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COVID 19: Arrival and Departure

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FOUNDATION FOR ECONOMIC GROWTH AND WELFARE

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Abstract

The SARS Corona Virus-2 originated in Wuhan, China and caused the disease classified by WHO as COVID-19. The virus has spread from China to the rest of the World. This paper analyses the differential speed of spread of the virus from China to different countries, i.e. it analyses the determinants of the inter-country transmission of the virus. Part two of the paper will analyze the determinants of the speed of spread within a country, i.e. the intra-country spread of the virus. Part III will examine the determinants of deaths and eventual Departure.

Keywords: SARS Cov2, COVID – 19, Pandemic, Arrival

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Introduction

A global pandemic has hit the world with surprising speed and spread. Reports suggest that the Corona Virus identified as COVID19 by W.H.O, and as SARS Corona Virus 2 by medical researchers in the USA, originated in Wuhan, China. As per the Oxford University, COVID data base the number of infected cases in China was 17 on January 1, 2020. It is therefore likely that the first reported COVID case occurred in Wuhan late 2019. In late January 2020, official sources in China confirmed the presence of the virus.

Allen-Ebrahim of Axios, a news and information organization, has compiled a timeline of the earliest weeks of the Corona virus outbreak in China. It identified Dr. Wei Guixian as one of the earliest known Coronavirus patients, who started feeling ill on December 10, 2019. It then goes on to say that on December 16 a patient was admitted to the Wuhan Central Hospital, who could be said to have a new version of SARS Corona Virus as he had an infection in both lungs, but was resistant to anti-flu drugs. It reports that staff later learnt that he worked in a wildlife market connected to the outbreak.1 There have also been reports that a Wuhan doctor reported the first "new Corona Virus" case, as early as November 17, 2020.2

The second country to officially report the presence of the virus: Thailand, 13th January 2020. Four countries reported their first virus case on January 22nd – Korea, Japan, Taiwan and USA. This is most likely the reason why the pioneering John Hopkins University database on the COVID crisis starts its' tabulation of COVID data from January 22nd. From then on it has been a linear, rather an accelerating linear, process of transmission to different countries. By January 31st, 2020, twenty-two other countries (in addition to China and Thailand), reported their first virus case. Excluding China, these countries accounted for 2.8 billion people. At the time of writing, two hundred and one countries (again excluding China) have the virus in their midst, encompassing a total population of more than 7 billion.

As has rightly been observed, the COVID epidemic is like no other. The Spanish flu of 1918 is the closest parallel but there are major differences. The former occurred in the pre-vaccine era, infected about 500 million individuals (at that time about a third of the world's population) and killed somewhere between 20 and 50 million individuals, including

[1]https://www.axios.com/timeline-the-early-days-of-chinas-coronavirus-outbreak-and-cover-up-ee65211a-afb6-4641-97b8-353718a5faab.html?utm_source=twitter&utm_medium=social&utm_campaign=organic&utm_content=1100).

[2]https://economictimes.indiatimes.com/topic/South-China-Morning

approximately 700,000 Americans. As of the May 3, 2020, there were 3.5 million COVID infections with just over 250,000 deaths.

At the time of the Spanish flu, no vaccines were available. Health systems, and vaccine development, have advanced considerably over the last 100 odd years; unfortunately, as of end April 2020, no COVID vaccine is available. What is clear, however, is that the two pandemics are not strictly comparable, with the present virus considerably less lethal than one that occurred more than a century ago.

In the short space of three months, investigation of COVID, and its' spread from China, has likely been the most studied item. With lockdowns in most parts of the world, it has also been more studied than any other pandemic, or disease in world history. In this paper, we examine various aspects about the arrival, stay, and (expected) departure of this virus. Part I discusses Arrival – How, and through what transmission processes, did the virus spread to almost the entire world? Part II discusses various aspects about Stay – how fast was transmission once entry into the country was "obtained"; what were the determinants of the flattening out of the curve, for both the virus, and the deaths, it has caused? How important have some of the policy measures undertaken to confront the virus been? How important, or relevant, or necessary is testing for identification, and containment, of the virus? Part III will be concerned with estimation of the dates for the (expected) departure of COVID.

Part I: Arrival of COVID in Different Countries

A. A Short History of Virus Spread

The 1918 Spanish flu epidemic was one of the most deadly pandemics, infecting about one-third of the world's population, and causing about 50 million deaths. The Severe Acute Respiratory Syndrome or SARS-Cov-1 outbreak occurred in 2002-2004; its' spread was limited to just around 10000 cases but had a high fatality rate of 11%. In 2009, a variant of the avian flu (H5N1), was declared a pandemic. The death toll from this pandemic was estimated by W.H.O at a minimum of 18,500; the US Center for Disease Control, (CDC), estimated it at a much higher 284,000.[3] Covid-19 is the second version of SARS, caused by a corona virus, which is why it is classified by epidemiologists as SARS-CoV-2. As mentioned earlier, to date Covid-19 has caused 250,000 deaths with a (measured) fatality rate of around 7 %. Our estimate in Part III places a high probability that total deaths from COVID will end up somewhat higher than those caused by SARS-1, at around 325,000. Thus, it is very likely that COVID will be the most widespread virus and most deadly epidemic since the Spanish flu.

[3] https://www.cidrap.umn.edu/news-perspective/2012/06/cdc-estimate-global-h1n1-pandemic-deaths-284000.

Even prior to the 1918 pandemic, most influenza pandemics developed in Asia and spread from there to the rest of the world. Many of these have been identified as originating in China. Epidemics typically travel along the most important and active lines of trade and communication. The worst epidemics in history have been those which followed migrants or traders, carving out new routes for travel or trade [Humphries (2014)].4

For example, from 1916 to 1918, the route of travel to Europe for the laborers included checkpoints in Singapore, Durban, Cape Town, North Africa, and Canada. Additional reports of the first wave of the virus in the spring of 1918 suggest that the pandemic originated with Chinese workers at Camp Funston, Kansas, where the workers began suffering from 2 to 3 day fevers, gastrointestinal symptoms, and general weakness [Radusin (2012), Weaver and Von Bergen(2014)].5 Humphries (2013) suggests that the transfer of labourers from China to assist Allied forces in World War-I inadvertently resulted in the spread of the virus to Europe. "The most likely origin for this flu was China where, during the winter of 1917-18, a new and deadly virus first appeared and then diffused around the globe with the mobilization of the Chinese Labour Corps (CLC)."

Travel Itinerary of COVID

Something similar seems to have happened with COVID. As mentioned earlier, Thailand was the second country to report the presence of the virus. At last count (May 4, 2020) 202 countries in the world have reported at least one case of the virus. It is safe to assume that by now the virus has affected every part of the world.

However, its presence in different populations, or countries, is variable. The magnitude of the presence (the number of cases and the number of COVID deaths) are also highly variable across and within countries. The magnitude is different, the spread is different. Analysts have attempted to decipher patterns in this transmission, and we are part of this large investigation.

The spread of COVID has many fathers. Weather is thought by some to be a cause i.e. higher temperatures mean less contagion. The same is thought to be the case with humidity. Age also matters – for both the contracting of the disease, and for deaths related to the virus. Older individuals (those above the age of sixty) are believed to be more affected than younger people, especially in the case of mortality. Men are more vulnerable than women.

Social distancing is believed to matter – before the availability of vaccine, this is thought to be the most potent preventive weapon. Since social distancing cannot work in airplanes (or so

4 As Humphries (2013) wrote, "In the sixth century, the Byzantine Empire was stuck by the Plague of Justinian, probably transmitted with shipments of grain from North Africa… Likewise, the Black Death of the mid-fourteenth century moved across the Mediterranean as Italian Traders began plying the waters between the Black Sea and Sicily with greater frequency."

5 https://bmcinfectdis.biomedcentral.com/articles/10.1186/s12879-019-3750-8

it is believed) flights across the world have been cancelled. The same "determinant" has led to cancellation of sporting events almost everywhere. Schools have also been closed, as have offices and factories.

There are several dimensions to ours (or any) investigation into the pandemic. What determines the speed of arrival of the virus into each country? Why were as geographically diverse countries like Thailand, US, and Japan the first to contract the virus? Temperature, nor humidity, nor median age of population, or number of old people, is any help in explaining the diverse pattern of arrival. The final magnitude of the spread, and the speed with which it travelled, may well be explained by age composition, or temperature, or humidity.

The causes behind introduction of COVID into a host population, and the causes behind its diffusion, may well be very different. And we keep this distinction in mind in our study. Hence, the three different parts of the paper, and possibly different explanations, for Arrival, Stay, and Departure.

B. Explaining Arrival

We hypothesize that the primary determinant of Arrival was the probability of contact with persons from the point of origin of the crisis, namely China. In the first phase the virus emerged in Wuhan around November 2019 and spread silently from Hubei and other parts of China, to the Rest of the World. In this phase transmission was primarily through people travelling to or from China. It is precisely this phenomenon that we empirically try to capture in the analysis presented below.

But first, a bit of "history" about the spread of virus within China. The evidence points to Wuhan, a city of 11 million people and a major transportation hub. Wu, Cai, Watkins and Glans (2020), published an article entitled "How the Virus Got Out" in a New York Times article dated March 22, 2020. They used mobile telephone data obtained from a Chinese telephony company to trace the international transmission of COVID from Wuhan to the rest of the world. They present video maps which show the large flow of people (with cell phones) moving out of Wuhan to South Korea, Taiwan, China, Hong Kong, China and Bangkok, Thailand, and (a smaller number) to other countries.[6]

Another map shows the volume of movement from Wuhan to the major cities of mainland China, with an estimated 175,000 people leaving Wuhan on January 1st, 2020, and an estimated 7 million people leaving in January, before travel from Wuhan was restricted.

[6] Article dated, March 22, 2020 at, https://www.nytimes.com/interactive/2020/03/22/world/coronavirus-spread.html .

Other observers have put the number at a lower 5 million.7 Shaman et al (2020) estimate that before travel restrictions were imposed on January 23rd 86% of all infections were undocumented in China. The per-person transmission rate of undocumented infections was 55% of documented infections. However, the undocumented infections were the infection source for 79% of documented cases, because they presented fewer red flags to those they encountered.

Another important factor pertaining to the travel of the virus is that soon after its origin, and spread within China, the annual Chinese Lunar festival, Chunyun (January 24 to January 30) began. An estimated 3 billion trips are made by the Chinese during a 40-day period from January 18 to February 18 as people journey to their home provinces and villages to be with their family. An estimated 20% of the Chinese population is believed to travel during this period.8 Those who can, start returning home, even before the end of the 40-day period. History may well have been different if the virus had been identified well before the start of the Chinese New Year.

The hypothesis we test is that interaction between the virus hosts and virus recipients is a critical determinant of the speed of arrival. This has also been the case with earlier pandemics whose origin has been attributed to migration from affected countries, opening of new areas to international trade, and conflicts and wars.

Globalization of the world economy since 1980s, has covered every channel of bilateral interaction e.g. merchandise trade, travel and tourism, migration of workers and professionals, capital flows etc. The degree of personal interaction varies with the channel, with the highest level of contact involved in bilateral tourism, followed by migration and services involving movement of people. China has been one of the greatest beneficiaries of globalization, becoming the largest merchandise exporter in the world ($2.1 trillion) and its share of world exports continuing to rise after the global financial crisis in 2008 and continuing merchandise surpluses of approximately $2.9 billion a year. Similarly, Chinese tourists to other countries have risen progressively, along with tourist visitors from these countries. In 2018 the outbound Chinese tourists numbering approximately 135.5 million, exceeded inbound tourists into China by 23 million. The flow of Chinese migrants has also increased along with the outward FDI and FII investments. Chinese migrants in the rest of the world are estimated to be over 6.9 million.

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[7] https://www.businessinsider.in/science/news/5-million-people-left-wuhan-before-china-quarantined-the-city-to-contain-the-coronavirus-outbreak/articleshow/73677674.cms .

[8] https://www.businessinsider.in/slideshows/miscellaneous/people-in-china-will-make-3-billion-trips-in-the-next-40-days-to-celebrate-lunar-new-year-the-worlds-largest-annual-human-migration/chunyun-also-known-as-chinese-new-year-or-spring-festival-has-begun-/slideshow/73236412.cms

C. Data, Estimation and Results

We proxy arrival of virus into a country (the variable to be explained) by dayfc1 which is defined as days taken for the first virus case to be observed in each country after its date of origin in China. There is some uncertainty about the start of COVID in China; there is no data source giving the daily number of cases in China prior to January 22nd, a date after which daily data are available, for every country in the world. The Oxford University COVID database does present the data for China from December 31st, 2019, a date on which 58 COVID cases had already been identified. Since Thailand had its first virus case on January 14, dayfc1 for Thailand is 14. The first case in the US was January 22nd – daysfc1 for US is 22, and so on and so forth. This is the variable we try to explain. It ranges from 14 (Thailand) to 123 for Comoros, a small island of around 850,000 people in Africa.

We use data from the Johns Hopkins University and the Oxford University COVID data base for all countries in the world. These data are updated, daily, and made available on websites. Economic data for different countries is obtained from different multilateral organizations like the IMF, United Nations, World Bank and WTO.

We estimate the following equation to determine Arrival:

dayfc1 = f (X),

where X consists of globalization variables.

Dayfc1 and X variables are defined as follows (prefix l stands for logs)

Dayfc1 = The number of days from December 31, 2019 (assumed date of appearance of first case in China), to first Corona Virus Case (CVC) in Country.

Ltourfrchn = Tourists from China to Country- Annual numbers for 2018 or latest available year.

Ltourtochn = Tourists to China from Country- Annual numbers for 2018 or latest available year.

Lmigfc = Migrants from China in 2015 (data only available on a five-year basis)

Lexptch = Exports to China from Country; Annual numbers for 2018.

Limpfch = Imports from China into Country; Annual numbers for 2018.

Table 1a presents a correlation matrix of the variables used in the analysis.

Table 1a: Correlation Matrix of variables likely to be associated with arrival of first COVID case

Table 1a: Correlation Matrix of Variables likely to be associated with first arrival of first COVID cases

	Days to Arrival	Tourists from China	Migrants from China	Tourists to China	Imports from China	Exports to China
Days to Arrival	1					
Tourists from China	-0.732	1				
Migrants from China	-0.671	0.755	1			
Tourists to China	-0.646	0.826	0.747	1		
Imports from China	-0.619	0.729	0.711	0.777	1	
Exports to China	-0.590	0.657	0.587	0.701	0.780	1

Source: Authors calculations based on Data from Johns Hopkins University, Oxford University & WTO.

Notes: All variables in logs except dayfc1.

The table shows that the date of arrival of the virus is most highly correlated with the number of tourists from China (last available data for tourists is 2018). Days to first virus case is also highly correlated with migrants from China, imports from China, and exports to China. The second noteworthy fact is the high correlation between the tourism, trade and migrant variables (0.70 to 0.86), suggesting significant joint correlation among the globalization variables.

There is a possibility that the correlations (or regressions) may contain selectivity bias. All data are not available for all countries; tourists from China data are available for 141 countries, migrants from China data are available for 125 countries and imports and exports from China data are available for 192 countries. One method to avoid data selectivity bias is to run all regressions for only the 99 countries for whom all globalization variables are available.

Table 1b reports the correlations for these countries – the correlation ordering stays the same i.e. tourists from China is the most influential variable, exports to China (relatively) the least

Table 1b: Correlation Matrix of Variables like to be associated with first arrival of first COVID cases

	Days to Arrival	Tourists from China	Migrants from China	Tourists to China	Imports from China	Exports to China
Days to Arrival	1					
Tourists from China	-0.714	1				
Migrants from China	-0.663	0.717	1			
Tourists to China	-0.642	0.856	0.770	1		
Imports from China	-0.624	0.717	0.687	0.774	1	
Exports to China	-0.553	0.702	0.662	0.733	0.809	1

Note: For the set of 99 countries for which all variables are present

Table 2 presents the results of our regression analysis (which yields the same "ordering" by statistical significance). Tourists from China to the country in question remain the most significant explanator, no matter what other variable is introduced into the equation.

Over 54 % of the variation of a noisy variable (dayfc1) is explained by just one variable (Chinese tourists to the country in 2018). The value of dayfc1 varies from 14 for Thailand, to 22 for four other countries, and a maximum value of 121 for Tajikistan. The mean value for dayfc1 is 62 days with a standard deviation of 19.4. As we document via charts below, contact with the "host" is a large part of the explanation of the Arrival of COVID.

Table 2: Speed of Arrival of Corona Virus in Country from China (dayfc1)

	(1)	(2)	(3)	(4)	(5)
ltourfrchn	-5.63				
	(0.49)**				
lmigfc		-5.50			
		(0.51)**			
ltourtochn			-4.56		
			(0.53)**		
limpfc				-4.40	
				(0.59)**	
lexptc					-2.68
					(0.28)**
Constant	121.5	106.0	107.7	157.2	117.5
	(5.0)**	(4.0)**	(4.6)**	(12.3)**	(5.2)**
R squared	0.54	0.45	0.42	0.38	0.35
RMSE	13.3	15.2	15.4	15.5	15.9

Note: ** = significant at 1% level

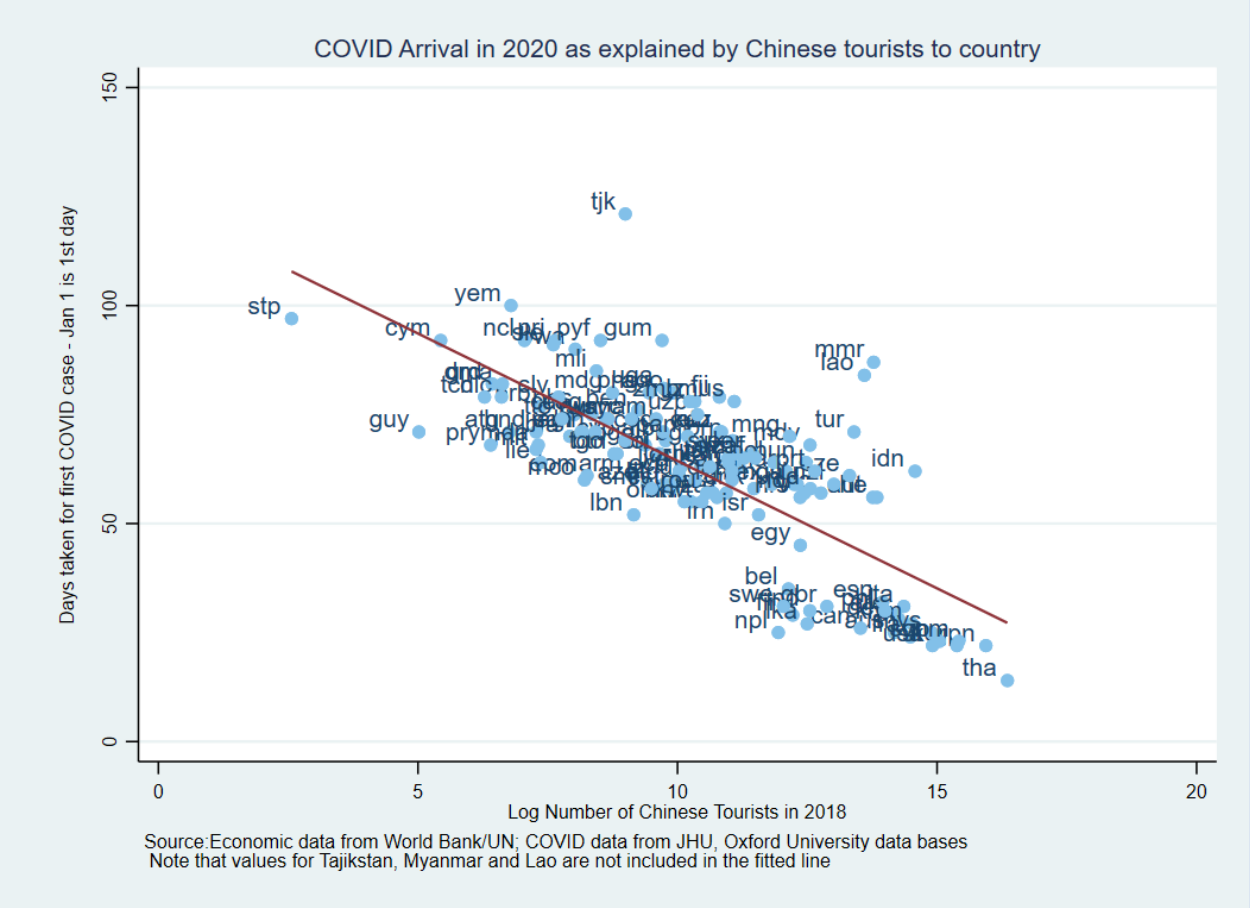
Source: Authors calculations based on data from JHU, World Bank and WTO

Note that the two variables (date of first arrival of the virus in the country and (log) tourists to that country) are not related to each other in an obvious, predictable manner. The data for tourists from China is for 2018; the virus occurred outside of China between January-April 2020. The NYT article alluded to earlier attempts to directly measure the spread of virus through individual person to person contact in the month of January 2020. We proxy this contact with an estimate of tourists in 2018. The obvious reason for inclusion of this determinant is the assumption that person-to-person contact via travel in 2020 is reasonably approximated by travel in 2018. We ourselves are (pleasantly) surprised with how well this proxy performs.

Below we present three graphs to illustrate the "predictive" power of tourism. Graph 1 is a simple scatter plot (and a fitted line) between these two variables. Figures 2 and 3 represent the same model, but different countries are highlighted. Figure 2 highlights the top 25 countries in terms of magnitude of virus spread, while Figure 3 highlights the "bottom" 29 countries.

Figure 1 represents all countries.

Figure 1



Note the close fit of the model for 128 countries. The prediction of the model for nearly a third (41 countries) is less than +- 5 per cent. Both Indonesia and Turkey have large residuals, 23 and 25 days respectively i.e. Indonesia obtains the virus 23 days after the "predicted" date of the model. Indonesia, from the time of President Suharto, has a history of suspicion of Indonesian Communists and Communist China's influence on them.9 Turkey was the first and one of the few Islamic country to criticize the treatment of Uighurs in the Xingjian province of China and this may have reduced the intensity of personal interaction between citizens of the two countries in 2020.10

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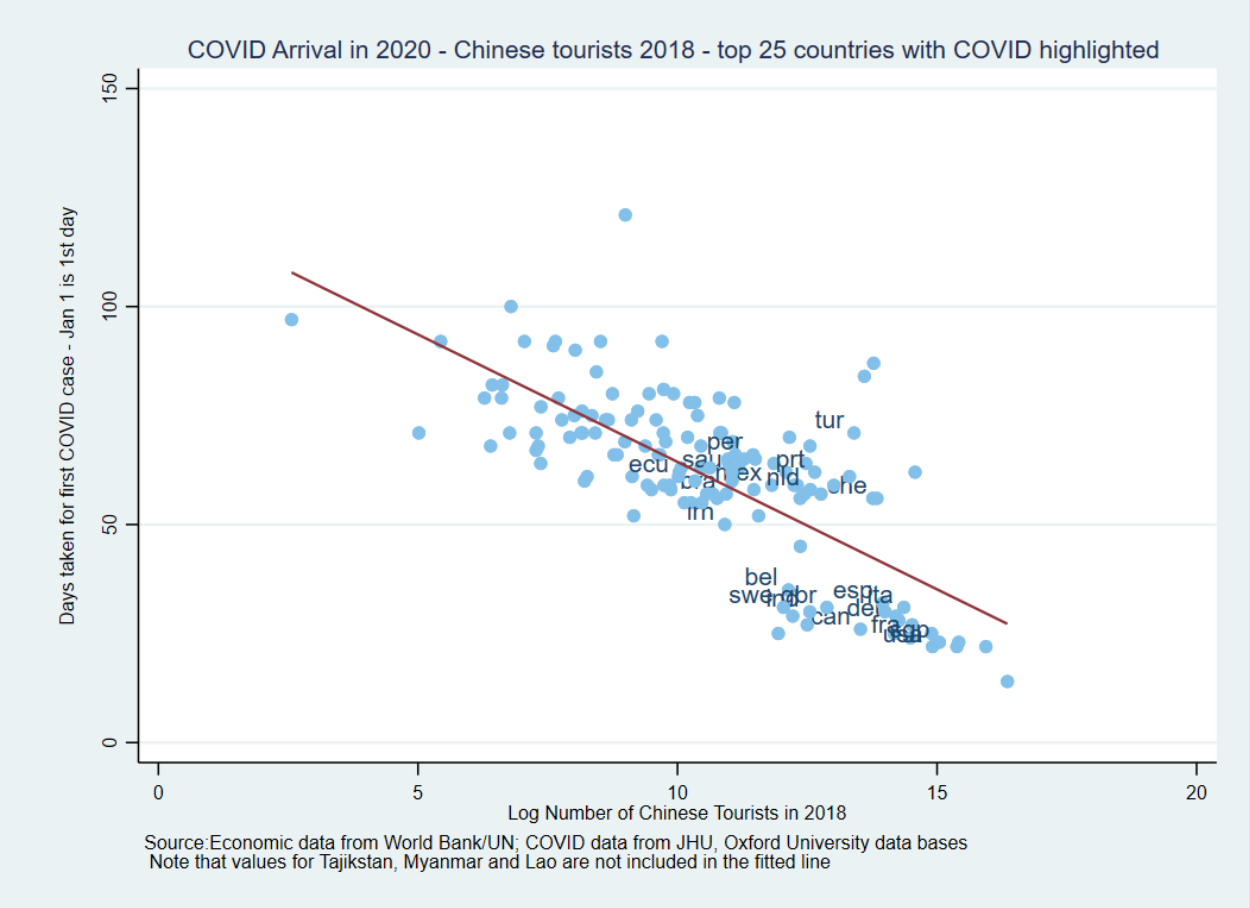
[9] Indonesia's historical relations with Communists and communist China https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=11&cad=rja&uact=8&ved=2ahUKEwjEjoLzlIPpAhUy73MBHZgmBDYQFjAKegQIAhAB&url=https%3A%2F%2Fwww.jstor.org%2Fstable%2F2642634&usg=AOvVaw0NmriyHykgFj9aDSlI8Nw2

[10] Turkey and Uyghurs in Xinjiang: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=11&cad=rja&uact=8&ved=2ahUKEwjus72WlIPpAhWh_XMBHVIeCIQQFjAKegQIAxAB&url=https%3A%2F%2Fwww.aljazeera.com%2Fnews%2

Figure 2 is a graph highlighting the 25 countries with the highest diffusion of the virus.

Figure 2



Several European countries (and Canada) are visited by the virus before our prediction of the same. Sri Lanka was predicted to have the first case on day 51; it was visited 24 days earlier. Thailand was supposed to have the virus by day 29; it was visited on day 14. Singapore has ethnic and economic links with China and is recognized as a bridge between China and other countries and has a multifaceted relationship with China. Thailand's ethnic Chinese population constitutes 14% of the total population as of 2012 and is the largest overseas Chinese community in the world. It is also reported to be highly integrated with the rest of the population. Sri Lanka's bilateral relationship has expanded rapidly since the M.M. Rajapaksa Government signed the agreement for development of Hambantota Port in 2008, and has become heavily dependent on China for their development programs. These considerations of

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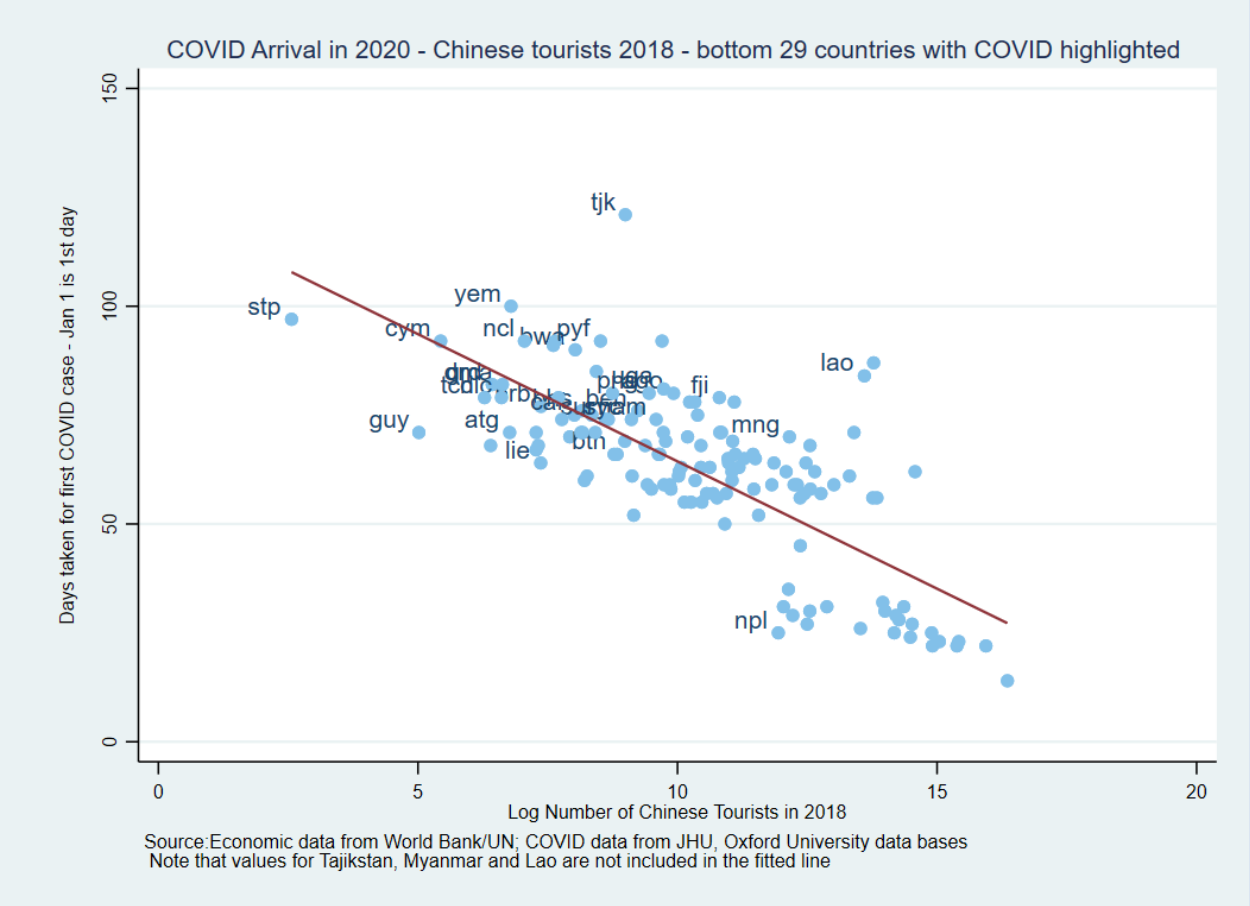
F2019%2F02%2Fhumanity-turkey-urges-china-close-uighur-camps-190209202215688.html&usg=AOvVaw1oR6jRPm13A4_7PmaGaC3j ,
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=10&cad=rja&uact=8&ved=2ahUKEwjus72WlIPpAhWh_XMBHVIeCIQQFjAJegQIAhAB&url=https%3A%2F%2Fwww.aljazeera.com%2Fnews%2F2019%2F07%2Fturkey-erdogan-solution-china-muslims-190704163630632.html&usg=AOvVaw1e2i9eWVhbNsr6g0lLkFjJ

contact are not captured by our tourism available; once tourism data for 2019 and early 2020 are available, we plan to update our analysis.

Figure 3 highlights the appearance of those counties where the total cases of COVID are amongst the lowest (bottom 29 countries in countries with tourism data).

Figure 3



As per the official data, Tajikistan (tjk) is one of the countries in which the Corona Virus infection arrived much later than predicted by us (figure 3). The first set of Tajik citizens were airlifted form Wuhan, Hubei, China on February and transferred to Tajik hospitals. Subsequent arrivals of Tajik citizens and other travellers from China and later all arrivals from other countries were quarantined. No corona virus cases were reported in these quarantined locations or elsewhere during February, March or April. Initially the WHO representative in Dushanbe confirmed the official zero count of cases, but in the last week of April stated that WHO could not confirm that Tajikistan was free of COVID19.11

Lao is another (outlier) country in which the arrival of COVID19 was later than predicted. It was reported on 13th March that provincial authorities had closed “some” border posts with

[11] https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Tajikistan.

neighboring China.12 Thus, despite the relatively open land border, Lao was the last ASEAN country to confirm its first COVID19 case (on March 27). This could happen, if, either overland movement of tourists is a small fraction of total tourists from China, or Yunnan province was relatively free of Corona virus till end-March, or a combination of the two factors. Similar issues arise with respect to Myanmar which reported its first COVID19 case one week before Lao and shares a land border with the Yunnan province of China.

Conclusion

The major objective of this paper was to study the determinants of the Arrival of the corona virus in different countries. We hypothesized that Arrival would be affected by the breadth and depth of the bilateral connection between China and these countries. We used several standard globalization variables to test the hypothesis. Chinese tourism to different countries was the most significant in explaining the speed with which the SARS Corona Virus 2 or COVID19 infection spread. An improvement in the quality of medical data on first arrival of SARS Corona Virus 2 in each country and more comprehensive data for 2019 on other determinants will likely strengthen our conclusions about the role of human travel in the spread of contagion.

The second part of the study will focus on the determinants of the speed of spread of the Corona Virus within each country, after its arrival. These determinants, though unlikely to be identical, may overlap. The third part of the study will look at Departure – the "end" of the virus. This part will also investigate, in some detail, the incidence, and determinants, of death from the virus.

[12] "Laos Shutters Small Checkpoints on Borders With Vietnam, Cambodia, Citing Coronavirus Spread". Radio Free Asia. 16 March 2020. Retrieved 7 April 2020.

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