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Published online: 24 Jun 2021.

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Forecasting a post-COVID-19 economic crisis using fuzzy cognitive maps: a Spanish tourism-sector perspective

Julio Vena-Oya [a], José Alberto Castañeda-García [b] and Miguel Ángel Rodríguez-Molina [b]

aUniversity of Jaén; bUniversity of Granada

ABSTRACT

Those in positions of leadership are accustomed to having to deal with complex and uncertain situations. However, the on-going COVID-19 pandemic has taken this challenge to a new level of complexity. Although econometric models are being used to predict economic scenarios relating to the fall-out from the pandemic, these forecasts do not factor-in the uncertainty generated by new changes announced weekly by policymakers. The aim of the present study is therefore to apply a *fuzzy* approach to develop a method for providing consistent and reliable forecasting scenarios that facilitate managers' and policymaker's decision-making in complex and uncertain situations. The chosen context of the study is the case of the potential consequences of COVID-19 for the international tourism sector in Spain, using fuzzy cognitive maps. This semi-quantitative model can help researchers to forecast the potential impact of major events in fuzzy or uncertain environments by constructing flexible and adaptable scenarios.

1. Introduction

The COVID-19 pandemic has brought about dramatic change for tourism as it was long known and understood. Issues of major concern, such as overtourism (Seraphin et al., 2018), including environmental sustainability (Isik et al., 2018) and destination sustainability (Nunkoo & Ramkissoon, 2010), and low-cost tourism (Eugenio-Martin & Inchausti-Sintes, 2016), are no longer center-stage. Today's tourism-stakeholders' efforts must be redirected toward the recovery of the entire sector (Zhang et al., 2021) and the new challenges that tourism is now facing due to the pandemic, such as tourist perceptions of risk or behavioural factors (Villacé-Molinero et al., 2021). These and other issues are continually shifting as new ones emerge.

When dealing with such highly-complex and uncertain situations, governments may have no previous data on which to draw in making their projections. Furthermore, econometrics and quantitative methods are not always well-suited to forecasting the potential consequences of unstable scenarios on a national or international scale. In terms of drawing comparisons to assist in making predictions, there has been only one other pandemic in the twenty-first Century (influenza A-H1N1 or swine flu), but its consequences are not comparable with those of COVID-19 (either in terms of contagions or mortality levels). Nor did it have such a radical impact on the world economy, particularly in the case of the tourism sector.

In light of the paucity of comparative information, it is necessary to complement the quantitative data currently provided by institutions such as the International Monetary Fund (IMF) with *semi-qualitative* data that take into account the fuzzy and asymmetric nature of some scenarios when

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CONTACT Julio Vena-Oya ✉ jvena@ujaen.es

modelling future projections (Carvalho & Tomè, 1999). The aim of the present research is therefore to show how semi-qualitative methods may be better-suited than traditional econometric modelling to addressing the needs of the COVID-19 age. In this regard, Fuzzy Cognitive Mapping (FCM) can provide a particularly useful tool (Nair et al., 2019).

To exemplify how fuzzy cognitive maps (FCMs), combined with a scenario-building methodology, can assist decision-making, the present study is based on a case study that seeks to forecast the potential impact of the COVID-19 pandemic on Spanish inbound tourism. When assessing which new measures to impose as the crisis unfolds, policymakers are advised by expert panels. In the present study, then, we draw on expert opinion to predict the economic impact of the pandemic by constructing a model that takes into account the fuzziness of two variables critical for tourism recovery: a resumption of inbound tourism in Spain through the reactivation of air traffic, and the incidence of COVID-19 outbreaks.

Having selected a panel of international tourism experts, from 15 June to 15 July 2020 we gathered data from this panel on their predictions for (i) the reduction in the volume of inbound tourism to Spain, the reduction in air traffic arrivals to Spain, the probability of new outbreaks of COVID-19 in Spain in 2020, and (ii) the relationships between these variables and a potential post-COVID economic crisis in Spain. In a second phase, conducted three months later (15 October 2020), we checked the validity of the experts' forecasts. We then created FCMs to develop three empirical scenarios envisioning a post-COVID economic crisis, taking as a benchmark the known economic effects of the most recent Global Financial Crisis (GFC) in 2008, based on the expert knowledge of our panel members. The three empirical scenarios were (1) pessimistic outlook (outbreaks + restricted air traffic); (2) panel-predicted scenario (high probability of outbreaks + moderate air traffic); and (3) optimistic outlook (vaccine).

Our rationale for taking the perspective of inbound tourism to forecast the potential economic impact of the COVID-19 pandemic in Spain is threefold. First, tourism is the primary sector of activity in the Spanish economy; second, following the 2008 GFC, it was thanks to this sector that the Spanish economy recovered relatively quickly; and third, the extensive measures imposed by governments to bring the pandemic under control, including severe restrictions on travel, hotel services, and so on, have rendered international tourism among the most gravely-affected sectors in this global health crisis.

While the present case study analyzes post-COVID-19 scenarios in terms of their potential impact on Spanish inbound tourism, using the FCM methodology, the FCM approach could also be extended to other sectors and countries wanting to forecast the various potential economic consequences of major, high-impact disasters with many unstable variables.

2. Literature review

2.1. Pandemics and tourism

By the time the SARS epidemic had been contained, in 2003, the virus had caused a dramatic decrease in international tourist arrivals in many Asian destinations (Bustelo & Isbell, 2003). More recently, the swine flu and avian flu outbreaks, coupled with the global financial crisis of 2008 (hereafter, 2008 GFC), had a direct combined impact on international tourist arrivals generally, which fell by more than 39 million in 2009 (Leggat et al., 2010; Wilder-Smith, 2006). In these cases, the outbreaks were limited to certain parts of the world (mainly Asian and Pacific areas), yet nevertheless affected the entire international tourism market. Following the outbreak of a new coronavirus – COVID-19 – in December 2019 in Wuhan, China, it quickly escalated into a global pandemic. By October 2020, more than 40 million people had been infected, and more than 1.1 million had died from complications of the virus (WHO, 2020). India, the United States, and Brazil were the most heavily-affected countries in terms of the COVID-19-related death rate globally, while France and Spain were the hardest-hit European countries.

Given the scale and complexity of this pandemic, unprecedented in the twenty-first Century, it is difficult to predict its ultimate impact on the global economy and, in particular, on sectors that rely on international travel, such as tourism (UNWTO, 2020a). It is known, however, that tourism, and especially international arrivals, are deeply affected by global crises (Ritchie, 2008).

According to the Organization for Economic Cooperation and Development (OECD), in 2018, the tourism sector accounted for more than 4.4% of GDP and almost 6.9% of all employment (OECD, 2020). In the case of Spain, the figures were even more striking: 12.3% of GDP and 12.7% of all employment, with tourism accounting for 2.7 million jobs (INE, 2020a). The current crisis provoked by the COVID-19 pandemic is therefore expected to exert a deep and lasting effect on the Spanish economy and particularly on international tourism, which accounted for more than 33% of total tourism arrivals in 2019 (INE, 2020b). Furthermore, unlike the 2008 GFC, when the tourism sector helped sustain the Spanish economy, this time, with severe travel restrictions in place for the foreseeable future, tourism can no longer function as an economic driver for the country.

In their forecasts on the impact of the post-COVID economic crisis for Spain, institutions such as the IMF[1] and the Banco de España (BDE, 2020) are predicting a reduction in GDP for 2020 of more than 12% and a partial recovery of the economy (around 7% in GDP) for 2021. These predictions are based on the economic indicators used in econometrics models. But the current situation is dominated by uncertainty. New and drastic measures – lockdown, curfews, time restrictions, quarantines, capacity restrictions, and so on – that make a critical impact on the economy are announced each week. Policymakers and managers are therefore taking decisions with far-reaching consequences while impeded by a complex and continually-changing set of circumstances (Xu & Yager, 2008), because even those econometric models with the best predictive power struggle to process such volatile shifts. Other predictive methods better-suited to such environments are needed.

2.2. Managing the pandemic in the Spanish tourism sector

We focus on the case of Spain, where tourism is a key sector accounting for 12% of GDP and 13% of total employment (three times and twice the OECD average, respectively) (INE, 2020a). As noted earlier, this sector was especially resilient to the 2008 GFC (Santamaria & Filis, 2019). Regarding tourist travel, 2019 saw a total of 256 million trips, 67% of which related to domestic tourists (173 million trips) and 33% to international arrivals (83 million) (FAMILITUR, 2020; INE, 2020b).

In terms of seasonality, inbound tourism in Spain is quite stable throughout the year, with certain peaks in the summer months, with the exception of the Balearic Islands, where 65% of foreign tourists arrive between June and September. The United Kingdom (UK) accounts for most of Spain's inbound tourism (18 million arrivals in 2019), followed by France and Germany (11 million each). Overall, the European Union (EU) is the most important market for Spain, accounting for 40% of total inbound tourism (INE, 2020b). Regarding preferred transport, airlines accounted for more than 82% of total international tourism arrivals to Spain in 2019 (69 million tourists), followed by car (15%), ship (including cruise tourism) (approximately 2%), and train (less than 1%).

3. Methodology

3.1. Forecasting the impact of the economic crisis generated by COVID-19 and the decline in inbound tourism: the scenarios method

In the case of COVID-19, Spain was among the first European countries to be affected by the original outbreak and the first one to suffer a new outbreak after the first wave. As the second most-visited country in the world (UNWTO, 2020b), where tourism is the primary economic sector, the current pandemic is of grave concern given its impact on tourism, which is crucial for the recovery of the national economy. To predict the impact of the pandemic, we take a scenario-based approach.

According to Jordán (2016), the analysis and construction of scenarios are based on answering 'what if … ?' questions, imagining and outlining future alternatives (Barma et al., 2016). Kahn and Wiener (1967) defined scenarios as 'attempts to describe in some detail a hypothetical sequence of events that could lead plausibly to the situation envisaged.' More recently, Godet and Durance (2009) defined them as 'a set formed by the description of a future situation and the course of events that enables one to progress from the original situation to the future situation.'

Such scenarios are not built on evidence showing the causal relationship between variables, taking into account their respective weights. Rather, they are based on provisional *assumptions* about causal relationships (Bernstein et al., 2000). This method does not endeavour to predict the future but simply to represent how different alternative futures might look, in light of certain variables (Godet & Durance, 2009).

To construct the scenarios, both quantitative and qualitative data can be used to characterize the main variables that shape the scenarios in question. In light of the high degree of uncertainty and ongoing change being generated by the COVID-19 pandemic, a modelling technique that provides greater flexibility – such as FCM – would appear to be more fit-for-purpose and more likely to produce scenarios that are free from the assumptions that typically affect econometric modelling.

FCM is a decision support tool used to analyze causal-based systems in terms of modelling, decision-making, prediction, or behaviour, among other purposes (Bakhtavar et al., 2020). Although it was originally developed several years ago (e.g. Kosko, 1986), this tool has been widely applied in the recent literature, thanks to the advantages it offers over purely quantitative approaches (e.g. Luo et al., 2020; Yuan et al., 2020). FCMs are fuzzy-graph structures for representing complex problems, and they are widely used in tourism studies (e.g. Estêvão et al., 2019; Kardaras et al., 2013) and other behavioural-science disciplines (Papageorgiou & Salmeron, 2013). FCM is used in conjunction with scenario analysis, for example, to help policymakers predict different hypothetical situations (Amer et al., 2013).

When modelling complex realities, FCMs are equipped to model the dynamics of causal relations as perceived by experts, enabling the causal variables to capture various states or levels at various points in time. The causes will have a dynamic effect as a result of a change in the state or the level (that is, the causal relationship may be non-linear, non-monotonic, or asymmetric). It is this flexibility that supports the integration of FCMs in the scenario-building methodology (Jetter & Kok, 2014; Kok, 2009).

3.2. Constructing theoretical scenarios: key variables

To construct the different scenarios, we followed the nine-step procedure described by Jordán (2016), as follows:

Step 1. Define the basic parameters of the analysis

Using fuzzy approximation, this study aims to predict the probability of an economic crisis in Spain that is worse, in terms of its economic consequences, than the 2008 GFC, due to the impact of COVID-19 on the inbound tourism sector in particular.

Step 2. Identify the research needs

Before the scenarios can be constructed, we must identify the appropriate sources of data about the current context. As noted earlier, we opted to compare objective data with fuzzy knowledge, using observed data published by the Spanish National Statistics Institute (INE, 2020b) and an international tourism expert panel as our two main data sources.

Step 3. Identify the main variables

We identified two main variables in the case of the Spanish tourism sector: the lifting of restrictions on international air travel and tourists' perceived risk of a new outbreak of COVID-19 in Spain. First, as travel by air is the main means of arrival into Spain for international tourists, due to the geographical location of Spain, inbound tourism will struggle to pick up as long as airlines are forced to cut back on flights. Second, previous pandemics such as SARS or avian flu had only a short-term negative impact on international arrivals due to the low perceived risk of new outbreaks (Sio-Chong & So, 2020). Nevertheless, as we highlighted in the literature review, the perceptions of a disease among potential tourists and its associated risks are important indicators that are known to alter travel patterns, adversely affecting international arrivals in particular (Cahyanto et al., 2016; Reisinger & Mavondo, 2005).

Step 4. Identify basic trends

There are no precedents for such a global pandemic in recent years, but the analyses undertaken following outbreaks of other diseases in the twenty-first Century – SARS, avian flu, and swine flu – may provide useful insights into potential trends in this present crisis vis-à-vis inbound tourism. The general trend observed in these previous crises was a deep and sudden decline in international arrivals in the affected parts of the world – with repercussions beyond the local level and a negative impact on employment and economies worldwide. Regarding the drop in international arrivals, 60% of inbound tourism was lost in the hardest-hit areas (Bustelo & Isbell, 2003; Sio-Chong & So, 2020) and there was an 8% decline globally (Cao et al., 2017; Leggat et al., 2010). Regarding employment, it is difficult to calculate with any accuracy how many jobs were lost as a result of these previous pandemics, but overall trends suggest that the true impact on tourism employment will only be seen in the long-term, as a knock-on effect of the decline in international arrivals. We can infer, then, that the variable of international arrivals tends to be highly sensitive to global health crises (Cahyanto et al., 2016; Reisinger & Mavondo, 2005).

Step 5. Identify the game-changers

In view of the previous data, it seems clear that a major new outbreak of COVID-19 could trigger a new crisis in international tourism, for example by leading to renewed restrictions on international air travel. By contrast, the development of an effective vaccine and its global accessibility by 2021 could change the situation, bringing with it the reactivation of international air travel and a return to healthier levels of tourism traffic. We therefore selected these three factors as our 'game-changers' – the variables that could change our theoretical scenarios. Table 1 summarizes the three game-changers we identified for our analysis.

Table 1. Game-changers.

A vaccine is made available in early 2021	Around 80 research groups in different countries are currently working on a vaccine for COVID-19.[a] In an optimistic scenario, this vaccine will be made available by early 2021. Here, the baseline assumption is that this development would imply a decrease in the perceived risk associated with COVID-19, and international travel would pick up rapidly.
A major new outbreak	A pessimistic scenario is a major new outbreak of COVID-19 in Spain by 2021, the complete shutdown of inbound tourism, and a potential failure of the sector.
Restrictions on international air travel lifted in 2021	Albeit unlikely, the scenario of a full resumption of international air travel (without restrictions such as quarantine or PCR test) by early 2021 is being considered. More realistic would be a lifting of restrictions by mid-to-late 2021, when a vaccine programme has been implemented.

[a]https://www.bbc.com/news/health-51665497

Step 6. Construct the theoretical scenarios

Taking into account the previous steps, four general theoretical scenarios arise out of the game-changers (see Figure 1).

The theoretical scenario in Quadrant 1 points to an early recovery of inbound tourism, due to international tourist flights being allowed again by the end of 2020 and potential travellers presenting a low perceived risk of a new outbreak due to the availability of a vaccine or a decline in new cases. In this theoretical scenario, the trend could be similar to that for previous pandemics such as SARS or avian flu, whereby inbound tourism suffers only a short-term effect and makes an early recovery by 2021. This quadrant must be discounted as Spain is already experiencing continued new outbreaks, and highly restrictive measures remain, or are being reintroduced, throughout Europe.

In quadrant 2, international airports are still not fully operational in early 2021 but there is a low perceived risk of a new global outbreak of COVID-19. People are keen to travel, so, despite the restrictions, inbound tourism could make a quick recovery in mid-2021. Again, the current data on the spread of COVID-19 in Europe, the UK, and other countries relevant to the Spanish tourism sector lead us to discount this theoretical scenario.

Quadrant 3 contemplates an early resumption of international air travel but a high perceived risk of a major new outbreak. Some people have serious reservations about travelling, but the losses would not be so serious because the lifting of restrictions on international air travel would enable
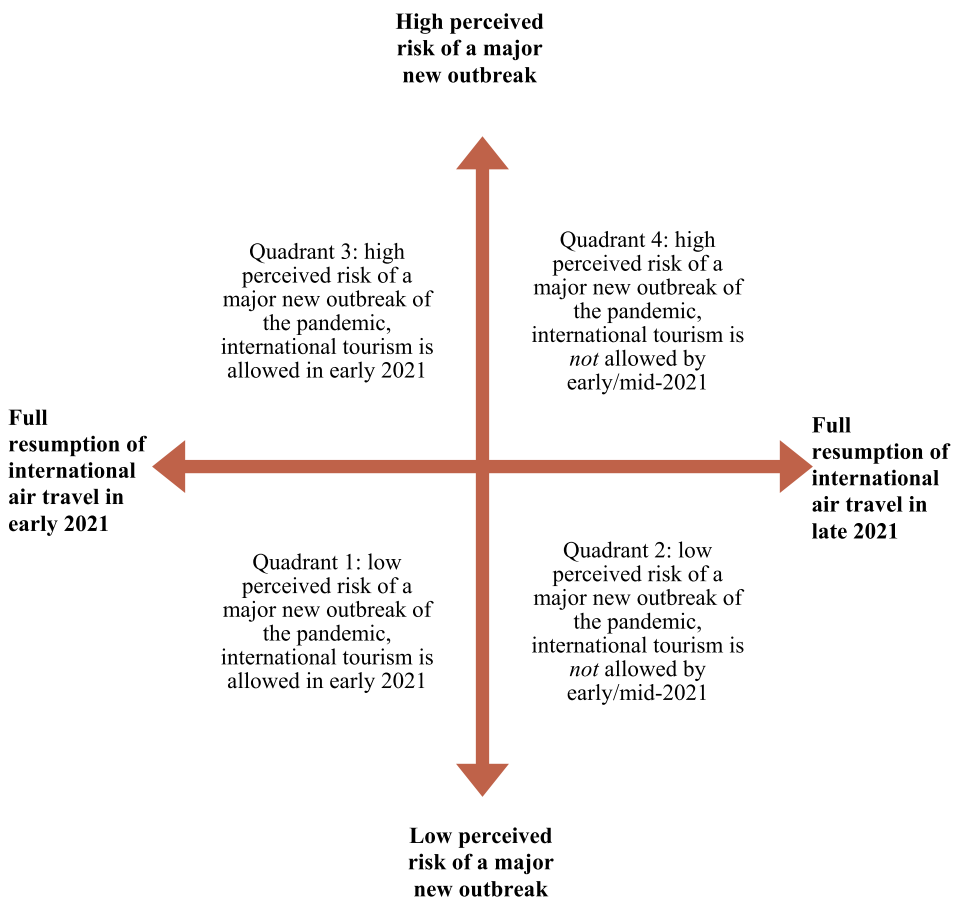

Figure 1. Theoretical scenarios.

those who wish to travel to do so. The recovery would be more gradual than in theoretical scenario 1, but countries would derive a minimal income from inbound tourism.

Quadrant 4 shows the most pessimistic theoretical scenario. The continued severe restrictions on international air travel combined with a perceived high risk of a major new outbreak in Spain would lead to the partial or total loss of international arrivals to the country for the whole of 2021. Countries would have to focus on domestic tourism (which will also suffer significant losses) while developing a strategy to revive inbound tourism.

Step 7. Check the internal consistency and plausibility of the theoretical scenarios

Once we had developed the theoretical scenarios shown in Figure 1, we consulted an international-tourism expert panel on the plausibility and validity of the main variables we had preselected to predict the scope of the economic crisis generated by the COVID-19 pandemic, from the perspective of the inbound tourism sector in Spain.

Between June 15 and July 15, 2020, we consulted a panel of 12 experts in tourism (academics and professionals) and in health (with expertise in tourism research) via a semi-structured questionnaire. Primarily, the questionnaire asked for their views on the main variables that could affect inbound tourism, the relationship between these variables, and the expected volume of international arrivals for the remainder of the 2020 summer season. To ensure the international scope of the study, eight out of the 12 experts were non-Spanish (from Europe, America, Asia, and Africa) with an average of 19 years' experience (standard deviation 7.77) in the field of tourism. Further details about the panel are shown in Appendix 1.

To construct the empirical scenarios, taking into account the total volume of international arrivals to Spain, the main drivers of the impact and length of the post-COVID economic crisis, according to the expert panel, were (1) the lifting of restrictions on international flights and (ii) tourists' perceived risk of a major new outbreak. Other variables, such as government support (subsidies and public aid), active promotion of the most badly-affected regions, or border control for incoming tourists, were also cited by the panel (with 8.3%, 8.3%, and 16.6% of the experts mentioning them, respectively). However, regarding these three particular variables, Collins-Kreiner and Ram (2020) conducted an analysis of seven countries, examining a range of measures proposed by the WTO. They found that Italy was carrying out two of the three: conducting extensive regional tourism promotion and taking steps to facilitate the entry of incoming tourists. Meanwhile, Austria was implementing just one of these strategies, following a policy of regional tourism promotion. Generally, where countries *are* implementing aid strategies, it is merely to mitigate the immediate effects of the crisis rather than to support the recovery and acceleration of the tourism sector. This is of grave concern, given that all countries worldwide have seen their air traffic restricted and have suffered new outbreaks of the virus.

As noted earlier, the perceived risk of an outbreak is an important indicator that can affect travel patterns, due to fears among international tourists regarding travelling by plane or governments' restrictions on international flights to the absolute minimum in response to escalating outbreaks (Cahyanto et al., 2016; Leggat et al., 2010; Reisinger & Mavondo, 2005; Uğur & Akbıyık, 2020).

The experts were asked to validate the relevance of the reactivation of air traffic and future major outbreaks of the virus in Spain in terms of determining the probability of an economic crisis; identify other variables that, in their opinion, were relevant; and make a three-month forecast of tourist arrivals, air traffic, and the probability of an outbreak of a similar magnitude to the initial outbreak in Spain. Finally, they were asked to build a map of relationships between the variables: resumption of international air travel (the arrival of inbound tourists was not included because most arrive by plane, so this would constitute redundant information in the model); a new outbreak; and economic crisis. For each relationship, the experts only had to mark the direction (positive vs. negative) and the effect size in qualitative terms (small, medium, large).

Regarding the validation of the key factors linked to the severity of the post-COVID-19 economic crisis, two extra factors raised by the experts were government assistance (such as business support) and health controls, such as polymerase chain reaction (PCR) testing. However, these variables were supported by just one-third of our experts, and only one of them attached more importance to public aids related to air traffic reactivation (such as tax breaks). In sum, the majority of the expert panel (58%) deemed air traffic reactivation the key factor that would revive the tourism sector in Spain. In turn, air traffic reactivation and the likelihood of a further global outbreak were deemed the key factors that would explain an economic crisis in Spain graver than that of 2008, due to the current challenges faced by the tourism sector.

To validate the opinions of the experts selected for the panel, we subsequently compared their initial predictions with the real data from Spain regarding inbound tourism volumes and air travel. The panel predicted that just 27% of the volume of international arrivals in 2019 would be achieved by the end of the 2020 summer season. Real data up to October 1, 2020, show that the volume of international arrivals was approximately 25% of the total arrivals for the same period (June/July to September) in 2019 (INE, 2020c). The experts also predicted that Spain's international airports would return to 40% of the volume of flights they handled in 2019. According to ENAIRE[2] (the public company that is the main provider of air navigation services in Spain), the data for air travel from January to September 2020 was 41.1%. The expert predictions on both these issues therefore provided a good fit.

Their predictions about the probability of an outbreak with a similar impact to the initial one provided less of a fit. The experts set this probability at 60%, but, by October, it was a known fact that this indeed was the case (that is, a 100% probability). Both the expert predictions and the observed data led us to discount quadrants 1 and 2, which are based on a low probability of major new outbreaks.

Step 8. Configure the final set of empirical scenarios

With the internal validity and plausibility of the theoretical scenarios verified, we proceeded to configure three empirical scenarios into the general theoretical scenarios, as follows:

Data-based scenario: Assuming that the data available in October 2020 will continue to be valid for 2021, in this scenario, there is very limited air traffic in Spain, representing just 25% compared to the same period (July, August, and September) in 2019 (AENA, 2020[3]), and there will unquestionably be further outbreaks to deal with. This empirical scenario corresponds to quadrant 3, far from the origin in the Figure 1 intersect. This is a pessimistic scenario, considering the current evolution of the pandemic.

Experts' scenario: This is based on the predictions made by the expert panel, summarized in previous paragraphs, who forecast a recovery in air traffic in the 2020 summer season of approximately 40% and a 60% probability of new outbreaks similar to the initial one. This scenario must be placed in quadrant 3, close to the origin of the quadrants. This is a moderate scenario.

Vaccine scenario: This empirical scenario takes as a hypothesis the development of an effective vaccine that limits the probability of new outbreaks (50%) and that allows the removal of restrictions on international air traffic, at least for EU countries (which account for 70% of the international arrivals to Spain). This optimistic scenario is based on the forecast that herd immunity would not be reached until the end of summer 2021,[4] when it is anticipated that between 50% and 60% of the European population will be immunized.[5,6]

Step 9. Assess the implications of each empirical scenario

Once we had identified the empirical scenarios, we generated FCMs to assess the influence of each scenario in terms of generating a possible post-COVID-19 economic crisis worse than the

2008 GFC. This semi-quantitative method requires both a cognitive map (Axelrod, 1976) and causal-reasoning representation (Kosko, 1986).

First, a cognitive map – a signed digraph in which nodes are variable concepts and edges are causal connections – is represented. The cognitive maps are derived from the links established by the experts between the three variables (air traffic reactivation, outbreak probability, and economic crisis) (Figure 2). The lifting of restrictions on international air travel with no vaccine in place would increase the impact of an outbreak, so the relationship between these two variables is positive. On the other hand, the lifting of restrictions on international air travel would contribute to a recovery of the sector, reducing the likelihood and/or impact of an economic crisis. Finally, a major new outbreak would lead to new restrictions and revive fears among tourists, which could result in a serious risk of a deep economic crisis.

The FCMapper package in R[7] was used to develop the FCM. To run the algorithm, a matrix with quantitative values for the links in the cognitive maps must be added. The correlations were assigned by the experts, who were consulted on the relationship (small, medium, large) between the variables. To quantify the correlations, we followed Cohen's guidelines (1988). We assigned a small relationship a weight of 0.1, 0.3 for medium, and 0.5 for large. To check the internal consistency of the method, we introduced the weighting recommended by Asuero et al. (2006) into the software (S = 0.25; M = 0.65; L = 0.85), which produced fairly similar results to Cohen's weights, although there were substantial differences between the two proposed effect sizes (see Appendix 2). The relationship between air traffic reactivation and new outbreak is 0.43; between air traffic reactivation and economic crisis −0.33; and between outbreak and economic crisis 0.375.

Finally, we introduced the three empirical scenarios as activating vectors to create the possible evolution of an economic crisis. The three hypothetical situations were described previously. In the expert scenario, as noted earlier, the experts predicted air traffic of about 40% (compared with 2019), while (in July 2020) they set the likelihood of a new outbreak at 60%. So the first scenario-activation vector is (0.4, 0.6). However, in October, we can confirm with observed data that the air traffic by the end of the summer season was approximately 25% of that in 2019, and that we are currently immersed in a new outbreak (a known fact, 100%), so the data scenario vector is (0.25, 1). This empirical scenario is worse than those predicted by the experts.

Lastly, for the vaccine scenario, we needed to make some assumptions. Drawing on the latest information published in *The Lancet* about a possible COVID-19 vaccine, outbreaks, and air traffic, the renowned authors Peiris and Leung (2020) conclude that: (1) the 'WHO recommends that successful vaccines should show disease risk reduction of at least 50%, with 95% CI that true vaccine
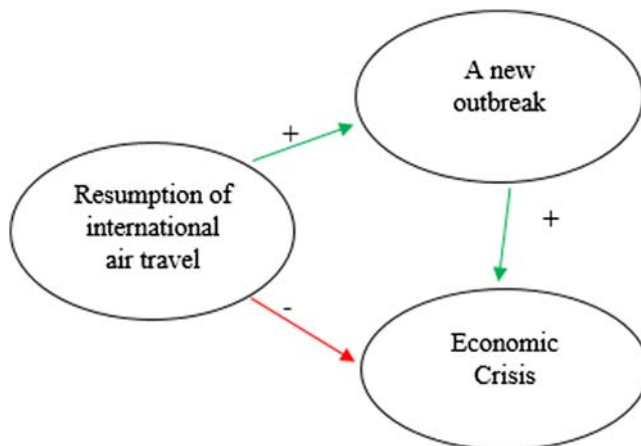
Figure 2. Cognitive and causal reasoning map.

efficacy exceeds 30%. Nevertheless, the Pfizer vaccine has demonstrated an efficacy of 95% (Mahase, 2020). However, the impact of these COVID-19 vaccines on infection, and thus transmission, is not being assessed. Even if vaccines were able to confer protection from disease, they might not reduce transmission similarly' (Peiris & Leung, 2020); and (2) if international travel were to fully recommence, ' … no country will be truly protected from COVID-19 until virtually the entire world is.'

Based on conclusion 1, we can take a 0.5 probability of new outbreaks as an optimistic scenario given that only 50–60% of the EU population will be immunized at the beginning in the first half of 2021 and herd immunity will not be achieved at this point. Regarding conclusion 2, according to the data published by the Spanish Air Transport and Logistics Observatory[8] for 2018, the volume of international passenger arrivals from EU countries excluding the UK (51 million) was approximately 55.4% of the total volume of international arrivals (91.2 million), while internal air traffic stood at about 40 million. Assuming that national air traffic and inbound traffic from the EU will recover, Spain would be in a recovery scenario of 70%. In summary, the vaccine scenario is characterized by the activation vector 0.7, 0.5. This could be considered an optimistic scenario.

4. Results

When generating FCMs, we need to assess whether the model will coalesce around a stable state. By maintaining the initial conditions of the weight matrix through time and considering an initial steady-state vector (a value of 1 for each element of the vector), we can determine if the model reaches a steady-state outcome (Kosko, 1986). The square matrix of the cognitive map is multiplied by an initial vector, then the resulting vector is subject to transformation using a logistic expression $(1/ (1 + e{-}1^{xx}))$ to restrict the results to the interval [0,1]. This new vector is then multiplied by the original matrix and again subject to the logistic function, repeating these steps until a steady state is obtained. We can then run hypothetical 'what-if' scenarios, where the reactivation of air traffic and the probability of new outbreaks are set, to compare the outcomes in terms of the probability of a harsher economic crisis than the 2008 GFC.

We used the FCMapper package in R (Turney & Bachhofer, 2016) to compute the process described in the previous paragraph. In the steady state, we obtained the centrality index for each variable. Its value reflects the relative importance of each variable in the model. For the research question we analyzed, the three variables presented similar values, with a slightly higher centrality parameter for the probability of new outbreaks (see Table 2).

Table 3 shows the outcomes for the different simulated scenarios. The results of the FCM suggest that, in the current data-based situation, the probability of an economic crisis worse than the 2008 GFC is high. Even in the vaccine scenario, within a realistic theoretical scenario, we can infer that Spain faces a high probability of heading toward a serious crisis. Here, we should remember that the 2008 crisis reduced GDP per capita to its early-2000s level.

5. Discussion, conclusions, and implications

Regarding the impact of the COVID-19-related safety measures on Spain's economy, the Banco de España[9] estimates that restrictions on mobility explain approximately 35% of the drop in Spanish

Table 3. Outcomes of the FCM model for the empirical scenarios.

Empirical scenario	Activation vector		Outcome
From the more pessimistic to the more optimistic	Air traffic reactivation	Outbreak probability	Probability of worse economic crisis than the 2008 GFC
Data-based scenario	0.25	1.00	0.74
Experts' scenario	0.40	0.60	0.69
Vaccine scenario	0.7	0.50	0.65

GDP in 2020, while the reduction in tourism-related journeys accounts for 20%. Rather than taking a retrospective view, our study adopted a prospective approach by constructing scenarios and drawing on the combined knowledge of an international expert panel. The results of our analysis indicate that the possibility of a major new outbreak of COVID-19 in Spain and the related restrictions on movement have a marginally greater relevance (centrality parameter = 0.805) in explaining the probability of a worse economic crisis than the 2008 GFC than the reduction in tourism-related air travel (centrality parameter = 0.760), albeit with less marked differences than those identified by the Banco de España. The reason for this latter discrepancy might be that the scenarios we modelled already included greater control of COVID-19 outbreaks and, accordingly, the removal of some mobility restrictions.

With regard to the volatility of the forecasts produced by econometric models, in October 2020, the IMF predicted an increase of 7.2% in Spanish GDP for 2021,[10] but, just three months later, revised this figure downward by approximately 20%. Taking a fuzzy perspective grounded in the opinions of our expert panel, we concluded that, even in very different scenarios, this methodology can be used to estimate the probability of an economic crisis worse than the 2008 GFC in Spain with just 9 percentage points of variance (between 65% and 74%).

The 2008 GFC lowered the GDP per capita by 2.575€, taking the Spanish economy back to levels last seen in the early-2000s. However, the impact of that crisis on the tourism sector was minor, with international arrivals and local tourism both witnessing a drop of just 4% in 2009 and a total recovery by 2010. Unlike the 2008 GFC, the COVID-19 pandemic affects *primarily* the tourism sector. The total loss of one of the key sectors of the Spanish economy would trigger a profound economic crisis for the country, particularly if we take into account that this sector was critical to Spain's 2008 recovery.

The results of the present study provide a new perspective on recent econometric forecasts because those predictions do not, and cannot, take into account the new restrictive measures that governments are introducing almost week-by-week in response to evolving data on the pandemic. The present paper complements the results of econometric estimates with a fuzzier perspective that does not attempt to quantify reductions in GDP but rather draws on expert knowledge and nuanced opinion, which is what should count when states are making decisions on issues of such magnitude.

In addition to this primary contribution, the present study also makes other contributions, on the methodological level. First, we test the validity of an expert panel to predict complex and uncertain problems. Second, we employ a flexible, user-friendly, and inexpensive methodology to draw future scenarios. Although FCMs are not new, we successfully adapted the methodology to the COVID-19 problem, drawing on expert knowledge to build the different hypothetical scenarios. In the future, the econometric models used to predict economic growth could benefit from fuzzy information being included in the estimation – that is, this method could be usefully adopted in other sectors (and other countries dealing with other large-scale, complex problems), thanks to its robustness.

Notably, even with crucial modifications, the results remain similar (see Appendix 2, where comparable results are achieved even after the transformation parameters are modified from fuzzy to numerical links). This is because the model seeks a steady state. Furthermore, FCM provides the flexibility needed to obtain different scenarios depending on the evolution of the variables under analysis. It does not require multiple surveys and is not inordinately time-consuming (a vital consideration in crisis situations) as it is designed to be able to gather the accumulated knowledge of an expert panel. The present paper seeks to contribute to the research direction proposed by authors such Woodside (2019) regarding asymmetric modelling – in this case, focusing on the tourism sector and the decision-making of policymakers during times of high uncertainty (e.g. Işık et al., 2020).

Regarding the literature dealing with various aspects of the COVID-19 phenomenon, this paper contributes a novel semi-qualitative methodology that will provide both researchers and policymakers with a reliable system for decision-making based on stable and accurate scenarios in a turbulent environment. This focus brings a fresh perspective that complements current research concerned with the prediction of tourist behaviour (Arbulú et al., 2021), the new challenges

facing the sector (Villacé-Molinero et al., 2021), or the impact of the pandemic on the tourism sector (Lee & Leung, 2021; Sigala, 2020).

Finally, the conclusions of our study are shaped by certain limitations. For example, the results depend on the expert panel selection, and this part of the process requires particular care to be taken. We endeavoured to reduce the potential impact of this limitation by evaluating the experts' predictive capacity and testing alternative scenarios based on observed data. Another limitation of the method is that we needed to select some method or other for converting the fuzzy links (small, medium, large) into numerical values in the weight matrix (in the event, we chose Cohen's effect-size values for our case study). The choice of method inevitably has some influence on the results, but we tested (see Appendix 2) that the results were robust when we used different values to transform fuzzy links into quantitative data.

Notes

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2. https://www.enaire.es/es_ES/2020_10_07/ndp_estadisticas_vuelos_septiembre_2020.
3. http://www.aena.es/es/corporativa/aena-registra-resultado-neto-negativo-1076-millones-euros-en-nueve-primeros-meses-ano-crisis-covid-19.html?p=1237548067436.
4. The herd immunity threshold is approximately 67% (Randolph & Barreiro, 2020).
5. https://www.rtve.es/noticias/20201227/claves-campana-vacunacion-espana/2061225.shtml.
6. https://www.theguardian.com/world/2020/dec/27/vaccination-rolls-out-across-europe-but-anger-remains-over-late-start.
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8. https://apps.fomento.gob.es/BDOTLE/visorBDpop.aspx?i=607 (data for 2018, last updated in November 2019).
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Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Julio Vena-Oya 🆔 http://orcid.org/0000-0002-8120-6590
José Alberto Castañeda-García 🆔 http://orcid.org/0000-0003-0805-3628
Miguel Ángel Rodríguez-Molina 🆔 http://orcid.org/0000-0002-3841-4706

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Appendices

Appendix 1

Expert 1: Assistant Professor at Endicott College of International Studies, Woosong University, Daejeon, South Korea. He is a crowdfunding consultant. He has 7 years of experience. His areas of research are crowdfunding, fintech, behavioural finance, islamic finance and service quality.

Expert 2: PhD in hotels management and full professor of hotel management, Faculty of tourism and hotels, Alexandria University. She has about 30 years of expertise. She was the head of the hotels management department.

Expert 3: Hotel Manager with 20 years of expertise. The hotel is located on a World Heritage Site recognized Spanish city.

Expert 4: Paradores Manager with 27 years of expertise. Paradores is a luxury hotel chain placed in iconic sites of the cities, such as castles. He is currently retired.

Expert 5: Director of international relations and knowledge management, economic innovation institute for Africa with 25 years of expertise in destination development and management. From Canada.

Expert 6: Principal Lecturer of Strategy and Marketing within the School of Sport and Service Management at a Brighton University with 15 years of expertise.

Expert 7: Senior lecturer at Laurea University of Applied Sciences in Finland. Head manager of various international projects tourism based. 23 years of expertise.

Expert 8: Senior HTA and Health Policy Researcher at Andalusian Regional Department of Health (area of HTA, AETSA) with 9 years of expertise.

Expert 9: PhD in Economics and full Professor at Andalusian School of Public Health with 20 years of expertise. His research encompasses the economic consequences of health policies.

Expert 10: Representative Manager of Paradores and Area Manager of Paradores Andalusia and Canary Islands with 20 years of expertise.

Expert 11: PhD in hotels management and full professor of hotel management, Faculty of tourism and hotels, Alexandria University. She has about 31 years of expertise. She was the head of the hotels management department.

Expert 12: PhD in Hospitality Management, Associate Professor, Hotel Studies Department, Faculty of Tourism and Hotels, Alexandria University. Certified Hospitality Department Trainer, from the American Hotel and Lodging Educational Institute (AHLEI), in the specialty of Front Office Management. He has 19 years of expertise.

Appendix 2

Asuero et al. (2006) weights (W = 0.25; M = 0.65; L = 0.85)

Table A1. Control Outcomes of the FCM model for scenarios (size effect from Asuero et al., 2006)

Scenario	Activation vector		Outcome
From the more pessimistic to the more optimistic	Air traffic recovery	Outbreaks probability	Probability worse economic crisis than 2008 GFC
Data scenario	0.25	1.00	0.699
Experts scenario	0.40	0.60	0.783
Vaccine scenario	0.70	0.50	0.627