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Reevaluating Tourism Gravity Models: Insights from Small Island Destinations

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Reevaluating Tourism Gravity Models: Insights from Small Island Destinations

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Abstract: This study investigates the applicability of gravity models in predicting tourist arrivals in small island destinations. The aim of this study is to determine the applicability of gravity models to the case of small island destinations, as these models were not designed to be used to predict tourist behavior and due to the particularities of small island destinations. Using linear regression analysis, we examined the significance of two key gravity model variables: economic size and distance, across 34 small islands. The results revealed that neither economic size nor distance was a significant predictor of tourist arrivals in these islands. These findings underscore the unique challenges faced by small island destinations, which often defy the conventional assumptions of gravity models. This study has important implications for destination management, suggesting that alternative models and research methodologies should be explored to better capture the drivers of tourism in small island destinations.

Keywords: gravity model; small island; destination; tourism econometrics; GDP; distance

1. Introduction

Gravity is an original concept created by physicians to name the phenomenon by which all things with mass or energy are attracted to one another (Comins & Kaufmann, 2008). Despite the importance of gravity in physics, not all physic theories have included gravity as an important fact to explain different phenomenon, as gravity highly depend on the scale and the space (Verlinde, 2011). In spite of being a theory originated in physics, gravity theory has shown to have similarities with the estimation of international economic trade flows. This has derived in the creation of the gravity model of international trade in economics (Isard, 1954).

Following Hua & Porell (1979), the gravity model has a huge range of applications in many different types of studies and this explains why it rapidly gained popularity when it was introduced in international economics research. Despite its wide range of uses, gravity models present several limitations that do not allow them to be fully usable when studying certain topics. For example, these models do not consider non-monetary variables as important variables that could influence trade flows (Bhattacharya & Bhattacharyay, 2007). Moreover, they are only based on the importance of distance between trade units but do not consider the types of transports required to move from one of these places to the other, among other geographical issues that should be addressed (Porojan, 2001). Other of their more common limitations is its focus on tangible goods (Kahouli & Maktouf, 2015).

There are several economic activities that might not suffer from the effect of the aforementioned limitations of gravity models. However, in the case of tourism in small island destinations, these limitations could derive in the inefficacy of the use of gravity models to estimate trade flows. First, because islands -and more even small islands- cannot be usually accessed through roads or trains but boats or airplains. This derives in price inequalities linked to the means of transport required to access these destinations not linked with distance but other geographical matters. Second, tourism services are characterized for being highly heterogeneous as each service and tourist is different (Assaf & Dwyer, 2013). This makes tourism not being the ideal activity to apply gravity models as they assume

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that homogenous products are being traded (Kahouli & Maktouf, 2015). Last, many island destinations are usually countries that were colonies of other countries in the past (Feyrer & Sacerdote, 2009). This historical relationship with third countries usually derives in the maintenance of current economic and political relationships with previous colonizing countries. This fact has an impact on factors such as a higher number of flight connections between these countries or reduced visa controls that derive in a higher tourism activity between these countries. As mentioned before, gravity models do not consider political factors as a relevant element explaining trade flows, so they ignore the political relationships between islands and third countries when explaining tourist visits.

Despite all these limitations, several authors have carried out research on the application of gravity models on small island tourism destinations (Archibald et al., 2008; Vítová et al., 2019). Vítová et al. (2019) and Dropsy et al. (2020) found that economic size (measured by GDP and population) and distance (proxied by air distance) are significant factors of bilateral tourism flows. These studies used advanced econometric methods like systems-generalized methods of moments (SYS-GMM) and two-stage least squares (2SLS), which address potential endogeneity issues, highlighting the importance of including these variables in gravity models.

Investigating the inefficacy of gravity models in the context of studying tourism demand in small island destinations represents a groundbreaking departure from conventional research in the field. Gravity models have long been a staple in tourism studies, effectively explaining visitor flows based on geographic proximity and economic size. However, their applicability to small island destinations, which often defy conventional gravity logic due to their unique geographical and socio-economic characteristics, has remained largely unexplored. This novel study challenges the status quo by shedding light on the limitations of these models in capturing the nuanced factors that influence tourism demand in such settings. By doing so, it not only opens a new frontier in tourism research but also provides valuable insights for policymakers and industry stakeholders striving to understand and promote sustainable tourism in small island destinations. Thus, the objective of this study is to analyze the factors influencing tourist arrivals to small island destinations using an enhanced gravity model that accounts for economic size, distance, and additional variables to address potential biases in traditional models. This study aims to fill the gap in the literature by providing a comprehensive analysis that includes multilateral resistance terms (MRT) and addresses endogeneity issues.

2. Literature Review

2.1. The Use of Gravity Models in International Trade

Gravity models in economics are used to explain international trade. These models can basically predict international trade flows based on the economic sizes and proximity between two countries. Economic sizes are usually measured through Gross Domestic Product (GDP) of the countries or, particularly, through their GDP per capita. To measure proximity, researchers use the geographical distance between countries. Gravity modelling basically points that countries have higher changes of exchanging goods and services when they have a similar economic size and are closer to each other. Despite gravity models are typically used to predict international trade flows, they have shown to be also valid to analyze trade between regions, states, among others.

Gravity models were first introduced in economics by Walter Isard (1954), who pointed to the possibility of predicting trade between countries following the equation:

$$F = C * \frac{E_i * E_j}{D_{ij}}$$

In this equation, F refers to the trade flow that the researcher intends to estimate, C is a constant, E is the economic size of the units of study, D is the distance, i relates to one of the units studied -usually a country- and j to the other one -another country-. Afterwards, Tinbergen (1962) was the first to use the gravity model to explain trade flows, marking a seminal contribution to this field.

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Following this, Anderson (1979) and Bergstrand (1985) provided the first theoretical economic foundations for gravity models, establishing their relevance and application in trade economics. Recent advancements in structural gravity models have emphasized the necessity of including MRT. As Yotov et al. (2016) explain, MRT translates the initial, partial equilibrium effects of trade policy at a bilateral level to country-specific effects on consumer and producer prices. In essence, MRT reflects the barriers to trade faced by each country with all its trading partners, and omitting MRT can lead to significant biases in estimations.

Despite the popularity of gravity models, researchers have pointed to several limitations they present over the years. For example, Doumbe and Belinga (2015) argue that these models can only focus on variations in bilateral trade flows, not being able to explain substitutions between these flows. Thus, gravity models do not consider certain non-monetary factors explaining an increase on a country's exports and imports, such as political agreements between countries, technological improvements, scale economies or others (Bhattacharya & Bhattacharyay, 2007). Moreover, gravity models focus on analyzing the forecasted behavior of large groups of individuals and they are not prepared to study specific individuals or small groups where changes on one of the components of the group might drastically change the general overview of the whole group (Huff, 1962). In addition, gravity models do not estimate the role of location as one of the key variables explaining trade flows, they just focus on distance (Porojan, 2001). Despite distance is important to estimate flows, Porojan (2001) that for some places -such as islands- the distance is not the only relevant factor that should be considered but also the means of transport to reach these places, among other factors.

Following Hua and Porell (1979), different versions of gravity models -and methods to estimate them- have arisen over time because gravity models theory has been built upon theoretical assumptions that have derived in difficulties to properly apply the models to practice due to their limitations. Thus, researchers had to adapt these models to be capable of empirically use them. Despite this, even current studies continue using them, particularly for analyzing foreign direct investment of tangible goods (Kahouli & Maktouf, 2015). However, these models have been also applied to forecast service exchanges, such as tourism and hospitality services (Archibald et al., 2008; Vítová et al., 2019).

2.2. The Use of Gravity Models in Tourism

Following Morley, Rosselló, and Santana-Gallego (2014), the use of gravity models in tourism research was neglected for decades. However, the analysis of Rosselló Nadal and Santana Gallego (2022) indicates that these models have gained importance over years. Despite this, these authors also point to multiple challenges that researchers must address when empirically applying gravity models in tourism research (Rosselló Nadal & Santana Gallego, 2022). In these lines, tourism involves the movement of people while trade involves the exchange of goods and services. This substantial difference already poses a gap that increases the difficulties linked to the application of gravity models to tourism (Morley et al., 2014).

Despite the differences between trade and tourism, past literature has found possible the adaptation of gravity models to tourism (Santana-Gallego et al., 2016; Xu et al., 2019). Previous studies have used gravity models to analyze a wide range of factors, such as the role of Olympic Games in the attraction of tourists (Chasapopoulos et al., 2014), the effect of globalization and terrorism on tourist arrivals (Ulucak et al., 2020), or the relevance of enhancing institutional reforms at developing countries to boost tourism activity (Ghalia et al., 2019). Moreover, several studies have used gravity models as a mean of analyzing the competitiveness of tourism destinations (Archibald et al., 2008; Park & Jang, 2014). Harb and Bassil (2020) conducted a gravity analysis of tourism flows, incorporating the concept of MRT to tourism. Their work highlighted the importance of considering multilateral resistance terms in understanding tourism dynamics. Yazdi and Khanalizadeh (2017) used a panel data approach to study tourism demand, providing insights into the factors driving tourism flows across different regions. Yerdelen Tatoglu and Gul (2020) analyzed tourism demand

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using a multi-dimensional panel gravity model, further contributing to the understanding of tourism economics through the lens of gravity models.

Even if gravity models have been frequently applied in tourism research, Morley, Rosselló, and Santana-Gallego (2014) indicate that studies applying these models make several assumptions and changes in the equation recommended by World Trade Organization (Yotov et al., 2016) to properly apply these models in tourism research. This happens because of the aforementioned characteristics of the activity that make it different to the trade of conventional goods and, thus, affects to the applicability of these models. While distance and economic development are always used as important variables when applying gravity models in tourism research -as recommended by Yotov, Piermartini, and Larch (2016)-, other variables are included in the models to adapt them to the particularities of tourism (Morley et al., 2014). To illustrate this fact, Table 1 shows a list of variables that have been included to the equation of gravity models in past studies to adapt them to tourism activity.

Table 1. Variables included to gravity models in past studies.

Type of Variable	Variable	Reference
Economic	Price	(Chasapopoulos et al., 2014; Dropsy et al., 2020; Eryiğit et al., 2010; Morley et al., 2014; Park & Jang, 2014; Rosselló Nadal & Santana Gallego, 2022; Ulucak et al., 2020)
	Exchange rate	(Morley et al., 2014; Ulucak et al., 2020)
	Income	(Chasapopoulos et al., 2014; Ulucak et al., 2020)
	Household debt level	(Ulucak et al., 2020)
Socio-political	Common language	(Dropsy et al., 2020; Morley et al., 2014)
	Socio-cultural similarities	(Xu et al., 2019)
	Social openness	(Park & Jang, 2014)
	Historical relationship	(Dropsy et al., 2020)
	Globalization	(Ulucak et al., 2020)
	Population	(Eryiğit et al., 2010)
	Degree of urbanization	(Santeramo & Morelli, 2016)
	Common borders	(Eryiğit et al., 2010; Morley et al., 2014)
	Migration between countries	(Santana-Gallego & Paniagua, 2022; Xu et al., 2019)
	Political agreements	(Santeramo & Morelli, 2016)
	Infrastructures	(Chasapopoulos et al., 2014; Park & Jang, 2014)
	Political stability	(Chasapopoulos et al., 2014; Ghalia et al., 2019)
	Destination risk, violence, or terrorism	(Eryiğit et al., 2010; Ghalia et al., 2019; Morley et al., 2014; Ulucak et al., 2020)
Tourism-related	Tourism climate index	(Eryiğit et al., 2010)
	Abundance of tourism resources	(Park & Jang, 2014)

Source: Own elaboration based on a literature review.

As can be seen in the table, authors have included several variables in their equations when applying gravity models in tourism research despite these variables might not be recommended by World Trade Organization (Yotov et al., 2016). Moreover, it seems that there are no clear guidelines related to the variables to include in gravity models as each researcher has included different variables depending on the goal of their study. In fact, as pointed by Rosselló Nadal and Santana Gallego (2022), tourism studies using gravity models have focused on the statistical significance of the variables included but not on the relative importance of all these factors and their interrelationship to help deciding which ones should be included.

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Despite all the different variables employed to adapt gravity models to tourism industry characteristics, researchers have also pointed to different variables or destination assets that could also condition the applicability of the models and have not been studied. For example, Khadaroo and Seetanah (2008) stated that transport infrastructure is key for destinations but has not been included in previous studies using gravity models. Other factors such as climate change (Priego et al., 2015) or the celebration of special events (Fourie & Santana-Gallego, 2011) could also generate future significant variations of tourists arrival and they are not included as variables in gravity models. In addition, it seems that the type of destination to be analyzed plays also a critical role in explain tourist flows. In fact, some of the studies mentioned in Table 1 were applied to small island destinations and, thereby, included variables -such as the colonial history between the island and the country of origin- as a key variables to include in gravity models that were not included in studies applied to other type of destinations (Dropsy et al., 2020).

2.3. The Use of Gravity Models in Small Island Tourism

Thereby, there have been various attempts aimed to applying gravity models to small island destinations, as researchers seek to understand the unique factors influencing tourism flows in these regions. Archibald, LaCorbinière, and Moore (2008) tried to analyze the competitiveness of Caribbean destinations using gravity models and they found that gravity models had to be more intensively adjusted in order to apply them to small island destinations than for other tourism destinations. In addition, they found that certain variables -for example, prices or airfares- that were not relevant to apply gravity models to other destinations were very important to apply these models to small islands. These results are consistent with studies of other authors that have pointed to variables such as sharing a colonial past or weather conditions as key variables to include in gravity models when applied to small island destinations (Dropsy et al., 2020; Vítová et al., 2019). Moreover, Dropsy, Montet, and Poirine (2020) found other differences, such as the higher elasticity of the demand related to the distance from the origin to the destination.

Despite the studies mentioned use gravity models for their estimations, these differences in the application of models and the results obtained can be also observed in other models and studies when applied to small island destinations. For example, Archibald, LaCorbinière, and Moore (2008) indicated that World Economic Forum competitiveness indicators give mixed results when applied to small island destinations, making them not fully usable to analyze the competitiveness of these destinations. Similar results were obtained by Jackman et al. (2011), who is unable to explain the increase in the success of these destinations, despite this study was unable to find an official competitive advantage to explain this increase. Other studies have also observed that tourism had a smaller multiplier effect on small island destinations than others (Cannonier & Burke, 2019) or a different relationship between tourism development and the quality of life of residents (Croes et al., 2018).

Small island destinations possess a unique set of characteristics that distinguish them from larger, mainland counterparts (Croes, 2011). Their geographical isolation often results in a higher dependence on external factors, such as international trade, foreign investment, and tourism (Croes, 2006). Many small island nations rely heavily on tourism as a primary source of income, which introduces an added layer of complexity to their economic dynamics (Croes, 2006). Given their limited landmass, finite resources, and susceptibility to external shocks like natural disasters and global economic fluctuations, the economic intricacies of small island destinations require specialized attention (Croes, 2011). It becomes crucial, therefore, to critically analyze the suitability of traditional econometric models in capturing the multifaceted interplay of factors that shape these economies. Focusing on local-scale analysis in tourism not only helps policymakers and researchers better understand the unique challenges and opportunities faced by destinations but also aids in the formulation of more effective policies to promote economic sustainability and resilience (Ioannides & Holcomb, 2003; Padrón Ávila, 2020).

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3. Data and Method

The data used to carry out this study come from a variety of different sources. First, data related to the number of tourists visiting each island country were gathered from World Tourism Organization (UNWTO, 2019). Data used for this study relate to tourists arrived during 2017, as it was the most recent year considered in the reports by UNWTO (2019). We only considered small islands, considering as such those island countries with a population under 1.5 million inhabitants as proposed by the United Nations Alliance of Small Islands States (AOSIS), which has been used in past literature (Ashe et al., 1999; Ronneberg, 2016). We also decided not to include island countries that not fully occupies an island, such as Haiti, Papua New Guinea, or Brunei. We decided to do this because we considered that these countries do not suffer the effects that other small islands experience, such as the inability to access by land borders or the increased costs of raw materials and commodities due to its transportation. We considered including island regions or islands belonging to non-island countries to the study but we finally decided not to do it due to differences in data collection procedures and issues related to accessing these data. Even so, we had to use data related to hotel arrivals in the case of Cabo Verde instead of tourist arrivals as these data were missing in the report. Moreover, we also used data from 2016 for Cuba, 2015 for Saint Kitts and Nevis, and 2014 for Saint Maarten because more recent data were not available for these countries or data were not split by the countries of origin of tourists. As there were no data for Nauru and São Tomé and Príncipe these countries were omitted from the analysis. Second, data related to GDP were obtained from World Bank database. We collected data related to GDP per capita to do the analysis as proposed by Eryiğit, Kotil, and Eryiğit (2010) and Morley, Rosselló, and Santana-Gallego (2014). GDP per capita was chosen instead of total GDP as bigger countries usually show higher GDP values related to having a bigger territory or more population, independently of the economic development of the country. The use of GDP per capita solves these issues. Data relate to GDP per capita in 2017 at constant 2015 US$ prices. As the data for Niue and Cook Islands were not available, they had to be omitted for the analysis. Third, data related to the coordinates of each country were collected from Geographic Names Information System (GNIS).

In this study we apply a gravity model analysis using data related to number of tourists, GDP per capita and distances from a set of countries to a group of island countries. We also address potential endogeneity of explanatory variables using 2SLS and SYS-GMM estimators. After filtering data, we decided to study 34 islands countries and tried to explain the visits made by tourists coming from 231 countries through the comparison of their GDPs per capita and their distances. Data related to number of tourists did not required processing. In the case of GDPs per capita, after gathering the data, the difference between the GDPs of each island country with each of the 231 countries studied were obtained, creating a variable to compare the differences between the economies of all countries as proposed by Keum (2010) and Santeramo and Morelli (2016). In the case of the calculations of the distance between countries, data gathered relate to the centroid of each country and the distances estimated refer to the distances between their centroids, as proposed by Panzera, de Graaff, and de Groot (2021) and Zhang, Li, and Wu (2019). After creating the matrix with the data for these three variables, we applied linear regressions using XLSTAT. This program ignores those case where here are missing values, what makes it useful to analyze our dataset because there were several countries of origin that presented no data for certain small island countries. Linnear regressions are the method more commonly used to estimate gravity models, as show the studies of Oguledo and MacPhee (1994), Ranjan and Tobias (2007), and Westerlund and Wilhelmsson (2011).

4. Results and Discussion

The results of the gravity models applied using the difference between the GDPs per capita of the counties studied and the distances between these countries can be seen in Table 2. The table also shows the level of significance of the coefficients obtained after applying the linear regression models.

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Table 2. Coefficients of the linear regression applied to analyze the applicability of gravity models to small island destinations.

	GDP per Capita	Distance
Antigua and Barbuda	0.131	-0.098
Aruba	0.123	-0.126
Bahamas	0.018	-0.118
Barbados	0.117	-0.101
Bermuda	-0.199	-0.410
Cabo Verde	0.008	-0.325
Cayman Islands	-0.196	-0.129
Comoros	-4.676	5.157
Curaçao	0.182	0.006
Cyprus	0.006	0.062
Dominica	0.109	-0.221*
Fiji	0.285	-0.699***
Grenada	0.159	-0.099
Iceland	-0.512	0.296
Kiribati	0.435	-0.606
Maldives	0.087	-0.087
Malta	-0.100	-0.046
Marshall Islands	0.426	0.024
Mauricio	0.058	-0.134
Micronesia	-0.293	0.395
Palau	-0.082	-0.253
Saint Kitts and Nevis	0.796	-0.224
Saint Lucia	0.262	-0.012
Saint Vicent and the Grenadines	0.435	-0.494
Samoa	0.640	-0.719*
Seychelles	0.111	-0.075
Singapore	-0.078	-0.434*
Sint Maarten	0.358	0.136
Solomon Islands	0.634*	-0.751*
Tonga	0.594*	-0.589*
Trinidad and Tobago	0.165*	-0.143
Turks and Caicos Islands	0.605	-0.283
Tuvalu	0.456	-0.734*
Vanuatu	0.611	-0.334

Significance level: *<0.05 **<0.01 ***<0.001.

Previous research has often utilized gravity models to predict trade between countries (Kahouli & Maktouf, 2015; Oguledo & MacPhee, 1994). Similarly, gravity models have been applied in studies explaining tourist arrivals in various destinations (Keum, 2010; Santana-Gallego & Paniagua, 2022). However, our findings appear to challenge this trend. Previous studies primarily focused on analyzing tourist arrivals in cities, regions, non-island countries, or larger island destinations, considering as this those islands with more than 1.5 million inhabitants following AOSIS criteria.

Our study is centered on small island destinations, and our results indicate that distance and economic disparities between these islands and tourists' countries of origin may not be significant factors in explaining tourist arrivals. In fact, distance seems to be significant just to explain tourist arrivals to Fiji, while it is just slightly significant to explain arrivals to 6 other small island destinations. In the case of GDP per capita differences, this variable is only slightly significant to explain tourist arrivals to 3 small island destinations. Furthermore, our analysis reveals that neither economic size nor distance are significant factors in explaining tourist arrivals in 26 out of the 34

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small island destinations we studied. This may challenge general economic literature on gravity models but aligns with previous research on small island destinations, which showed that economic size and distance were not significant variables in analyzing tourist arrivals (Rosselló Nadal & Santana Gallego, 2022).

Past studies on gravity models for tourist arrivals in small island destinations also had to include additional variables, such as a common language or historical relationships, to obtain significant results (Santana-Gallego et al., 2016). In our study, we deliberately excluded these variables to demonstrate the limitations of traditional gravity models when applied to small island destinations. Despite this, our research remains valuable and pioneering as it is the first comprehensive study of the applicability of gravity models across various small island destinations. Prior studies mainly focused on single destinations, such as Montesinos et al. (2003) and Represas et al. (2012). Our findings shed light on the inefficacy of gravity models in predicting tourist arrivals in small island destinations.

5. Conclusion

This paper has explored the efficacy of gravity models in predicting tourist arrivals in small island destinations. The study focused on 34 small islands and employed linear regression analysis to assess the significance of economic size and distance as predictors of tourist arrivals. The results have revealed several key findings that shed light on the limitations of applying gravity models to these destinations. First, the analysis demonstrated that the differences in the economic size between the small island destinations and the countries of origin of tourists are not a significant predictor of tourist arrivals in 31 out of the 34 islands studied. This finding is contrary to the typical assumptions made in gravity models, which suggest that more similar economic development between origin and destination attracts more tourists. Second, the study found that the distance between the islands and the country of origin of tourists was also not a significant factor in explaining tourist arrivals for the majority of the destinations. This contradicts the standard gravity model hypothesis, which posits that shorter distances would lead to higher levels of tourism due to reduced travel costs and increased accessibility.

The inefficacy of gravity models in predicting tourist arrivals in small island destinations can be attributed to several unique characteristics of these places. Small island destinations often have distinct features that make them stand out from the standard assumptions underlying gravity models. For instance, their limited carrying capacity, vulnerability to external factors such as weather conditions, and the influence of natural attractions like beaches and marine life can significantly impact tourism flows. Moreover, the cultural and environmental preservation efforts, as well as specific marketing strategies employed by small island destinations, may play a more substantial role in attracting tourists than their economic size or proximity to the countries of origin of tourists.

The findings of this study have several significant implications. First, it highlights the need for a more nuanced approach to tourism research and destination management in small island contexts. Understanding the unique factors that drive tourist arrivals in these destinations is crucial for the development of effective tourism strategies. This research also implies that reliance on traditional gravity models may not be suitable for predicting tourist arrivals in small islands, and alternative methodologies should be explored. Further research should focus on identifying the specific drivers of tourism in these destinations, including the role of marketing, environmental sustainability, and cultural appeal.

Despite the variety of small island destinations analyzed, we have to acknowledge the limitations of this study. This study has several limitations that should be addressed in future research. First, the data set is limited to a specific time period and group of islands, which may affect the generalizability of the findings. Future research should consider using longer time series data and a broader range of destinations to validate the results. Additionally, the inclusion of other potential determinants of tourism flows, such as cultural and environmental factors, could provide a more comprehensive understanding of the factors influencing tourism demand. Moreover, the analysis did

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not consider other potential variables used to adjust gravity models, such as marketing efforts, political stability, or the impact of global events, which may have influenced tourist arrivals.

References

1. Anderson, J. (1979). EA Theoretical Foundation of the Gravity Model. *American Economic Review*, *69*(1).
2. Archibald, X., LaCorbinière, J., & Moore, W. (2008). *Analysis of tourism competitiveness in the Caribbean: A gravity model approach*. 29th Annual Review Seminar Research Department Central Bank of Barbados.
3. Ashe, J. W., Van Lierop, R., & Cherian, A. (1999). *The role of the alliance of small island states (AOSIS) in the negotiation of the United Nations framework convention on climate change (UNFCCC)*. *23*(3), 209-220.
4. Assaf, A. G., & Dwyer, L. (2013). Benchmarking international tourism destinations. *Tourism Economics*, *19*(6), 1233-1247.
5. Bergstrand, J. H. (1985). The gravity equation in international trade: Some microeconomic foundations and empirical evidence. *The review of economics and statistics*, 474-481.
6. Bhattacharya, S. K., & Bhattacharyay, B. N. (2007). *Gains and losses of India-China trade cooperation-A gravity model impact analysis*.
7. Cannonier, C., & Burke, M. G. (2019). The economic growth impact of tourism in Small Island Developing States—Evidence from the Caribbean. *Tourism Economics*, *25*(1), 85-108.
8. Chasapopoulos, P., Den Butter, F. A., & Mihaylov, E. (2014). Demand for tourism in Greece: A panel data analysis using the gravity model. *International Journal of Tourism Policy*, *5*(3), 173-191.
9. Comins, N. F., & Kaufmann, W. J. (2008). *Discovering the Universe: From the Stars to the Planets*. MacMillan.
10. Croes, R. (2006). A paradigm shift to a new strategy for small island economies: Embracing demand side economics for value enhancement and long term economic stability. *Tourism Management*, *27*(3), 453-465.
11. Croes, R. (2011). Measuring and explaining competitiveness in the context of small island destinations. *Journal of Travel Research*, *50*(4), 431-442.
12. Croes, R., Ridderstaat, J., & van Niekerk, M. (2018). Connecting quality of life, tourism specialization, and economic growth in small island destinations: The case of Malta. *Tourism Management*, *65*, 212-223.
13. Doumbe, E. D., & Belinga, T. (2015). A gravity model analysis for trade between Cameroon and twenty-eight European Union Countries. *Open Journal of Social Sciences*, *3*(08), 114.
14. Dropsy, V., Montet, C., & Poirine, B. (2020). Tourism, insularity, and remoteness: A gravity-based approach. *Tourism Economics*, *26*(5), 792-808.
15. Eryiğit, M., Kotil, E., & Eryiğit, R. (2010). Factors affecting international tourism flows to Turkey: A gravity model approach. *Tourism Economics*, *16*(3), 585-595.
16. Feyrer, J., & Sacerdote, B. (2009). Colonialism and modern income: Islands as natural experiments. *The Review of Economics and Statistics*, *91*(2), 245-262.
17. Fourie, J., & Santana-Gallego, M. (2011). The impact of mega-sport events on tourist arrivals. *Tourism Management*, *32*(6), 1364-1370.
18. Ghalia, T., Fidrmuc, J., Samargandi, N., & Sohag, K. (2019). Institutional quality, political risk and tourism. *Tourism Management Perspectives*, *32*, 100576.
19. Harb, G., & Bassil, C. (2020). Gravity analysis of tourism flows and the 'multilateral resistance to tourism'. *Current Issues in Tourism*, *23*(6), 666-678.
20. Hua, C., & Porell, F. (1979). A critical review of the development of the gravity model. *International Regional Science Review*, *4*(2), 97-126.
21. Huff, D. L. (1962). A note on the limitations of intraurban gravity models. *Land Economics*, *38*(1), 64-66.
22. Ioannides, D., & Holcomb, B. (2003). Misguided policy initiatives in small-island destinations: Why do up-market tourism policies fail? *Tourism Geographies*, *5*(1), 39-48.
23. Isard, W. (1954). Location theory and trade theory: Short-run analysis. *The Quarterly Journal of Economics*, 305-320.
24. Jackman, M., Lorde, T., Lowe, S., & Alleyne, A. (2011). Evaluating tourism competitiveness of small island developing states: A revealed comparative advantage approach. *Anatolia*, *22*(3), 350-360.
25. Kahouli, B., & Maktouf, S. (2015). The determinants of FDI and the impact of the economic crisis on the implementation of RTAs: A static and dynamic gravity model. *International Business Review*, *24*(3), 518-529.

 doi:10.20944/preprints202501.0007.v1

26. Keum, K. (2010). Tourism flows and trade theory: A panel data analysis with the gravity model. *The Annals of Regional Science*, *44*(3), 541-557.
27. Khadaroo, J., & Seetanah, B. (2008). The role of transport infrastructure in international tourism development: A gravity model approach. *Tourism Management*, *29*(5), 831-840.
28. Montesinos, F., Camacho, A., Nunes, J. C., Oliveira, C., & Vieira, R. (2003). A 3-D gravity model for a volcanic crater in Terceira Island (Azores). *Geophysical Journal International*, *154*(2), 393-406.
29. Morley, C., Rosselló, J., & Santana-Gallego, M. (2014). Gravity models for tourism demand: Theory and use. *Annals of tourism research*, *48*, 1-10.
30. Oguledo, V., & MacPhee, C. R. (1994). Gravity models: A reformulation and an application to discriminatory trade arrangements. *Applied Economics*, *26*(2), 107-120.
31. Padrón Ávila, H. (2020). *La medición del impacto económico del turismo: Metodología y principales resultados de la Cuenta Satélite del Turismo en la Unión Europea*.
32. Panzera, E., de Graaff, T., & de Groot, H. L. (2021). European cultural heritage and tourism flows: The magnetic role of superstar World Heritage Sites. *Papers in Regional Science*, *100*(1), 101-122.
33. Park, J.-Y., & Jang, S. C. (2014). An extended gravity model: Applying destination competitiveness. *Journal of Travel & Tourism Marketing*, *31*(7), 799-816.
34. Porojan, A. (2001). Trade flows and spatial effects: The gravity model revisited. *Open economies review*, *12*(3), 265-280.
35. Priego, F. J., Rosselló, J., & Santana-Gallego, M. (2015). The impact of climate change on domestic tourism: A gravity model for Spain. *Regional environmental change*, *15*(2), 291-300.
36. Ranjan, P., & Tobias, J. L. (2007). Bayesian inference for the gravity model. *Journal of Applied Econometrics*, *22*(4), 817-838.
37. Represas, P., Catalao, J., Montesinos, F. G., Madeira, J., Mata, J., Antunes, C., & Moreira, M. (2012). Constraints on the structure of Maio Island (Cape Verde) by a three-dimensional gravity model: Imaging partially exhumed magma chambers. *Geophysical Journal International*, *190*(2), 931-940.
38. Ronneberg, E. (2016). *Small islands and the big issue: Climate change and the role of the alliance of small Island States*.
39. Rosselló Nadal, J., & Santana Gallego, M. (2022). Gravity models for tourism demand modeling: Empirical review and outlook. *Journal of Economic Surveys*.
40. Santana-Gallego, M., Ledesma-Rodríguez, F. J., & Pérez-Rodríguez, J. V. (2016). International trade and tourism flows: An extension of the gravity model. *Economic Modelling*, *52*, 1026-1033.
41. Santana-Gallego, M., & Paniagua, J. (2022). Tourism and migration: Identifying the channels with gravity models. *Tourism Economics*, *28*(2), 394-417.
42. Santeramo, F. G., & Morelli, M. (2016). Modelling tourism flows through gravity models: A quantile regression approach. *Current Issues in Tourism*, *19*(11), 1077-1083.
43. Tinbergen, J. (1962). *Shaping the world economy; suggestions for an international economic policy*.
44. Ulucak, R., Yücel, A. G., & İlkay, S. Ç. (2020). Dynamics of tourism demand in Turkey: Panel data analysis using gravity model. *Tourism Economics*, *26*(8), 1394-1414.
45. UNWTO. (2019). *Yearbook of Tourism Statistics, Data 2013–2017* (2019 Edition). UNWTO.
46. Verlinde, E. (2011). On the Origin of Gravity and the Laws of Newton. *Journal of High Energy Physics*, *2011*(4), 1-27.
47. Vítová, P., Harmáček, J., & Opršal, Z. (2019). Determinants of tourism flows in small island developing states (SIDS). *Island Studies Journal*, *14*(2), 3-22.
48. Westerlund, J., & Wilhelmsson, F. (2011). Estimating the gravity model without gravity using panel data. *Applied Economics*, *43*(6), 641-649.
49. Xu, L., Wang, S., Li, J., Tang, L., & Shao, Y. (2019). Modelling international tourism flows to China: A panel data analysis with the gravity model. *Tourism Economics*, *25*(7), 1047-1069.
50. Yazdi, S. K., & Khanalizadeh, B. (2017). Tourism demand: A panel data approach. *Current Issues in Tourism*, *20*(8), 787-800.
51. Yerdelen Tatoglu, F., & Gul, H. (2020). Analysis of tourism demand using a multi-dimensional panel gravity model. *Tourism Review*, *75*(2), 433-447.

 doi:10.20944/preprints202501.0007.v1

52. Yotov, Y. V., Piermartini, R., & Larch, M. (2016). *An Advanced Guide to Trade Policy Analysis: The Structural Gravity Model*. World Trade Organization.
53. Zhang, Y., Li, X., & Wu, T. (2019). The impacts of cultural values on bilateral international tourist flows: A panel data gravity model. *Current Issues in Tourism*, *22*(8), 967-981.