index recorded 11.5 percent then; the Nasdaq Composite fell to 10.5 percent6 and the stocks to 18,592

points (Dow average). In fact, on 7 March, the US stocks fell by 7 percent, which caused temporary halt for trading,

According to the US Bureau of Labor Statistics, male unemployment increased sharply from 3.55 million in February to 11 million in April 2020, while female unemployment (which was lower than the pre-crisis men's) rose from 2.7 million to 11.5 million in the same period.

Multivariate GARCH -DCC model

In this section, we present the two-stage model of the dynamic conditional correlations proposed by Engle (2002). For example, let's consider a vector consisting of any two variables $Y_t = \left[y_{1t} y_{2t} \right]'$ **where** each variable is a constant function and its own past values. Thus, the reduced form of the autoregressive process is written as **follows**:

$$A(L)Y_t = c + \varepsilon_t \text{ avec } \varepsilon_t \to N(0, H_t), \forall t = 1, 2, ..., T \quad (2.4)$$

Where $A(L)$ is the polynomial delay and $\varepsilon_t = \left[\varepsilon_{1t} \varepsilon_{2t} \right]'$ is a vector of residuals from the estimation auto regression process for each variable whose variance-covariance matrix is described by $H_t = \left\{ h_i \right\}_t$ with $i = 1, 2$.

The DCC-GARCH model can be easily apprehended by rewriting the matrix of the variance-covariance H_t such as: $H_t = D_t R_t D_t$

Where $D_t = diag\left\{ \sqrt{h_{it}} \right\}$ is a diagonal matrix of the standard deviations, which is temporally different from variable estimation of the two previous equations in a univariate GARCH process; $R_t = \left\{ \rho_{ij,t} \right\}$ which represents the matrix of the conditional correlation coefficients? Then, the elements contained in D_t are generated in a GARCH (P,Q) process, which can be formulated as follows:

$$h_{it} = w_i + \sum_{p=1}^{P} \alpha_{ip} \varepsilon_{it-p}^2 + \sum_{q=1}^{Q} \beta_{iq} h_{it-q} \quad (2.5)$$

In addition, Engle (2002) adopted a GARCH-type structure in his modelling of the dynamics of the correlations. Thus, a DCC process of the order (M, N) can be described by:

$$R_t = \left(Q^*_t \right)^{-1} Q_t \left(Q^*_t \right)^{-1}$$

$$Q_t = \left(1 - \sum_{m=1}^{M} a_m - \sum_{n=1}^{N} b_n \right) \bar{Q} + \sum_{m=1}^{M} a_m \left(\xi_{t-m} \xi'_{t-m} \right) + \sum_{n=1}^{N} b_n Q_{t-n} \quad (2.6)$$

where $\xi_t = \left\{ \varepsilon_{it} / \sqrt{h_{it}} \right\}$ is the vector containing the standardized residuals from the univariate GARCH model estimation, which is the matrix of the conditional variance-covariance of these standardized residuals, whereas $Q_t = \left\{ q_{ij,t} \right\}$ is the matrix of the unconditional variance-covariance, which **is** temporally invariant. Therefore, the parameters $\left(a_m ; b_n \right)$ are supposed to intercept, respectively, the effects of the shock and delay the dynamic correlations on the level of *recent contemporary*. As for Q^*_t it is a diagonal matrix containing the square root of the main diagonal elements of Q_t. According to our example, this matrix is written as follows:

$$Q^*_t = \begin{pmatrix} \sqrt{q_{11}} & \\ 0 & \sqrt{q_{22}} \end{pmatrix} \tag{2.7}$$

Where $\rho_{12,t} = \dfrac{q_{12,t}}{\sqrt{q_{11,t} q_{22,t}}}$ are the dynamic conditional correlations, which are the matrix elements R_t whose main diagonal is 1.

Then, the model parameters are estimated by the DCC method of the maximum likelihood. Engle (2002) showed that the log-likelihood function can be expressed as follows:

$$L = -\frac{1}{2} \sum_{t=1}^{T} \left\{ 2\log\left(2\pi\right) + 2\log\left|D_t\right| + \log\left|R_t\right| + \xi_t R_t^{-1} \xi_t \right\} \tag{2.8}$$

The estimation process involves two steps. The first is the substitution of an identity matrix to matrix R_t in the function of the log-likelihood. The advantage of this method is that it allows for the sum of the likelihood function of the GARCH univariate processes. In other words, through this first step, we obtain the parameters of equation (2.5). The second step is devoted to the estimation of the equation (2.6) parameters by adopting the original likelihood function described by equation (2.8). This allows for the dynamic correlations between the studied variables.

Table 1 Estimation of the long memory parameters number of cases and deaths

Countries	Cases	Death	Fatality- rate
China	81439	3274	0,04020187
Italy	59138	5476	0,09259698
USA	21638	1685	0,07787226

This period corresponds to the time elapsing between contamination and the appearance of the first symptoms (fever, cough, difficulty in breathing, etc.). It usually lasts a few days but can reach two weeks. This is the reason why a “quarantine” of at least 15 days is necessary to prevent any contamination.

In very rare cases, this incubation period may be a little longer. According to a study published two weeks ago in the journal Annals of internal medicine, the symptoms appear after a quarantine of 14 days for a hundred people in 10,000, or about 1% of cases.

Table 2 Estimation of the long memory parameters of the number of infected cases and deaths

	Number of cases	Number of deaths
China	0.7552	0.9379
USA	0.997	1.0386
Italy	1.0274	0.9603

Table3. Results of the MGARCH-DCC (1, 1) models

	China-USA		China-Italy		USA-Italy	
	Cases	Death	Cases	Death	Cases	Death
c_1	78925	2883	78957	2882.31	10071	632.67
c_2	8628	568.625	19273	1757.51	23149	1960.66
w_1	9104568	164143	9066478	172557.60	51981416	774749.72
w_2	62619120	68836	380832185	1489902.85	291035056	6600866.35
α_1	0.050884	0.037	0.049525	0.04	0.099180	0.00
α_2	0.040432	0.022	0.035472	0.02	0.080103	0.01
β_1	0.414904	0.534	0.421721	0.51	0.560729	0.14
β_2	0.614754	0.905	0.675636	0.85	0.636567	0.36
a_m	0.230187	0.152	0.230531	0.16	0.149524	0.20
b_n	0.000000	0.313	0.004095	0.24	0.480639	0.17

We found β_c being bigger than α_c, *under restriction that coefficients and* $\alpha_c + \beta_c < 1$. The evidence from these results suggests that the big shock has led to the small correction in the oncoming mutual fluctuation (or covariance) between markets. The DCC model for each country shows significant coefficients for the covariance matrix of u_t.

Our findings indicate that the correlation coefficients, α_c and β_c respectively, are pretty small, and are **all** below 0.5, indicating that the selected conditioning variables contain sufficiently orthogonal

information. We **also fou**nd **that** $\beta_c(0.480)$ is greater than α_c , 0.149 under *restriction that coefficients and* $\alpha_c + \beta_c < 1$ is 0.63. The evidence from these results suggests that a big shock just causes a small correction in the oncoming mutual fluctuation (or covariance) between the countries, **such as** china, USA, Italy. The results of **the** DCC multivariate GARCH model show that the coefficients are significant, indicating that the dynamics of epidemics transmission from are found in **the** china, USA, Italy.

Conclusion

This paper has investigated the epidemic contagion in a multivariate time-varying asymmetric framework focusing on Asian and European countries, including China, Italy, and the USA, during the epidemic corona virus. The dynamic conditional correlation (DCC) approach has been used to capture non-linear correlation dynamics during the period from January 22, 2020, to March 23, 2020.

In fact, the empirical evidence has confirmed that a contagion effect is compelling from an epidemic country to all other countries for each of the examined corona viruses. Therefore, the estimation process involves two steps. The first step is the substitution of an identity matrix to a function matrix in the log-likelihood method. The advantage of this method is that it allows for the sum of the likelihood functions of the univariate processes of GARCH. Through this first step, we have obtained the parameters of equation 2.5. And, in the second step, we have obtained the estimation of the parameters of Equation 2.6 by adopting the original likelihood function described by Equation 2.8, which has allowed us to make dynamic correlations between the study variables.

The findings of the study indicate that the correlation coefficients are very small and all are below 0.5, which means that the selected conditioning variables contain sufficient orthogonal information. The results indicate that the β (0.480) is greater than $\boldsymbol{\alpha}$ (0.149), under the restriction of coefficients ($\boldsymbol{\alpha}$+β <1 = 0.628). This evidence of the result suggests that a big shock just causes a small correction in the oncoming mutual fluctuation (or covariance) among China, Italy, and the USA. The results of the DCC multivariate GARCH model show that the coefficients are significant, which indicates that the dynamics of the epidemic transmission are found in these countries.

The findings of the study urge investors to diversify their portfolios while advising policymakers and regulators to reduce market risks. The COVID–19 phase not only affects the international stock market but also brings volatility in foreign exchange market. More significant costs of hedging in the equity market, combined with currency mismatches in portfolios, have increased both market and credit risk for international investors. This development forces market participants (particularly banks) to reduce their risk-taking capacity and dampen the growth in both financial markets and global economies. In order to prevent these actions, policymakers should keep providing liquidity to international markets as illustrated by the recent global swap arrangements made by the Federal Reserve. Research on the effects of COVID–19 is still in a very nascent stage. Further research on this topic is guaranteed in the future.

The limitations of this study are confined to limited data samples on the onset of the pandemic. This research study and its data will help the scientific community to evaluate the results to assess the impact of covid-19 results on international economies several years later.

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