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RESEARCH ARTICLE

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Air transport and tourism flows to islands: A panel analysis for southern European countries

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Abstract

Air transport is an essential component of the tourism industry, and the number, frequency, and capacity of flight connections may influence the level of tourism demand, especially for island destinations. This paper evaluates the influence of air transport on tourism arrivals to selected islands in seven southern European Union countries to determine the nature of the relationship between tourist arrivals and air transport, specifically, whether air transport services generate tourism demand or merely enable touristic flows. The paper uses panel data and applies an econometric model with justifications for endogeneity and dynamic issues. Results show a moderate impact of transport infrastructures on generating additional tourist arrivals; however, the model shows that air transport is a prerequisite to developing tourism demand and is not the only determinant in increasing tourist arrivals. Tourist arrivals appear more a determinant than a consequence of changes in-flight connections.

KEYWORDS
air transport, destinations, development, islands, tourism

1 | INTRODUCTION

Tourism has become crucial for the local development of many island economies and a major source of employment and foreign exchange earnings; thus, it has become a dominant economic sector on many islands (Seetanah, 2011), with some insular regional economies becoming highly specialised and focusing on tourism and related activities. Their geographical characteristics often represent distinct clusters within the national economy (Chen, 2006). Lack of investments, both in general and specifically in tourism facilities and attractions, a deficit in institutional accountability, a failure to plan and implement policies, and the presence of corruption have reduced the tourism potential of several small islands, illustrating the importance of appropriate policy formulation and implementation (Sharpley and Ussi, 2014).

The need to evaluate destination strategies and policies is observed in the case of the air transport sector because of the importance of this sector (Forsyth, 2008) in reducing time and space constraints, making island locations more accessible to visitors. In general, islands, particularly remote ones, face geographic, environmental, structural, and political constraints. Appropriate provision and management of air transport connections can reduce some of the constraints on tourism development. Transport services can support and encourage tourism demand (Bieger and Wittmer, 2006) by enabling a transition from an unknown or limited destination to a popular one. Simultaneously, tourism growth itself may increase demand for transport services to a destination. These two effects lead to the evolution of destinations, as noted in Butler's model of the destination life cycle (Butler, 1980).

The expansion of tourism, resulting in a luxury or exclusive destination, changing to a mass-appeal destination (to the benefit of some enterprises, including hotels, taxis, and local food producers), if not well managed, can also lead to negative effects and impacts on

residents and the environment in general, including the recently recognised problem of over-tourism (Mihalic, 2020). The tourism literature demonstrates that, while different positions exist on potential tourism development strategies, a stated central orientation is increasingly towards a more sustainable approach (Lim and Cooper, 2009), although according to Sharpley (2003), promoting sustainable or 'quality' tourism might not be as effective as the mass marketing approach in terms of economic performance (Kokkranikal et al., 2003). In the specific context of islands, Graci & Dodds (2010) and Carlsen and Butler (2010), among others, have addressed the importance of sustainability-oriented tourism development for islands because of their limited extent and resources. In addition, Ghina (2003) explored the status of sustainable development in small island developing states (SIDSs), stating that this approach has proven effective in reducing the negative impacts of tourism, a view supported more recently by McLeod et al. (2022). Sustainability principles and related policies in fragile territories are inevitably linked to transport impacts and policies, with tourism and transport being heavily responsible for island sustainability and economic development. Given these relationships, there is a clear need to pay particular attention to the carrying capacity of the destination level and nature of community involvement, dynamic political environment, and special interest activities (Lim and Cooper, 2009).

An examination of the relevant literature reveals numerous studies on tourism and air transport systems, particularly in the context of international tourism (Spasojevic et al., 2018). Air transport is one of the most regulated sectors. Countries that wish to develop international tourism often have to balance airline interests with tourism and community interests in determining their aviation policies (Forsyth, 2008). This study contributes to this argument by examining the role of air transport and related infrastructure in island tourism development. The analysis examined 13 islands and archipelagos of southern European Union (EU) countries, which were compared to evaluate the performance of local air transport infrastructure, tourism supply, and relevant local policies for transport and tourism. After describing insular characteristics in terms of geographic conditions and socioeconomic development, this study presents a focused literature review on transport and tourism, providing the basis for the theoretical framework used in the analysis. The illustration of the data and display of the results of the empirical research follow the presentation of the methodology used. Finally, the implications and contributions, both academic and operational, for further studies and decision-making processes for local administrators are discussed.

2 | RESEARCH CONTEXT: INSULARITY

Many studies have addressed the theme of tourism development in island regions, highlighting that islands must overcome several obstacles to reach a permanent and acceptable level of development and economic growth (Briguglio, 1995; Hampton and Christensen, 2007; Scheyvens and Momsen, 2008). Tourism plays a significant role in small island tourism economies (SITEs) as measured through indicators, such as aggregate tourism spending and tourist density. These indicators reveal three factors common to most SITEs: an extended and intense period of colonisation which led to the development of basic infrastructure and the establishment of market institutions after colonisation, geographic proximity to major global markets, and early post-war development of international tourism (Seetanah, 2011), which indicates that many small island economies rely heavily on international tourism for their economic growth. Schubert, et al. (2011) studied the impact on the economic growth of a small tourism-driven economy resulting from an increase in the growth rate of international tourism demand. They observed that an increase in the development of tourism demand led to an increase in general economic growth, confirming the tourism-led growth hypothesis (Durbarry, 2002), supported by Seetanah (2011), who identified a two-way correlation between tourism and growth.

The difficulties that islands encounter in reaching an acceptable and appropriate level of tourism demand can be ascribed to four categories: small size, remoteness, environmental vulnerability, and socioeconomic factors. Small size tends to imply dependence on the mainland to meet local demand, often because of limited natural resources, leading to a high propensity to import goods and services and an inability to produce locally (in terms of both quality and quantity), which tourists demand and consume (Sharpley and Ussi, 2014). Moreover, island nations (e.g. Malta and Cyprus) have limitations concerning raw materials, skilled labour, and technology, restricting their ability to compete in global export markets. Small size also implies a limited demand for domestic products and hence a dependency on imports, making it difficult for domestic industries to gain economies of scale. Remoteness causes high transportation costs, potential supply uncertainty, and consequent vulnerability to price volatility and exchange rate fluctuations.

Because islands are geographically isolated and are mostly reachable only by ships and airplanes, transport development is essential to make them accessible to markets and visitors (Warnock-Smith and Christidis, 2021). A relevant policy objective can then be to boost activities and services, such as transportation, while simultaneously limiting negative effects and containing threats linked to the expansion of tourism demand (Dorta Antequera et al., 2021). The positive and negative impacts of tourism on islands can be central to all aspects of island life (Croes, 2011; Croes, 2006; McLeod et al., 2021). Tourism to island destinations is often associated with the expectation that tourists will spend their holidays in a more natural setting with minimal development. Thus, there is a need to focus on product development efforts on arrangements consistent with local strengths, which is in line with the economic policies of respective governments, and incorporating the necessary investment for adequate infrastructure. Simultaneously, it is necessary to manage and mitigate the potential negative social and environmental impacts of tourism to ensure that this sector remains the dominant force in local development, as noted in research in the area of sustainable tourism and island development (Carlsen and Butler, 2010; Chen, 2006; Craigwell and Maurin, 2011; Graci and Dodds, 2010; Griffith, 2002; McLeod et al., 2022; Sharpley, 2003). Finally, socioeconomic barriers to

economic growth, particularly in the case of SIDSs, reflect heavy dependency on foreign aid, cooperation, and preferential trade agreements.

Island states have a strong tendency for migration, low and variable GDP growth, high unemployment and extensive under-employment, large public sectors that can restrict the private sector, and excessive bureaucracy, sometimes with corruption, as noted earlier (Christensen and Mertz, 2010; Guan and McElroy, 2012). Tourism, in these contexts, provides a realistic chance for independent (exogenous) economic growth and increasing standards of living and represents varying opportunities, such as an opportunity for the host government to obtain foreign exchange and tax revenues, the local population to gain income and employment, and to improve basic services and infrastructure, such as roads, airports, and utilities that the local people can use. This last opportunity is essential for enabling initial tourism development and encouraging further development. Moreover, there is often a distinctive cultural allure to islands that can motivate visitors to choose these destinations (Seetanah, et al. 2019).

The previously noted obstacles and limitations for island development and the general lack of developed tourist attractions, such as theme parks and museums, have implied that islands often focus their promotional efforts on sustainable tourism because of their inherent natural environments and attractions. Such a scenario is closely linked to transport infrastructure development, particularly air services, because accessibility is the most critical limitation for island tourism development in many cases (Martínez Raya and González-Sánchez, 2021). This study focuses on the role and importance of air transport services in stimulating and responding to tourism growth on islands. The literature review revealed a relative lack of attention to this issue.

3 | LITERATURE REVIEW ON TRANSPORT AND TOURISM

3.1 | Literature identification

While many studies have examined the effect of air transport services on regional development, very few have specifically analysed the relationship between tourism and transport flows (Favro et al., 2016) and their interlinked role in the growth process of a territory (Spasojevic et al., 2018). Even fewer studies have explicitly explored the relationship between air transport and tourism demand in the islands. No study has specifically analysed the relationship between air transport and tourism in the southern European islands, despite the great significance of these islands as major tourist destinations. In contrast to the traditional literature review approach, in which a researcher begins by describing the main studies on a specific topic and then discusses its evolution, this study first provides a general overview of the primary literature relating to air transport and tourism before focusing on the literature of direct relevance to the topic examined here, such as the relationship between air transport services and growth in island tourism demand. Statistics and variables were identified for use in subsequent analyses of this literature.

The first step was to conduct a systematic literature review using the Scopus database. Because it was anticipated that the number of studies in this specific field would be limited, it began with a broad approach using the keywords, such as 'Air transport and tourism' and 'Airport and tourism'. In this manner, the vast literature concerning studies on the relationship between air transport, airport policy, and the effect on tourism flows was obtained, regardless of whether the observed areas were islands or mainland territories. This research searched the fields 'Article Title', 'Abstract', and 'Article Keywords', obtaining a total of 933 documents, excluding any overlap between the two search labels.

Because this number was too large to allow individual analysis, in the second step, limitations were introduced to reduce the set of documents. Observing the variation in the number of publications over the years revealed that the main body of the literature was concentrated between 2010 and 2018. The research literature in this field increased markedly from 2010, reflecting European air transport liberalisation, which was completed in 2008. This liberalisation process improves the efficiency of air transport and reduces costs. A corresponding increase in air transport demand for leisure travel began in 2010, followed by the first analysis concerning the effects of the new air transport policy on tourism demand. Based on this consideration, it was decided to limit the literature research to 2010–2018, reducing the number of papers from 933 to 563. After excluding irrelevant and un-refereed studies such as conference proceedings, reports, magazines, and studies not in English, the number of results was further reduced to 429.

Given that the analysis is explicitly focused on the socioeconomic effects of the air transport policy on island tourism demand in this study, the literature search was further restricted to the following subject areas: social science (including environmental aspects), business, and economics. Thus, the number of studies was further reduced from 429 to 365. Finally, the focus was limited to documents included in journals that published more than five articles on a specific topic during the selected period. Authors who had published more than two papers on the subject had at least four citations or single published documents with at least eight citations. Thus, the number of relevant papers was reduced from 365 to 21.

The selected papers were analysed individually, resulting in the exclusion of six papers because they were not strictly focused on the chosen topic. The final 15 papers that passed this selection process were considered the starting point to identify the most important methodologies used and the results obtained by previous researchers, which would form the basis for selecting variables to be used in the subsequent analysis.

Tables 1 and 2 show the selected articles concerning the relationship between air transport activity and tourism demand, grouped by the prevailing issues and categories of most authors.

3.2 | Literature findings and research questions

As discussed earlier, there have been many studies concerning the effects of tourism and air transport on local economies, however

TABLE 1 Selected literature on air transport activity

Low-cost carrier (LCC)	Bieger and Wittmer, 2006; Rey et al., 2011; Taumoepeau et al., 2017; Alsumairi and Hong Tsui, 2017; Dobruszkes et al., 2016; Graham and Dennis, 2010; Wang et al., 2017
Full-service airlines/FSAs (airline that fly regularly offering a full service)	Bieger and Wittmer, 2006; Dobruszkes et al., 2016
Charter airlines (CA)	Bieger and Wittmer, 2006; Wu et al., 2018; Dobruszkes et al., 2016
Typology of passengers carried	Zhang et al., 2017

TABLE 2 Selected literature on tourism demand

People arrived in tourist accommodation	**Dobruszkes et al., 2016; Taumoepeau et al., 2017**
Number of stay in tourist accommodation of people arrived	Dobruszkes et al., 2016; Graham and Dennis, 2010; Tsui, 2017
People not resident arrived for different motivation: Study, work, second residences, and so forth	Alsumairi and Hong Tsui, 2017

there are very few concerning the interplay between air transport activity and tourism flow. Based on an examination of the relevant literature noted above, three specific questions were formulated to explore this relationship, which are discussed below.

3.2.1 | Q1: Are air transport flows and infrastructures limiting islands' tourism demand expansion?

How different authors had defined the terms 'tourism demand' and 'air transport activity' and what type of data they had used, were analysed and was relevant to this first research question (Q1). There is no single homogeneous definition for each of these terms, as each study used aggregations of different data, which generates serious problems when comparing the results. One issue is which variable should be considered as the dependent variable in estimating the relationship between tourism demand and transport activity. The authors have treated this issue in different manners. Although most authors agree that air transport liberalisation has produced a decrease in cost and an increase in the supply of air transport services, simultaneously producing growth in tourism, particularly in new forms of tourism and new destinations (Bieger and Wittmer, 2006), there was no convergence on the concept that a variation in air transport supply causes significant effects on tourist flows.

For example, Rey et al. (2011) highlight that low-cost carriers (LCCs) play an essential role in increasing tourism demand in Spain. Other authors have also considered the relationship between air transport and tourism (e.g. Alsumairi and Hong Tsui, 2017; Dobruszkes et al., 2016; Taumoepeau et al., 2017), providing empirical and theoretical evidence that strengthening air transport activity produces an expansion in tourism demand and employment generation (Cifuentes-Faura, 2021). However, other authors have presented the opposite view of the role played by air transport activity in improving tourist flows. For example, Wu et al. (2018) analysed the relationship between air transport and tourism resulting from Taiwan's air transport policy. A study of cross-strait aviation policies empirically showed that air transport activity had no strong influence on increasing tourism demand. Using descriptive statistics, Bieger and Wittmer (2006) showed that in many situations, tourism acted as a driving factor and, in some cases, also as a stimulus for changes in air transport services, thus inverting the primary nexus of causality between the two variables.

3.2.2 | Q2: Are territorial variables such as tourism supply and cultural endowments more relevant than air transport activity in expanding tourism demand?

The second question (Q2) dealt with the role played by public authorities in developing the desired level of tourism supply in terms of establishments, services, and international attractions. Contrary to the neoclassical paradigm, it is widely assumed that the free market cannot reach a condition of Pareto optimality; thus, public intervention is required to ensure the optimal combination of air transport and tourist supplies (Tsui, 2017; Zhang et al., 2017). It must be emphasised that none of the studies examined used a specific proxy to test this assumption, but arrived at this conclusion on a deductive basis, considering that, in many cases, tourism demand level is affected by different factors that could have significant effects if coordinated among themselves.

3.2.3 | Q3: Compared to continental tourism, are islands more dependent on air transport supply than other variables?

For the third question (Q3), the effect of air transport policy on tourism to islands specifically, on which few papers have been published, and no systematic analysis concerning the impact of air transport policy on tourism demand on islands that explicitly considered the influence of overall economic variables on these unique economies were identified. Rey et al. (2011) examined the correlations between tourist demand and other economic variables, such as the per capita GDP of

the origin country, relative prices concerning the origin, and quality of infrastructure of the host country, a factor also examined by Teeroovengadum et al. (2020), who explored the importance of airport quality in the context of repeat visitation. Rey et al. (2011) observed a high level of significance for GDP, exchange rate, and quality of infrastructure in the host country. A similar conclusion was reached by Tsui (2017) when studying the impact of New Zealand's low-cost carriers (LCC) on domestic tourism demand. Some authors examining the relationship between air transport and tourism on certain islands highlighted that airport infrastructure represented a precondition for developing tourism on an island, but it did not define the main variable guaranteeing a sustainable level of tourist flows (Graham and Dennis, 2010; Gundelfinger-Casar and Coto-Millán, 2018).

4 | DATA AND MODEL SPECIFICATION

4.1 | Panel data

Three research questions were tested for a selected group of islands and archipelagos belonging to seven EU Mediterranean countries (Figure 1). Data were collected from 2000–2017 to include the potential negative

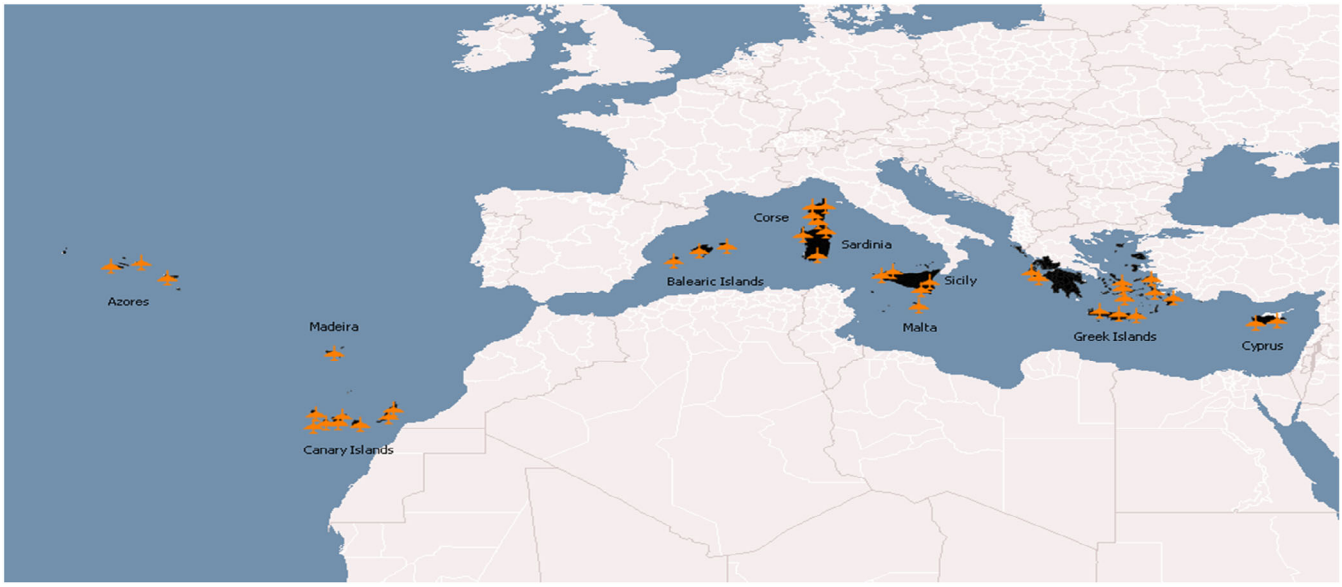

FIGURE 1 The study area [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 3 Sample descriptive statistics (2000–2017)

Variable	Number of airports	Area	Population	Number of tourists	Passenger arrivals
Island regions	Mean of period × 1000	km^2 × 100	Mean of period × 1000	Mean of period × 1000	Mean of period × 1000
Sicily	4	257	5029	4312	11,275
Sardinia	3	241	1654	2232	6088
Cyprus	2	93	794	2418	7221
Corsica	3	87	302	2207	2757
Canaries	5	75	2012	11,220	29,826
Crete	3	83	612	2711	7366
Balearic Islands	3	50	1033	9362	9722
Northeastern Aegean Islands	1	9	199	359	1266
Ionian Islands	1	23	207	1281	3585
South Aegean Islands	2	39	327	3016	7242
Azores	3	23	245	385	1294
Madeira	1	7	257	965	2454
Malta	1	3	414	1310	3428

TABLE 4 Variables and indicators

Variable	Acronym	Type of variable	Indicator	Expected effect
Tourism demand (arrivals)	TOURARR	Dependent variable	Number of tourists arrived	
Tourism demand (overnights)	TOUROVER	Dependent variable	Average number of tourist overnights	
Air transportation (supply)	AIRCRAFT	Transportation variable	Total number of aircraft landed and taken off in selected airports/ number of airports	+
Air transportation (infrastructure)	RUNSURF	Transportation variable	Kilo meter of airport runways/islands surface	+
Tourism supply	BEDSEST	Territorial variable	Number of beds/number of establishments	+
Tourism supply	ESTPOP	Territorial variable	Number of establishments/populations	+
Cultural endowment	UNESCO	Territorial variable	Number of UNESCO sites	+
Agglomeration economies (density)	POPDENS	Economic variable	Number of people per square meter	+/−
Economic activity	GDPPOP	Economic variable	Gross domestic product/population	+/−
Economic activity	INCPCAP	Economic variable	Income per capita	+/−

effects of the Great Recession (2008). A panel composed of 13 islands and archipelagos over 18 years was constructed, providing 234 observations. Several factors were considered when selecting these islands: their similar warm-water tourism appeal, the presence of an international airport, their relative proximity to the same European markets, and the availability of reliable and comparable data during the study period. The fact that the seven countries involved are all members of the EU ensures a degree of standard policy formulation and application concerning airline regulation/deregulation and freedom of movement between countries.

Table 3 illustrates the main descriptive statistics for the 13 islands and archipelagos. These locations account for 42 million tourists and 94 million passengers annually, covering an area of almost 100,000^2 km.

The islands examined exhibited considerable variation in size. Therefore, all the selected variables were transformed into a logarithmic form to reduce this effect. Based on the primary literature (Gundelfinger-Casar and Coto-Millán, 2018; Wu et al., 2018), three main groups of variables influencing tourist arrival on an island were considered.

4.2 | Model estimation

The first group includes transportation variables such as aircraft arrivals per airport (*AIRCRAFT*) and kilometres of runway per island (*RUNSURF*). This group provides the dimensions of air transport activity for different islands, allowing an estimate of their role in attracting tourists. It was expected that the greater the number of air movements, the greater the number of tourist arrivals on the island. The same relationship was expected for airport runway kilometres.

The second group includes territorial variables that describe and indicate the relevance of tourism facilities in terms of the dimensions of the territory. This group consists of the number of tourist accommodations per inhabitant (*ESTPOP*), the number of available beds per establishment (*BEDSEST*), and the number of UNESCO sites on each island (*UNESCO*). A higher number of tourism facilities is expected to attract more tourists.

The third group includes economic variables that provide a measure of the socioeconomic dimensions of an island and includes residential population density (*POPDENS*), which captures agglomeration economies, per-capita GDP (*GDPPOP*), and income per capita (*INCPCAP*), which captures the relative economic strength of an island. Because the socioeconomic dimension represents an attraction factor for tourism, it was considered that an island with a higher per-capita GDP (or income) and a high population would be more attractive for tourists than an island with low GDP (or income) and sparse settlement (Gundelfinger-Casar and Coto-Millán, 2018).

In this manner, the centrality of transportation variables in testing the assumption that a higher level of air transport and airport infrastructure contributes to increasing tourist arrivals on an island was explored. The other two groups of variables (territorial and economic) represent the control variables used to test whether other factors affect the number of tourist arrivals to an island.

Different model specifications related to the theoretical framework were tested. In contrast to previous studies, data were collected over 18 years (2000–2017), representing a significant refinement over earlier research. The simultaneous availability of cross-sectional and time-series data allowed the specification of more flexible models than simple cross-sectional models. Because the primary research focuses on testing the relationship between tourism demand and air transport activity, tourist arrivals were the primary dependent variable. In line with previous studies and the theoretical framework, seven explanatory variables were considered as covariates. The model specifications are as follows.

$$\begin{aligned}\ln TOURARR = {} & \beta o + \beta_1 \ln AIRCRAFT_{it} + \beta_2 \ln RUNSURF_{it} \\ & + \beta_3 \ln BEDSEST_{it} + \beta_4 \ln ESTPOP_{it} + \beta_5 \mathrm{UNESCO}_{it} \\ & + \beta_6 \ln POPDENS_{it} + \beta_7 \mathrm{INCPCAP}_{it} + \mathrm{error}. \end{aligned} \quad (1)$$

The variables are defined in Table 4, and the error term followed a fixed effect or random effect structure using standard model selection procedures (Hausman test).

5 | RESULTS

5.1 | Baseline model results

Correlation coefficients (Table 5) were calculated to exclude severe collinearity in the model. All variables were transformed into logarithm values, except *UNESCO*, as noted earlier, as logarithmic transformations normalise a variable with an asymmetric distribution; moreover, these tend to reduce the effects of outliers. Table 5 shows no significant multicollinearity among the explanatory variables.

First, a fixed-effect panel data model of Equation (1) was estimated, as well as some variants of the same equation. Table 6 reports the estimation results. All explanatory variables, except *UNESCO*, are expressed in logarithms. For all models in Table 6, fixed-effect estimation was preferred to linear regression and random-effect models based on the Breusch-Pagan (BP) and Hausman (H) tests.

The total number of tourists arriving on an island per year (*TOURARR*) was used as the dependent variable, and the number of tourist overnights (TOUROVER) was used in Model 5. In Model 1, all explanatory variables except U*NESCO** and *INCPCAP* had, as expected, a positive impact with highly significant coefficients. The sign of the coefficients of these two variables was counterintuitive, though not statistically significantly different from zero. The effects of density and territorial variables were more robust and significant than transport variables.† In Model 2, a dummy variable was included for the economic crisis period (2008–2014). The results of Model 1 were fully confirmed, and, as expected, the dummy showed a negative and highly significant effect on tourist arrivals. Although territorial attractiveness for tourism was mainly related to income rather than production level, in Model 3, the income per capita variable was substituted with per capita GDP. In Model 3, the coefficient of this variable was negative and significant, while all other variables showed similar coefficients and significance levels to Models 1 and 2. Therefore, it appears that tourist arrivals in the southern European Union islands increased as the level of economic activity decreased. This may reflect an increased search for more secluded islands as destinations preferred by tourists or cost-of-living considerations.

However, the negative impact of economic activity on tourist arrivals to islands may also be related to a possible inconsistency in the estimates because of the potential endogeneity of the explanatory variable capturing economic activity. For this reason, in Model 4, we substituted the lagged value of income per capita instead of the contemporaneous value. The negative effect was enhanced, whereas the significance and impact of the other variables were substantially unchanged.

Finally, in Model 5, the dependent variable was changed by considering the (logarithm of the) number of tourists overnight as an indicator of tourist demand. Again, the results confirmed the more significant impact of territorial variables on transport variables, although the significance and elasticity of the *AIRCRAFT* variables slightly increased.

Given these results, tourist arrivals were used as the dependent variable in further analysis to focus on the main issue related to the importance of air transport as a specific policy tool to improve the touristic attractiveness of islands.

5.2 | Endogeneity issues-results

The issue of endogeneity also concerned the main transport variables, that is, the average number of aircraft landed and taken off from the selected islands' airports. As addressed in the first research question (see Section 3.2), the literature is not unanimous in considering tourism demand instead of transport activity as the dependent variable in estimating the relationships between the two variables. To further explore endogeneity issues, in Table 7, the simultaneous causality of tourist arrivals and aircraft connections in simpler fixed-effect panel specifications that considered both the simultaneous and lagged values of the two variables were investigated by switching the dependent variable between them.‡ Table 7 shows that although contemporaneous and lagged values of *AIRCRAFT* are both relevant in explaining tourist arrivals (see columns 1 and 2), the relationship may also run in the opposite direction (from tourist arrivals to aircraft flights, see columns 3 and 4), reflecting the possibility of dual causality in this relationship.

Indeed, the impact of tourist arrivals on the number of flight connections was highly significant and greater than the impact of flight connections on tourist arrivals, for both contemporaneous and lagged values. Moreover, tourist arrivals at time t were also relevant in explaining the variation in aircraft flights at the previous time, that is, airline companies decide the number of flight connections to be operated according to the (predicted) value of tourist flows. All these considerations allow us to conclude that an apparent endogeneity problem may characterise the estimation of Equation (1) related not only to the variable *INCPCAP* but also mainly to the variable *AIRCRAFT*. Therefore, a correct estimation procedure should determine a valid instrument for each of these two variables to avoid incurring inconsistent estimates, given the contemporaneous correlation between the error term and some regressors.

A valid instrument can be observed in a variable correlated with the explanatory variable but not the error term. A possible test for this last requirement is that the potential instrument would be uncorrelated with the residuals originating from the estimation of Equation (1). In searching for a valid instrument for the *AIRCRAFT* variable, a regression was performed on the residuals of Model 1 of Table 6 against the lagged value of *AIRCRAFT*, which can be considered a potentially valid instrument for the contemporaneous value of *AIRCRAFT* in Equation (1). The results of this auxiliary estimation revealed a significant coefficient for *AIRCRAFT* (-1),§ necessitating the search for an alternative instrument. The lagged value of passengers transported (*PASSENGER*), which is related to *AIRCRAFT and* assumes that airline companies may increase their number of flight connections by a more significant number of passengers transported in the previous year, was considered. The number of passengers at time $t-1$ was still correlated with the residuals of the estimation of Equation (1), whereas the number of passengers at time $t-2$ was not.¶ Therefore,

TABLE 5 Correlation matrix

Variable	AIRCRAFT	RUNSURF	BEDSEST	ESTPOP	UNESCO	POPDENS	GDPPOP
AIRCRAFT	1.0000						
RUNSURF	0.4173	1.0000					
BEDSEST	0.2376	−0.2212	1.0000				
ESTPOP	−0.0373	0.0869	−0.5446	1.0000			
UNESCO	0.2519	0.3877	−0.3077	−0.1034	1.0000		
POPDENS	0.0434	−0.6375	0.2765	−0.4314	0.0761	1.0000	
INCPCAP	0.4444	0.5237	0.1125	0.2573	0.1387	−0.5082	1.0000

Note: All variables except UNESCO are on a logarithmic scale.

TABLE 6 Fixed effect panel estimation—Baseline model

	Model 1	Model 2	Model 3	Model 4	Model 5
Explanatory variables	**TOURARR**	**TOURARR**	**TOURARR**	**TOURARR**	**TOUROVER**
AIRCRAFT	0.1067	0.0819	0.1086	0.1008	0.2227
	(3.30)***	(2.61)**	(3.60)***	(3.10)***	(7.47)***
RUNSURF	0.1985	0.1690	0.1954	0.1852	0.1553
	(3.06)***	(2.72)**	(3.14)***	(2.85)***	(2.60)**
BEDSEST	0.6909	0,6826	0.7066	0.8223	0.7148
	(6.69)***	(6.92)***	(7.65)***	(7.08)***	(7.52)***
ESTPOP	0.7770	0.7991	0.7769	0.8734	0.6858
	(11.28)***	(12,12)***	(12.61)***	(11.27)***	(10.81)***
UNESCO	−0.0052	−0.0093	−0.0001	−0.0061	0.0134
	(−0.24)	(−0.45)	(−0.01)	(−0.26)	(0.66)
POPDENS	1.5473	1.9042	1.6397	2.0433	0.5365
	(7.53)***	(9.04)***	(8.87)***	(8.56)***	(2.84)***
INCPCAP	−0.0597	−0.0205	–	–	−0.1292
	(−0.75)	(−0.27)			(−1.75)*
DUMCRIS	–	−0.0807	–	–	–
		(−4.65)***			
GDPPOP	–	–	−0.1243	–	–
			(−4.05)***		
INCPCAP (−1)	–	–	–	−0.1925	–
				(−2.33)**	
Constant	−0.5832	−2.2396	−0.5366	−2.5314	5.9628
	(−0.53)	(−2.02)**	(−0.51)	(−2.00)**	(5.89)***
N	234	234	234	234	234
R^2 within	0.7376	0.7618	0.7556	0.7426	0.6771
BP	222.42***	218.39***	301.47***	190.27***	159.97***
H	70.37***	79.64***	63.36***	74.98***	83.16***

Abbreviations: BP, Breusch and Pagan LM test for testing the hypothesis of appropriateness of random effects versus linear regression model; H, Hausman test for testing the hypothesis of appropriateness of fixed effects versus random effects model.
Note: *Significant at 10%.
Note: **Significant at 5%.
Note: ***Significant at 1%.

the number of passengers with two lags (*PASSENGER* [−2]) was used as a valid instrument for the number of flight connections (*AIRCRAFT*) in Equation (1).

The coefficient of the lagged value of the variable per capita income (*INPCAP* (−1)) is not significant in explaining the residual of Equation (1).** In contrast, the lagged value of GDP per capita was

TABLE 7 Simultaneous causality of tourist arrivals and number of aircraft flights—FE models

Dependent variable					
	TOURARR	TOURARR	AIRCRAFT	AIRCRAFT	AIRCRAFT (−1)
Explanatory variables	Model 1	Model 2	Model 3	Model 4	Model 5
AIRCRAFT	0.3361	–	–	–	–
	(7.27)***				
AURCRAFT (−1)	–	0.3148	–	–	–
		(6.52)***			
RUNSURF	−0.0142	0.0009	−0.1240	−0.1066	−0.1620
	(−0.17)	(0.01)	(−1.11)	(−0.91)	(−1.36)
TOURARR	–	–	0.5781	–	0.5431
			(7.27)***		(6.52)***
TOURARR (−1)	–	–	–	0.5446	–
				(6.14)***	
Constant	10.9531	11.0928	3.3401	3.7292	4.0951
	(13.43)***	(2.80)**	(2.34)**	(2.38)**	(2.73)***
N	234	221	234	221	221
R^2 within	0.1963	0.1725	0.2007	0.1603	0.1799
BP	810.25***	706.00***	694.99***	587.88***	694.99
H	23.45***	23.44***	6.36**	6.64**	8.01**

Abbreviations: BP, Breusch and Pagan LM test for testing the hypothesis of appropriateness of random effects vs. linear regression model; H, Hausman test for testing the hypothesis of appropriateness of fixed effects versus random effects model.
Note: *Significant at 10%.
Note: **Significant at 5%.
Note: ***Significant at 1%.

TABLE 8 Determinants of tourist arrivals—instrumental variable estimation

	Model 1	Model 2	Model 3	Model 4
	Instruments			
Explanatory variables	AIRCRAFT (−1)	PASSENGER (−2)	INCPCAP (−1)	PASSENGER (−2) INCPCAP (−1)
AIRCRAFT	0.0950	0.2753	0.1478	0.4254
	(2.55)**	(1.76)*	(4.20)***	(2.35)**
RUNSURF	0.2008	0.2057	0.1796	0.1913
	(3.11)**	(3.00)***	(2.71)***	(2.43)**
BEDSEST	0.7312	0.7746	0.8578	0.8969
	(6.24)**	(5.54)***	(6.77)***	(5.34)***
ESTPOP	0.8110	0.8265	0.8883	0.8895
	(10.47)***	(8.70)***	(10.67)***	(7.90)***
UNESCO	−0.0022	0.0126	−0.0065	0.0131
	(−0.10)	(0.49)	(−0.28)	(0.44)
POPDENS	1.7814	1.5800	1.9642	1.5091
	(7.78)***	(3.45)***	(8.66)***	(2.89)***
INCPCAP	−0.0173	−0.0869	−0.2743	−0.4226
	(−0.21)	(−0.65)	(−2.38)	(−2.22)**
Constant	−2.3291	−2.9398	−2.0437	−1.7027
	(−1.84)*	(−1.50)	(−1.59)*	(−0.75)
N	221	208	221	208
Within R^2	0.7433	0.7263	0.7333	0.6401

Note: *Significant at 10%.
Note: **Significant at 5%.
Note: ***Significant at 1%.

TABLE 9 Determinants of tourist arrivals—Hausman–Taylor estimation

	Model 1	Model 2	Model 3	Model 4
	Time-varying endogenous variables			
Explanatory variables	AIRCRAFT RUNSURF	BEDSEST ESTPOP	POPDENS INCPCAP	AIRCRAFT INCPCAP
AIRCRAFT	0.1168 (3.66)***	0.1172 (3.68)***	0.1123 (3.50)***	0.1173 (3.67)***
RUNSURF	0.2044 (3.27)***	0.1937 (3.14)***	0.1898 (3.07)***	0.1953 (3.17)***
BEDSEST	0.6805 (7.43)***	0.7022 (7.48)***	0.7022 (7.61)***	0.6824 (7.45)***
ESTPOP	0.7673 (12.54)***	0.7852 (12.47)***	0.7822 (12.67)***	0.7681 (12.56)***
UNESCO	−0.0010 (−0.05)	−0.0046 (−0.22)	−0.0059 (−0.28)	−0.0027 (−0.13)
POPDENS	1.3010 (8.84)***	1.3152 (8.91)***	1.3960 (8.93)***	1.3012 (8.84)***
INCPCAP	−0.0203 (−0.27)	−0.0288 (−0.38)	−0.0355 (−0.47)	−0.0195 (−0.26)
SURFACE	0.8193 (5.71)***	0.8375 (5.84)***	0.8813 (6.03)***	0.8277 (5.78)***
Constant	−6.6037 (−3.99)*	−6.8187 (−4.09)	−7.4291 (−4.33)***	−6.6301 (−4.01)
N	234	234	234	234
WALD	657.50***	656.37***	658.20***	656.97***

Note: *Significant at 10%.
Note: **Significant at 5%.
Note: ***Significant at 1%.

significant. Therefore, the lagged value was used as the instrument for the contemporaneous value of *INCPCAP* in the instrumental variable estimation of Equation (1).

Table 8 presents the results of the instrumental variable estimation of Equation (1). The results of Model 1 are similar to those in Table 6, but, as noted, the measure was distorted by the endogeneity of the lagged connection flight ($AIRCRAFT_{t-1}$). When the variable number of passengers transported (with two lags) acts as the instrument in the model, the impact of transport supply improves (the elasticity approaches 0.3). By contrast, the coefficients of all other variables maintain their significance, size, and impact.

The first two models show that income per capita is not relevant for explaining tourist arrivals. However, when income per capita was used with its lagged value, the coefficient was negative and significant, showing that tourists' preferences seem to be directed towards low-income rather than high-income islands, perhaps driven by sustainability and cost of living considerations. Finally, Model 4 appeared to be the correct specification model to consider endogeneity because it incorporated reasonable restrictions for the *AIRCRAFT* and *INCPCAP* variables. All the previous analysis results were confirmed in this model, and all coefficients (except for the *UNESCO* one) were significant, at least at the 5% level.

5.3 | Results of robustness checks

Additional robustness checks are performed to strengthen the analysis. Table 9 displays the results of the Hausman-Taylor procedure to control for alternative problems of regressor endogeneity owing to the correlation with the fixed effect. In estimating these models, the surface area of an island as a time-invariant variable was included along with four different sets of potentially endogenous time-invariant variables related, in turn, to transportation, territorial (tourism supply), and economic variables and, in Model 4, with the two variables considered endogenous in Section 5.2.

It can be observed from Table 9 that the results from this estimation are very similar to those in the baseline model, leaving substantially unchanged conclusions regarding the relationship between tourist arrivals and transportation variables. Finally, in Table 10, the Arellano-Bond dynamic panel data estimator was used to analyse whether previous information on the dependent variable (including past values of the explanatory variables, including transportation supply) affects tourist arrivals in the current year.

The results clearly show that the autoregression component of the dependent variable was highly significant. In this regression, the significance level and importance of the variable group tied to

TABLE 10 Determinants of tourist arrivals—DYNAMIC model estimation

Explanatory variables	Model 1	Model 2	Model 3	Model 4
TOURARR (−1)	0.6999	0.6381	0.6718	0.6103
	(12.92)	(11.69)***	(9.32)***	(8.55)***
TOURARR (−2)	–		0.0025	−0.0088
			(0.03)	(−0.12)
AIRCRAFT	0.0883	0.0732	0.0797	0.0649
	(2.47)**	(2.10)**	(2.17)**	(1.82)*
RUNSURF	0.0538	−0.0153	0.0640	−0.0071
	(0.75)	(−0.21)	(0.88)	(−0.10)
BEDSEST	0.2763	0.2327	0.3758	0.3224
	(2.21)**	(1.92)*	(2.77)***	(2.45)**
ESTPOP	0.3030	0.3100	0.3789	0.3836
	(3.42)***	(3.63)***	(3.90)***	(4.11)***
UNESCO	−0.0001	−0.0025	0.0031	0.0006
	(−0.00)	(−0.13)	(0.15)	(0.03)
POPDENS	0.4224	0.7407	0.6063	0.9754
	(2.04)**	(3.44)***	(2.68)***	(4.13)***
INCPCAP	0.0517	0.0705	0.0610	0.0811
	(0.78)	(1.10)	(0.85)	(1.17)
DUMCRIS	–	−0.0510	–	−0.0536
		(−4.06)***		(−4.19)***
Constant	−1.6890	−1.7053	−2.9820	−3.0425
	(−1.22)*	(−1.27)	(−1.97)**	(−2.08)**
N	208	208	195	195
WALD	1264.56***	1374.65***	1167.66***	1267.41***

Note: *Significant at 10%.
Note: **Significant at 5%.
Note: ***Significant at 1%.

the air transport supply were reduced, further supporting the previous analysis. By contrast, the other two groups of variables continued to allocate greater importance to explaining the phenomenon at hand. However, territorial variables and touristic supply coefficients significantly reduced this size. Therefore, it can be confirmed that transport supply is a prerequisite to developing tourism demand but that, simultaneously, it alone does not determine the dimension of tourist flows.

6 | DISCUSSION

This study examined the impact of air transport on a selected group of 13 islands and archipelagos from 2000–2017. The tourism sector represents, in general, the most important economic activity for these islands, accounting on average for 22% of all added value produced. Furthermore, the incidence of businesses dealing with tourism out of the total number of artisan businesses present is over 25% (UNWTO, 2017). Excluding the public sector, tourism, transport, and satellite activities are the principal sources of employment and foreign exchange earnings for these islands, as is the case for many insular destinations (Seetanah, 2011). The air transport sector in European Union countries, and consequently in their islands, has undergone significant changes during the observed period, including infrastructure improvement, liberalisation, and modification of the requirement to establish private airlines (Warnock-Smith and Christidis, 2021). These changes have improved the ease of entry into the airline market, thus affecting the sector's performance differently, as noted by Seetanah et al. (2019). The significance of the insularity of the examined islands makes it necessary to explore the relationship between air transport and tourism in detail, as argued by Bieger and Wittmer (2006), and Forsyth (2008).

The literature review revealed considerable variation in how terms, such as tourist demand and air transport activities, were used, as illustrated in previous research (Favro et al., 2016; Spasojevic et al., 2018), indicating that definitive and consistent meanings had not been applied in the previous analyses. The relative importance of factors other than air transport services in developing tourism demand in an island context has not been tested before, for example, using a proxy in any analysis. Third, there was no analysis of whether air transport was more critical for island destinations than mainland destinations. These three gaps in

the literature provide the basis for selecting variables and focus on the analysis conducted in this study.

The models examined three different macro factors affecting island tourist arrival. Airport infrastructure (RUNSURF) has a reduced positive impact on repeat visitation to destinations. The variable was significative with low magnitude, and this is rather in contrast to Teeroovengadum et al. (2020).

For air transport flights (AIRCRAFT), however, this variable was significant enough to increase the level of tourism arrivals. It can be argued that an increase of approximately 10% in air transport activities increases tourism arrival by 1%.

Considering the territorial variables, an increase of 10% in the ratio between beds and establishments resulted in a 7% increase in tourist arrivals. The number of UNESCO sites (*UNESCO*) has no impact on explaining the phenomenon, which can be justified considering that tourism in the islands studied is heavily beach-focused. The population density of an island is strongly related to its number of tourist arrivals. In other words, tourists appear to choose an island for fun, and the presence of an existing population is essential, in line with a study by Rey et al. (2011). A dummy variable (*DUMCRIS*) was included and evaluated to verify the effects of the world post-2007 Great Recession and to confirm an inflexion in tourist arrivals during the 2008–2014 period.

To analyse the direction of the phenomenon, the analysis explored whether the aviation variables (*AIRCRAFT*) would drive the number of tourist arrivals or whether tourist arrivals would push air companies and airport operators to increase their air transport activities (Martínez Raya and González-Sánchez, 2021). The results, based on the dynamic estimation procedure, clearly demonstrated that the autoregression of the dependent variables had a high significance level, and that tourist arrivals drive the air transport offer at least as much as the contrary. The analysis confirmed that increased tourist arrivals also activate air transport demand for islands, as shown by Cifuentes-Faura (2021), and that this increase determines the requirement of both additional air connections and air seats. In this manner, tourism destinations are responsible for attracting more tourists; therefore, they stimulate an increase in air transport demand. In contrast, regressors belonging to other variables (i.e. tourist infrastructure and population density) continued to maintain high importance in explaining tourist demand. It can be concluded that air transport services are a prerequisite to developing tourism demand, although the transport services alone do not determine tourist flows once the market has become established, which supports the arguments of Graham and Dennis (2010) and Gundelfinger-Casar and Coto-Millán (2018).

7 | CONCLUSION

The main findings show that air transport infrastructure is essential but not decisive for tourism development on the islands studied and confirm that dual or reverse causality exists between air transport services and tourist demand in these destinations. The analysis showed that the impact of tourist arrivals on the number of flight connections was highly significant and greater than the impact of flight connections on tourist arrivals, for both contemporaneous and lagged values. This result is coherent with the Gundelfinger-Casar and Coto-Millán (2018) study for Canary Islands, even if the authors considered the frequency of fly. The analysis clarified the relative importance of factors other than transportation in shaping tourism demand. It has been shown that liberalisation processes and the strengthening of the free market in the air transport sector produced beneficial results in terms of tourism demand. However, while many additional flights to the islands are promotional factors for tourism demand, this variable is not the main factor in increasing tourism arrivals. The incorporation of data spanning more than a decade in this analysis represents an innovative element in modelling the influence of changes in air transport services on tourism numbers to islands. However, financial support, services, and attractions may be critical factors in increasing tourism demand. Thus, while the liberalisation processes and the strengthening of the free market in the air transportation sector have produced positive results in increased tourism demand, tourism supply and the general economic conditions of insular economies also remain crucial.

These results have transport policy implications for island tourism and development. First, although air transport infrastructure is a prerequisite for tourism development in the islands studied, it is not the sole driving factor. Thus, while establishing and maintaining such services is critical for successful tourism development, other factors also exert a significant influence. Second, the increase in tourist arrivals to the tourist destinations on those islands is responsible for the increase in new flight connections, which may exacerbate potential sustainability problems, a factor of concern in the light of increasing overtourism in some destinations. This suggests that tourist numbers should not be encouraged or allowed to expand beyond a destination's capacity to handle them appropriately. Third, the analysis shows that island tourists are not primarily attracted by cultural motivations (e.g. UNESCO did not assume a high significance level) but by good weather and appropriate social activity. This suggests that it is essential to implement relevant policies for tourism, focusing on creating suitable infrastructure and opportunities that match both the motivations of incoming tourists and residents' preferences to move towards sustainability.

Finally, research on air transport costs might provide insight into why tourists choose to visit a specific island, and the nature of the demand elasticity of such air transport costs. There is no specific analysis on this topic for islands apart from the study of Seetanah (2011) who highlights that fly costs can have a positive influence on the islands' tourism but not as strong as expected. In terms of future research, the study's main findings can be broadened by examining the difference between incoming and outgoing tourist flows. Other useful information, which could be explored and utilised in the model, would be the number of attractions to help determine a complete picture of the motivation to visit any specific island. Furthermore, it would be useful to compare the importance of air transport to insular destinations with the significance of this factor in mainland destinations where other forms of transportation are generally available.

Similarly, a similar study of the relationship between sea transportation and tourist arrivals could clarify the importance of this form of transportation and whether it has increased or decreased over time. The impact of low-cost airlines on visitor numbers has been significant in the case of several European cities in recent years (Roncak, 2019) and has become a major service provider for some of the islands studied (Rey et al., 2011), thus warranting further study. Finally, given the growing global concerns over climate change and the role of air travel emissions in the generation of greenhouse gases, studies on tourist access to island destinations may have to revisit the role of air transport compared to alternative means of access. This could include other modifications, such as the use of larger but fewer aircraft, which may necessitate changes in airports and related infrastructure and better integration of all forms of access to the islands in question. The close links between climate change, sustainability, and over-tourism all suggest that the role and scale of air travel to tourist destinations, insular, and otherwise, will be subject to considerable study and potential change.

ENDNOTES

* This circumstance may be justified by the fact that islands' tourism is mostly related to sea attractiveness.

† The elasticity of territorial variables is approximately 0.7 while the elasticity of transport variables is below 0.2.

‡ In all models, the other transport variable (*RUNSURF*) was included and tested for the validity of a fixed-effect model concerning random-effect and linear regression models.

§ The auxiliary regression estimate of the parameter of AIRCRAFT (−1) is 0.0958 with a t-statistic of 3.57.

¶ The auxiliary regression estimate of the parameter of *PASSENGER* (−1) is 0.0873 with a t-statistic of 2.87 while the one of the parameters of *PASSENGER* (−2) is 0.0612 with a t-statistic of 1.88.

** The auxiliary regression estimate of the parameter of *INCPCAP* (−1) is −0.0217 with a t-statistic of −0.34.

DATA AVAILABILITY STATEMENT

Data subject to third party restrictions.

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