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Environmental Externalities in the Tourism Sector through COVID-19

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Abstract

Due to the spread of COVID-19, a global pandemic has developed since December 2019, severely affecting various economic sectors, including tourism and secondary and tertiary industries. To analyse the effects of the European tourism sector on CO_2 emissions, emissions are modelled together with tourism indicators. The model allows for estimating the impact of the tourism sector on greenhouse gas emissions, distinguishing them from time and space effects. The model's results suggest a positive impact of tourism arrivals and tourism-related expenditure on CO_2 emissions, meaning that the decrease in tourism contributed significantly to the overall reduction of CO_2 emissions. Analysing the spatial autocorrelation shows that all countries we investigated are similarly affected by a reduction in tourism, and there appears to be no regional differentiation of impacts by COVID-19. To conclude the model's results, the reduction in emissions can be partly explained by the decrease in travel, which points to the potential in this relation that could be used as leverage in conceptualising measures to reduce CO_2, targeting the tourism sector.

Keywords: Environmental Externalities, Tourism, COVID-19, Greenhouse Gases, CO_2 emissions, Spatiotemporal Model

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1. Introduction

Tourism is a relevant factor in economic activity in the European Union and one of the fast-growing industries in the world (Ntibanyurwa, 2006). Among many other advantages, the economy benefits from an ameliorated infrastructure and investments besides job opportunities (Saayman, Saayman, & Rhodes, 2001), an increase in foreign exchange earnings, and an increase in tax revenue. The specific utility depends on tourist, travel, and destination-based variables of a country (Mayer & Vogt, 2016).
In the European Union, the highest share of tourism to GDP is created by countries such as Croatia, Italy, Malta, Spain, Portugal, Greece, and Cyprus (UNWTO, 2021a). These countries are relatively more dependent on tourists and resulting economic activity. Still, aside from positive economic effects, an opposing side of tourism is an increase in CO_2 emissions produced by the tourism industry, specifically by the transportation used to reach destinations and travel.

Moreover, nationally imposed travel restrictions for most countries in Europe and worldwide due to COVID-19, from March 2020 to May 2020, show that CO_2 emissions decreased drastically, especially in countries where the number of people travelling, or the number of tourists is high. In **Figure 1**, the CO_2 emissions based on the consumption of transportation fuels (kerosene, diesel, or gasoline) are calculated by multiplying the fuel amounts with their respective CO_2 emissions potential. Countries with higher CO_2 emissions experienced a significant drop due to travel restrictions. In contrast, other countries with a lower emission level at the start of the timeframe exhibited a smaller emissions decline (Eurostat, 2021c).

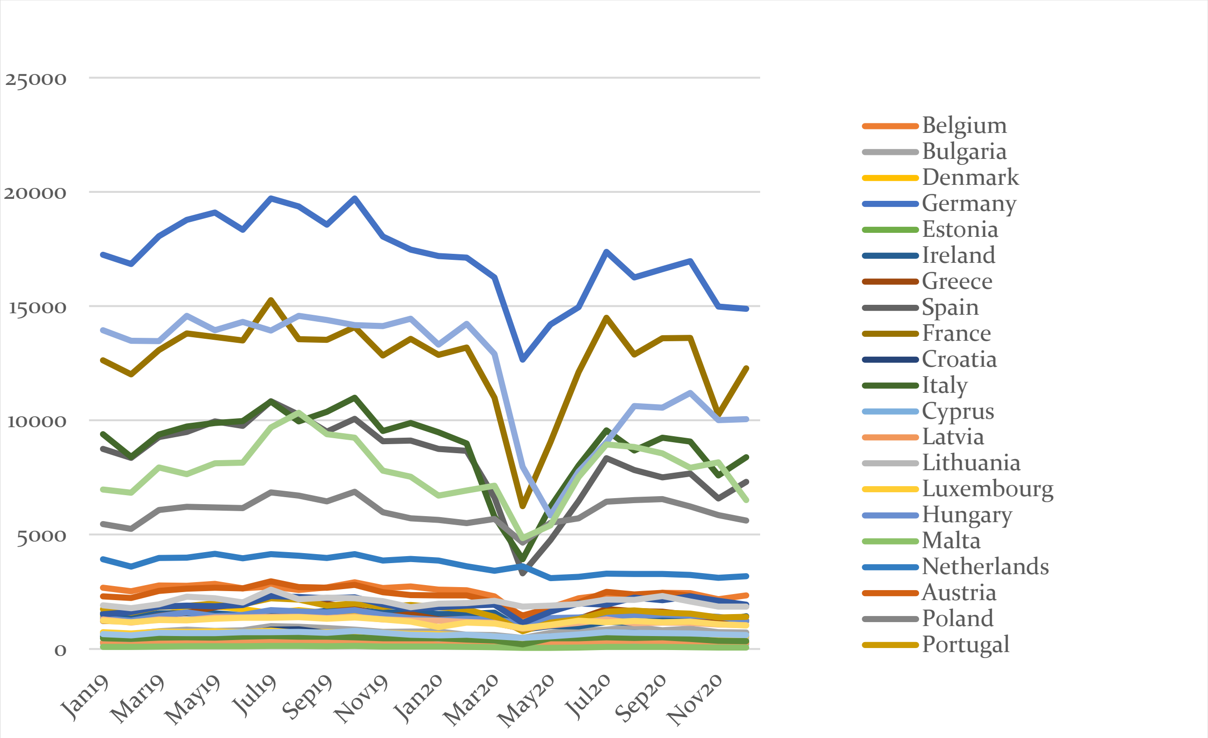


Figure 1. *Monthly CO_2 emissions for European countries 2019-2020 in tons.*
Source: Own calculations, based on Table 1 and the following sources containing information about CO_2 emission potentials of the different fuels: (Bundesverband der deutschen Bioethanolwirtschaft e.V., 2021; CoolConversion.com, 2021; Eurostat, 2021a, 2021c; International Carbon Bank and Exchange ICBE, 2021; Revesz, 2009).

The number of tourists travelling by train is low (Eurostat, 2021b), so the overall shares of fossil fuel-based transportation forms with higher CO_2 emissions dominate (Eurostat, 2021b). This underlines how COVID-19 has shown how unsustainable the tourism industry is when it comes to modes of travel. This study applies a spatial regression model investigating transport emissions in the tourism sector and suggests policy and decision makers take action to put a stop to ongoing environmental pollution (Gronau & Groß, 2019, p. 181).

2.Background

To fulfil the world's needs to reduce the burden of excessive exploitation, depletion, and unrecoverable destruction of the planet and accounting for climate change, the United Nations took action and mapped global goals that affect and represent the needs of all countries (Mastrángelo et al., 2019, p. 1115). It turns out, however, that positive externalities on the environment cannot be observed to a similar extent across all countries and regions and are strongly influenced by local tourism characteristics (Newsome, 2020, p. 2).

This paper measures tourism as the tourist demand within the European Union's borders. The coronavirus pandemic had affected Europe by March 2020, and the development of tourist arrivals mirrors this, showing a significant drop. Following March 2020, countries started closing their borders or implementing travel restrictions to take action against the spread of the virus. Contrasting the adverse economic effects caused by restrictions on society and the economy, positive environmental externalities also occur. Less travel also means fewer greenhouse gases are emitted, less littering of vacation areas can be observed, and natural habitats of animals recover through reduced tourism (Więckowski, 2021, p. 9).

The coronavirus pandemic has shown how sensitive the tourism sector generally reacts to shocks (Fotiadis, Polyzos, & Huan, 2021, p. 13). Aside from the significant negative impacts on tourism, nature recreation is achieved by triggering decreased CO_2 emissions and other favourable environmental factors (Laesser, Bieger, & Beritelli, 2021, p. 7). Still, countries have been forced to deal with the adverse effects of the pandemic's unambiguousness and obviousness (Sigala, 2020, p. 312). The tourism industry is confronted with a sensitive demand – when events lead to uncertainty, the demand decreases quickly (Betsch et al., 2020, p. 18). COVID-19 shocks the global economy with still unclear effects on different industries (Bouarar, Mouloudj, & Mouloudj, 2020; Păvăluc, BrÎnză, Anichiti, & Butnaru, 2020; Sheresheva, 2020). Still, it stresses the impact on the tourism industry and could aid the industry in changing to a more sustainable sector (Chang, McAleer, & Ramos, 2020; Gössling, Scott, & Hall, 2020; Spalding, Burke, & Fyall, 2021). Furthermore, emission-offsetting effects of COVID-19 regarding pollution and emissions caused by the tourism industry can be observed, which is investigated further in this study in a spatial comparison across European countries (Nagaj & Žuromskaitė, 2021).

3. Research Methodology

Data are obtained monthly for CO_2 emissions and tourist arrivals (compare **Table 1** for a description). A period from 2019 and 2020 is covered as these data contain one year without distortion in travel activity by governmental measures resulting from the COVID-19 pandemic and one year where measures to counteract the spreading of the pandemic have exuded full effect (UNWTO, 2021a).

Table 1. *Data description.*

Short Cut	Variable	2019			2020		
		Minimum value of the data	Maximum value of the data	Average value of the data	Minimum value of the data	Maximum value of the data	Average value of the data
CO2	CO_2 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
ID	Country identifier	1	29	-	1	29	-
month	Month identifier	1	12	-	1	12	-

Source: Own calculations (Bundesverband der deutschen Bioethanolwirtschaft e.V., 2021; CoolConversion.com, 2021; Eurostat, 2021a; International Carbon Bank and Exchange ICBE, 2021; Revesz, 2009; UNWTO, 2021b).

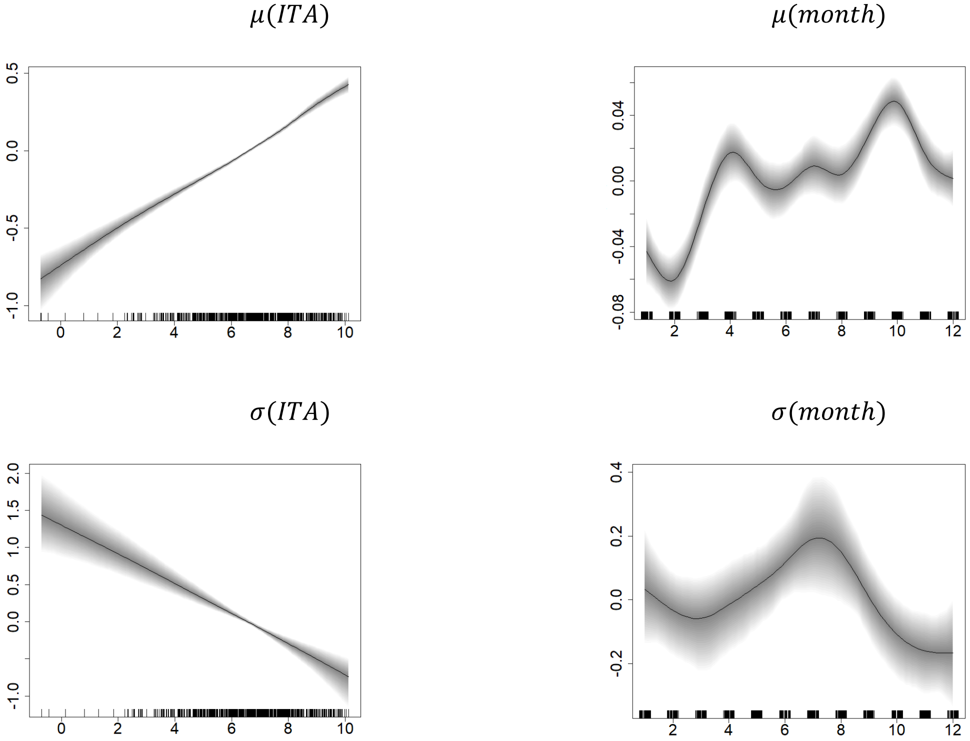
Aside from accounting for the time variation in the data illustrating the impact of COVID-19, an additional spatial effect is also included to account for neighbourhood effects (Tobler, 1970). By adding this term, regional dependency can be accounted for efficiently, e.g., whether particular regions are affected differently than others regarding the effects of COVID-19 on tourism and, thus, CO_2 emissions. The model's covariates are modelled non-parametrically, and it is accounted for heteroscedastic errors that show an improved fit for the data. The model is as follows:

$$CO2 \sim N(\mu = \rho_{\mu}, \exp(\sigma) = \rho_{\sigma})$$
$$\rho_{\mu} = \beta_0 + f_1(ITA) + f_2(month) + f_4(ID)$$
$$\rho_{\sigma} = \alpha_0 + g_1(ITA) + g_2(month) + g_4(ID)$$

It is assumed that the model follows a Gaussian distribution where $f_i(.)$ and $g_i(.)$ are functions applying penalized splines. The models also contain a Markov random field prior with a corresponding penalty matrix for neighbouring countries that accounts for geographical relations between countries. The model results are produced by applying the full-Bayes estimation procedure via the R-package BAMLSS (Umlauf, Klein, & Zeileis, 2018).

4. Results

The model's results are illustrated in Figure 2 (for extended results, see Table A. 1), with the upper row giving the estimated means (μ) for the covariates and the lower row presenting the effects of the errors (σ). For the covariate ITA, there are positive and significant effects estimated on CO_2. The mean functions are nearly linear, stating clear correlations. The higher ITA, the more tourism arrivals in accommodation establishments occur (and the higher spending is at the location, fuelling the economy), and the higher the CO_2 emissions by transport fuels. The amount of expenditure and the duration of the stay do not matter much once the travel has occurred. Generally, the sigma effects looking at the variability of the data, show that 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).



$\mu(ITA)$ $\mu(month)$

$\sigma(ITA)$ $\sigma(month)$

Figure 2. *Estimated effects of the spatiotemporal model.*
Source: Own calculations.

Looking at the model's spatial residuals in **Figure 3**, the effects estimated are mainly close to zero and vary considerably across regions. Aside from the slightly adverse effects of Scandinavia and South-Eastern Europe, with the exceptions of Portugal and Ireland, most other countries exhibit positive values. Testing the data for autocorrelation and, thus, spatial dependency via the Moran I statistic (Moran, 1950) results in a state of relative spatial inverse correlation and low dependence. This can be explained by the COVID-19 pandemic affecting all countries similarly and simultaneously.

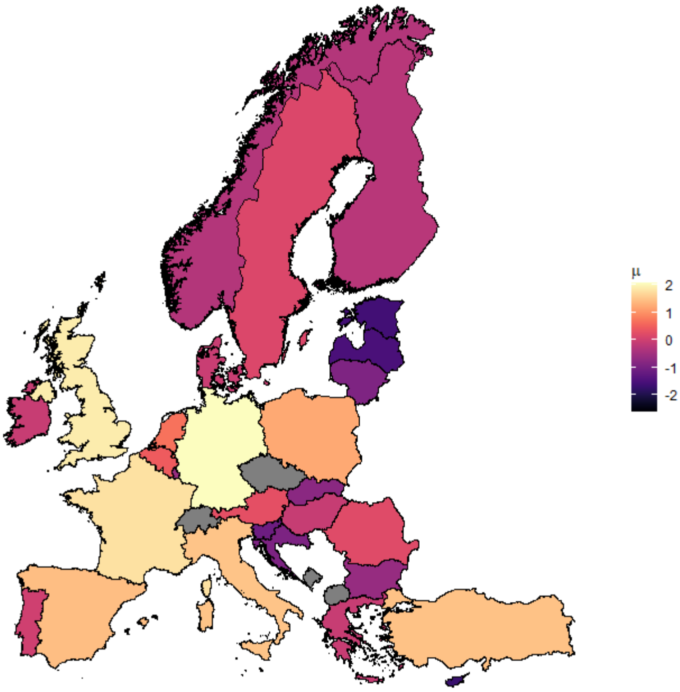


Figure 3. *Estimated spatial residual effect. Source: Own calculations.*

Generally, the positive effects of tourist arrivals on CO_2 emissions also mean that a significant decrease in tourism and travel activities during the COVID-19 pandemic contributed strongly to the reduction in emissions. Consequently, transport and travel options with lower CO_2 emission potentials are needed to reduce emissions. Policymakers should therefore consider additional CO_2 pollution with bans or restrictions, especially for heavily touristed areas, for example, by only allowing e-vehicles or lower fees for vehicles with less greenhouse gas emissions.

5. Policy Implications

Still, even though all countries are affected similarly by the pandemic, and travel restrictions led to reduced mobility and transport and decreased emissions, a one-size-fits-all approach regarding policy would be suboptimal. Tourism and transportation differ strongly across countries, and policy should target the sectors accordingly. Furthermore, non-tourism transport needs to be included in policy recommendations as the need to cut back overall emissions is immediate (Department for Transport, 2021).

Policymakers need to focus on the recreation of the tourism sector to help European countries to redevelop 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 and globally suffered significantly from COVID-19, created huge debts, and faced higher unemployment. As shown in Chapter 4, the dependence on the tourism industry has an enormous impact on some countries in the European Union. Rising economic activity in any sector, including the tourism industry, can help pay back debts, save and create jobs, and bring back prosperity, financial security, and a future competitive ability with innovation, research, and development. It is essential to point out that this redevelopment of the tourism industry needs to be done sustainably to fulfil also environmental goals.

Policy implications can be directed to the (national) governments to reduce environmental pollution. As climate change is a global issue affecting all countries, including those that profit from tourism, CO_2 emissions should be reduced efficiently and feasibly globally. For emission reduction, two different approaches in a normative way can be used. A carbon tax is an effective method to reduce carbon emissions (Heal & Schlenker, 2019). A redistribution mechanism to achieve an overall improvement of the environment could be executed here. Individual regions that internalize less from an economic point of view due to higher costs can support other areas that can exploit a higher potential for improvement with fewer monetary resources (Keppler, 2010).

Additionally, as the EU redistributes final resources to achieve overall environmental goals, some regions that face a heavy burden from tourism environmentally can get access to subsidies to improve energy efficiency and lower CO_2 levels. Second, Arthur Pigou addresses a European tax solution with a system of progressive taxes (Pigou, 1951). These only correct a market failure by internalizing external effects and help reduce CO_2 emissions (Kallbekken, Kroll, & Cherry, 2011, p. 53). This approach 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 must be to fulfil the goal. The approach must consider that the pollution levels of the countries where the flights start and end could differ. Furthermore, the inclusion of the transport sector into the European emissions trading system is vital. It applies a carbon offsetting and reduction scheme, combining cross-border adjustments and incentives to curtail carbon-intensive individual travel (European Commission, 2021a, 2021b).

Overall, our analyses also support local low-level recommendations like monetary incentives to foster electric mobility, affordable public transportation solutions (e.g. Germany's 9-Euro-Ticket, Loder et al., 2022), and active forms of mobility, e.g., cycling. Regional tourism can provide another option for the tourism sector to bounce back, which policy could support by subsidizing low-emission transportation modes or facilitating the legal deployment of fiscal incentives for remote communication for working (Le Quéré et al., 2021).

6. Conclusion

The international travel restrictions during the coronavirus pandemic have significantly impacted CO_2 emissions. With less tourism due to COVID-19, positive externalities occurred, measured by transportation emissions, wildlife, and nature. The EU should take the pandemic as a lesson showing how severe the environmental damage caused by the tourism industry is regarding CO_2 emissions. Without COVID-19, it may not have been uncovered how much the CO_2 emissions are correlated with tourism in general and how fast the emissions drop when the tourist activity is at the lowest level. Future research on the impacts of differentiated economic activity could focus on regional tourism hotspots to account for higher spatial variation. Additionally, the effects of policy support for local businesses in the tourism industry and possibilities for a taxing scheme could be evaluated.

Still, besides generating fewer CO_2 emissions, the overall goal should be a more sustainable industry that will benefit the present and future generations with inter-generation fairness and a stable environment. This can be achieved by addressing the problem on a supranational level. It is not dependent on current politics or political developments but on the EU as a leading institution that guides the member states into a more sustainable future by taking more responsibility for the demand and behaviour of the generations.

Appendix

Table A. 1: Extended estimation results.

Formula mu: CO2 ~ s(ITA) + s(month) + s(IDf, bs = "mrf", xt = list(penalty = k))					
Parametric coefficients:					
	Mean	2.50%	50%	97.50%	parameters
(Intercept)	7.360	7.350	7.360	7.360	7.350
Acceptance probability:					
	Mean	2.50%	50%	97.50%	
alpha	1.000	1.000	1.000	1.000	
Smooth terms:					
	Mean	2.50%	50%	97.50%	parameters
s(ITA).tau21	0.095	0.000	0.024	0.650	0.380
s(ITA).alpha	1.000	1.000	1.000	1.000	NA
s(ITA).edf	3.923	1.217	3.702	7.333	6.860
s(month).tau21	0.144	0.017	0.104	0.494	0.250
s(month).alpha	1.000	1.000	1.000	1.000	NA
s(month).edf	7.628	5.758	7.746	8.654	8.480
s(IDf).tau21	0.229	0.128	0.214	0.410	0.210
s(IDf).alpha	1.000	1.000	1.000	1.000	NA
s(IDf).edf	27.994	27.990	27.994	27.997	28.000
Formula sigma: sigma ~ s(ITA) + s(month) + s(IDf, bs = "mrf", xt = list(penalty = k))					
	Mean	2.50%	50%	97.50%	parameters
(Intercept)	-2.500	-2.560	-2.500	-2.440	-2.580
Acceptance probability:					
	Mean	2.50%	50%	97.50%	
alpha	0.983	0.870	1.000	1.000	
Smooth terms:					
	Mean	2.50%	50%	97.50%	parameters
s(ITA).tau21	0.117	0.000	0.011	0.925	0.000
s(ITA).alpha	0.951	0.642	0.998	1.000	NA
s(ITA).edf	1.545	1.003	1.189	3.511	1.050
s(month).tau21	0.881	0.012	0.424	4.376	1.300
s(month).alpha	0.898	0.452	0.978	1.000	NA
s(month).edf	4.380	1.862	4.372	6.970	5.580
s(IDf).tau21	0.012	0.002	0.010	0.032	0.030
s(IDf).alpha	0.555	0.016	0.516	1.000	NA
s(IDf).edf	20.956	14.230	21.450	25.145	24.960
Sampler summary:					
DIC = -1439 logLik = 755 pd = 69.9			runtime = 13.9		
Optimizer summary:					
AICc = -1445	edf = 76.9	logLik = 809			
logPost = 816	nobs = 696		runtime = 4.82		

Source: Own calculation.

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