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**COVID-19, Air Transportation, and International  
Trade in the ASEAN+5 Region**

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**Abstract:** *This paper provides an in-depth description of the coronavirus disease (COVID-19) pandemic and its interactions with air transportation in the Association of Southeast Asian Nations (ASEAN)+5 region, and then links the changes in air connectivity to trade using a gravity regression model. We find that almost all the countries probably reacted too late in their decision to reduce flights in the early stage of the pandemic. As the pandemic evolved, most countries have significantly cut the number of flight connections, especially international flights. The reduced connectivity is found to have a significantly negative impact on trade for time-sensitive merchandise that is essential to consumers and businesses. This points to the importance of the region seeking alternative arrangements to restore air connectivity. We offer a way to construct optimal travel bubbles by using risk indexes introduced here. Other policy issues such as uniform standards and regulations, and regional ‘open skies’, are also discussed.*

**Keywords:** ASEAN, ASEAN+5, COVID-19, air transportation, trade

**JEL Classification:** L93, F14, F15, H12, I18

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## 1. Introduction

The coronavirus disease (COVID-19) pandemic is considered the biggest social and economic shock since the Great Depression. In what could be considered a highly uncoordinated, almost chaotic manner, countries have closed their borders, and people are reluctant/unable to travel due to country-specific lockdown measures. Airlines were forced, by the obliteration of demand, into cancelling flights and grounding fleets. Air transport is, accordingly, one of the hardest hit sectors by the pandemic, while probably being one of the pandemic's largest initial drivers. The International Civil Aviation Organization estimated that the aviation industry overall would lose up to \$418 billion.<sup>1</sup>

Doubtlessly, the pandemic has had a major impact on the economies in the Asia Pacific. At the early stages of COVID-19, borders were suddenly closed, flights banned, and the regular mobility of people almost completely halted in the region. Overall, the pandemic has been testing the strength of the relationships between the Southeast and East Asian economies. Relatedly, the region witnessed a major development through the completion of the Regional Comprehensive Economic Partnership (RCEP) negotiations, which was the key outcome of the 37<sup>th</sup> Association of Southeast Asian Nations (ASEAN) Summit (9–15 November 2020). By bringing ASEAN together with Japan, the Republic of Korea (henceforth, Korea), China, Australia, and New Zealand, the RCEP agreement would make the 'ASEAN+5' the largest free trade area in the world, covering about one-third of the world's gross domestic product (GDP) – at \$25.84 trillion in 2019 (vs \$21.37 trillion for the United States (US) and \$15.59 trillion for the European Union).

In this study, we investigate the impacts of COVID-19 on air transport connectivity in the 'ASEAN+5' and the region's international trade. ASEAN+5 consists of the 10 ASEAN Member States (AMS), plus Japan, Korea, China, Australia, and New Zealand. As mentioned above, those five countries have been known as ASEAN's major free trade partners.<sup>2</sup> We first examine the pandemic's

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<sup>1</sup> Unless indicated otherwise, the currency in this paper is United States (US) dollars.

<sup>2</sup> India had also been involved in RCEP negotiations. It pulled out of RCEP talks in November 2019, but the RCEP members have indicated that the door remains open to India. We note that the

evolution in this region and its interaction with air transportation. We find, amongst others, that the pandemic has significantly reduced the region's air transport connectivity. We then link the changes in air connectivity to trade using a gravity regression model, a reliable empirical tool commonly used in international trade literature. The reduced connectivity will, based on the regression analysis, have a significantly negative impact on trade. Thus, both individual countries and the region as a whole need to actively seek alternative arrangements and measures to restore air connectivity. We will examine policies such as optimal 'travel bubbles', uniform standards, and regional 'open skies' when dealing with the pandemic and air transport connectivity.

One contribution of this paper lies in the study area, as no studies have, to our best knowledge, quantitatively examined the impact of air connectivity on trade in the ASEAN or ASEAN+5 regions – a critical, emerging region in both aviation and overall economic/trade activities.<sup>3</sup>

Our second contribution is that we examine the mutual interactions between air transportation and the COVID-19 pandemic. A number of recent studies have examined the question of how air transportation contributes to the spread of COVID-19. These studies, in essence, employ existing aviation data sets (usually concerning the number of flights or the number of passengers between airport pairs) to understand the spreading processes in the early months of 2020, where the major medium of disease transmission was still air travel (e.g. Lau et al., 2020; Nakamura and Managi, 2020; Zhang, Zhang, and Wang, 2020; Zhang et al., 2020). For instance, Zhang et al. (2020) measured the imported case risk of COVID-19 from international flights. Further, compartmental meta-population models or data science techniques are used to obtain relationships between the number of cases and air travel between different regions in the world, leading to predictions about the time and extent of an arrival of COVID-19 in these places.<sup>4</sup> Overall, the findings in

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present study can, in a future study, be extended by including India in the context of the 'ASEAN+6'.

<sup>3</sup> More generally, as typical international trade literature using the gravity model does not take air transport connectivity into account, our findings suggest that this could be a major omission.

<sup>4</sup> Here, some studies take a rather global, network perspective (e.g. Coelho et al., 2020; Hussain et al., 2020) while others focus on specific regions, e.g. China (e.g. Li et al., 2020); the European Union/US (e.g. Nikolaou and Dimitriou, 2020; Peirlinck et al., 2020); Iran (Tuite et al., 2020);

these studies are largely consistent, given the earlier (pre-COVID-19) work on disease spreading. They found, in particular, that the number of passengers is a rather reliable indicator of predicting when the disease arrives, given a fixed place of origin, a concept known as ‘effective distance’ in the literature (Brockmann and Helbing, 2013). As for the other direction of this air transport/COVID-19 link (i.e. how the pandemic affects global, regional, and domestic air transportation, in both the short and long term), it is a topic of numerous studies; see Sun et al. (2021) for a comprehensive literature review. Complementing these two streams of literature, we look at the mutual interactions between the pandemic and air transportation. Moreover, since this is one of a few studies on COVID-19 and air transportation for the ASEAN or ASEAN+5 regions, we will provide an in-depth description of the interactions from a complex system perspective using network science tools.

Finally, the present paper attempts to offer insights for a better policy response to the crisis by the ASEAN+5. As indicated in ERIA (2020) and Kimura (2020), connectivity enhancement is an important policy to improve the attractiveness of the ASEAN region as an investment destination. One such enhancement initiative is the ASEAN Open Skies policy, which came into effect in 2015. The policy – also known as the ASEAN Single Aviation Market (ASEAN-SAM) – is intended to increase regional connectivity, integrate production networks, and enhance regional trade by allowing airlines from AMS to fly freely throughout the region via the liberalisation of air services under a single, unified air transport market.<sup>5</sup> The implications of our analysis for the ASEAN Open Skies will be discussed.

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Brazil (Ribeiro et al., 2020); or Columbia (Gómez-Rios, Ramirez-Malule, and Ramirez-Malule, 2020).

<sup>5</sup> Studies have found that frequencies of air flights play an important role in the location, agglomeration, and evolution of economic activities. Fu, Oum, and Zhang (2010) and Zhang and Graham (2020) pointed out that air transport imposes significant positive externalities to other industries. For example, Button and Lall (1999) found that the presence of a hub airport could greatly increase high-tech employment by an average of 12,000 jobs in the airport catchment. Therefore, air transport has been long regarded as a critical sector to the normal operation of an economy.

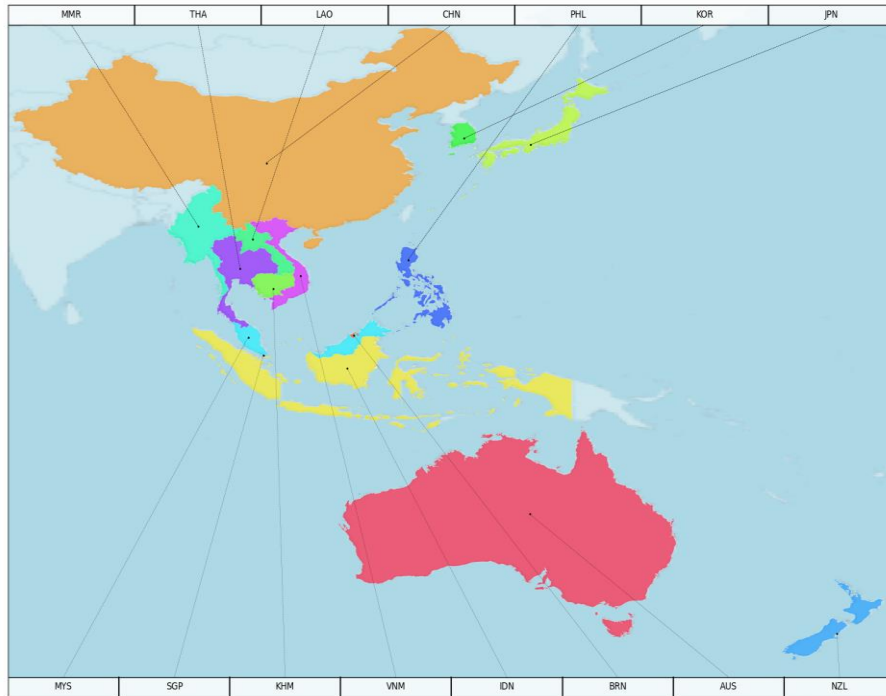
The paper is organised as follows. Section 2 describes the background of the ASEAN+5 and the COVID-19 pandemic in the region. Section 3 examines the interactions between the pandemic and air transportation, including the impact on air transport connectivity. Section 4 develops the gravity model and reports its regression results. Section 5 discusses policy implications for travel bubbles, uniform standards, and open skies. Section 6 summarises the results and discusses directions for further research.

## **2. Background of the ASEAN+5 and the Pandemic**

ASEAN was created on 8 August 1967; the founding members were Indonesia, Malaysia, the Philippines, Singapore, and Thailand. Between 1984 and 1999, five additional members joined in the following order: Brunei, Viet Nam, the Lao People's Democratic Republic (Lao PDR), Myanmar, and Cambodia. On 15 December 2008, ASEAN became a legal entity. The major focus of ASEAN is on economic cooperation and trade amongst its members and with the rest of the world. It now covers a population of 600 million people, which is notably larger than those of the European Union (447 million) and the US plus Canada (367 million). Indonesia and Thailand are the largest economies in ASEAN, with smaller countries expecting to boost their economies through the association.

In the aftermath of the 1997 Asian Financial Crisis, an informal 'ASEAN+3' (China, Japan, and Korea) was built, named the East Asia Vision Group. As mentioned above, in November 2020 the RCEP agreement brought together ASEAN, China, Japan, Korea, Australia, and New Zealand. Our analysis focuses on this 'ASEAN+5' region; see Figure 1 for a visual representation of the countries' geography and Table 1 for an overview. Of the 15 countries, China is by a considerable margin the largest and most populous country, followed by Australia (in terms of size) and Indonesia (in terms of population). The country with the least population is Brunei and the smallest country is Singapore. We use the ISO 3 code (see the first column of Table 1) to refer to the countries.

**Figure 1: Fifteen Countries in ASEAN+5**



ASEAN = Association of Southeast Asian Nations, ISO = International Organization for Standardization.

Note: The countries are labelled by their ISO 3 country codes.

Source: Authors (data from Flightradar24 (n.d.), <https://www.flightradar24.com> (accessed 25 February 2021); visualisation: Matplotlib).

**Table 1: Overview of the 15 ASEAN+5 Countries**

ISO 3	Full name	Capital	Area (km <sup>2</sup> )	Population
BRN	Nation of Brunei	Bandar Seri Begawan	5,765	428,962
IDN	Republic of Indonesia	Jakarta	1,904,569	267,663,435
KHM	Kingdom of Cambodia	Phnom Penh	181,035	16,249,798
LAO	Lao People's Democratic Republic	Vientiane	236,800	7,061,507
MMR	Republic of the Union of Myanmar	Naypyidaw	676,578	53,708,395
MYS	Malaysia	Kuala Lumpur	330,803	31,528,585
PHL	Republic of the Philippines	Manila	342,353	106,651,922
SGP	Republic of Singapore	Singapore	710	5,638,676
THA	Kingdom of Thailand	Bangkok	513,120	69,428,524
VNM	Socialist Republic of Viet Nam	Hanoi	331,212	95,540,395
AUS	Commonwealth of Australia	Canberra	7,692,024	24,982,688
CHN	People's Republic of China	Beijing	9,706,961	1,392,730,000
JPN	Japan	Tokyo	377,930	126,529,100
KOR	Republic of Korea	Seoul	100,210	51,606,633
NZL	New Zealand	Wellington	270,467	4,841,000

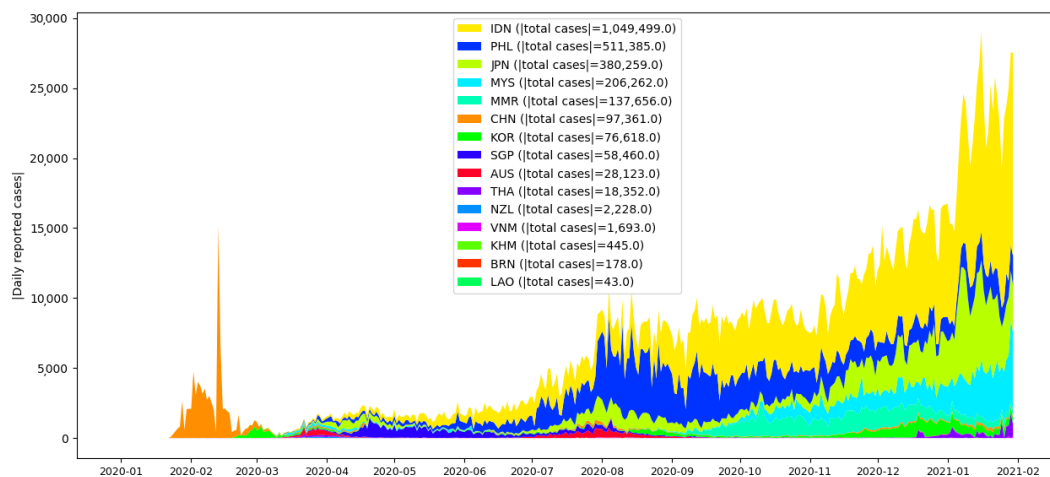
ASEAN = Association of Southeast Asian Nations, ISO = International Organization for Standardization, km<sup>2</sup> = square kilometre.

Source: World Bank (2020), *World Development Indicators*, 2020. Washington, DC: World Bank.

<https://databank.worldbank.org/source/world-development-indicators> (accessed 15 December 2020).

All 15 countries have confirmed cases, yet the success in fighting COVID-19 varies across the countries. Figure 2 shows the temporal evolution of the number of reported COVID-19 cases in each country, as a stacked line plot over January 2020–February 2021. It can be seen that Indonesia, the Philippines, Japan, and Malaysia are hit hardest by COVID-19, while other countries, such as the Lao PDR, Brunei, Cambodia, New Zealand, and Australia did much better according to these indicators.

**Figure 2: Daily COVID-19 Cases in Each ASEAN+5 Country,  
Jan 2020–Feb 2021**



ASEAN = Association of Southeast Asian Nations, COVID-19 = coronavirus disease, ISO = International Organization for Standardization.

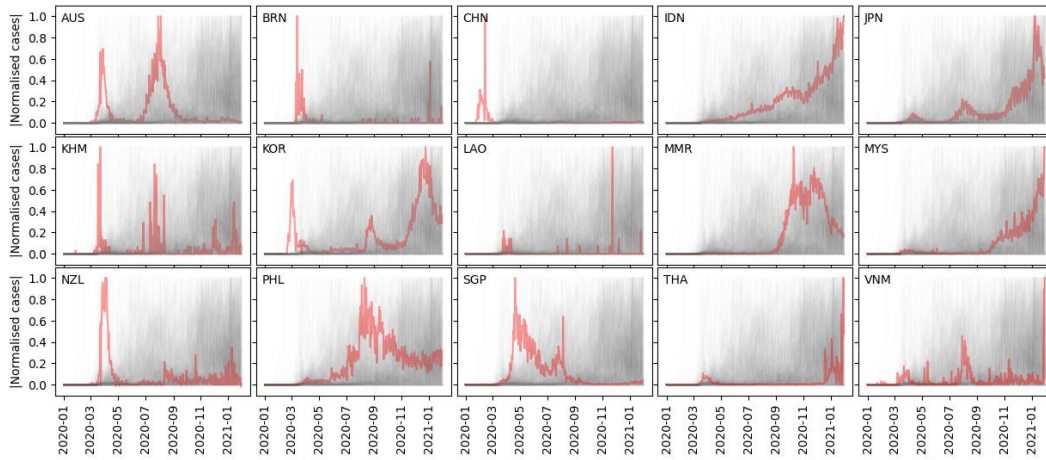
Notes: The total cases in each country are also given, with the countries being sorted according to their total number of (reported) cases in descending order. The countries are labelled by their ISO 3 country codes: AUS = Australia, BRN = Brunei, CHN = China, IDN = Indonesia, JPN = Japan, KHM = Cambodia, KOR = Republic of Korea, LAO = Lao People's Democratic Republic (Lao PDR), MMR = Myanmar, MYS = Malaysia, NZL = New Zealand, PHL = Philippines, SGP = Singapore, THA = Thailand, VNM = Viet Nam.

Source: Authors (data from GitHub (n.d.), OWID/COVID-19 data. <https://github.com/owid/covid-19-data> (accessed 25 February 2021); visualisation: Matplotlib).

To better understand the evolution/phases of COVID-19 in the ASEAN+5, Figure 3 reports the normalised number of cases for each country over time (Jan 2020–Feb 2021). Here, the normalisation is performed as a max-normalisation, where all the daily reported cases in a country are divided by the country's maximum number of reported cases. As can be seen from Figure 3, China was hit strongest in the early stage of the pandemic, with the number of infections reaching a peak

in March 2020. Following a very strict quarantine and testing policy, together with heavy (and early) travel bans and flight restrictions, China was able to quickly contain the spread of COVID-19. Now, it is one of the few countries that is considered essentially COVID-19-free. Brunei and New Zealand exhibit similar patterns to China, having an early peak but then being able to control the number of infections. Australia and Singapore show a two-peak pattern, encountering a second wave around August 2020 but then being able to control the number of infections. Other countries have had to fight higher infection counts towards the later stages of the pandemic, e.g. the Philippines, Japan, Indonesia, Malaysia, and Myanmar. Compared to the global situation, however, the ASEAN+5 countries as a whole have performed much better in terms of confirmed cases (and deaths related to COVID-19).

**Figure 3: Normalised Daily COVID-19 Cases in the ASEAN+5,  
Jan 2020–Feb 2021**



ASEAN = Association of Southeast Asian Nations, COVID-19 = coronavirus disease, ISO = International Organization for Standardization.

Notes: The normalised daily COVID-19 cases in the ASEAN+5 are in red, while those of all the other countries in the world are in grey. The countries are labelled by their ISO 3 country codes: AUS = Australia, BRN = Brunei, CHN = China, IDN = Indonesia, JPN = Japan, KHM = Cambodia, KOR = Republic of Korea, LAO = Lao People's Democratic Republic (Lao PDR), MMR = Myanmar, MYS = Malaysia, NZL = New Zealand, PHL = Philippines, SGP = Singapore, THA = Thailand, VNM = Viet Nam.

Source: Authors (data from GitHub (n.d.), OWID/COVID-19 data. <https://github.com/owid/covid-19-data> (accessed 25 February 2021); visualisation: Matplotlib).

We next look at the synchronisation between the numbers of reported cases amongst the ASEAN+5 countries. The experimental data are generated as follows:



For each pair of countries, the number of infections induce two sets of time series. The time series are then 0-1-normalised to reduce the effects of larger populations, since we are interested in a similar evolutionary pattern, not in the same order of magnitude. For each pair of the normalised time series, the Pearson R is computed. The country-pairwise correlation between COVID-19 (number of) infections is reported in Figure 4. The obtained R-value is reported on the upper right of each panel; the diagonal entries are not shown. It can be seen that some countries are surprisingly synchronised regarding this correlation indicator, e.g. Malaysia and Myanmar. For many other country pairs, there is not much correlation. For instance, for all the pairs involving China, there is no high correlation with the other countries. This may be because China went through its peak at the earliest phase of the pandemic.

**Figure 4: Pairwise Correlation of COVID-19 Cases Between Countries in the ASEAN+5, Jan 2020–Feb 2021**



ASEAN = Association of Southeast Asian Nations, COVID-19 = coronavirus disease, ISO = International Organization for Standardization.

Notes: The countries are labelled by their ISO 3 country codes: AUS = Australia, BRN = Brunei, CHN = China, IDN = Indonesia, JPN = Japan, KHM = Cambodia, KOR = Republic of Korea, LAO = Lao People's Democratic Republic (Lao PDR), MMR = Myanmar, MYS = Malaysia, NZL = New Zealand, PHL = Philippines, SGP = Singapore, THA = Thailand, VNM = Viet Nam. Correlations with coefficient  $\geq 0.65$  are highlighted in red.

Source: Authors (data from GitHub (n.d.), OWID/COVID-19 data. <https://github.com/owid/covid-19-data> (accessed 25 February 2021); visualisation: Matplotlib).

### **3. Air Transport Connectivity and Interactions with the Pandemic**

#### **3.1. Air transport connectivity in the ASEAN+5**

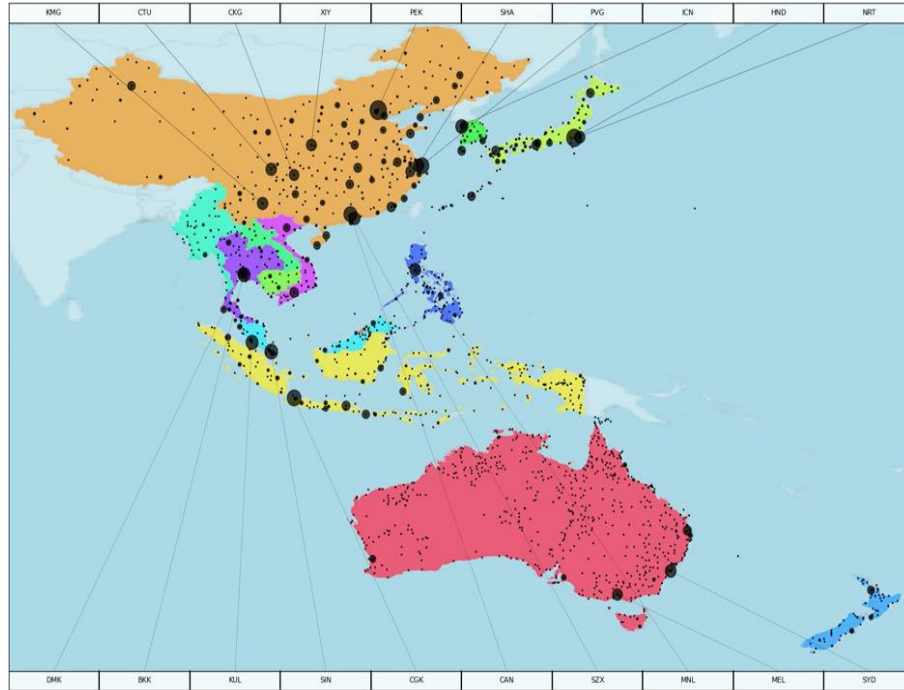
It has been a long-standing goal of ASEAN to integrate and boost the air travel sector; see its Roadmap for Integration of Air Travel Sector and the follow-ups, which aim at advancing the full liberalisation of air transport services in ASEAN (Law, Zhang, and Zhang, 2018). A wide range of open skies instruments have emerged throughout the years, indicating the importance of air transportation for an integrated ASEAN economy. In particular, if the ASEAN–SAM were successfully implemented (absent the COVID-19 pandemic), there would be no regulatory limits on the frequency or capacity of flights between international airports across the 10 AMS.

Figure 5 visualises the airports located in the ASEAN+5. We use the number of passengers at an airport in 2019 to measure its market size. The top 20 airports are highlighted with their 3-letter International Civil Aviation Organization (ICAO) code.<sup>6</sup> This region contains some of the busiest airports in the world, e.g. PEK (Beijing Capital Airport), PVG (Shanghai Pudong Airport), HND (Tokyo Haneda Airport), ICN (Incheon Airport), CGK (Jakarta Airport), SYD (Sydney Airport), and CYN (Guangzhou Airport).

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<sup>6</sup> Here, ‘China’ refers to Mainland China, so (for example) Hong Kong is not included.

**Figure 5: Airports in the ASEAN+5 and Its Top 20 Airports**



ASEAN = Association of Southeast Asian Nations.

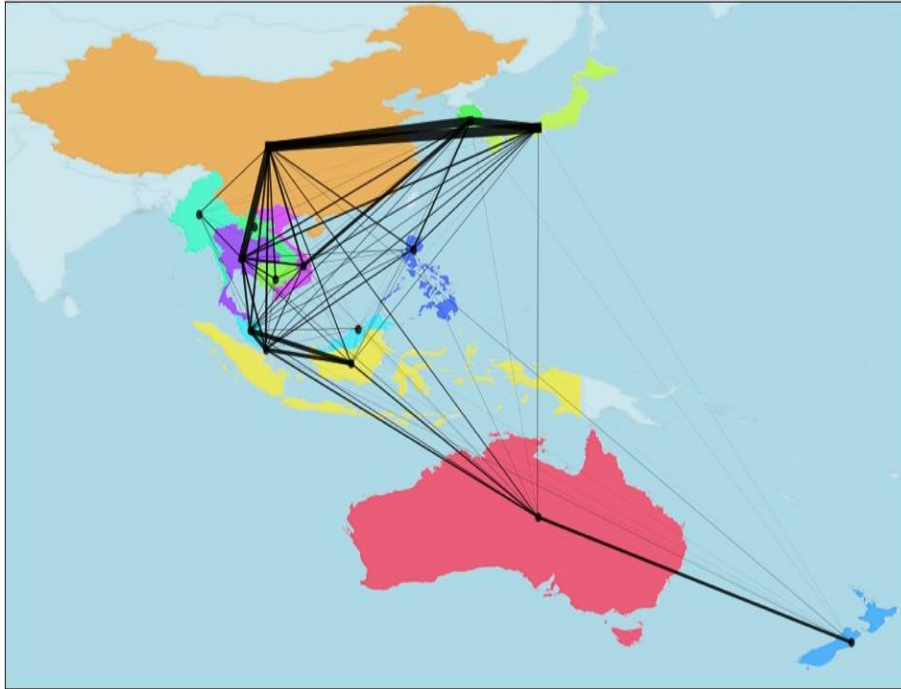
Notes: The size of a circle marker correlates with the number of passengers at the airport in 2019. The top 20 airports indicated are (clockwise, from the top left): KMG = Kunming Airport, CTU = Chengdu Airport, CKG = Chongqing Airport, XIY = Xian Airport, PEK = Beijing Capital Airport, SHA = Shanghai Hongqiao Airport, PVG = Shanghai Pudong Airport, ICN = Incheon Airport, HND = Tokyo Haneda Airport, NRT = Tokyo Narita Airport, SYD = Sydney Airport, MEL = Melbourne Airport, MNL = Manila Airport, SZX = Shenzhen Airport, CAN = Guangzhou Airport, CGK = Jakarta Airport, SIN = Changi Airport, KUL = Kuala Lumpur Airport, BKK = Bangkok Suvarnabhumi Airport, DMK = Bangkok Don Mueang Airport.

Source: Authors (data from Flightradar24 (n.d.), <https://www.flightradar24.com> (accessed 25 February 2021); visualisation: Matplotlib).

In the following analysis, we examine the regional and international air transport connectivity of the ASEAN+5. In Figure 6, the regional air connectivity within the ASEAN+5 is visualised. Here, all airports inside a country are aggregated into a single node representing the whole country; domestic flights inside a country are discarded (i.e. there are no self-loops). We computed the average number of daily flights for all the pairs of countries in the ASEAN+5; the line width of a country pair correlates with this average number of flights. It can be seen that China has very strong ties to several countries: Japan (almost 200 flights per day), Thailand (175 flights per day), and Korea (172 flights per day). Japan and Korea are well connected with each other (at 154 flights per day). In

addition, Malaysia and Indonesia (95 flights per day) and Singapore and Indonesia (75 flights per day) have relatively strong ties with each other.

**Figure 6: Regional Connections as Average Daily Flights Between ASEAN+5 Countries in 2019**



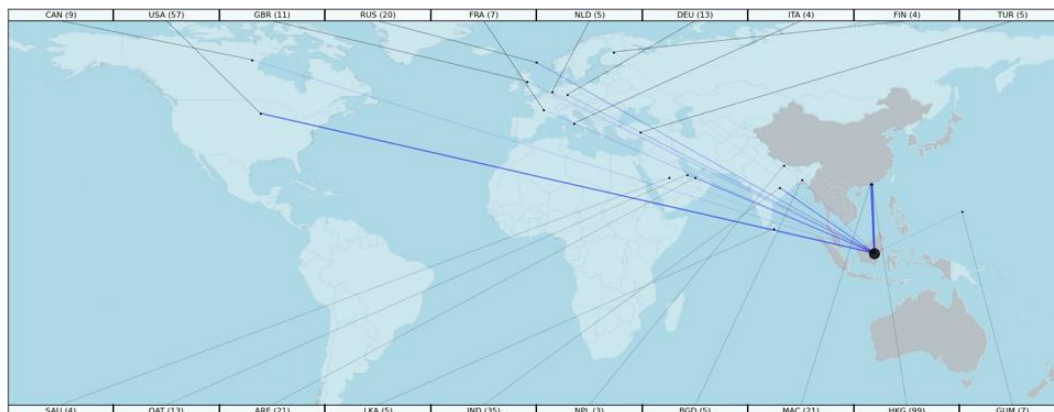
ASEAN = Association of Southeast Asian Nations.

Notes: All airports inside an ASEAN+5 country are aggregated into a single node representing the whole country. The thickness of a line represents the degree of air connections between two ASEAN+5 countries.

Source: Authors (data from Flightradar24 (n.d.), <https://www.flightradar24.com> (accessed 25 February 2021); visualisation: Matplotlib).

Next, consider the international connectivity of the ASEAN+5 with the rest of the world. For this purpose, we collected all flights between any ASEAN+5 country and all the external countries/regions for the year 2019. Figure 7 reports the top 20 such external partners, in terms of the average daily number of flights. It can be seen that Hong Kong is – by a large amount – the partner with the best country/region-level air connectivity, having almost 100 daily flights with the ASEAN+5. Other countries/regions with frequent connections include the US (57 flights per day) and India (35 flights per day).

**Figure 7: International Connections as Average Daily Flights Between the ASEAN+5 and Other Countries/Regions in 2019**



ASEAN = Association of Southeast Asian Nations.

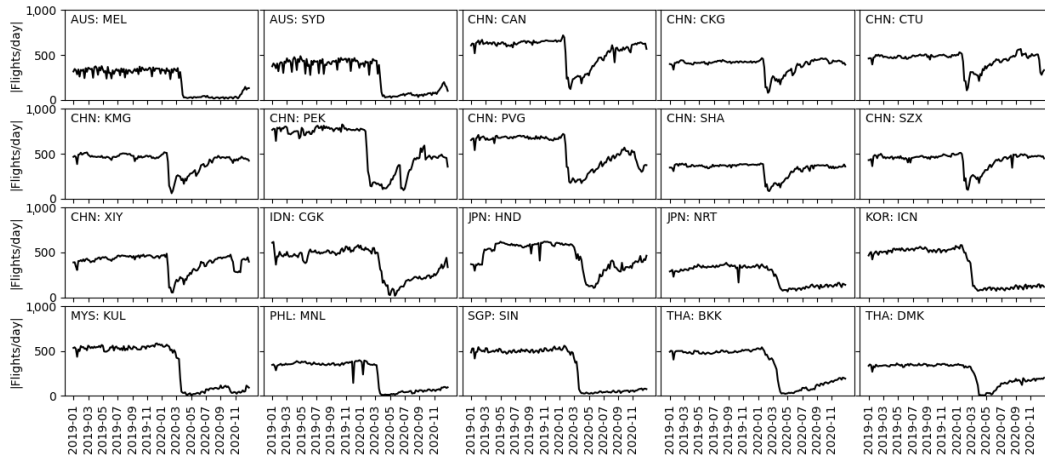
Notes: The ASEAN+5 is represented by a black circle marker over Indonesia. The 3-letter codes in the figure stand for different countries: CAN = Canada, US = United States, GBR = United Kingdom, RUS = Russia, FRA = France, NLD = Netherlands, DEU = Germany, ITA = Italy, FIN = Finland, TUR = Turkey, SAU = Saudi Arabia, QAT = Qatar, ARE = United Arab Emirates, LKA = Sri Lanka, IND = India, NPL = Nepal, BGD = Bangladesh, MAC = Macau, HKG = Hong Kong, GUM = Guam. The number inside the parentheses for each country indicates the international connections.

Source: Authors (data from Flightradar24 (n.d.), <https://www.flightradar24.com> (accessed 25 February 2021); visualisation: Matplotlib).

### 3.2. Evolution of air transportation during the advent of COVID-19

We now describe the temporal evolution of air transportation of ASEAN+5 countries during the advent of COVID-19 (i.e. the so-called ‘first wave’). Figure 8 shows the total number of flights per day for the top 20 airports from 1 January 2019 to 31 December 2020. This 2-year period covers (i) 1 year before the COVID-19 pandemic, (ii) about 4 months of the intensive first wave around Asia and the world, and (iii) another 8 months with distinct case developments in different regions. Given that air transportation can play a significant role in the initial phase of a pandemic – the World Health Organization (WHO) declared COVID-19 a global pandemic on 12 March 2020 – this 2-year period is, we believe, adequate for analysing the initial drivers. We use aircraft-specific flight data from <http://www.flightradar24.com>. The data set covers almost 3,000 airports in the world and more than 100 airlines. We extract the daily flights for the regions under consideration.

**Figure 8: Number of Daily Flights at Top 20 Airports in the ASEAN+5,  
Jan 2019–Dec 2020**



ASEAN = Association of Southeast Asian Nations.

Notes: The code in the upper left corner of each box represents a specific airport. AUS: MEL = Melbourne Airport, AUS: SYD = Sydney Airport, CHN: CAN = Guangzhou Airport, CHN: CKG = Chongqing Airport, CHN: CTU = Chengdu Airport, CHN: KMG = Kunming Airport, CHN: PEK = Beijing Capital Airport, CHN: PVG = Shanghai Pudong Airport, CHN: SHA = Shanghai Hongqiao Airport, CHN: SZX = Shenzhen Airport, CHN: XIY = Xian Airport, IDN: CGK = Jakarta Airport, JPN: HND = Tokyo Haneda Airport, JPN: NRT = Tokyo Narita Airport, KOR: ICN = Incheon Airport, MYS: KUL = Kuala Lumpur Airport, PHL: MNL = Manila Airport, SGP: SIN = Changi Airport, THA: BKK = Bangkok Suvarnabhumi Airport, THA: DMK = Bangkok Don Mueang Airport.

Source: Authors (data from Flightradar24 (n.d.), <https://www.flightradar24.com> (accessed 25 February 2021); visualisation: Matplotlib).

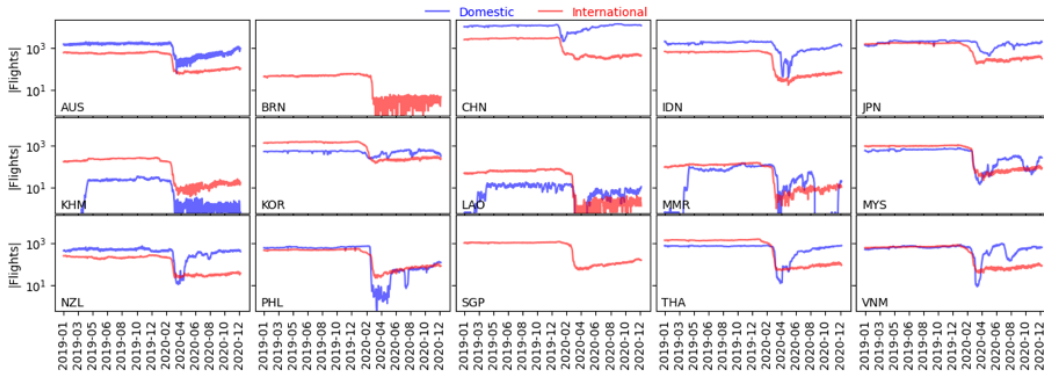
It can be seen from Figure 8 that all 20 airports are equally affected by the first wave, albeit some airports earlier (e.g. Chinese airports) and others slightly later (e.g. airports in Korea, Singapore, and Thailand). The magnitude of flight reductions at these airports is striking: Except for CAN (Guangzhou), PVG (Shanghai Pudong), SZX (Shenzhen), and HND (Tokyo Haneda), all these major airports came to a complete halt for a specific period of time. Some of them are on the way to recovery, e.g. major Chinese airports, while others remain at marginal operations, e.g. MEL (Melbourne), AUS (Sydney), ICN (Incheon), KUL (Kuala Lumpur), MNL (Manila), NRT (Tokyo Narita), SIN (Changi), and BKK (Bangkok Suvarnabhumi). Notably, the airports in the latter category often are the dominant international hubs in their countries.

The next analysis concerns the ASEAN+5-wide evolution of air transportation dissecting, separately, the effects on domestic flights and international flights. Figure 9 visualises the temporal evolution of domestic flights



(in blue) and international flights (in red) during the 2-year period. Note that some countries do not have any domestic flights due to their size, e.g. Brunei and Singapore. While domestic and international flights were initially reduced equally, it can be seen that the long-term effects of flight bans/cancellations are mainly taking place on the international flights. Especially in China, Japan, Indonesia, and Viet Nam, the numbers of domestic flights have quickly reached their pre-COVID-19 levels. This means that the countries/airlines remain concerned mainly with controlling the international flow of passengers, while being less afraid of the effects of domestic passenger travelling. This observation is noteworthy, since the virus does not concern political or administrative borders.

**Figure 9: Evolution of Domestic and International Flights in the ASEAN+5, Jan 2019–Dec 2020**



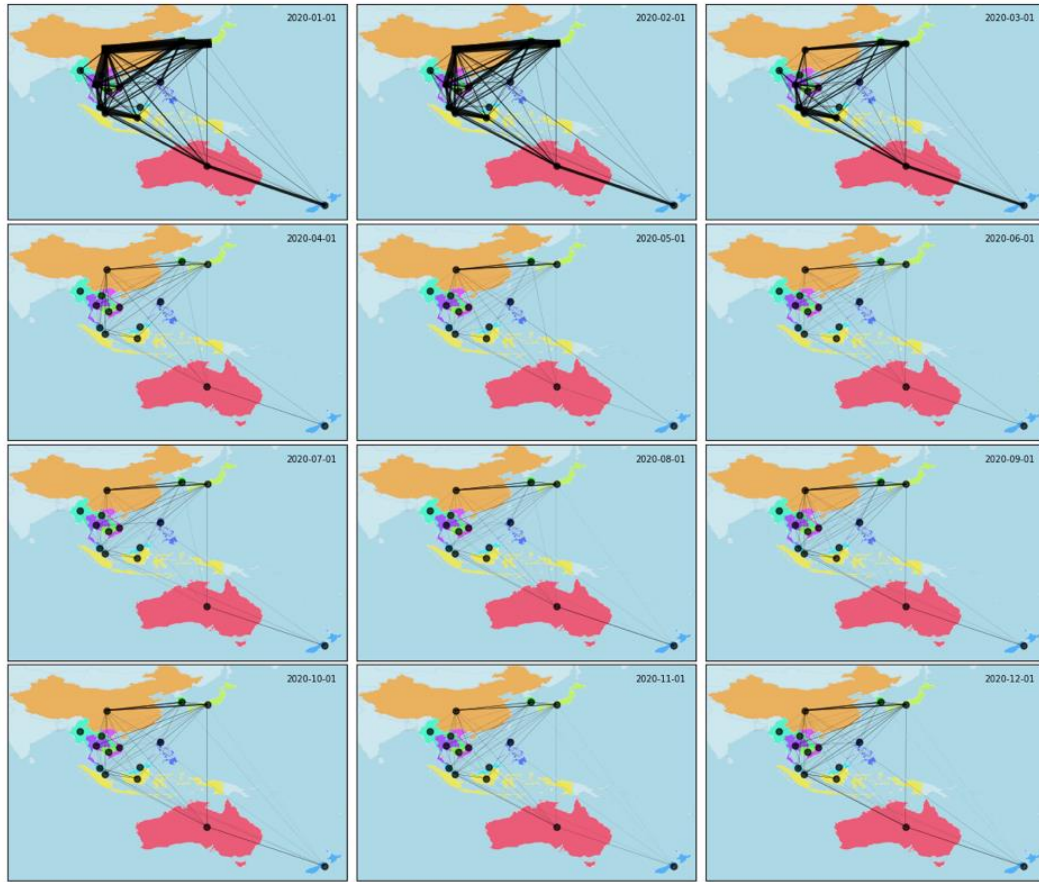
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Source: Authors (data from Flightradar24 (n.d.), <https://www.flightradar24.com> (accessed 25 February 2021); visualisation: Matplotlib).

In Figure 10, we investigate the evolution of intra-ASEAN+5 flights as a network. For the first day of each month from January to December 2020, we show the intra-ASEAN+5 country network, where the width of a link correlates with the number of flights between two countries. We can see that the topological connectivity is somehow still present between countries in the ASEAN+5, but the magnitude of flights is significantly reduced owing to the pandemic.

**Figure 10: Evolution of the Country Network Within the ASEAN+5, Jan–Dec 2020**



ASEAN = Association of Southeast Asian Nations.

Note: The width of a link correlates with the number of flights between two countries.

Source: Authors (data from Flightradar24 (n.d.), <https://www.flightradar24.com> (accessed 25 February 2021; visualisation: Matplotlib).

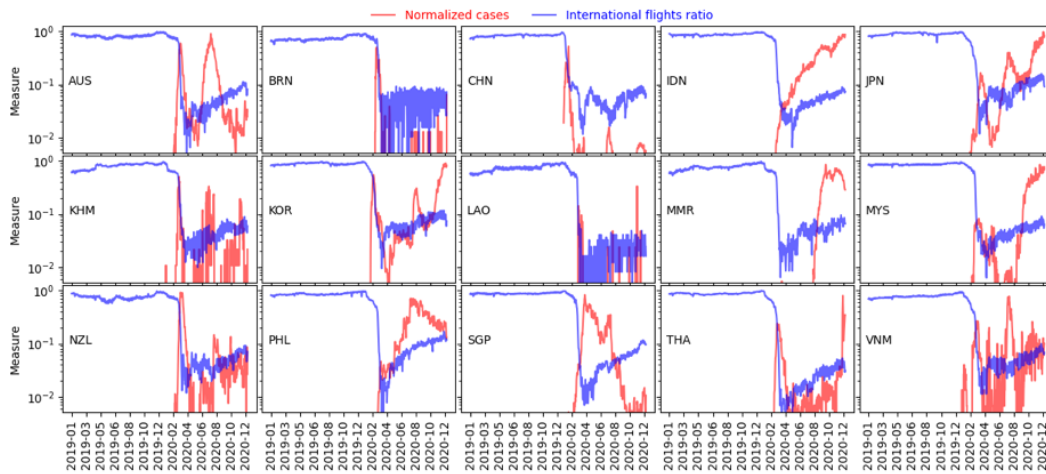
### 3.3. Synchronisation between international flights and COVID-19 cases?

The previous subsection has revealed that the number of international flights was greatly reduced for all the ASEAN+5 countries; and remained low until the summer of 2020. A natural question is then: Were these countries' borders closed on time, or too late already? To obtain a first-cut visual impression of the synchronisation between (i) the time when the number of international flights was reduced for a country and (ii) the time when COVID-19 reached the country, Figure 11 reports the temporal evolution of the international flight ratio (in blue) and normalised cases (in red) by country. Here, the international flight ratio is obtained as the current number of flights on a specific day over the maximum number of flights (usually before COVID-19). The normalised number of cases is



min-max normalised. Both measures are plotted using a log-scale, in order to see the initial outbreak. We find that that almost all the countries had reported cases prior to a significant reduction in international flights. In other words, the international connectivity was cut only after the disease had already arrived.

**Figure 11: Evolution of the Normalised COVID-19 Cases vs the International Flight Ratio (Min-Max Normalised) in the ASEAN+5, Jan 2019–Dec 2020**



ASEAN = Association of Southeast Asian Nations, COVID-19 = coronavirus disease, ISO = International Organization for Standardization.

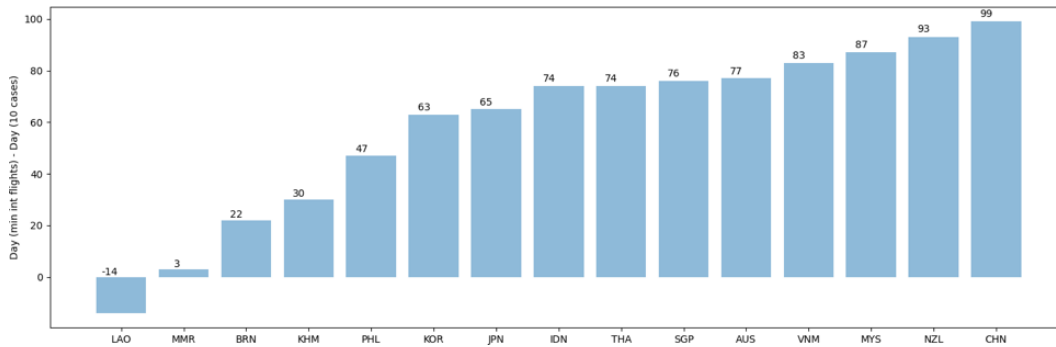
Note: The countries are labelled by their ISO 3 country codes: AUS = Australia, BRN = Brunei, CHN = China, IDN = Indonesia, JPN = Japan, KHM = Cambodia, KOR = Republic of Korea, LAO = Lao People's Democratic Republic (Lao PDR), MMR = Myanmar, MYS = Malaysia, NZL = New Zealand, PHL = Philippines, SGP = Singapore, THA = Thailand, VNM = Viet Nam.

Source: Authors (data from Flightradar24 (n.d.), <https://www.flightradar24.com> (accessed 25 February 2021) and GitHub (n.d.), OWID/COVID-19 data. <https://github.com/owid/covid-19-data> (accessed 25 February 2021); visualisation: Matplotlib).

Figure 12 takes the analysis one step further, by computing the number of days between the day with the first 10 confirmed cases and the day with the maximal reduction of international flights. The difference is positive for all the countries except the Lao PDR. This, again, shows that the measures against COVID-19, i.e. closing borders/flight bans, came too late in the ASEAN+5 region.<sup>7</sup>

<sup>7</sup> A similar look at the mutual interactions between the pandemic and air transportation for the rest of the world revealed that the ASEAN+5 acted more timely than other regions. This contributes to its overall better performance in containing the virus spread than the other regions' performance.

**Figure 12: Delay in the Number of Days Between the First 10 COVID-19 Cases and the Maximum International Flight Ban**



COVID-19 = coronavirus disease, ISO = International Organization for Standardization.

Note: The countries are labelled by their ISO 3 country codes: AUS = Australia, BRN = Brunei, CHN = China, IDN = Indonesia, JPN = Japan, KHM = Cambodia, KOR = Republic of Korea, LAO = Lao People's Democratic Republic (Lao PDR), MMR = Myanmar, MYS = Malaysia, NZL = New Zealand, PHL = Philippines, SGP = Singapore, THA = Thailand, VNM = Viet Nam.

Source: Authors (data from Flightradar24 (n.d.), <https://www.flightradar24.com> (accessed 25 February 2021) and GitHub (n.d.), OWID/COVID-19 data. <https://github.com/owid/covid-19-data> (accessed 25 February 2021); visualisation: Matplotlib).

## 4. Gravity Model and Regression Results

As seen from section 3, while the topological connectivity is somehow still present between countries in the ASEAN+5, the magnitude of flights is significantly reduced during the pandemic. We now employ econometric regressions to explore how the changes in air connectivity have affected regional economic integration in terms of international trade.

### 4.1. Gravity model

Economists have attributed the rapid growth in international trade since World War II to the decline in international transport costs (Hummels, 2007). Air transport had a negligible share in the international trading system in the 1950s. However, with the advance in technology, the decrease in transport cost, and liberalisation of airfreight service, air cargo has become a supporting pillar of today's international trading system, carrying 35% of value of global trade that is less than 1% by volume (IATA, 2016). Grosso and Shepherd (2011) reported a

strong relationship between air transport liberalisation and trade in high-end manufactured goods and time-sensitive products, parts, and components.<sup>8</sup>

Restrictions on the movement of flights across international borders due to the COVID-19 outbreak have implications for international trade. Although freight flights are allowed to operate as usual, a significant amount of merchandise is transported as belly cargo in passenger flights,<sup>9</sup> and the decrease in passenger flights implies a significant rise in transport costs. The regulatory restrictions implemented during the COVID-19 crisis include

- the suspension of e-visa and visa-on-arrival programmes and visa waiver/visa free entry;
- the suspension of the entry of foreign nationals;
- the suspension of international flights;
- restrictions on the number of international flights; and
- physical distancing requirements for airlines to block seats on international flights.

All these measures have the effect of reducing the movement of people and at the same time, come with the effect of stifling the flow of air cargo and trade and disrupting supply chains. The effects may be particularly present for the types of commodities that are time- and temperature-sensitive and normally require air transportation.

To establish the relationship between air transport connectivity and merchandise exports that rely on good air transport connectivity, the econometric model is developed on a gravity model, a reliable empirical tool commonly used in international trade literature. The estimated gravity model can then be used to forecast the trade flows in the future when regulatory restrictions and air transport connectivity change. A simple intuitive gravity model can be expressed as follows:

$$X_{ijt} = \alpha_0 GDP_{it} GDP_{jt} Dist_{ij} \quad (1)$$

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<sup>8</sup> See also, amongst others, Zhang and Zhang (2002) and Dewulf, Meersman, and Van de Voorde (2019).

<sup>9</sup> Passenger flights usually carry around 40%–50% of global air cargo capacity in their bellies.

where  $X_{ijt}$  denotes the bilateral flow between region  $i$  and region  $j$ ; and  $GDP_{it}$  ( $GDP_{jt}$ ) denotes the GDP of region  $i$  (region  $j$ ). Traditional gravity models assume that trade between two countries is related positively to GDP, and negatively to the distance between them. GDP measures the size of the economy.  $Dist_{ij}$  denotes the distance between the two regions, which is considered as a proxy for trade cost.

Apart from the bilateral distance, other trade costs or incentive variables that potentially impede or facilitate bilateral trade flows are included in the model, including air transport connectivity, travel restriction measures, a common border, a common language, colonial links, trade agreements, etc. Amongst these variables, a decrease in transport connectivity and the implementation of travel restrictions raise transport costs and thus reduce trade between countries.

Following the above discussion, we expand (1) by further specifying the gravity model in a log-linear form as follows:<sup>10</sup>

$$\begin{aligned} \ln y_{ijt} = & a_0 + a_1 \ln GDP_{it} + a_2 \ln GDP_{jt} + a_3 \ln DIST_{ij} + \alpha_4 paxflight_{ijt} + \\ & \alpha_5 cargoflight_{ijt} + \alpha_6 border_{ij} + \alpha_7 commlang\_off_t + \alpha_8 comcol + \\ & \alpha_{10} 2020Q1 + \alpha_{11} 2020Q2 + \alpha_{12} 2020Q3 + \varepsilon_{ijt} \end{aligned} \quad (2)$$

where  $\ln$  denotes the natural logarithms of the variables;  $i$  and  $j$  indicate exporter and importer, respectively;  $t$  denotes the time period; and  $\varepsilon_{ijt}$  is the disturbance term. The passenger flight frequency variable,  $paxflight$ , is the number of passenger flights between countries  $i$  and  $j$  in a time period, and is used as a proxy for air transport connectivity. Further,  $y_{ijt}$  is the exports' value from country  $i$  to country  $j$  at time  $t$  in current US dollars. The freight data may also help us detect flows of manufacturing activities, especially in the high-tech sector (ERIA, 2020). Based on earlier studies, this paper considers six merchandise exports extracted from the United Nations (UN) Comtrade database:

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<sup>10</sup> An alternative approach using the aggregate export data is presented in Appendix A to show the long- and short-run relationships between trade and the availability of passenger flight services.

- Fresh fruits (commodity codes 0807–0810; hereafter, fruits)
- Medicaments consisting of mixed or unmixed products for therapeutic or prophylactic use, put in measured doses or in forms or packings for retail sale (commodity code 3004; hereafter, medicaments)
- Line telephony or line telegraphy apparatus, including such apparatus as carrier-current line systems (commodity code 8517; hereafter, telephony)
- Medical equipment and instruments (commodity codes 9018–9022; hereafter, medical instruments)
- Diodes, transistors, and similar semiconductor devices, including photovoltaic cells assembled or not in modules, panels, and light emitting mounted piezo-electric crystals (commodity code 8541; hereafter, semiconductor)
- Electronic integrated circuits and micro-assemblies (commodity code 8542; hereafter, electronics).

The gravity model, (2), is estimated with panel data from multiple countries and years. Quarterly export data for the above six products amongst the 15 ASEAN+5 countries are obtained for the first quarter (Q1) of 2010 to Q3 2020.<sup>11</sup> The GDP data were obtained from the World Bank’s World Development Indicators in 2010 constant US dollars. Quarterly passenger frequency (*paxflight*) data are taken from the International Air Transport Association (IATA) Airport Intelligence database.

Furthermore, the distance variable (*dist*) in model (2) measures the great circle distance between two countries’ capital cities (Table 1). We also include a border dummy (*border*) that takes the value of 1 when two countries share a common border. Similarly, a common language dummy (*commlang\_off*) is considered if two countries speak the same language. A common coloniser dummy (*comcol*) refers to those sharing a common coloniser. Apart from the GDP and flight frequency data, all other data are from the Centre d’Etudes Prospectives et d’Informations Internationales (CEPII) database. Finally, a dummy for each of the three quarters of 2020 is created to capture the effects of COVID-19 in each quarter.

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<sup>11</sup> Note that Q3 2020 is the latest quarter when all the data are available for our variables.

As discussed earlier, these effects may differ due to different stages and intensity/extensity levels of the virus spread, as well as different travel restriction measures.

Not all the countries produce and export the abovementioned six categories of products. Therefore, there is a large number of zero trade flows in our sample. How to deal with the zero-trade-flow problem has received much attention in the last decade and many methods have been proposed (see Zhang, Lin, and Zhang (2018) for a review). Identifying the best performing model remains controversial (Kareem, Martinez-Zarzoso, and Brümmer, 2016). Given the situation, we first use the Poisson pseudo-maximum likelihood (PPML) estimator technique. It was proposed by Santos Silva and Tenreyro (2006) with simulation evidence that it can effectively solve the large zero value observations. Second, we simply add a small constant (0.01) to all the zero values to allow for the use of the log-linear equation to be estimated. We then use the generalised method of moments (GMM) system approach developed by Blundell and Bond (1998) to estimate a dynamic gravity model.

#### **4.2. Regression results**

The estimation results of the two approaches are given in Tables 2 and 3, respectively. As expected, a larger size of the economy would mean more transactions of the six categories of products. The distance variable does not always have a significantly negative impact for the exports of these products, especially when the dynamic model is used. This is understandable when exporting these products is significantly associated with air transport. Zhang and Zhang (2016) argued that deregulation in air transportation has brought about lower airfares and cargo rates, and that geographical distance is no longer a good proxy for travel cost. Furthermore, if a significant part of these products is transported by air, then it is also understandable that the coefficients of the border dummy may not always promote international trade. Speaking the same language would strengthen the international trade of the products considered in this study. Moreover, the lagged dependent variables in Table 3 are generally positive and significant, indicating that a certain degree of inertia exists in exporting and importing these products. Ignoring the past trend may overstate the effects of other trends.

**Table 2: PPML Estimator Results**

<b>Variables</b>	<b>Fruits</b>	<b>Medicaments</b>	<b>Medical instruments</b>	<b>Telephony</b>	<b>Semiconductor</b>	<b>Electronics</b>
<i>Paxflight</i>	0.246*** (0.046)	0.126*** (0.044)	0.451*** (0.037)	0.280* (0.145)	0.155*** (0.034)	0.245*** (0.046)
<i>export_GDP</i>	0.203*** (0.043)	0.281*** (0.066)	0.304*** (0.031)	0.694*** (0.105)	0.468*** (0.055)	0.203*** (0.043)
<i>import_GDP</i>	0.609*** (0.069)	2.471*** (0.042)	0.424*** (0.028)	0.561*** (0.091)	0.675*** (0.058)	0.608*** (0.070)
<i>dist</i>	−0.680*** (0.182)	0.188 (0.166)	0.007 (0.067)	−0.767 (0.321)	−0.613*** (0.125)	−0.680*** (0.182)
<i>border</i>	−0.477* (0.280)	−0.339** (0.149)	−0.633*** (0.089)	0.789* (0.475)	−0.673*** (0.186)	−0.476* (0.279)
<i>comlang_off</i>	1.439*** (0.235)	0.004 (0.215)	1.326*** (0.23)	1.011*** (0.284)	0.753*** (0.204)	1.439*** (0.235)
<i>comcol</i>	0.315 (0.326)	1.183*** (0.229)	1.514*** (0.127)	−0.765 (0.611)	1.250 (0.272)	0.315 (0.326)
<i>2020Q1</i>	−1.545*** (0.569)	−3.303*** (0.976)	−2.341*** (0.375)	−3.552*** (0.710)	−2.212*** (0.671)	−1.545*** (0.569)
<i>2020Q2</i>	−0.137***	−1.494* (0.716)	−1.244** (0.512)	−3.870*** (0.710)	−2.681*** (0.671)	−2.137*** (0.569)

	(0.731)	(0.935)	(0.516)	0.736	(0.595)	(0.731)
<i>2020Q3</i>	−0.972	−1.762	−1.479***	−5.364***	−5.748***	−0.942
	(0.602)	(0.642)	(0.431)	(0.766)	(0.659)	(0.602)
<i>Constant</i>	12.449***	4.211***	5.603***	7.328**	8.158	12.449
	(1.381)	(1.374)	(0.680)	(2.876)	(1.243)	(0.182)
Observations	9,030	9,030	9,030	9,030	9,030	9,030
Adjusted R-squared	0.062	0.017	0.199	0.063	0.083	0.062

PPML = Poisson pseudo-maximum likelihood.

Notes: The robust standard errors are in parentheses; \*\*\* significant at 1%, \*\* significant at 5%, \* significant at 10%.

Source: Authors.



**Table 3: System GMM Results of a Dynamic Gravity Model**

<b>Variables</b>	<b>Fruits</b>	<b>Medicaments</b>	<b>Medical instruments</b>	<b>Telephony</b>	<b>Semiconductor</b>	<b>Electronics</b>
<i>Lag_devar</i>	0.631***	0.490***	0.716***	0.336***	0.116*	0.181***
	(0.071)	(0.064)	(0.039)	(0.060)	(0.062)	(0.053)
<i>paxflight</i>	−0.030	−0.013	0.046**	0.086***	0.082***	0.062**
	(0.029)	(0.032)	(0.023)	(0.028)	(0.026)	(0.028)
<i>export_GDP</i>	0.243***	0.261***	0.312***	0.122***	0.306***	0.263***
	(0.058)	(0.044)	(0.074)	(0.063)	(0.067)	(0.074)
<i>import_GDP</i>	0.062	0.073***	0.240***	0.104***	0.311***	0.339***
	(0.044)	(0.048)	(0.065)	(0.060)	(0.068)	(0.068)
<i>Dist</i>	−0.201	−0.177	−0.128	0.087	−0.037	−0.200
	(0.124)	(0.139)	(0.153)	(0.173)	(0.118)	(0.205)
<i>border</i>	−0.488**	−0.449	−0.371	0.049	−0.270	−0.244
	(0.231)	(0.284)	(0.277)	(0.331)	(0.325)	(0.369)
<i>comlang_off</i>	0.213	0.335	1.087***	0.928**	1.134**	1.573**
	(0.219)	(0.278)	(0.494)	(0.394)	(0.554)	(0.614)
<i>comcol</i>	0.777**	0.904**	0.735**	0.116	−0.249***	−0.334
	(0.371)	(0.376)	(0.324)	(0.393)	(0.308)	(0.310)

<i>2020Q1</i>	−0.511**	−0.771***	−2.259***	−1.705***	−1.009***	−0.713**
	(0.240)	(0.261)	(0.500)	(0.301)	(0.253)	(0.300)
<i>2020Q2</i>	−0.256	−0.537**	−1.417***	−1.075***	−0.738***	−0.828***
	(0.223)	(0.245)	(0.274)	(0.254)	(0.268)	(0.229)
<i>2020Q3</i>	−0.522***	−0.823***	−1.433***	−1.462***	−1.292***	−1.060***
	(0.169)	(0.212)	(0.294)	(0.228)	(0.209)	(0.227)
<i>Constant</i>	−1.649	−2.391*	−3.343***	−4.285***	−7.288***	−5.596***
	(0.949)	(1.267)	(1.414)	(1.316)	(1.385)	(1.398)
Observations	8,820	8,820	8,820	8,820	8,820	8,820

GMM = generalised method of moments.

Notes: The corrected standard errors are in parentheses; \*\*\* significant at 1%, \*\* significant at 5%, \* significant at 10%.

Source: Authors.

The passenger flight frequency variable, *paxflight*, is our primary interest. The PPML approach (Table 2) shows that passenger flight frequency is positively associated with all the sectorial exports at the 1% significance level except for the line telephony or line telegraphy apparatus. This variable is also statistically significant in the dynamic gravity model (Table 3) for the exports of medical instruments, telephony, semiconductor, and electronics. As typical international trade literature using the gravity model does not take air transport connectivity into account, these findings suggest that this could be a major omission. Zhang, Zhang, and Wang (2020) found that the frequencies of air flights and high-speed rail services out of Wuhan, China are significantly associated with the number of COVID-19 cases in the destination cities in China. However, Chinazzi et al. (2020) reported that travel restrictions applied to Wuhan only resulted in a slight delay of epidemic progression by 3–5 days in China, and that international travel restrictions again only had a moderate effect. The transmission reduction interventions such as early detection, hand washing, self-isolation, and household quarantine would have a greater effect in mitigating the pandemic. The merchandise considered here is essential to consumers and businesses. Some of the products are critical to patients and health workers fighting COVID-19 on the frontline. Restrictions on international travel can cause cross-border trade for these products to decline significantly, as also evidenced by the 2020 quarterly dummies. We can thus argue that each country should actively seek alternative arrangements to avoid long-term lockdowns and restore air transport connectivity.

## **5. Travel Bubbles, Uniform Standards, and Open Skies**

Our analysis in section 4 suggests that the ASEAN+5 countries need to seek alternative arrangements to avoid long-term lockdowns and restore air connectivity. These can include establishing travel bubbles amongst countries where the pandemic has been largely contained, and relaxing travel restrictions for vaccinated people holding vaccine certificates or immunity passports (e.g. QR code). These measures may be implemented bilaterally, or within a small number of countries, at the initial stage and then be gradually extended to include more countries.

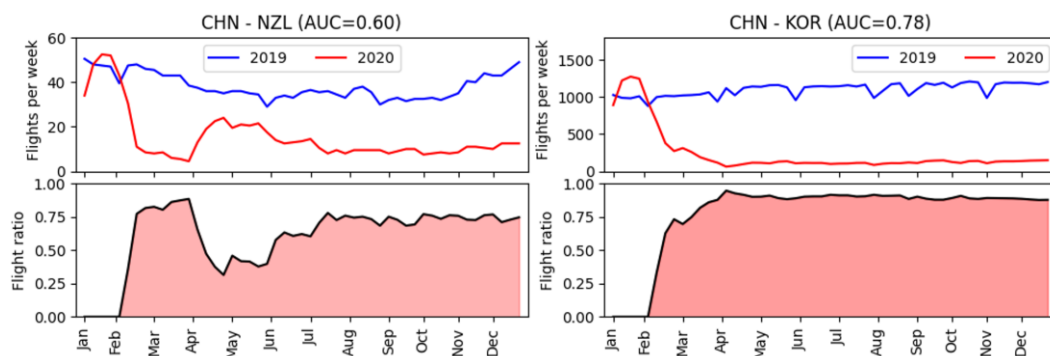
### 5.1. Analysis of flight bans

The existence of a travel bubble between two countries is expected to have significantly less flight bans between each other, compared with countries outside the bubble; otherwise, the notion of a bubble would be misleading. Therefore, this section takes the aggregated flight ratio as a baseline for computing the intensity of a flight ban between two countries. The flight ratio discrepancy (FRD) for time interval  $i$  is computed as:

$$FRD(i) = 1 - \min\left(\frac{Flights_{2020}(i)}{Flights_{2019}(i)}, 1.0\right) \quad (3)$$

and the area under the  $FRD$  as  $\sum_{i \in I} FRD(i)$  where  $I$  is the set of all time intervals. Here, the intervals are weeks 1 to 52 in 2019 and 2020. The intuition for the computation of  $FRD$  is as follows: A high value of  $FRD(i)$  suggests a strong reduction in the number of flights. The value is cut off at 1.0 to avoid introducing compensation effects, where the number of flights in 2020 is (temporarily) larger than in those 2019. Finally, the area under the  $FRD$  over all  $I$  is a representation of how intense the travel bans between two countries were, with larger values indicating stronger travel bans. Figure 13 further visualises the intuition behind the chosen measure based on China. The temporal evolution of the FRD is shown for two selected connections: towards New Zealand and Korea, respectively. It can be seen that both time series are quite different regarding the relative number of flights in 2020. While a strict travel ban between China and Korea is observed, the connection towards New Zealand underwent a temporary travel bubble between April and July 2020.

**Figure 13: Comparison of the Flight Ratio Discrepancy for Two Country Pairs: China–New Zealand (left) and China–Republic of Korea (right)**

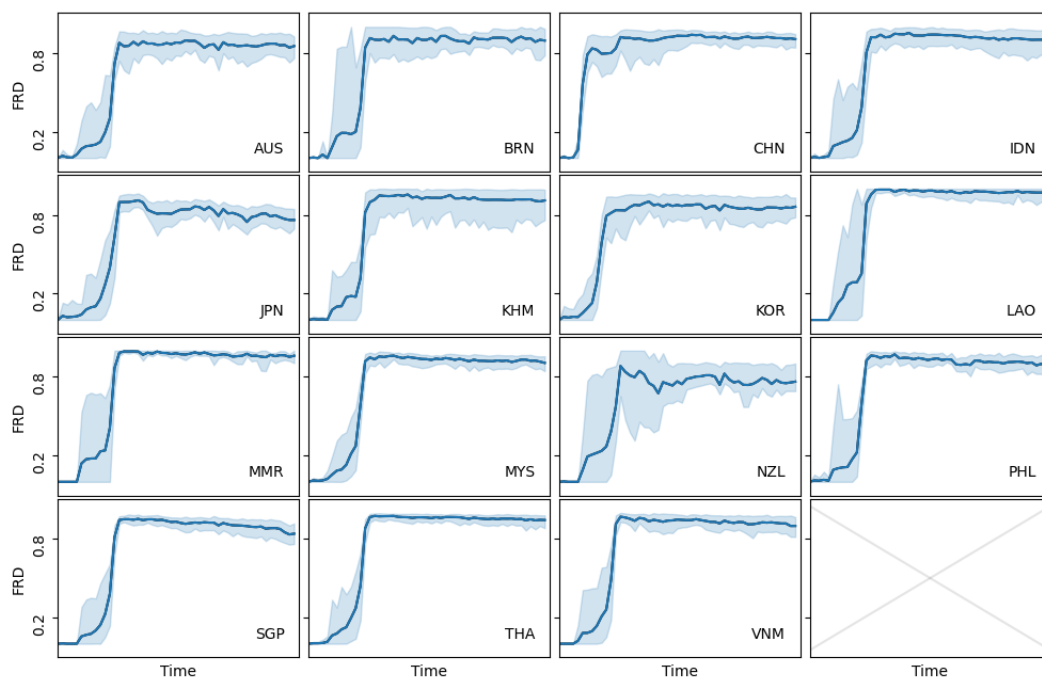


AUC = area under the curve, CHN = China, KOR = Republic of Korea, NZL = New Zealand.

Note: The AUC of the flight ratio over all months is highlighted in red. A larger AUC indicates stricter implementation of flight bans.

Source: Authors (data from Flightradar24 (n.d.), <https://www.flightradar24.com> (accessed 25 February 2021); visualisation: Matplotlib).

**Figure 14: Temporal Evolution of Flight Ratio Discrepancy for the ASEAN+5**



ASEAN = Association of Southeast Asian Nations, FRD = flight ratio discrepancy, ISO = International Organization for Standardization.

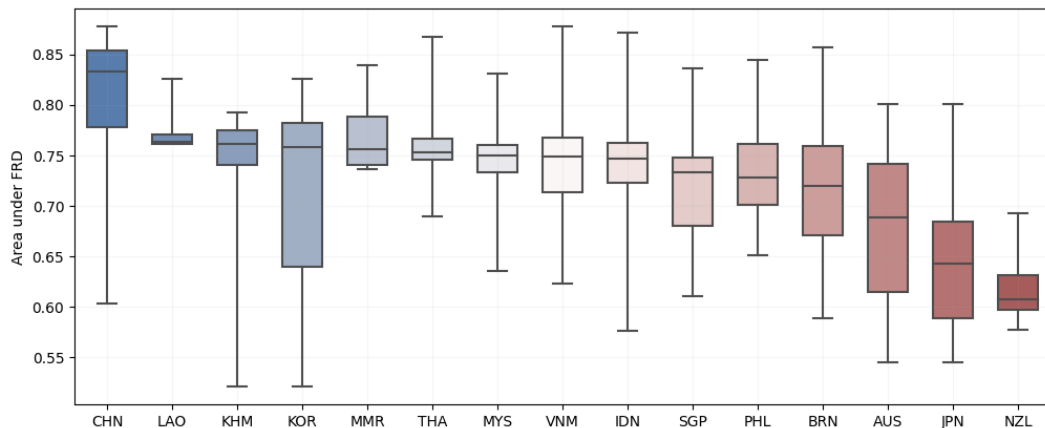
Notes: Solid blue lines represent the average FRD; shaded areas represent the 95% confidence interval over all destinations in a country. The countries are labelled by their ISO 3 country codes: AUS = Australia, BRN = Brunei, CHN = China, IDN = Indonesia, JPN = Japan, KHM = Cambodia, KOR = Republic of Korea, LAO = Lao People's Democratic Republic (Lao PDR), MMR = Myanmar, MYS = Malaysia, NZL = New Zealand, PHL = Philippines, SGP = Singapore, THA = Thailand, VNM = Viet Nam.

Source: Authors (data from Flightradar24 (n.d.), <https://www.flightradar24.com> (accessed 25 February 2021); visualisation: Matplotlib).

Figure 14 reports the FRD for all 15 countries in this study. The solid line represents the evolution of the average FRD value over all destinations of a country for the specific origin country in a subplot. The blue area is the 95% confidence interval for the data in that subplot. It can be seen that many countries exhibit FRD curves with significant variance. For instance, New Zealand tried to reopen air travel to selected countries on several occasions throughout 2020. The curve for Myanmar, on the other hand, reveals a very strict travel ban towards all other countries, after an initial transition period in March 2020.

To explore this effect further, Figure 15 shows the distribution of the area under the FRD for each country. The countries are sorted by their median area under the FRD. It can be seen that China had the strongest median flight ban. Towards the right-hand side, it can be observed that a few countries kept significantly more flights active, e.g. Australia, Japan, and New Zealand.

**Figure 15: Deviation of the Area Under the FRD for All ASEAN+5 Countries**



ASEAN = Association of Southeast Asian Nations, FRD = flight ratio discrepancy, ISO = International Organization for Standardization.

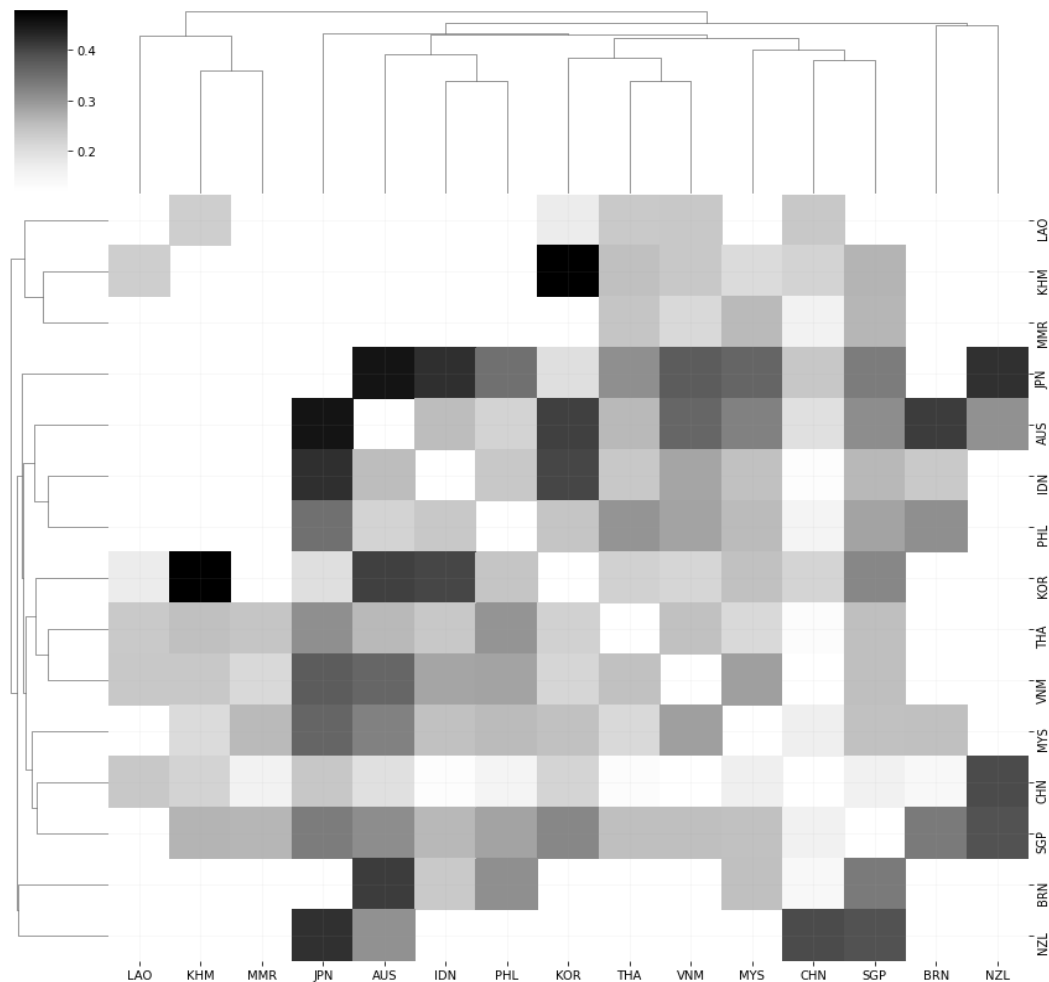
Note: The countries are labelled by their ISO 3 country codes: AUS = Australia, BRN = Brunei, CHN = China, IDN = Indonesia, JPN = Japan, KHM = Cambodia, KOR = Republic of Korea, LAO = Lao People's Democratic Republic (Lao PDR), MMR = Myanmar, MYS = Malaysia, NZL = New Zealand, PHL = Philippines, SGP = Singapore, THA = Thailand, VNM = Viet Nam.

Source: Authors (data from Flightradar24 (n.d.), <https://www.flightradar24.com> (accessed 25 February 2021); visualisation: Matplotlib).

Figure 16 reports the area under the FRD curve for each country pair in this study. A darker cell indicates a smaller area under the FRD, which in turn indicates a smaller reduction in the number of flights in 2020, with 2019 as a baseline. The countries are clustered hierarchically based on their aggregated similarity, as

indicated by the tree structures along the left and top axis. This chart allows for reading off explicitly which countries chose to create a travel bubble with which neighbours. For instance, New Zealand had a high level of connections with China, Japan, and Singapore. Korea, on the other hand, kept connections with Australia, Cambodia, and Indonesia. Viet Nam also kept a high level of connectivity with Australia and Japan.

**Figure 16: Heat Map and Clustering for Country Pairs in the ASEAN+5**



ASEAN = Association of Southeast Asian Nations, ISO = International Organization for Standardization.

Note: The countries are labelled by their ISO 3 country codes: AUS = Australia, BRN = Brunei, CHN = China, IDN = Indonesia, JPN = Japan, KHM = Cambodia, KOR = Republic of Korea, LAO = Lao People's Democratic Republic (Lao PDR), MMR = Myanmar, MYS = Malaysia, NZL = New Zealand, PHL = Philippines, SGP = Singapore, THA = Thailand, VNM = Viet Nam.

Source: Authors (data from Flightradar24 (n.d.), <https://www.flightradar24.com> (accessed 25 February 2021); visualisation: Matplotlib).

## 5.2. Towards travel bubbles?

An eternal lockdown of international aviation is not a feasible solution for dealing with the pandemic, in terms of the long-term mobility of people and trade and economic activities. With the ongoing impact of COVID-19 on air transportation, different future solutions are being discussed. One of these solutions is the introduction of so-called ‘travel bubbles’: When two countries form a bubble, it means that air travellers can travel freely between the two countries without having to quarantine on arrival. For instance, Japan announced plans to create a travel bubble with five other Asian countries/regions (Cambodia, the Lao PDR, Malaysia, Myanmar, and Taiwan) in September 2020. New Zealand and Australia announced, in December 2020, that they would launch a trans-Tasman bubble in early 2021.

While there have been talks/plans for some months throughout Asia about travel bubbles, the pace of actual implementation has been slow compared with other regions, especially given its overall better performance in handling the pandemic (in terms of the number of confirmed cases). The region could provide a multilateral platform with several phases, enabling countries that have contained the virus to be the first to establish travel bubbles, with others to follow in subsequent phases. In the following, we discuss one way to construct optimal travel bubbles, given the air transportation demand and the current case distribution amongst the ASEAN+5 countries. First, we compute a risk index for each country pair. This risk index is obtained as:

$$\text{Min} [100*((1 \text{ cases/population})^{\text{passengers}}), 5] \quad (4)$$

Intuitively, this risk index expresses the probability that an infected passenger crosses the border between two countries, assuming simple uniform distributions. We define a cut-off at risk index 5, which means that the probability of transmission is at least 5%.<sup>12</sup>

Figure 17 reports the values of the risk indexes for all country pairs on the first days of months in 2020. We take the number of passengers from 2019 to have a real demand baseline. It can be seen from Figure 17 that there is a transition for the risk index importance between countries over time. In February 2020, other

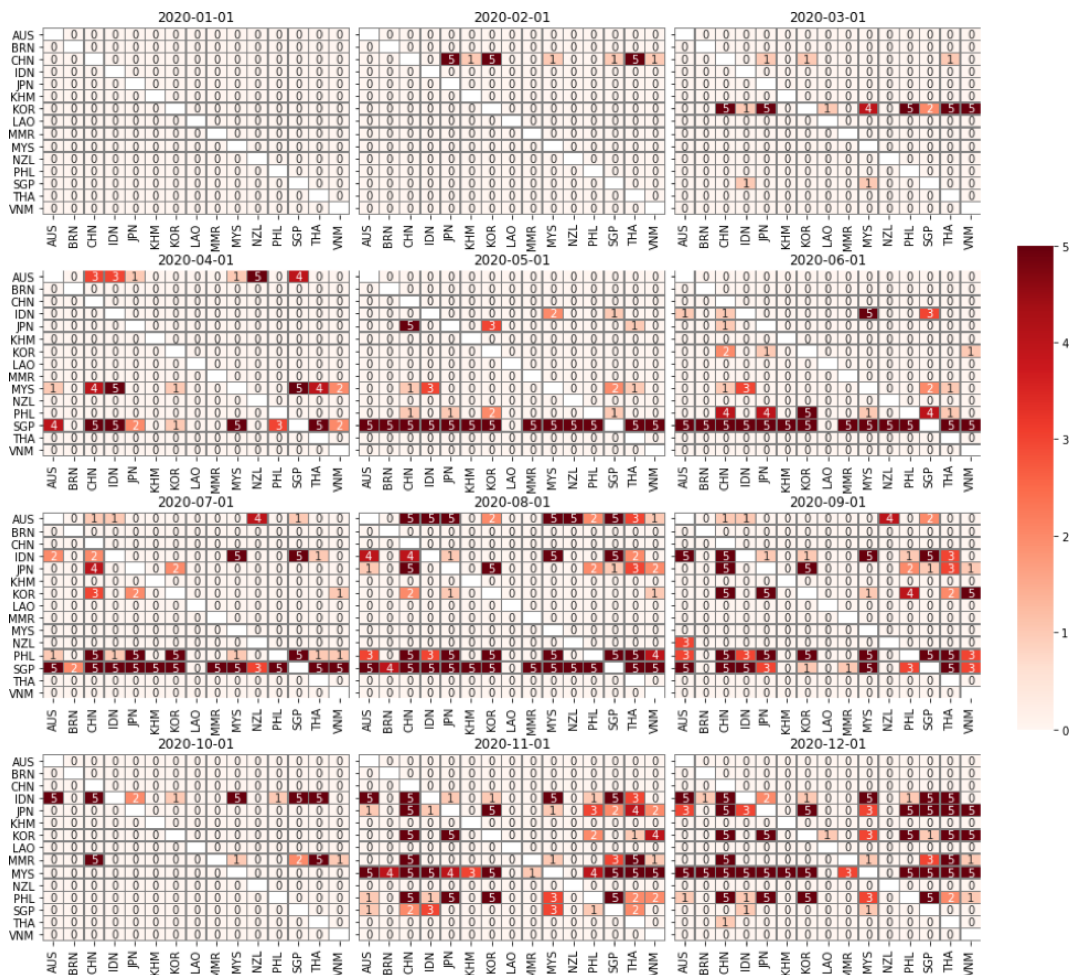
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<sup>12</sup> Depending on the requirement, we could vary the cut-off values and see the sensitivity with respect to the construction of travel bubbles.



countries should have closed their borders with China (in particular, Japan, Korea, and Thailand had a very high risk; note that the actual risk could be greater than 5%). In March 2020, the focus shifted towards Korea, which was the major COVID-19 hot spot at that time. Towards the end of 2020, the risk indexes become more diverse, where many pairs of countries would have a high risk if their connectivity returned to the usual level. This situation gives rise to the construction of travel bubbles between pairs of countries that have significantly low infection rates or a smaller number of actual passengers.

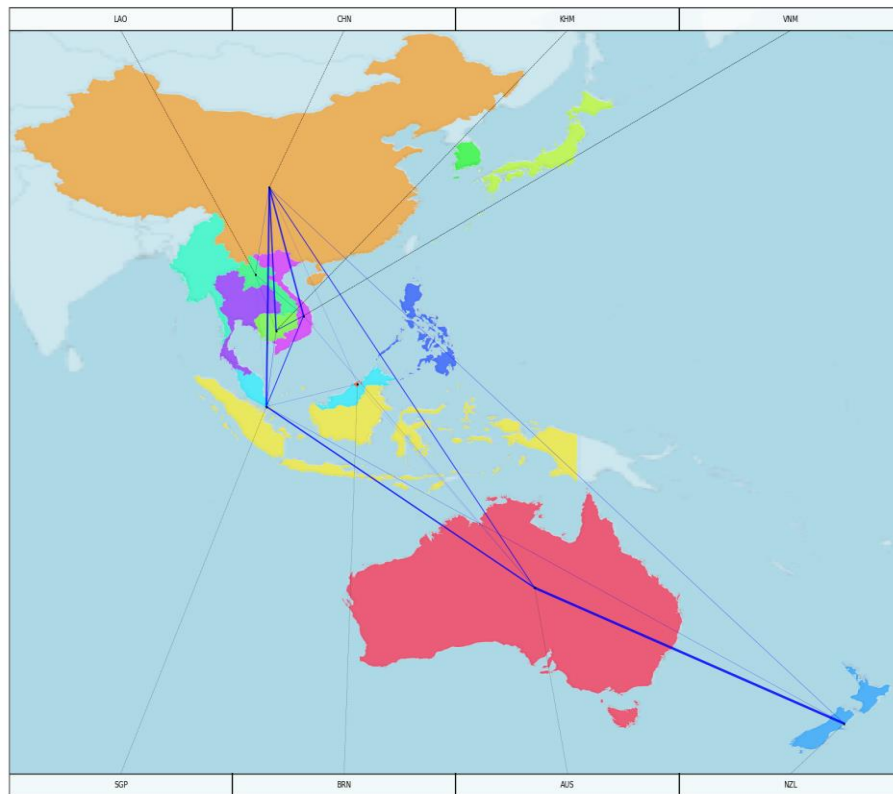
**Figure 17: Travel Bubble Risk Indexes for Country Pairs in the ASEAN+5, Jan–Dec 2020**



ASEAN = Association of Southeast Asian Nations, ISO = International Organization for Standardization.  
Notes: Smaller risk indexes (= lighter colours) are an indication for safer travel. The countries are labelled by their ISO 3 country codes: AUS = Australia, BRN = Brunei, CHN = China, IDN = Indonesia, JPN = Japan, KHM = Cambodia, KOR = Republic of Korea, LAO = Lao People's Democratic Republic (Lao PDR), MMR = Myanmar, MYS = Malaysia, NZL = New Zealand, PHL = Philippines, SGP = Singapore, THA = Thailand, VNM = Viet Nam.  
Source: Authors (data from Flightradar24 (n.d.), <https://www.flightradar24.com> (accessed 25 February 2021) and GitHub (n.d.), OWID/COVID-19 data. <https://github.com/owid/covid-19-data> (accessed 25 February 2021); visualisation: Matplotlib).

To compute the optimal travel bubble with respect to the introduced risk index, we iterate all  $2^{15}$  possible subsets of the ASEAN+5 countries and compute the sum of risk factors. Then we choose the country subset (= travel bubble), which has a risk index of 0 and maximises the number of passengers. Based on the computed risk indexes and as an illustration, Figure 18 visualises the obtained travel bubble for December 2020 (the last month of the analysis). The travel bubble consists of Australia, Brunei, China, Cambodia, the Lao PDR, New Zealand, Singapore, and Viet Nam. Gradually reopening the borders between these countries seems to be safe, according to the idea of travel bubbles and taking into account our definition of risk index.

**Figure 18: Optimal Travel Bubbles Based on Risk Indexes, Dec 2020**



Note: The countries are labelled by their International Organization for Standardization (ISO) 3 country codes: AUS = Australia, BRN = Brunei, CHN = China, KHM = Cambodia, LAO = Lao People's Democratic Republic (Lao PDR), NZL = New Zealand, SGP = Singapore, VNM = Viet Nam.

Source: Authors (data from Flightradar24 (n.d.), <https://www.flightradar24.com> (accessed 25 February 2021) and GitHub (n.d.), OWID/COVID-19 data. <https://github.com/owid/covid-19-data> (accessed 25 February 2021); visualisation: Matplotlib).

### 5.3. Uniform standards and regulations

ASEAN was formed to (amongst others) promote the cooperation of AMS in economic activities including international trade. The COVID-19 pandemic has been testing the strength of these bonds. At the early stages of COVID-19, borders were suddenly closed, flights banned, and the regular mobility of people almost completely halted; similar patterns were observed in Europe at the time, with similar political implications. Accordingly, it is reported that the regional diplomacy in ASEAN was largely curtailed. There is a stark contrast between the day-to-day work on ASEAN interests in 2019 and the on-the-surface, losing-least-face diplomacy in 2020. These ongoing developments might have long-term effects on the ability to trust and cooperate with each other. The degree of these tensions is still acceptable at present, but there are increasing concerns that they put the seemingly loose regional arrangement at high risk. Notably, similar observations were made during the Asian Financial Crisis (in 1997/1998), when an absence of regional, coordinated crisis management was apparent.

The above observation may also apply to the ASEAN+5. Already devastated by the pandemic, air transportation in the region has been set back further by the failure to have a coordinated aviation policy, including the establishment of travel bubbles (as mentioned above). Here, the region may experiment with some common threshold (standard) for imposing air travel restrictions.<sup>13</sup> If governments agree on the new rules, airlines could gain relief from the current situation of uncoordinated, country-by-country announcements on quarantine requirements for incoming travellers and abrupt travel bans (see Appendix B for more details). For instance, some AMS still require airlines to block seats and not fly at full capacity (for physical distancing) despite global guidelines discouraging any capacity restrictions. Blocking seats is uneconomical and considered unviable over the long term, given the impact on fares and airline efficiency (Peoples, Abdullah, and Satar, 2020).

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<sup>13</sup> An example is the European Union's proposal in late 2020: Restriction-free travel would be allowed between regions with fewer than 25 new coronavirus cases per 100,000 people for the previous 14 days, and with a level of positive virus tests lower than 4%.

Likewise, the region may advocate and facilitate uniform standards and regulations, which are urgently needed to support the resumption of international travel within the ASEAN+5. In general, the ASEAN+5 countries went into the COVID-19 crisis earlier (Q1 2020) than other regions of the world, but they also came out of the crisis earlier (Sun, Wandelt, and Zhang, 2020). While domestic travel has resumed to a large extent (e.g. the number of passengers carried by Chinese domestic flights in September 2020 was 47.75 million, at 98% of the pre-pandemic level), the number of scheduled international passenger flights within the region is currently operating at around 3%–5% of the normal level. The ASEAN+5 will need uniform standards and regulations to facilitate flights between countries and travel bubbles.

#### **5.4. Open skies**

As indicated earlier, the ASEAN Open Skies policy is intended to increase regional connectivity, integrate production networks, and enhance regional trade by allowing airlines from AMS to fly freely throughout the region via the liberalisation of air services under a single, unified air transport market. If the policy were successfully implemented (absent the COVID-19 pandemic), there would be no regulatory limits on the frequency or capacity of flights between international airports across the 10 AMS. ASEAN has been working for years to secure this open skies agreement.

Interestingly, not included in the current agreement are steps towards opening up ASEAN aviation to common ownership, in a market still very much populated by state-owned airlines. To ensure airline financial and economic sustainability, governments have provided bailout subsidies to their airlines during the COVID-19 pandemic, with massive amounts in some cases (Abate, Christidis, and Purwanto, 2020; Zhang and Zhang, 2020; Andreana et al. 2021). As a consequence, governments with large stakes in airlines may not want to see their carriers facing major competition until they get their subsidies back. Furthermore, the unequal resources of various countries in subsidising national airlines could generate an unequal ‘level playing field’ in the future. Taken together, these two observations suggest that there may be a real danger that the decades of progress on regional

liberalisation would, owing to the pandemic, be pushed backwards. This is an important issue that warrants vigilant and careful monitoring by policymakers.

## **6. Concluding Remarks**

In this paper, we have provided an in-depth description of the COVID-19 pandemic and its interactions with air transportation in the ASEAN+5, and then linked the changes in air connectivity to trade using a gravity regression model. We found that almost all the countries probably reacted too late in their decision to reduce flights in the early stage of the pandemic. As the pandemic evolved, most countries have significantly reduced the number of flight connections, especially international flights. The reduced connectivity was found, based on the regression analysis, to have a significantly negative impact on trade time-sensitive merchandise that is essential to consumers and businesses. This points to the importance for both individual countries and the region as a whole to seek alternative arrangements and measures to restore air connectivity, COVID-19 permitting. While there have been talks for some months throughout the ASEAN+5 about travel bubbles, the pace of implementation has been slow. We provided a way to construct optimal travel bubbles by using the risk indexes introduced in this paper. Other policy issues such as uniform standards and regulations, and regional ‘open skies’, were also discussed.

The paper has also opened several avenues for future research. First, our proxy variable for air connectivity in the gravity model can be further decomposed. We have observed two extremes of actions taken by different countries/airlines: diversity reduction and capacity reduction. While the former strategy attempts to reduce the number of countries served by airlines, the latter strategy intends to reduce the frequency of connections while keeping most of their connections alive. Second, our estimated gravity model can further be used to forecast the trade flows in the future, when regulatory restrictions and air transport connectivity change – owing, for example, to alternative travel bubble scenarios. Third, the construction of travel bubbles should be based not only on the low infection rates of the countries involved (low risk indexes), but also on the importance of the travel links in terms of economic viability, sustainability aspects, etc.

Fourth, the reduction in air travel mobility would not only reduce the trade volumes, but also affect their distribution across countries/regions. This may be done by computing the network measures for air connectivity and trade connectivity. Specifically, we can calculate the Theil's T index (Theil, 1967) of these measures across the ASEAN+5 countries, to look at the spatial distributional impacts of the pandemic on regional air connectivity and trade activities, i.e. whether inequalities amongst countries have increased or decreased over the study period. Theil's T index allows us to examine both the disparity within a group and the disparity across country groups, after grouping countries according to, for example, geographic regions (ASEAN vs the five partner countries, and several other scenarios), country/economy sizes, or countries' infection rates. Finally, due to the short period of time, the 'full' (medium- to long-term) impact of the pandemic on trade and economic activities may not be realised during the present study time. So, other research methods (such as interviews with senior government and industry executives, and surveys from other industries/regions) may be employed to complement the present study.

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## Appendix A

The panel autoregressive distributed lag (ARDL) dynamic framework is used here to examine the relationship between total exports and the availability of passenger flights. The ARDL framework integrates the short- and long-run effects with an error correction model if there is a long-run relationship between the variables. The ARDL (k p q) model in the error correction term (ECT) form can be specified as follows:

$$\Delta \ln \text{TRADE}_{ijt} = \alpha_i + \sum_k \phi_{1k} \Delta \ln \text{paxflight}_{i,t-k} + \sum_p \phi_{2p} \Delta \ln \text{GDP}_{ij,t-p} + \theta \text{ECT}_{i-1} + \mu_{it}$$

where  $k$ ,  $p$ , and  $q$  denote the optimal lag length variable following the commonly used Akaike information criterion, Schwartz information criterion, and Hannan-Quinn criterion;  $\Delta$  is the first difference operator;  $\alpha_i$  are the country pair-specific intercepts, and  $\mu_{i,t-1}$  indicates the error correction term.  $\theta$  is the speed of adjustment.  $\text{ECT}_{i-1}$  is the error correction term. A negative and significant coefficient  $\theta$  denotes how fast a deviation from the long-run equilibrium is eliminated after a shock.  $\text{TRADE}_{ijt}$  is the aggregate exports from country  $i$  to country  $j$  in time period  $t$ . Quarterly trade data are obtained from the UN Comtrade database.  $\text{paxflight}$  is the frequency of passenger flights between countries  $i$  and  $j$ .  $\text{GDP}$  denotes the sum of the gross domestic product (GDP) of the exporting and importing countries. The data span a period from 2010 to 2020.

The ARDL (1 1 1) model is adopted and the results are reported in Table A1.

**Table A1: Panel ARDL Model Results**  
(dependent variable: lnTRADE)

Variable	Coefficient	Std. Error	Prob.
Long-run equation			
lnGDP	0.425***	0.054	0.000
lnpaxflight	0.016**	0.007	0.015
Short-run equation			
ECT	-0.421	0.255	0.000
D(lnGDP)	0.028	0.477	0.952
D(paxflight)	0.077	0.104	0.458
C	6.341	0.384	0.000

ARDL = autoregressive distributed lag.

Notes: \*\*\* significant at 1%, and \*\* at 5%.

Source: Authors.

The coefficient of the ECM reflects the speed of adjustment at which the model converges to the long-run equilibrium. The negative and significant coefficient of the error correction term suggests that there is a long-run stable relationship between bilateral trade, passenger flight services, and the sizes of the economies. In particular, a 1% increase in passenger flight frequency would lead to a 0.016% increase in the total exports between two countries. The convergence speed value is between 0 and  $-1$ , which implies that a deviation from the long-run equilibrium can be restored with an adjustment period of about 2.4 quarters ( $1/0.425$ ). Interestingly, the short-run effects are not statistically significant.

The country pairs between which the amount of passing flight services has a significant and positive impact on the bilateral trade in the short run are listed in Table A2. The country pair estimation is generated by the pooled mean group (PMG) procedure of the ARDL model.

**Table A2: Short-Run Country-Specific Results (PMG)**

Country pair	ECT(-1)	D(lnpaxfight)
Australia–Japan	-0.094** (0.057)	0.086** (0.036)
Australia–New Zealand	-0.547*** (0.125)	0.056*** (0.027)
Australia–Philippines	-0.714*** (0.146)	0.135* (0.078)
China–Myanmar	-0.095 (0.093)	0.035** (0.154)
Japan–Australia	-0.429*** (0.099)	0.197*** (0.039)
Japan–Indonesia	-0.036 (0.046)	0.309*** (0.043)
Japan–Malaysia	-0.109** (0.049)	0.171*** (0.029)
Japan–New Zealand	-0.555*** (0.121)	0.073*** (0.021)
Japan–Philippines	-0.297*** (0.081)	0.158*** (0.021)
Japan–Singapore	-0.209** (0.095)	0.058* (0.031)
Japan–Thailand	-0.137* (0.071)	0.079*** (0.021)
Malaysia–Singapore	-0.591*** (0.218)	3.492*** (0.467)
Malaysia–Thailand	-0.844*** (0.255)	1.632** (0.807)
Philippines–Indonesia	-0.304*** (0.101)	0.239*** (0.065)
Singapore–Myanmar	-0.109 (0.096)	1.026*** (0.221)
Thailand–Lao PDR	-0.205** (0.103)	0.469** (0.186)
Thailand–Myanmar	-0.147 (0.092)	0.367** (0.166)
Thailand–Malaysia	-0.304** (0.135)	1.431*** (0.551)

Lao PDR = Lao People's Democratic Republic, PMG = pooled mean group.

Notes: \*\*\* significant at 1%, \*\* at 5%, and \* at 10%.

Source: Authors.

## Appendix B

**Table B1: ASEAN+5 Current Travel Curb Policies**

ISO 3	Full name	Current Travel Restrictions
BRN	Nation of Brunei	<ul style="list-style-type: none"> <li>▪ Citizens, permanent residents, and long-term visa holders are restricted from leaving Brunei Darussalam with few exceptions.</li> <li>▪ Self-isolation is mandatory, with length dependent on government risk assessment.</li> <li>▪ COVID-19 negative results are required for incoming travellers.<sup>1</sup></li> <li>▪ Foreign citizens, meeting certain requirements, may enter for essential travel only.</li> <li>▪ All other foreign citizens are barred from entering or transiting Brunei.</li> <li>▪ Royal Brunei Airlines has suspended most of its routes until 30 October 2021, with limited scheduled service continuing to Hong Kong, Jakarta, Kuala Lumpur, London, Manila, Melbourne, and Singapore only.<sup>2</sup></li> </ul>
IDN	Republic of Indonesia	<ul style="list-style-type: none"> <li>▪ Holders of diplomatic and official permits/visas and an Indonesian Residence Card may be permitted entry.</li> <li>▪ Most foreign passengers are not permitted to enter, with a few exceptions.</li> <li>▪ 5-day isolation at a certified accommodation is mandatory.<sup>3</sup></li> <li>▪ COVID-19 negative results are required for domestic flights.<sup>4</sup></li> <li>▪ Indonesia has established travel corridor arrangements with the United Arab Emirates, China, the Republic of Korea (henceforth, Korea), and Singapore for those traveling for diplomatic or business purposes.<sup>5</sup></li> </ul>
KHM	Kingdom of Cambodia	<ul style="list-style-type: none"> <li>▪ Visa exemptions and tourist visas, including e-visas and visas on arrival, are suspended.</li> <li>▪ Only applications for diplomatic, official, and 'sponsored' business-linked visas are being accepted.</li> <li>▪ Foreign nationals require a valid visa, certified negative COVID-19 status, and proof of health insurance documents for entry into Cambodia.<sup>6</sup></li> <li>▪ Commercial flights are operating.</li> <li>▪ All arriving foreigners must quarantine for 14 days at a designated hotel and pay a \$2,000 deposit upon arrival at airports for mandatory COVID-19 testing and potential treatment services.<sup>7</sup></li> </ul>
LAO	Lao People's Democratic Republic	<ul style="list-style-type: none"> <li>▪ All international flights to/from the Lao PDR remain closed with the exception of sporadic international flights (often to Seoul, Korea) and weekly United Nations humanitarian flights.</li> <li>▪ Tourist visas, visas on arrival, and standing visa exemptions remain suspended. People who hold valid multiple-entry long-term visas may return to the Lao PDR.</li> </ul>

ISO 3	Full name	Current Travel Restrictions
		<ul style="list-style-type: none"> <li>All entrants will be subject to COVID-19 testing and a 14-day self-quarantine requirement.<sup>8</sup></li> <li>The government allows Chinese nationals from provinces without COVID-19 activity to enter with reduced quarantine requirements.<sup>9</sup></li> </ul>
MMR	Republic of the Union of Myanmar	<ul style="list-style-type: none"> <li>New tourist visa applications are currently suspended.</li> <li>At present, Myanmar authorities can offer business visas to foreign nationals with a compelling case.<sup>10</sup></li> <li>No international commercial passenger flights are allowed to land at any airport in Myanmar, with very few exceptions. This suspension will last through 31 March 2021.</li> <li>A limited number of outbound commercial flights are operating on Myanmar Airways International, Singapore Airlines, and Korean Air.</li> <li>All foreign nationals must first self-quarantine in their countries of origin, quarantine in a government facility or designated hotel upon arrival, and then self-quarantine at home.</li> <li>Foreign nationals are also required to present proof of a negative COVID-19 test and must be tested for COVID-19 at the end of each quarantine period.<sup>11</sup></li> </ul>
MYS	Malaysia	<ul style="list-style-type: none"> <li>Foreign travellers with long-term passes may enter Malaysia with the approval of the Immigration Department of Malaysia.</li> <li>Travelers must have formal written approval from the Malaysian Government before attempting to enter Malaysia.</li> <li>All travellers are required to undergo COVID-19 testing and a mandatory quarantine at a designated facility.<sup>12</sup></li> <li>Most foreigners remain banned from entering Malaysia; exemptions are in place for resident diplomats, permanent residents, foreign spouses and dependents of Malaysian citizens, etc.</li> <li>Foreigners may transit at Malaysian airports as long as they do not pass through immigration points.<sup>13</sup></li> </ul>
PHL	Republic of the Philippines	<ul style="list-style-type: none"> <li>The entry of all foreign nationals has been suspended effective 22 March 2021 through 21 April 2021, with a few exemptions such as diplomats, foreign spouses, etc.</li> <li>Commercial flights are operating with a daily cap on the number of incoming passengers.<sup>14</sup></li> <li>A 14-day quarantine at a hotel and the wearing of face shields and masks are mandatory for all incoming travellers.</li> <li>In response to the new variant of COVID-19, the Philippines has placed a temporary ban on non-Filipino passengers arriving from several countries.<sup>15</sup></li> </ul>
SGP	Republic of Singapore	<ul style="list-style-type: none"> <li>Singaporeans and residents of Singapore may travel overseas to Australia, Brunei Darussalam, New Zealand, Mainland China, and</li> </ul>

ISO 3	Full name	Current Travel Restrictions
		<p>Taiwan.</p> <ul style="list-style-type: none"> <li>▪ Border measures for the Business Travel Pass scheme have been tightened.<sup>16</sup></li> <li>▪ Returning Singapore citizens/permanent residents, long-term pass holders, and family members of Singapore citizens/permanent residents are applicable for general entry.</li> <li>▪ Singapore has arranged additional Safe Travel Lanes with a handful of countries/regions to facilitate shorter-term entry into Singapore.</li> <li>▪ The Air Travel Bubble launch has been deferred for Hong Kong.</li> <li>▪ Given the increase in the number of COVID-19 cases in Viet Nam, the Air Travel Pass has been suspended for Viet Nam.</li> <li>▪ All travellers are required to take COVID-19 tests, quarantine, use Stay-Home Notice (SHN) Electronic Monitoring Devices, and purchase COVID-19 travel insurance.<sup>17</sup></li> <li>▪ Australia and Singapore are in talks on a possible travel bubble that will allow residents to travel between both countries without having to quarantine.<sup>18</sup></li> </ul>
THA	Kingdom of Thailand	<ul style="list-style-type: none"> <li>▪ Commercial flights are still operating.</li> <li>▪ A 14-day quarantine and negative COVID-19 test are mandatory.<sup>19</sup></li> <li>▪ The new Special Tourist Visa is available for long-stay visitors to Thailand of all types – from tourists to business travellers, investors, and others.<sup>20</sup></li> <li>▪ Holders of US, Canada, UK, and Australia passports are not required to obtain a visa for tourism purposes and will be permitted to stay for not more than 45 days on each visit.</li> <li>▪ All foreign nationals are still required to obtain the Certificate of Entry and quarantine for 14 days.<sup>21</sup></li> </ul>
VNM	Socialist Republic of Viet Nam	<ul style="list-style-type: none"> <li>▪ Entry is suspended into Viet Nam for all foreigners, including people with a Vietnamese visa exemption certificate. This policy has very limited exemptions for diplomatic, official duty, and special cases.</li> <li>▪ All entrants will be placed under medical surveillance for at least 28 days.</li> <li>▪ One-way outbound commercial flights from Viet Nam to other countries are still available.</li> <li>▪ Inbound commercial flights from abroad to Viet Nam are still suspended.<sup>22</sup></li> </ul>
AUS	Commonwealth of Australia	<ul style="list-style-type: none"> <li>▪ Travellers arriving may need to go into mandatory quarantine for 14 days. Exceptions include travellers who are coming from a green safe travel zone or in an exemption category. Currently, the only green travel zone is New Zealand.<sup>23</sup></li> </ul>



ISO 3	Full name	Current Travel Restrictions
		<ul style="list-style-type: none"> <li>▪ Australia has enacted a travel ban on all non-residents and non-Australian citizens entering Australia.</li> <li>▪ The Australian government requires all individuals travelling to or transiting through Australia, with limited exceptions, to provide evidence of a negative COVID-19 (PCR) test at the time of check-in.</li> <li>▪ Australia has limited the numbers of inbound passengers on international flights.<sup>24</sup></li> <li>▪ Australian citizens or permanent residents cannot leave Australia due to COVID-19 restrictions unless they have an exemption.<sup>25</sup></li> <li>▪ Australia has extended their international border closure (other than from New Zealand) to 17 June 2021.<sup>26</sup></li> <li>▪ Qantas plans to resume international flights in October 2021 instead of July.<sup>27</sup></li> </ul>
CHN	People's Republic of China	<ul style="list-style-type: none"> <li>▪ China currently allows foreign nationals with valid residence permits and visas to enter the country under certain conditions.</li> <li>▪ A negative COVID-19 test is required for entry.</li> <li>▪ All inbound passengers are required to quarantine for at least 14 days upon arrival. Commercial flights between the US and China are available, but limited.<sup>28</sup></li> <li>▪ The Chinese authorities have suspended all direct flights from the UK.<sup>29</sup></li> </ul>
JPN	Japan	<ul style="list-style-type: none"> <li>▪ Strict travel regulations bar most foreign entry into Japan. There are specific additional entry restrictions for any traveller who has been present in an area with the new COVID-19 variant.</li> <li>▪ Japanese citizens and foreign residents with a re-entry permit will be generally permitted to re-enter the country.</li> <li>▪ Current restrictions include the suspension of short-term travel programmes, suspension of quarantine relaxations for certain travellers, imposition of travel deadlines for already-issued visas, and enhanced COVID-19 screening protocols for travellers arriving from specific locations.</li> <li>▪ Visa-free travel, and all travel for tourism, remains suspended.</li> <li>▪ All travellers are required to quarantine for 14 days.<sup>30</sup></li> <li>▪ All travellers, including Japanese nationals, have to submit a certificate of a negative test result conducted within 72 hours when entering Japan.<sup>31</sup></li> <li>▪ Foreign nationals who have stayed in any of some 152 countries/regions within 14 days prior to the application for landing are denied entry to Japan.<sup>32</sup></li> </ul>

ISO 3	Full name	Current Travel Restrictions
KOR	Republic of Korea	<ul style="list-style-type: none"> <li>▪ All travellers must provide proof of a negative COVID-19 test result issued within 72 hours of their departure and submit to a mandatory 14-day quarantine upon entry.</li> <li>▪ Despite reductions in flight services by several carriers, Korea remains well-served by commercial aviation.</li> <li>▪ Some US citizens travelling to Korea for business or emergencies may be exempt from self-quarantine requirements.<sup>33</sup></li> <li>▪ Authorities allow 'fast track' entry for essential business trips and official travel from mainland China, Japan, UAE, Singapore, and Indonesia.<sup>34</sup></li> </ul>
NZL	New Zealand	<ul style="list-style-type: none"> <li>▪ Commercial flights are operating but limited. All travellers entering New Zealand (except those from Australia, Antarctica, and most Pacific islands) are required to have a COVID-19 test taken and a negative result returned within 72 hours of their flight and quarantine.</li> <li>▪ Only New Zealand citizens and permanent residents are permitted to enter New Zealand.<sup>35</sup></li> <li>▪ There is a one-way travel bubble between New Zealand and Australia which allows travellers who have been in New Zealand for 14 days to travel to Australia quarantine-free.<sup>36</sup></li> <li>▪ Entry to New Zealand from all countries, including Australia, remains strictly controlled to help prevent the spread of COVID-19.</li> <li>▪ Australian citizens or permanent residents who are ordinarily residents of New Zealand are permitted to enter.<sup>37</sup></li> </ul>

ASEAN = Association of Southeast Asian Nations, COVID-19 = coronavirus disease, ISO = International Organization for Standardization, Lao PDR = Lao People's Democratic Republic, PCR = polymerase chain reaction, UAE = United Arab Emirates, UK = United Kingdom, US = United States.

<sup>1</sup> Brunei Tourism Development Department (2021), 'Travellers Advisory on the 2019 Coronavirus (COVID-19)', 8 March.

<sup>2</sup> US Embassy in Brunei Darussalam (2021), 'COVID-19 Information', 29 March.

<sup>3</sup> Department of Foreign Affairs, Ireland (2021), 'Travel Advice: Indonesia', 29 March.

<sup>4</sup> US Embassy in Indonesia (2021), 'COVID-19 Information', 17 February.

<sup>5</sup> Embassy of the Republic of Indonesia in Singapore (2020), 'Reciprocal Green Lane/Travel Corridor Arrangement (RGL/TCA) Singapore to Indonesia (Business and Officials Purposes)', 11 April; Ministry of Foreign Affairs, Indonesia (2020), 'Travel Corridor Arrangement/Fast Lane Indonesia – Tingkok', 26 August; Ministry of Foreign Affairs, Indonesia (2020), 'Indonesia–South Korea Travel Corridor Arrangement', 24 August; and Indonesia (2020), 'Safe Travel Corridor Arrangement Indonesia – UAE', 29 July.

<sup>6</sup> Ministry of Foreign Affairs, Cambodia (2020), 'Information on Cambodia Travel Restrictions', 8 August.

<sup>7</sup> US Embassy in Cambodia (2021), 'COVID-19 Information', 26 March.

<sup>8</sup> US Embassy in the Lao PDR (2021), 'COVID-19 Information', 4 February.

<sup>9</sup> *Xinhua* (2020), 'Laos to Launch Fast-Track Immigration Service for Chinese Travelers', 26 October.

<sup>10</sup> Government of the United Kingdom (n.d.), 'Foreign Travel Advice: Myanmar (Burma)'.

<sup>11</sup> US Embassy in Burma (2021), 'COVID-19 Information', 26 March.

<sup>12</sup> US Embassy in Malaysia (2021), 'COVID-19 Information', 17 March.

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- <sup>13</sup> Government of the United Kingdom (n.d.), 'Foreign Travel Advice: Malaysia'.
- <sup>14</sup> US Embassy in the Philippines (2021), 'COVID-19 Information', 29 March.
- <sup>15</sup> Department of Foreign Affairs, Ireland (2021), 'Travel Advice: Philippines', 30 March.
- <sup>16</sup> Singapore Ministry of Health (2021), 'Updates on COVID-19 Local Situation', 9 February.
- <sup>17</sup> SafeTravel Singapore (2021), 'Travelling to Singapore', 30 March.
- <sup>18</sup> Channel News Asia (2021), 'Singapore, Australia in Discussions on Travel Bubble', 14 March.
- <sup>19</sup> US Embassy in Thailand (2021), 'COVID-19 Information', 29 March.
- <sup>20</sup> Tourism Authority of Thailand Newsroom (2020), 'Thailand Welcomes First Group of Visitors Under New Special Tourist Visa (STV) Scheme', 22 October.
- <sup>21</sup> CNN (2021), 'Traveling to Thailand', 25 March.
- <sup>22</sup> US Embassy in Viet Nam (2021), 'COVID-19 Information', 30 March.
- <sup>23</sup> Government Department of Health, Australia (2021), 'Coronavirus (COVID-19) Advice for International Travelers', 19 March.
- <sup>24</sup> US Embassy in Australia (2021), 'COVID-19 Information', 22 March.
- <sup>25</sup> Government Department of Home Affairs, Australia (2021), 'Leaving Australia', 29 March.
- <sup>26</sup> *Xinhua* (2021), 'Australia Extends Border Closure Until June', 3 March.
- <sup>27</sup> CNN (2021), 'Australia's Qantas Says It Will Resume International Flights in October of 2021', 24 February.
- <sup>28</sup> US Embassy in China (2021), 'COVID-19 Information', 22 March.
- <sup>29</sup> Government of the United Kingdom (n.d.), 'Foreign Travel Advice: China'.
- <sup>30</sup> US Embassy in Japan (2021), 'COVID-19 Information', 25 March.
- <sup>31</sup> Ministry of Foreign Affairs, Japan (2021), 'Border Enforcement Measures to Prevent the Spread of Novel Coronavirus (COVID-19)', 26 March.
- <sup>32</sup> Japan National Tourism Organization (2021), 'Coronavirus Advisory Information', 30 March.
- <sup>33</sup> US Embassy & Consulate in Korea (2021), COVID-19 Information, 19 March.
- <sup>34</sup> *Xinhua* (2020), 'S. Korea, Japan Agree to Launch Fast-Track Entry for Businessmen from Oct. 8', 6 October.
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- <sup>36</sup> Government Department of Home Affairs, Australia (2021), 'New Zealand Safe Travel Zone', 29 March.
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