Do tourists stand by the tourism industry?
Examining solidarity during and after a pandemic

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ABSTRACT

How does the suffering of a whole industry influence people's attitudes toward that industry? This research is the first, across disciplines, to examine this question. The authors provide the first conceptual study and empirical test for the phenomenon called tourism solidarity. Based on seminal social psychology research, tourism solidarity is conceptualized and defined as an individual's compassion with and support of an industry, resulting from an observation of suffering. The authors use a covariance-based structural equation model as well as a novel Bayesian estimation approach (i.e., non-parametric) to develop a reliable and easy-to-apply tourism solidarity scale and assess its role of solidarity in two consecutive empirical studies. By doing so, the authors are able to empirically demonstrate the importance of tourism solidarity for tourist behavior, and provide both tourism researchers and practitioners with a conceptual model and measurement tool to assess, quantify and actively manage solidarity toward the tourism industry.

KEYWORDS

1 INTRODUCTION

The COVID-19 pandemic has caused substantial losses for the tourism and hospitality industry, with many businesses struggling to survive or filing for bankruptcy (UNWTO 2021a). Indeed, the tourism industry has suffered more from the pandemic than most other industries, with tourist arrivals globally having declined 87% in January 2021 compared to January 2020 (UNWTO 2021b). The scope and scale of the suffering is unprecedented, as is the degree to which it has entered public discourse. Rarely before has a suffering industry gained this much attention in the media as has the tourism industry during the COVID-19 pandemic. In consequence, tourists are often aware of the difficult situation that the tourism industry has faced, or is facing. This context allows for a unique opportunity to study a theoretically and managerially pressing question: As consumers become aware of the struggle of tourism businesses and are able to travel again, will they declare solidarity with the suffering tourism industry? Posing and empirically addressing this question is original, and potentially disruptive because it is widely assumed that consumers largely prioritize their own interests in interactions with profit-oriented entities. In contrast to charities, the tourism and hospitality industry is, in its vast majority, a profit-oriented business. Do tourists show solidarity with a profit-oriented industry that is intended to generate a return for its stakeholders? The current research sets out to shed light on this question.

Anecdotal evidence hints that tourists may stand by the tourism and hospitality industry and demonstrate solidarity during a time of suffering. For example, initiatives to support the local hospitality industry (e.g., restaurants or pubs) became widespread during the pandemic. The initiative 'Support your local bar', which enables virtual tipping for hospitality employees, is only one example of several successful crowdfunding campaigns that emerged during the pandemic-induced lockdowns. Another initiative was the option of booking a "soli" room in a favorite hotel during the pandemic and redeeming the booking after the pandemic was over. Going beyond tourism, the pandemic has elicited countless calls for solidarity, with the Secretary-General of the United Nations explicitly calling for solidarity in March 2020 (António Guterres 2020). Indeed, we can observe many hints that the pandemic continues to have a substantial impact on tourism and people's behavior: Research suggests that the pandemic will leave deep marks in travelers' psyches (Kock, Nørfelt, Josiassen, Assaf and Tsionas 2020). Recent publications support this notion as international tourist arrivals in the first half of 2022 are still 54% below pre-pandemic levels (UNWTO 2022). Additionally, 88% of Americans believe that the pandemic has changed their lives forever (IPSOS 2022).

In addition to the substantial financial support of governments, could solidarity be instrumental in bringing destinations, hotels and restaurants back on track? Addressing this question is not only intriguing but can yield substantial theoretical as well as managerial insights. First, we seek to establish a theoretical foundation for the potentially very relevant phenomenon of tourism solidarity: How do tourists feel about a suffering industry? Can solidarity drive tourists' willingness to pay and will they be more generous or more forgiving toward the industry? Lastly, and importantly, will tourists show solidarity toward both domestic and foreign destinations? These questions are interesting from a theoretical point of view but can also yield important managerial insights. With the tourism industry thwarted by the pandemic and the future still uncertain, tourism managers should consider the phenomenon of tourism solidarity as a new opportunity to grow. This research can help managers understand how to identify, elicit and actively manage solidarity tendencies to their advantage. In this regard, the current study aims to study solidarity as a blessing in disguise in the aftermath of the pandemic. Solidarity might be particularly important for those destinations and tourism businesses that cannot rely on governmental support.

Drawing on the instrumental in-group bias literature, recategorization and intergroup threat theory, we conceptualize tourism solidarity as an individual's compassion for and support for the suffering tourism and hospitality industry. Against this background, our conceptualization is aligned with the common understanding of solidarity and is substantially different from the existing emotional solidarity concept which is a relational concept explaining resident-tourist interactions. It is important to emphasize that this research is among the first to examine the solidarity phenomenon in business research, complementing recent tourism research on solidarity in times war (Josiassen, Kock and Assaf 2022; Josiassen, Kock, Assaf and Berbekova 2023). Considering that solidarity may be elicited by many events and circumstances, the contribution of the current research reaches beyond the tourism and hospitality context as well as the ramifications of the pandemic,. To our best knowledge, no research exists on whether consumers experience solidarity and sympathy with a business entity, and if so, how this phenomenon would impact consumer behavior. In particular, we introduce solidarity as a phenomenon that is experienced by individuals as a response to industry suffering. While the pandemic lends itself to the examination of solidarity, the phenomenon may occur in countless other situations, such as natural disasters (e.g., hurricanes in destinations), industry-inherent turmoil (e.g., high energy costs) or through an event that is business- or region-specific.

In addition to these theoretical and managerial contributions, the current research provides a methodological contribution. Specifically, it sets out to introduce and empirically test a novel Bayesian approach that is capable of assessing the impact of solidarity on tourist behavior in a non-parametric way. This is particularly important because given the novelty of the area, we wish to validate the impact of solidarity on outcomes without the restrictive parametric assumptions (e.g., functional form and normality, among others). We develop the non-parametric model using the local maximum likelihood principle following Kumbhakar, Park, Simar and Tsionas (2007). The local likelihood approach is used in many non-parametric analyses as it is easy to perform the computations because it is anchored (locally) on a parametric linear model. In turn, the coefficients change when we consider other data points and, effectively, it becomes fully nonparametric. Regarding the properties of the procedure, we refer to Petrova (2019) and Kumbhakar et al. (2007) for its asymptotic properties.

The remainder of this article is structured as follows: We start with developing a conceptualization of tourism solidarity by drawing on seminal social psychology concepts of in-group bias: the instrumental in-group bias literature and intergroup threat theory. Then, we discuss the existing research on emotional solidarity and resident support for tourism, and explain the difference between our concept and the existing ones. Based on this conceptual work, Study 1 develops a reliable, valid and parsimonious tourism solidarity scale. In Study 2, the role of solidarity in tourism is empirically validated using both a covariance-based structural equation model and a novel non-parametric Bayesian estimation approach. By doing so, we are able to empirically demonstrate the importance of tourism solidarity in tourist behavior. We conclude by discussing a rich set of substantial implications for both tourism theory and tourism practice.

2 INTRODUCING TOURISM SOLIDARITY

While solidarity already emerged during the Roman empire, the modern understanding of solidarity evolved through the works of Marx (1964), Habermas (1990) and Durkheim (1984) who discussed class solidarity, communism and organic solidarity as remedies for suffering caused by pauperism, egoism and class hierarchies. Complementing these sociological, political and philosophical lenses, an earlier account (Kropotkin 1902) explains solidarity as a natural instinct of humans and animals that drives cooperation and thereby helps survival. This view aligns with biological considerations in recent tourism research (Kock, Josiassen and Assaf 2018) that consider affiliation and cooperation as fundamental evolutionary motives. While these studies discuss the nature of

solidarity and why it exists, they do not provide directly actionable definitions of what constitutes the solidarity we have observed during the pandemic. Going beyond these considerations, we now draw on socio-psychological research streams to conceptualize tourism solidarity.

We define *tourism solidarity* as *an individual's compassion with and support of an industry, resulting from an observation of suffering*. Our definition of tourism solidarity is grounded in two distinct, yet conceptually interlinked building components: 1) an individual's compassion with and support of an industry that is caused by 2) the observation of suffering of that industry. Thus, in order for tourism solidarity to exist, both components of the definition need to be present, with the latter giving rise to the former. To the best of our knowledge, no existing literature, neither in tourism nor psychology or marketing, has examined this phenomenon, making it necessary to develop a new concept. We do this by intertwining two social psychology research streams: instrumental in-group bias literature and intergroup threat theory.

First, we conceptualize tourism solidarity as a positive in-group bias. Members within a group generally tend to like and support one another; a phenomenon that is referred to as positive in-group bias or in-group favoritism (Buttelmann and Böhm 2014; Hewstone, Rubin, & Willis, 2002). For decades, social psychology and adjacent disciplines have used this approach to explain why people support each other, hence, it is a strong and suitable conceptual basis for solidarity. By explaining people's attitudes and behaviors as a manifestation of their perceived group membership, we echo Pearce and Stringer's important notion that "people's tourism behavior will derive from primary or secondary groups to which they belong" (1991, p. 147). In recent years, the socio-psychological concept of in- and out-group favoritism has received mounting attention from tourism researchers to understand how individuals construct positive attitudes toward in- and out-groups in the complexities of touristic activities (Boukamba, Oi and Sano 2021, Chen, Hsu and Li 2021; Josiassen, Kock and Nørfelt 2022; Kock, Josiassen, Assaf, Karpen and Farrelly 2019). The conceptualization of solidarity as a manifestation of group membership is not only theoretically appropriate but also aligned with the general definition of solidarity as 'an agreement between and support for the members of a group' (Cambridge Dictionary). Importantly, in-group bias can occur on various levels because all individuals perceive memberships in a myriad of groups, such as those based on demographics (e.g., gender, nationality, age, ethnicity), societal roles (e.g., job, parent, student, sports fan) or common experience (e.g., suffering from COVID-19).

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More specifically, we categorize tourism solidarity as an in-group bias that is instrumental in nature (Gaertner and Insko 2000; Scheepers, Spears, Doosje and Manstead 2006). The function of an instrumental in-group bias is a material one (e.g., reallocation of resources) and its goal is to achieve a material advantage for the in-group and its members (e.g., a monetary one). Thus, instrumental in-group biases are a means to improve the position of a group. In contrast to such instrumental biases, identity-expressive in-group biases serve the symbolic functions of creation, expression, preservation and confirmation of a group identity and its values (Leonardelli and Brewer 2001). Against this background, we conceptualize tourism solidarity as an instrumental in-group bias that aims to improve the financial situation of the domestic tourism industry and its employees through resource reallocation (i.e., governmental and private spending on the domestic industry). Next, we discuss why solidarity is indeed an in-group bias, and not an out-group bias. More specifically, we now explain what makes tourists include the tourism industry in their self-concept, thus establishing a common group membership and consequentially support.

We suggest that the observation of suffering (i.e., seeing the tourism and hospitality industry suffering) creates the perception of a common group membership via recategorization. Recategorization in the current context describes the process of dissolving group boundaries between demand- (i.e., tourists) and supply-side (i.e., tourism industry) group memberships, with the consequence of a common group-identity (i.e., 'tourism') and thus common group membership. The condition for such a recategorization is the sharing of suffering and threats. The pandemic has created a context in which different groups are suffering and exposed to the same threats, thus creating a fruitful ground for in-group support. This notion is grounded in intergroup threat theory (Riek, Mania and Gaertner 2006; Stephan and Stephan 2000), which argues that the observation and sharing of suffering elicits compassion and support. Specifically, we propose that the COVID-19 pandemic, which arguably poses both a health and a financial threat, elicits tourism solidarity as a response to that group threat. This proposition is corroborated by existing research noting that instrumental in-group biases occur through and under conditions of group threat (Scheepers, Spears, Doosje and Manstead 2003). Against this background, we propose that tourism solidarity is a likely response of tourists during times of a pandemic (or other incidents where an industry is suffering), however, it is yet to be researched. This line of thought is further supported by terror management theory (Solomon, Greenberg, & Pyszczynski, 1991), which proposes that individuals support other in-group members when made aware of the inevitability of their own and fellow in-group members'

deaths. As the pandemic triggers mortality salience and vulnerability (Hu, He and Zhou 2020), we suggest that solidarity is a likely response.

Next, we discuss how tourism solidarity is positioned in and different from existing research, in particular, emotional solidarity and residents' support for tourism. Emotional solidarity (Woosnam 2002) describes the relationship between residents and tourists based on shared beliefs, shared behavior and interaction (Woosnam, Norman and Ying 2009). Importantly, emotional solidarity is not aligned with the common definitions of solidarity (c.f. Cambridge Dictionary as mentioned above) but rather a relational concept explaining resident-tourist interactions. This is not surprising because emotional solidarity is rooted in the work of Emil Durkheim (1915/1995), a sociologist (more precisely: a structural functionalist) and not a psychologist. In contrast, and as evident from our preceding discussion, we develop tourism solidarity on socio- psychological grounds (i.e., in-group favoritism), which differs substantially from how solidarity is understood in sociology. Further, while emotional solidarity focuses on the relationship between residents and tourists, tourism solidarity focuses on the support of tourists for the tourism and hospitality industry. Against this background, we can conclude that the two concepts have little in common beyond sharing the same name.

Consequently, studies investigating emotional solidarity have predominantly examined residents' solidarity (Woosnam, Stylidis and Ivkov 2020). Emotional solidarity has been applied to explain residents' attitudes toward and support of specific forms of tourism activities in a destination, such as AirBnB accommodation (Suess, Woosnam and Erul 2020). Emotional solidarity has also been explored in light of the COVID-19 pandemic and results suggest that those residents who perceive higher levels of emotional solidarity perceive lower levels of risk (Joo, Xu, Lee, Lee and Woosnam 2021). Indeed, emotional solidarity has been linked to the concept of support for tourism development (e.g., Joo et al. 2021; Woosnam 2012). However, support for tourism development is very different from our notion of solidarity support for tourism for two reasons. First, support for tourism development captures residents' evaluation of the contributions tourism makes to the community and thus their support for further development of tourism in their area (McGehee and Andereck 2004). In contrast, tourism solidarity is a response to observed suffering, which causes support for that industry (and not its development). Second, support for tourism development takes a resident perspective (like emotional solidarity), while our tourism solidarity concept takes a tourist perspective. Against this background, while both emotional solidarity and support for tourism

development continue to contribute substantially to tourism knowledge, we conclude that the tourism solidarity construct has not been comprehensively addressed yet.

We emphasize that tourism solidarity can be leveraged for destinations in the crisis and post-crisis recovery stages. The potential that such an approach bears has been document by two recent studies that examine the role of place solidarity in times of war (Josiassen et al. 2022; Josiassen et al. 2023). Yet, solidarity toward an industry has not been explored or employed yet, although potential applications are manifold. Previous research has implicitly hinted at how solidarity can be used in marketing messages for destinations recovering after natural disasters (Carlsen and Hughes 2008; Wearing, Beirman and Grabowski 2020). Yet, the effectiveness of solidarity-triggering messages in times of the COVID-19 pandemic has not been proven to be particularly successful (Volgger, Taplin and Aebli 2021).

3 EMPIRICAL STUDIES

3.1 STUDY 1: SCALE DEVELOPMENT

Examining tourism solidarity and its role in tourist behavior requires, first and foremost, the development of a reliable and valid scale. The purpose of Study 1 is to develop that scale. The development is necessary because no solidarity scale exists in tourism, psychology or related disciplines that can comprehensively measure the phenomenon we identified at the conceptualization stage. More specifically, the only existing scale, emotional solidarity, measures a sense of closeness between residents and tourists (or between tourists) based on shared beliefs and interaction (Joo and Woosnam 2020). While this scale is very appropriate to measure a generic attitude, it cannot reflect tourism solidarity as we conceptualize it. Emotional solidarity items (e.g., "I have made friends with some visitors" or "I feel affection toward visitors") cannot be meaningfully adapted to tourism solidarity and hence cannot serve as a basis for our scale development.

In order to develop the tourism solidarity scale, we employed established scale development procedures (Kock 2021), and generated an initial item pool from two different sources. First, we identified narratives about the suffering tourism and hospitality industry as well as calls for support, by analyzing media articles from the U.S., Europe and Australia (e.g., interviews with politicians and tourism stakeholders). The analysis of media articles was then complemented by discussions on the online discussion platform reddit. We decided to draw on articles from various countries

because we conceive solidarity as a global phenomenon. In particular, all countries we draw on experienced COVID-19 and had, at times, various restrictions in place, consequently resulting in a suffering tourism and hospitality industry. Further, sourcing items from various countries lowers the risk of missing out on particular facets of solidarity that might be more pronounced in one country than another country. In addition, this approach also ensures that our developed scale has validity across countries. Second, we reviewed seminal literature on helping behavior and compassion (e.g., Penner, Dovidio, Piliavin and Schroeder 2005; Dovidio 1984).

This procedure resulted in an initial pool of 25 items. In order to reach a more manageable number of items, we reviewed all items for potential redundancy and eliminated seven. Redundancy of items exists because individuals use different expressions to convey the same meaning. For example, our initial item pool contained three items that quintessentially represented a call for government support for the suffering industry: 1) 'Politicians should do more to help tourism business', 2) 'The government should support the suffering tourism industry financially', 3) 'The government has to bring economic relief for those businesses that are hurt'. In this exemplary case, only item 2 was kept while the other two were dropped because of redundancy. We removed Item 1 because it is more ambiguous ('should do more') and could be interpreted differently. We dropped item 3 because the expression 'economic relief' may not be as self-explanatory as 'should support financially'. We then judged all remaining items as to how well they reflect the full content of tourism solidarity (assessment of content validity) and how well they reflect the solidarity construct instead of another construct (assessment of face validity). This step resulted in the elimination of another 10 items, leaving eight items for further analysis.

We continued by developing questionnaires containing the eight tourism solidarity items, complemented by behavioral intention measures and several classificatory items. In January 2021, we administered this questionnaire to a sample of U.S. respondents that we recruited from Amazon's Mechanical Turk (MTurk) platform. The MTurk platform can yield data quality that compares at least equally well to other data collection sources and has thus been used in tourism research before (e.g., Kock 2021). However, a strict data quality control is necessary. Hence, we implemented various measures. First, only respondents from a third-party curated sub-panel could access our questionnaire that we designed in QualtricsXM. Second, before respondents could enter the actual questionnaire, we filtered out those respondents who showed click-through tendencies and bot-like response behavior. This was done by implementing a simple Turing test: We asked respondents to click five or more times in a designated area on the screen before continuing to the

next page. Only those who passed this test, were admitted to the questionnaire. Third, some respondents may engage in straight-lining, satisficing, or other biasing response behavior. In response to this risk, we included an instructional manipulation check to detect and alleviate such behavior: 'Please select agree as the answer here' (measured on a 7-point ordinal scale in the questionnaire). Those respondents who provided a wrong answer to the manipulation check question (13 respondents; 3.8% of total respondents), were dropped from the sample. Fourth, we followed the guidelines by Kock, Berbekova, and Assaf (2021) to mitigate the occurrence of common method bias. Specifically, we implemented the following procedural controls: Hiding the causal link between the independent and dependent variables, providing concise and clear instructions, proximally separating the measures of independent and dependent variable and DV, keeping the survey brief, ensuring the anonymity of respondents, and avoiding complicated or ambiguous items,. After we cleaned the sample from manipulation check violations, we obtained completed questionnaires from 327 respondents. Table 1 summarizes the characteristics of this sample, along with those of other samples used in this research.

Insert Table 1 about here

3.1.1 Exploratory and Confirmatory Factor Analysis

We started our analysis by assessing the eight items with an exploratory factor analysis (EFA), employing maximum-likelihood in combination with a Varimax rotation. In contrast to a Promax rotation, Varimax rests on the assumption of orthogonal factors, and hence better matches the conceptualization of solidarity as a unidimensional construct (where items are supposed to load on one factor without cross-loadings on another). Both the Kaiser-Meyer-Olkin (KMO) criterion and Bartlett's test of sphericity (BTS) (KMO = .890; BTS = 1890.801; d.f. = 28, p = .000) were satisfactory. Next, we conducted a parallel analysis (Horn 1965) to assess how many factors to retain. This step is necessary because the commonly used Kaiser–Guttman criterion (i.e., the retention of factors with eigenvalues > 1.00) often lacks accuracy in identifying the appropriate number of factors (Lance, Butts and Michels 2006). This parallel analysis (and the Kaiser-Guttman criterion) yielded one factor, thus corroborating our conceptualization of solidarity as a unidimensional construct.

The eight items exhibited satisfactory item-to-total correlations and factor loadings, with the lowest being .66 (see Appendix 2 for all factor loadings and item wordings). Further, very high inter-item

correlations (i.e., >.9) were not observed, indicating the absence of item redundancy. Next, for each item, we assessed whether its deletion increases the composite reliability of the scale (. If this was the case and if content validity was not impaired by the deletion of the item, we dropped the item. This step resulted in the deletion of two items, leaving six items in the final scale that is shown in Table 2 (all items are listed in Appendix 1).

3.2 STUDY 2: ASSESSING THE ROLE OF TOURISM SOLIDARITY: CO-VARIANCE-BASED AND BAYESIAN ESTIMATION OF THE STRUCTURAL MODEL

While Study 1 has developed the new solidarity scale, the purpose of Study 2 is to validate the scale and demonstrate the importance of tourism solidarity through three intertwined paths. These paths are consecutively examined in Studies 2a, 2b and 2c. In Study 2a, we provide a nomological validation of solidarity because the contribution of a new scale should be demonstrated by testing important covariates thereof (Kock, Josiassen and Assaf 2019). In response to this notion, we set out to identify and test important consequences of the solidarity scale, along with relevant covariates: collectivism, tourism ethnocentrism and willingness to visit. Then, in Study 2b, we conduct a second nomological validation through a newly developed non-parametric Bayesian estimation method that we compare against the more traditional covariance-based SEM approach we use in Study 2a, as well as a Bayesian parametric approach. The development and empirical testing of our non-parametric approach allowed us to explicate a novel methodological approach. Finally, in Study 2c, we demonstrate the external validity of the solidarity scale over time: For different phases of the pandemic (January and June 2021), we validate the solidarity scale through a nomological model to understand potential changes in tourists' solidarity levels over time. This approach enables us to investigate whether tourists' solidarity is a phenomenon that rapidly declines as the immediate threat for tourism destinations and the hospitality industry fades (as has happened during the summer of 2021) or whether it is a more stable attitude that can be used in crisis recovery on a long-term basis by leveraging the positive impact of emotions in tourism marketing.

3.2.1 Sampling and Data Collection

For study 2, we executed two data collection rounds; one in January 2021 (n = 262) and the other in June 2021 (n = 260). The data collected in January is employed in Studies 2a and 2b, while the data

collected in June 2021 is used in Study 2c with the purpose of comparing it against the data collected in January. We followed the exact same data collection approach as in study 1. We deleted 43 respondents who failed the intentional manipulation check (i.e., 7.61% of total respondents) and obtained completed questionnaires from 522 respondents. The sample characteristics are shown in Table 1.

3.2.2 Study 2a: Assessing the nomological validity of tourism solidarity

Study 2a tests whether tourism solidarity is rooted in important psychological phenomena and can determine important outcome variables. We test collectivism as an antecedent, and tourism ethnocentrism and willingness to visit as outcomes of solidarity. First, collectivism is an individual difference variable that describes the tendency to see oneself as a member of one or more in-groups, the adherence to group norms, the prioritization of the in-group's goals and well-being and an emphasis on the connectedness to other in-group members (Jackson, Colquitt, Wesson and Zapata-Phelan 2006; Triandis 1995). Accordingly, we expect that those individuals who are high on collectivism will exert higher tourism solidarity. As such, we consider tourism solidarity as a concrete, context-specific manifestation of collectivism in times of a pandemic. This notion rests on social identity theory (Tajfel 1981) according to which the social identity of individuals derives from their knowledge of group membership and the significance they attribute to it. In that sense, exhibiting solidarity is a plasticity of the need for social identity (which itself originates from high collectivism), reassuring the individual of her membership.

Second, recent tourism research has devoted considerable effort to the phenomenon of tourism ethnocentrism (Kock et al. 2019a), defined as "an individual's prescriptive beliefs and felt moral obligation to support the domestic tourism economy" (p. 427-428). Our rationale is the following: When tourists feel solidarity with the suffering tourism economy, they are likely to translate this solidarity into higher levels of tourism ethnocentrism because the support of the domestic tourism industry is a straightforward means to enact the solidarity impetus. Third, we hypothesize that higher levels of solidarity and ethnocentrism will in turn increase people's willingness to visit and to pay more for a holiday after the pandemic ends. The nomological model that we test is displayed in Figure 1.

Insert Figure 1 about here

We show all items, wordings and their respective parameters in Table 2. All items met the assumption of multivariate normality (Appendix 3 shows kurtosis, skewness, means and standard deviations for all items). We included the newly developed solidarity scale and an adapted version of the seminal collectivism scale from Jackson et al. (2006). Further, we included the tourism ethnocentrism measure of Kock et al. (2019a), which we slightly modified with a different introductory sentence ("Once the pandemic fades...") to tailor it to the pandemic context. In addition, we measured willingness to visit and pay with three items adapted from Kock et al. (2016). Further, as our study is conducted in the context of the COVID-19 pandemic, we captured respondents' own health perceptions and their expectations of their future financial situation. This set of measures is complemented by the demographic variables age, gender and education. Table 2 shows all employed measures along with their parameters; the factor loadings are estimated and shown in the nomological network.

Insert Table 2 about here

After assessing the measurement models of all constructs, we continued by estimating the structural model (Figure 1) that tests how well solidarity relates to relevant psychological concepts and, specifically, can predict the endogenous variables tourism ethnocentrism and willingness to visit. The model fits the data reasonably well (χ^2/df = 3,328; CFI = .908; TLI = .891; RMSEA = .094) and its inner loadings document the predictive validity of the solidarity measure. As hypothesized, solidarity has a positive relationship with tourism ethnocentrism (.49, p.001), indicating that tourists who feel solidarity with the suffering tourism industry also exhibit higher levels of tourism ethnocentrism. Given the important role of tourism ethnocentrism documented in earlier studies (Boukamba et al. 2021; Kock et al. 2019), the identification of solidarity as a pandemic-induced driver thereof is of theoretical and managerial importance. In addition, solidarity also relates positively and significantly to willingness to visit (.28, p < .001), thereby indicating that it has direct and substantial implications for tourists' future travel behavior, especially in a post-pandemic context.

Further, our results document that collectivism, as hypothesized, positively relates to solidarity (.31, p < .001), documenting their conceptual and empirical relation, thereby indicating nomological validity. In addition, we find that collectivism positively relates to ethnocentrism (.25, p < .001) but has no direct effect on willingness to visit (.02, p = .800). This full mediation documents that solidarity and ethnocentrism are both important correlates of the seminal collectivism phenomenon. In order to calculate the effect of solidarity on intentions, we summed up the direct effect and the indirect effect through the mediator, yielding a standardized total effect of .36 that solidarity has on WTV. Against this background, we conclude that the results demonstrate empirical evidence for the relevance of our new solidarity measure for people's travel attitudes during a pandemic.

3.2.3 Study 2b: Nomological validation with non-parametric Bayesian estimation

Given the rather small sample size and for robustness checks, we also estimated the model in a Bayesian framework. As already proven in Assaf, Tsionas and Oh (2018), Bayesian estimation is known to work better in relatively small sample sizes, like in this study.

For the Bayesian estimation, we estimated the model in both parametric and non-parametric fashion. The parametric estimation enables a direct comparison with the AMOS model estimated in Study 2.1. For the non-parametric estimation, the goal was to eliminate the need to impose functional form on the equations or the probability distribution of the disturbances. Given the novelty of the area, the non-parametric estimation would also unveil whether any non-linearity exists in the various path relationships of the model. Following that, we present the results of both the parametric and non-parametric models.

3.2.3.1 Parametric Model

As the Bayesian parametric estimation to SEM if well explained in Assaf et al. (2018), we do not provide a detailed description of the model here. Tables 3 and 4 report the results of the structural and measurement models, respectively. We use flat priors on all parameters. As can be seen, these non-standardized estimates strongly converge to the AMOS model results. For instance, solidarity positively relates to tourism ethnocentrism. In addition, solidarity also relates positively and significantly to willingness to visit. Further, the Bayesian results indicate that collectivism, as hypothesized, positively relates to solidarity, documenting that these variables are conceptually and empirically related. In addition, we find that collectivism positively relates to ethnocentrism but has no direct effect on willingness to visit, as indicated by the large posterior standard deviation.

3.2.3.2 Non-Parametric Model

Appendix 4 provides more technical details on how we arrive at a non-parametric specification of our SEM model. For the first time in the literature, we use the local likelihood approach, which is a successful nonparametric estimation technique based on fitting an anchor model (for example a linear model). We use a Bayesian extension for better small sample performance.

The Bayesian approach to local linear SEMs is based on (12). We define a posterior

$$p_D(\theta|\mathfrak{D}) = \frac{\exp\{\log L_D(\theta; \mathfrak{D})\}}{\int \exp\{\log L_D(\theta'; \mathfrak{D})\}d\theta'}.$$

This formulation is consistent with Chernozhukov and Hong (2003) who have provided a posterior for any loss function. Here, we extend their approach to the context of local linear likelihood estimation as indicated in the Appendix. Our prior for all fixed parameters of the model and parameters of the local likelihoods are $N(0,1)$. The results for the main relationships of the model are expressed in Figure 1. Again, we observe and agreement between the covariance-based and the Bayesian parametric results. For instance, it is clear that collectivism and solidarity do not have a significant impact on visit intention. Collectivism also seems to positively relate to solidarity, though this relationship does not seem to be linear. In addition, we find that collectivism positively relates to ethnocentrism. Finally, we notice no-linearity in the relationship between visit intention and tourism ethnocentrism but in general the relationship tend to be positive and significant.

Insert Table 3 about here
Insert Table 4 about here
Insert Figure 2 about here

3.2.4 Study 2c: Assessing tourism solidarity over the course of the pandemic

In this study, we set out to assess the external validity of the solidarity scale over time: For two different phases of the pandemic (January and June 2021), we validate the solidarity scale through a nomological model to understand potential changes in tourists' solidarity levels over the course of a

pandemic. This setup addresses the theoretically and managerially relevant question of whether tourism solidarity may fade over the course of a pandemic (thus being relatively short-lived) or whether it constitutes a long-lasting phenomenon that tourism stakeholders should bank on. In order to do so, we compared the estimated nomological models from January and June 2021. The results are show in Table 5 and indicate that differences between means are negligible. Specifically, none of the mean differences is statistically significant, thereby indicating that tourism solidarity is a longer-lasting phenomenon that shapes tourist behavior during and after the course of a pandemic.

Insert Table 5 about here

4 CONCLUSION

How does the suffering of a whole industry influence people's attitudes toward that industry? We started out with this research question and motivated the current pandemic as a unique context to empirically examine a phenomenon we call tourism solidarity. Our research provides substantial contributions to both theory and practice, and will hopefully pave the way for more research on the solidarity phenomenon.

4.1 THEORETICAL IMPLICATIONS

Our study contributes to both tourism and hospitality research, as well as consumer research in various ways. This study is the first to conceptualize and empirically validate the phenomenon of solidarity toward an industry phenomenon and its role in shaping tourist behavior. Grounded in seminal social psychology theory, we develop a solidarity conceptualization that includes both the observation of suffering (as cognitive impetus) and the compassion with and support of an industry (the affective and conative consequence). By doing so, we provide a novel theoretical ground on which future solidarity research can capitalize. As we find that tourism solidarity relates to relevant conative and attitudinal tourism phenomena (i.e., ethnocentrism and willingness to visit), we highlight the potential importance of solidarity for understanding future tourist decision-making, both during and after the pandemic. Specifically, we note that sole reliance on a destination's tangible and functional attributes is likely to yield an incomplete picture at best. Against this background, a theoretical contribution is that solidarity can be useful to include in future examinations that investigate tourists' symbolic underpinnings of their decision-making. With the pandemic still pressuring and shaping the tourism, hospitality and events industry, understanding

that solidarity can be a pathway through which tourists build and enact favorable attitudes, is very relevant.

Another theoretical contribution is the development of the reliable, valid and parsimonious tourism solidarity scale that allows future tourism research to capture this phenomenon in various contexts, such as solidarity toward specific destinations and hospitality businesses or solidarity differences between travel groups. For example, it could be tested whether solidarity is stronger in some parts of the world than others. Particularly, differences in collectivism across countries and cultures may play an important role in determining tourism solidarity as we empirically identify collectivism as a deep-rooted psychological correlate of solidarity. In addition, it could be examined whether some destinations elicit more solidarity than others. By providing the first tourism solidarity scale, we offer a tool to researchers to examine solidarity in their own studies. Further, we find ethnocentrism to be an important correlate of solidarity, thereby contributing to burgeoning research on the role of ethnocentrism. Specifically, conceptualizing and empirically examining solidarity as another response to the pandemic complements recent research on the effect of the pandemic on ethnocentrism (Kock, et al., 2020).

It is important to note that our study on solidarity constitutes a contribution beyond the tourism and hospitality literature. To the best of our knowledge, this study is the first to provide a conceptualization, operationalization and nomological test of solidarity, thereby constituting a contribution that can be of potential use for many disciplines, such as marketing, politics or psychology. While our scale is developed within a tourism context, the conceptualization and measure can help researchers analyze the role of solidarity in other contexts. For example, our scale can be used to estimate whether people endorse the far-reaching governmental support for suffering industries during the pandemic. In addition to these theoretical contributions, our study also makes a methodological contribution as it introduces and develops a novel non-parametric SEM model. The model is more general and does not require the restrictive assumptions of parametric SEM.

Further, the applicability of our solidarity construct is not limited to the circumstances of a pandemic but has versatile fields of application. While we have chosen the pandemic as a proof-of-concept context in which solidarity occurs, solidarity is also likely to emerge in various other contexts and situations which cause a market entity to suffer. Among others, this could be a natural disaster hitting a destination or an old established local hotel suffering from high energy costs (as experienced during the high inflationary times beginning in summer 2022). Further, whole

destinations might elicit solidarity merely because of a wealth gap, such as when tourists from rich countries visit substantially poorer ones. While our scale would have to be adapted to fit this research purpose, it may pave the way for new examinations on a phenomenon we would call 'solidarity tourism'.

4.2 MANAGERIAL IMPLICATIONS

Further, our research yields valuable insights for managers and other practitioners. First, our conceptualization and measurement of tourism solidarity makes this phenomenon appreciable and tangible to tourism and hospitality practitioners. Our study allows practitioners to actively manage the tourism solidarity phenomenon, for example, by eliciting solidarity when communicating offerings. While many destinations, hotels, restaurants and other tourism entities have faced (and are still facing) various challenges during the pandemic, the question of whether one should talk about it had yet to be answered. We show that solidarity actually exists and can shape tourists' favorable attitudes toward that business, hence talking about it may indeed be rewarding. Yet, this decision needs to consider whether the target customers of the respective business are actually solidarity with the tourism industry; a question that can be answered by employing our solidarity measure.

4.3 LIMITATIONS AND FUTURE RESEARCH

Like any study, our research also has certain limitations. To begin, we derive our empirical findings from Western tourists, specifically Americans from the United States. Future studies should consider replicating our results across other cultural contexts. Indeed, our finding that collectivism correlates with solidarity indicates the potential for observing differences in solidarity across cultures. Understanding such differences can be relevant for tourism stakeholders to assess to what extent they can hope for solidarity in different markets. Secondly, we have not tested whether solidarity may differ between tourism businesses: Are poor destinations more likely to elicit solidarity than rich ones? Is there a difference between local and foreign destinations? Are there differences between destinations, restaurants, airlines or hotels? These questions are both theoretically and managerially relevant, and our measure paves the way for such future efforts. Thirdly, our study addresses the potential dynamic of solidarity over time as we measure it at two points in time. While we do not find differences, it is still possible that tourism solidarity increases

or fades over the course of the pandemic, and in its aftermath. Our research provides the tool to track changes in solidarity over time.

In addition, future research can build on our conceptualization of solidarity to further unveil the psychological mechanism from which solidarity emerges. As said, this is the first study to examine solidarity, hence we still lack insights into this phenomenon. Social identity theory might play a role in further enlightening it, as well as research on empathy and compassion. Specifically, future research should examine the motives and accompanying emotions of solidarity. We suggest three motives that future research could investigate. First, tourists may be solidarity because they sincerely care and want to bring about change (functional motive). Second, they may show solidarity to confirm or enhance their social identity (identity motive)Third, they may show solidarity as a response to a felt moral obligation emerging from their in-group (moral motive). All three pathways may be possible, and may occur across individuals. Another important future path for research is to bring solidarity into new contexts. This is possible because our conceptualization and developed scale was tested in the context of the pandemic and the tourism industry. However, the measurement instrument is not limited to the pandemic and the tourism industry, but is meant to also work with other sources of suffering, and other industries. To the best of our knowledge, such research does not exist and lends itself to many contexts in various disciplines. Indeed, the 'David vs. Goliath' theme is an interesting narrative to be considered. The current study provides the insights needed to launch such interesting studies. Further, future research can also examine solidarity as a response to natural disasters. As such events usually stimulate media attention (for example, hurricanes, tsunamis or earthquakes) and are not self-inflicted, they share similarities with the pandemic and may hence also elicit solidarity. The same might be true for individual hotels, restaurants or hotels that, not self-inflicted, run into trouble and then elicit solidarity.

Lastly, while our research examines solidarity through structural equation modelling approaches (both covariance-based and the new Bayesian approach), future research is advised to venture into experimental research designs with the goal of designing solidarity-eliciting communication cues. Insights generated through this method may not only further inform the psychological pathway through which solidarity emerges, but would also be valuable for practitioners, enabling them to actively elicit and manage solidarity.

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TABLES

Table 1: Sample characteristics

Sample	Study 1: Scale Development	Study 2a & 2b: Nomological	Study 2c: Nomological over time
Sample size	327	262	260
Age (%)			
18 - 24 years	9.5	5.3	7.7
25 - 34 years	41.0	34.4	38.1
35 - 54 years	39.4	43.8	45.0
> 55 years	10.1	16.5	9.3
Gender (%)			
Female	43.4	48.9	45.0
Male	55.7	51.1	53.5
Education (%)			
Finished a master's degree or higher	19.0	22.1	10.0
Finished a bachelor's degree	49.8	46.2	51.9
Enrolled at university	13.8	11.1	15.8
Finished secondary school	15.9	19.5	20.8
Finished primary school	1.5	1.1	1.5

Table 2. Employed measures of Study 2a and 2b

Construct/Items	Mean (StD.)	Factor Loadings	CR	AVE
Tourism Solidarity (newly developed)			.89	.59
The government should support the suffering tourism industry financially. (Soli1)	4.99 (1.46)	.76		
I have a feeling of solidarity with those working in tourism. (Soli2)	4.37 (1.508)	.69		
Each of us can play a positive role in alleviating the consequences of the pandemic for the tourism industry. (Soli3)	4.88 (1.370)	.69		
We should unite with the tourism industry in the face of the pandemic. (Soli4)	4.82 (1.287)	.85		
It is our common responsibility to help the tourism industry. (Soli5)	4.45 (1.517)	.84		
The tourism industry has a hard time which wasn't self-inflicted; hence, the government should help. (Soli6)	5.10 (1.439)	.76		
Tourism Ethnocentrism (adapted from Kock et al. 2019) *Once the pandemic fades, ...*			.94	.81
We should support the American tourism industry by traveling to holiday destinations in the US. (TE1)	4.79 (1.684)	.88		
Americans should spend a lot on their domestic holidays to help the industry. (TE2)	4.46 (1.687)	.87		
It comes down to all Americans to spend their next holiday in the US and support the suffering industry. (TE3)	4.44 (1.747)	.91		
Americans should spend their next holiday in the US because this brings back jobs that got lost in the pandemic. (TE4)	4.76 (1.646)	.93		
Collectivism (Jackson et al. 2006) *Now, think about the groups to which you currently belong (that, for example, could be family, friends, work etc.). The items below ask about your relationship with, and thoughts about, those particular groups.*			.83	.50
Working in those groups is better than working alone. (Coll1)	4.48 (1.611)	.71		
I feel comfortable counting on others in my group when needed. (Coll2)	4.89 (1.560)	.75		
I accept the rules of groups that I am part of. (Coll3)	5.23 (1.260)	.70		
Group goals are more important to me than my personal goals. (Coll4)	3.92 (1.631)	.61		
I care about the well-being of others in my groups. (Coll5)	5.66 (1.320)	.77		
Willingness to visit and to pay after the pandemic ends (adapted from Kock et al. 2016)			.91	.78
I will spend more on my holidays than I used to. (WTV1)	3.94 (1.946)	.91		

I will holiday more often. (WTV2)	4.14 (1.903)	.91
I will book a holiday right away. (WTV3)	3.95 (2.010)	.83

Table 3. Measurement model

	Posterior Mean	Posterior Standard Deviation
Tourism Solidarity		
Soli1	1.0000	-
Soli2	0.8819	0.0688
Soli3	0.7964	0.0641
Soli4	0.9099	0.0535
Soli5	1.0700	0.0636
Soli6	0.9351	0.0617
Collectivism		
Coll1	1.0000	-
Coll2	0.9904	0.0762
Coll3	0.7422	0.0634
Coll4	0.8576	0.0812
Coll5	0.8515	0.0652
Tourism Ethnocentrism		
TE1	1.0000	-
TE2	0.9841	0.0456
TE3	1.0520	0.0458
TE4	1.0040	0.0421
Willingness to Visit		
WTV1	1.0000	-
WTV2	1.1030	0.0568
WTV3	1.0750	0.0623

Table 4. Structural Model

	Posterior Mean	Posterior Standard Deviation
Solidarity ←--- Collectivism	0.3626	0.0782
Ethnocentrism ←--- Collectivism	0.3354	0.0825
Ethnocentrism ←--- Solidarity	0.6422	0.0832
WTV ←--- Solidarity	0.4091	0.0986
WTV ←--- Ethnocentrism	0.1799	0.0787

WTV ←--- Collectivism	0.0458	0.0906

Table 5: Comparing Tourism Solidarity in January (Study 2b) and June (Study 2c) 2021

| Construct/Items	Mean (StD.) January 2021	Mean (StD.) June 2021
Tourism Solidarity (newly developed)		
The government should support the suffering tourism industry financially. (Soli1)	4.99 (1.46)	4.72 (1.594)
I have a feeling of solidarity with those working in tourism. (Soli2)	4.37 (1.508)	4.38 (1.624)
Each of us can play a positive role in alleviating the consequences of the pandemic for the tourism industry. (Soli3)	4.88 (1.370)	4.85 (1.370)
We should unite with the tourism industry in the face of the pandemic. (Soli4)	4.82 (1.287)	4.80 (1.429)
It is our common responsibility to help the tourism industry. (Soli5)	4.45 (1.517)	4.35 (1.685)
The tourism industry has a hard time which wasn't self-inflicted; hence, the government should help. (Soli6)	5.10 (1.439)	4.80 (1.549)

FIGURES

Figure 1: Nomological Model of Study 2a
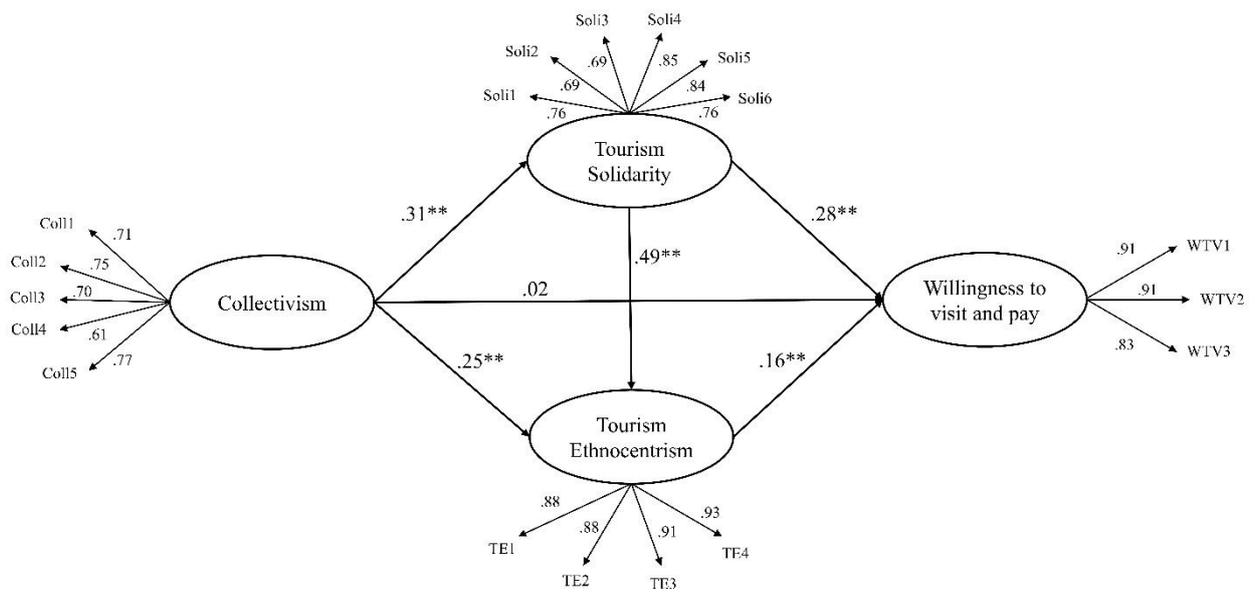
Model fit: (χ^2/df = 3,328; CFI = .908; TLI = .891; RMSEA = .094).   ** p < .000

Figure 2: Non-Parametric Bayesian Results

Ethnocentrism ⬅--- Collectivism   Ethnocentrism ⬅--- Solidarity

Solidarity ⬅--- Collectivism   WTV ⬅--- Collectivism

(c) $\xi_2 = f_3(\xi_1)$

(d) $\eta = f_4(\xi_1)$
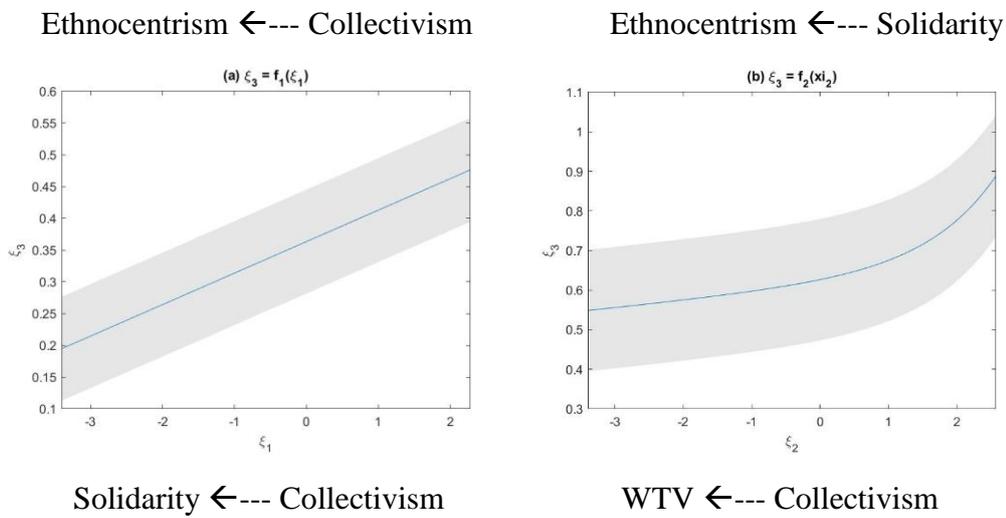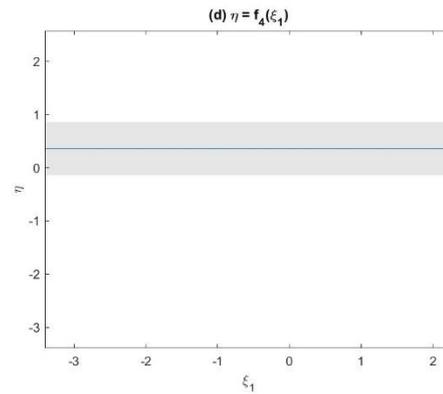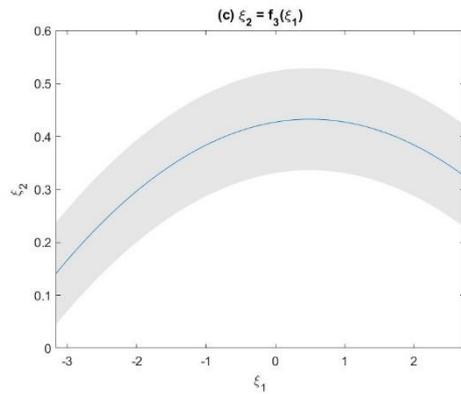
WTV ←--- Solidarity

WTV ←--- Ethnocentrism

(e) $\eta = f_5(\xi_2)$

(f) $\eta = f_6(\xi_3)$
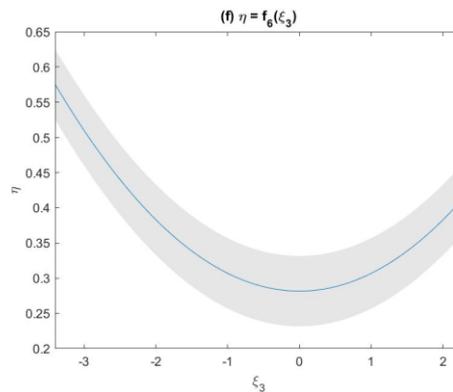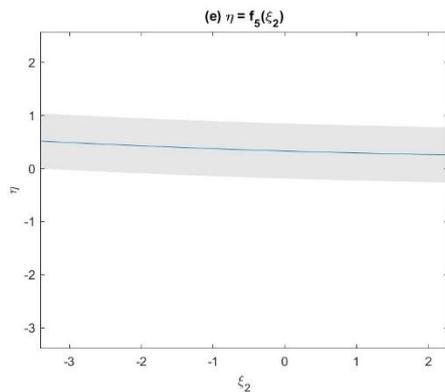
APPENDICES

Appendix 1. Measures employed in Study 1 and Study 2

We measure the following concepts:

Tourism Solidarity (new development) → final items are 1-6 (Soli1 – Soli6)

1. The government should support the suffering tourism industry financially. (Soli1)
2. I have a feeling of solidarity with those working in tourism. (Soli2)
3. Each of us can play a positive role in alleviating the consequences of the pandemic for the tourism industry. (Soli3)
4. We should unite with the tourism industry in the face of the pandemic. (Soli4)
5. It is our common responsibility to help the tourism industry. (Soli5)

6. The tourism industry has a hard time which wasn't self-inflicted; hence, the government should help. (Soli6)
7. I feel connected to people who work in tourism. (dropped)
8. The tourism industry is suffering in the current pandemic and needs help. (dropped)

Tourism Ethnocentrism (adapted from Kock et al. 2019) (TE)

Once the pandemic fades, ...

1. We should support the American tourism industry by traveling to holiday destinations in the US. (TE1)

2. Americans should spend a lot on their domestic holidays to help the industry. (TE2)

3. It comes down to all Americans to spend their next holiday in the US and support the suffering industry. (TE3)

4. Americans should spend their next holiday in the US because this brings back jobs that got lost in the pandemic. (TE4)

Collectivism (Jackson et al. 2006)

Jackson, C. L., Colquitt, J. A., Wesson, M. J., & Zapata-Phelan, C. P. (2006). Psychological collectivism: A measurement validation and linkage to group member performance. Journal of Applied Psychology, 91(4), 884.

Now, think about the groups to which you currently belong (that, for example, could be family, friends, work etc.). The items below ask about your relationship with, and thoughts about, those particular groups.

1. Working in those groups is better than working alone. (Coll1)

2. I feel comfortable counting on others in my group when needed. (Coll2)
3. I accept the rules of groups that I am part of. (Coll3)

4. Group goals are more important to me than my personal goals. (Coll4)

5. I care about the well-being of others in my groups. (Coll5)

Willingness to visit and to pay after the pandemic ends (WTV)

After the pandemic ends, ...

I will spend more on my holidays than I used to. (WTV1)
I will holiday more often. (WTV2)
I will book a holiday right away. (WTV3)

Appendix 2. Factor matrix of explanatory factor analysis in Study 1

	Factor loadings
The tourism industry is suffering in the current pandemic and needs help. (dropped)	.664
The government should support the suffering tourism industry financially. (Soli1)	.834
I have a feeling of solidarity with those working in tourism. (Soli2)	.774
Each of us can play a positive role in alleviating the consequences of the pandemic for the tourism industry. (Soli3)	.672
We should unite with the tourism industry in the face of the pandemic. (Soli4)	.812
It is our common responsibility to help the tourism industry. (Soli5)	.837
I feel connected to people who work in tourism. (dropped)	.730
The tourism industry has a hard time which wasn't self-inflicted; hence, the government should help. (Soli6)	.842

Appendix 3. Study 2a: Item means, standard deviations, skewness and kurtosis

Study 1: Item Means, StD.'s, Skewness and Kurtosis

Item	Mean	StD.	Skewness	Kurtosis
Tourism Solidarity				
The government should support the suffering tourism industry financially. (Soli1)	4.99	1.457	-.706	.273
I have a feeling of solidarity with those working in tourism. (Soli2)	4.37	1.508	-.236	-.443
Each of us can play a positive role in alleviating the consequences of the	4.88	1.370	-.597	.252

pandemic for the tourism industry. (Soli3)				
We should unite with the tourism industry in the face of the pandemic. (Soli4)	4.82	1.287	-.551	.554
It is our common responsibility to help the tourism industry. (Soli5)	4.45	1.517	-.370	-.379
The tourism industry has a hard time which wasn't self-inflicted; hence, the government should help. (Soli6)	5.10	1.439	-.720	.227
Tourism Ethnocentrism				
We should support the American tourism industry by traveling to holiday destinations in the US. (TE1)	4.79	1.684	-.625	-.251
Americans should spend a lot on their domestic holidays to help the industry. (TE2)	4.46	1.687	-.320	-.571
It comes down to all Americans to spend their next holiday in the US and support the suffering industry. (TE3)	4.44	1.747	-.303	-.689
Americans should spend their next holiday in the US because this brings back jobs that got lost in the pandemic. (TE4)	4.76	1.646	-.587	-.166
Collectivism				
Working in those groups is better than working alone. (Coll1)	4.48	1.611	-.543	-.243
I feel comfortable counting on others in my group when needed. (Coll2)	4.89	1.560	-.724	.066
I accept the rules of groups that I am part of. (Coll3)	5.23	1.260	-.648	.408
Group goals are more important to me than my personal goals. (Coll4)	3.92	1.631	-.042	-.684
I care about the well-being of others in my groups. (Coll5)	5.66	1.320	-1.389	2.330
Willingness to Visit and Pay				
I will spend more on my holidays than I used to. (WTV1)	3.94	1.946	-.082	-1.099
I will holiday more often. (WTV2)	4.14	1.903	-.229	-1.018

| I will book a holiday right away. (WTV3) | 3.95 | 2.010 | -.046 | -1.164 |

Appendix 4: Non-parametric SEM

Following Bollen (1989, pp. 319-320), the SEM model can be written as:

$$\underset{(m\times1)}{\eta} = \underset{(m\times m)}{B}\,\eta + \underset{(m\times n)}{\Gamma}\,\underset{(n\times1)}{\xi} + \underset{(m\times1)}{\zeta}\,, \text{ (1)}$$

$$\underset{(p\times1)}{y} = \underset{(p\times m)}{\Lambda_y}\,\underset{(m\times1)}{\eta} + \underset{(p\times1)}{\varepsilon}, \text{ (2)}$$

$$\underset{(q\times1)}{x} = \underset{(q\times n)}{\Lambda_x}\,\underset{(n\times1)}{\xi} + \underset{(q\times1)}{\delta}, \text{ (3)}$$

$$\zeta \sim N\left(0,\Psi\right),\ \varepsilon \sim N\left(0,\Theta_\varepsilon\right),\ \delta \sim N\left(0,\Theta_\delta\right). \text{ (4)}$$

Θ_ε and Θ_δ are often diagonal.

From Bollen (1989, p. 325) and after collecting all unknown parameters into the vector $\theta \in \Theta \subseteq \mathbb{R}^d$, where d is the number of parameters, we have:

$$\Sigma\left(\theta\right) = \begin{bmatrix} \Sigma_{yy}\left(\theta\right) & \Sigma_{yx}\left(\theta\right) \\ \Sigma_{xy}\left(\theta\right) & \Sigma_{xx}\left(\theta\right) \end{bmatrix}, \text{ (5)}$$

where

$$\Sigma_{yy}\left(\theta\right) = \Lambda_y\left(I - B\right)^{-1}\Gamma\Phi\Gamma' + \Psi\left[\left(I - B\right)^{-1}\right]'\Lambda_y' + \Theta_\varepsilon, \text{ (6)}$$

$$\Sigma_{yx}\left(\theta\right) = \Lambda_y\left(I - B\right)^{-1}\Gamma\Phi\Lambda_x', \text{ (7)}$$

$$\Sigma_{xy}\left(\theta\right) = \Lambda_x\Phi\Gamma'\left[\left(I - B\right)^{-1}\right]'\Lambda_y', \text{ (8)}$$

$$\Sigma_{xx}\left(\theta\right) = \Lambda_x\Phi\Lambda_x' + \Theta_\delta. \text{ (9)}$$

Based on the above the maximum likelihood criterion to be *maximized* is (Bollen, 1989, p.335) is

$$F_{ML}\left(\theta\right) = -\left(\log\left|\Sigma\left(\theta\right)\right| + tr\left(S\Sigma^{-1}(\theta)\right)\right) + \log|S| + (p+q),$$

where "S is the empirical covariance matrix, the last two terms can be omitted and a "quick" necessary condition for identification is $d \leq \frac{1}{2}\left(p+q\right)\left(p+q+1\right)$."

Suppose $L\left(\theta; D\right)$ is the likelihood function of the model where D denotes all available data on x and y. Denote $\mathcal{D} = \left[x_i, y_i; i = 1, \ldots, N\right]$, $D_i \equiv \left(x_i, y_i\right) \in \mathbb{R}^{d_D}$. We assume the data are in deviations about their means to simplify notation. The parametric likelihood of the SEM is:

$$L\left(\theta; \mathcal{D}\right) = \left(2\pi\right)^{-\frac{N\,p+q}{2}}\left|\Sigma\left(\theta\right)\right|^{-N/2}\exp\left(-\tfrac{1}{2}\sum_{i=1}^{N}D_i'\Sigma\left(\theta\right)^{-1}D_i\right). \quad (10)$$

To arrive at a practical non-parametric specification, we proceed in the following steps.

<u>Step 1</u>: Based on (10) we specify the likelihood as $L = L\left(\theta_i\right), i = 1,...,N$ so that all parameters are made observation-specific.

<u>Step 2</u>: We use the local likelihood concept by localizing each parameter, so that the entire vector of parameters localized at a data point D is:

$$\theta(D) = a_0 + A_0(D - D_i), \quad (11)$$

where α_0 is a vector and A is a matrix of parameters. In particular when $D = D_i$ then the value of the parameter is $\theta(D_i) = a_0$. We define:

$$\alpha = \left[a_0', \text{vec}\left(A_0\right)'\right]'.$$

<u>Step 3</u>: Then, we define the local log likelihood criterion instead of (10) in the usual manner, localized at a point D :

$$logL_D(\theta; \mathcal{D}) = \sum_{i=1}^{N}\left\{-\tfrac{p+q}{2}\log(2\pi) - \tfrac{1}{2}\log|\Sigma(\theta_i)| - \tfrac{1}{2}D'_i\Sigma(\theta_i)^{-1}D_i\right\}K_B(D - D_i), \quad (12)$$

We can localize parameters of the covariance matrices Ψ, Θ_ε and Θ_δ. If Ψ is a general positive definite matrix, we use the Cholesky decomposition $\Psi = H_\Psi' H_\Psi$ where H_Ψ is a lower triangular matrix with $\frac{m(m+1)}{2}$ free elements. Moreover, there are p and q free elements in Θ_ε and Θ_δ. Suppose the elements of H_Ψ are denoted by $h_{(s)}^\Psi, s = 1,...,\frac{m(m+1)}{2}$ and the elements of Θ_ε and Θ_δ are $h_{(s)}^{\Theta_\varepsilon}, s = 1,...,\frac{p(p+1)}{2}$ and $h_{(s)}^{\Theta_\delta}, s = 1,...,\frac{q(q+1)}{2}$ respectively, where the diagonal elements (variances) of Θ_ε and Θ_δ are $\exp\left(h_{(s)}^{\Theta_\varepsilon}\right), s = 1,...,\frac{p(p+1)}{2}$ and $\exp\left(h_{(s)}^{\Theta_\delta}\right), s = 1,...,\frac{q(q+1)}{2}$ respectively.

Collect all these parameters in $h = \left[h_{(s)}, s = 1,...,s^*\right]$, where $s^* = \frac{m(m+1)}{2} + \frac{p(p+1)}{2} + \frac{q(q+1)}{2}$. We localize these parameters at D as follows:

$$h_{(s),D} = h_o + H_o(D - D_i), i = 1,...,N, \quad (13)$$

We choose:

$$K_B(u) = |B|^{-1}K(B^{-1}u), \quad (14)$$

where B is a bandwidth matrix parameter.

For the kernel function we assume:

$$\int K(u)dx = 1, \int uu'K(u)du = m_2 I, \quad (15)$$

for some positive constant m_2. The kernel function is chosen as a product of univariate kernels along the lines of Kumbhakar et al. (2007, section 2.3).

Specifically, we use:

$$K(u) = \prod_{j=1}^{d_D} K_o(u_j), \quad (16)$$

where "$K_o(u)$ is a symmetric univariate probability function (the standard normal in our case) and D denotes the dimensionality" (Tsionas and Matmazakis, p. 642) . In this case:

$$\int uu'K(u)du = \left[\int u_o^2 K_o(u_o)du_o\right] I_{d_D}. \quad (17)$$

The "local likelihood criterion in (12) can be maximized using standard numerical optimization techniques to yield local linear estimates $\hat{\alpha}(D_{it})$. The local linear estimator at D is $\hat{\alpha}_o(D)$ where $\hat{\alpha}(D)$ maximizes (11). The asymptotics of the estimator under general regularity conditions are provided in Theorem 2.2 of Kumbhakar et al. (2007. Initial conditions are chosen as described in section 3.1 of Kumbhakar et al. (2007) in connection to Gozalo and Linton (2000)" (see Tsionas and Matmazakis, p. 643).[1] Regarding bandwidth selection, refer to Kumbhakar et al. (2007).

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[1] We used again the filterSD software which is written in Fortran77.