



HAL
open science

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

Jean-François Hoarau

► To cite this version:

Jean-François Hoarau. Is international tourism responsible for the pandemic of COVID-19? A preliminary cross-country analysis with a special focus on small islands. 2021. hal-03234289

HAL Id: hal-03234289

<https://hal.science/hal-03234289>

Preprint submitted on 25 May 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



WORKING PAPER

N° 2020-4

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

JEAN-FRANCOIS HOARAU

www.tepp.eu

TEPP – Theory and Evaluation of Public Policies - FR CNRS 2042

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

Jean-François Hoarau, CEMOI, Université de La Réunion, TEPP
jfhoarau@univ-reunion.fr

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 2008-09¹.” 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 areas².

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 considered⁴. 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 2020⁵ obtained from the database published on line by Johns Hopkins University⁶. 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 variables⁷.

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 terminals⁸).

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
<i>USA</i>	245 646	<i>France</i>	86900000
<i>Spain</i>	117 710	<i>Spain</i>	82000000
<i>Italy</i>	115 242	<i>USA</i>	75600000
<i>Germany</i>	85 903	<i>China</i>	59300000
<i>China</i>	82 509	<i>Italy</i>	52400000
<i>France</i>	59 929	<i>Mexico</i>	39300000
<i>Iran</i>	53 183	<i>United Kingdom</i>	37700000
<i>United Kingdom</i>	38 659	<i>Turkey</i>	37600000
<i>Switzerland</i>	19 303	<i>Germany</i>	37500000
<i>Turkey</i>	18 135	<i>Thailand</i>	32600000

Panel B. The small island world

Countries	Number of COVID-19 cases	Countries	Inbound tourism arrivals
<i>Iceland</i>	1 364	<i>Hong Kong</i>	29263000
<i>Singapore</i>	1 114	<i>Macao</i>	18493000
<i>Hong Kong</i>	862	<i>Singapore</i>	12051000
<i>Bahrain</i>	672	<i>Bahrain</i>	11621000
<i>Puerto Rico</i>	378	<i>Hawaii</i>	9760000
<i>Cyprus</i>	356	<i>Puerto Rico</i>	3542000
<i>Reunion</i>	321	<i>Cuba</i>	3491000
<i>Hawaii</i>	319	<i>Cyprus</i>	3187000
<i>Cuba</i>	233	<i>Jamaica</i>	2182000
<i>Malta</i>	202	<i>Malta</i>	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 sample⁹

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 4¹⁰.

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

Variables	The whole sample			The reduced sample		
	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 attractiveness¹¹. 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.

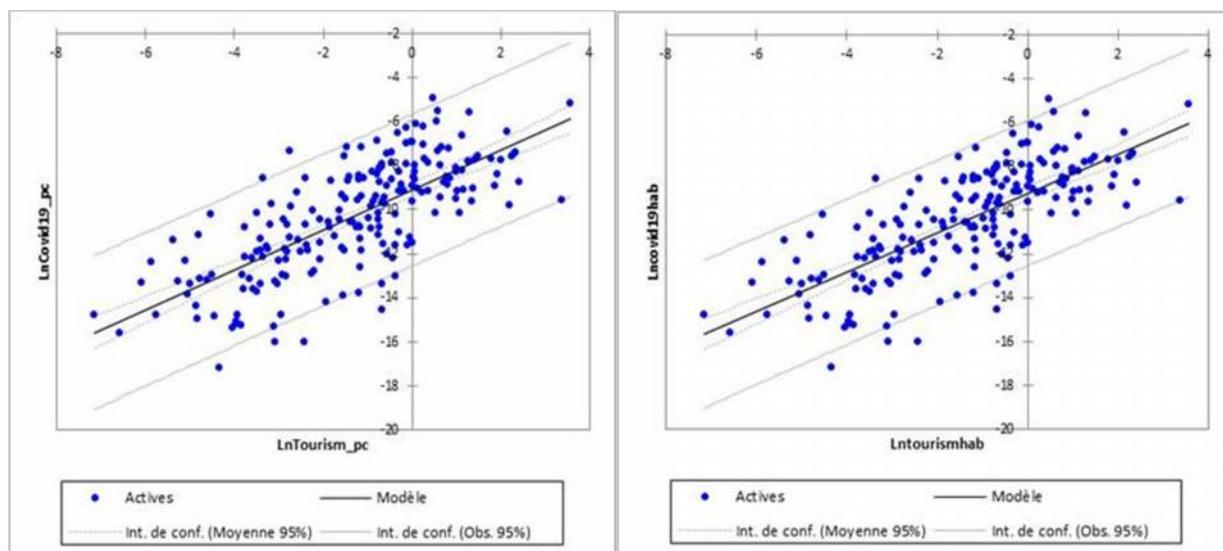
¹⁰ The robustness tests usually applied to check the statistical reliability of the specifications have been implemented with success. Indeed, the linear form is accepted (Harvey Reset test) together with the normality (tests of Shapiro-Wilks and Jarque-Bera) and the homogeneity (tests of Breusch-Pagan 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		$\text{LnCovid19_pc} = -9.10559 + 0.90309 * \text{LnTourism_pc}$				
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		$\text{LnCovid19_pc} = -9.22673 + 0.89714 * \text{LnTourism_pc}$				
Source	Value	Standard error	t	Pr > t	Lower bound (95%)	Upper bound (95%)
Constant	-9.227	0.143	-64.491	< 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/inequality¹², 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 rationale¹³. 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 disease¹⁵. 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:

$$\mathit{LnCovid19_pc}_i = \alpha + \beta \mathit{LnTourism_pc}_i + \gamma X_i + \delta W_i + \varepsilon_i \quad \forall i = 1, \dots, N \quad (1)$$

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% respectively¹⁶. 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 R² 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.

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) <i>Baseline</i>	(2) <i>Demographics</i>	(3) <i>Climate Temperate</i>	(4) <i>Climate Tropical/Equatorial</i>	(5) <i>East Asia</i>	(6) <i>Complete Temperate</i>	(7) <i>Complete Tropical/Equatorial</i>
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)
Climateeequa				-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

	<i>(1) Baseline</i>	<i>(2) Demographics</i>	<i>(3) Climate Temperate</i>	<i>(4) Climate Tropical/Equatorial</i>	<i>(5) East Asia</i>	<i>(6) Complete Temperate</i>	<i>(7) Complete Tropical/Equatorial</i>
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 considered 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 crises²¹. 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.

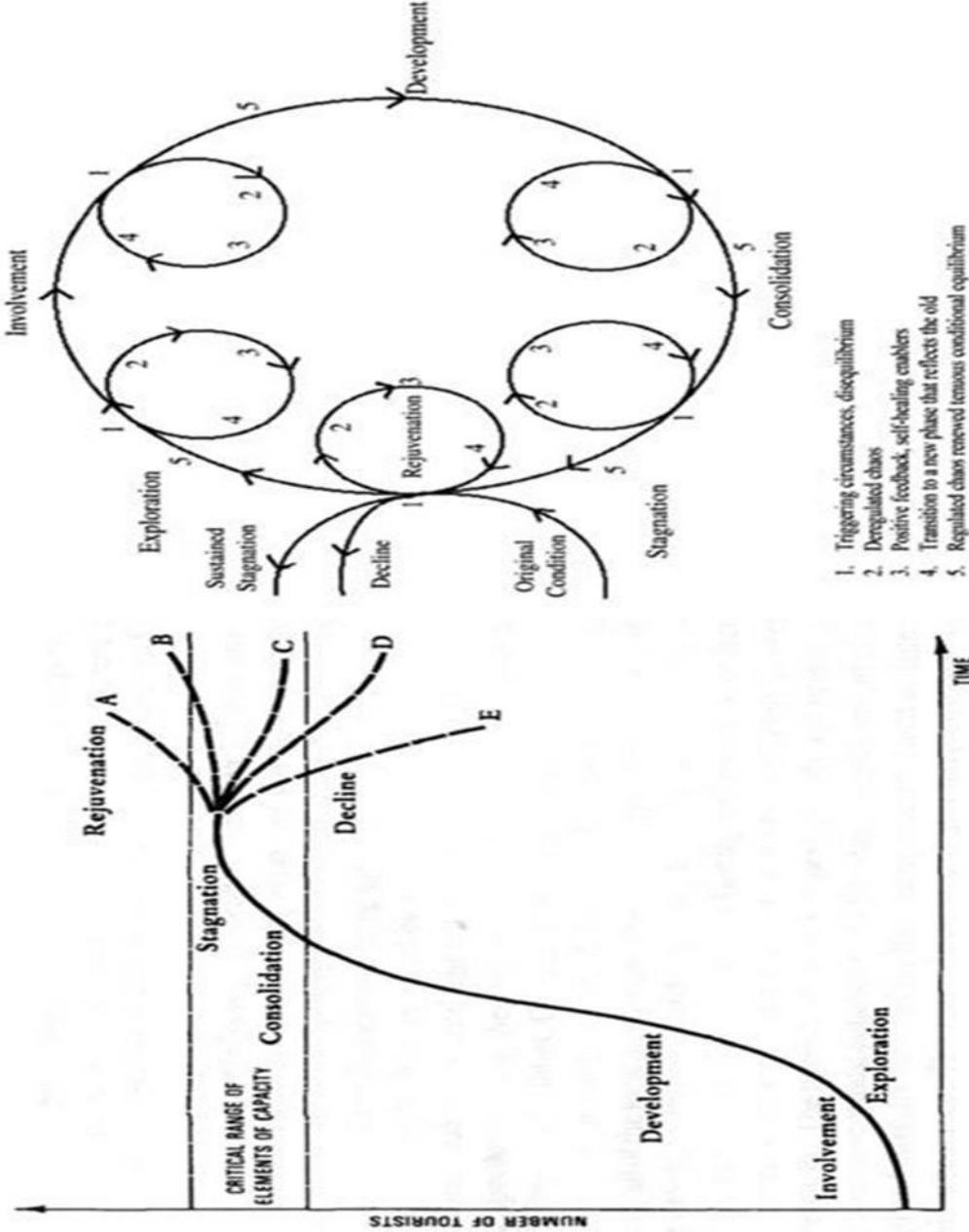
²⁰ The MIRAB model, originally developed by Bertram and Watters (1985), describes a specific development model found in the insular world underlining the importance of migration, overseas remittances, foreign aid and public bureaucracy for the functioning of the local economy.

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 specialization²³.

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.

References

- Baker D.Mc.A. (2005). “Tourism and the health effects of infectious diseases: Are there potential risks for tourists?”, *International Journal of Safety and Security in Tourism/Hospitality*, 12, 1–17.
- Baldacchino G., Milne D. (2000). *Lessons from the political economy of small islands: the resourcefulness of jurisdiction*, Basingstoke: Macmillan.
- Bertram G., Poirine B. (2007). “Island Political Economy”, in G. Baldacchino (ed.), *A World of Islands: an island studies reader*, Canada and Malta, Institute of Island Studies and Agenda Academic, 332-378.
- Bertram G., Watters R.F. (1985). “The MIRAB economy in South Pacific microstates”, *Pacific Viewpoint*, 26(3), 497-519.

- Brau R., Di Liberto A., Pigliaru F. (2011). Tourism and Development: A Recent Phenomenon Built on Old (Institutional) Roots?, *The World Economy*, 34(3), 444-472, March.
- Brida, J.G., Cortes-Jimenez, I., Pulina, M., 2016, « Has the tourism-led growth hypothesis been validated? A literature review », *Current Issues in Tourism*, 19, 394–430.
- Brigulio L. (1995). “Small island developing states and their economic vulnerabilities”, *World Development*, 23(9), 1615-1632.
- Butler R.W. (2011). *Tourism Area Life Cycle: Contemporary Tourism Reviews*, 1–33, Oxford: Goodfellow Publishers.
- Cannonier C, Galloway Burke M. (2018). “The economic growth impact of tourism in Small Island Developing States-evidence from the Caribbean”, *Tourism Research*, 25(1), 85-108.
- Charles A., Darne O., Hoarau J.F. (2019). “How resilient is La Réunion in terms of international tourism attractiveness: an assessment from unit root tests with structural breaks from 1981-2015”, *Applied Economics*, 51(24), 2639–2653.
- Closset M., Feindouno S., Guillaumont P., Simonet C., (2018). “A Physical Vulnerability to Climate Change Index: Which are the most vulnerable developing countries?”, *Ferdi Working paper*, P213, october.
- Duchâtel M., Godement, F., Zhu V. (2020). Fighting COVID-19: East Asian Responses to the Pandemic, *Policy Paper*, Institut Montaigne, April:
<https://www.institutmontaigne.org/ressources/pdfs/publications/fighting-covid-19-east-asian-responses.pdf>.
- Faulkner B., Russell R. (2001). “Turbulence, Chaos, and Complexity in Tourism Systems: A Research Direction for the New Millennium”, in *Tourism and the 21st Century: Reflections on Experience*, edited by B. Faulkner, G. Moscardo, and E. Laws, 328–349. London: Continuum Books.
- Goujon M., Hoarau J.F. (2020). “Le tourisme insulaire à la merci du changement climatique : une évaluation par un indice synthétique de vulnérabilité physique”, *Etudes et Documents*, CERDI, Forthcoming.
- Guillaumont P. (2010). “Assessing the economic vulnerability of small island developing states and the least developed countries”, *Journal of Development Studies*, 46 (5), 828-854.
- Hoberg E.P., Brooks D.R. (2015). Evolution in action: climate change, biodiversity dynamics and emerging infectious disease, 370(1665), *Philosophical Transaction of the Royal Society B: Biological Sciences*, April 5:
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4342959/>.
- Hufnagel L., Brockmann D., Geisel T. (2004). “Forecast and control of epidemics in a globalized world”, 101(42), *Proceedings: National Academy of Sciences, USA*, 15124-15129, October.
- Leder K., Newman D. (2005). “Respiratory infections during air travel”, *International Medicine Journal*, 35, 50-55.
- Lenzen M., Sun Y.Y., Faturay F., Ting Y.P., Geschke A., Malik A. (2018). “The carbon footprint of global tourism”, *Nature Climate Change*, 8(6), 522-528, June.
- Mangili A., Gendreau M.A. (2005). “Transmission of infectious diseases during commercial air travel”, *Lancet*, 365, 989-996.

- McElroy J.L. (2006). “Small island tourist economies across the life cycle”, *Asia Pacific Viewpoint*, 47(1), 61-77.
- Novelli M., Gursing Burgess L., Jones A., Ritchie B.W. (2018). “No Ebola ... still doomed – The Ebola-induced tourism crisis”, *Annals of Tourism Research*, 70, 76-87.
- Observatoire Français de Conjoncture Economique [OFCE] (2020). “Évaluation au 30 mars 2020 de l’impact économique de la pandémie de COVID-19 et des mesures de confinement en France”, *OFCE Policy brief*, 65, 30 mars:
<https://www.ofce.sciences-po.fr/pdf/pbrief/2020/OFCEpbrief65.pdf>.
- Organization for Economic Cooperation and Development [OECD] (2020). “Evaluating the initial impact of COVID-19 containment measures on economic activity”, *OECD note*,
http://www.cica.net/wp-content/uploads/2020/04/200331_OECD_evaluating-initial-impact-of-Covid-19.pdf.
- Peeri N.C., Shrestha N, Rahman M.S., Zaki R., Tan Z., Bibi S., ..., Haque U (2020). “The SARS, MERS, and novel coronavirus (COVID-19) epidemics, the newest and biggest global health threats: What lessons have we learned?”, *International Journal of Epidemiology*, Forthcoming:
<https://doi.org/10.1093/ije/dyaa033>.
- Pratt S. (2015). “The economic impact of tourism in SIDS”, *Annals of Tourism Research*, 52, 148-160, May.
- Russell R. (2006). “Chaos Theory and Its Applications to the Tourism Area Life Cycle Model”, in *The Tourism Area Life Cycle: Conceptual and Theoretical Issues*, edited by R. W. Butler, 164–179, Clevedon: Channelview Publications.
- Russell R., Faulkner B. (2004). “Entrepreneurship, Chaos, and the Tourism Area Life Cycle”, *Annals of Tourism Research*, 31(3), 556–579.
- Siu A., Wong Y.C.R. (2004). “Economic Impact of SARS: The Case of Hong Kong”, *Asian Economic Paper*, 3(1), 62-83.
- Simmons M.T. (2015). Climate and microclimates: challenges for extensive green roof design in hot climates, in R.K. Sutton (Ed.), *Green Roof Ecosystems*, Springer, Chapter 3, 63-80.
- Smolinski M.S., Hamburg M.A., Lederberg J. (2003). *Microbial Threats to Health: Emergence, Detection, and Response*, Committee on Emerging Microbial Threats to Health in the 21st Century, 398p.:
<http://www.nap.edu/catalog/10636.html>.
- World Health Organization [WHO] (2020). *Coronavirus disease (COVID-2019) situation reports*:
<https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports/>.
- Wick R.L.Jr, Irvine L.A. (1995). “The microbiological composition of airliner cabin air”, *Aviat Space Environ Med*, 66(3), 220–4.
- Yang Y., Zhang H., Chen X. (2020). “Coronavirus pandemic and tourism: Dynamic stochastic general equilibrium modelling of infection disease outbreak”, *Annals of Tourism Research*, Forthcoming.

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	Trinidad & 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

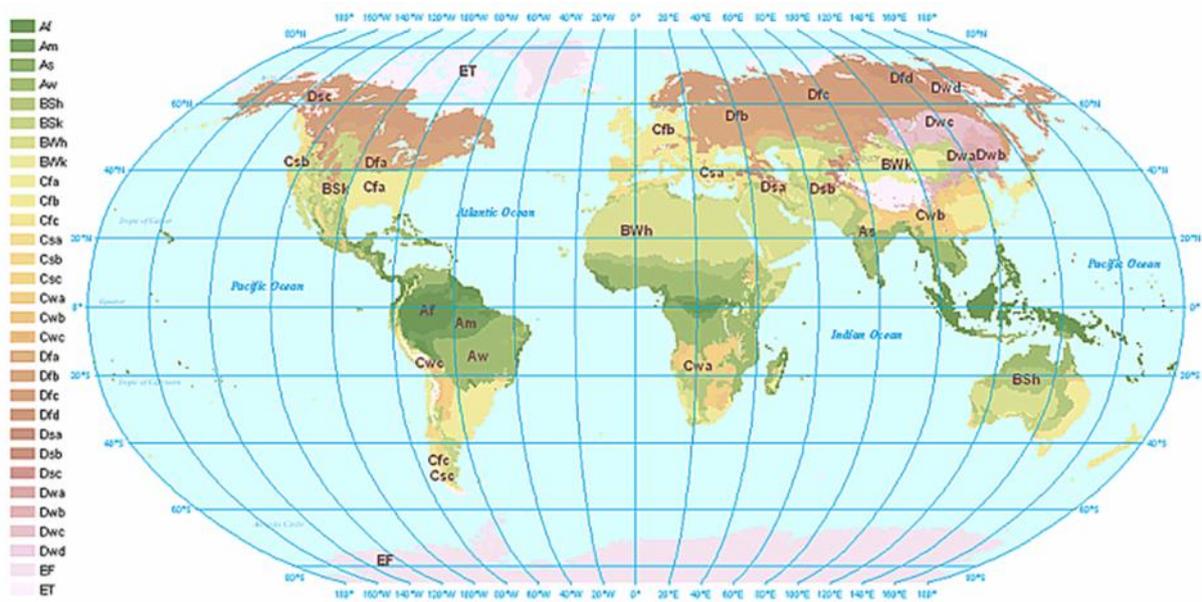
Note: Small island economies are in bold.

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' groupings 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' groupings 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' groupings 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

20-3. Does Labor Income React more to Income Tax or Means Tested Benefit Reforms?

Michael Sicsic

20-2. Optimal sickness benefits in the Principal-Agent model

Sébastien Ménard

20-1. The specific role of agriculture for economic vulnerability of small island spaces

Stéphane Blancard, Maximin Bonnet, Jean-François Hoarau

19-8. The impact of benefit sanctions on equilibrium wage dispersion and job vacancies

Sebastien Menard

19-7. Employment fluctuations, job polarization and non-standard work : Evidence from France and the US

Olivier Charlot, Idriss Fontaine, Thepthida Sopraseuth

19-6. Counterproductive hiring discrimination against women: Evidence from French correspondence test

Emmanuel Duguet, Loïc du Parquet, Yannick L'Horty, Pascale Petit

19-5. Inefficient couples: Non-minimization of the tax burden among French cohabiting couples

Olivier Bargain, Damien Echevin, Nicolas Moreau, Adrien Pacifico

19-4. Seeking for tipping point in the housing market: evidence from a field experiment

Sylvain Chareyron, Samuel Gorohouna, Yannick L'Horty, Pascale Petit, Catherine Ris

19-3. Testing for redlining in the labor market

Yannick L'Horty, Mathieu Bunel, Pascale Petit

19-2. Labour market flows: Accounting for the public sector

Idriss Fontaine, Ismael Galvez-Iniesta, Pedro Gomes, Diego Vila-Martin

19-1. The interaction between labour force participation of older men and their wife: lessons from France

Idriss Fontaine

TEPP Working Papers 2018

18-15. Be healthy, be employed: a comparison between the US and France based on a general equilibrium model

Xavier Fairise, François Langot, Ze Zhong Shang

18-14. Immigrants' wage performance in the routine biased technological change era: France 1994-2012

Catherine Laffineur, Eva Moreno-Galbis, Jeremy Tanguy, Ahmed Tritah

18-13. Welfare cost of fluctuations when labor market search interacts with financial frictions

Elini Iliopoulos, François Langot, Thepthida Sopraseuth

18-12. Accounting for labor gaps

François Langot, Alessandra Pizzo

18-11. Unemployment fluctuations over the life cycle

Jean-Olivier Hairault, François Langot, Thepthida Sopraseuth

18-10. Layoffs, Recalls and Experience Rating

Julien Albertini, Xavier Fairise

18-9. Environmental policy and health in the presence of labor market imperfections

Xavier Pautrel

18-8. Identity mistakes and the standard of proof

Marie Obidzinski, Yves Oytana

18-7. Presumption of innocence and deterrence

Marie Obidzinski, Yves Oytana

18-6. Ethnic Discrimination in Rental Housing Market: An Experiment in New Caledonia

Mathieu Bunel, Samuel Gorohouna, Yannick L'Horty, Pascale Petit, Catherine Ris

18-5. Evaluating the impact of firm tax credits. Results from the French natural experiment CICE

Fabrice Gilles, Yannick L'Horty, Ferhat Mihoubi, Xi Yang

18-4. Impact of type 2 diabetes on health expenditure: an estimation based on individual administrative data

François-Olivier Baudot, Anne-Sophie Aguadé, Thomas Barnay, Christelle Gastaldi-Ménager, Anne Fargot-Campagna

18-3. How does labour market history influence the access to hiring interviews?

Emmanuel Duguet, Rémi Le Gall, Yannick L'Horty, Pascale Petit

18-2. Occupational mobility and vocational training over the life cycle

Anthony Terriau

18-1. Retired, at last? The short-term impact of retirement on health status in France

Thomas Barnay, Eric Defebvre

TEPP Working Papers 2017

17-11. Hiring discrimination against women: distinguishing taste based discrimination from statistical discrimination

Emmanuel Duguet, Loïc du Parquet, Pascale Petit

17-10. Pension reforms, older workers' employment and the role of job separation and finding rates in France

Sarah Le Duigou, Pierre-Jean Messe

17-9. Healthier when retiring earlier? Evidence from France

Pierre-Jean Messe, François-Charles Wolff

17-8. Revisiting Hopenhayn and Nicolini's optimal unemployment insurance with job search monitoring and sanctions

Sebastien Menard, Solenne Tanguy

17-7. Ethnic Gaps in Educational Attainment and Labor-Market Outcomes: Evidence from France

Gabin Langevin, David Masclet, Fabien Moizeau, Emmanuel Peterle

17-6. Identifying preference-based discrimination in rental market: a field experiment in Paris

Mathieu Bunel, Yannick L'Horty, Loïc du Parquet, Pascale Petit

17-5. Chosen or Imposed? The location strategies of households

Emilie Arnoult, Florent Sari

17-4. Optimal income taxation with composition effects

Laurence Jacquet, Etienne Lehmann

17-3. Labor Market Effects of Urban Riots: an experimental assessment

Emmanuel Duguet, David Gray, Yannick L'Horty, Loïc du Parquet, Pascale Petit

17-2. Does practicing literacy skills improve academic performance in first-year university students? Results from a randomized experiment

Estelle Bellity, Fabrices Gilles, Yannick L'Horty

17-1. Raising the take-up of social assistance benefits through a simple mailing: evidence from a French field experiment

Sylvain Chareyron, David Gray, Yannick L'Horty

16-8. Endogenous wage rigidities, human capital accumulation and growth

Ahmed Tritah

16-7. Harder, better, faster...yet stronger? Working conditions and self-declaration of chronic diseases

Eric Defebvre

16-6. The influence of mental health on job retention

Thomas Barnay, Eric Defebvre

16-5. The effects of breast cancer on individual labour market outcomes: an evaluation from an administrative panel

Thomas Barnay, Mohamed Ali Ben Halima, Emmanuel Duguet, Christine Le Clainche, Camille Regaert

16-4. Expectations, Loss Aversion, and Retirement Decisions in the Context of the 2009 Crisis in Europe

Nicolas Sirven, Thomas Barnay

16-3. How do product and labor market regulations affect aggregate employment, inequalities and job polarization? A general equilibrium approach

Julien Albertini, Jean-Olivier Hairault, François Langot, Thepthida Sopraseuth

16-2. Access to employment with age and gender: results of a controlled experiment

Laetitia Challe, Florent Fremigacci, François Langot, Yannick L'Horty, Loïc Du Parquet, Pascale Petit

16-1. An evaluation of the 1987 French Disabled Workers Act: Better paying than hiring

Thomas Barnay, Emmanuel Duguet, Christine Le Clainche, Yann Videau

15-10. Optimal Income Taxation with Unemployment and Wage Responses: A Sufficient Statistics Approach

Kory Kroft, Kavan Kucko, Etienne Lehmann, Johannes Schmieder

15-9. Search frictions and (in) efficient vocational training over the life-cycle

Arnaud Chéron, Anthony Terriau

15-8. Absenteeism and productivity: the experience rating applied to employer contributions to health insurance

Sébastien Ménard, Coralia Quintero Rojas

15-7. Take up of social assistance benefits: the case of homeless

Sylvain Chareyron

15-6. Spatial mismatch through local public employment agencies. Answers from a French quasi-experiment

Mathieu Bunel, Elisabeth Tovar

15-5. Transmission of vocational skills at the end of career: horizon effect and technological or organisational change

Nathalie Greenan, Pierre-Jean Messe

15-4. Protecting biodiversity by developing bio-jobs: A multi-branch analysis with an application on French data

Jean De Beir, Céline Emond, Yannick L'Horty, Laetitia Tuffery

15-3. Profit-Sharing and Wages: An Empirical Analysis Using French Data Between 2000 and 2007

Noémie Delahaie, Richard Duhautois

15-2. A meta-regression analysis on intergenerational transmission of education: publication bias and genuine empirical effect

Nicolas Fleury, Fabrice Gilles

15-1. Why are there so many long-term unemployed in Paris?

Yannick L'Horty, Florent Sari

TEPP Working Papers 2014

14-14. Hiring discrimination based on national origin and the competition between employed and unemployed job seekers

Guillaume Pierné

14-13. Discrimination in Hiring: The curse of motorcycle women

Loïc Du Parquet, Emmanuel Duguet, Yannick L'Horty, Pascale Petit

14-12. Residential discrimination and the ethnic origin: An experimental assessment in the Paris suburbs

Emmanuel Duguet, Yannick L'Horty, Pascale Petit

14-11. Discrimination based on place of residence and access to employment

Mathieu Bunel, Yannick L'Horty, Pascale Petit

14-10. Rural Electrification and Household Labor Supply: Evidence from Nigeria

Claire Salmon, Jeremy Tanguy

14-9. Effects of immigration in frictional labor markets: theory and empirical evidence from EU countries

Eva Moreno-Galbis, Ahmed Tritah

14-8. Health, Work and Working Conditions: A Review of the European Economic Literature

Thomas Barnay

14-7. Labour mobility and the informal sector in Algeria: a cross-sectional comparison (2007-2012)

Philippe Adair, Youghourta Bellache

14-6. Does care to dependent elderly people living at home increase their mental health?

Thomas Barnay, Sandrine Juin

14-5. The Effect of Non-Work Related Health Events on Career Outcomes: An Evaluation in the French Labor Market

Emmanuel Duguet, Christine le Clainche

14-4. Retirement intentions in the presence of technological change: Theory and evidence from France

Pierre-Jean Messe, Eva Moreno – Galbis, Francois-Charles Wolff

14-3. Why is Old Workers' Labor Market more Volatile? Unemployment Fluctuations over the Life-Cycle

Jean-Olivier Hairault, François Langot, Thepthida Sopraseuth

14-2. Participation, Recruitment Selection, and the Minimum Wage

Frédéric Gavrel

14-1. Disparities in taking sick leave between sectors of activity in France: a longitudinal analysis of administrative data

Thomas Barnay, Sandrine Juin, Renaud Legal

13-9. An evaluation of the impact of industrial restructuring on individual human capital accumulation in France (1956-1993)

Nicolas Fleury, Fabrice Gilles

13-8. On the value of partial commitment for cooperative investment in buyer-supplier relationship

José de Sousa, Xavier Fairise

13-7. Search frictions, real wage rigidities and the optimal design of unemployment insurance

Julien Albertini, Xavier Fairise

13-6. Tax me if you can! Optimal nonlinear income tax between competing governments

Etienne Lehmann, Laurent Simula, Alain Trannoy

13-5. Beyond the labour income tax wedge: The unemployment-reducing effect of tax progressivity

Etienne Lehmann, Claudio Lucifora, Simone Moriconi, Bruno Van Der Linden

13-4. Discrimination based on place of residence and access to employment

Mathieu Bunel, Emilia Ene Jones, Yannick L'Horty, Pascale Petit

12-3. The determinants of job access channels: evidence from the youth labor market in Franc

Jihan Ghrairi

13-2. Capital mobility, search unemployment and labor market policies: The case of minimum wages

Frédéric Gavrel

13-1. Effort and monetary incentives in Nonprofit et For-Profit Organizations

Joseph Lanfranchi, Mathieu Narcy

The TEPP Institute

The CNRS Institute for Theory and Evaluation of Public Policies (the TEPP Institute, FR n°2024 CNRS) gathers together research centres specializing in economics and sociology:

- L'**Equipe de Recherche sur l'Utilisation des Données Individuelles en lien avec la Théorie Economique** (Research Team on Use of Individuals Data in connection with economic theory), **ERUDITE**, University of Paris-Est Créteil and University of Gustave Eiffel
- Le **Centre d'Etudes des Politiques Economiques de l'université d'Evry** (Research Centre focused on the analysis of economic policy and its foundations and implications), **EPEE**, University of Evry Val d'Essonne
- Le **Centre Pierre Naville** (Research on Work and Urban Policies), **CPN**, University of Evry Val d'Essonne
- Le **Groupe d'Analyse des Itinéraires et des Niveaux Salariaux** (Group on Analysis of Wage Levels and Trajectories), **GAINS**, University of Le Mans
- Le **Centre de Recherches en Economie et en Management**, (Research centre in Economics and Management), **CREM**, University of Rennes 1 et University of Caen Basse-Normandie
- Le **Groupe de Recherche ANgevin en Économie et Management** (Angevin Research Group in Economics and Management), **GRANEM**, University of Angers ;
- Le **Centre de Recherche en Economie et Droit** (Research centre in Economics and Law) **CRED**, University of Paris II Panthéon-Assas ;
- Le **Laboratoire d'Economie et de Management Nantes-Atlantique** (Laboratory of Economics and Management of Nantes-Atlantique) **LEMNA**, University of Nantes ;
- Le **Laboratoire interdisciplinaire d'étude du politique Hannah Arendt** – Paris Est, **LIPHA-PE**
- Le **Centre d'Economie et de Management de l'Océan Indien**, « **CEMOI** », équipe d'accueil n°EA13, rattachée à l'Université de la Réunion

The TEPP Institute brings together 223 researchers and research professors and 100 PhD students who study changes in work and employment in relation to the choices made by firms and analyse public policies using new evaluation methods.