

Introduction

COVID-19 has impacted all global systems, but perhaps none more than world travel networks. The drop in tourism has reached unseen lows, almost ceasing to exist, making the future uncertain and difficult to predict. In the past, crisis, whether terrorist attacks, natural disasters, or financial, have significantly impacted international tourism, but the system has always recovered, in other words, it is quite resilient. However, the lack of travel never reached the point that it has today. Because of this, the past successes cannot fully tell us when the industry will fully return to normal. There are several factors to consider: the status of the virus, the economy, perceptions and fear of travel, and others.

The world travel network is complex and contains over 25,000 different links between countries, adding up to around 1.4 billion international arrivals per year. Half of these people go to “advanced economies,” while the other half travel to “expanding economies.” (UNWTO 2020 Barometer) This travel generates around \$1.4 trillion every year. However, the split in the money is different, around two thirds of the receipts go to “advanced economies.” Additionally, Europe, Asia, and the Americas, generate considerably more in both numbers of arrivals and monetary gain, than Africa and the Middle East. (UNWTO 2020 Barometer) Although there are 25,000 links, tourism is largely made up of a few thousand of these connections, often between the same group countries. In Maps 1 and 2 we see twenty-five and ten percent of all world travel in 2018. The maps show how top-heavy travel is, very few connections represent a significant amount part of the network. Reyes (2013) came to a similar conclusion based on the United Nations World Tourism Organization (UNWTO) data from 2006: “travel is concentrated among a small number of countries... and these countries also correspond to the World Bank’s classification of high-income economies.” (Reyes, 2013) When we look closely at the figures we also see nodes of importance. For instance, in Asia most of the links involve China, while in the America’s the network surrounds the United States. The issue this presents is that if one of the key nodes fails, or shuts down travel, many of the surrounding countries will be impacted. COVID-19 has exposed this issue. Furthermore, we see that many of the countries on the map are nations that have had some of the more severe and earlier coronavirus cases.

Crisis Impacting Travel

The world travel network is especially susceptible to crisis situations, especially disease. There are many case studies prior to COVID, from the seasonal flu to SARS and MERS. SARS, a coronavirus similar to the pandemic we are seeing today, emerged in 2003 in China. It created panic throughout the world but only actually arrived in 32 countries (WHO Summary Table of SARS Cases by Country). Just like the number of cases, the impact on travel was limited. International arrivals dropped by around 1% from the prior year and growth in the tourism economy fell from around 5% to around 3%. (Wilder-Smith, 2006) In the short term, places where the outbreak was more substantial suffered larger losses: Beijing lost over a billion dollars and Ontario lost over two billion and 20,000 tourism related jobs. During the height of the outbreak, travel to Asia dropped by 9% and in mid-April it decreased by 41% in East Asia. (Wilder-Smith, 2006). Overall, the impact was limited and the world recovered quickly. Likewise, H1N1, the Swine Flu in 2009, was limited. The Spanish Flu of 1919 caused a loss of

4.8-10.7% loss in GDP, but it is difficult to tell how much of that was directly related to tourism. (Gossling, et al., 2020)

Other crisis events have caused great losses to the travel industry. 9/11 is an example. Although the world economy and the number of tourists recovered within a few years, the events caused losses in the number of travelers. Cornwell and Roberts (2010), who focus on whether it was individual choice or newly implemented policy that caused such a drop in the United States, also found that travel had recovered within a few years. Terrorism around the world has a similar effect to that on the tourism industry in the United States. Attacks often precede drops in tourism to certain countries. In some cases, “tourists substitute away from high-risk places toward low-risk locations as the intensity of terrorist incidents increases in a given country.” (Drakos and Kutun, 2003) Furthermore, the impact is often limited if violence and instability do not persist on an everyday basis. (Fletcher and Morakabati, 2008) This often relates to the perception of a country; if potential visitors view a certain location as safe, they will travel there: “the perceived risk of a particular destination is everything because it is that perception that will influence demand.” (Fletcher and Morakabati, 2008) Buda (2016), conducted interviews in Jordan, and came to a similar conclusion about the risk perception in a country being very important. Sonmez, et al. (1999) argue that officials need to have plans in place to deal with terrorism, as well as the media fallout from the actual event. Finally, financial issues can also have an adverse effect on global travel. During the recession of 2008 and 2009 world travel dropped, much like at other crisis periods. (Gossling, et al., 2020) However, it impacted each country differently. In Canada, fewer people planned winter vacations, while in Mexico, the tourism economy was impacted, but not as much as by natural disasters and hurricanes. Similarly, the crash had a smaller effect on the United States in comparison to 9/11. (Ritchie, et al. 2010)

COVID-19 has caused problems in travel that have not been seen before. Due to both personal choice and travel restrictions, world tourism has plummeted. The UNWTO tracks monthly travel between every country. World arrivals in April dropped by 97% from 2019 to 2020 and in May by 98%. In the first five months of the year travel was down by 56%, which amounts to \$320 Billion in lost revenue. (UNWTO 2020 Barometer, July Update) The UN projects between a 58% to 78% drop in Tourism through the entire year. This range accounts for 850 million to 1.1 billion people. The loss in tourism receipts is equally disastrous: a loss of \$910 Billion to \$1.1 Trillion. (UNWTO 2020 Barometer May Update) The World Travel and Tourism Council’s (WTTC) projections are equally bad: 41% to 73% reduction in travelers leading to 98.2 million to 189 million tourism job losses and \$2.686 trillion to \$5.4 trillion lost. (WTTC 2020 Travel and Tourism Recovery Scenarios) However, countries are taking steps to mitigate this effect. Many have implemented economic stimulus packages, both for their economy in general, but also the tourism sector. The bailout of United States airlines is an example of this. Others have decreased taxes and fees associated with tourists and the tourism industry. Furthermore, countries have encouraged domestic travel. (UNWTO Briefing Note – Tourism and COVID-19 Issue 1: Tourism Recovery) This tactic has proven useful in past crisis events. In Hawaii, after 9/11, Bonham, et al. (2006) found that travel to the state from the mainland United States made up for the loss in international travelers to the state: “international (i.e., mostly Japanese) visitor arrivals to Hawaii fell after 9/11 and have yet to reach pre-9/11 levels, domestic arrivals from the United States mainland have risen by more than enough to compensate for the fall in international visitors.” (Bonham, et al., 2006) While this was useful in a one-off crisis event, it is unclear how much domestic travel will help with the coronavirus situation. Finally, Small Island Developing States (SIDS) could be disproportionately impacted by a lack of travel

because these countries are hugely reliant on Tourism (up to 80% of their economies). (UNWTO Briefing Note – Tourism and COVID-19 Issue 2: SIDS) Given this, these countries may be more impacted both by current restrictions and a future focus on domestic travel. Efforts should be made to support travel to these countries, in addition to the domestic programs.

Tourism Impact of Crisis

Tourism is not only affected by COVID-19, but has also propagated its spread. Studies of past diseases, like SARS and the seasonal flu show that infections are spread via international travel. As discussed before, following 9/11 there was a drop in travel, specifically international arrivals to the United States. Every year, the Influenza season in America peaks around February 17th. However, in 2002 it reached its summit two weeks later, due to the lack of incoming visitors. France on the other hand, a country that did not create flight restrictions following 9/11, had a normal flu season. Fewer flights to the US led to the flu spreading later in the year. (Brownstein, et al., 2006) The modern era has also increased the problems created by travel and disease. Modelling an influenza pandemic that originated in Hong Kong in the 1960's with travel numbers from 2000, Grais et al. (2010) found that "the pandemic reaches northern hemispheric cities an average of 111 days earlier than it was forecast in 1968" and Cumulative reported cases were forecast to be an average of 188% greater" (Grais et al., 2010) In other words, more connections and more travelers means infections can spread more easily.

COVID-19 has followed a similar pattern to other viruses. Chinazzi et al. (2020) found that as the disease initially emerged, there were few travel restrictions, both within China and on an international scale. However, in the seven days following the restrictions on leaving Wuhan, COVID-19 cases in mainland China dropped by 10% as did international imports of the virus by 77% (as the disease spread to other locations the numbers increased again). The ban on travel from Wuhan also caused the majority of the outgoing cases to come from other major cities within China. Restricting travel successfully decreased the initial spread of the virus. (Chinazzi et al., 2020) Taking data from the Johns Hopkins University Center for Systems, Science and Engineering and travel statistics from the UNWTO (most of the travel numbers are from 2018 as that was the most complete year), we begin to see a relationship between the two. The UN data was created by compiling each of the individual nation's respective excel sheets, reporting arrivals by country of origin. Because using every tie would be difficult to visualize I limited it to the links with more than a million travelers. The logic behind this was that the more travelers there are, the more likely COVID would be transmitted. The map began with China, given that it is the origin of the virus (Figure 1). Countries were added to the map as they reached one thousand cases. On February 26th and 29th, South Korea and Italy reported their thousandth (Figure 2 and 3). Both nations had large connections with China. We also see a majority of the connections are to Europe, Asia, and the United States. The first surprise is Iran (3/02), which did not have any major links to countries that contained a large number of known cases early on during the pandemic. Following a week-long delay, the disease began to spread throughout Europe. On March 8th and 9th, France, Germany, and Spain each reported their thousandth case (Figure 4). Like the nations prior to them, each of them had multiple links with over a million travelers with previously infected countries. On March 11th, the United States and the United Kingdom each had their thousandth case (Figure 5). Both had over three connections with at least one million tourists. However, all but one of the United Kingdom's links reached one thousand a few days prior. When the United States is added we see an increasing number of connections to the Americas as well as Asia. In Figure 6, we see more European nations with at

least one thousand cases. By this point, many European nations had at least one link with over one million people. On March 20th and March 21st, countries outside of Europe also began to increase in number of cases. By the end of March travel restrictions were put in place in most nations, meaning international travel should not have been playing as large of a roll in the spread of the disease. (Salcedo, et al., NY Times, 2020) (UNWTO, Travel Remains at a Standstill, 2020) The maps show that the virus mainly spread to countries that had large travel connections with other nations where COVID-19 was already spreading.

Although most countries that got the disease earlier had large connections with other infected nations, not all states with such links had major outbreaks early on. Because of this, a more formal simple regression analysis was needed. The first model looked at whether the overall number of inbound travelers to a country could explain the date when the first case was discovered and the date when the thousandth case was found. In both cases, see Tables 1 and 2, the overall number of travelers proved to be a small but significant predictor of when the virus first appeared. However, it was less important than the region of the country. This tells us that there is a relationship between number of travelers and the time when COVID-19 first appeared. I followed up on this by using number of links to a specific country, like China as the independent variable. In Table 3 and 4 we see that there is causation between the number of travelers from China and the date that coronavirus first appeared, but the result is very small. The findings for the thousandth case were not significant. South Korea, see Table 5, showed a small result for predicting the first case but not the thousandth, while Italy on the other hand showed no results at all. Though the virus initially spread to some of these countries, the overall number of inbound travelers is a more important factor to look at when studying the spread of disease.

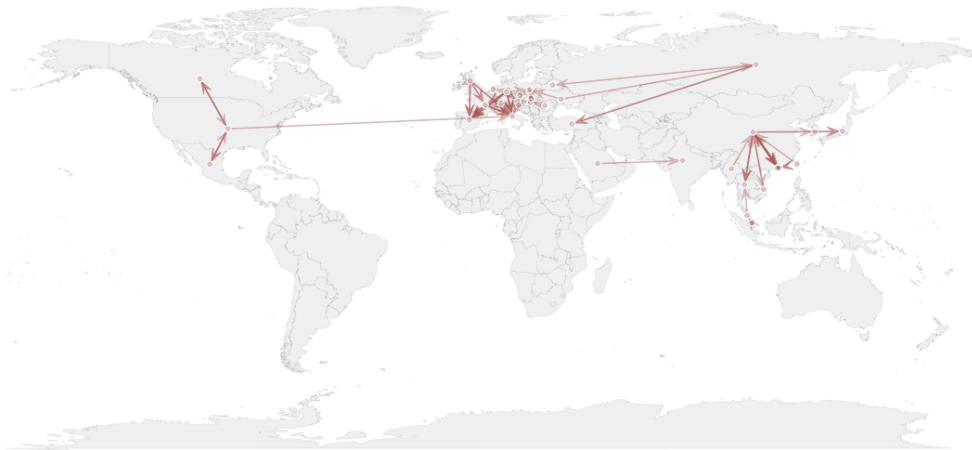
Discussion and Future

The scholarly work, along with mapping and formal data analysis, show a clear causal connection between COVID-19 and travel that runs in both directions. However, the travel data used is far from perfect. The UNWTO relies on each country to report their own incoming data, and many use slightly different units (some only count overnight tourists, while others account for all overnight visitors). Because of this, the data is not necessarily accurate. Furthermore, the most complete data came from 2018, and since then, the numbers may have changed. Additionally, the statistics are yearly, and do not show the nuances of travel and how it differs throughout the year. COVID also caused the travel numbers to drop throughout March and even February (UNWTO 2020 Barometer May Update), which the UNWTO dataset does not account for. Though the statistics are organized by the country of origin, the numbers are collected by the destination country. Because of this, the data does not always account for citizens returning to their country, it only accounts for visitors. For example, if a citizen of Italy visits China, the Chinese government reports when that individual arrived. But it does not report when that person leaves, nor would the Italians report in their dataset when the person returns. The UNWTO does have data on overall number of people leaving each country, but for the most part it was incomplete. Finally, there are plenty of other factors that influence the spread of the virus that are not considered in the analysis, from national policies to population density.

The UN is hopeful that travel will return and have pointed out that, since May, numbers have begun to improve again. Even if it takes years, the past examples have shown that tourism will adapt and recover. In the short term, the domestic travel initiatives described by the UN will hopefully alleviate some of the damage done to nations' tourist economies. In the long run, perception of safety will be a key factor in restarting tourism. In other words, countries could

promote themselves as safe destinations without the virus. This is especially important for SIDS, since they are some of the most reliant on international travel. The economic steps that the UN describes, are also vital to both getting people to travel, but also preventing businesses associated with travel from closing. Doing this assures a country that once people are willing to travel, the infrastructure and necessities will be operational. A further step that should be taken is setting measures at key travel nodes, that prevent imported cases for COVID and future diseases. This could include testing and facilities for quarantine and isolation. If I had more time on the project I would have liked to look into any plans for future pandemics that countries were creating or considering. Overall, the pandemic exposed the faults in tourism, it both spreads and then is subsequently hurt by the disease, and even if COVID goes away, future viruses could have a similar impact of nothing is changed.

Appendix I: Figures



Map 1: Top 25% of world travel. (UNWTO Compiled Tourism Statistics)



Map 2: Top 10% of world travel. (UNWTO Compiled Tourism Statistics)

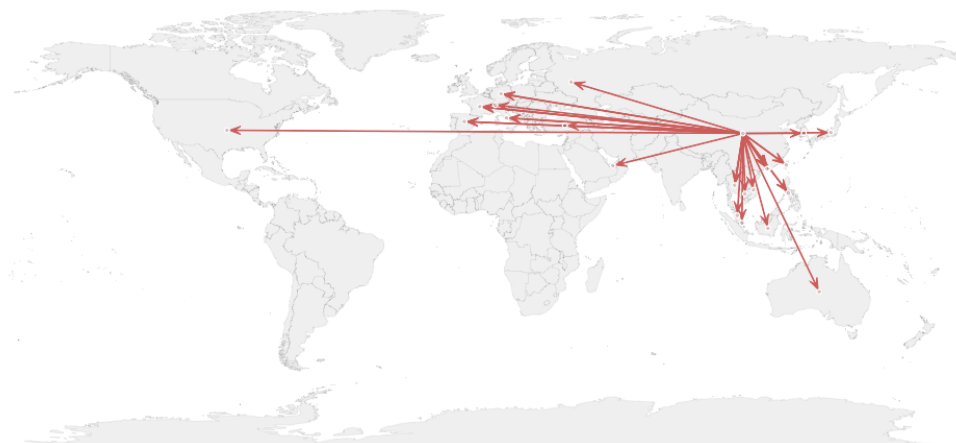


Figure 1: Map of links between China and other nations with at least 1,000,000 travelers. (UNWTO Compiled Tourism Statistics)

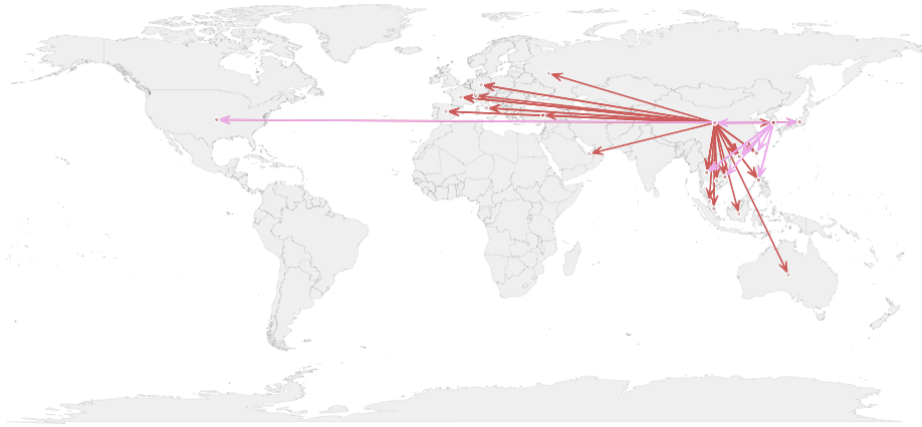


Figure 2: 2/26 South Korea is added. (UNWTO Compiled Tourism Statistics and JHU CSSE COVID-19 Time Series Data)

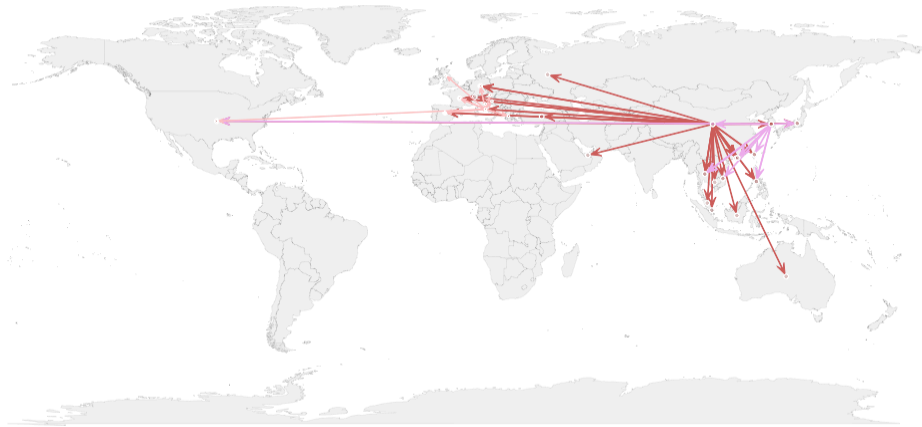


Figure 3: 2/29 and 3/02 Italy and Iran are added. (UNWTO Compiled Tourism Statistics and JHU CSSE COVID-19 Time Series Data)

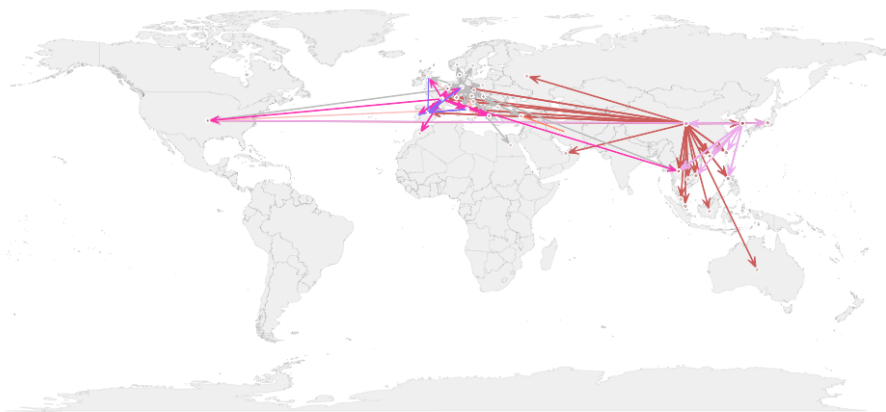


Figure 4: 3/08 and 3/09 Germany, France, Spain all added. (UNWTO Compiled Tourism Statistics and JHU CSSE COVID-19 Time Series Data)

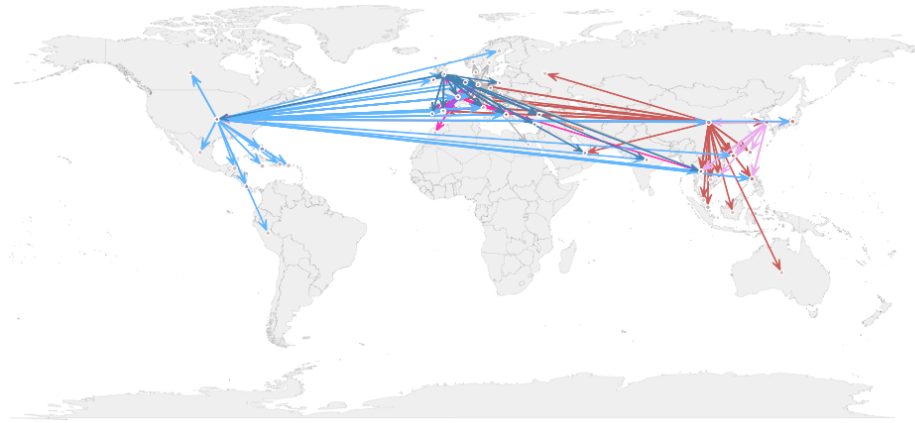


Figure 5: 3/11 the United States and the United Kingdom are added. (UNWTO Compiled Tourism Statistics and JHU CSSE COVID-19 Time Series Data)

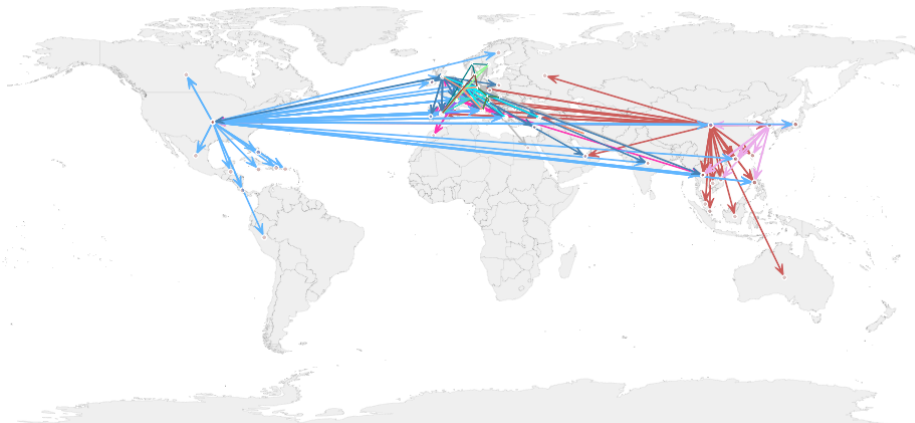


Figure 6: 3/12 to 3/18 Multiple European nations are added. (UNWTO Compiled Tourism Statistics and JHU CSSE COVID-19 Time Series Data)

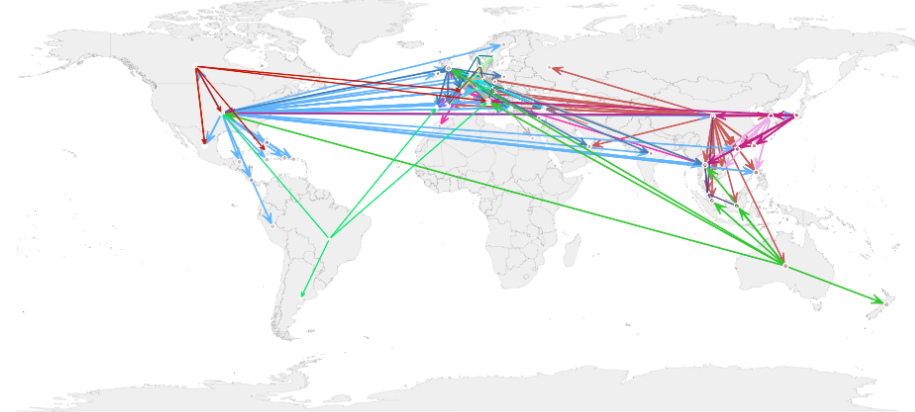


Figure 7: 3/20 and 3/21 Australia, Japan, and Brazil are added, along with a few other European nations. (UNWTO Compiled Tourism Statistics and JHU CSSE COVID-19 Time Series Data)

Appendix II: Tables

	<i>Estimate</i>	<i>Std. Error</i>
<i>(Intercept)</i>	1.834e+04 ***	2.447e+00
<i>Inbound Travelers</i>	-4.399e-04***	7.717e-05
<i>Asia</i>	-2.409e+01***	3.914e+00
<i>Australia</i>	-9.385e+00	6.263e+00
<i>Caribbean</i>	-1.857e+00	4.130e+00
<i>Central America</i>	-2.643e+00	6.691e+00
<i>Europe</i>	-1.435e+01***	3.577e+00
<i>Middle East</i>	-1.991e+01***	5.052e+00
<i>North America</i>	-1.667e+01*	8.423e+00
<i>South America</i>	-1.071e+01 *	4.887e+00

Table 1: Linear Regression; date of first case vs. number of travelers and region of the country. (UNWTO Compiled Tourism Statistics and JHU CSSE COVID-19 Time Series Data). The sign of the estimates are negative because as the number of travelers decreases the number corresponding with each day gets larger (the date is later on).

	<i>Estimate</i>	<i>Std. Error</i>
<i>(Intercept)</i>	1.841e+04	6.076e+00
<i>Inbound Travelers</i>	-5.368e-04 ***	1.645e-04
<i>Asia</i>	-3.331e+01 ***	9.597e+00
<i>Australia</i>	-6.112e+01 **	2.228e+01
<i>Caribbean</i>	-3.259e+01 .	1.852e+01
<i>Central America</i>	-1.784e+01	1.485e+01
<i>Europe</i>	--4.724e+01***	8.353e+00
<i>Middle East</i>	-3.011e+01 **	1.067e+01
<i>North America</i>	-4.371e+01*	1.994e+01
<i>South America</i>	-3.054e+01**	1.097e+01

Table 2: Linear Regression; date of thousandth case vs. number of travelers and region of the country. The data is analysis is limited to countries in which the thousandth case appeared prior to April due to the unreliability of the data due to travel restrictions. (UNWTO Compiled Tourism Statistics and JHU CSSE COVID-19 Time Series Data).

	<i>Estimate</i>	<i>Std. Error</i>
<i>(Intercept)</i>	1.841e+04 ***	1.756e+00
<i>Inbound Travelers</i>	-4.400e-04 ***	8.610e-05
<i>Travelers from China</i>	-5.955e-07 *	2.496e-07

Table 3: Linear Regression; date of first case vs. number of travelers from China and overall travelers. (UNWTO Compiled Tourism Statistics and JHU CSSE COVID-19 Time Series Data).

	<i>Estimate</i>	<i>Std. Error</i>
<i>(Intercept)</i>	1.838e+04 ***	3.761e+00
<i>Inbound Travelers</i>	-7.562e-04 ***	1.595e-04
<i>Travelers from China</i>	5.069e-07	1.595e-04

Table 4: Linear Regression; date of thousandth case vs. number of travelers from China and overall travelers. (UNWTO Compiled Tourism Statistics and JHU CSSE COVID-19 Time Series Data).

	<i>Estimate</i>	<i>Std. Error</i>
<i>(Intercept)</i>	1.833e+04***	1.750e+00
<i>Inbound Travelers</i>	-3.641e-04***	8.527e-05
<i>Travelers from China</i>	-7.213e-06 ***	1.902e-06

Table 5: Linear regression; date of first case vs. number of travelers from South Korea and overall travelers (UNWTO Compiled Tourism Statistics and JHU CSSE COVID-19 Time Series Data).

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