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Article

Staggression: The economic and financial impact of the COVID-19 pandemic

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Staggression: The Economic and Financial Impact of the COVID-19 Pandemic

Mario Arturo Ruiz Estrada¹, Evangelos Koutronas², Minsoo Lee³

ABSTRACT

This paper formulates an analytical framework to understand the spatiotemporal patterns of epidemic disease occurrence, its relevance, and implications to financial markets activity. The paper suggests a paradigm shift: a new multi-dimensional geometric approach to capture all symmetrical and asymmetrical strategic graphical movement. Furthermore, it introduces the concept of staggression, a new economic phenomenon to explain the uncharted territory the world economies and financial markets are getting into. The Massive Pandemic Contagious Diseases Damage on Stock Markets Simulator (ϕ -Simulator) to evaluate the determinants of capital markets behavior in the presence of an infectious disease outbreak. The model investigates the impact of COVID-19 on the performance of ten stock markets, including S&P 500, TWSE, Shanghai Stock Exchange, Nikkei 225, DAX, Hang Seng, U.K.-FTSE, KRX, SGX, and Malaysia-FTSE

KEY WORDS:

Staggression, pandemics, economic modeling, economic desgrowth, policy modeling, stock market, COVID-19.

JEL Classification:

R11, R12.

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1. Introduction

The world is on the verge of an unprecedented pandemic disease, as many cities across the globe go on lockdown in response to the spread of novel coronavirus, the so-called COVID-19. The consensus among economists about the global economic shutdown due to disease pandemic is believed to be the primary determinant of stock market volatility that could lead to the biggest stock market crash in the 21st century¹. Historically, only two broadly similar episodes the Black Death of 1347 to 1351 and the Spanish Flu of 1918 to 1919. Recent events appeared to have adverse consistent, considerable, widespread short-term severe financial disruptions and medium-term consequences for economic growth and development.

Indeed, it is estimated that the SARS outbreak

caused more than 50 billion dollars of damage to the global economy (Candeias & Morhard, 2018), which knocked off an estimated 1 percent or more from China's growth rate (Johnson & Palmer, 2020). In parallel, the MERS outbreak caused irreparable damage in South Korea's tourist industry, translating into 2.6 billion dollars in losses (Joo et al., 2019). Furthermore, empirical evidence on seasonal epidemics such as influenza, dengue virus (DENV), zika virus (ZIKV), and Ebola virus (EBOV) also have a considerable economic impact in the affected areas. In the United States, the annual economic costs of influenza varied from 13.9 thousand dollars to 957.5 million dollars across U.S. counties, with a median of 2.47 million dollars (Liang et al., 2012). In the case of dengue fever, the overall annual cost in 2013 amounted approximately up to 8.9 billion dollars spread in 141 countries (Shepard et al., 2016). The recent zika outbreak caused socio-economic costs of approximately US\$7-18 billion in Latin America and the Caribbean from 2015 to 2017 (United Nations,

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2017). Finally, the most severe epidemic of Ebola, an estimated \$2.2 billion was lost in 2015 in the gross domestic product (GDP) of Guinea, Liberia, and Sierra Leone (Centers for Disease Control and Prevention [CDC], 2020).

Chinese authorities implemented social distancing policies to minimize the transmission of infectious disease, enforcing widespread restrictions on labor mobility and travel effective immediately after the Lunar New year holiday period. The synchronized shutdown of the factory production lines implies sharp cutbacks and sizeable output contraction with imminent repercussions on economic activity. According to the National Bureau of Statistics, microeconomic indicators exhibit a sharp decline in January and February: industrial output (-13.4 percent); fixed-asset investment (-25 percent); unemployment (+6.3 percent); and retail sales (-20.5 percent) (L. He, 2020). In the latter category, there were sharp declines in durable consumption: automobiles (-37 percent), clothing (-30.9 percent), jewelry (-41.1 percent), home appliances (-30.0 percent), furniture (-33.5 percent), and building materials (-30.5 percent) (Kalish, 2020). The Chinese CPI in January rose by 5.4 percent, the highest monthly rate since October 2011, while the manufacturing PMI hit a three-month low of 50 percent. The fact that inflation is rising when it fell in 2003 during the Severe Acute Respiratory Syndrome (SARS) outbreak is because this time, both supply and demand are falling but supply is falling faster (C. He, 2020). Recent estimates show that the gross domestic product will contract 10 to 11 percent in the first quarter (Cheng, 2020).

In the financial market context, the impact of COVID-19 is depicted the first two months of 2020. Capital markets materialized the increased uncertainty regarding given a new pandemic by leading to the financial market volatility of Shanghai (-10%), Shenzhen (-6%), and Hong Kong (-19%) are down by comparatively modest percentages this year (Karlgaard, 2020). Energy, retailing, and transportation industries experienced substantial losses, whereas healthcare followed an opposed path (Rammelli & Wagner, 2020). In response to the coming economy's shock, the central bank of China announced a stimulating package of 1.2 trillion yuan

(\$174 billion) to support the economy and the financial system in early February, while it has lowered benchmark lending rates in an attempt to stimulate business and investment activity (Wu, 2020).

Beyond the public health impacts of regional or global emerging and lay wider socio-economic consequences that are often not considered in risk or impact assessments. Endemic infectious diseases set in motion a complex chain of events in the economy. Outbreak and epidemics are rare and extreme events, highly diverse and volatile over time and across geographical space. Estimating epidemic and pandemic risk depends upon several factors that varied by the type of activity. The idiosyncratic nature of endemic infectious diseases is based, among others, on the magnitude and duration of the event, the size and state of the local economy, the geographical locations affected, the population density, and the period it occurs. The calculation of direct medical and hospitalization costs attributable to endemic infectious disease treatment is readily traceable. On the other hand, the estimation of the indirect costs on trade, economic development, human movement, and cultural exchange can be an onerous task.

This paper formulates an analytical framework to understand the spatiotemporal patterns of epidemic disease occurrence, its relevance, and implications to financial markets activity. The paper suggests a paradigm shift: a new multi-dimensional geometric approach to capture all symmetrical and asymmetrical strategic graphical movements in real space and time (Ruiz Estrada et al., 2016). The Massive Pandemic Contagious Diseases Damage on Stock Markets Simulator (φ -Simulator) to evaluate the determinants of capital markets behavior in the presence of an infectious disease outbreak. The φ -Simulator investigates the complicated structures of agent interactions based on econographicological² (Ruiz Estrada, 2017) graphical geometric approach within a framework of a Dynamic Imbalanced State³ (Ruiz Estrada, 2011) and the *Omnia Mobilis*⁴ assumption (Ruiz Estrada & Yap, 2013). The model investigates the impact of COVID-19 on the performance of ten stock markets, including S&P 500, TWSE, Shanghai Stock Exchange, Nikkei 225, DAX, Hang Seng, U.K.-FTSE, KRX, SGX, and Malaysia-FTSE.

The paper is organized as follows. The first sec-

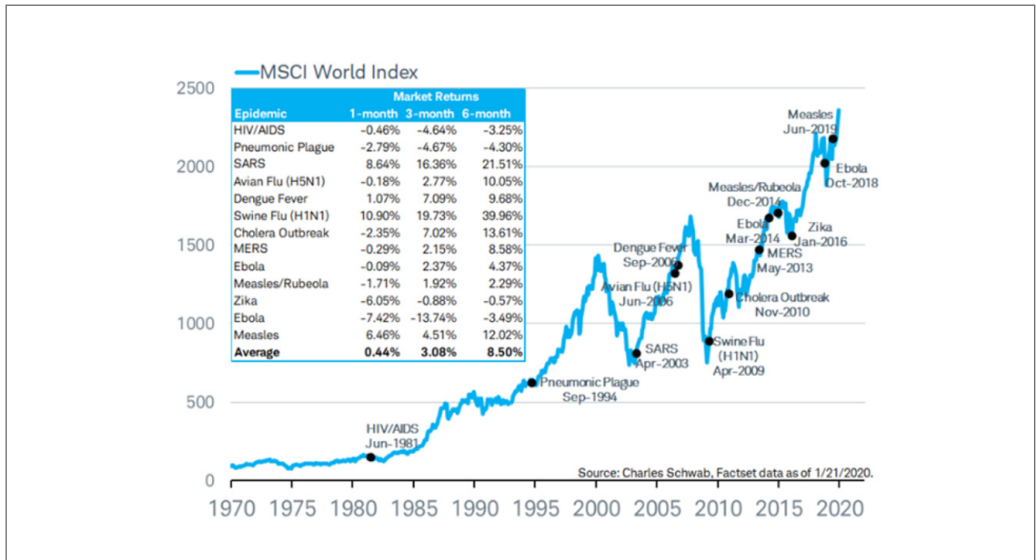


Figure 1. Historical MSCI World Index and S&P performance under epidemic risk.
Source: DeCambre, 2020

Table 1. Historical MSCI World Index and S&P Performance Under Epidemic Risk.

Epidemic	Month End	6-month % change of S&P	12-month % change of S&P
HIV/AIDS	6/1/1981	-0.3	-16.5
Pneumonic plague	9/1/1994	8.2	26.3
SARS	4/1/2003	14.59	20.76
Avian flu	6/1/2006	11.66	18.36
Dengue fever	9/1/2006	6.36	14.29
Cholera	11/1/2010	13.95	5.63
MERS	5/1/2013	10.74	17.96
Ebola	3/1/2014	5.34	10.44
Measles/Rubeola	12/1/2014	0.2	-0.73
Zika	1/1/2016	12.03	17.45
Measles/Rubeola	6/1/2019	9.82	N/A

tion offers an overview of the financial contagion. The second section introduces the model. The third section sets a simulation for the COVID-19 impact on the financial markets. The final section summarizes the conclusions and provides policy recommendations.

2. Literature Review

Notwithstanding the extensive empirical literature on the propagation of financial contagion, there is no empirical study related to epidemic risk. Plausibly, unforeseen and rare events that are subject to market-wide systematic risk will influence investor behavior. The Mexican Peso crisis of 1994, the Thailand Baht crisis of 1997, the Russian Ruble crisis of 1998, the United States' subprime mortgage crisis of 2007, and the Greek debt crisis of 2010 effectuate the most notable paradigms of country-specific crises. Based on arbitrary assumptions and self-fulfilling beliefs, the aggregate macroeconomic behavior of firms, banks, and financial institutions set off a chain of reactions that triggered international capital flow reversals. As a result, financial disturbances extended across neighboring countries, or even regions, adversely affecting the macroeconomic fundamentals, jumping to multiple equilibria⁵. Historically, the capital market reaction on epidemic infectious diseases tend to be short-termed (DeCambré, 2020).

151 empirical studies investigated financial market contagion, covering the period from 1990-2015 (Seth & Panda, 2018). The extensive literature views the financial contagion phenomenon from qualitative and quantitative angles. The list is endless; we present the most known studies in the field. Several studies concentrated on understanding the underlying fundamentals of the economy and or the market at the epicenter of crisis (Dorra & Achraf, 2014; Flavin & Sheeman, 2015; Roy & Roy, 2015). Alternative strands of literature consider the timeline of events to investigate the micro- and macroeconomic behavior in the short-run (Billio & Pelizzon, 2003; Pan et al., 2015) and long-run (Calvo & Reinhart, 1996; Eichengreen et al., 1994). Other studies concentrated on the analysis of the event per se: the Mexican crisis of 1994 (Bannier, 2006; Bodart & Candelon, 2009; Mighri & Mansouri, 2014); the Asian financial crisis of 1997-1998 (Cho & Parhizgari, 2008; Ito & Hashimoto, 2005; C. Wu et al., ; the Russian crisis of 1998 (Rigobon, 2003; Saleem, 2009; Sojli,

2007; Steinherr, 2006), and; the global financial crisis of 2008 (Kenourgios & Dimitriou, 2015; Kim, Kim, & Lee, 2015; Luchtenberg & Vu, 2015); Greek debt crisis of 2010 (Arghyrou & Kontonikas, 2012; Chira & Marciniak, 2014; Constancio, 2012; Mink & De Haan, 2013).

In the quantitative context, empirical studies employed numerous econometric techniques: Co-skewness, Co-volatility and Co-kurtosis (Fry-McKibbin & Hsiao, 2015; Hsiao & Morley, 2015; Tabak, de Castro Miranda, & da Silva Medeiros, 2016); regression analysis (Caporin et al., 2018; Dooley & Hutchison, 2009; Glover & Richards-Shubik, 2014; Mondria & C., 2013); Generalized Auto-Regressive Conditional Heteroskedasticity (GARCH) (Abbara & Zevallos, 2014; Hoesli & Reka, 2013; Jayech, 2016); Granger causality (Bekiros, 2014; Gomez-Puig & Sosvilla-Rivero, 2016; Islam, 2014; Mollah et al., 2016); Markov switching models (Dimitriou & Simos, 2013; Flavin & Sheeman, 2015; Guo et al., 2011; Rotta & Pereira, 2015), and; VAR analysis (Flavin & Sheeman, 2015; Kilic & Ulusoy, 2015; Mollah et al., 2016; Roy & Roy, 2015; Samarakoon, 2011).

3. The Model

Consider a multi-dimensional interlinked coordinate space obtained by multiplying the n -spaces of the n -players. The construction of the inter-linkage coordinate space is based on Ruiz Estrada's (2016) Econographicology framework. Each dimension has an n -dimension state vector that contains the effect of prior strategic interactions relative to that dimension. N -dimensional equilibrium points depict the symmetric and asymmetric virus behavior that occurs at the same time and space. The projection of N -dimensional state vectors in a multi-dimensional Euclidean n -sphere manifold embeds in the Euclidean $(n+1)$ -plane. The multi-dimensional representation of endogenous and exogenous variables depicts the entire simultaneous strategic interaction of stock market performance within differential formations in space and time mapping, of which a two-dimensional Euclidean plane fails to capture (see Figure 2)(Ruiz Estrada, 2009b).

The inter-linkage coordinate space is formed by "n" number of general axes (market daily behavior: Y'Wuhan), of which consists of "n" number of sub-spaces (stock markets: S1, S2, S3, S4, S5, S6, S7, S8, S9, S10). Time zero is considered the day where an infectious disease appeared in a population for the first time, whereas

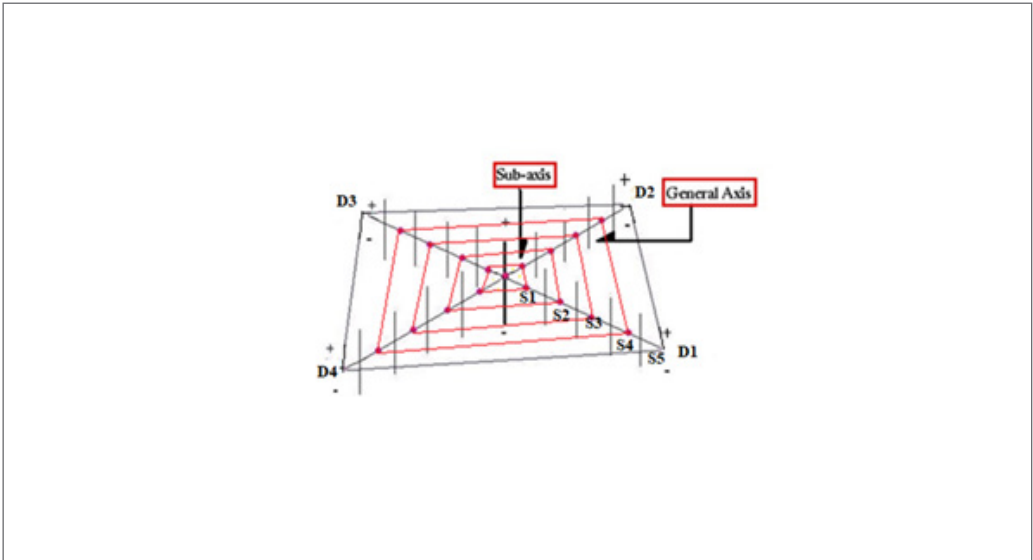


Figure 2. -φ- Simulator coordinate system.

the terminal time is considered as the day where the epidemic is under control. The crossover point is equal to zero, which is the epicenter of the coordinated system. Each general space (axis) is divided into three sections, followed by positive integers and negative integers. The inter-linkage coordinate system allows the allocation of any value on its coordinate system based on the plot value on its sub-space (sub-axis). All general spaces start from general space 0 and take values in $[0, \infty]$. The graphical value representation takes place in the same general space. There are as many layers as there are dimensions; the links between nodes within each layer are simply all the links for a given dimension. The chain of all values through straight lines generates a single large manifold into the same graphical space and time. All the sub-axes (stock markets) are interconnected by straight lines to the end of each general axis (D) by the application of the inter-linking sub-axis system “ $\#$ ”. The connection of all general axes and sub-axes stock markets in the same level of analysis until we arrive at the last sub-axis called the global average stock market performance index (\bar{G}). \bar{G} is estimated by expression 1. Each sub-axis (stock market) performance (maximum/minimum) is calculated by the partial differentiation from $\left(\frac{\partial \dot{Y}_{ij}}{\partial s_{ij}}\right)$ to $\left(\frac{\partial^2 \dot{Y}_{ij}}{\partial^2 s_{ij}}\right)$ in real-time

(\odot) (see Expression 2 and 3) (Ruiz Estrada, 2009a).

$$\bar{G}_i = \log \left\{ \frac{\left(\odot \left(\frac{\partial \dot{Y}_{ij}}{\partial s_{ij}} \right)^{n-1} + \odot \left(\frac{\partial \dot{Y}_{in}}{\partial s_{in}} \right) \right)}{n} \right\} \quad (1)$$

where $\Delta \dot{Y}_{i,j}$ corresponds to the infectious disease daily growth rate. Differentiation of expression (1) will give the maximum or minimum

$$\begin{aligned} D'_1 &= \left[\odot \left(\frac{\partial \dot{Y}_{1:1}}{\partial S_{1:1}} \right) \# \odot \left(\frac{\partial \dot{Y}_{1:2}}{\partial S_{1:2}} \right) \# \dots \# \odot \left(\frac{\partial \dot{Y}_{1:n}}{\partial S_{1:n}} \right) \# \dots \# \bar{G}_1 \right] \\ D'_2 &= \left[\odot \left(\frac{\partial \dot{Y}_{2:1}}{\partial S_{2:1}} \right) \# \odot \left(\frac{\partial \dot{Y}_{2:2}}{\partial S_{2:2}} \right) \# \dots \# \odot \left(\frac{\partial \dot{Y}_{2:n}}{\partial S_{2:n}} \right) \# \dots \# \bar{G}_2 \right] \\ &\vdots \\ D'_n &= \left[\odot \left(\frac{\partial \dot{Y}_{n:1}}{\partial S_{n:1}} \right) \# \odot \left(\frac{\partial \dot{Y}_{n:2}}{\partial S_{n:2}} \right) \# \dots \# \odot \left(\frac{\partial \dot{Y}_{n:n}}{\partial S_{n:n}} \right) \# \dots \# \bar{G}_n \right] \end{aligned} \quad (2)$$

The second differentiation of expression (2) determines the critical point (inflection point)

$$\begin{aligned} D''_1 &= \left[\odot \left(\frac{\partial^2 \dot{Y}_{1:1}}{\partial^2 S_{1:1}} \right) \# \odot \left(\frac{\partial^2 \dot{Y}_{1:2}}{\partial^2 S_{1:2}} \right) \# \dots \# \odot \left(\frac{\partial^2 \dot{Y}_{1:n}}{\partial^2 S_{1:n}} \right) \# \dots \# \bar{G}_1 \right] \\ D''_2 &= \left[\odot \left(\frac{\partial^2 \dot{Y}_{2:1}}{\partial^2 S_{2:1}} \right) \# \odot \left(\frac{\partial^2 \dot{Y}_{2:2}}{\partial^2 S_{2:2}} \right) \# \dots \# \odot \left(\frac{\partial^2 \dot{Y}_{2:n}}{\partial^2 S_{2:n}} \right) \# \dots \# \bar{G}_2 \right] \\ &\vdots \\ D''_n &= \left[\odot \left(\frac{\partial^2 \dot{Y}_{n:1}}{\partial^2 S_{n:1}} \right) \# \odot \left(\frac{\partial^2 \dot{Y}_{n:2}}{\partial^2 S_{n:2}} \right) \# \dots \# \odot \left(\frac{\partial^2 \dot{Y}_{n:n}}{\partial^2 S_{n:n}} \right) \# \dots \# \bar{G}_n \right] \end{aligned} \quad (3)$$

All distributed functions in different micro-spaces under different general-space and sub-space levels apply the Omnia Mobilis, “Everything is moving,”

assumption. This assumption allows a large number of variables to be simultaneously observed in our multi-dimensional analysis, as opposed to the *Ceteris Paribus* assumption, which keeps variables constant.

Partial differentiation generates asymmetric fluctuations of different periodicity in the form of waves. These waves affect all sectors in the economy, causing a smash effect (Ruiz Estrada, 2013). Whereas the Kondratieff wave theory (Kondratieff, 1922; Schumpeter, 1954) identifies the phases of business cycle – expansion, peak, contraction, trough, and recovery, smash effect identifies financial and economic crises because of improbable, unpredictable events such as earthquakes, floods, droughts, epidemics or terrorist incidents. In parallel, the Black Swan theory (Taleb, 2007) situates natural and human-made events in a historical and theoretical context to categorize event patterns and pinpoint early warning signs so that a realistic prevent assessment can be prepared. Notwithstanding theory's wide acceptance among finance professionals, it provides a limited understanding of the social, economic, cultural, and environmental impacts of unexpected events on capital markets due to lack of scientific rigor.

The socio-economic landscape is subject to endogenous and exogenous uncertainties. In principle, these drivers of change may retain their essential properties; however, their impact on financial markets has changed. The new complex environment emerged unknown systematic risks (regulatory/legislative changes, political uncertainty, environmental scarcity, climate change, regional conflicts, and cybercrime) and unique needs (social protection, food and water security, increased poverty). These conditions require a dynamic assessment framework, which requires to suggest policies that promote adaptation and resiliency rather than a philosophy of control.

4. The Application of the ϕ -Simulator on Ten Major Stock Markets

ϕ -Simulator conceptualizes the time of evolution of epidemic mathematically and shapes the interaction between the rate of spread of infectious disease and the capital markets environment. The proposed analytical

framework assumes that all capital markets are subject to epidemic risk. Each infectious disease phenomenon is independent in terms of vulnerability, frequency, intensity, magnitude, and economic impact on capital market performance. ϕ -Simulator attempts to quantify the risk and the probability of epidemic events, conceptualizing micro-foundations, and satisfy all a priori conditions and constraints. The dynamic imbalanced state environment constitutes an ex-ante epidemic assessment and monitoring burdensome. Nevertheless, an ex-post evaluation of epidemic damages via time series analysis is possible.

The model employs qualitative and quantitative data from Asian the Chinese Ministry of Health. We employed secondary data from ten major worldwide stock market exchanges: United States (S1 = S&P 500); Taiwan (S2 = TWSE); China (S3 = Shanghai Stock Exchange); Japan (S4 = Nikkei 225); Germany (S5 = DAX); Hong Kong (S6 = Hang Seng); U.K. (S7 = FTSE); South Korea (S8 = KRX); Singapore (S9 = SGX); and Malaysia (S10 = FTSE Bursa). The simulation scenarios consider an epidemic period of 150 days. The model algorithm consists of 85 main variables and 1,200 sub-variables. Authors run 650 random and fuzzy simulations based on different contagion and mortality risk scenarios across China. They identified the drivers of the potential magnitude of the disease outbreak given the current 150-day data availability (December 15th – March 15th) of the COVID-19 coronavirus along with the stock markets daily performance for the same period and the extended Chinese government's coronaviruses database (1995–2019). All equations in this model were transformed into a large algorithm by using Mathematica Wolfram version 11 language programming that allows authors to generate a large pool of possible results to the problem at hand.

Model preliminary findings on the global average stock market performance are summarized in Figure 3. Although the onset of symptoms was epidemiologically identified in Wuhan city on December 8th, Chinese Health officials informed the WHO (World Health Organisation) on December 31st about a cluster of 41 patients with mysterious pneumonia. There is a significant time lag between the first virus symptoms and the confirmed cases officially reported by Chinese authorities. The incubation period of the virus may appear in as few as 2 days or as long as 14 (WHO: 2-10 days; China's

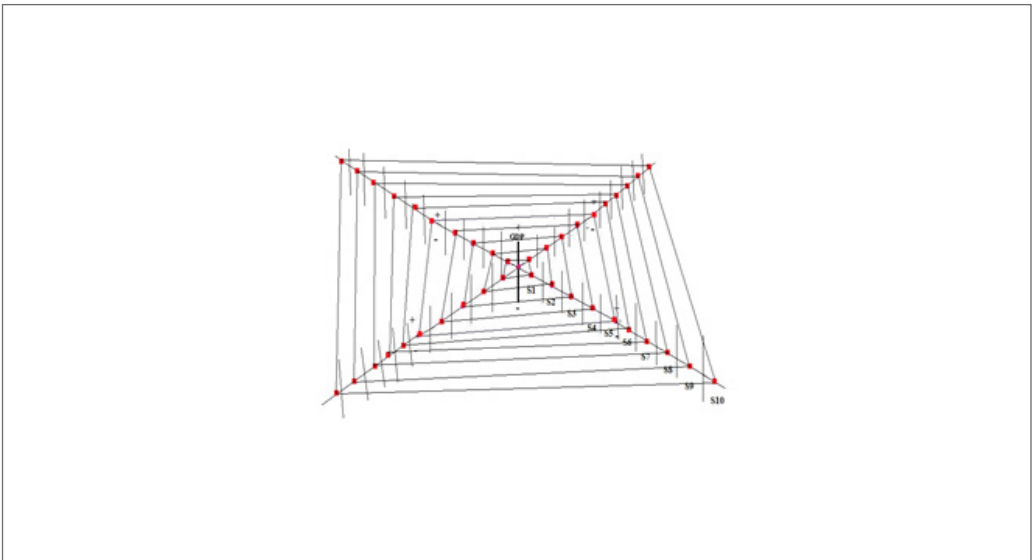


Figure 3. The Economic Smash effect from COVID-19.

National Health Commission (NHC): 2-14 days; The United States' Centers for Disease Control and Prevention (CDC) and 10-14 days), during which the virus is contagious, but the patient does not display any symptom. Recent studies report an extended incubation period of up to 28 days (Lauer et al., 2020). Given the high population density and distribution, it is plausible to argue that epidemics extended beyond the geographical boundaries of Hubei Province. Besides, virus acceleration spread rate and intensity are higher than those of Severe Acute Respiratory Syndrome (SARS) (Ruiz Estrada & Koutronas, 2020).

All estimates are based on confirmed infected cases who developed symptoms, making no inferences about the role of asymptomatic infection in virus transmission dynamics. Asymptomatic transmission epicheirema has been subject to skepticism among epidemiologists. Nevertheless, the asymptomatic transmission can explain to a great extent why coronavirus outbreak overwhelmed countries like Italy, the United States, and Spain. In spite of the Draconian measures of social distancing, countries' epidemic forecasting was based on false assumptions on virus transmission and incubation period, leading to underestimated projections about the epidemic trajectories.

Furthermore, COVID-19 projections were based on China's official confirmed COVID-19 incidents, of which asymptomatic cases are excluded. Most important, the tracking criteria for infectious incidents have been updated several times by the Chinese officials since the beginning of the outbreak, leaving the classified confirmed cases paradoxically unchanged. These kinds of practices are inconsistent with the WHO's guidance, indicating that epidemiological models developed to estimate the spread of COVID-19 rely on skewed data (Xie, 2020). Indeed, distinct epidemiologists mentioned five underlying reasons why China's official COVID-19 data seem contradictory: assumptions about China's forthrightness; the challenges of treating the new virus in rapidly changing conditions; the limitation of predictive models; time differences in overlapping reports; and the uncertainty of implications (Sherman, 2020).

φ -Simulator assesses mild, moderate, and asymptomatic infection as part of the infected population. This assumption brings significant qualitative differences in the time-evolution of the epidemic, capturing the ground zero sub-exponential growth dynamics. Day-1 of the pandemic is considered the December 27th, 2019 (the first official reported cases). On Day-1 ($\Delta\ddot{Y}$ Wuhan = 0.01) ($\bar{G}1 = 1.88$), estimates indicate a negative cor-

relation between the initial state of the epidemic and the stock market performance index (\bar{G}).

On Day-10 ($\Delta Y_{\text{Wuhan}} = 0.10$) ($\bar{G}_{10} = 1.62$), coronavirus spread quickly across China. Domestic capital markets (S3 = Shanghai Stock Exchange); (S6 = Hong Kong Hang Seng) continued their downward trend started on December 15th and 17th, respectively. Chinese authorities shut down Huanan Seafood Wholesale Market, but they decided to quarantine the infected areas in the Chinese New Year's holiday. Chinese New Year week-long vacation motivated some companies to increase their inventory coverage by another week. So, for most companies, the inventory coverage they have will allow them to match their supplies with demand, with no additional supply, for between two to five weeks, depending on the company's supply chain strategy. Supply lead times will also have an impact. Shipping by sea to either the United States or Europe takes, on average, 30 days. It implies that if Chinese plants stopped manufacturing prior to the beginning of the Chinese holiday on January 25th, the last of their shipments would be arriving in the last week of February.

In Day-30 ($\Delta Y_{\text{Wuhan}} = 0.25$) ($\bar{G}_{30} = 1.27$), manufacturing lockdown due to social distancing measures has a direct effect on production activity. According to China Beige Book's flash survey, 31 percent of the firms suspend their operations, and those who reopened coping with raw materials supply shortage: 40 to 50 percent of the truck fleet remains idle (Lloyd, 2020). The coming supply-shock and trade irregularities in the first quarter fueled expectations of an economic contraction, of which interpreted to excess volatility in the domestic capital markets. The trade deal between the United States and China strengthened temporarily investor sentiment mid-January, followed by market corrections. In the regional context, Asian stock markets fell rapidly as rampant volatility takes hold: Taiwan (S2 = TWSE); Japan (S4 = Nikkei 225); South Korea (S8 = KRX); Singapore (S9 = SGX), and; Malaysia (S10 = FTSE Bursa). Taiwan Stock Exchange underperformed by a modest margin due to the fact the Taiwanese government had successfully controlled COVID-19. In contrast, the Nikkei Stock Average index has plunged, which experienced a further decline after the announcement from the Olympic Committee that the Tokyo 2020 Olympic Games will be postponed by up to a year. South Korea,

along with Singapore and Malaysia, lagged as the prospect of weaker global growth due closely linked to China in global supply chains. The peripheral economies in Southeast Asia are heavily dependent on travel and tourism and are expected to be impacted by reduced visitors from China.

In Day-60 ($\Delta Y_{\text{Wuhan}} = 0.45$) ($\bar{G}_{60} = 1.10$), coronavirus crossed the Chinese borders. Singaporean and Malaysian governments announced a 4.5 billion-dollar and a 20 billion-ringgit fiscal stimulus packages, respectively. S&P 500 had been experiencing a market correction, erasing the profits of the trade deal between the United States and China. The economic consequences of the pandemic are becoming obvious in the American economy. The unemployment rate remains at a 50-year low of 3.5 percent, but in the last two weeks of the month, almost 10 million people applied for unemployment benefits. With COVID-19 accelerating throughout the country, investor sentiment has been fueled by uncertainty about the economic consequences of getting the pandemic under control, which was translated into excess market volatility. The Federal Reserve announced a benchmark rate cut by one percent and an injection into the financial markets of 1.5 trillion dollars in the form of treasury and mortgage-backed securities. At the end of the month, the overall picture shifted when Trump administration announced an initial 2.2 trillion-dollar economic recovery package to be distributed to millions of American citizens in the form of cash backs, loans, grants, and tax breaks for businesses.

In Europe, there have been rapidly growing numbers of severe and fatal cases in many EU/EEA countries, and several countries in Europe have already reported nationwide community transmission. Italy, Spain, France, and the Netherlands have already registered healthcare system saturation due to very high patient loads requiring intensive care. Stock markets have plummeted: France, -17.21 percent; Germany, -16.44 percent; the United Kingdom, -13.74 percent and; Italy, -22.85 percent. The European Central Bank announced to inject 780 billion euros into financial markets and refinancing options for the private sector of 3 trillion euros. In the United Kingdom, the Bank of England proceeded to interest rate cuts, whereas the government announced expansionary measures of 30 billion pounds. Germany will launch a stimulus package of 750 billion euros to support the local economy.

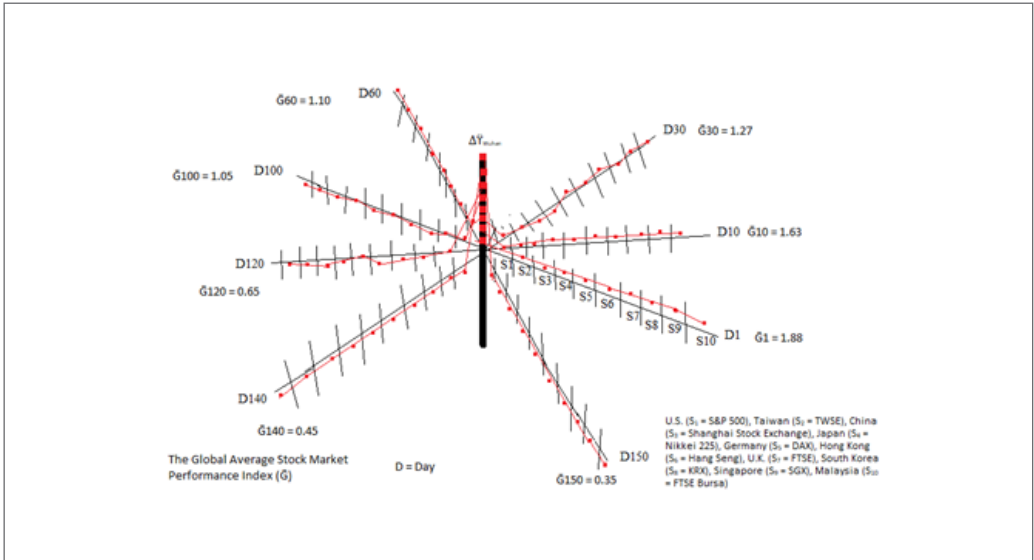


Figure 4. The $-\phi$ -Simulator final results from 10 stock markets.
 Source: WHO (2020), S&P 500 (2020), TWSE (2020), Shanghai Stock Exchange (2020), Nikkei 225 (2020), DAX (2020), Hang Seng (2020), FTSE (2020), KRX (2020), SGX (2020), FTSE Bursa (2020).

In Day-120 ($\Delta Y_{Wuhan} = 0.55$) ($\bar{G}_{120} = 0.65$), stock markets officially become bearish. Every economic assumption that seemed valid a month ago is now being reevaluated and revised downward. Stock prices reflect expectations of future profits, and investors see the virus dampening economic activity and reducing profits. According to ϕ -Simulator, it is possible to get in Day-140 optimistic estimates ($\bar{G}_{140} = 0.45$, $\Delta Y_{Wuhan} = 0.65$), and in Day-150 pessimistic estimates ($\bar{G}_{150} = 0.35$, $\Delta Y_{Wuhan} = 0.85$) given the assumption that we arrive to the maximum damage of COVID-19. Suddenly the COVID-19 is under control and exist a possible vaccination worldwide.

Intuitively, the pandemic aftermath will be uncharted territory for the world economies and financial markets. It is a plausible conjecture that the world economy may experience a new economic phenomenon, so-called by authors as a staggression. In this situation, recession overlaps depression causing structural economic deconstruction. It will present a dilemma for economic policy since expansionary actions intend to boost economic activity through monetary and fiscal stimulus would be inefficient if economies cross their sustain-

ability threshold level. The structural resilience of an economy depends on its strength to absorb the impact of economic lockdown without affecting business and employment viability. If the economy crosses the sustainability level, production, consumption, and wealth will plummet; then it will be required a revitalization of the economy. Rejuvenation involves restoring the flow of goods and services within the country and across the border, through infrastructure, private sector, human capital, and financial sector development. In particular, the implementation of place-based policies will focus on rebuilding local economies, create new employment opportunities, and ensure sufficient financial assistance for the displaced, unemployed, under-employed, and new entrants. Consumer spending should restore to its default values since it constitutes 50 to 70 percent of GDP.

Empirical evidence shows that gradual unfavorable supply and demand shocks with medium- and short-term effects in output and employment characterizes the previous episodes of financial crises. In the case of staggression, the epidemic impact on economic activity differs in terms of magnitude and intensity: an

economy experiences a supply and demand shocks in the short-run with instant effects in output and employment. In contrast to previous financial crises, the double impact on demand will contract imports and exports.

The disruption of global economic production due to the shutdown of China-centric global supply chains generated output shortages on intermediate and final goods. Even if the Chinese government introduces an infrastructure spending program to restore its pre-pandemic production capacity, this effort will not be followed by pre-pandemic demand levels. In parallel, export dependence and export concentration economies in durable goods, mining, and oil production will be severely hurt, shifting from a short-term recession to a medium and -maybe- a long-term depression by the end of 2020. In contrast, agriculture sector economies will enforce restrictions or even ban exports in an attempt to secure domestic demand first, triggering major trade disruptions in the complex food value chain: production, processing, packaging, storage, transportation, and retail sales. Domestically, tourism, transportation, entertainment, retail, and small businesses are devastated, followed by durable goods value chain. Logically, some sectors may benefit, such as e-commerce, food retail, and the healthcare industry - providing at least some economic growth to offset the damage.

Consistent with the literature, a sharp decline of production will affect future capital and inflows and outflows, translating into high stock market volatility. In turn, volatility shocks affect economic activity with a further decline in investment, GDP, output, and employment. As a result, further increase liquidity constraints and credit market tightening in global financial markets, with adverse fallout effects on economic growth. The prospect of economic growth determines the behavior of the financial markets, of which is based on several factors, including the magnitude and duration of national shutdowns, the extent of reduced demand for goods and services in other parts of the economy, and the speed at which significant fiscal and monetary support takes effect. Given the current conditions, American financial markets will experience substantial capital inflows, especially from emerging Asian economies. The impact on the European financial markets seems ambiguous.

5. Concluding Remarks

The model provides a preliminary explanation and prediction of infectious disease behavior and adds new theoretical information about the nature of epidemics since there is always a gap between a real influence on the nature of an epidemic and a theoretical understanding of that influence. Furthermore, the paper introduces the concept of stagpression, a new economic phenomenon to explain the uncharted territory that is getting into the world economies and financial markets.

It is plausible to expect that the aftermath of COVID-19 has the potential to cause widespread economic disruption. Φ -Simulator findings suggest that the 150 lockdown period can be disastrous for all economies if they cross their sustainability threshold level. The analysis of ten major stock markets worldwide shows that the effects of COVID-19 can generate similar damage to the Crisis 1929 ($\bar{G} = 0.23$). It will require a 9-to-12-month recovery phase considering the outcome of American elections, the reconstruction measures of the European economies, and the decentralization of production from China. We can observe with the ϕ -Simulator possible scenarios and the final effect of any massive pandemic infectious diseases by the levels of the global average stock market performance index (\bar{G}).

Undoubtedly, the counter-pandemic measures have had sudden and profound economic impacts. In view of the coming recession, automatic stabilizers will provide a significant economic stimulus to those who needed it. However, this is not a normal recession but rather a stagpression. In the short run, so long as confinement and lockdown constraints are on, potential output will remain much lower. Economic contraction is already on its way with irreversible repercussions to the economy. In previous recessions, trade protectionism policies, along with export subsidies, enabled businesses to recover in the medium term. However, the current pandemic constitutes the traditional policy response irrelevant. Each government has to preserve the country's productive capacity restoring consumer spending, business investment, and market expectations.

Further and coordinated action is required from all governments to support economic activity directly. Employment has to be recovered close to pre-re-

cession levels. Conventional monetary policy action aimed to lower borrowing costs for individuals and businesses, thereby encouraging both immediate consumption and investment. This policy will not be effective since the economy's sustainability threshold level is crossed. Pandemic has already generated an economically unacceptable environment characterized by business bankruptcies, foreclosures/evictions, and forbearance on debt. Government intervention is imperative to correct the economy's failures and promote the general welfare of the society.

Φ-Simulator offers to policymakers, central banks, academics, and students an alternative multi-dimensional graphical modeling approach to analyze the pandemic impact on capital markets from a multi-dimensional perspective. The multi-dimensional approach to financial market analysis presented in this study needs to be explored further to realize its full potential. The classic two-dimensional Euclidean configuration carries mathematical and graphical limitations that fail to capture all possible financial market equilibria. It is, therefore, necessary to continue the empirical validation exercises by considering professional subjects, designing new experiments with more cases and different algorithms, running case studies with real data from the economic environment to ensure conclusion validity.

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Endnotes

1. Many experts have argued that it is an 'accelerant' rather than the sole core reason behind the crash (Karabell, 2020; Pankratyeva, 2020).
2. Econographicology revolves around the efficacy of multi-dimensional graphs in the storage of meta-database and the visualization of multi-variable data behavior based on the application of Cartesian coordinate space.
3. *Dynamic Imbalance state* assumption incorporates internalities and externalities in the explanation of market behavior.
4. *Omnia Mobilis* assumption suggests the simultaneous observation of changes in all variables in real-time. This assumption allows a large number of variables to be simultaneously observed in a multi-dimensional analysis, as opposed to the *ceteris paribus* assumption, which keeps variables constant.
5. A fundamentals-driven crisis is more contagious than a beliefs-driven crisis, and is more contagious than when information is less complete (Chang & Majnoni, 2002).