Chance in the Challenge – Positive Environmental Externalities in the Tourism Sector through COVID-19

Ann-Katrin Voit[1]*, Imke Rhoden[2]

[1]FOM Hochschule für Oekonomie und Management, Leimkugelstraße 6, 45141 Essen

[2]Institute of Energy and Climate Research – Systems Analysis and Technology Evaluation, Forschungszentrum Jülich, Wilhelm-Johnen-Str., 52428 Jülich

*corresponding author

1. Introduction

“The gladdest moment in human life is a departure into unknown lands.” This quote by Richard Burton describes the feeling of many travelers, especially from industrialized countries with a high wage level and the budget to travel. For most people, travelling for vacation, work, or other reasons is part of their everyday life.

With rising numbers of people travelling, the demand of CO_2 intensive transportation such as flights, car rides and cruises have risen significantly in the past years. It can be seen that the ongoing development of countries in the past years has led to higher tourist activity not only inside but also outside their country. As more people are travelling around the world, an increase in economic activity can be observed that is caused by tourism.

Tourism is an important factor for many economies. There exists a wide range of factors that influence the possibility for a country of being a tourist destination, such as average temperature, coast lines or mountains, overall security level, political stability and many more (Qiu et al. 2020, p. 102994). The relevance of tourism can be measured by the Tourism Direct Gross Domestic Product (TDGDP). In the European Union, the highest share of tourism from the GDP is created by countries such as Croatia, Italy, Malta, Spain, Portugal, Greece, or Cyprus (UNWTO, 2021). Those countries are more dependent on tourists and economic activity that is caused by tourism. The negative side of tourism is the rising numbers of CO_2 emissions that are produced by the tourism industry and especially by the transportation used to reach the destination and used while staying at the destination itself.

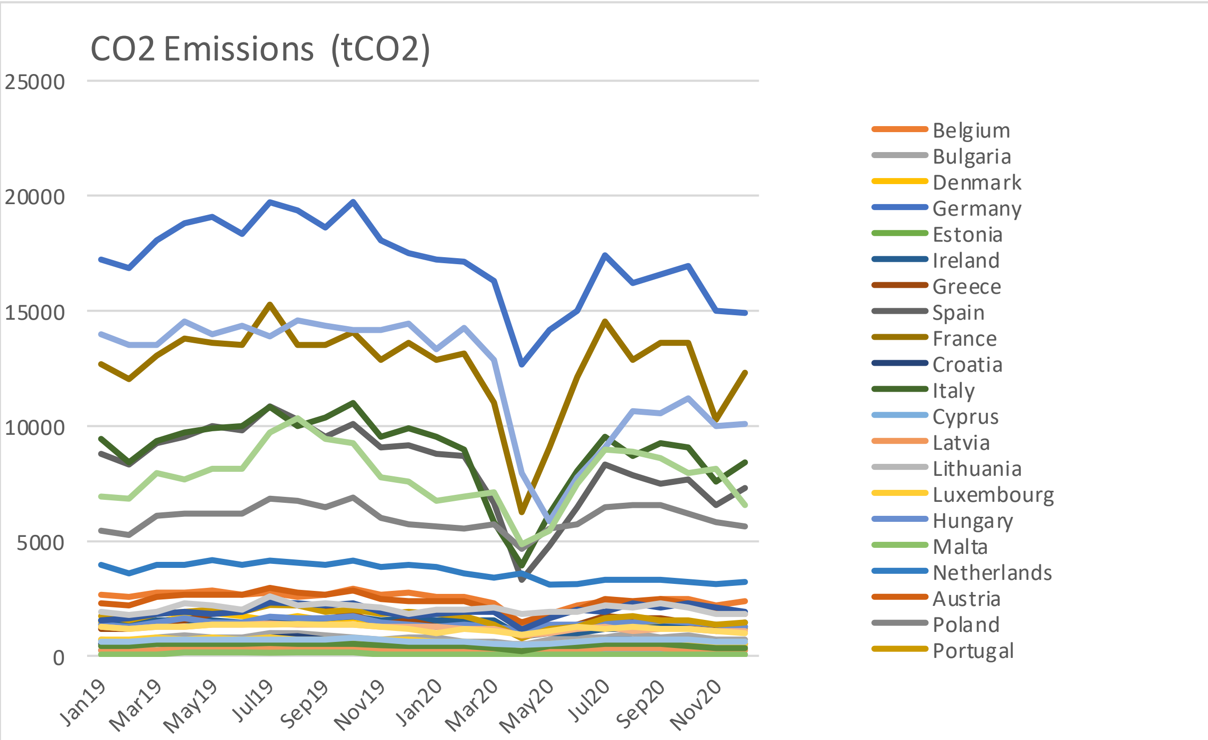
The more people tend to travel, especially while using CO_2 intense transportation options, the more CO_2 will be produced from the tourism sector and increase the overall CO_2 production of a country.

A huge change in the touristic demand of mainly all countries happened with the coronavirus pandemic. It affected all countries around the globe and all economies in different sectors and is one of the main challenges these days not only economically but also politically. It has dramatically changed the daily life of many people and caused a huge impact on the GDP and other economic factors such as employment rates, the average propensity to consume, and the savings. Like an external shock, the coronavirus pandemic shows a similar decline in demand for goods in the tourism sector as can be observed as a result of wars or natural disasters (Jin et al., 2021, p. 1). COVID-19 also changed the travel patterns in many countries. Due to globalization the overall trend before the coronavirus pandemic lead not only to more global interaction in trade of capital or goods, but also to a higher and easier available travel worldwide and a general increase in supply and demand around the world. Over the recent years, many countries have opened their borders for tourists, reduced travel restrictions, and simplified visas to benefit economically from tourism. While tourism can be economically very beneficial, it has also negative sides with environmental strain, increasing amounts of waste and a higher need for resources like water or energy as well as CO_2 emissions caused by travel.

The development of the CO_2 emissions is closely linked to the spread of the coronavirus, as Figure 1 shows. Focusing on data from the European Union, nearly every country had less CO_2 emissions when COVID-19 hit Europe in March 2020. This effect occurs globally and can therefore also be seen world-wide (UNWTO, 2021).

When reviewing the data and bringing together that most European countries as well as most countries worldwide had huge travel restrictions for their countries from March 2020 to May 2020, the result is not surprising. It can be seen that the CO_2 emissions decreased drastically, especially in countries where the amount of people travelling is high and / or the amount of tourists is high such as in Germany, Greece, France and Spain. This shows drastically how CO_2 emissions change over time when less or no travel is possible, and huge positive externalities for the environment can be observed as well as less pollution overall. Figure 1 indicates that some countries that are already on a high level when it comes to CO_2 emissions have a significant drop while other countries that were on a low level have fewer declines in their emissions.

Figure 1: Monthly CO_2 emissions for European countries 2019-2020.



Source: Own calculations, Eurostat 2021, International Carbon Bank and Exchange (ICBE) 2021, Thompson & Taylor 2019, Revesz 2009, Bundesverband der deutschen Bioethanolwirtschaft e.V. (BDBE) 2021, CoolConversion.com 2021.

For the most part, the analysis of the tourism sector and sustainability is only done by comparing the environmental effects in measuring produced additional waste, water consumption and energy, but not with CO_2 intense fuels that are used for transportation. Transportation here means the amount of kerosene, diesel, or gasoline emissions that are caused by travelling. Tourists mainly can choose between four ways of travelling: by car, train, airplane, or ship.

The amount of tourists travelling by trains is low (Eurostat, 2021) so the overall shares of these other transportation forms that are higher in CO_2 emissions are dominant (Eurostat, 2021). It is clear that COVID-19 has shown how unsustainable the tourism industry is and that there is a need for policy implications to change this ongoing environmental pollution that is caused especially by that industry (Gronau and Groß, 2019, p. 181).

The aim of this paper is to explain these effects more into detail and point out relevant policy implications for decision makers in the long term. It can likely be assumed that in post-COVID-19 times tourism will rise fast (Kiefl and Kagelmann, 2021, p. 289) and then emissions will be on the previous level. This needs to be taken into account by policy makers when planning the future development of the tourism sector or planning to change the tourism sector to be more sustainable. Sustainability and a change in industries will be one of the main challenges in the future to fulfil the needs for the next generations and therefore actions need to be taken now. The paper explains the effect of the coronavirus pandemic and indicates the negative effects that tourism has created in the past.

2. Importancies

The world has shifted priorities in the last years to fulfill the needs of sustainability (Barbier and Burgess, 2017, p.3). Sustainability is no longer a topic that only belongs to environmental decisions but influences many other sectors, goals, and industries in economics, society, and the everyday life (McKinnon et al., 2010, p. 4).

To fulfill the needs of the world to reduce the burden of excessive exploitation, depletion, and unrecoverable destruction of the planet, the United Nations took action and mapped global goals that affect and represent the needs of all countries (Mastrángelo et al., 2019, p. 1115). These goals can be seen as an overall action plan to allow the recovery and may also make the rescue of the planet to a top priority not only from an environmental point of view but also from a social point of view (Barbier and Burgess, 2017, p.3). It turns out, however, that the positive externalities on the environment cannot be observed to the same extent across all countries and regions and are strongly influenced by local tourism characteristics. Clusters and hot spots can be observed that are experiencing a particularly positive development, whereas other areas show less improvements (Newsome, 2020, p. 2).

The United Nations implemented those main goals on 25 September 2015 with the 2030 Agenda for Sustainable Development and with it the Sustainable Development Goals (SDGs) (Barbier and Burgess, 2017, p.1). The SDGs consist of 17 goals and address 169 different targets in total to meet the global change for a sustainable development (Barbier and Burgess, 2017, p.3). These goals need to be implemented by the member states of the UN, the civil societies and the private sector a well.

The goals have a wide range of topics and key factors, but have one focus that is highly important for the tourism industry: One of the needs to achieve the SDGs will be the drastic reduction of CO_2 in every industry, also in the tourism and transportation sector. The need of change in the industry is therefore a global goal and needs to be addressed on the political agenda of every country as well as the European Union (Laesser et al., 2021, p. 23).

As mentioned in chapter 1, the transportation used for tourism produces high amounts of CO_2, so it can easily be seen that the SDGs and the demand for kerosene, gasoline, or diesel do not follow the same path of sustainability. There is a high need for action plans that help to develop a sustainable tourism industry to reach the goals by maintaining the economic goal of employment, sales, and revenues at the same time (Laesser et al., 2021, p.18).

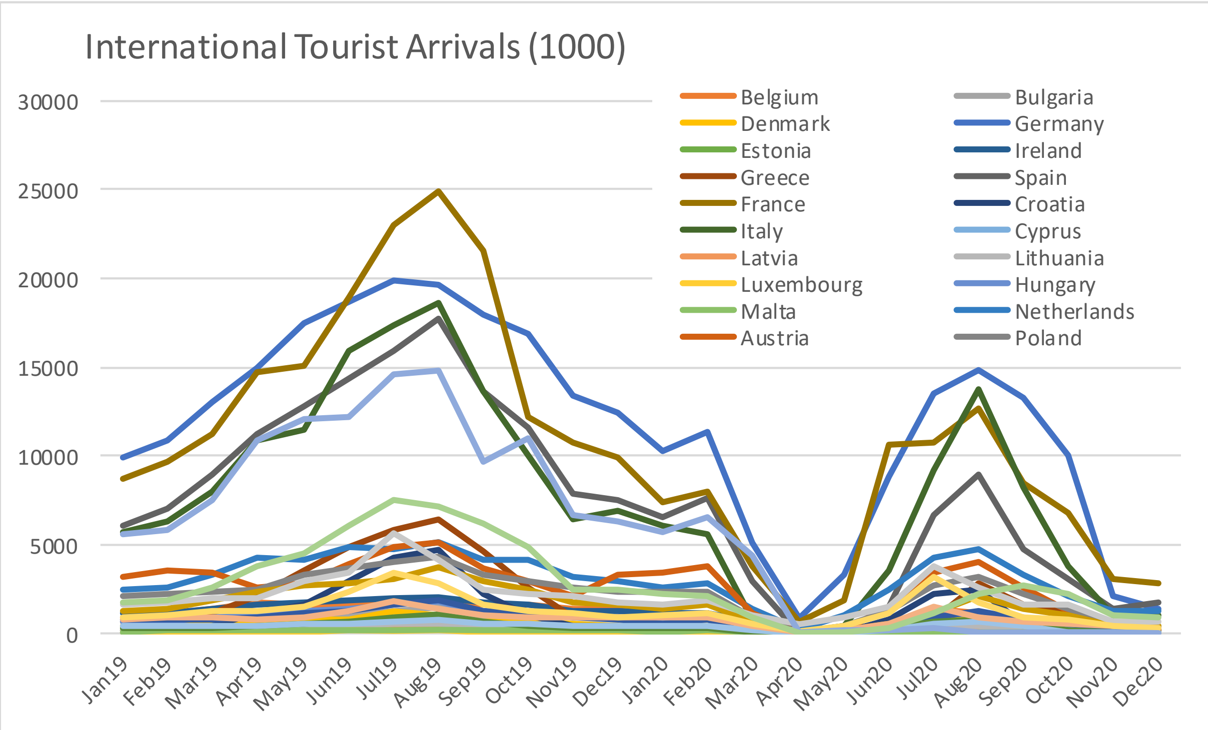
First of all: How important is the tourism sector in Europe? The following figure 2 shows the monthly international tourist arrivals in different European countries from January 2019 until December 2020.

As the coronavirus pandemic affected most countries in Europe starting from March 2020, the development of the tourist arrivals shows a significant drop during that time. Other countries like China already suffered from the pandemic starting from the end of 2019, but in Europe we see a time lag due to the development of the infections with the virus worldwide.

It has to be taken into account that Europe has generally more arrivals in the summer and a typical rise of tourist arrivals from spring to summer and then a drop in autumn and less tourists in winter due to factors such as temperature, days of rain, and vacation times for pupils in many countries (Kulinat, 2007, p. 108). The first effects of the coronavirus pandemic on international tourist arrivals happened at the beginning of 2020, because the virus was first monitored in Asia and therefore the first developments also affected Europe as it is one of the favorite travel destinations for Asian tourists (Pechlaner and Eichstätt, 2006, p. 85). Since March 2020 nearly all countries have been reached by the virus and therefore started to close their boarders and implement travel restrictions to take action against the spread of the virus.

Figure 2 shows that the amount of tourists that visit European countries is very high and therefore the economic importance of tourism is obvious for many countries. The highest numbers of international tourist arrivals are monitored in France, Germany, Italy, and Spain.

Figure 2: Monthly international tourist arrivals in European countries 2019-2020.



Source: Own calculations, Eurostat 2021, UNWTO 2021, Central Statistics Office Ireland 2021.

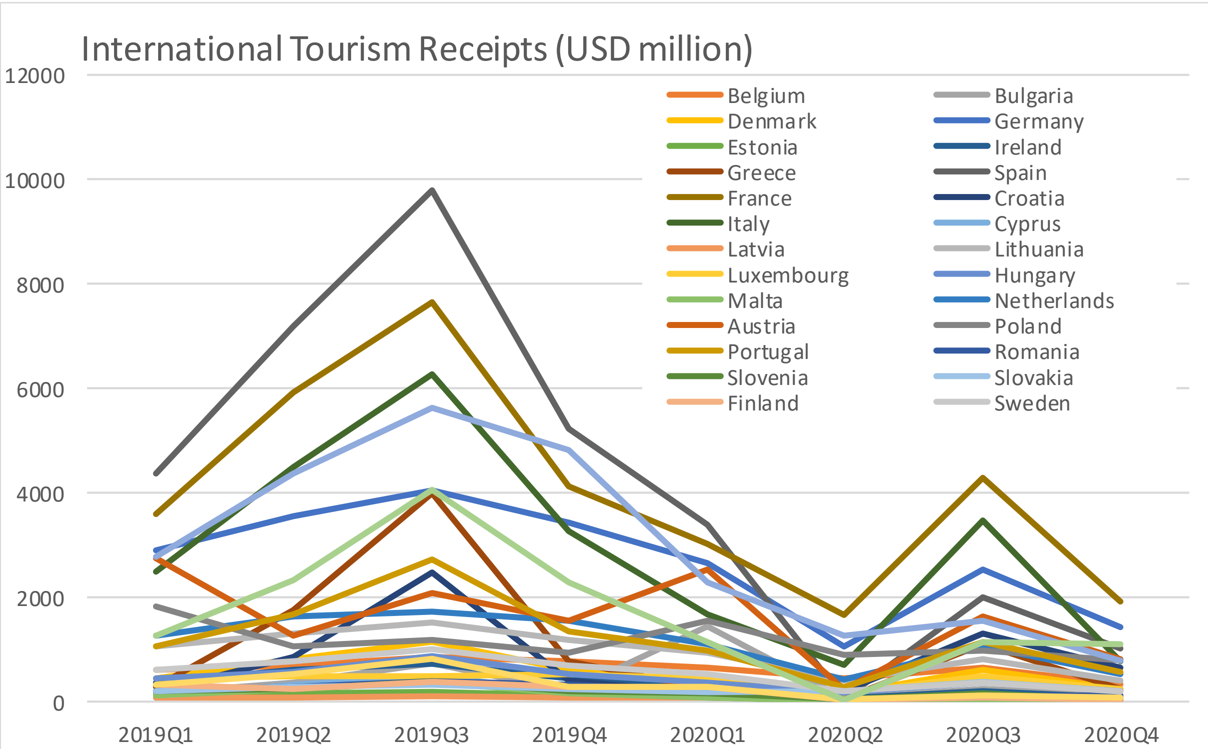
It can be seen that the European tourism, as well as the tourism in most other countries, stood still in April and May 2020. Due to travel restrictions and governmental decisions to close tourism sports such as hotels, restaurants, monuments and to restrict tourists from abroad to enter the country, the international tourism arrivals were close to zero for the first time ever. This development not only happened in Europe but applies for most countries around the world that have a significant tourism sector (Fotiadis et al., 2021, p. 1).

While analyzing the tourism industry, the monetary effect of spending can be monitored by the international tourism receipts. The international tourism receipts are expenditures by international inbound visitors and include any payments to national carriers for international transport such as airplane tickets, train tickets, or taxi rides. These receipts also include any other payments made for goods or services received in the destination country such as restaurant spendings or entry tickets.

When travel restrictions happened due to the coronavirus pandemic, not only the directly linked companies such as hotels, restaurants, rental car or airplane businesses suffered but also the connected industries such as souvenir shops, event organizers, and many more.

How big is this monetary effect? Figure 3 shows the quarterly international tourism receipts from European countries that were spent in the years 2019 and 2020, meaning before and during the pandemic. It can be seen that the spendings have in general the same developments over the year as the international tourist arrivals in general. The highest amount is spent in Spain, but also France and Italy receive a huge contribution to their GDP from tourism spending.

Figure 3: Quarterly International tourism receipts in European countries 2019-2020.



Source: Own calculations, UNWTO 2021, National Statistics Office Malta 2021, Statistics Poland 2021.

As already explained, the pre-COVID-19 season for tourist activities in Europe in general has a rising activity in spring, the peak in summer, and then a dropping activity in autumn and less activities in winter. Figure 3 divided the year into quarters. As Q2 of 2019 shows, this is the rise of touristic spending with the month April to June. The months July to September, represented by Q3, include the other months with high touristic spending. If Q2 and Q3 are compared with the COVID-19 year 2020 with travel restrictions and governmental entry bans, the spending dropped significant in all countries to a particularly low level in Q2 of 2020. Q3 of 2020 and Q4 of 2020 show a huge decrease of tourism spending because in many countries travel restrictions still applied in this period, some countries had also travel bans or quarantine requirements for tourists and the local population when returning from certain countries.

Contrasting the negative effects caused by the pandemic, there also occur other externalities which exhibit positive developments, especially from an environmental point of view. Less travel also means that less greenhouse gases are emitted, less littering of vacation areas can be observed, and the natural habitats of animals recover through reduced tourism (Wieckowski, 2021, p. 9). These findings are also important when focusing on the effects that the coronavirus pandemic caused on the travel industry.

The loss in GDP is high for many countries because of fewer visitors and therefore fewer receipts (Sigala, 2020, p. 313). Uncertainty is one of the reasons why sensitive industries such as tourism can be affected very fast and with a high intensity, as tourism is psychologically an activity that reacts fast and intense in the demand to negative events (Pierburg, 2020, p. 26). It also shows this high changes from the perspective of the demand, because it can be reduced to zero when a development or an event happens that influences the stability of the destination or the circumstances in a negative way (Pierburg, 2020, p. 26). How uncertainty is seen by demanders is highly individual and can be understood as the risk that influences emotions, decisions, and behavior. The perception of risks in general is important for human decision-making and also applies for the decision if someone books a vacation, stays at home and decides about the destination itself (Betsch et al., 2020, p. 18). For the individual behavior emotions such as fear play an important role as well as control about a situation or the possibility of being threatened (Betsch et al., 2020, p. 18). COVID-19 may trigger also these psychological factors that lead to the decision of tourists to reduce or cancel their travel or shift the touristic activity from the international to the domestic market (Kiefl and Kagelmann, 2021, p.284).

Similar developments can be seen for other epidemics such as MERS and SARS, but also when a natural disaster happens such as an earthquake, a hurricane, or an ecological disaster. When these shocks occur, the touristic demand decreases fast or shifts to other countries or regions with higher stability.

It can be seen that the tourism industry is confronted with a sensitive demand – when events happen that lead to uncertainty, the demand decreases quickly (Betsch et al., 2020, p. 18). Furthermore, the tourism industry in general is an industry that produces high CO_2 emissions and therefore needs to change to fulfill the world's needs of a sustainable environment and less pollution.

As a result of these considerations in the interconnectedness of CO_2, traveling and tourism and the effects of the coronavirus pandemic, the following hypothesis is formulated to be tested: The reduction in CO_2 emissions can be associated with the reduction in tourism that is caused by COVID-19.

3. Research Methodology

To test the hypothesis, monthly data about CO_2 emissions and tourism activity is obtained from Eurostat and the UNWTO. For the CO_2 emissions data, the dataset about supply and transformation of oil and petroleum products provides information about transport fuels relevant for traveling that can be accounted to tourism. Among all products, aviation gasoline, motor gasoline, gasoline-type and kerosene-type jet fuels, other kerosene products, and road diesel are selected. In a second step, CO_2 emissions from combustion of those fuels are derived by connecting the CO_2 emission potentials to the amounts in the dataset, thus calculating the CO_2 emissions from travel/transport (compare figure 1). It has to be stated that these oil and petroleum products and their resulting emissions are used under the assumption that those fuels can be attributed to tourism-related activity, but they are not exclusive as the mentioned products are also used in transport and trade of goods and people not consuming the products with the aim of tourism.

For tourism data, the Eurostat database about arrivals at tours accommodation establishments is used together with the UNWTO Tourism Data Dashboard that additionally provides data about the international tourism receipts. Both datasets account for tourism related stays in the European countries, proxying the amount of tourism and the importance of tourism by accounting for money spent during those travels (UNWTO, 2021).

Data is obtained on a monthly level for CO_2 emissions and tourist arrivals and on quarterly level for the tourism receipts (compare table 1 for a description). The period from 2019 and 2020 is covered as these data contain a year without distortion in travel activity by governmental measures resulting from the COVID-19 pandemic and a year where measures to counteract spreading of the pandemic have exuded full effect. At the beginning of 2020, awareness of COVID-19 and its implications started spreading worldwide, resulting in the first nation-wide restrictions in April that affected countries all over the world (UNWTO, 2021).

Overall, the data used for modeling encompasses 24 months, where missings in Eurostat and UNWTO data are filled from further national databases. In cases where no data could be received, missings are imputed by inserting a value following the general mean trend of all European countries of the dataset. Thus, in the final dataset there are no missings for the 29 European countries used. Further European countries are omitted as there has not been enough data or no data at all.

Table 1: Data description.

Short Cut	Variable	2019			2020		
		Min	Max	Average	Min	Max	Average
CO2	CO2 emissions derived from transport, proxied via transport fuels (aviation gasoline, motor gasoline, gasoline-type jet fuel, kerosene-type jet fuel, other kerosene products, road diesel) in tons (Eurostat: NRG_CB_OILM)	82.6	19716.9	3756.6	44.6	17376.4	3126.8
ITA	International tourism arrivals, proxied by international arrivals at tourism accommodation establishments in 1000 (Eurostat: TOUR_OCC_ARM)	67.8	24913.4	3385.4	0.5	14883.5	1385.2
ITR	International tourist receipts in million US Dollar	70.4	9790.4	1495.5	13.6	4298.5	656.9
ID	Country identifier	1	29	-	1	29	-
month	Month identifier	1	12	-	1	12	-

Sources: Own calculations, Eurostat 2021, International Carbon Bank and Exchange (ICBE) 2021, Thompson & Taylor 2019, Revesz 2009, Bundesverband der deutschen Bioethanolwirtschaft e.V. (BDBE) 2021, CoolConversion.com 2021, UNWTO 2021, Central Statistics Office Ireland 2021, National Statistics Office Malta 2021, Statistics Poland 2021.

To account not only for the time variation in the data illustrating the impact of COVID-19, an additional spatial effect is included. The spatial effect accounts for the first law of Tobler (1970) and included neighborhood effect. Methodologically, this follows a spatiotemporal setup, where time and space are allowed to vary across the data, contributing to an increased explanatory content. Additionally, the inclusion of the spatial effect is able to exhibit if there exist regional differences in the strength of the effects. In this model, it can be stated if there exists regional dependency on whether certain regions are affected differently than others regarding the effects of COVID-19 on tourism, and thus, CO_2 emissions.

The model's covariates are modeled non-parametrically and it is accounted for heteroscedastic errors that show an improved fit for the data. The estimated model (model 1) follows contains the two tourism variables, a time effect and a spatial effect containing a weighted neighborhood matrix of all countries.

$$CO2 \sim N(\mu = \rho_\mu, \exp(\sigma) = \rho_\sigma)$$

$$\rho_\mu = \beta_0 + f_1(ITA) + f_2(ITR) + f_3(month) + f_4(ID)$$

$$\rho_\sigma = \alpha_0 + g_1(ITA) + g_2(ITR) + g_3(month) + g_4(ID)$$

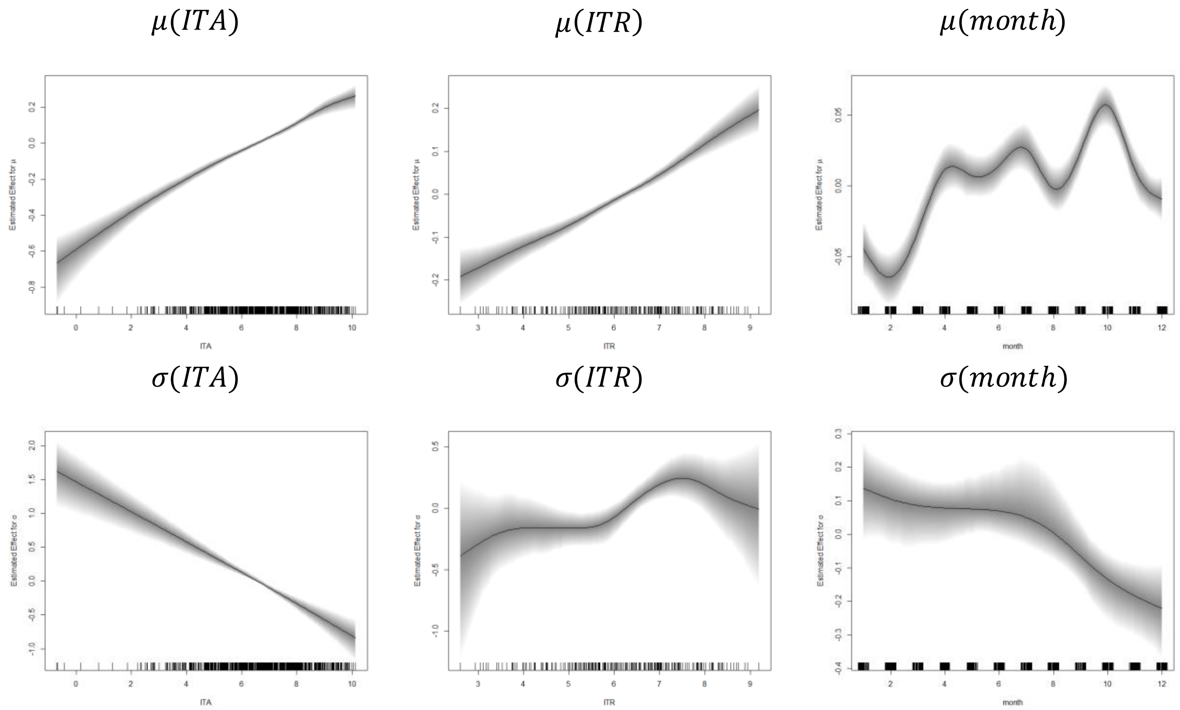
It is assumed that the model follows a Gaussian distribution where $f_i(.)$ and $g_i(.)$ are functions for applying penalized splines to the data. The models also contains a Markov random field prior with corresponding penalty matrix for neighboring countries that accounts for the spatially dependent structure of the regions and thus for the geographical relations between countries. The results of the model are produced by applying full-Bayes estimation procedure via the R-package BAMLSS (Umlauf et al. 2018, 2019).

Different model specifications, among them a model containing an additional year effect are tested, but adding a year effect does not contribute to the explanatory content and is thus omitted. The monthly effect is kept for reflecting the impacts of COVID-19, as monthly variation in the data is much clearer. However, as more data is collected, an additional effect for the year or for region-specific governmental restrictions on mobility ("lock-down") may add to the model's potential to exhibit significant effects. Additionally, a reduced model where ITR is omitted is estimated (model 2), as ITA and ITR can be understood to approximate similar effects.

4. Results

The model's results are illustrated in figure 4, the upper row giving the estimated means (μ) for the covariates and the lower row presenting the effects for the errors (σ).

Figure 4: Estimated effects of the spatiotemporal model 1.

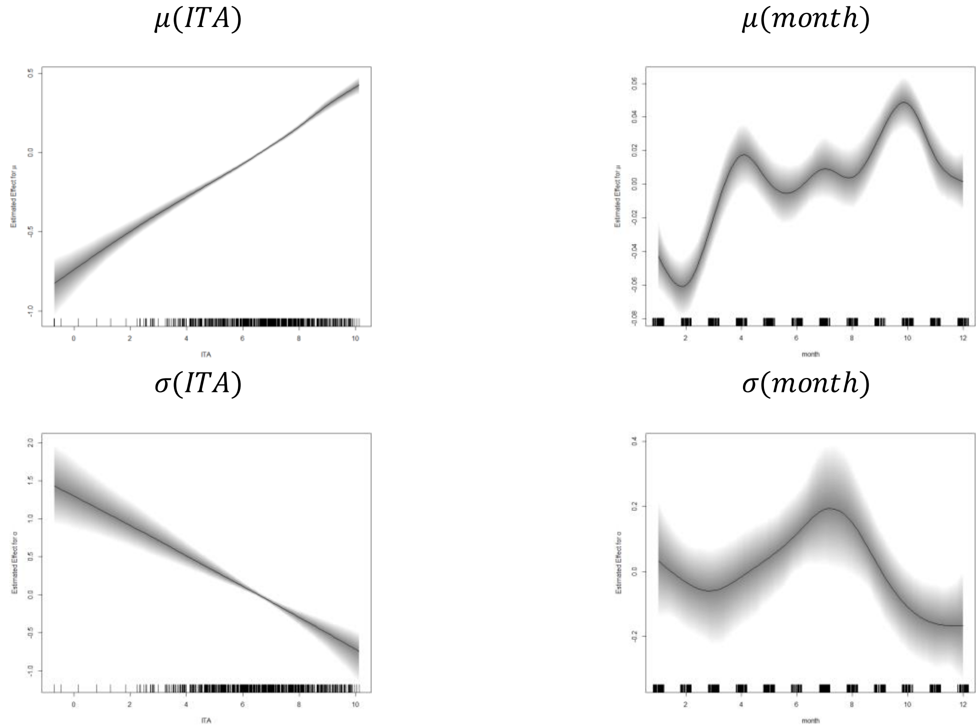


Source: Own calculations.

For all covariates, the estimated effects are 'significant', as the 95% credible intervals do not constantly contain zero for all regions. The rug plots included contain information about the regional density of the data, as each tick corresponds to a country, starting from countries with low absolute values of the covariate on the left up to countries with high absolute values for the respective covariate on the right. Where the ticks are rather separated, data availability is sparse and the interpretations for regions in those value ranges are made to be with caution. This is also reflected in wider credible intervals. The model fit is reasonable, as the estimated functions do not vary a lot and exhibit clear trends.

For the covariates ITA and ITR, there are clear positive effects estimated on CO_2. The mean functions are nearly linear, stating clear correlations. The higher ITA, meaning the more tourism arrivals in accommodation establishments occur, the higher the CO_2 emissions by transport fuels. Additionally, the higher the ITR, the amount of spending at tourist locations, the higher the CO_2 emissions. Still, the effect for ITR increases slower, meaning that the effect of ITA is more pronounced. This corresponds to the nature of the data, as once a travel to a tourist location has been made, the amount of spending which could also approximate the duration of the stay, does not matter that much. In addition, both variables are linked, which suggests omitting one. Estimations with a reduced model without ITR strengthens the positive effect of ITA on CO_2, showing a slightly increased relation (compare figure 5). The model's deviance information criterion also benefits slightly, so that the second model specification (model 2) proves to be the preferable one.

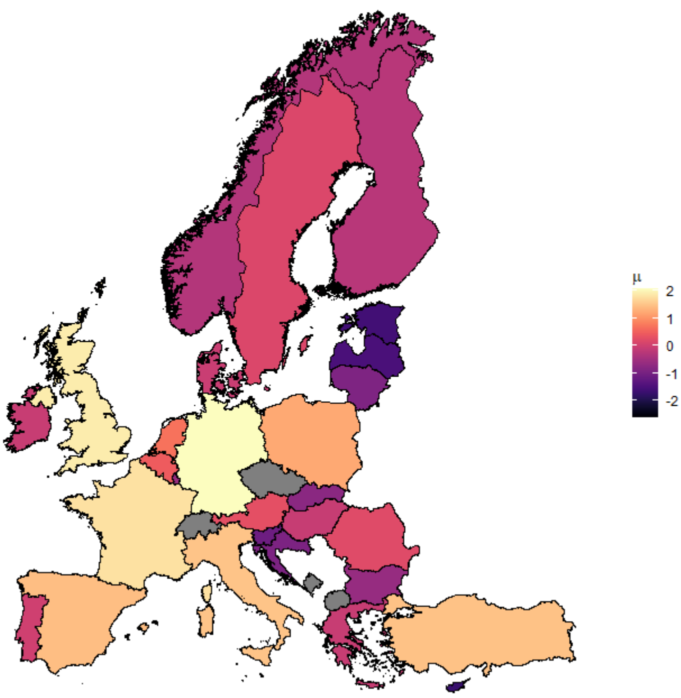
Figure 5: Estimated effects of the spatiotemporal model 2.



Source: Own calculations.

The error term's variances are rather high, which is true for ITA (as well as for ITR). Also, there is high seasonal variability. Generally, these sigma effects are reasonable when looking at the variability contained in the data itself, as the impact produced by COVID-19 is exceptional and disrupting the usual seasonal tourism variability pattern (less tourism in winter, high tourism activity in summer).

Figure 6: Estimated spatial residual effect of model 2.



Source: Own calculations.

Looking at the model's spatial residuals (compare figure 6), the effects estimated are mostly close to zero and vary considerably across regions. Aside the slightly negative effects of Scandinavia and south-eastern Europe, with exceptions of Portugal and Ireland, most other countries exhibit positive values. Especially for Germany, France, and the United Kingdom, there seems to be additional variation in the residuals that could prove valuable for the explanatory content of the model. Still, these are the regions with the highest CO_2 emissions of the dataset, so the high residuals can be attributed to that. Another remark considering the spatial dependency not only via heterogeneity, but also via autocorrelation, is the Moran I statistic (Moran 1950). Testing the data results in a state of relative spatial inverse correlation, meaning that the degree of dependency is low. This can be reasoned by the COVID-19 pandemic affecting all countries similarly and at a similar point in time, as well. All countries are affected and released governmental resolutions as a response to the pandemic rather similarly (as far as time and general severity are considered). This is also reflected in the model's results.

Generally, the estimation outcomes point into a clear direction – the positive effects of tourist arrivals on the amount of CO_2 emissions also means that a significant decrease in tourism and travel activities during the COVID-19 pandemic contributed strongly to the decrease in emissions. Consequently, transport and travel options with lower CO_2 emission potentials could provide a crucial instrument for accounting for the SDGs and, not at last, climate change.

5. Policy Implications

Pre COVID-19 tourism was a significant factor and driver when it comes to GDP and economic development for many countries, including European ones (Fotiadis et al., 2021, p.3). With steady growing tourism markets the importance has risen constantly over time for many European countries as one of the major drivers of economic development and growth. Most European member states have steadily benefitted from attracting tourists around the globe and being an attractive destination with rising receipts from the tourism spending.

The coronavirus pandemic has shown how sensitive the tourism sector reacts to shocks (Fotiadis et al., 2021, p. 13). One could say that the tourism sector replies directly to any event or development that could be classified as negative and reacts with a decrease of touristic arrivals and a strong elasticity in demand of touristic offers (Sigala, 2020, p. 312). This can also be seen when a country suffers from a terrorist attack, a natural disaster, or a political coup as already mentioned. The impact of the coronavirus pandemic was so strong because it released directly restricting effects from the destination countries as well as the departure countries. These effects, along with the major factor of uncertainty have led to a dramatic decrease in tourism activity in Europe and also around the world.

At the same time the coronavirus pandemic has shown the significant negative impacts that tourism creates by triggering decreased CO_2 emissions and other positive environmental factors that lead to a recreation of the nature. The fact that increasing touristic activity in many countries could develop negative effects of the environment is not new but often kicked into the long grass because of maintaining and creating (new) jobs, the secondary, and tertiary industries that benefit from tourism and the strategic development for the future (Lasser et al., 2021, p. 7). The coronavirus pandemic has forced the countries to deal with the negative effects because of its unambiguousness and obviousness in the past 18 months (Sigala, 2020, p. 312).

What will the future in tourism bring and how can the EU react to it? On the one side, policy makers need to focus on the recreation of the tourism sector to help European countries to develop their economic activities back to the pre-COVID-19 level with rising employment rates, higher tourism spending, and more activity in general (Laesser et al., 2021, p.8). All economies in Europe as well as on the global level suffered significantly from COVID-19, created huge debts, and faced higher unemployment as before. Rising economic activity in any sector can help paying back the debts, save and create jobs, and bring back prosperity, economic security, and a future competitive ability with innovation, research, and development.

On the other side, policy makers need to take the lesson from the increasing environmental strain that is released by the tourism sector due to the CO_2 intensive transportation. Policy makers should learn from the effects during the coronavirus pandemic and development future action plan on how to change the tourism industry in their countries to reduce emissions and fulfill the need to a significant change of the sector (Laesser et al., 2021, p.15). Therefore, it is necessary to change especially three main parties that are responsible for a major part of emissions: The flight industry with kerosene emissions, the cruise industry with heavy oil and diesel, as well as the car industry in the cities with petrol and diesel. This needs to be addressed for the ongoing touristic economic activities as well as the future developing economic activities that will be a result from increasing numbers of tourists in the future.

It could be an overall solution to create action plans, especially for the major attracting cities, harbors, or tourist areas to be reached by public transport and may prohibit any access for non-locals by car. Therefore, it will be necessary to have a reliable and fully developed public transportation network with low prices or for free, possibly with cross-subsidization by a tourism tax such as a visitor's tax that allows the tourists to enter any public transportation without costs or with high subsidies. In some cities it can also be beneficial to provide bikes for free or at lower costs to have an alternative for transportation on a local level.

At the same time it is important to focus, not only on the primary sector of the tourism industry but also on the secondary and tertiary sector which include e.g. industrial laundries, wellness suppliers, or excursion providers. They are dependent of the tourists and increase their economic activity simultaneously with increasing numbers of tourists. At the same time, they also cause negative externalities with increasing emissions, waste, water, or energy demand. Therefore it is vital that also industries that are highly linked with tourism are part of the sustainable change and not only direct industries are addressed. The countries need to focus on the tourism industry with all its linked industries and include the connected industries in their sustainable action plan to stimulate investments in sustainable ways of production, e.g. e-cars, energy, and water reduced laundry systems. When considering the tourism industry as a whole, the negative effects can be reduced and sustainability goals can be reached.

How can we deal with the findings and what is the best way to internalize the costs for sustainability? Policy implications can be directed from here to the (national) governments for reducing environmental pollution. As climate change is a global issue that affects all countries, including those who profit from tourism, CO_2 emissions should be reduced in an efficient and feasible way on a global scale. For emission reduction, two different approaches can be used: Arthur Pigou's tax approach as well as Ronald Coase's theory of certificate trade to deal with environmental pollution.

According to Coase's theory of internalization, tangible solution mechanisms are to be worked out that enable cost-benefit considerations. Which region can achieve the highest level of positive environmental development at which costs? Should a redistribution mechanism take place here in order to achieve an overall improvement of the environment, whereby individual regions internalize less from an economic point of view due to higher costs and support other regions that can exploit high potential for improvement with the use of fewer monetary resources (Keppler, 2010, p.1)? For the EU that means the local governments have to work hand in hand with the EU institutions and internalize the negative effects that are caused in some countries by all members. Additionally, this means the EU redistributes final resources in order to achieve overall environmental goals that are set by the EU. Some regions that face a heavy burden from tourism environmentally will get access to subsidies to modernize and improve their CO_2 levels.

Arthur Pigou addresses a global tax solution with a system of a progressive tax. A Pigou tax is a specific case of incentive taxes, i.e. taxes that have less of a fiscal purpose than primarily serve to steer behavior in a targeted manner. Pigou taxes only serve to correct a market failure by internalizing external effects and therefore help to reduce the amount of CO_2 emissions that are produced (Kallbekken et al., 2011, p. 53). The approach from Pigou would mean the regions with higher CO_2 levels have to take a tax from the tourists and use this tax to internalize the CO_2 emissions, e.g. by investing in modern transportation systems. The higher the pollution level and the environmental strain, the higher the tax needs to be to fulfill that goal.

Forms of Pigou tax can be ultimately classic tax solutions such as an environmental tax or tourism tax that are to be compared with a negotiated solution based on pollution certificates as a solution mechanism. This is intended to weigh up the efficiency of the two methods. Policy implications to handle the global CO_2 emissions can be made afterwards.

In addition to that it is obvious that most or many European countries need a sustainable tourism management system that allows touristic activity and a beneficial economic development for the shareholders and stakeholders in the countries (Laesser et al., 2021, p. 17). The economic benefits of tourism are clear and the aim is not to forbid tourism or decrease activity but to structure tourism-caused problems, address them, and create solutions to bring both overall goals together: A sustainable economy that saves and fulfill the needs of future generations and creates stable revenues for the shareholders and stakeholders (Yeh, 2020, p. 188).

6. Conclusion

The earth is what we all have in common – a quote written by American author Wendell Berry that sums up the importance for institutions, countries, politicians, decision makers, and society to take advantage of new technologies and innovation to fight climate change today.

The responsibility of a sustainable development of the economy and everyday life is an obligation, especially for industrialized countries such as European countries with access to research, innovation, and new technologies.

The coronavirus pandemic as a shock on the tourism industry has shown a significant impact on CO_2 emissions. One could say that not only measured by transportation emission, but also for wildlife and nature in general. With less tourism due to COVID-19, positive externalities occurred.

The EU should take the pandemic as a lesson that has shown how high the environmental damage is that is caused by the tourism industry when it comes to CO_2 emissions. Without COVID-19 it may have not been uncovered how much the CO_2 emissions are correlated with tourism in general and how fast the emissions drop when the touristic activity is at the lowest level.

When developing back to the pre-COVID-19 level, the EU should take action and start to work on action plans and sustainable tourism management systems to work on two major goals: reducing the ongoing CO_2 emission in already established tourism industries in the member states and make plans for the developing touristic destinations to be sustainable from the beginning. The Pigou or Coase approach can be used here to find a way to internalize the need to develop a more sustainable tourism for the future and a financial system behind it.

The overall goal, besides generating less CO_2 emissions, should be a more sustainable industry that will be beneficial for the present generation as well as future generations with inter-generation fairness and a stable environment. This can be reached by addressing the problem on a supranational level because then it is not dependent from current politics or political developments but from the EU as a leading institution that guides the member states into a more sustainable future with taking more responsibility for the generations demand and behavior.

7. List of Literature

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8. Annex

Table A1: Estimation results for model 2.

```
*---
Formula mu:
---
CO2 ~ s(ITA) + s(month) + s(IDf, bs = "mrf", xt = list(penalty = k))
-
Parametric coefficients:
             Mean  2.5%   50% 97.5% parameters
(Intercept) 7.357 7.350 7.357 7.364      7.354
-
Acceptance probability:
      Mean 2.5% 50% 97.5%
alpha    1    1   1     1
-
Smooth terms:
                    Mean      2.5%       50%     97.5% parameters
s(ITA).tau21   9.535e-02 2.615e-04 2.438e-02 6.502e-01      0.382
s(ITA).alpha   1.000e+00 1.000e+00 1.000e+00 1.000e+00         NA
s(ITA).edf     3.923e+00 1.217e+00 3.702e+00 7.333e+00      6.856
s(month).tau21 1.444e-01 1.687e-02 1.037e-01 4.941e-01      0.252
s(month).alpha 1.000e+00 1.000e+00 1.000e+00 1.000e+00         NA
s(month).edf   7.628e+00 5.758e+00 7.746e+00 8.654e+00      8.477
s(IDf).tau21   2.287e-01 1.277e-01 2.142e-01 4.105e-01      0.211
s(IDf).alpha   1.000e+00 1.000e+00 1.000e+00 1.000e+00         NA
s(IDf).edf     2.799e+01 2.799e+01 2.799e+01 2.800e+01     27.995
```

```
Formula sigma:
---
sigma ~ s(ITA) + s(month) + s(IDf, bs = "mrf", xt = list(penalty = k))
-
Parametric coefficients:
              Mean   2.5%    50%  97.5% parameters
(Intercept) -2.503 -2.561 -2.503 -2.443     -2.582
-
Acceptance probability:
        Mean   2.5%    50% 97.5%
alpha 0.9833 0.8700 1.0000     1
-
Smooth terms:
                    Mean      2.5%       50%     97.5% parameters
s(ITA).tau21   1.171e-01 1.332e-04 1.111e-02 9.246e-01      0.003
s(ITA).alpha   9.507e-01 6.422e-01 9.979e-01 1.000e+00         NA
s(ITA).edf     1.545e+00 1.003e+00 1.189e+00 3.511e+00      1.050
s(month).tau21 8.812e-01 1.234e-02 4.238e-01 4.376e+00      1.302
s(month).alpha 8.976e-01 4.521e-01 9.781e-01 1.000e+00         NA
s(month).edf   4.380e+00 1.862e+00 4.372e+00 6.970e+00      5.583
s(IDf).tau21   1.190e-02 2.411e-03 1.045e-02 3.158e-02      0.029
s(IDf).alpha   5.549e-01 1.575e-02 5.164e-01 1.000e+00         NA
s(IDf).edf     2.096e+01 1.423e+01 2.145e+01 2.515e+01     24.961

Sampler summary:
-
DIC = -1439.406 logLik = 754.6604 pd = 69.9146
runtime = 13.89
---
Optimizer summary:
-
AICc = -1445.154 edf = 76.9217 logLik = 809.1963
logPost = 815.8526 nobs = 696 runtime = 4.82
```

Source: Own calculation.