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# IS INTERNATIONAL TOURISM RESPONSIBLE FOR THE PANDEMIC OF COVID- 19 ? A PRELIMINARY CROSS-COUNTRY ANALYSIS WITH A SPECIAL FOCUS ON SMALL ISLANDS

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# Is international tourism responsible for the pandemic of COVID-19? A preliminary cross-country analysis with a special focus on small islands

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**Abstract:**

This article aims at analysing the role of international tourism attractiveness as a potential factor for the outbreak and the spread of the recent COVID-19 disease across the world with a special focus on small island economies. Econometric testing is implemented over a cross-country sample including 205 countries/territories (with 58 small islands) after controlling for several usual suspects. The results state a positive and significant relationship between COVID-19 prevalence and inbound tourism arrivals per capita. Thus international tourism must be seen as one of the main responsible factors for the recent pandemic, validating the "tourism-led vulnerability hypothesis". Accordingly, this finding suggests that the tourism specialization model in the context of small islands is too vulnerable to be considered as sustainable in the medium and long-run. Policymakers must opt for economic diversification when possible.

**Keywords:** COVID-19, Health epidemics, International tourism, Small islands, Vulnerability.

## 1. Introduction

Since the first official case of COVID-19 reported by the Chinese authorities in mid-December 2019, what was initially a Chinese problem became rapidly an international concern. Only three months were sufficient to transform a local epidemic into an unprecedented pandemic affecting now more than 190 economies around the world (WHO, 2020). Even if it is too soon to have a clear idea about the economic consequences, the first assessments suggest that this health crisis and the associated measures to limit its spread would damage dramatically almost all countries. In a recent note, OECD (2020) argues that "the initial direct impact of the shutdowns could be a decline in the level of output of between one-fifth to one-quarter in many economies with consumers' expenditure potentially dropping by around one-third. Changes of this magnitude would far outweigh anything experienced during the global financial crisis in 2008-09[1]." Unsurprisingly tourism will be one of the most impacted sectors. OFCE (2020) has already estimated €14 billion losses for France for each month of containment measures. More generally, the earlier literature demonstrated that infectious disease outbreaks (SRAS in 2003, Chikungunya in 2005, MERS in 2012, Ebola virus in 2014 or different events of influenza) caused a strong and immediate drop in the tourism frequentation for the affected countries, even if the effect appeared often transitory (Siu and Wong, 2004; Novelli et al., 2018; Peeri et al., 2020). Very recent economic works relative to the COVID-19 go in the same direction, but the adverse impacts both on the supply and demand sides would be undoubtedly deeper and longer (Peeri et al., 2020; Yang et al., 2020).

However, very few works have studied the reverse link that is the impact of tourism attractiveness of a destination on infectious disease outbreaks. International tourism is obviously a victim of infectious epidemics but it is also a major usual suspect for health epidemic spread. Scholars in epidemiological and medicine studies shed light on the potential for dramatically rapid dissemination of virus throughout the world as the world continues to experience expanding global trade markets and increasing international travel (Smolinski et al. 2003 ; Baker, 2015). In particular, infections carried by humans and transmitted from person to person are especially likely to move from one region to another. A virus such as the COVID-19, which can colonize without causing symptoms or can be transmissible at a time when infection is asymptomatic, spread easily in the absence of recognized infection in traveling hosts. Then, assuming that the contemporaneous transportation networks give the opportunity to go around the world in less than 36 hours, international tourism flows could transform local epidemics to global pandemics (Hufnagel et al., 2004). That is the reason why the WHO usually gives the recommendation to close prematurely many borders and discourages tourism in the affected areas[2].

At our knowledge, no article in the field of economics has studied this relationship at date. The aim of this paper is to fill this gap by checking if this proposition holds in the context of the COVID-19 crisis. We estimate a multiple linear regression between the

[1] It is similar to a decrease of about 2-3% in annual GDPs for each month of confinement.

[2] Hufnagel et al. (2004) claimed that simulations strongly support the strategy of travel restrictions, especially isolation of largest cities, as a necessary requirement for controlling highly contagious epidemics.

domestic magnitude of the epidemic, i.e. the prevalence of COVID-19 (per capita), and the destinations' tourism attractiveness, i.e. international tourism arrivals per capita, after controlling for several usual suspects (the share of elderly population, urban population rate, climate, population density, the Eastern Asian specificity) over a worldwide cross-section sample (205 countries/territories including 58 small islands)[3]. We make a special focus on small island economies for which the contribution of tourism to economic output generally exceeds that in other regions of the world (Pratt, 2015; Cannonier and Galloway Burke, 2018). Undoubtedly, these economies will be more exposed and more impacted than any other territories in the world. Our simulations highlight a significantly strong and positive influence of international tourism on the Covid-19 infections. This finding cast doubts on the sustainability of tourism specialization in the medium and long run for small islands.

The rest of the paper is as follows. Section 2 presents a preliminary statistical investigation about the nexus between the prevalence of Covid-19 and international tourism attractiveness using a cross-country setting. Section 3 implements a cross-sectional multiple linear approach to check if the relationship remains valid when introducing several controlling variables. Section 4 discusses the main implications for small island economies. Section 5 concludes.

## 2. An exploratory statistical investigation

### *Some striking stylized facts*

Tourism attractiveness is measured by the number of international tourism arrivals in 2018 (the last available year) extracted from the WTO's database. Obviously, this annual indicator does not give a perfect view about the intensity of visitation during the first quarter of 2020 that is the period conditioning directly the spread of the infectious disease. However, it still reflects the potential average attractiveness of the country considered[4]. The use of the year 2018 for tourism flows ensures that tourism arrivals are exogenous relative to the COVID-19 crisis, then allowing us to interpret the later estimated regressions as causal ones, i.e. the endogeneity bias does not exist. Note that in the context of infectious disease outbreaks, studying the role of outbound international tourists would have been also informative, but this data does not exist for numbers of small countries. Moreover, we opt to follow strictly the conventional definition of international tourism so that we do not consider cruise passengers. COVID-19 prevalence for each country/territory is proxied by the number of cases up to April 3 2020[5] obtained from the database published on line by Johns Hopkins University[6]. For several small island territories the data was obtained from local health

[3] The full list of the countries/territories is given in Table A.1. in appendix.

[4] We do not have the means to take into account seasonality effects due to a lack of quarterly data. Then, we make the strong assumption of an equal distribution of the flows across the four quarters.

[5] Most countries across the world experimented strict lockdowns since the third week of March. Considering a mean incubation period of 14 days, this early date secures our measurement of tourism arrivals from the influence of lockdowns.

[6] These data must be taken with caution due to a different strategy of domestic testing by each country. However the order of magnitude still stays informative.

institutions. We also take into account the size effect by dividing the original series by the number of population. In order to limit the problem of outliers, we applied the log transformation to the original series (in levels and per capita). Table 1 gives basic statistics for both original and modified variables[7].

**Table 1. Summary statistics for the variables**

| Statistics | Nb of obs. | Min | Max | First Quartile | Median | Third Quartile | Mean | Standard deviation |
|---|---|---|---|---|---|---|---|---|
| Covid19 cases | 205 | 0 | 245646 | 14 | 156 | 1015 | 5051 | 22729 |
| Int. tourism arrivals | 205 | 2400 | 86900000 | 295500 | 1296000 | 5360500 | 6051958 | 12918663 |
| Covid19 per capita | 205 | 0.00000 | 0.00728 | 0.00001 | 0.00004 | 0.00021 | 0.00030 | 0.00082 |
| Int. tourism per capita | 205 | 0.00078 | 34.67262 | 0.05748 | 0.31597 | 1.01053 | 1.35413 | 3.61564 |
| LnCovid19_pc | 205 | -17.16537 | -4.92244 | -12.00284 | -10.12705 | -8.45231 | -10.32777 | 2.52452 |
| LnTourism_pc | 205 | -7.16306 | 3.54595 | -2.85630 | -1.15212 | 0.01047 | -1.35333 | 2.03500 |

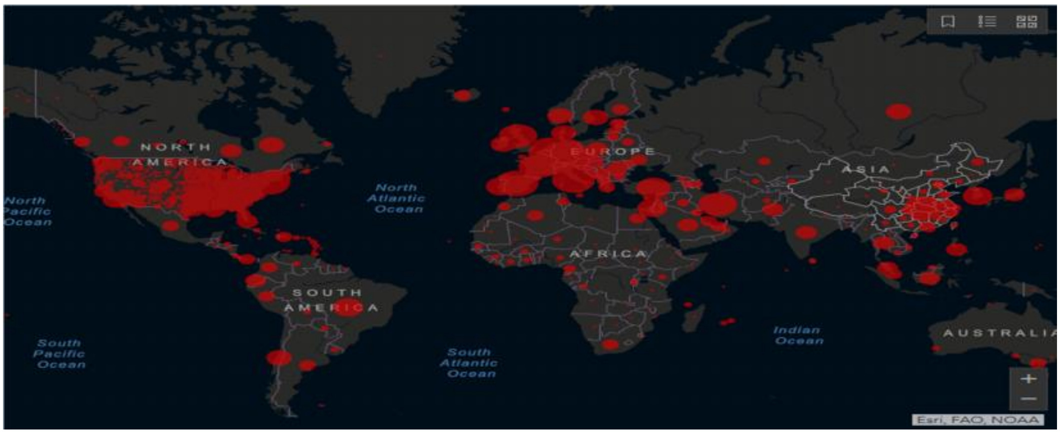
Source: author's calculations. LnCovid19_pc and LnTourism_pc are the log transformations of the variables of Covid19 per capita and international tourism per capita respectively.

Before implementing preliminary econometric testing, simple interesting stylized facts about the nature of the relationship between COVID-19 infection outbreaks and inbound tourism flows must be discussed. Figures 1 and 2 put forward a strong matching between the highly infected areas (East Asia, Western Europe and USA) and the distribution of world transport networks. The apparent connection between the air transport network and the most affected regions is particularly striking but perfectly in line with the literature in medicine sciences. There is a consensus today about the impact of air travel on the spread of emerging and established infectious diseases (Smolinski, 2003; Mangili and Gendreau, 2005; Leder and Newman, 2005). Concerning the COVID-19, the potential ways for the dissemination consist in (i) of course the ability of a contagious human to travel to virtually any part of the world within only one or two days, (ii) the travel process itself because of infections might be spread on the aircraft through close contact, large droplets and small-particle aerosols, and (iii) the time spent before boarding (the use of mass transportation to get to the airport and the close exposure to many people inside the often crowded terminals[8]).

[7] Details about measurement, expected signs, time period, and sources are given in Table A.2 in appendix.

[8] Wick and Irvine (1995) stated that the air inside the bus and airline terminal could have a higher level of microbial contamination than that inside the aircraft itself.

**Figure 1. Coronavirus COVID-19 cumulative Cases in the world, April 3 2020**




Source: the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University.

**Figure 2. Global transport networks (road, sea, air)**

Note: road transport in green, sea transport in blue, air transport in red.
Source: AndrewGloe, December 6 2017.

Moreover, Table 2 points out that the countries the most concerned by the epidemic are also the countries the most attractive in terms of international tourism. Indeed, looking at the top-10 of the best performers relative to the variable of inbound tourism flows (Panel A), we find 8 of the 10 most infected economies that is USA, Spain, Italy, Germany, China, France, United Kingdom and Turkey. A similar conclusion can be formulated for the small island world (Panel B). 8 out of the 10 most affected small islands (Singapore, Hong Kong, Bahrain, Puerto Rico, Cyprus, Hawaii, Cuba, and Malta) belong to the 10 best insular performers in terms of international tourism arrivals. These first promising findings require of course a more robust investigation.

**Table 2. Top-10 of the most concerned countries by COVID-19 cases and international tourism arrivals**

**Panel A. The Worldwide sample**

| Countries | Number of COVID-19 cases | Countries | Inbound tourism arrivals |
|---|---|---|---|
| *USA* | 245 646 | *France* | 86900000 |
| *Spain* | 117 710 | *Spain* | 82000000 |
| *Italy* | 115 242 | *USA* | 75600000 |
| *Germany* | 85 903 | *China* | 59300000 |
| *China* | 82 509 | *Italy* | 52400000 |
| *France* | 59 929 | Mexico | 39300000 |
| Iran | 53 183 | *United Kingdom* | 37700000 |
| *United Kingdom* | 38 659 | *Turkey* | 37600000 |
| Switzeland | 19 303 | *Germany* | 37500000 |
| *Turkey* | 18 135 | Thailland | 32600000 |

**Panel B. The small island world**

| Countries | Number of COVID-19 cases | Countries | Inbound tourism arrivals |
|---|---|---|---|
| Iceland | 1 364 | *Hong Kong* | 29263000 |
| *Singapore* | 1 114 | Macao | 18493000 |
| *Hong Kong* | 862 | *Singapore* | 12051000 |
| *Bahrain* | 672 | *Bahrain* | 11621000 |
| *Puerto Rico* | 378 | *Hawaii* | 9760000 |
| *Cyprus* | 356 | *Puerto Rico* | 3542000 |
| Reunion | 321 | *Cuba* | 3491000 |
| *Hawaii* | 319 | *Cyprus* | 3187000 |
| *Cuba* | 233 | Jamaica | 2182000 |
| *Malta* | 202 | *Malta* | 1966000 |

Source: the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University; the UNWTO.

***A first simple econometric analysis over a worldwide cross-country sample[9]***

Our main goal is to detect an empirical causal link between the prevalence of COVID-19 disease and international tourism attractiveness for a large worldwide sample including 205 countries/territories. Then, the hypothesis we want to validate is the more an economy characterized by high international tourism levels per capita the more this economy concerned with high levels of COVID-19 infections per capita. The empirical strategy is based on two steps: (i) testing for the correlation between COVID-19 infections per capita and international tourism arrivals per capita, and (ii) estimating within a cross-section framework a causal

[9] All econometric simulations use XLSTAT and Eviews.

linear regression of COVID-19 infections with inbound tourism flows as an explanatory variable. Note that the log transformation should strongly limit the influence of outliers. However, considering the fact that the 8 most affected countries by the COVID-19 represent together 77% of total cases, we ran the estimations also onto a reduced worldwide sample that is without USA, Spain, Italy, Germany, China, France, Iran and the United Kingdom.

On the one hand, we applied the usual procedures of Pearson, Spearman and Kendall, to test for the correlation between the number of COVID-19 infections per capita and inbound tourism flows per capita. Regardless of the sample, the correlation coefficients and the associated p-value (at the 1% significance level) displayed in Table 3 indicate that a strong, positive and significant correlation holds between the two variables.

On the other hand, as already noted earlier, considering that the endogeneity bias is not expected to exist enables us to estimate the number of COVID-19 cases per capita (the dependant variable) as a linear function of international tourism arrivals per capita (the explanatory variable). The results are displayed in Figure 3 and Table 4[10].

**Table 3. Correlation tests between COVID-19 prevalence and International tourism arrivals**

| | **The whole sample** | | | **The reduced sample** | | |
|---|---|---|---|---|---|---|
| **Variables** | **Pearson** | **Spearman** | **Kendall** | **Pearson** | **Spearman** | **Kendall** |
| Coefficient | 0.728 | 0.741 | 0.538 | 0.743 | 0.762 | 0.557 |
| p-value | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 |

Source: author's calculations. The tests are implemented at the 1% significance level.

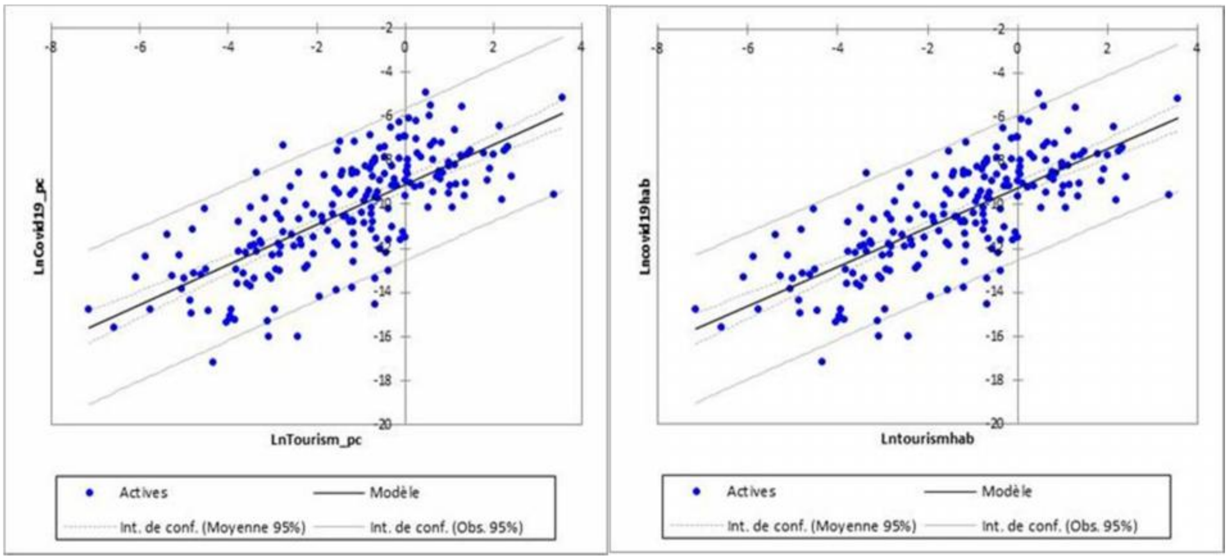
First, surprisingly for a simple linear regression, the $R^2$ is clearly strong. This indicates that 52.8% for the Panel A and 55% for the Panel B of the variability of the COVID-19 prevalence is explained by the international tourism attractiveness[11]. Furthermore, the F test of Fisher emphasizes that the variable of inbound tourism arrivals alone provides a significant proportion of information. The probability associated to the F-stat is lower than 0.0001, supporting that we cannot reject the null of a well-suited specification.

[10] The robustness tests usually applied to check the statistical reliability of the specifications have been implemented with success. Indeed, the linear form is accepted (Harvey Reset test) together with the normality (tests of Shapiro-Wilks and Jarque-Bera) and the homogeneity (tests of Breusch-Pagan and White) of the residuals. The tests of Grubbs and Dixon have been used for detecting potential outliers. The results are available upon request.

[11] Of course, this result also indicates that taking into account additional determinants would improve significantly the explanatory power of the model. This will be done below.

**Figure 3. Representation for the linear models, the whole and reduced samples**

**Panel A. The whole sample** **Panel B. The reduced sample**




Source: author's calculations.

**Table 4. The estimated linear models for the entire and reduced worldwide samples**

**Panel A. The whole sample** LnCovid19_pc = -9.10559+0,90309*LnTourism_pc

| Source | Value | Standard error | t | Pr > \|t\| | Lower bound (95%) | Upper bound (95%) |
|---|---|---|---|---|---|---|
| Constant | -9.106 | 0.146 | -62.414 | < 0.0001 | -9.393 | -8.818 |
| LnTourism_pc | 0.903 | 0.060 | 15.128 | < 0.0001 | 0.786 | 1.021 |
| $R^2$ | 0.570 | | | | | |
| $R^2$ (adjusted) | 0.528 | | | | | |
| F (Fisher) | 228.869 | | | | | |
| Pr > F | < 0.0001 | | | | | |

**Panel B. The reduced sample** LnCovid19_pc = -9.22673+0.89714*LnTourism_pc

| Source | Value | Standard error | t | Pr > \|t\| | Lower bound (95%) | Upper bound (95%) |
|---|---|---|---|---|---|---|
| Constant | -9.227 | 0.143 | -64491 | < 0.0001 | -9.509 | -8.945 |
| LnTourism_pc | 0.897 | 0.058 | 15.498 | < 0.0001 | 0.783 | 1.011 |
| $R^2$ | 0.555 | | | | | |
| $R^2$ (adjusted) | 0.552 | | | | | |
| F (Fisher) | 244.079 | | | | | |
| Pr > F | < 0.0001 | | | | | |

Source: author's calculations.

Second, looking at the estimated equations, a positive and significant trend characterises the nexus between COVID-19 infections per capita and annual inbound tourism arrivals per capita. Note that the intervals of confidence relative to both the constant and the coefficient of interest are very tight given some robustness to the estimates. Moreover, regardless the sample considered, the coefficient approximately equals 0.9, underlining the presence of a quasi-proportional relation between the two variables. Insofar as these latter are used in logs, the estimated coefficient must be interpreted as an elasticity so that an increase of 10% in international tourism attractiveness results in an increase of around 9% in the expected number of COVID-19 infections per capita. Accordingly, this preliminary study concludes that international tourism may be considered as both responsible for and victim of the outbreak and the spread of the COVID-19 crisis across the world.

## 3. A cross-sectional multiple approach for modelling the relationship between Covid-19 prevalence and international tourism attractiveness

### *The data and the rationale*

Even if the previous econometric analysis put forward a clear conditioning role for international tourism flows in the contagion process, the specification suffers from a lack of robustness. Indeed, international tourism is not the only determinant of the spread of epidemics, and the bias of omitted variables casts doubts on the reliability of the results. Therefore, we estimate a multiple linear regression model by introducing several usual suspects suggested by the specialized literature in medicine sciences.

Smolinski et al. (2003) developed the most influencing approach in the field called “the convergence model”. The authors show how the convergence of factors in four domains, that is (i) genetic and biological factors, (ii) physical environmental factors, (iii) ecological factors, and (iv) social, political, and economic factors, impacts on the human–microbe interaction and results in infectious disease. Eleven main factors, belonging to one or more of these four domains, were identified, namely (i) microbial adaptation and change, (ii) human susceptibility to infections, (iii) climate and weather, (iv) changing ecosystems, (v) economic development and land use, (vi) human demographics and behaviour, (vii) technology and industry, (viii) breakdown of public health measures, (ix) poverty and social inequality, (x) war and famine, (xi) lack of political will, and (xii) intent to harm.

It is still too soon to have a clear idea about the biological characteristics of the virus, forcing us to not consider microbial adaptation and changing ecosystems. Moreover, considering the modes of transmission of this disease, that is direct contact or through air-borne transmission, we do not retain the factors of land use and technology/industry. Moreover, the most impacted regions at date are the most developed ones, then removing possible influences of poverty/inequality[12], war and famine, and intent to harm. Thus, in the

[12] There is no macroeconomic evidence of any influence of poverty and inequality in the generating process of Covid19 epidemics. But poverty and inequality are likely to be important factors on the microeconomic side. Within a population, the poorest individuals are also the most fragile and the most exposed to the disease. In addition, in wealthier contexts, the risk falls disproportionately on the shoulders of “essential” workers who

empirical investigation, we finally focus on human susceptibility to infections, climate and weather, human demographics and behaviour, international travel and trade, breakdown of public health measures, and lack of political will. We present below the variables used and the rationale[13]. We do not discuss the factor “international travel and trade” because it correspond to our key variable, namely international tourism attractiveness, already presented in section 2.

First, demographics and interactive behaviours increasing an individual’s risk of exposure to a pathogen, or the increased probability of exchange of a contagious virus between humans, obviously boost the spread of an infectious disease. Consequently, demographic changes such as urbanization and the growth of megacities, the aging of the domestic population, and the growing number of individuals concerned by co-morbidity factors are likely to have a positive effect on Covid-19 cases in a country. Following this rationale, the proxies selected are population density [denspop], the urbanization rate [urbanpop], and the population aged 65 years and older in % of the total population [65pop]. This latter variable could also reflect human susceptibility to infections because of the population ageing naturally alters the immune system.

Second, many infectious diseases are either strongly influenced by short-term weather conditions or display a seasonality indicating the possible influence of longer-term climatic changes. Climate can directly impact disease transmission through its effects on the replication and movement (perhaps evolution) of pathogens and vectors. Climate can also operate indirectly through its impacts on ecology and/or human behaviour. For the moment there is no scientific consensus about the role of climate on the replication and the survival probability of the SARSCov2. However, the fact that the vast majority of cases are concentrated in the temperate zones brings us to study the potential role of climate. Starting from the well-known climate classification of Köppen (see Figure A.1 in appendix)[14], we decide to adopt a less restrictive approach with only three different classes of climate: temperate, tropical and equatorial. To do that, three dummies, one for each climate, are introduced [hereafter, climattemp, climattrop and climatequa for the temperate, tropical and equatorial classes respectively]. Following Simmons (2015), temperate climates are generally defined as “environments with moderate rainfall spread across the year or portion of the year with sporadic drought, mild to warm summers and cool to cold winters”. Therefore, our temperate climate dummy takes together the C and D types of Köppen. Moreover, we do not consider directly the B and E in the extent that they often correspond to sparsely populated regions. The countries associated with the B type are classified relative to its second dominant climate. Finally, within the A class, we disentangle the tropical type from the strict equatorial type. To assess the possible influence of mild temperature on Covid-19 cases, we use alternatively in the regression climattemp and climattrop/climatequa.

have the modest wages. The occupations most resistant to remote working (construction, transportation, agriculture) are obviously working-classes.

[13] Details about measurement, expected signs, time period, and sources are given in Table A.2 in appendix.

[14] Overall, the Köppen classification identifies five climate classes: A for tropical climates, B for dry climates, C for temperate climates, D for continental climates, and E for polar climates.

Third, breakdown or absence of public health measures and lack of political will are considered together. Indeed, these two factors belong to same reality of a bad preparation or complacency toward the threat of infectious diseases. We refer here to appropriate and quick reactions from all actors against the epidemics, governments of course but also corporations, officials, health professionals, and citizens. In this domain, the recent literature tends to oppose the East Asian model and the rest of the world including the western developed world (Duchâtel et al., 2020). No observer seems to contest today the exemplarity of East Asian countries in the fight against the Covid-19 disease[15]. Accordingly, we add another dummy to control the specificity of the East Asian way of managing the Covid-19 crisis [hereafter, East Asia].

***Estimation and results***

To study the impact of international tourism on the Covid-19 epidemic, we use the traditional cross-section multiple linear regression so that:

$$LnCovid19\_pc_i = \alpha + \beta LnTourism\_pc_i + \gamma X_i + \delta W_i + \varepsilon_i \quad \forall i = 1, \dots, N \qquad (1)$$

where the dependent variable is the prevalence of Covid-19 cases (per capita) and the key explanatory variable is international tourism attractiveness (per capita). $X$ is a vector of additional explanatory continuous variables (urban population, elderly population, population density), and $W$ encompasses all the dummies (climate, East Asian model). These latter allow us to control the robustness of the results about the effects of inbound tourism arrivals per capita.

Note that it is the first time that an empirical work in economics tries to identify econometrically the determinants of the Covid-19 epidemic which remains fundamentally a new infectious disease. Thus, we do not have any idea about an ideal for a well-suited specification. For this reason, we begin our analysis by using the most parsimonious specification, that is, by running our OLS regression excluding all other potential determinants of Covid-19 infections. Accordingly, our baseline model (Model (1) in Tables 5 and 6) is the simple linear regression analysed in section 2. Subsequently, several controls derived from the theory are included to assess the robustness of our results. Tables 5 and 6 display the results for the whole sample and the reduced sample respectively. We do not discuss the results given in Table 6 as they are quite similar to those of Table 5.

Let's begin with the model (2) which takes into account alongside our key variable the dimensions of demographics and human susceptibility to infections. Three main controls are used that is Denspop, Urbanpop and 65pop. All these factors have the expected signs but Denspop is clearly not significant statistically. All other things being equal, an increase of one

[15] The East Asian toolbox includes (i) enforcement of individual quarantine with digital surveillance tools, rather than mass confinement, (ii) early border controls to track imported infection at early stages of the crisis, also as an alternative to confinement, including with meticulous, sometimes intrusive, contact tracing, (iii) the mobilization of industry in support of the national need for medical equipment, especially protective items like masks, and (iv) social self-discipline and responsibility in times of epidemics.

unity in Urbanpop and 65pop leads to an increase in Covid-19 cases of about 2.9% and 13.8% respectively[16]. Note that introducing the new variables does not change the significance and the sign of LnTourism but its estimated coefficient decreased notably from 0.903 to 0.483. Moreover, this augmented model leads to a strong improvement in the $R^2$ moving from 0.528 to 0.709. This finding states the fundamental role of both international tourism and demographics for understanding epidemic dynamics.

Besides, the inclusion of the potential influence of climate in the specifications (3) and (4) does not change the main results concerning the impact of international tourism. Indeed, the coefficient of our key variable is significant and its value stays roughly the same. It should be noted that the model (3) gives the effect on the Covid-19 infections of living in a temperate region rather than in a hot region. The model (4) analyses the opposite that is the impact of living in a tropical or equatorial region rather than in temperate one. Whatever the specifications considered, a significantly high positive role of mild temperatures appears in the extent that living in a temperate climate increases the number of Covid-19 cases of about 170%[17]. This finding is in accordance with the observation that almost all the Southern hemisphere is not strongly impacted by the infectious disease.

Another crucial determinant is the East Asian model. The model (5) points out that living in an East Asian country reduces drastically the number of Covid-19 infections of 84.6%[18]. Consequently, our estimations seem to underline the effectiveness of the East Asian countries' responses to the epidemic. However, and more importantly, the international tourism parameter remains positive, stable, and highly significant.

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[16] These explanatory variables are in levels, then the estimates must be understood as the growth rate (multiplied by 100) of Covid-19 cases.

[17] See the footnote 16.

[18] See the footnote 16.

**Table 5. The estimated multiple linear model for the complete worldwide sample**

| | *(1) Baseline* | *(2) Demographics* | *(3) Climate Temperate* | *(4) Climate Tropical/Equatorial* | *(5) East Asia* | ***(6) Complete Temperate*** | *(7) Complete Tropical/Equatorial* |
|---|---|---|---|---|---|---|---|
| LnTourism_pc | 0.903*** | 0.483*** | 0.827*** | 0.828*** | 0.909*** | **0.532*** ** | 0.545*** |
| Std error | (0.010) | ((0.061) | (0.054) | (0.058) | (0.000) | **(0.059)** | (0.061) |
| Denspop | | 0..21 | | | | | |
| Std error | | (6.066) | | | | | |
| Urbanpop | | 0.029*** | | | | **0.029*** ** | 0.030*** |
| Std error | | (0.005) | | | | **(0.005)** | (0.005) |
| 65pop | | 0.138*** | | | | **0.099*** ** | 0.101*** |
| Std error | | (0.019) | | | | **(0.023)** | (0.022) |
| Climattemp | | | 1.701*** | | | **0.737*** ** | |
| Std error | | | (0.227) | | | **(0.246)** | |
| Climatetrop | | | | -1.629*** | | | -0.809*** |
| Std error | | | | (0.258) | | | (0.262) |
| Climateequa | | | | -1.656*** | | | -0.521* |
| Std error | | | | (0.291) | | | (0.290) |
| EAM | | | | | -0.846* | **-0.977*** ** | -1.078*** |
| Std error | | | | | (0.516) | **(0.394)** | (0.404) |
| Constant | -9.106*** | -12.884*** | -9.838*** | -8.182*** | -9.048*** | **-12.562*** ** | -11.316*** |
| Std error | (0.146) | (0.474) | (0.162) | (0.185) | (0.149) | **(0.359)** | (0.457) |
| $R^2$ adjusted | 0.528 | 0.709 | 0.628 | 0.620 | 0.532 | **0.729** | 0.728 |
| F-Fisher | 228.869*** | 125.158*** | 173.544*** | 111.879*** | 116.724*** | **110.837*** ** | 92.243*** |
| P-value | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | **(0.000)** | (0.000) |
| Ramsey Reset | 0.366 | 12.552*** | 1.076 | 1.210 | 0.108 | **2.131** | 3.729* |
| p-value | (0.546) | (0.001) | (0.301) | (0.273) | (0.743) | **(0.146)** | (0.055) |
| Jarque-Bera | 1.981 | 2.063 | 13.446*** | 13.435*** | 1.832 | **2.751** | 1.999 |
| p-value | (0.371) | (0.357) | (0.001) | (0.001) | (0.400) | **(0.253)** | (0.368) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Breusch-Pagan | 0.412 | 1.451 | 2.436* | 1.733 | 0.504 | **2.055*** | 1.717 |
| p-value | (0.522) | (0.219) | (0.090) | (0.162) | (0.605) | **(0.073)** | (0.119) |

Note: the dependent variable is LnCovid19_pc. The number of observations is 205. (*)(**)(***) indicates the reject of the null at the 10%, 5% and 1% significance level. The Schwarz and Hannan-Quinn information criteria design the model (6) as the best specification.
Source: Author's calculations.

## Table 6. The estimated multiple linear model for the reduced worldwide sample

| | *(1) Baseline* | *(2) Demographics* | *(3) Climate Temperate* | *(4) Climate Tropical/Equatorial* | *(5) East Asia* | ***(6) Complete Temperate*** | *(7) Complete Tropical/Equatorial* |
|---|---|---|---|---|---|---|---|
| LnTourism_pc | 0.897*** | 0.509*** | 0.833*** | 0.834*** | 0.909*** | **0.552*** ** | 0.574*** |
| Std error | (0.058) | (0.060) | (0.054) | (0.058) | (0.057) | **(0.059)** | (0.061) |
| Denspop | | 0.023 | | | | | |
| Std error | | (0.065) | | | | | |
| Urbanpop | | 0.028*** | | | | **0.028*** ** | 0.029*** |
| Std error | | (0.005) | | | | **(0.005)** | (0.005) |
| 65pop | | 0.127*** | | | | **0.010*** ** | 0.102*** |
| Std error | | (0.019) | | | | **(0.023)** | (0.022) |
| Climattemp | | | 1.492*** | | | **0.546*** * | |
| Std error | | | (0.232) | | | **(0.248)** | |
| Climatetrop | | | | -1.423*** | | | -0.642*** |
| Std error | | | | (0.261) | | | (0.261) |
| Climateequa | | | | -1.438*** | | | -0.270 |
| Std error | | | | (0.293) | | | (0.295) |
| EAM | | | | | -1.230** | **-1.167*** ** | -1.343*** |
| Std error | | | | | (0.515) | **(0.408)** | (0.424) |
| Constant | -9.227*** | -12.745*** | -9.829*** | -8.384*** | -9.142*** | **-12.435*** ** | -11.979 |
| Std error | (0.143) | (0.019) | (0.161) | (0.192) | (0.146) | **(0.350)** | (0.451) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $R^2$ adjusted | 0.550 | 0.715 | 0.627 | 0.619 | 0.560 | **0.736** | 0.730 |
| F-Fisher | 240.197*** | 120.689*** | 165.501*** | 106.974*** | 125.855*** | **106.483*** ** | 89.256*** |
| P-value | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | **(0.000)** | (0.000) |
| Ramsey Reset | 0.039 | 9.534*** | 1.594 | 1.705 | 0.005 | **1.512** | 3.101* |
| p-value | 0.844 | (0.002) | 0.208 | (0.193) | (0.945) | **(0.220)** | (0.088) |
| Jarque-Bera | 3.098 | 2.244 | 12.259*** | 12.152*** | 3.769 | **2.930** | 2.344 |
| p-value | (0.212) | (0.326) | (0.002) | (0.002) | (0.152) | **(0.231)** | (0.310) |
| Breusch-Pagan | 0.429 | 1.598 | 1.973 | 1.356 | 0.733 | **1.666** | 1.328 |
| p-value | (0.513) | (0.176) | (0.142) | (0.258) | (0.482) | **(0.145)** | (0.247) |

Note: the dependent variable is LnCovid19_pc. The number of observations is 197. (*)(**)(***) indicates the reject of the null at the 10%, 5% and 1% significance level. The Schwarz and Hannan-Quinn information criteria design the model (6) as the best specification.

Source: Author's calculations.

Finally, the models (6) and (7) ran the regression with all the controls simultaneously. There is no notable difference between the two models even if the model (6) is the best one in terms of robustness. Indeed, the two models resist to the tests of global suitability, normality, heteroskedasticity, linearity, and multicollinearity at the 5% significance level (see Table 7). However, the model (6) is associated with a stronger $R^2$ and better performs according to the Schwarz and Hannan-Quinn information criteria. All the coefficients are significant and have the expected signs. Our key variable that is international tourism attractiveness remains an important factor of Covid-19 infections even if the value of the coefficient has reduced from 0.903 to 0.532. We can conclude that an increase in inbound tourism arrivals per capita of 10% results in an increase in per capita Covid-19 cases of 5.32%. In short, international tourism must be consider as a main factor of the Covid-19 outbreak, alongside with other important usual suspects derived from demographics, climate, and a strong public and private commitment in fighting against the disease.

**Table 7. Multicollinearity and the Variance Inflation Factors (VIF)**

**Panel A. The whole sample**

Climate=Climattemp

| Statistique | LnTourism_pc | Urbanpop | EAM | 65pop | LnDensity | Climattemp |
|---|---|---|---|---|---|---|
| Tolerance | 0,571 | 0,704 | 0,947 | 0,379 | 0,810 | 0,560 |
| VIF | 1,751 | 1,421 | 1,056 | 2,636 | 1,234 | 1,785 |

Climate=Climattrop/Climatequa

| Statistique | LnTourism_pc | Urbanpop | EAM | 65pop | LnDensity | Climattrop | Climatequa |
|---|---|---|---|---|---|---|---|
| Tolerance | 0,529 | 0,695 | 0,893 | 0,386 | 0,803 | 0,525 | 0,458 |
| VIF | 1,890 | 1,438 | 1,120 | 2,589 | 1,245 | 1,905 | 2,183 |

**Panel B. The reduced sample**

Climate=Climattemp

| Statistique | LnTourism_pc | Urbanpop | EAM | 65pop | LnDensity | Climattemp |
|---|---|---|---|---|---|---|
| Tolerance | 0,572 | 0,710 | 0,941 | 0,393 | 0,813 | 0,579 |
| VIF | 1,749 | 1,408 | 1,063 | 2,546 | 1,230 | 1,728 |

Climate=Climattrop/Climatequa

| Statistique | LnTourism_pc | Urbanpop | EAM | 65pop | LnDensity | Climattrop | Climatequa |
|---|---|---|---|---|---|---|---|
| Tolerance | 0,527 | 0,701 | 0,876 | 0,400 | 0,806 | 0,522 | 0,445 |
| VIF | 1,898 | 1,426 | 1,142 | 2,501 | 1,241 | 1,914 | 2,247 |

Source: Author’s calculations.

## 4. Discussion and implications for the small island economies

The findings resulting from this study are particularly relevant and crucial for small island territories. Undoubtedly, most of them are largely dependent on international tourism both in terms of GDP and of exports (see Table 8).

**Table 8. International tourism indicators for a selected set of small island economies**

| Small island economies | International tourism | | |
|---|---|---|---|
| | per 1000 inhabitants | receipts % of GDP | receipts % of exports |
| Turks and Caicos | 11708.483 | 76.982 | .. |
| Macao | 29277.939 | 73.266 | 88.730 |
| Sint Maarten | 4378.413 | 71.539 | 58.871 |
| Aruba | 10222.495 | 68.764 | 75.190 |
| Antigua and Barbuda | 2793.760 | 60.289 | 84.311 |
| Maldives | 2877.664 | 57.326 | 82.694 |
| St. Lucia | 2171.654 | 51.461 | 81.271 |
| Grenada | 1659.878 | 46.209 | 84.338 |
| Palau | 5919.473 | 42.959 | 86.262 |
| Seychelles | 3741.138 | 38.423 | 35.421 |
| St. Kitts & Nevis | 2383.631 | 36.307 | 60.639 |
| Vanuatu | 396.337 | 35.546 | 62.844 |
| US Virgin Islands | 3561.513 | 31.180 | .. |
| St. Vincent & the Grenadines | 725.887 | 29.705 | 76.270 |
| Bahamas | 4234.519 | 27.228 | 77.247 |
| Cabo Verde | 1305.706 | 26.507 | 53.584 |
| Belize | 1276.526 | 26.026 | 45.206 |
| Fiji | 984.739 | 24.744 | 51.324 |
| Samoa | 836.180 | 23.315 | 62.574 |
| Barbuda | 2372.305 | 21.866 | .. |
| Dominica | 879.581 | 20.149 | 68.538 |
| Jamaica | 842.631 | 19.721 | 53.376 |
| Curacao | 2702.551 | 19.342 | 31.568 |
| Guam | 9344.385 | 17.800 | .. |
| Sao Tome and Principe | 158.273 | 17.026 | 73.194 |
| Cayman Islands | 7214.760 | 15.209 | 19.864 |
| Mauritius | 1105.664 | 15.197 | 38.881 |

Source: The World Development Indicators, The World Bank.

Mainstream literature often claims that tourism specialization is the best option for the small island world. Academics supporting the so-called "tourism-led growth hypothesis" argue that tourism specialization is the main if not the only way of sustainable economic development for small islands (Brau et al., 2011 ; Brida et al., 2016). Moreover, McElroy

(2006) highlights that the "Small Island Tourist Economies" [SITE][19] display significant better macroeconomic performances than their "Migration, Remittances, Aid, and Bureaucracy" [MIRAB][20] counterparts. Following the seminal work of Baldacchino and Milne (2000) about the "People, Resources, Overseas management, FInance, and Transport" [PROFIT] model, Bertram and Poirine (2007) support the previous results evidencing the spectacular effectiveness of the specific model based on high-quality tourism and offshore finance.

The favourable impact of tourism specialization makes a certain consensus in the short-run. However, its positive effect on the long-run is not so evident. Conversely, a recent strand of the literature in tourism economics promotes the "tourism-led vulnerability hypothesis" (Charles et al., 2019). The most influential approach (Butler, 2011), the so-called "Tourism Area Life Cycle [Hereafter, TALC], argues that all tourism destinations are characterized by a common dynamic process reproducing a S-shaped curve and experiencing a series of stages from exploration to involvement, development, consolidation, stagnation, and post-stagnation which can be a decline without convenient economic policies (see Figure 4). In short, tourism development contains the seeds of its own destruction because beyond a certain threshold it damages the economic, social, cultural and ecological carrying capacity of the host territory. In addition, the transition from one stage to the next guided by chaos dynamics is not linear or deterministic (Russel and Faulkner, 2001; Russel, 2006). Tourism resorts, whatever its maturity, heavily depend on a set of unpredictable triggers whose impacts are also unpredictable with a magnitude out of proportion to the initial shock. Amongst these triggers, the literature emphasized particularly the role of exogenous shocks, such as health crises[21]. These one-off shocks are expected to damage the attractiveness of the destination sharply and instantly, but with the possibility of a persistent impact in accordance with the butterfly effect principle (Faulkner and Russel. 2001).

Our results are in line with this latter strand of literature. However, contrary to the previous works we question the exogenous property of health crises. We argue that international tourism development due to its globalized dimension strongly increases the probability of health epidemic outbreaks. In other words, the more a country attractive in terms of foreign tourism, the more this probability high, and the more it will be hurt by the necessary measures for limiting the spread of the disease such as air traffic restrictions and strict lockdowns. Thereafter, these health-care measures are likely to generate a dramatic and deep economic and social crisis, especially for the countries largely depending on tourism such as numbers of small islands. Furthermore, the on-going climate change process, partly generated by the tourism industry (Lenzen et al., 2018)[22], should magnify this phenomenon in

[19] The SITE model characterizes the small islands for which international tourism is the almost exclusive driving force of the economy.

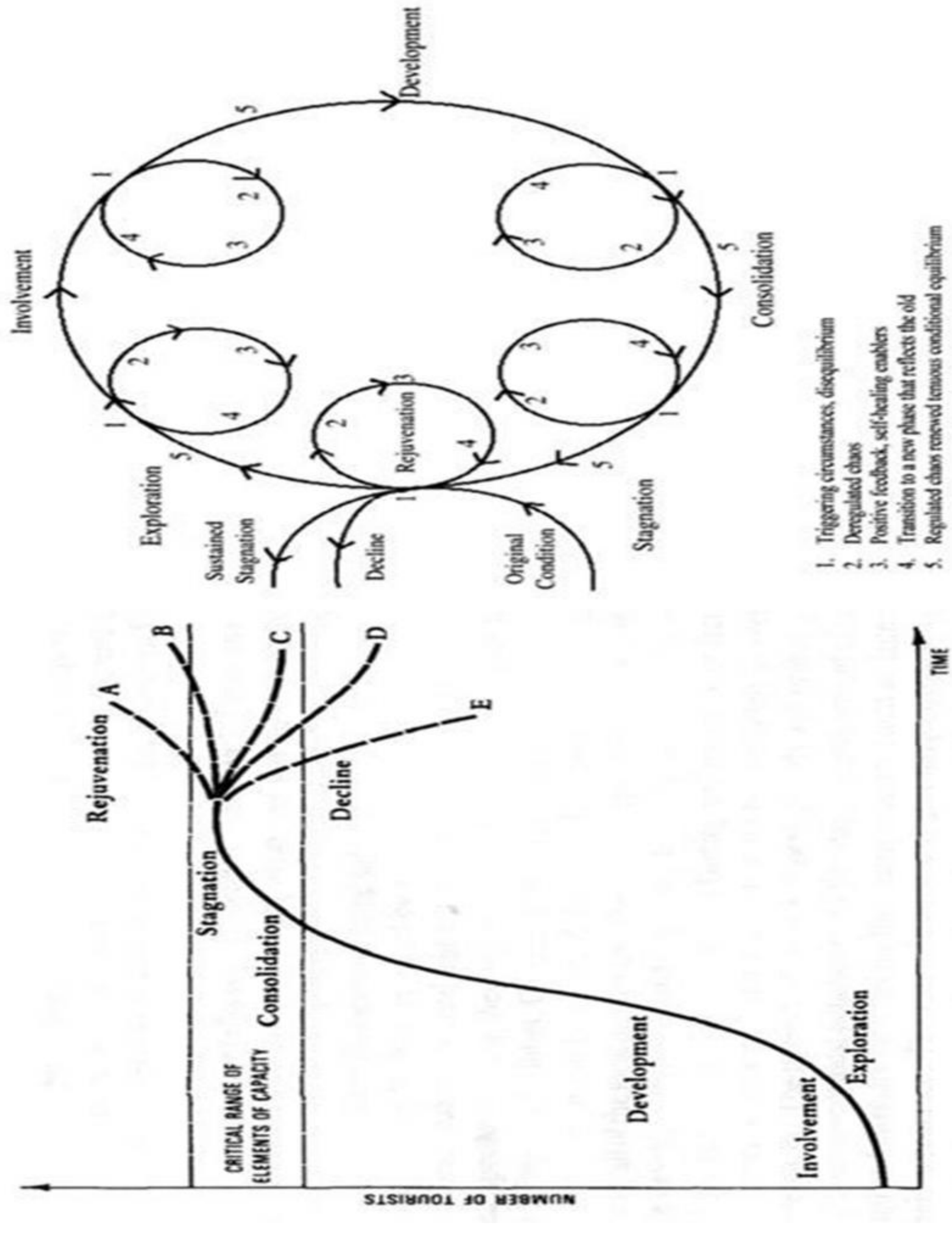
[20] The MIRAB model, originally developed by Bertram and Watters (1985), describes a specific development model found in the insular world underlining the importance of migration, overseas remittances, foreign aid and public bureaucracy for the functioning of the local economy.

[21] Other exogenous shocks are also discussed, namely international economic and financial crises, wars, terrorism, and natural disasters (Baker, 2005).

[22] The tourism contribution to greenhouse gas emissions represents 8% of the total emissions over the recent period.

the future. Humans can expect more such disease to emerge in the future, as climate change shifts habitats and brings wildlife, crops, livestock, and humans into contact with pathogens to which they have never been exposed (Hoberg and Brooks, 2015). Thus, in the context of the insular world, tourism specialization is too much vulnerable to be considered as a sustainable strategy in the medium and long-run. This is due to a very high exposure to health epidemics as the recent COVID-19 one. Accordingly, we claim that relying on tourism is too dangerous for small islands, suggesting that policymakers should opt for a strategy of diversification rather than tourism specialization[23].

**Figure 4. The TALC model (standard and with chaos)**




Source: Charles et al. (2019).

[23] Earlier works already put forward this observation in the context of climate change (Closset et al., 2018; Goujon and Hoarau, 2020).

## 5. Conclusion

Finally, this study showed that international tourism more than a victim appears mostly as a major factor of the COVID-19 pandemic outbreak. A positive and significant relationship exists, suggesting that an increase of 10% in inbound tourist arrivals per capita leads to an increase of 5.5% in the prevalence of COVID-19 infections after introducing several controls. This finding supports the well-accepted result in epidemiological and medicine studies that international travel and tourism constitute strong forces in the emergence of diseases and will continue to shape the outbreak, frequency, and spread of infections in geographic areas and populations (Baker, 2005).

This important conclusion is very disturbing for the small island economies. Most of them have adopted for a long time a model of development largely focused on international tourism. Taking into account the obvious impact of major extreme events such as health epidemics gives support to the "tourism-led vulnerability hypothesis". We claim that tourism specialization is too vulnerable to be considered as sustainable in the medium and long-run. Therefore, our conclusion is in accordance with the strand of the literature which argues that small island economies, and in particular small island tourist economies, are highly structurally vulnerable and require a special attention from the international community (Briguglio, 1995; Guillaumont, 2010; Closset et al., 2018). But more than public assistance, local policymakers in charge of the development strategy should reduce the domestic dependence on international tourism when possible. The quest of diversification must become a priority.

Note that this preliminary work needs additional investigations. In a future study, we will test for the validity of our relationship of interest by introducing into the econometric specification other variables of control coming from medicine and climate sciences. It will be especially interesting to disaggregate our climate variable by taking into account more climate types. Moreover, including a dummy focusing on the countries with a well-known experience about hydroxychloroquine could be somewhat informative for the actual debate relative to an effective and not expensive treatment against the Covid-19 disease.

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## Appendix

### Table A.1. The worldwide sample

| | | | | |
|---|---|---|---|---|
| South Africa | Congo | **Cayman Isl.** | Mexico | San Marino |
| Albania | South Korea | **Solomon Isl.** | Moldavia | **St Vincent & the Gren.** |
| Algeria | Costa Rica | **UK Virgin Isl.** | **Monaco** | **Samoa** |
| Germany | Côte d’Ivoire | **US Virgin Isl.** | Mongolia | **Sao Tome & Principe** |
| Andorra | Croatia | India | Montenegro | Senegal |
| Angola | **Cuba** | Indonesia | Mozambique | Serbia |
| **Antigua & Barbuda** | **Curacao** | Iraq | Myanmar | **Seychelles** |
| Saudi Arabia | Danemark | Iran | Namibia | Sierra Leone |
| Argentina | Djibouti | Ireland | Nepal | **Sin Maarten** |
| Armenia | **Dominica** | **Iceland** | Nicaragua | **Singapore** |
| **Aruba** | Egypt | Israel | Niger | Slovakia |
| Australia | El Salvador | Italy | Nigeria | Slovenia |
| Austria | Unit. Arab Emirates | **Jamaica** | Norway | Sudan |
| Azerbaijan | Ecuador | Japan | **New Caledonia** | Sri Lanka |
| **Bahamas** | Eritrea | Jordan | New Zeland | Sweden |
| **Bahrain** | Spain | Kazakhstan | Oman | Switzerland |
| Bangladesh | Estonia | Kenya | Uganda | **Suriname** |
| **Barbuda** | Eswatini | **Kiribati** | Uzbekistan | Syria |
| Belgium | USA | Kuwait | Pakistan | Tajikistan |
| **Belize** | Ethiopia | Kyrgyzstan | **Palau** | Taiwan |
| Benin | **Fiji** | Lao PDR | Panama | Tanzania |
| **Bermuda** | Finland | Lesotho | **Papua New Guinea** | Chad |
| Bhutan | France | Latvia | Paraguay | Czech Rep. |
| Belarus | Gabon | Lebanon | Netherlands | Thailand |
| Bolivia | Gambia | Libya | Perou | **Timor-Leste** |
| Bosnia & Herzegovina | Georgia | Liechtenstein | Philippines | Togo |
| Botswana | Ghana | Lithuania | Poland | **Tonga** |
| Brazil | Greece | Luxembourg | **French Polynesia** | **Trinitad & Tobago** |
| Brunei | **Grenada** | **Macao** | **Puerto Rico** | Tunisia |
| Bulgaria | **Guadeloupe** | North Macedonia | Portugal | Turkmenistan |
| Burkina Faso | **Guam** | Madagascar | Qatar | **Turks & Caicos** |
| Burundi | Guatemala | Malaysia | Central African Rep. | Turkey |
| Cambodia | Guinea | Malawi | D.R. Congo | **Tuvalu** |
| Cameroun | **Guinea-Bissau** | **Maldives** | Dominican Rep. | Ukraine |
| Canada | **Guyana** | Mali | **Reunion** | Uruguay |
| **Cabo Verde** | **French Guyana** | **Malta** | Roumania | **Vanuatu** |
| Chile | **Haiti** | Morocco | United Kingdom | Venezuela |
| China | **Hawaii** | **Martinique** | Russia | Vietnam |
| **Cyprus** | Honduras | **Mauritius** | Rwanda | Yemen |
| Colombia | **Hong Kong** | Mauritania | **St Lucia** | Zambia |
| **Comoros** | Hungary | **Mayotte** | **Saint Kitts & Nevis** | Zimbabwe |

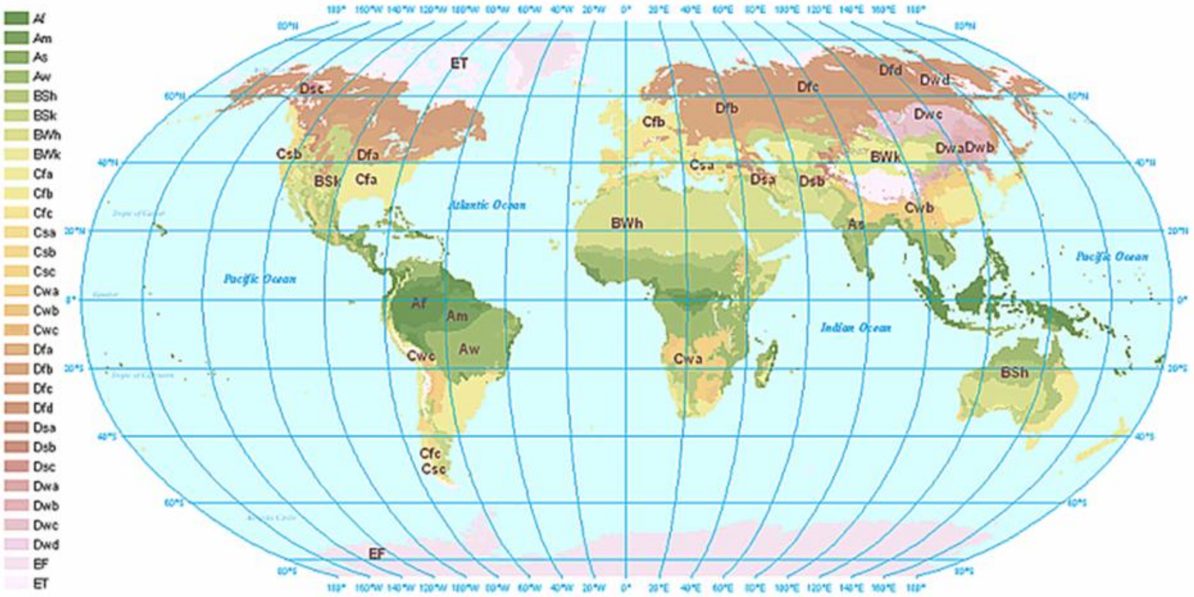
Note: Small island economies are in bold.

**Table A.2. The Variables (Description, expected signs, unit, year of observation, and sources)**

| Variables | Description | Expected sign | Unit | Year | Sources |
|---|---|---|---|---|---|
| Covid19 per capita* | number of Covid19 infections per inhabitant | | In log | 2020, 3 april | Johns Hopkins University (https://coronavirus.jhu.edu/map.html) |
| International tourism per capita* | Number of inbound tourism arrivals per inhabitant | + | In log | 2018 | World Tourism Organization (https://www.e-unwto.org/doi/pdf/10.18111/9789284421251) |
| Urban population | Total population living in urban areas in percentage of total population | + | in % | 2018 | World Development Indicators, World Bank (https://data.worldbank.org/indicator/SP.URB.TOTL.in.zs) |
| Elderly population | Population ages 65 and above in percentage of total population | + | in % | 2018 | World Development Indicators, World Bank (https://data.worldbank.org/indicator/SP.POP.65UP.TO.ZS) |
| Population density | People per square kilometers of land area | + | In log | 2018 | World Development Indicators, World Bank (https://data.worldbank.org/indicator/EN.POP.DNST) |
| Temperate climate | A dummy taking 1 for a country located in a temperate zone, and 0 otherwise | + | dummy | | Authors' groupins relative to the Köppen classification (with adjustments) |
| Tropical climate | A dummy taking 1 for a country located in a tropical zone,and 0 otherwise | - | dummy | | Authors' groupins relative to the Köppen classification (with adjustments) |
| Equatorial climate | A dummy taking 1 for a country located in a equatorial zone, and 0 otherwise | - | dummy | | Authors' groupins relative to the Köppen classification (with adjustments) |
| East Asian model | A dummy taking 1 for a country located in East Asia, and 0 otherwise | - | dummy | | Authors' groupings based on a large definition of East Asia |

Note: (*) Concerning the variables of Covid19 per capita and International tourism per capita, the number of population is extracted from the World Bank database. For the number of COVID-19 cases we applied the formula log(1+x) because of the presence of 0.

**Figure A.1. World Climate patterns according to Köppen**




Source: Courtesy NOAA

## TEPP Working Papers 2020

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