The Evaluation of the Final Impact of Wuhan COVID-19 on Trade, Tourism, Transport, and Electricity Consumption of China

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Economic simulation, contagious disease, China, trade, tourism, air transportation, electricity consumption

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Abstract

In this paper, we evaluate the impact of Wuhan COVID-19 (Coronavirus Disease 2019) on four strategic sectors - i.e. tourism, air transportation, international trade, and electricity consumption of the Chinese economy. To do so, we develop and apply a new model - the economic crisis from massive contagious infection diseases simulator (ECMCID-Simulator). The simulator deploys a macro-dynamic analysis under different possible scenarios to evaluate the impact of a massive contagious infection disease on the short-run economic performance of a country.

1. Introduction

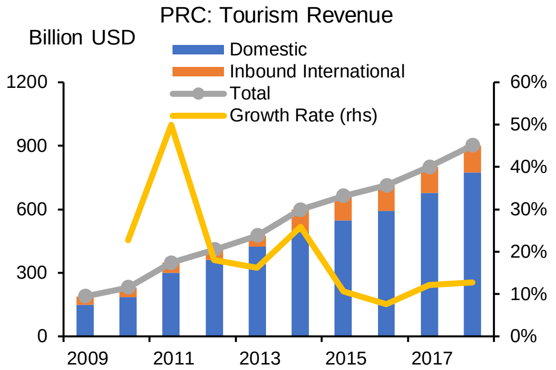
COVID-19 or Coronavirus Disease 19 has erupted in Wuhan, the capital city of Hubei province in the PRC, in December 2019 and spread across Asia and the world like a wildfire. It has become a global public health crisis in just a matter of few months. As of 8 March 2020, the cumulative number of confirmed cases worldwide reached 106,369. The PRC accounted for the overwhelming majority of the confirmed cases - 80,695 – but a significant outbreak also occurred in other countries and regions. The number of cases exceeded 7,300 in Korea and 5,800 in both Iran and Italy. Many other major countries also witnessed significant numbers of confirmed infections – France (949), Germany (800), Spain (525), Japan (461), and US (433). The number of worldwide fatalities approached 3,600. Within the PRC, Hunan province, the epicenter of COVID-19, accounted for 67,707 cases. Other provinces with significant numbers of cases included Guangdong, Henan, Zhejiang, Hunan and Anhui. As a public health crisis, COVID-19 already dwarfs earlier episodes of major coronavirus outbreaks – SARS of 2002-3 (8,437 confirmed cases and 813 fatalities) and MERS of 2012 (2,499 confirmed cases and 861 fatalities.

Above all, COVID-19 is a global public health crisis. Despite its low fatality in comparison to SARS and MERS, its highly infectious nature has spawned a contagion of fear worldwide. While the most immediate and direct effect of COVID-19 is on health and health care, it is bound to have outsized economic ramifications. There are a number of channels through which COVID-19 can adversely affect the economy. Consumption, retail and service industries are expected to take a big hit as consumer confidence is adversely affected and consumers refrain from going out. International tourism and travel will also be disrupted due to travel restrictions and reduction of airline flights. In addition, COVID-19 will harm international trade, due to both weakening of demand and disruptions of global supply chains.

Although COVID-19 will have ramifications for global economy and trade, the PRC is likely to bear the lion's share of its negative economic effects. This was the case during the SARS crisis of 2003, and we expect this to be the case for COVID-19. After all, despite its spread across the world, the bulk of confirmed cases are still concentrated in the PRC, which is thus likely to suffer the bulk of the economic impact of the disease. At the same time, the economic impact on the PRC will differ across sectors. In our analysis, we examine four key strategic sectors where the impact of the disease is likely to be tangible, namely tourism, international trade, air transportation, and electricity consumption.

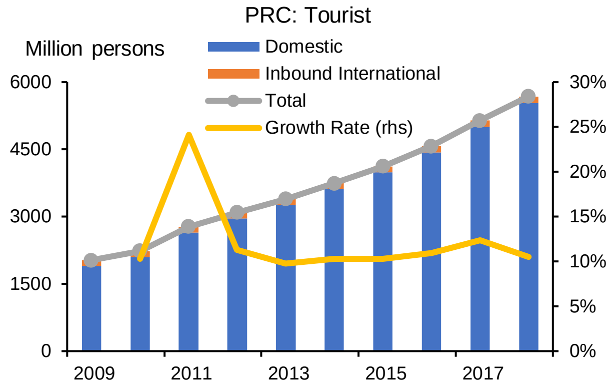
First, between 2010 and 2018, tourist revenues in the PRC have been expanding by 19.5% per year on average, up from $231.6 in 2010 to $902 billion in 2018. During the same period, the number of tourists increased by 12.2% on average per year, reaching 5.7 billion in 2018. According to the National Bureau of Statistics, tourism and related industries accounted for 4.48 percent of GDP in 2018 (see Figure 1 and 2).

Fig. 1 Tourism Revenue and Growth



Source: Ministry of Culture and Tourism.

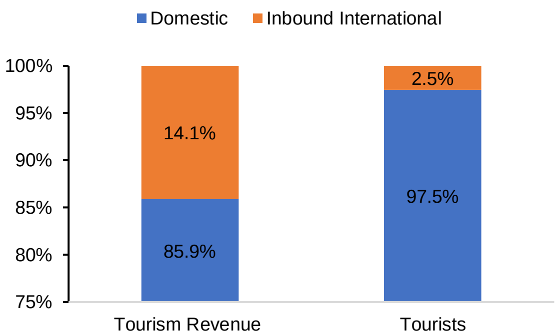
Fig. 2 Tourists and Growth



Source: Ministry of Culture and Tourism.

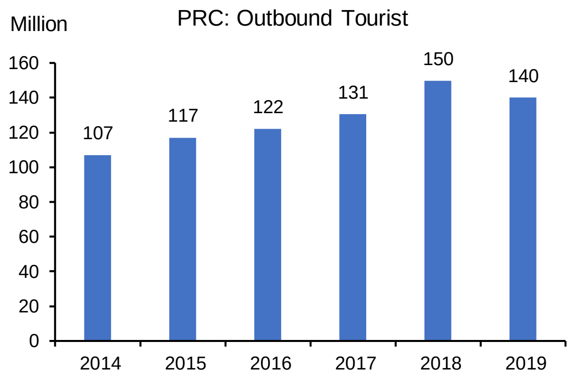
Domestic tourism has been the main pillar of the tourism industry. In 2018, it accounted for 85.9% of total revenue and 97.5% of total tourists. The revenue of domestic tourism and number of domestic tourists outgrew inbound international tourism, with average growth rates of 20.2% and 12.7% respectively during 2010-2018. On 24 January 2020, the PRC officially suspended domestic and overseas group tours, and suspended sales of certain travel products such as flight tickets and hotel bundle packages due to COVID-19. This policy not only affects domestic tourism, which generated $774.9 billion revenue in 2018, but also outbound tourism. There were 140 million Chinese outbound tourists in 2019. The outbound tourism expenditure was $115.3 billion in 2017 (see Figure 3 and 4).

Fig. 3: Share of Inbound International Tourism and Domestic Tourism in 2018



Source: Ministry of Culture and Tourism.

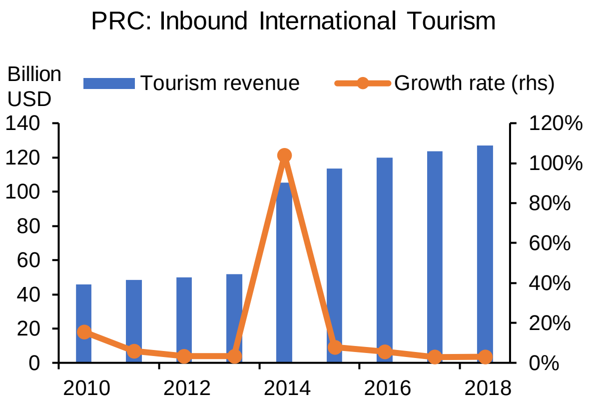
Fig. 4: Outbound Tourist



Source: Ministry of Culture and Tourism.

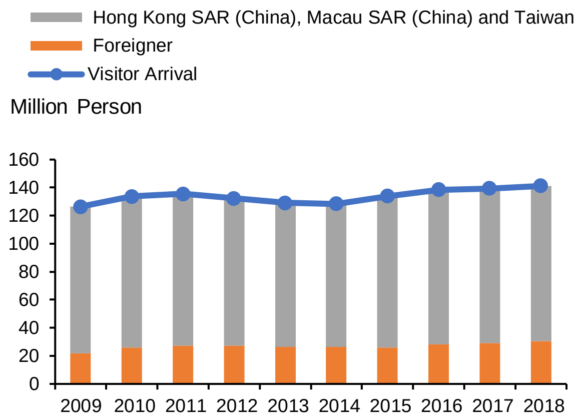
At the same time, inbound international tourism also experienced fast growth. During 2010-2018, inbound international tourism revenue grew by 19.5% per year on average, reaching $127.1 billion in 2018. During the same period, the PRC received 134.7 million visitor arrivals on average. Of this number, about 80% were from Hong Kong SAR (China), Macau SAR (China) and Taiwan. On 30 January 2020, WHO declared COVID-19 a global health emergency. This led to several airlines cancelling their flights to China, which will significantly reduce the number of international visitors to the PRC (see Figure 5 and 6).

Fig. 5: Inbound International Tourism Revenue



Source: Ministry of Culture and Tourism.

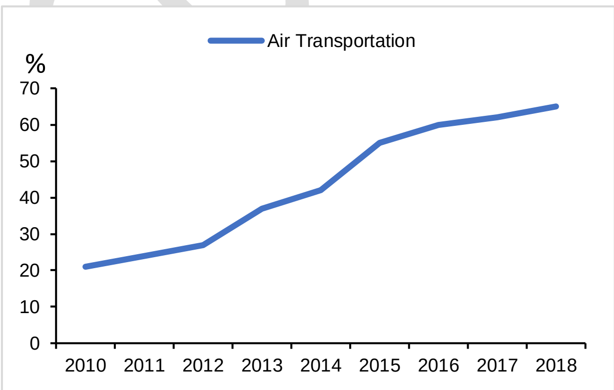
Fig. 6: Visitor Arrival



Source: Ministry of Culture and Tourism.

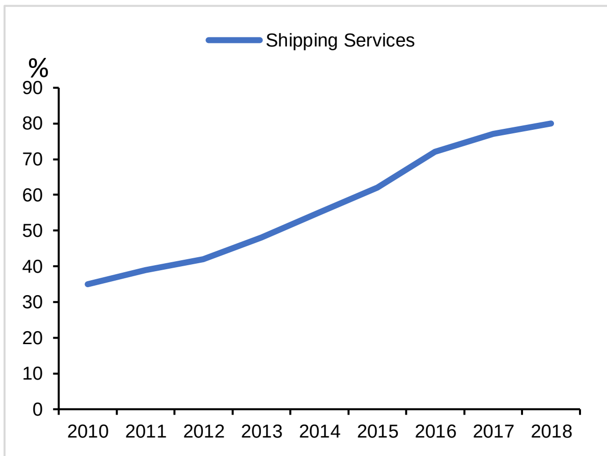
In addition, we are interested in the impact of COVID-19 on air and shipping transportation, which is vital for the movement of goods and people. The two sectors grew rapidly by 75% and 87% in 2010-2018 (see Figure 7 and 8).

Fig. 7: Air Transportation Revenue (Domestic plus international)



Source: Ministry of Transportation.

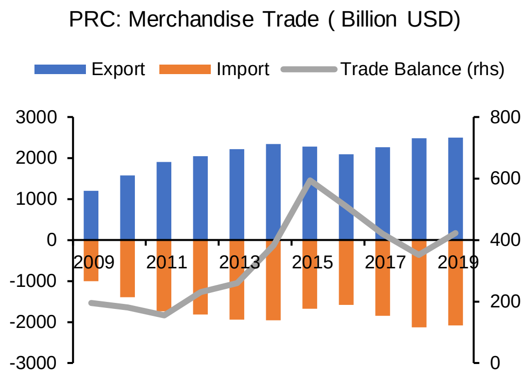
Fig. 8: Shipping Services



Source: Ministry of Transportation.

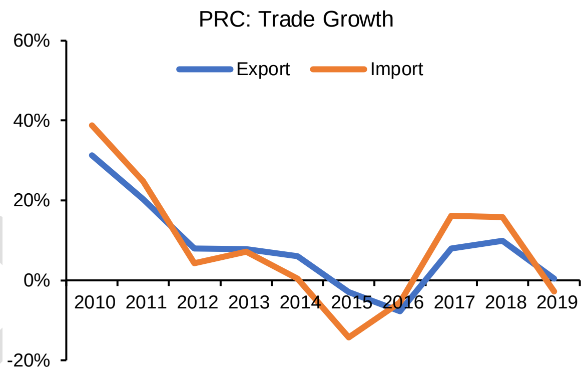
In the case of international trade, we can observe that in the past ten years, merchandise exports and imports (in US dollar-terms) in the PRC grew by 8.1% and 8.5% per year on average, resulting in an average of $350.5 billion trade surplus per year[1]. However, the trade conflict between the US and the PRC had an adverse impact on PRC's trade in 2019. Exports grew by only 0.5% and imports declined by 2.7%. As a result, the merchandise trade surplus increased from $350.9 billion in 2018 to $421.9 billion in 2019. Since COVID-19 reduced working days and delayed transport and production, Q1 trade data will be weaker than usual (see Figure 9 and 10).

Chart 9: Merchandise Trade



Source: General Administration of Customs.

Chart 10: Merchandise Trade Growth

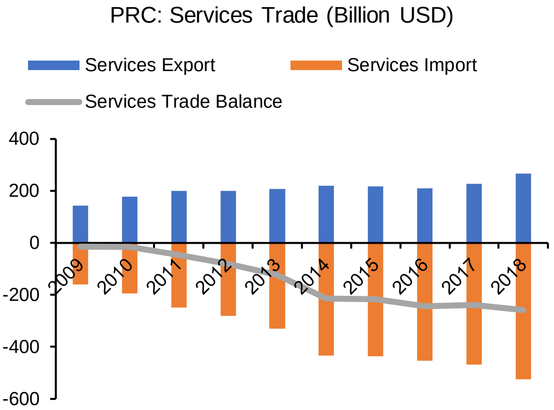


Source: General Administration of Customs.

During 2010-2018, services trade of the PRC has been expanding rapidly, with services imports increasing 14.7% on average and services exports growing 7.5% on average[2]. The service trade deficit rose to $258.2 billion in 2018, up from $15.1 billion in 2010. Services trade is expected to be affected more by COVID-19 than goods since cross border travel and tourism accounted for 52.7% of services imports and 14.8% of services exports in 2018 (see Figure 11 and 12).

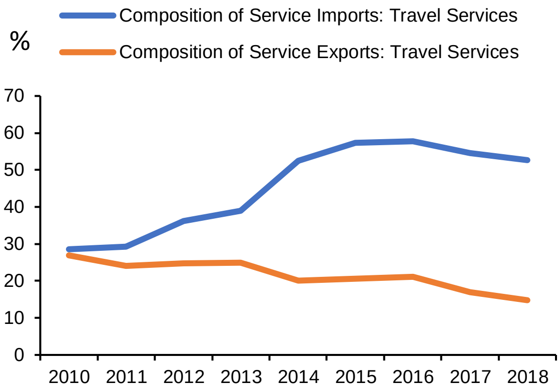
[1] Merchandise trade data is from General Administration of Customs
[2] Services trade data is from Ministry of Commerce

Chart 11: Services Trade



Source: Ministry of Commerce.

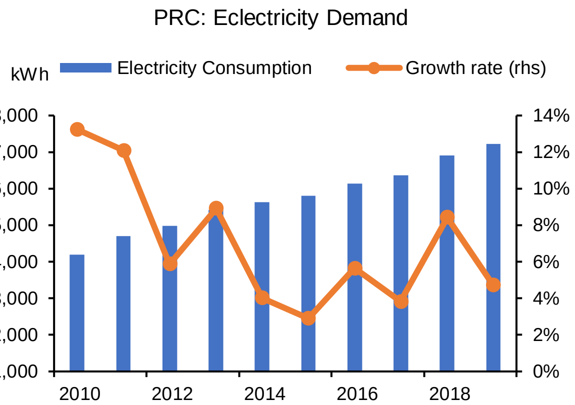
Chart 12: Composition of Services Trade



Source: Ministry of Commerce.

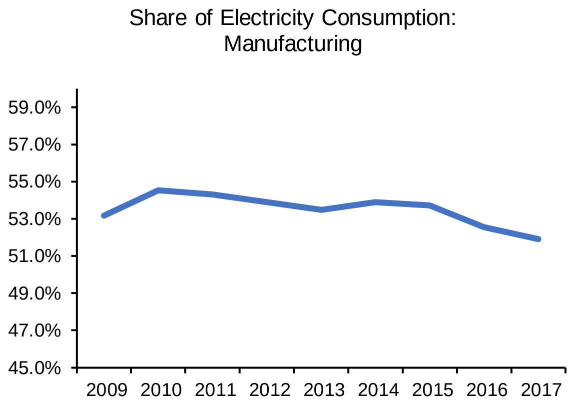
Moreover, we can observe that the PRC's average annual electricity consumption was 5735.0 kWh bn in 2010-2019, growing 7.0% per year on average. Manufacturing accounted for more than half of the electricity consumption. (see Figure 13 and 14).

Chart 13: Electricity Consumption



Source: China Electricity Council.

Chart 14: Manufacturing Electricity Consumption



Source: China Electricity Council.

2. *An Introduction to the Economic Crisis from Massive Contagious Infection Diseases Simulator (ECMCID-Simulator)*

To assess the impact of COVID-19 on the PRC's four strategic economic sectors, we develop and apply the economic crisis from massive contagious infection disease simulator (ECMCID-Simulator) model. To build the model, we apply multi-dimensional economic modeling and economic modeling in real time (Ruiz Estrada, 2017). The ECMCID-Simulator uses four strategic economic sectors "ΔS_i" where i = {1,2,3,4} in its analysis. Each strategic economic sector has a general axis, which consists of a large number of sub-axes. All the sub-axes are interconnected by straight lines until the end of the general axis. Each sub-axis is based on different first partial differentiations ($\text{☼}\partial Y_{ij}/\partial X_{ij}$) in real time (☼). The underlying idea behind applying partial differentiation in real time is to generate the effect of movement in real time in our simulator in the same graphical space.

According to the ECMCID-Simulator, each sub-axis is interconnected to the same general axis via an inter-liking sub-axis system "╬". We then link all general axes and sub-axes in the same level of analysis under four vectors, where each vector uses three first partial differentiations result simultaneously in the same period of time (see Expression 1). We assume that all sub-axes and general axes are moving under the application of economic modeling in real time "☼". In addition, we apply the Omnia Mobilis assumption [Ruiz Estrada (2011) and Ruiz Estrada and Park (2018)] to facilitate simulation into each sub-axis and the general axis. In the end, we can observe a movement of large surface based on our simulator. The surface movement starts from the epicenter of its multi-dimensional coordinate system until it ends in the last sub-axis in the same general axis. The real impact of this simulation is located in the last sub-axis (see Figure 1). The final analysis of the results can be derived general axis by general axis or by constructing the general surface.

$$\Delta S_1 = (\text{☼}[\partial Y_{ij} / \partial X_{ij}]_{11} \text{╬} \text{☼}[\partial Y_{ij} / \partial X_{ij}]_{12} \text{╬} \text{☼}[\partial Y_{ij} / \partial X_{ij}]_{13})$$

$$\Delta S_2 = (\text{☼}[\partial Y_{ij} / \partial X_{ij}]_{21} \text{╬} \text{☼}[\partial Y_{ij} / \partial X_{ij}]_{22} \text{╬} \text{☼}[\partial Y_{ij} / \partial X_{ij}]_{23})$$

$$\Delta S_3 = (\text{☼}[\partial Y_{ij} / \partial X_{ij}]_{21} \text{╬} \text{☼}[\partial Y_{ij} / \partial X_{ij}]_{22} \text{╬} \text{☼}[\partial Y_{ij} / \partial X_{ij}]_{23})$$

$$\Delta S_4 = (\text{☼}[\partial Y_{ij} / \partial X_{ij}]_{4\,1} \text{╬} \text{☼}[\partial Y_{ij} / \partial X_{ij}]_{42} \text{╬} \text{☼}[\partial Y_{ij} / \partial X_{ij}]_{43}) \qquad (1)$$

In fact, each final output contribution from each economic strategic sector in the GDP formation growth rate of any country (ΔO) is observed in Expression 2.

$$\Delta O_1 = \int(\text{☼}[\partial Y_{ij} / \partial X_{ij}]_{11} \text{╬} \text{☼}[\partial Y_{ij} / \partial X_{ij}]_{12} \text{╬} \text{☼}[\partial Y_{ij} / \partial X_{ij}]_{13})d_{ij}/Ot_{ij}$$

$$\Delta O_2 = \int(\text{☼}[\partial Y_{ij} / \partial X_{ij}]_{21} \text{╬} \text{☼}[\partial Y_{ij} / \partial X_{ij}]_{22} \text{╬} \text{☼}[\partial Y_{ij} / \partial X_{ij}]_{23})d_{ij}/Ot_{ij}$$

$$\Delta O_3 = \int(\text{☼}[\partial Y_{ij} / \partial X_{ij}]_{21} \text{╬} \text{☼}[\partial Y_{ij} / \partial X_{ij}]_{22} \text{╬} \text{☼}[\partial Y_{ij} / \partial X_{ij}]_{23})d_{ij}/Ot_{ij}$$

$$\Delta O_4 = \int(\text{☼}[\partial Y_{ij} / \partial X_{ij}]_{4\,1} \text{╬} \text{☼}[\partial Y_{ij} / \partial X_{ij}]_{42} \text{╬} \text{☼}[\partial Y_{ij} / \partial X_{ij}]_{43})d_{ij}/Ot_{ij} \qquad (2)$$

Partial differentiation level: i= {o,1,2,3…∞} and Level: j= {o,1,2,3…∞}

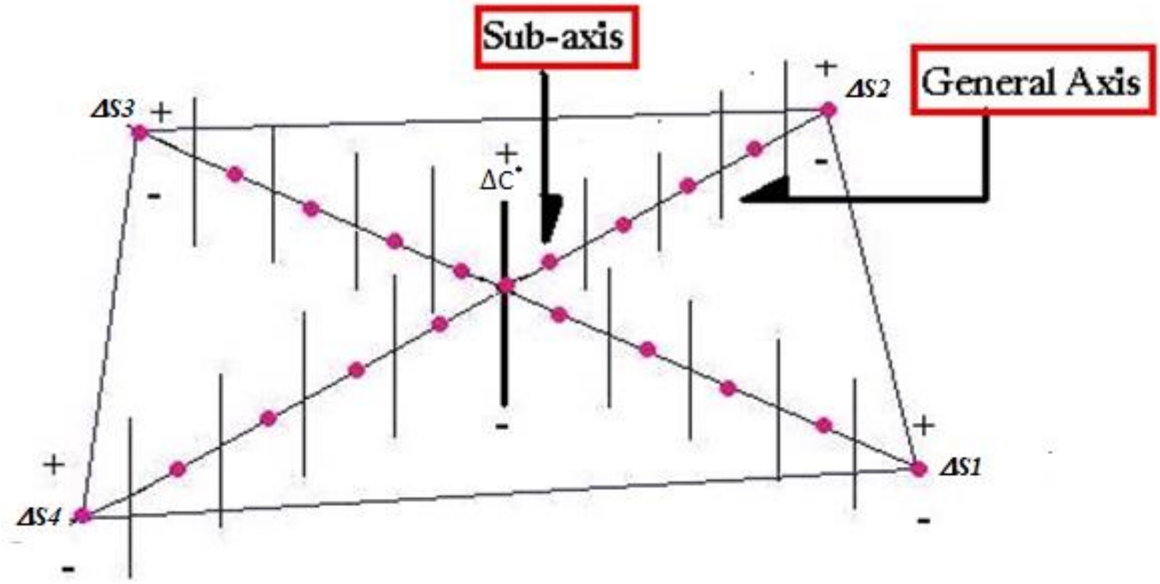


Fig. 1: The ECMCID-Simulator Coordinate System

3. *An Application of the ECMCID-Simulator: to Assessing the Impact of COVID-19 on 4 Strategic Sectors of the Chinese Economy*

We apply the ECMCID-Simulator to examine the impact of COVID-19 on four key strategic sectors of the Chinese economy. More specifically, we simultaneously look at its impact on tourism growth rate (ΔS_1), international trade growth rate (ΔS_2), air transportation growth rate (ΔS_3), and electricity consumption growth rate (ΔS_4) simultaneously. These four strategic sectors are examined in connection with COVID-19 cases growth rate (ΔC^*). The four general axes represent (ΔS_1), (ΔS_2), (ΔS_3), and (ΔS_4) (see Expression 3). Each general axis or strategic economic sector is divided by five sub-axes, which are demand growth rate (ΔD), unemployment growth rate (ΔUE), stock market performance growth rate (ΔSM), foreign direct investment growth rate (ΔFDI), and finally, the final output contribution of each economic strategic sector to the GDP growth rate of China (ΔO). The calculation of (ΔO) is based on Expression 4.

We applied first partial differentiation, which can help us observe the final impact of any infectious and contagious disease crisis on each economic strategic sector as well as the full economy of China. We apply first partial differentiation in real time between ΔC^* and ΔD, ΔC^* and ΔUE, ΔC^* and ΔSM, ΔC^* and ΔFDI. In the calculation of ΔO for each economic strategic sector, we applied four indefinite integrals according to Expression 4. All partial differentiation results are included in a single vector for each economic strategic sector. This allows us to simultaneously assess many different possible scenarios and impact levels in case of a massive infectious and contagious disease crisis for each strategic sector in our analysis.

For the calculation of (ΔO), we apply four indefinite integrals calculations, using each vector from each economic strategic sector (dx) and the final potential GDP of China (ΔO_p) (dy). As such, we can join three first partial differentiations and the final indefinite integral in each sub-axis and general axis, which allows us to build a single surface. It is then possible to observe a large surface that is moving like waves in the same space and time from the epicenter toward the end of each general axis, which represents a strategic economic sector. The final objective is to run the ECMCID-Simulator based on different scenarios and disease impact levels based on COVID-19 cases growth rate (ΔC^*). Doing so enables to visualize the destructive effect of any massive infectious and contagious disease crisis from a global perspective. The model makes it possible to map the economic effects on the Chinese onto the same graphical space.

$$\Delta S_1 = (\text{☼}[\partial \Delta C^*/\partial \Delta D_1] \text{╬} \text{☼}[\partial \Delta C^*/\partial \Delta UE_1] \text{╬} \text{☼}[\partial \Delta C^*/\partial \Delta SM_1] \text{╬} \text{☼}[\partial \Delta C^*/\partial \Delta FDI_1])$$
$$\Delta S_2 = (\text{☼}[\partial \Delta C^*/\partial \Delta D_2] \text{╬} \text{☼}[\partial \Delta C^*/\partial \Delta UE_2] \text{╬} \text{☼}[\partial \Delta C^*/\partial \Delta SM_2] \text{╬} \text{☼}[\partial \Delta C^*/\partial \Delta FDI_2])$$
$$\Delta S_3 = (\text{☼}[\partial \Delta C^*/\partial \Delta D_3] \text{╬} \text{☼}[\partial \Delta C^*/\partial \Delta UE_3] \text{╬} \text{☼}[\partial \Delta C^*/\partial \Delta SM_3] \text{╬} \text{☼}[\partial \Delta C^*/\partial \Delta FDI_3])$$
$$\Delta S_4 = (\text{☼}[\partial \Delta C^*/\partial \Delta D_4] \text{╬} \text{☼}[\partial \Delta C^*/\partial \Delta UE_4] \text{╬} \text{☼}[\partial \Delta C^*/\partial \Delta SM_4] \text{╬} \text{☼}[\partial \Delta C^*/\partial \Delta FDI_4]) \qquad (3)$$

We can proceed to calculate the contribution of the four key strategic economic sectors to the GDP growth rate of China (ΔO) (see Expression 4)

$$\Delta O_1 = \int \Delta S_1 d_{ij}/Ot_{ij}$$
$$\Delta O_2 = \int \Delta S_2 d_{ij}/Ot_{ij}$$
$$\Delta O_3 = \int \Delta S_3 d_{ij}/Ot_{ij}$$
$$\Delta O_4 = \int \Delta S_4 d_{ij}/Ot_{ij} \qquad (4)$$

We now describe the economic waves from COVID-19. The waves are generated from a large surface plotted in the same graphical space. A large surface is formed by different parts that represent four different strategic sectors, namely tourism growth rate (ΔS_1), international trade growth rate (ΔS_2), air transportation growth rate (ΔS_3), and electricity consumption growth rate (ΔS_4), all of which are connected directly to a single epicenter. For our purposes, the epicenter is fixed by the COVID-19 growth rate (ΔC^*), which can experience dramatic, uncontrolled and non-logical changes at any time, including expansion, contraction or stagnation (Ruiz Estrada and Yap, 2013). A sudden increase in cases growth rate (ΔC^*) in China can simultaneously inflict serious damage on the four sectors simultaneously due to reduction of demand for goods and services.

We assume that the four strategic sectors have a large number of windows refraction (or quadrants), each of which is formed by its X-axis, which represents time (years), and its Y-axis, which represents the main variable(s) under consideration. The main variabless are demand growth rate (ΔD), unemployment growth rate (ΔUE), stock market growth rate (ΔSM), foreign investment growth rate (ΔFDI), and finally the contribution of each strategic sector to the GDP of China (ΔO). Thus, each strategic sector consists of five windows refraction within the same coordinate space (see Figure 17).

In addition, we assume that the economic wave from COVID-19 in each strategic sector propagates at different speeds and sizes. The size and speed of the economic waves from COVID-19 depends on uncontrolled forces of a disease. The main objective of modelling these economic waves is to evaluate the negative impact of COVID-19 on the Chinese economy. To do so, we use multi-dimensional graphical modelling that can illustrate the movement of economic waves from the disease in real time. Multi-dimensional graphical animation technique (Ruiz Estrada, 2017) allows us to observe the effects COVID-19 on four different strategic sectors and, at the same time, gauge the level of dependency and vulnerability of those sectors.

Our analysis of the four strategic sectors points to a possible recession in the Chinese economy in 2020-2021. We assume that the epicenter which is connected to all four strategic sectors is the 2019 novel coronavirus (2019-nCoV) cases growth rate (ΔC^*) of China, At the same time, each strategic sector has a large number of windows refraction. Economic waves from COVID-19 is generated first by plotting a single value (growth rate) in each window refraction and joining each single value located in each window refraction by straight lines from the epicenter to the last window refraction in each economic strategic sector. We call this concept "windows refraction links (╬)" (Ruiz Estrada, 2017). Windows refraction links (╬) facilitates the simultaneous connection of all windows refraction in the same strategic sector and other strategic sectors simultaneously, as well as from the epicenter to the last window refraction in the same strategic sector. Therefore, the epicenter will affect four economic strategic sectors simultaneously in the same graphical space but at different magnitudes and speeds. We assume that these strategic sectors are constantly highly vulnerable.

In our analysis, economic waves originate from COVID-19 and spreads to strategic economic sectors, significantly impacting the sector's demand, unemployment, stock market, foreign direct investment, and contribution to GDP of China. Figure 16 presents the economic waves from COVID-19. The figure shows the final output contribution of China between 2020 and 2021 is (ΔO_1 = +0.3%), (ΔO_2 = +2.5%), (ΔO_3 = +0.2%), and (ΔO_4 = +1.5%). The output contribution of each strategic sector to China's growth rate (ΔO) indicates that COVID-19's negative economic impact will not be confined to China.

As noted earlier, COVID-19 has spread from China to the rest of the world, affecting Korea, Iran, Italy and many other countries. Therefore, although the economic effect of COVID-19 will fall mainly on China, the rest of the world will not be immune from its impact. In our simulation, we assume COVID-19 cases growth rate (ΔC^*) in China to be 65%. Our analysis (see Figure 16) indicates that the impact on the 4 sectors and their aggregate impact on GDP will be significant.

(i) In the tourism sector, demand will contract by 75%, unemployment rate rises to 10%, stock market index shrinks by 35%, and FDI declines by 25%. Finally, we can observe that this sector's contribution to China's GDP growth is relatively small, at 0.3%. (see Figure 16).

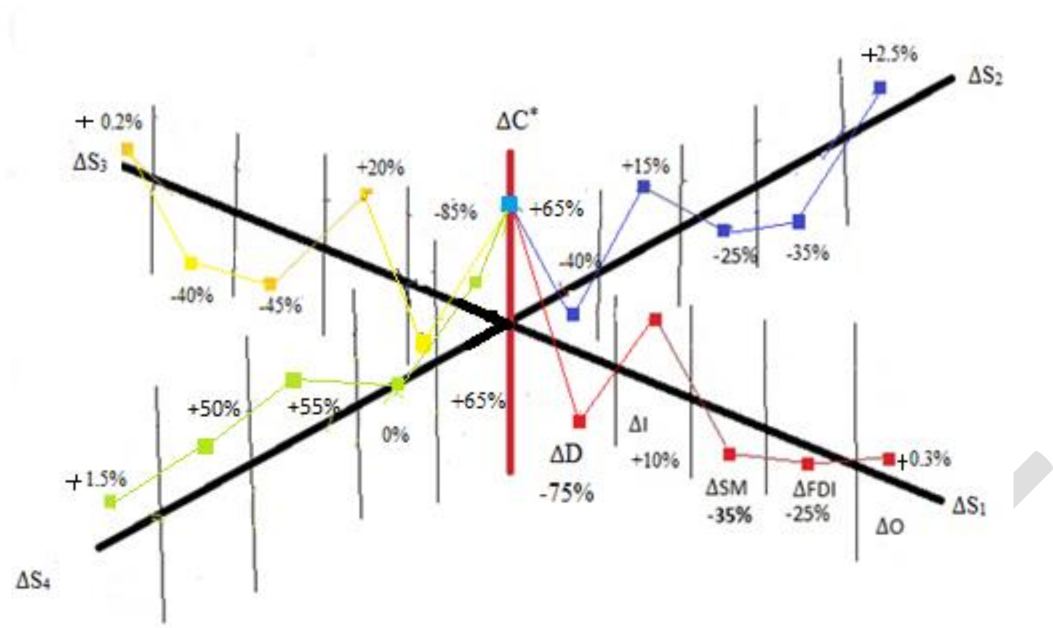
(ii) In the international trade sector, demand falls by 40%, unemployment rises to 15%, stock market index drops by 25%, and FDI shrinks by 35%. The sector's contribution to China's GDP growth is about 2.5% (see Figure 2).

(iii) The air transportation sector sees a dramatic drop of 85% in demand, unemployment rate of 20%, contraction of 45% in stock market index, and sharp contraction of 40% in FDI. The contribution of this sector to the GDP growth rate of China is 0.2% (see Figure 16).

(iv) Finally, the electricity consumption sector experiences a rapid growth rate of 65%, unemployment rate of 0%, solid stock market index gain of 55%, and increase of 50% in FDI. The sector's contribution to China's GDP growth rate is 1.5% (see Figure 16). The high electricity demand is partly due to extensive quarantines and explosion of demand for health services throughout China.

By calculating China's GDP growth rate as the last window refraction link, it is now possible to build economic waves from COVID-19. Our simulator can provide a clear illustration of how a massive infectious and contagious disease crisis can quickly spark a domestic and global economic crisis. At a broader level, this new type of graphical modeling offers economists, policy makers, students and academics a multi-dimensional graphical modeling method for analyzing the impact of any massive disease crisis from a domestic or global perspective.

Hence, we are able to show the impact of COVID-19 on the Chinese economy in 2020-2021 in a single graph. The graph makes it possible to visualize the four strategic economic sectors and 16 windows refraction interacting in the same graphical space. This graph has 1,500 values plotted into 16 windows refraction located within four economic strategic sectors. These four economic strategic sectors comprise tourism growth rate (ΔS_1), international trade growth rate (ΔS_2), air transportation growth rate (ΔS_3), and electricity consumption growth rate (ΔS_4). In the model, we display four strategic economic sectors within a multi-dimensional coordinate space.



Source: People's Republic of China and Asian Development Bank (2020)

Fig. 2: The Application of ECMCID-Simulator in the Case of 2019 Novel Coronavirus (2019-nCoV)

4. Comments and Remarks

In this paper, we assess the impact of COVID-19 on the Chinese economy. To do so, we develop and apply the economic crisis from massive contagious and infectious disease simulator (ECMCID-Simulator) model. The model is able to graphically show the final impact of COVID-19 on the Chinese economy from a multidimensional point of view. More specifically, we look at four strategic economic sectors, namely tourism growth rate (ΔS_1), international trade growth rate (ΔS_2), air transportation growth rate (ΔS_3), and electricity consumption growth rate (ΔS_4). The four sectors are plotted along the rays (axes) that are drawn from the centre, each ray having as many windows as are required at predetermined perimeter levels. The five windows are demand growth rate (ΔD), unemployment growth rate (ΔUE), stock market index growth rate (ΔSM), foreign investment growth rate (ΔFDI), and finally, the contribution of each strategic sector to the GDP growth rate of China (ΔO).

According to ECMCID-Simulator results, the final contribution of each sector to GDP growth rate in 2020-2021 is equal to (ΔO_1 = +0.3%), (ΔO_2 = +2.5%), (ΔO_3 = +0.2%), and (ΔO_4 = +1.5%). We can observe that the tourism, international trade, and air transportation sectors are negatively affected. On the other hand, electricity consumption experiences a surge, due to increased demand associated with quarantines and medical services. Furthermore, the high demand for electricity results in employment rate of 0%. The electricity sector's stock market index and FDI also perform well. Electricity consumption contributes considerably to Chinese GDP growth, according to the ECMCID-Simulator.

Finally, this paper offers policy makers, central banks, academics and students an alternative multi-dimensional graphical modeling approach to analyze the economic effect of any massive contagious and infectious disease from a multi-dimensional perspective. The ECMCID-Simulator allows us to explore different possible scenarios and different levels of impact. The simulator makes it possible to perform different simulations to measure the effect of any massive epidemic disaster on the economy of a country, region or the world.

4. References

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