University of Southern Queensland

THE EFFECTS OF TOURISM ON 4E'S (EARNINGS, EMPLOYMENT, ENERGY CONSUMPTION, AND ENVIRONMENT): AN AUSTRALIAN PERSPECTIVE

A Thesis submitted by

Avishek Khanal

EMBA

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ABSTRACT

This thesis consists of four papers that examine the relationship between tourism and 4Es (i.e., earnings, employment, energy consumption, and environment) using time series analysis. This research explores both the positive and negative impacts of international tourism activities on the aforementioned four factors in Australia. Globally, the travel and tourism industry is recognised as a top contributor to growth, employment, and increased foreign exchange. Paper 1 tests the air-transportation-led growth hypothesis (ALGH). The study investigated whether air travel (a proxy for tourism) boosts earnings. To investigate the impact on earnings, the asymmetric long-run and short-run impacts of air passengers carried (a proxy for tourism) were examined against the Australian gross domestic product (GDP) (a proxy for earnings). The results indicate any positive shock in air transport causes higher economic growth by 0.158% in the long-run. Further, any negative shock in air transport caused 0.382% which caused lower GDP (economic growth) confirming the asymmetric relationship between air transport and GDP. These results reveal that the more the passengers are carried by air transportation, the more the economic growth will boost, thus supporting the ALGH in the context of Australia. Paper 2 examines the relationship between tourism, market capital (MC), financial growth, and trade, as well as its symmetric and asymmetric impacts on the service sector employment. The results of co-integration tests, particularly the autoregressive distributed lag (ARDL) and NARDL bound tests, showed that the variables were connected throughout time. Long-term estimates obtained using both ARDL and NARDL methodologies indicated the favourable effect of tourist arrivals (TAs) on the service sector employment. Similarly, both methodologies supported the long-term beneficial relationship between financial development (FD) and economic growth. Paper 3 investigates the long-term co-integration link between foreign visitor arrivals and primary energy usage in Australia during the period of 1971–2019. Some control variables are also added. The results showed that TAs, GDP, and FD have a substantial long-term co-integrating relationship with each other. It is observed that an increase of 1% in TAs boosted energy use by 0.062%. Paper 4 investigates the long-run co-integrating link between tourism and environmental deterioration (a proxy for carbon dioxide (CO_2)). The ARDL bound test technique is used to derive both long-run and short-run coefficients using data from 1976 to 2019. According to the estimated outcomes, tourism prevents Australia from being carbon neutral. Along with TAs, energy use and GDP are important factors that have a long-term, positive and statistically significant link with carbon emissions. An increase of 1% in TAs is associated with a surge of 0.13% in CO_2 emissions in the long run at a 1% significance. To sum up, this research adds a greater understanding about the impact of tourism on earnings, employment, energy consumption, and environment, and has policy implications for Australia's long-term tourism growth. The results provide evidence-based information for stakeholders, including the tourism businesses, Australian tourism enterprises, and the government, and have potential to positively inform future strategies and procedures.

CERTIFICATION OF THESIS

I, Avishek Khanal, declare that the PhD Thesis entitled "Tourism effects on 4E's (Earnings, Employment, Energy consumption, and Environment): An Australian perspective" is not more than 100,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography, references, and footnotes.

This Thesis is the work of Avishek Khanal except where otherwise acknowledged, with the majority of the contribution to the papers presented as a Thesis by Publication undertaken by the student. The work is original and has not previously been submitted for any other award, except where acknowledged.

Date: 5th December 2022

Endorsed by:

Associate Professor Mohammad Mafizur Rahman
Principal Supervisor

Associate Professor Rasheda Khanam
Associate Supervisor

Dr Eswaran Velayutham
Associate Supervisor

STATEMENT OF CONTRIBUTION

The work carried out during this thesis was under the guidance of supervisors Associate Professor Dr Mohammad Mafizur Rahman, Associate Professor Dr Rasheda Khanam, and Dr Eswaran Velayutham. The following detail is about the agreed contribution for the candidate and co-authors in the publications presented in the thesis.

Paper 1:

Khanal, A., Rahman, M. M., Khanam, R., & Velayutham, E. (2022). Exploring the Impact of Air Transport on Economic Growth: New Evidence from Australia. Sustainability, 14(18), 11351. [**Published: Sustainability, Q1 Journal**]

The overall contribution to the first paper by Avishek Khanal was 80%, including the concept development, data management, analyses, interpretation, and drafting the final manuscript. The contribution of Dr Mohammad Mafizur Rahman, Dr Rasheda Khanam, and Dr Eswaran Velayutham was 20% (each with 10%, 5% and 5% respectively) where they assisted in developing the concept, editing, and offering intellectual feedback.

Paper 2:

Khanal, A., Rahman, M. M., Khanam, R., & Velayutham, E. (2022). The role of tourism in service sector employment: Do market capital, financial development and trade also play a role? PLoS ONE, 17(8), e0270772. [**Published: PLOS ONE, Q1 Journal**]

The overall contribution to the second paper by Avishek Khanal was 80%, including the concept development, data management, analyses, interpretation, and drafting the final manuscript. The contribution of Dr Mohammad Mafizur Rahman, Dr Rasheda Khanam, and Dr Eswaran Velayutham was 10%, 5%, and 5%, respectively, where they were involved in developing the concept, editing, and offering intellectual feedback.

Paper 3:

Khanal, A., Rahman, M. M., Khanam, R., & Velayutham, E. (2021). Are Tourism and Energy Consumption Linked? Evidence from Australia. Sustainability, 13(19), 10800. [**Published: Sustainability, Q1 Journal**]

The overall contribution to the third paper by Avishek Khanal was 75%, including the concept development, data management, analyses, interpretation, and drafting the final manuscript. The contribution of Dr Mohammad Mafizur Rahman, Dr Rasheda Khanam, and Dr Eswaran Velayutham was 15%, 5%, and 5%, respectively, where they were involved in developing the concept, editing, and offering intellectual feedback.

Paper 4:

Khanal, A., Rahman, M. M., Khanam, R., & Velayutham, E. (2021). Does tourism contribute towards zero-carbon in Australia? Evidence from ARDL modelling approach. Energy Strategy Reviews, 43, 100907. [**Published: Energy Strategy Reviews, Q1 Journal**]

The overall contribution to the fourth paper by Avishek Khanal was 75%, including the concept development, data management, analyses, interpretation, and drafting the final manuscript. The contribution of Dr Muhammad Mafizur Rahman, Dr Rasheda Khanam, and Dr Eswaran Velayutham was 10%, 5%, and 10%, respectively, where they assisted in developing the concept, editing, and offering intellectual feedback.

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DEDICATION

I wish to dedicate this PhD thesis work to my grandmother (Late Mrs Anjir Devi), who always wanted to see me as a doctor and provided me motivation to pursue this objective; to my father (Late Mr Amlesh Kumar Upadhyay), who lost his life battling cancer; to my mother, daughter, and newborn son; and – last but not least – to my wife (Kritika Dhakal), who was truly supportive and encouraging throughout my PhD journey.

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LIST OF ABBREVIATIONS

Abbreviation	Definition
ABS	Australian Bureau of Statistics
ADF	Augmented Dickey–Fuller
AIC	Akaike Information Criterion
ALGH	Air-transportation-Led Growth Hypothesis
ARDL	Autoregressive Distributed Lag
BDS	Brock-Dechert-Scheinkman
BRICS	Brazil, Russia, India, China, and South Africa
CO_2	Carbon Dioxide
EC	Energy Consumption
ECM	Error Correction Model
EKC	Environmental Kuznets curve
ELG	Export-Led Growth
EMP	Employment
EU	European Union
FD	Financial Development
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
GHG	Greenhouse Gas
IEA	International Energy Agency
ILO	International Labour Organization
IPAT	Impact Population Affluence Technology

JJ	Johansen–Juselius
MC	Market Capital
NARDL	Non-Linear Autoregressive Distributed Lag
OECD	Organisation for Economic Co-operation and Development
POS	Positive
PP	Phillips–Perron
RBA	Reserve Bank of Australia
SG	Social Globalisation
TA	Tourist Arrival
TLG	Tourism-Led Growth
TLGH	Tourism-Led Growth Hypothesis
TP	Total Population
TR	Tourism Receipt
UCB	Upper Critical Bound
UG	Urbanisation Growth
UK	United Kingdom
UN	United Nations
US	United States
VECM	Vector Error Correction Model
WTO	World Tourism Organization
WTTC	World Travel and Tourism Council
ZA	Zivot-Andrews

CHAPTER 1: INTRODUCTION

1.1 Background

International tourism is viewed as a key driver of development and employment (EMP) booster in both developed (Balaguer & Cantavella-Jorda, 2002) and developing countries (Samimi et al., 2011). Tourists typically expect four basic goods and services from a destination, which include lodging, food, transportation, and entertainment (Li et al., 2011). To meet these demands, the existing output levels of most emerging countries must be increased (Samimi et al., 2011), which will bring forward two significant consequences for their economies. First, production and earnings will be increased; second, EMP in the tourism sector will be boosted (Manzoor et al., 2019). As a result, the tourism industry has the potential to contribute to both earnings and EMP. On the other hand, tourism is also seen as a contributor to global warming, especially with the emissions of CO_2 (Eyuboglu & Uzar, 2019) caused by flights, cruise ships, and hotels, leading to excessive energy consumption (EC) (Anser, 2019; Ben Jebli & Hadhri, 2018). A large part of the tourism industry also includes air transportation and lodging, both of which need a significant amount of energy and have a negative impact on the environment in the form of high mass CO_2 emissions and greenhouse gas (GHG) emissions (Robaina et al., 2020).

Over the last two centuries, environmental changes due to human and economic activities have become a global issue for two major reasons. First, the world has been confronted with the issue of tremendous economic expansion while still seeking to maintain environmental quality (Shahbaz et al., 2017). As a result of global climate change, environmental quality has become one of the most urgent challenges for both developed and developing countries (León et al., 2014). Second, GHG emissions are mostly related to the use of energy required to generate goods and services (Liobikienė & Butkus, 2019). As a result of the links between GHG emissions and EC, steps to reduce GHG emissions have implications for economic growth

(Sarkodie et al., 2019). Given the urgency of tackling challenges due to climate change, several studies have been conducted to ascertain the primary determinants of environmental damage with the associated economic expansion. The focus on sustainable tourism in environmental literature is extensive; however, further research into the various socioeconomic factors and for sustainable development throughout nations is required. Thus, this study explores the influence of tourism on the economy (including earnings and EMP), EC, and the environment in Australia. Based on the findings, this study proposes a wide range of policy recommendations.

Research indicates that the most significant impacts on economic growth and the environment stem from human activities (Begum et al., 2015). And, in this context, tourism is one of very significant human activities. Due to its rapid growth, tourism is one of the most important components of the service economy and has the potential to stimulate the environment (Selvanathan et al., 2020). Thus, infrastructure constructed for tourist activities increases energy use (Khanal et al., 2021) and hence CO_2 emissions (Pan et al., 2021; Y. Shi & Yu, 2021). In the last three decades, there has been a great deal of research on the relationship between EC and economic growth (Dehghan Shabani & Shahnazi, 2019; Fatai et al., 2004; Kyara et al., 2021; Omri & Kahouli, 2014; M. M. Rahman, 2021), as well as on the relationship between economic growth and pollution (J. W. Lee & Brahmasrene, 2014; Shahbaz et al., 2017). However, there is insufficient research on the link between tourism, earnings, EMP, energy, and the environment.

The energy–growth–environment nexus (Acheampong, 2018) is the focal point of tourism–energy research, as the tourism sector is linked to both EC and environmental degradation (Katircioglu, 2014a). Each stage of tourism, from transportation (e.g., rental cars, railways, etc.) to accommodation (e.g., hotel/motel, backpackers' hostel), involves EC, either directly through fossil fuels or indirectly through electric power. Depending on the type of energy used (i.e., renewable or non-renewable), pollution levels in the tourism sector may be reduced or increased.

The impact of tourism on the environment can be altered by supportive policies and government actions aimed at reducing GHG emissions and promoting the use of clean energy technologies in the industry (Khan et al., 2019). However, the bulk of tourists choose to swim in the resort, sunbathe, and travel to different locations using motorised transportation (Davenport & Davenport, 2006) and therefore do not usually focus on the use of clean technologies.

The GHGs create air pollution induced by the use of fossil fuels and motorised vehicles (Kan et al., 2012). According to the World Tourism Organization (WTO), the tourism industry is responsible for 4.6% of global warming and accounts for 5% of CO_2 emissions (WTO, 2022). These negative consequences prompt industrialised countries to pursue tourism-related policies that will help to achieve zero-carbon. As a result of these steps, the notion of sustainable tourism has arisen – an area this thesis makes a contribution to.

1.1.1 An Overview of Tourism

According to the WTO, '*Tourism is a social, cultural and economic phenomenon which entails the movement of people to countries or places outside their usual environment for personal or business/professional purposes. These people are called visitors (which may be either tourists or excursionists; residents or non-residents) and tourism has to do with their activities, some of which involve tourism expenditure*' (UNWTO, 2022). There are three major categories of tourism according to UNWTO: i) *domestic tourism* – travel undertaken by residents within the borders of their own country; ii) *inbound tourism* – refers to travel by non-resident visitors to other countries; and iii) *outbound tourism* – travel undertaken by resident visitors to different countries. Thus, the combination of both *domestic* and *inbound* tourism is often termed as *internal tourism* while national tourism takes participation in both *outbound* and *domestic* tourism. Lastly, the tourism that involves both *inbound* and *outbound* tourism is termed as *international* tourism. Figure 1.1 illustrates the classification of tourism (UNWTO, 2022).

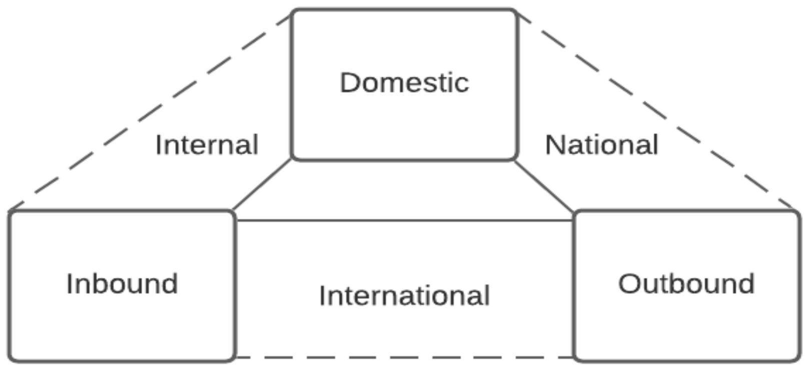

Figure 1. Classifications of tourism

Since the invention of air travel, global tourism trends to have grown at an exponential rate (Adedoyin et al., 2020). Aeroplanes provide the easiest and quickest means of transportation for travellers. In recent years, the tourism business has attracted many investors into the host economy; this is because it generated money and foreign reserves, assisted in job creation, and contributed to an economy's growth and development (Kweka et al., 2001; Rasool et al., 2021). According to the World Travel and Tourism Council (WTTC), in 2019, travel and tourism accounted for US$8.9 trillion (10.3%) of global GDP (WTTC, 2020). Thus, tourism contributed to economic development by creating EMP, providing sources of earning, and, as a result, increasing tax revenue (Kweka et al., 2001). In 2019, tourism created 330 million jobs, or 1 job in 10, around the world (WTTC, 2020).

However, the COVID-19 pandemic has had a large impact on the tourism industry. Currently, tourism is among the most affected sectors as the world struggles with an unprecedented global health, social, and economic disaster caused by COVID-19, with planes grounded, closure of hotels, and travel restrictions imposed in practically every country. Before the COVID-19 pandemic, the international tourism sector had 1.5 billion international TAs in 2019 around the world (UNWTO, 2022). Thus, at present, because of the COVID-19 pandemic, tourism is in a state of flux, and this research will help in economic recovery by minimising energy usage and maintaining the environment. It will also be very useful when the tourism industry returns after the pandemic.

1.1.2 The State of Tourism in Australia

During the 1970s and 1980s, Australia became a popular tourist destination. According to the Australian Bureau of Statistics (ABS), international TAs increased from 531,900 to 904,700 between 1976 and 1980 in Australia (ABS, 2022). In the 1980s, the original *Crocodile Dundee* movie paved the way for Australia to be put on the tourist map for travellers from the United States (US) (Riley & Van Doren, 1992). The expansion of tourism in Australia throughout the 1980s developed in terms of its scope, position, and significance. In the 1990s, Australia's tourism industry saw an increase in TAs, making tourism the country's highest earner of foreign currency at the time. The number of visitors increased to about 4,931,300 during the 2000 Summer Olympics held in Sydney, influenced by the popularity of the Olympic Games (ABS, 2022). This number steadily gained momentum until 2018 (ABS, 2022). In 2019, Australia greeted 9.4 million international tourists and, according to the WTTC (2020), Australia's tourism sector contributed 10.3% of its total GDP, creating 12.8% of total EMP in that year. In Australia, since September 2020, only three months (from May to July 2021) have welcomed more than 60,000 overseas arrivals, while some months have seen 20,000–40,000 arrivals (see Table 1 and Figure 2) (Overseas Arrivals and Departures, Australia, September 2021 | Australian Bureau of Statistics, n.d.).

Table 1. Trend of TAs in Australia

Year	TAs
1976	531,900
1980	904,700
1985	1,142,700
1990	2,214,900
1995	3,725,900
2000	4,931,300
2005	5,463,000
2010	5,871,600
2015	7,449,900
2018	9,245,800

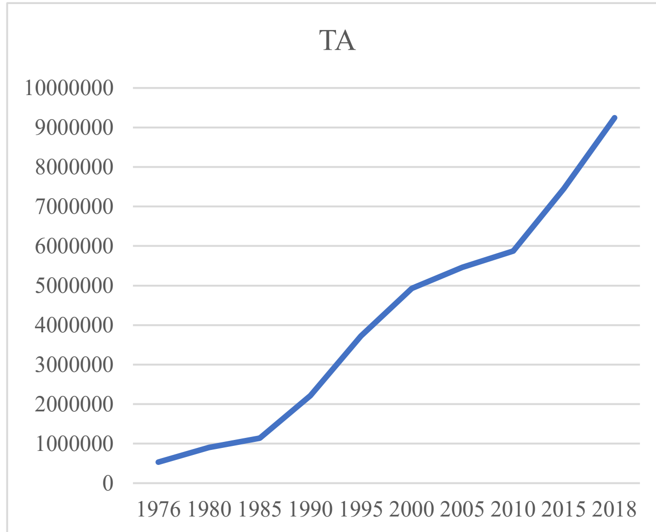

Figure 2. Trend of TAs in Australia

According to Tourism Australia, prior to the COVID-19 pandemic, Australia ranked as the number 1 country for visitor spend per trip and 7th globally for overall tourism receipts (TRs) (Australia, 2019). Visitor spending therefore contributed significantly to the national and state economies of Australia. Table 2 and Figure 3 show the top five number of visitors by country to Australia. Till 2014, visitors from New Zealand were among the list of visitors by country to Australia while Chinese tourist topped the list since then and China remains number 1 country among the visitors to Australia followed by the neighbouring country New Zealand from 2014 till 2019 before the pandemic.

Table 2 Top five numbers of visitors by country to Australia

Year/Country	2000	2005	2013	2014	2015	2019
China	120,000	250,000	708,900	839,000	1,310,900	1,323,000
New Zealand	817,000	1,098,900	1,100,000	1,241,400	1,309,000	1,272,000
UK	580,400	708,800	657,600	652,100	688,400	674,000
US	488,100	370,300	393,100	411,000	433,300	764,000

Singapore	285,700	266,100	339,800	372,100	395,800	407,000

Source: ABS (2022)

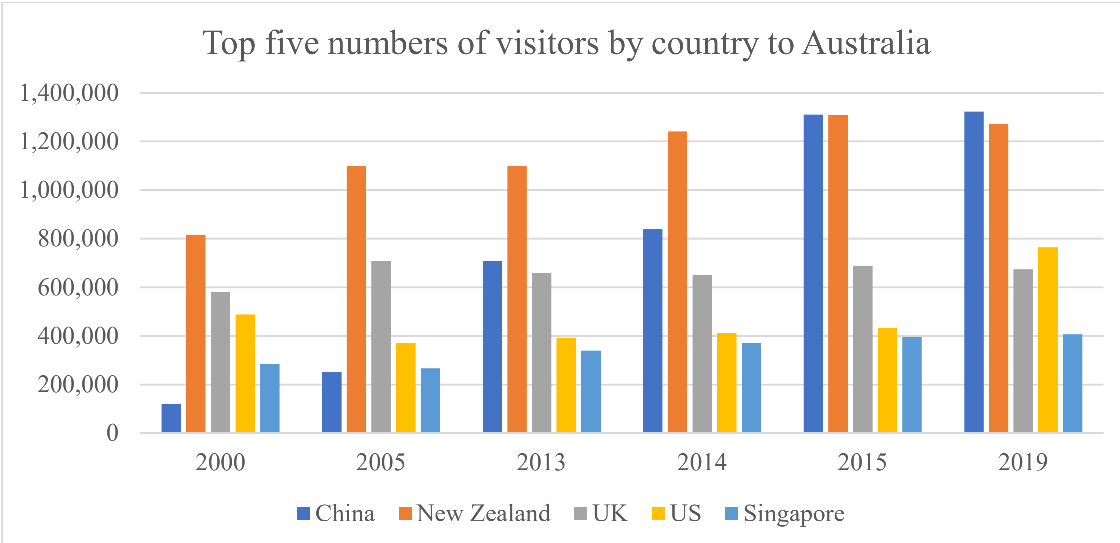

Figure 3. Top five numbers of visitors by country to Australia

1.1.3 The State of Economic Growth in Australia

Table 3. Trend of GDP in Australia

Year	**GDPPC (US$)**
1976	27,944.23
1980	29,907.79
1985	32,045.32
1990	35,912.21
1995	38,095.13
2000	44,334.39
2005	48,813.89
2010	52,022.13
2015	55,079.90
2018	56,864.30

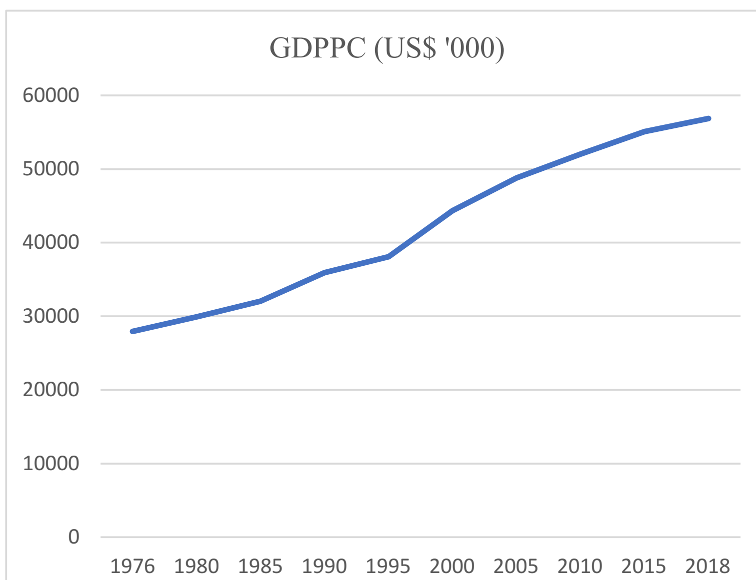

Figure 4. Trend of economic growth (GDP) in Australia

Although we don't have earnings data in tourism sector for our study period (1976 to 2018), we can make a comparison between total GDP and earning in tourism sector for selected years (2014/15 – 2021/22) as shown in Figure 4a.

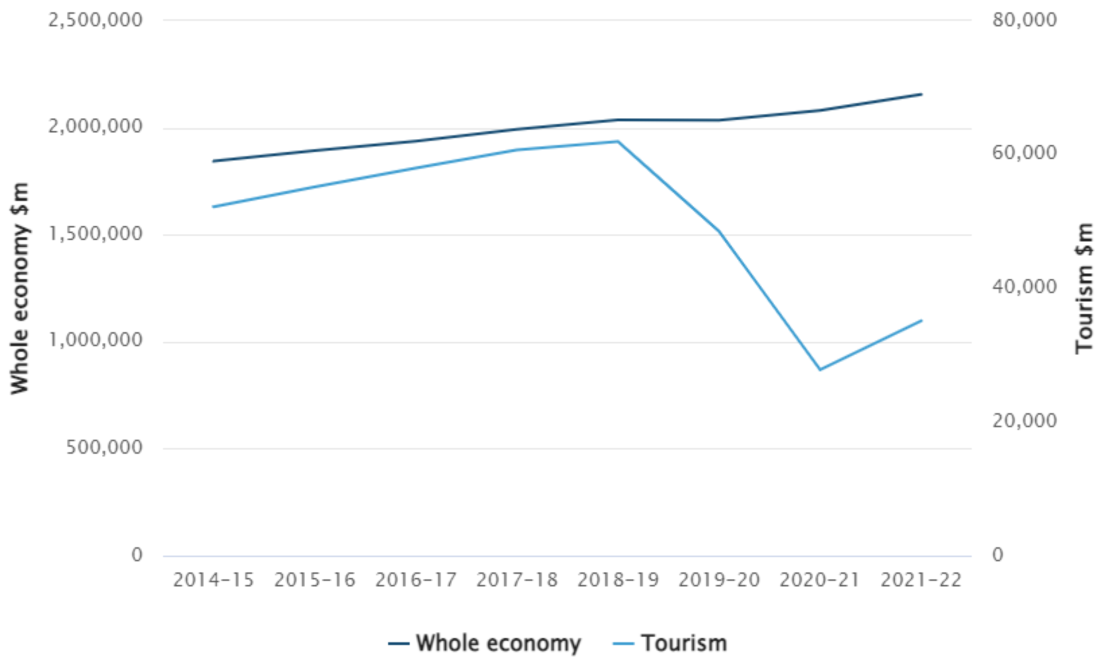

Figure 4a. Comparison of contributions from tourism sector and overall GDP in Australia. Source: Australian Bureau of Statistics, Australian National Accounts: Tourism Satellite Account 2021-22 financial year.

According to the Reserve Bank of Australia (RBA), the term 'economic growth' refers to the expansion of a country's economy through time. The overall production of goods and services in the economy, known as GDP, is commonly used to determine the size of an economy (RBA, 2022). The trend of economic growth in Australia's economy, as seen in Table 3, shows that the per capita GDP was US$27,944.23 and US$29,907.79 in 1976 and 1980, respectively. There was a steady rise in GDP from 1985 to 1995 as seen in Figure 4. In 2000, the growth was more than 14% compared to 1995, and the GDP reached US$44,334.39 per capita. The individual years from 2005 to 2018 also showed an increasing trend in the Australian economy. However, after 2019, the Australian economy declined by nearly 2% due to lengthy lockdowns across the country and closed borders as a result of the COVID-19 pandemic.

1.1.4 The State of EMP in Australia

Table 4. Trend of EMP in service sector in Australia

Year	EMP
1991	71.14
1995	72.60
2000	73.53
2005	75.29
2010	75.79
2015	77.97
2016	78.02
2017	77.97
2018	77.50
2019	78.38

Note: EMP in services (% of total EMP) (modelled International Labour Organization (ILO) estimate)

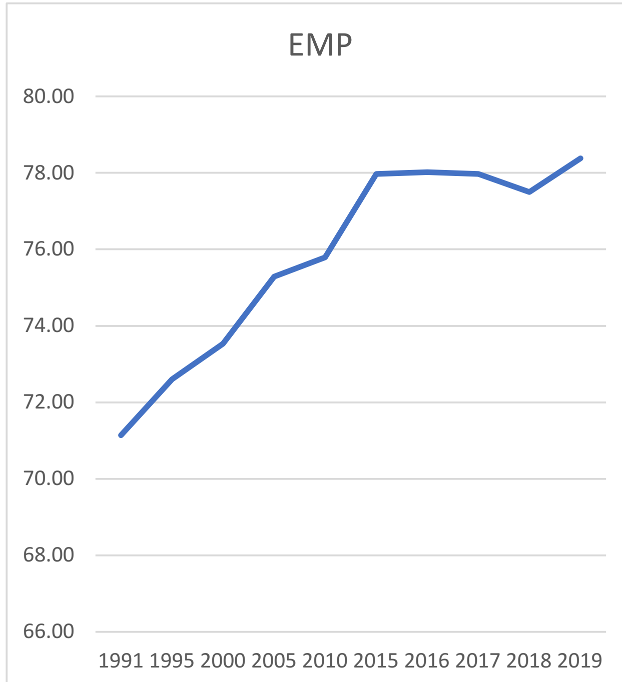

Figure 5. Trend of EMP in service sector in Australia

The EMP figures in Australia are the main determinant of socioeconomic development. The percentages of full-time or part-time EMP, unemployment, and labour force participation reflect the economy's strength. The number of people in the workforce is influenced by a variety of factors, including age structure; the economic foundation and job options available in the area; and the population's education and skill base. In the global economy, the travel and tourism industry is extremely important to enhance the EMP opportunities. This industry employed more than 235 million people in 2010. Table 4 and Figure 5 show that after a slight dip in 2008–2009 (because of the recession hit), the industry continued to rise steadily until the end of 2019 and the effects of the COVID-19 pandemic. According to ILO, it was predicted to increase at roughly 9% of total GDP in 2021, but it has been one of the hardest hits by the pandemic (ILO, 2022).

1.1.5 The State of EC in Australia

Table 5. Trend of EC in Australia

Year	EC
1976	192.80
1980	207.31
1985	205.04
1990	224.38
1995	233.07
2000	248.98
2005	250.74
2010	248.14
2015	243.89
2018	240.81

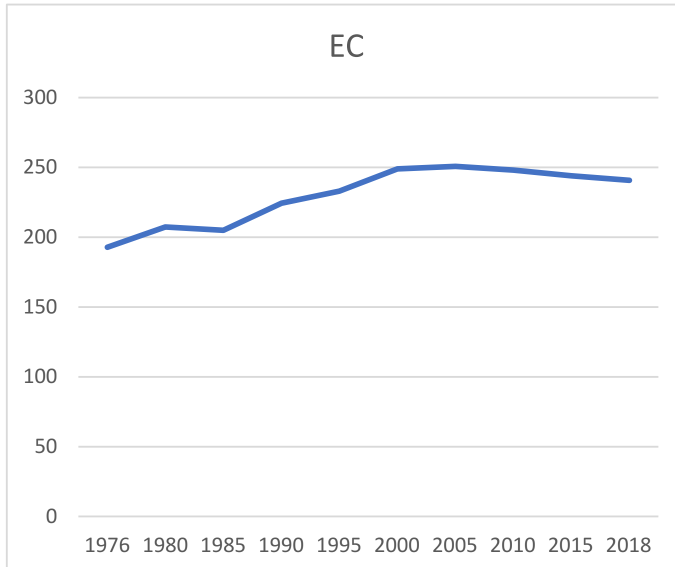

Figure 6. Trend of EC in Australia

According to the International Energy Agency (IEA), Australia is a major supplier of coal and uranium, and has enormous energy resources (IEA 2022). However, the energy industry in Australia is experiencing a major transition. Australia is one of the largest energy-producing countries and these industries are mostly dependent on coal for energy generation (IEA 2022). Due to its high energy and the carbon intensity of energy usage, Australia is one of the world's top 20 polluted countries, with per capita carbon pollution far exceeding that of any other developed country (World Pollution Review, 2021). As seen in Table 5, from 1976 to 1995, Australia's primary EC increased, rising from 192.80 to 233.07 GJ per capita. Figure 6 shows that the consumption of primary energy per capita climbed dramatically in the 2000s, reaching 2535.01 GJ per capita. One cause was the 2000 Summer Olympics held in Sydney, which had a direct impact on electricity demand and consumption due to the sharp rise of visitors into the country (Kellogg & Wolff, 2008).

1.1.6 The State of Environment Degradation in Australia

Table 6. Trend of CO_2 emissions in Australia

Year	CO_2 per capita
1976	14.14
1980	15.24
1985	15.07
1990	16.53
1995	17.24
2000	18.70
2005	18.78
2010	18.28
2015	17.27
2019	16.88

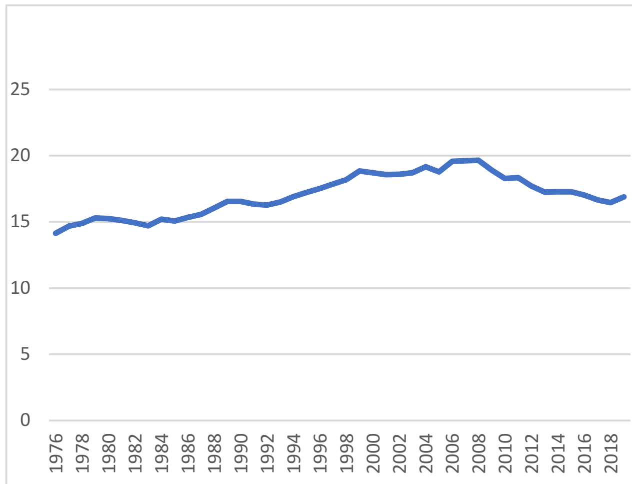

Figure 7. Trend of CO_2 emissions in Australia

Climate change is a threat to Australia, as is to many other countries throughout the world (Hanna et al., 2011). Global warming is mostly caused by the burning of fossil fuels, cement manufacturing, and other industrial processes, as well as deforestation and land clearing. The volume of CO_2 emissions in Australia has soared over the last four decades, as presented in Table 6. In 1976, carbon emissions were recorded to be 14.14 per capita. The rate of carbon emissions increased over the three decades until 2010. There has been a decline in CO_2 emissions from 2010 as shown on Figure 7, which may be due to the introduction of solar energy and a reduction in the use of fossil fuels in Australia (Mohsin et al., 2019). The country is, however, still one of the highest emitters of CO_2 in the world, accounting for 16.88 per capita carbon emissions in 2019 (Shahbaz et al., 2017).

1.2 Purpose and Objectives

The past literature on rising energy use and its impact on the environment in Australia, continuous growth in TAs, and a general lack of knowledge on how tourism contributes to the economic development through rise in earnings and EMP with minimising energy use and lessening carbon emissions indicate the need for research in this direction. The main aim of this thesis is to examine the impact of tourism on earnings, EMP, EC, and the environment in Australia. The objective of this thesis is to investigate the role of tourism and its impact on EMP and economic growth with respect to reducing EC in tourism to reduce environmental degradation in Australia.

The following research questions are addressed in the thesis using data from Australia:

I. Does tourism have long-run impact on earnings (GDP)?

II. Does a long-run relationship between tourism and employment exist?

III. Are tourism and energy consumption linked with each other?

IV. Do tourist arrivals impact the environment?

1.3 Justification for the Research

Tourism is an economic activity that stimulates economic growth. It has the potential to increase earnings and create job opportunities and influence the socioeconomic framework of a nation. Tourism facilitates the earnings from foreign exchange and thus plays an important role in the advancement of economic development; this development leads to the economic growth of the country (Schubert et al., 2011). More significantly, on a wider scale, over the last two decades, the tourism industry has quickly developed economic sectors globally (UNWTO, 2018). However, the industry may also intensify environmental degradation and over time this may overshadow the POS aspect of the industry if not managed properly (Solarin, 2014). Therefore, a greater understanding of the relationship between tourism and the environment is needed.

The tourism industry is a significant sector of the economy and is the biggest service sector in international trade (Lew, 2011). International tourism is a major source of profit and the primary monetary advantages from the tourism industry incorporate exchange earnings (Archer, 1995). Foreign exchange earnings have contributed substantially to the increase in tourism income and assist in the economic growth of a country (Ferro Luzzi & Flückiger, 2003). The earnings from the tourism industry through foreign exchange can create interest for new merchandise and administrations which can lead to the overall growth of the country (Akar, 2012). Additionally, tourism is the world's biggest industry and adds to EMP as far as venture capital is concerned (Aslan, 2008). Venture capital is a form of financial division that helps businesses to innovate and grow (Wadhwa et al., 2016). The tourism industry is considered to be a financial actor with the possibility to reanimate global monetary development because of its commitment to job creation (Castro-Nuño et al., 2013).

Therefore, the tourism industry has been one of the most significant influencers of economic growth globally, even when it is recovering from an economic crisis (Dogru & Bulut, 2018). After the COVID-19 pandemic, the world is likely to witness a considerable rise in the tourism growth, which could assist nations to recover from their current economic challenges.

While tourism has POS monetary effects, it might adversely affect the environment. Evidence demonstrates that an increase in local and international TAs increases a country's revenue meanwhile increasing EC. For example, a rise in tourism activities, such as hotel stays or use of transportation facilities, raises total EC (Dogan & Aslan, 2017; Dogru et al., 2020). Among these activities, transportation, particularly air transportation, contributes considerably to rising EC (Nepal, 2008). Tourism expansion is always accompanied by an increase in energy usage (Khanal et al., 2021). Thus, academic researchers and policymakers are interested in the nexus between tourism and energy usage.

Climate change is one of the world's most pressing issues, with GHG emissions, such as CO_2, causing environmental deterioration (CO_2). Vigorous tourism growth causes several environmental pressures, including CO_2 emissions, and biodiversity loss (Xie & Zheng, 2001). In addition, ozone-depleting substances, such as CO_2 from the tourism industry (Sunlu, 2003), will increase by 3.2% every year until 2035 if not managed properly (Peeters & Dubois, 2010). Thus, climate change has resulted in floods, droughts, and other climatic disasters (Escobar et al., 2009). Global warming has melted snow and sea ice, caused intense rainfall, protracted droughts, and degraded plant and animal habitats throughout the planet (Lindsey & Dahlman, 2020). Climate change is a result of global warming and has a detrimental impact on the environment. CO_2 emissions account for 74.4% of total GHGs when compared to other GHGs, including nitrous oxide, methane, and chlorofluorocarbons (Ritchie & Roser, 2020).

Although various studies have explored the energy–economic growth–environment (Dogan & Aslan, 2017; Dogan & Turkekul, 2016; Petrović & Lobanov, 2020; Z. U. Rahman & Ahmad, 2019), limited studies have investigated the effects of tourism on earnings, EMP, energy, and the environment as separate from the energy–carbon–tourism nexus (Eyuboglu & Uzar, 2019; Sharif et al., 2017).

1.4 Statement of the Problem

The growth of the tourism industry has been viewed as a productive way to increase revenue, employment possibilities, business sales, government taxes, and foreign exchange earnings. Earnings, employment, energy and environment (4Es) are vital factors that require greater attention for the overall wellbeing of people. Tourism can affect all these 4 Es. GDP (earning) is significant since it represents the size and health of an economy. Tourism can facilitate the increase of GDP by increasing foreign exchange earnings. For example, in 2021, total contribution of tourism industry to GDP in Australia was 4.7% of total economy (WTTC, 2022). Likewise, employment helps people to sustain themselves, their families, and their communities while also supporting a country's economic production. Tourism enhances employment opportunities in a country. In Australia, 11.7% of total jobs was contributed by tourism industry accounting 1.5 million jobs across the country in 2019 (WTTC, 2022). Furthermore, energy is crucial for economic growth. Since the beginning of the Industrial Revolution, energy consumption rises as economies expand, and if energy supplies are limited, GDP growth also slows. Tourism industry is also closely related to energy consumption. In addition, economic growth, environment, and people's wellbeing are linked, and tourism can also affect the environment of a country. Therefore, how these 4 Es are affected by tourism industry is a crucial topic of research.

Over the past decades, the growth of tourism has led to an increase in the economic growth of many countries by improving the foreign exchange rate and creating job opportunities. In Australia, according to the WTTC, prior to the COVID-19 pandemic, travel and tourism (including direct, indirect, and induced effects) accounted for one in every four new jobs worldwide, accounting for 10.6% of all occupations (334 million) and 10.4% of global GDP (US$9.2 trillion). Meanwhile, in 2019, overseas visitor expenditure was US$1.7 trillion (6.8% of total exports and 27.4% of global services exports) (WTTC, 2022). In regard to GDP and EMP, in 2019, Australia was ranked 76th in the world in terms of the relative contribution to the EMP, and when it comes to real growth and long-term growth, it ranks 116th and 158th, respectively, in world country rankings (WTTC, 2022). Like all other developed countries, the tourism sector of Australia is experiencing major economic and environmental challenges due to the COVID-19 pandemic. Though considerable improvement has been made within the tourism industry in 2022, fundamental challenges still exist for policymakers and stakeholders. In the era of globalisation, a rapidly growing tourism industry and the dependency of countries on energy indicate that carbon emissions will be one of the biggest problems in the world in the future. The increasing growth in tourism causes some environmental pressures, including biodiversity loss and carbon emissions (Xie & Zheng, 2001). Tourism contributed between 3.9% and 5.3% of total industry GHGs in Australia between 2003 and 2004 (Larry Dwyer et al., 2010) and this rose to 12.98% by 2010 (Tan et al., 2013).

Taking the above facts into consideration, a new research gap has arisen regarding tourism's impacts on earnings, EMP, EC, and the environment (i.e., 4E's) in the Australian context. However, none of the past research considers the Australian tourism and its impact on the 4E's. The possibility of the tourism industry as a powerful economic engine for Australia has until now been infrequently examined. Consequently, this study demonstrates the impact of the tourism industry on the 4E's. Even though being a developed country with healthy economic growth, Australia lacks policy recommendations on how to boost economic growth and at the same time on minimising energy usage and environmental degradation. Thus, this research provides an understanding of the effects of tourism on earnings and EMP to boost economic development and understand its impact on EC and its environmental effects.

This research makes a productive contribution to policy implementation for Australia in understanding the aforementioned problem.

1.5 Theoretical Underpinning

Long-run economic growth has always been of interest to researchers. The standard production function framework has been used by many studies to test the tourism-led growth (TLG) and a linear correlation between tourism and economic development (Zuo & Huang, 2018). A production function supported by neoclassical growth theory is found through the tourism-led growth hypothesis (TLGH) specification. The TLGH states that the existence of tourism determines long-term economic growth (Bouzahzah & El Menyari, 2013).

Solow's (1956) landmark work on economic growth emphasises the fact that the supply of factors of production affects the output/income over the long term and can be illustrated by the (aggregate) production function. This study follows Solow's (1956) framework, which is a derivative of the Cobb–Douglas production function and justifies the importance of tourism on economic growth, i.e., the TLGH (Tang & Tan, 2015). The Cobb–Douglas production function is often used among modern growth theories (Du et al., 2016).

Although there are a large number of general EMP models, investigations explicitly estimating tourism EMP are very limited in the literature. According to Brida, Cortes-Jimenez, et al. (2016), tourism performs a pivotal role in securing investments in new infrastructure, competition, and labour, which stems from the four production factors – capital, technological, and environmental resources and labour. Labour is one of the factors of tourism that allows this economic activity to be regarded as an opportunity to create new jobs (Brida, Cortes-Jimenez, et al., 2016).

Tourism is regarded as one of the principal contributors to economic growth in general and EMP in particular. The POSs of the service sector are that it creates jobs from a connection between entrepreneurship and human capital for the production of goods and services. The Keynesian theory of EMP states that demands (TAs) are considered as an engine to create jobs and that tourists' spending results in increased supply, which, in turn, requires more labour (hence job creation) (Habanabakize & Muzindutsi, 2018). Thus, this study examines the impact of TAs on EMP in Australia. The view was first postulated by Keynes as he demonstrated this demand expansion policy to contrast with the classic view, which advocated to boost EMP levels (Perles-Ribes et al., 2016).

Energy is an important factor for economic development. In fact, travelling and hoteling absorbs high frequencies of energy (Khanal et al., 2021), which has a negative influence on the environment due to CO_2 emissions (Majeed et al., 2021). Since the relationship between energy–growth–environment and tourism indicator has stimulated study to investigate the relationship between EC, environmental pollution, and tourism development. Fundamentally, the role of energy in the growth–environmental degradation plays a crucial role.

Recent research has investigated a new link between tourism and energy use. The focus of tourism–energy–environment research is on the energy–growth–environment nexus because the tourism industry is strongly connected to EC and the environment (Dogan & Aslan, 2017). The tourism industry is responsible for use of electric power through transportation and providing infrastructural services to guests, such as highways, ports, telecommunications, rail service, and airports (Katircioglu et al., 2014b). Many nations have significant energy-related concerns as a result of tourism (Khanal et al., 2021).

Vast research in the literature has examined the relationship between economic expansion and environmental degradation. The environmental Kuznets curve (EKC) concept, which ties economic development to the environment, lies at the heart of the foundations between growth and environment nexus (Pandey et al., 2020). Depending on the features of an economy, this connection is discovered to be an inverted U-shaped or U-shaped. An inverted U-shaped connection implies that as wealth per capita increases, environmental degradation also increases, but as economies advance and technology to generate cleaner energy sources emerges, this connection reverses (Shahbaz & Sinha, 2019). Tourism has lately been identified as a source of pollution and this argument is based on the EKC concept, in which increased international tourist demand raises EC, which degrades environmental quality (Adedoyin & Bekun, 2020). Thus, the EKC is a useful theoretical underpinning concept to understand the nexus between tourism, energy, and the environment.

1.6 Empirical Studies

Several studies exist that have examined the impact of tourism in relation to economic and environmental effects in specific countries or settings, such as different income levels ((H. Shi et al., 2020), China (Zhang & Gao, 2016), 19 Asia Cooperation Dialogue Members (Q. Ali et al., 2018), European Union (EU) 28 (Balsalobre-Lorente & Leitão, 2020), Greece (Işik et al., 2017a), and India (Tang et al., 2016)), but there has been little research on a country like Australia. The literature on the relationship between tourism and its impact on both earnings and EMP indicates that tourism has a significant impact as it secures foreign exchange earnings and leads to a number of POS changes in earnings and EMP (Gautam, 2011). Both of these have significant POS impacts on economic development. Despite having a POS influence on economic development, tourism may harm the environment through, for example, an escalation of carbon emissions and thus increasing pollution (Katircioglu, 2014a; J. W. Lee & Brahmasrene, 2013; H. Shi et al., 2020; Y. Shi & Yu, 2021).

Past studies have studied tourism and economic growth and the relationship between carbon emissions and tourism activity. However, more research is required to understand the link between tourism with EMP and earnings on the one hand, and EC and negative environmental impacts due to tourism on the other hand in the Australian context. This section reviews the literature by dividing it into three different sections: i) tourism and earnings; ii) tourism and EMP; iii) tourism and energy; and iv) tourism and the environment.

1.6.1 Tourism and Earnings

The tourism industry is one of the main drivers of the economy in Australia and contributes positively to numerous economic outcomes; for example, it contributes to increases in GDP and foreign exchange earnings (Pavlic et al., 2015). Earnings from tourism are significant elements of economic growth with the capacity to stimulate economic performance (Terzi, 2015). The short-run and long-run dynamic interactions between international tourism and economic growth have POS effects, including indirect effects in the long run (C. G. Lee, 2012). The foreign exchange earnings gained from tourism can be used to produce goods and services and to import intermediate and capital goods, thus promoting economic growth (Shakouri et al., 2017). The literature that has investigated the connection between tourism and economic growth has used different approaches. There are two theoretical articulations for economic growth and the impact of tourism that are observed: the export-led growth (ELG) hypothesis and the TLGH (Pavlic et al., 2015).

The ELG hypothesis depends on the Ricardian trade model, which states that economic growth leads to tourism growth, but it ignores the tourism development process (Zuo & Huang, 2017). In contrast to this, the TLGH considers that the tourism industry is a significant determinant of long-term economic development to the advancement of the tourism industry (Shahzad et al., 2017). TLG development proposes that unidirectional causality runs from tourism industry progression to financial enhancement (Paramati et al., 2017). Research by Balaguer and Cantavella-Jorda (2002) concluded that the tourism industry directs monetary improvement and consequently bolsters the TLGH.

Several recent studies that have been conducted helped to boost the TLGH (Balaguer & Cantavella-Jorda, 2002; Ertugrul & Mangir, 2015; Ridderstaat et al., 2014; Tang & Abosedra, 2014; Tang & Tan, 2015). The TLGH has been tested in many countries, such as Lebanon (Tang & Abosedra, 2014), Aruba (Ridderstaat et al., 2014), Malaysia (Tang & Tan, 2015), Turkey (Ertugrul & Mangir, 2015), Spain (Balaguer & Cantavella-Jorda, 2002), and many more. Research conducted in Lebanon examined the commitment of tourism to economic growth and investigated the validity of the TLGH; findings indicate that tourism and economic growth are co-integrated (Tang & Abosedra, 2014).

The long-run relationship between tourism development and economic growth in a small island destination (Aruba) was investigated by Ridderstaat et al. (2014). Their discoveries show that not only is tourism a driver for long-term FD, but also that the economic result itself can assume a significant role in giving long-run growth potential to tourism. The investments in tourism by themselves seem, by all accounts, to be inadequate for economic growth and, instead, the contribution of tourism to the long-term growth of an economy comes through standard income distribution (Du et al., 2016).

To additionally confirm the validity of the TLGH, an investigation was conducted on the Malaysian economy utilising a multivariate model (Tang & Tan, 2015). The findings demonstrate that tourism positively affects Malaysia's economic growth in both the short and long run. Similarly, the experimental connection between FD and the travel industry was dissected utilising diverse econometric systems in an investigation directed by Ertugrul and Mangir (2015). Their findings show that the Turkish case additionally bolstered the TLGH, where tourism has a POS effect on GDP and economic growth in both the long term and short term.

Based on the studies mentioned above, it is evident that there is a gap in the literature regarding the impact of tourism on earnings in Australia. The literature regarding the TLGH in the Australia tourism sector is rare (Corrie et al., 2013). According to the study conducted by Corrie et al. (2013), tourism expenditure may be the key growth factor in the tourism sector and there is a bicausal link between tourism and economic growth. However, the study only covered the expense aspect and did not examine the relationship between tourism and earnings.

Air travel is a necessary mode of transportation for foreign travellers to reach their destinations of choice. The economic impact of air travel is a topic that both developed and developing countries are interested in. As previously stated, most researchers use TAs and/or TRs (revenue) as proxies for tourism; however, very little research has been conducted using air transportation as a proxy for tourism, and thus little is known about the direct economic impact of the air transportation industry. This study adds further understanding to this area.

Brida, Bukstein, et al. (2016) conducted a time series study from 1971 to 2012 and found a co-integration connection between aircraft movements and GDP, demonstrating a long-term association between these two parameters. Chi and Baek (2013) examined at the dynamic link between air transportation demand and economic development in the US. The findings reveal that when there is economic expansion, both air passenger and freight services tend to rise in the long term. However, only air passenger services are sensitive to economic development in the short term. Similarly, Brugnoli et al. (2018) used random-effects panel data to assess air transportation and trade flow in Italy from 2004 to 2014. According to the findings, civil aviation has a favourable impact on international trade.

Balsalobre-Lorente et al. (2021) recently explored the asymmetric influence of air transportation on economic growth. The authors used air travel as a proxy for tourism to verify the TLGH. NARDL's empirical findings demonstrated that air travel, urbanisation, and social globalisation (SG) all have a POS and considerable impact on economic growth. According to the asymmetric NARDL long-run estimates, an increase of 1% in POS air transportation boosts GDP by 1.31%, whereas a rise of 1% in negative air transportation raises GDP by 1.44%.

To the best of our knowledge, just one study has been conducted to look at the economic impact of air travel in Australia. Baker et al. (2015) used panel data from 88 rural airports in Australia for their study, which spanned 25 years. According to the co-integration and Granger causality tests, air travel boosts Australia's economic development. Baker et al. (2015) assessed regional aviation/airports and used aggregate taxable income as a proxy for economic development. Furthermore, because the effect was analysed using aggregate taxable income, this analysis lacked the general Australian aviation context utilising national GDP as an indicator for earning. As a result, more research in the Australian setting is necessary. Thus, this study fills the gap in the literature by analysing the connection between tourism (proxied by air transportation) and earnings in the Australian context.

1.6.2 Tourism and Employment

The economic impact of tourism has been generally considered in the literature, with specific attention to its impacts on income and economic growth (Larry Dwyer et al., 2004). However, a particular investigation of the effects of the tourism activity on the level and development of EMP is still lacking in the literature.

Job creation is an important component of economic activities that can inspire economic growth worldwide (Castro-Nuño et al., 2013). Notwithstanding the income advantages of the travel industry, the travel industry offers the guarantee of making various work openings and these new EMP opportunities assist in economic development (Aslan, 2008). EMP, thus, leads to growth opportunities and is one of the main economic aspects within the tourism industry. For example, research conducted on the Republic of Macedonia shows that tourist visits increased total EMP (Dimoska, 2016).

The EMP impacts of tourism on a nation were investigated by L. Dwyer and Forsyth (1998) using Australian data. This paper concentrated on the total effects of foreign expenditure on EMP in the economy, which had been ignored until that point. The paper concluded with a discussion of the underlying mechanisms to estimate the EMP effects of increased inbound tourism. This effect of the travel industry on business helps to create change to existing unemployment (L. Dwyer & Forsyth, 1998). Another study conducted by Wei et al. (2013) on the impact of tourism on EMP modelled EMP and tourism. The results indicated that tourism-related industries have given rise to tourism EMP in China. These statistical models could be applied in different settings, such as Australia.

1.6.3 Tourism and Energy Consumption

Tourism is regarded as one of the biggest stimulators of economic growth for many countries. EC establishes a critical link between tourism and environmental quality, as EC is the primary source of pollution and GHG emissions (Liu et al., 2019). Gokmenoglu and Eren (2020) used 55 years of data (i.e., from 1960 to 2015) to study the impact of international tourism on Turkey's energy usage. Using Hacker and Hatemi bootstrap J's corrected causality results, the primary findings revealed unidirectional causation from TAs to energy usage. They concluded that foreign tourism is a substantial contributor to Turkey's energy usage.

Likewise, Selvanathan et al. (2020) examined the connections between tourism, EC, carbon emissions, and GDP in South Asian countries. The study used the panel ARDL and vector error correction model (VECM) frameworks to analyse data from 1990 to 2014. According to the study, tourism has a favourable influence on EC in Bangladesh, India, Nepal, and Pakistan.

Furthermore, rising EC resulting from South Asia's tourist development activities has posed substantial environmental dangers in the form of increased CO_2 emissions. Using data from 1981 to 2017, W. Ali et al. (2020) investigated the influence of TAs, structural change, economic growth, and EC on carbon emissions in Pakistan. Over the long term, an increase in TAs generated a 0.06% rise in CO_2 emissions, according to the study that used ARDL, Bayer and Hanck, VECM, and the Granger causality tests. According to the authors, TAs degrade the environment by using energy in the form of transportation, lodging, and shopping. Also, H. Shi et al. (2020) found that for upper-middle-income nations, one-way causation flowed from visitors' expenditure per capita and nett inflow of international tourism to primary EC over the long run. Unidirectional short-run causation flowed from primary energy usage to incoming tourist expenditure per capita in the high-income nations panel. Therefore, the findings revealed that the impact of tourism on EC differed depending on the nations' income levels.

The article considered the carbon emission nexus when calculating the impact of tourism on energy usage.

1.6.4 Tourism and Environment

While tourism has POS economic effects, it can adversely affect the environment. The travel industry and related enterprises, e.g., transportation, catering, and accommodation, lead to CO_2 emissions and consequently to worldwide environmental change (Pang et al., 2013). Thus, the increasing demand for tourism activities affects the quality of the environment, and the negative impact of tourism on the environment is undeniable and the world has now committed to achieving zero-carbon by 2050. In terms of tourism, particularly in the Australian context, very little research has been conducted with the tourism–environment nexus.

In the phase of economic development, the real income and international TA cause environmental damage. A nation encounters debasement of the environment, especially through the decay of natural resources that build environmental effects, e.g., pollution, soil erosion, and CO_2 emissions (Mikayilov et al., 2019). Using an ARDL approach, Akadiri et al. (2019) found that an increase of 1% in international TAs led to an increase of 3.030% in metric ton per capita CO_2 emissions (Akadiri et al., 2019).

The effects of tourism on economic growth and CO_2 emissions on 26 developed and 18 developing nations, from 1995 to 2012, using the Impact = Population * Affluence * Technology (IPAT) model, were investigated by Paramati et al. (2017). Similarly, using STIRPAT (the extended IPAT model) and panel data from 147 countries, the study conducted by H. Shi et al. (2019) experimentally investigated multi-relationships between tourism, economic growth, and primary EC at various developmental stages.

The outcomes demonstrated that the consumption of inbound visitors per capita overall has a POS effect on CO_2 emissions in low-income countries only, and expenditure of inbound tourists per capita essentially has a POS effect on CO_2 emissions in both low- and high-income nations, and if the income of a country is lower, then the impact of tourism on CO_2 is higher (H. Shi et al., 2019). Considering the emissions and environmental degradation, Simpson et al. (2008) contended that many visitors are picking ecologically well-disposed or environmentally friendly businesses to decrease negative effects. Furthermore, Tsagarakis et al. (2011) recommended that visitors from nations with higher energy awareness pick hotels with energy-saving installations and renewable energy sources. Thus, modelling the transition to a decarbonised environment or to achieve zero-carbon is crucial. Several studies have been conducted regarding renewable energy policies at the national and regional levels in Australia. However, though tourism is a significant contributor to carbon emissions, it was ignored in the study of Australia.

1.7 Original and Significant Contribution

In the past, the link between tourism, earnings, EMP, energy, and the environment has not been examined in the Australian context. In the extensive empirical literature, little evidence exists at the macro level. As a new regulatory regime is being introduced in Australia for the reduction of CO_2emissions and to achieve net zero, the analysis from this research informs the current policy debates. With very little existing empirical evidence in the literature, this research fills the void and aids the country in its policy-making decisions to attain long-term economic growth goals while reducing CO_2 emissions and to achieve net zero through tourism.

This research contributes to the significant gaps in the literature concerning the long-run relationship between tourism, earnings, EMP, and CO_2 emissions. It uses time series techniques to study the relationship between tourism and its effects on the 4E's in Australia.

Thus, this study uses time series analysis based on multivariate regression model choosing the theoretically relevant variables. This research also considers the up-to-date data over a period to have precise estimated results. To avoid omitted variable bias and have theoretically consistent results, other important variables are also used following past literature. Therefore, the findings from this research will be contributory and the policymakers can then obtain insight from the findings to support the promotion of tourism growth in Australia while also taking into consideration the impact on the environment. Therefore, the contribution of this research will be recovering economic growth via tourism without harming the environment.

1.8 Conceptual/Research Framework for the Study

In the conceptual framework, tourism assumes a basic role in earnings, EMP, and the environment. In this study, the conceptual framework is linked with the issue of tourism–economy–energy–environment relationship with various theoretical and methodological forms.

To address the research questions, the following hypotheses are tested in this research which is shown in Figure 8 below:

H1: Tourism (proxied by air transportation) has a positive effect on earnings (proxied by GDP).

H2: Tourism has a positive effect on employment.

H3: Tourism increases energy consumption.

H4: Tourism increases CO_2 *emissions (a proxy variable for environmental quality).*

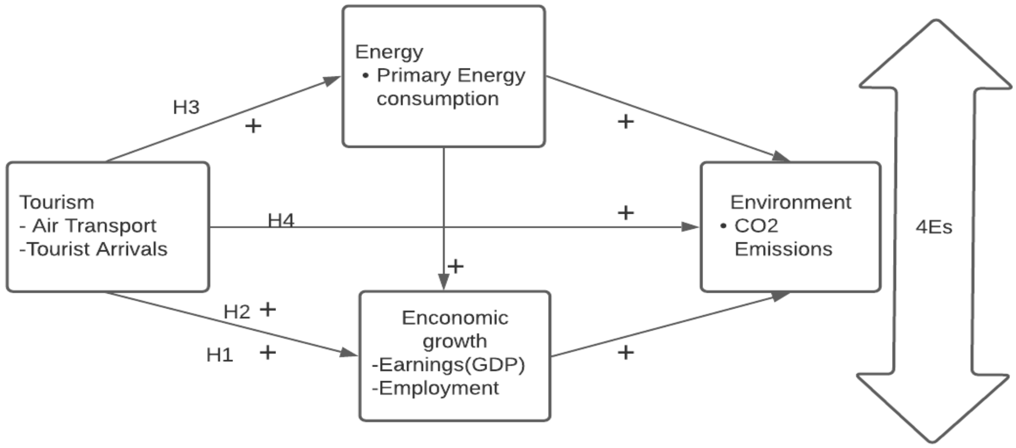

Figure 8: The conceptual framework of the thesis. The interaction among tourism, earnings, employment, energy consumption and environment.

1.9 Methodological Approaches

This thesis follows the format of thesis by publication. Therefore, the key methodologies used in each chapter are explained here. The specific methods applied to a specific study will be explained in each chapter. All the analysis in this study uses time series data to achieve the objectives.

Times series analysis helps to better understand the causes of trends and systemic patterns overtime; thus, this thesis consists of time series econometric techniques that are applied in Chapters 2–5. Time series analysis helps to know what factors are influencing a certain variable at various points in time (Shrestha & Bhatta, 2018). Thus, the time series assists with analysing and identifying patterns, which further aids in predicting and forecasting through taking past observations.

The unit root test is a widely used method to check the stationarity and non-stationarity of the time series variable. The non-stationary aspects of the data can be confirmed; if the variable contains unit root and the stationary of data cannot be confirmed if there is no unit root test. There are several ways of testing for the presence of a unit root; the ADF test is one of them. The ADF test is used to test the null hypothesis that a series does contain a unit root to confirm the data non-stationarity (Dickey & Fuller, 1981). The following regression form is used in the same context (Suresh & Senthilnathan, 2014):

Yt = pYt-1 + Ut

where Y denotes time series available, t time, p coefficient of Yt-1, and U error term.

After the unit root tests; Chapters 3 and 4 will go through the Brock-Dechert-Scheinkman (BDS) test. The BDS test is statistically highly effective in providing information about the linearity and non-linearity of the model (Broock et al., 1996). The BDS test follows the null hypothesis that data are independent and identically distributed (iid) or non-linear dependencies (Galadima & Aminu, 2020). Thus, if the data are non-linear, we apply NARDL to examine the relationship between the variables (Ahmad et al., 2020).

The following equation examines the BDS test:

$$\mathrm{BDS}_{\in,m} = \frac{\sqrt{N}\,\left[C_{\in,m} - \left(C_{\in,1}\right)^{m}\right]}{\sqrt{V_{\in,m}}} \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots . (1)$$

where $\left[C_{\in,m} - \left(C_{\in,1}\right)^{m}\right]$ an asymptotic normal distribution with zero is mean; $V_{\in,m}$ is a variance; and m is the number of consecutive points used in the set or embedding dimension.

After the unit root test for stationarity and BDS test (Chapters 2 and 3); co-integration tests will be applied to check the long-run association among the series. This research uses the co-integration technique developed by Pesaran et al. (2001), particularly the ARDL bound test. The ARDL approach has gained popularity among scientists due to its benefits compared to other standard co-integration methods for identifying the symmetric association of independent variables with dependent variables (Ghazouani, 2021; Nwani, 2017; Rehman et al., 2020). We accept that the test statistics surpass the upper critical bound (UCB) and thus conclude that a long-run relationship among the variables exists.

The following equations are used to estimate co-integration relationships among variables:

Chapter 2: Tourism Impact on Earnings

$$\Delta \ln GDP_t = \beta_0 + \beta_1 \ln AT_t^+ + \beta_2 \ln AT_t^- + \beta_3 \ln EC_t + \beta_4 \ln FD_t + \beta_5 \ln SG_t + \beta_6 UG_t + \sum_{i=1}^{n} \propto_6 \Delta \ln GDP_{t-i} + \sum_{i=0}^{n} \propto_7 \Delta \ln AT_{t-i}^+ + \sum_{i=0}^{n} \propto_7 \Delta \ln AT_{t-i}^- + \sum_{i=0}^{n} \propto_6 \Delta \ln EC_{t-i} + \sum_{i=0}^{n} \propto_6 \Delta \ln FD_{t-i} + \sum_{i=0}^{n} \propto_6 \Delta \ln SG_{t-i} + \sum_{i=0}^{n} \propto_6 \Delta \ln UG_{t-i} + \alpha ECM_{t-1} + \varepsilon_t \text{ ....(2)}$$

The above equation of NARDL examines the linear relationship between the variables, where β represents long-run coefficients, $\propto$ denotes short-run coefficients, Δ denotes difference operator, and ε_t is the white noise term.

Chapter 3: Tourism Impact on Employment

$$\Delta LNEMP_t = \beta_0 + \beta_1 LNEMP_{t-1} + \beta_2^+ LNTA_{t-1} + \beta_3^- LNTA_{t-1} + \beta_4^+ LNMC_{t-1} + \beta_5^- LNMC_{t-1} + \beta_6 LNFD_{t-1} + \beta_7 LNTR_{t-1} + \sum_{i=1}^{p} \theta_i \Delta LNEMP_{t-i} + \sum_{i=1}^{p} \theta_i^+ \Delta LNTA_{t-i} + \sum_{i=1}^{p} \theta_i^- \Delta LNTA_{t-i} + \sum_{i=1}^{p} \theta_i^+ \Delta LNMC_{t-i} + \sum_{i=1}^{p} \theta_i^- \Delta LNMC_{t-i} + \sum_{i=1}^{p} \theta_i \Delta LNFD_{t-i} + \sum_{i=1}^{p} \theta_i \Delta LNTR_{t-i} + \varepsilon_t \text{ .... (3)}$$

From equation (3), β_i^+, β_i^- and [$\sum_{i=1}^{p} \theta_i^+$], [$\sum_{i=1}^{p} \theta_i^-$] capture the long- and short-run POS and negative impacts of TA on service sector EMP.

Chapter 4: Tourism Impact on Energy Consumption

$$LNEC_t = \beta_0 + \sum_{i=1}^{p} \beta_1 LNEC_{t-i} + \sum_{i=1}^{p} \beta_2 LNTA_{t-i} + \sum_{i=1}^{p} \beta_3 LNGDP_{t-i} + \sum_{i=1}^{p} \beta_4 LNCAP_{t-i} + \sum_{i=1}^{p} \beta_5 LNTP_{t-i} + \sum_{i=1}^{p} \beta_6 LNFD_{t-i} + \varepsilon_t \text{ .... (4)}$$

where β denotes the long-run dynamic coefficients and LNEC, LNTA, LNGDP, LNCAP, LNTP, and LNFD are the log values of EC, TAs, GDP, gross fixed capital formation, TP, and FD, respectively. ε_t is the disturbance term.

Chapter 5: Tourism and Environment

$$\Delta logCO_{2t} = \beta_0 + \beta_1 logCO_{2t-i} + \beta_2 logTA_{t-i} + \beta_3 logEC_{t-i} + \beta_4 logGDP_{t-i} + \beta_5 logFD_{t-i} + \beta_6 logGFCF_{t-i} + \beta_7 logTP_{t-i} + \sum_{i=1}^{p} \beta_8 \, logCO_{2t-i} + \sum_{i=1}^{p} \beta_9 \, \Delta logTA_{t-i} + \sum_{i=1}^{p} \beta_{10} \, \Delta logEC_{t-i} + \sum_{i=1}^{p} \beta_{11} \, \Delta logGDP_{t-i} + \sum_{i=1}^{p} \beta_{12} \, \Delta logFD_{t-i} + \sum_{i=1}^{p} \beta_{13} \, \Delta \, logGFCF_{t-i} + \sum_{i=1}^{p} \beta_{14} \, \Delta \, logTP_{t-i} + \varepsilon_t \ldots \quad (5)$$

Here, β reflects the variance in the long-run variables, while $t - i$ indicates the optimal lags chosen by Akaike information criterion (AIC) for long-run estimates. The following error correction model (ECM) is used for the short-run ARDL model.

Chapters 2 and 3 use the NARDL model. The NARDL model assumes linearity and systematic adjustments among the variables that the traditional ARDL model cannot provide. To explore the changes in the time-series-dependent variables with respect to change in shocks or negative and POS changes in the independent variables, the NARDL model is used (Neog & Yadava, 2020). Like ARDL, NARDL is a widely used method because of its accurate and precise results when the variables are at level I (0), first difference I (1), or a combination of both I(0) and I(1). Further, in the ARDL model, the short-run and long-run effects of independent variables on the dependent variable are distinguished (Majeed et al., 2021). This is addressed in Chapters 4 and 5. This study used the ARDL bound test technique to examine the co-integration between EC and other explanatory variables of Australia. The ARDL bound test developed by Pesaran et al. (2001) provided two asymptotic critical value bounds when the independent variables are either I (0) or I (1). It is assumed that the F statistics value exceeds their UCB, i.e., I (1), so it can be concluded that there is co-integration between the variables, and a long-run relationship among the variables exists.

Each analytical chapter presents some details on the econometric techniques used, the sources of data, as well as the estimated models. For the time series analysis, the software STATA 12 and EViews were used for the modelling and output of the series.

The following figure shows the order of the chapters and the main hypothesis being tested.

Time Series Methodology

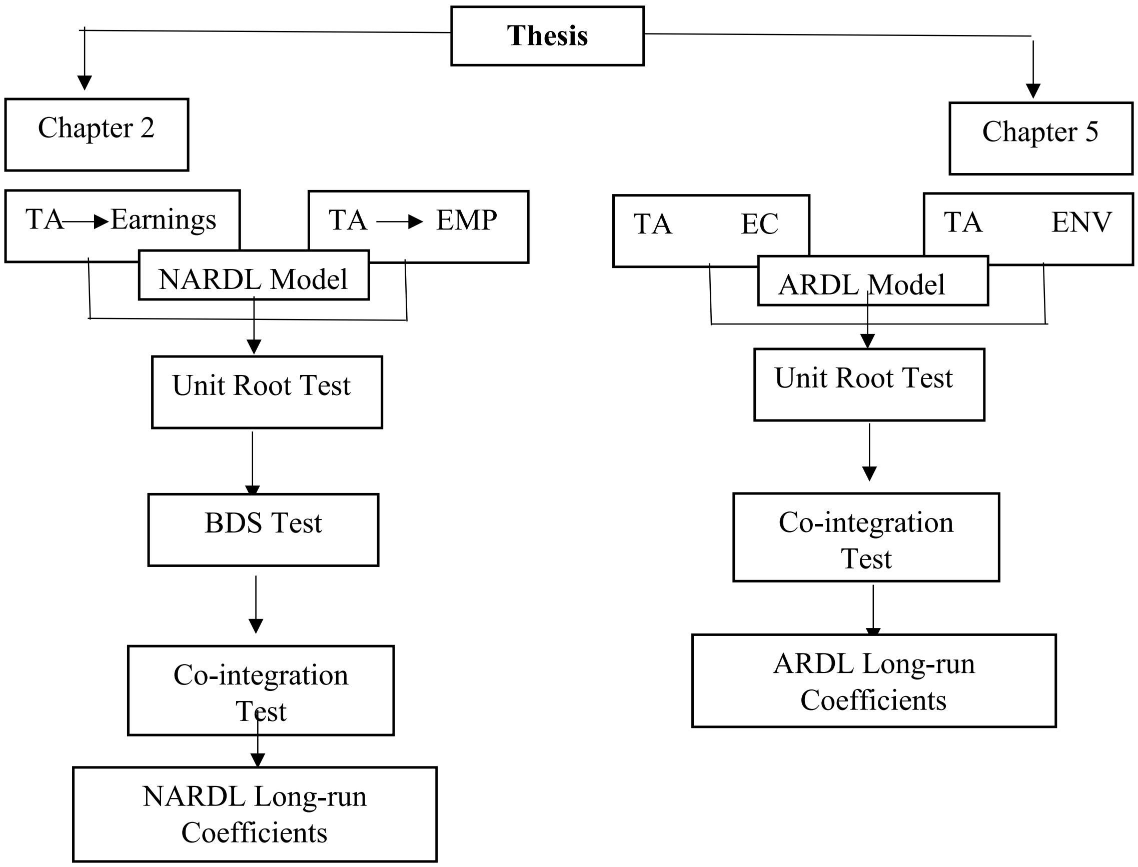

Figure 9. An overview of the methodological approaches of the thesis

1.9.1 Flow of Thesis

The flow of the thesis is graphically displayed below for a better understanding of the link between the research and publications.

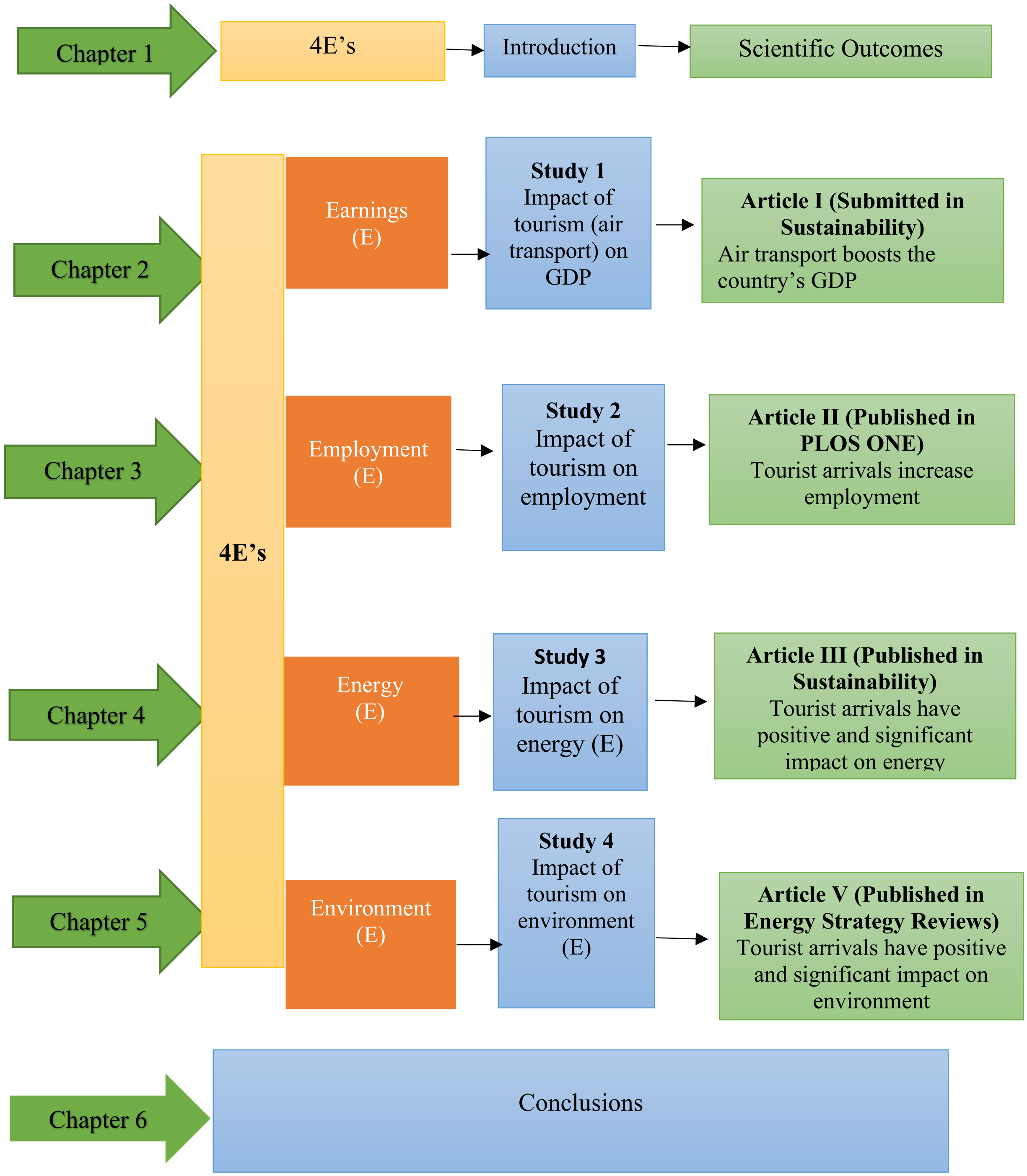

Figure 10. Flow of Thesis

1.10 Organisation of the Thesis

The organisation of thesis is divided into six analytical chapters. The chapters of this thesis are linked to each other under the broad category of tourism, earnings, EMP, energy and the environment; however, specific research issues are identified separately.

Chapter 1 describes the background of the study and provides an overview of global tourism with state of tourism, economic growth, EMP, EC, and the environment in Australia. In addition, this chapter also contains purpose and objectives, justification for the research, and statement of the problem. Furthermore, the theoretical underpinning, empirical studies (literature review), research gaps, conceptual framework, methodological approaches, and flow of the thesis are also covered in the first chapter.

Chapter 2 explores the impact of tourism on earnings. It investigates whether air transportation (a proxy for tourism) stimulates *earnings* (a proxy for GDP) to validate the ALGH in the Australian context. Using NARDL, the effects of some control variables (i.e., EC, FD, socialisation, and urbanisation) on economic growth are tested.

Chapter 3 analyses the impact of tourism on *EMP*. It examines the symmetric and asymmetric effects of tourism, MC, FD, and trade on service sector EMP in Australia.

Chapter 4 analyses the long-term co-integration link between foreign visitor arrivals and primary *EC* in Australia. Furthermore, the effects of GDP, gross fixed capital creation, FD, and TP on EC are investigated as control variables.

Chapter 5 investigates the long-run co-integrating relationship between international TAs and *environmental* degradation, controlling for specific factors.

Chapter 6 contains the overall conclusions of the study, key findings, and policy recommendations. This chapter also consists of key contributions to the literature, as well as limitations and the direction of future research.

CHAPTER 2: EXPLORING THE IMPACT OF AIR TRANSPORT ON ECONOMIC GROWTH: NEW EVIDENCE FROM AUSTRALIA

2.1 Introduction

The success of many economies throughout the world depends on tourism. Tourism has a number of advantages for any nation. A country's infrastructure is developed, its revenue is increased, and a sense of cultural interaction between locals and visitors is sown due to tourism. Thus, this chapter tests the air-transport-led-growth hypothesis (ALGH) in the Australian context by examining whether air transport, proxied for tourism, fosters economic growth. In order to undertake the study, the asymmetrical long- and short-term effects of air passenger on Australia's GDP are also examined. On data for Australia from 1971 to 2019, we apply the nonlinear autoregressive distributed lag (NARDL) modelling technique. We also look at how certain control factors, such as energy use, financial development, socialisation, and urbanisation, affect economic growth. The results show that impacts of air transport on GDP is positive and significant

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Article

Exploring the Impact of Air Transport on Economic Growth: New Evidence from Australia

Avishek Khanal *, Mohammad Mafizur Rahman , Rasheda Khanam and Eswaran Velayutham

School of Business, University of Southern Queensland, Toowoomba, QLD 4350, Australia
* Correspondence: avishek.khanal1984@gmail.com

Abstract: The COVID-19 pandemic has impacted all sectors of the tourism industry, particularly air transportation. However, air transport remains an important contributor to economic growth globally. Thus, this study examines whether air transport (a proxy for tourism) stimulates economic growth to validate the air-transportation-led growth hypothesis (ALGH) in the Australian context. To conduct the study, we analyse the asymmetric long-run and short-run impacts of the air passengers carried (a proxy for tourism) on the gross domestic product (GDP) in Australia. We use the nonlinear autoregressive distributed lag (NARDL) modelling approach on data for Australia from 1971 to 2019. We also examined the effects of selected control variables (i.e., energy consumption, financial development, socialisation, and urbanisation) on economic growth. In both the short and long run, we observed statistically significant asymmetric impacts of air transport on economic growth. The positive shocks in air transport propel the long-term growth of Australia's economy. Additionally, according to the findings, negative shocks of air trabsport have a stronger detrimental impact on economic development than positive shocks.

Keywords: air transport; economic growth; ALGH; NARDL; Australia

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1. Introduction

It is widely acknowledged that the tourism industry has a crucial influence on the economy [1]. Undoubtedly, the industry adds to foreign exchange reserves and thus helps in the country's balance of payments. Therefore, many nations promote their tourism industry to strengthen their economy. Tourism plays a significant role in economic growth by creating jobs, generating revenue, and thus boosting the nation's GDP. According to the WTTC, in 2019, travel and tourism contributed USD 9,170 billion to the economy globally, accounting for 10.4% of the world's total GDP [2]. Likewise, 334 million jobs were created around the world by tourism in 2019, and one in four net new jobs worldwide were from tourism over the five years (2014–2019) [2]. Before the COVID-19 pandemic, the tourism industry contributed significantly to the growth and development of the global economy.

However, the COVID-19 pandemic affected all sectors of the tourism industry, particularly air transportation. Air transportation is one of the noteworthy contributors to economic growth, creating jobs and boosting GDP [3]. Therefore, once the effect of the COVID-19 pandemic recedes and air transportation returns to pre-pandemic operation levels, it is expected that economic development will be accelerated, and therefore, the tourism industry will begin to recover and contribute to overcoming the financial crisis associated with the pandemic [4].

Among several facets of tourism, research most frequently uses the tourism-led growth hypothesis (TLGH) to validate the nexus utilising the variables such as arrivals [5,6], receipts [7,8], and expenditures [9]. This theory is presented in the literature to explain how tourism boosts economic development [10]. Air transport, however, is less frequently utilised in studies to analyse the economic impact of tourism and support the TLGH, which states that a boost in tourism activities leads to increased economic growth [11].

In order to investigate how air transport affects the economy, this study substitutes the TLGH with the air-transportation-led growth hypothesis (ALGH). The introduction of new transportation services has effects that have been extensively researched and investigated in many nations [12]. Efficient air transport contributes to economic growth because it is one of the most common modes of travel for tourists. The civil aviation sector, therefore, makes a vital contribution to the global economy. According to the International Air Transport Association (IATA), in 2018, 2.89 million jobs were created worldwide by the airline industry, with USD 125 billion in tax revenue collected from this industry [13].

In 2017, in Australia, 176,000 jobs were created by the air transport sector, contributing USD 69 billion in gross value added to GDP. Australia ranked forty-third in the world as a tourist destination, receiving approximately nine million tourists in 2019 [2]. The revenue from tourism in Australia was USD 47.95 billion [14]. Figures 1 and 2 show the trends in air transportation and economic growth, respectively, in Australia. Both figures reveal an increasing trend over time, and the IATA forecasts that the air transport market in Australia will grow by 63%, with an additional 51.9 million passengers by 2037 [13].

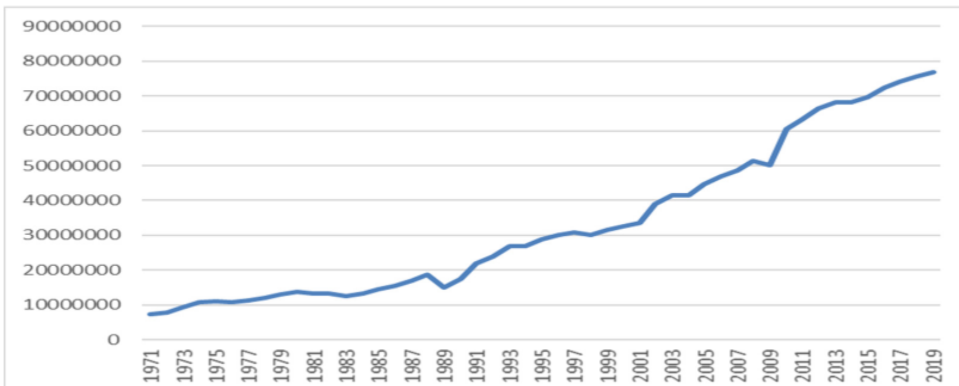

Figure 1. Air transportation trend in Australia from 1971 to 2019 (Data source: World Bank [15]).

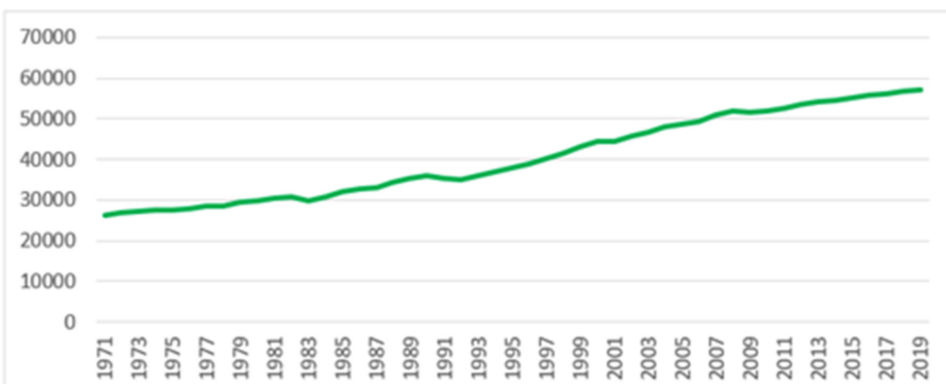

Figure 2. GDP trend in Australia from 1971 to 2019 (Data source: World Bank [15]).

Before the present economic crisis created by the global pandemic, the air transport sector was experiencing considerable growth, which is likely to continue when the economy recovers from the COVID-19 pandemic. To enable the sector's appropriate growth after the pandemic, precise planning is crucial. Thus, examination of the contribution of air transportation to the economy is essential to regain the momentum lost during the COVID-19 pandemic financial crisis and assists governments and aviation companies in rebuilding monetary and fiscal policies accordingly. This study's main goal is to investigate the connection between Australian economic development and air travel. The study is motivated by the fact that the aviation industry of Australia requires evidence relating to the ALGH and up-to-date and competent empirical evidence that can help this industry to recovery in Australia after the COVID-19 pandemic. This study's outcome will contribute to minimise the gap in the air transport and economic growth relationship in Australia and policy recommendations relating to the ALGH. The study analyses the ALGH using the NARDL approach. The main finding is that, throughout the research period, air transport had a very significant impact on economic growth in Australia. Policymakers should consider the evidence presented here when developing and implementing air transport (tourism) and sustainable economic development policies.

There are three significant ways in which this study adds to the body of literature. First, the study consolidates more tourism-related data and explores a wider range of tourist factors that are proxied by air transport. Second, this study demonstrates the asymmetric effects of air transportation and passengers in connection with economic development in Australia. Third, the study uses the variable financial development in the model, which has rarely been incorporated in prior research.

The remainder of this paper is organised into five sections. A summary of earlier research on tourism and economic growth and air transport and economic growth is provided in Section 2. Along with the materials and methods, Section 3 includes descriptions of the data. The empirical findings are presented in Section 4. The results are discussed in Section 5. The conclusions and the consequences of our results for policy are presented in Section 6.

2. Literature Review

The link between tourism and economic growth is often examined using two distinct methodologies in the literature on tourism economics, i.e., TLGH and the growth-led-tourism hypothesis (GLTH). Given that the main objective of this study is to test the TLGH using air transportation, we divide the literature into two sections: the TLGH and the ALGH.

2.1. Tourism-Led Growth Hypothesis (TLGH)

The tourism-led growth hypothesis was initially proposed by Balaguer et al. [16] to investigate the tourism and economic growth nexus The findings revealed that tourism boosts economic growth. This hypothesis states that tourism has a positive and significant effect on the economy. Since this study, several different researchers have contributed to extending this theory in various settings.

For instance, Corrie et al. [17] looked into how tourism affected Australia's economic development. The study discovered that there is a bi-causal link between GDP and tourism in Australia using Granger causality tests. In research conducted by Ghartey [18] to investigate the relationships between tourism and economic growth in Jamaica from 1963 to 2008. The results from the ARDL long-run and short-run approach confirmed that an increase in tourist arrivals increases economic growth.

To expand our understanding of the relationship between tourism and economic growth, it is useful to examine the connection in other countries. For example, the TLGH was further tested in European Union countries by Balsalobre-Lorente et al. [1]. Using different econometric techniques, the study sought to evaluate the TLGH's validity. The findings ascertain that a 1% increase in tourist arrivals boosts the economic growth by 0.62%. Thus, these results also confirmed the TLGH for European Union countries.

Wu et al. [19] performed research on the connection between tourism and economic growth between 1995 and 2016 with a focus on 11 Asian areas. Using the multivariate wavelet approach, the validity of the TLGH was confirmed in Cambodia, China, Macau, Malaysia, and Thailand. Global evidence for the validity of the TLGH was found by Tang et al. [10], who employed a panel dataset of 167 countries from 1995 to 2013 to test this hypothesis. The results from the panel generalised method of moments approach revealed that improving tourism receipts by 10% increases economic growth by 0.3%. Therefore, it is abundantly obvious that tourism contributes positively and significantly to economic growth around the globe.

Similarly, Perles-Ribes et al. [20] employed the TLGH in Spain, considering the 2008 economic crisis and using data from 1957 to 2014. The variables tourist arrivals (i.e., the number of visitors) and tourism receipts were employed by the authors as a proxy for tourism. The findings of the cointegration and Granger causality techniques showed that the TLGH was valid when the authors utilised the number of visitors, gross value added, and GDP but not when the variable tourist receipts (i.e., revenue). Ertugrul et al. [21] used the TLGH in a study conducted in the context of Turkey, which showed a strong indication that tourism made a strong contribution to economic growth. The study's main objective was to examine the empirical nexus between tourism and economic growth by using the bounds test approach and Granger causality. The study used quarterly data from 1998 Q1 to 2011 Q3. The long-run estimation from the ARDL revealed that a 1% rise in tourism leads to an increase of 0.237% in GDP. This shows strong indication tourism makes a strong contribution to increasing economic growth.

Recently, empirical findings of Wong et al. [22] demonstrated that, in eastern China, there is a positive association between the increase in foreign tourism and economic growth. Additionally, Matzana et al. [23], in a recent study, revealed tourism activity as an engine of growth, confirming TLGH in European countries.

However, several studies do not support the TLGH. For example, using an autoregressive distributed lag (ARDL) approach and the Granger causality test, Kyophilavong et al. [24] examined the TLGH and found it was not supported. Likewise, Aslan [25] investigated the relationship between tourist growth and economic development in Mediterranean nations from 1995 to 2010, and the findings using the panel Granger causality tests did not support TLGH in Malta or Egypt.

2.2. Air Transportation Led Growth Hypothesis (ALGH)

Air transportation is an essential means of allowing international tourists to travel to their desired destinations. The economic effect of air transportation is an area of interest to developed and developing countries. As stated, most researchers used the variables such as international tourist arrivals and/or tourism receipts (revenue) as a proxy for tourism; however, very little research has been conducted using air transportation as a proxy for tourism, and therefore, little is known about the direct effect that the air transportation industry has on the economy.

According to Brida et al. [26], there exists a cointegration relationship between aircraft movements and GDP, implying a long-run association between these two parameters. Similar to this, Chi et al. [27] investigated the dynamic link between American economic development and demand for air travel. The findings show that when there is economic expansion, both air passenger and freight services tend to rise over time. However, only air passenger services are responsive to economic expansion in the near term. Additionally, they revealed that the 9/11 terrorist attacks and the SARS epidemic negatively impacted the demand for air travel in the short- and long-term, respectively. Using random effects panel data to examine the impact of air travel on commerce, Brugnoli et al. [28] suggested that air travel had a favourable impact on global trade. Their findings suggest that the growth of the economy is significantly influenced by air transport.

Abate [29] empirically examined the financial effects of air travel while taking into ticket prices and service levels as indicated by departure frequency. While accounting for other factors, the empirical models assessed how airfares and departure frequency react to openness measures in air services agreements. According to the findings, routes that underwent some degree of liberalisation had a 40% rise in departure frequency compared to routes that were subject to restrictive bilateral air services agreements. In order to examine the association between trade ties and air passenger traffic across nations in the Asia-Pacific area from 1980 to 2010, Van De Vijver et al. [30] employed a heterogeneous Granger analysis. In the context of developed countries (such as Australia and New Zealand), the study found no significant association between trade and air passenger travel connections; however, it did find a significant association between air passenger connections and trade connections between Australia and Thailand.

Employment opportunities also lead to economic growth [31]. Thus, the role of air transport in employment opportunities and growth was examined by Njoya et al. [32] in South Africa. The study explored the impact of air transport on economic growth, focusing on its capacity to create employment opportunities. The results demonstrated that air transport significantly affects output, income, and employment.

Similarly, Balsalobre-Lorente et al. [33] analysed the asymmetric impact of air transport on economic growth in a recent study. The authors validated the TLGH using air transportation as a proxy for tourism. The empirical results from NARDL revealed that air transport, the urbanisation process, and social globalisation impact economic growth positively and significantly. The asymmetric NARDL long-run results revealed that a 1% increase in positive air transportation increases economic growth by 1.31% and that negative air transportation increases GDP by 1.44%. Likewise, Brugnoli et al. [28] conducted tests on air transportation and trade flow in Italy from 2004 to 2014 using random effects panel data. The findings showed that civil aviation had a positive impact on world trade.

From 1981 to 2017, Adedoyin et al. [34] examined the impacts of air transport, energy, information, and communications technology (ICT) and foreign direct investment on economic development in the United States. This was during the Industry 4.0 period. The casual and long-term relationship between air transport and economic growth was examined in the study. The investigation was carried out using canonical cointegrating regression, fully modified least squares, and dynamic ordinary least squares. The ALGH was validated in the context of their investigation by the econometric techniques, which showed that air travel boosts economic growth. Despite air transportation being an essential indicator of economic activity, it is not always clear that air transport leads to economic expansion; it can also function in the opposite direction. Between the years 1995 and 2006, Yao et al. [35] investigated the key factors of air transport in China's regions. Their empirical results suggest that land transportation is adversely correlated with economic growth due to a heightened production function, while air transportation is positively correlated with economic growth with population. Additionally, research by Tolcha et al. [36] found a connection between the desire for air travel and the advancement of the economy in Sub-Saharan African nations. In determining whether air travel spurs or retards economic growth, the findings showed that in South Africa, Nigeria, and Kenya, long-term causality runs from economic growth to air travel demand; in Ethiopia, however, causality runs in the opposite direction, with higher air travel demand spurring economic development; and in Senegal and Angola, the relationship was found to be too tenuous to suggest any causal directions.

It is clear that air transport plays a significant role in a nation's economic development. In a recent study, Law et al. [37] found the existence of a causal relationship between the expansion of air transport and economic growth. However, due to COVID-19, the air transport industry (international) has gradually decreased, but the tertiary sector has increased.

The literature presented here reveals mixed outcomes. To the best of the authors' knowledge, there is one study conducted to analyse the effect of air transportation on Australia's economy. In this study, Baker et al. [38] used panel data spanning 25 years from 88 regional airports in Australia. The cointegration and Granger causality tests suggested that air transportation increases Australia's economic growth. However, the study by Baker et al. [38] was conducted in the context of regional aviation/airports using aggregate taxable income as a proxy for economic growth. As a further impediment, this study lacked the overall Australian aviation context using national GDP as an economic indicator because the effect was evaluated using aggregate taxable income. Thus, further in-depth study in the Australian context is required. To fill this research gap, this study uses the control variables such as primary energy consumption, financial development, socialization, and urbanisation in the Australian environment and offers analysis of the impact of air transport on Australia's economic growth.

The main goal of this study was to determine the answer to the question: Do the relationship between air transport and economic growth symmetric or asymmetric controlling other variables? The following proposed hypothesis will be put to the test in the empirical study, taking into account the relationship between the dependent and explanatory variables:

H1: *There is a positive and significant relationship between air transport and economic growth.*

3. Materials and Methods

3.1. Data and Variables

This study explored the relationship between air transport (proxied for tourism) and economic growth (proxied by GDP) with a nonlinear model to determine long-run and short-run relationships to validate the ALGH in the context of Australia. For the analysis, the study used time-series data from Australia covering almost the past five decades: from 1971 to 2019. In addition, to avoid omitted variable bias, we employed additional explanatory variables such as energy consumption (EC), financial development (FD), social globalisation (SG), and urbanisation growth (UG) as control variables. The GDP, air transport (AT), FD, and UG data were acquired from the World Bank [15], SG from the KOF Globalisation Index [39], and EC from BP Statistical Review [40]. The data variable descriptions and data sources are shown in Table 1. The rationale for choosing the explanatory variables is briefly explained below.

GDP is a key statistic for determining a country's economic development, and it indicates whether the economy is growing or contracting. We utilise the yearly GDP per capita (constant USD 2010) as the dependent variable. In past literature, GDP per capita has often been used to measure the economic growth of a nation [33,34]. We employed annual data on passengers transported by air transport as an independent variable to examine the impact of air travel on economic development [33,34]. In the past several decades, there has been substantial research on the connection between energy usage and economic expansion [34,41–43]. Energy is considered an important input for growth [44,45]. Thus, to avoid omitted variable bias, we also used primary energy consumption per capita as a control variable. We also added the financial development percentage of GDP as a fundamental element of economic growth due to its potential significance as a driver of economic development [46,47]. Additionally, studies have shown that social globalisation has significant and favourable implications for economic growth [33,48]. Social globalisation includes interpersonal, informational, and cultural globalisation, which reflects the spread of information, ideas, and people [49] that can facilitate economic growth. Further, human beings play a very important role in boosting economic growth, and the many benefits of urbanisation, including work possibilities, health facilities, infrastructure services, and greater revenue, have been widely recognised [33,50]. Thus, urbanisation is crucial for economic development, as well.

Table 1. Data sources and variable descriptions.

Variable	Description	Definition	Source
Gross domestic product (GDP)	GDP per capita (constant USD 2010)	GDP per capita is the GDP divided by the mid-year population.	World Bank [15]
Air transport (AT)	Air transport, passengers carried	Air passengers carried include both domestic and international aircraft passengers of air carriers registered in the country.	World Bank [15]
Energy consumption (EC)	Primary energy consumption per capita	Primary energy comprises commercially traded fuels, including modern renewables, used to generate electricity.	BP Statistical Review [40]

Table 1. *Cont.*

Variable	Description	Definition	Source
Financial development (FD)	Domestic credit to the private sector (% of GDP)	Domestic credit to the private sector refers to financial resources provided to the private sector by financial corporations.	World Bank [15]
Social globalisation (SG)	Social integration index	Social globalisation refers to interpersonal, informational, and cultural globalisation.	Gygli et al. [39]
Urbanisation growth (UG)	Urban population growth (annual %)	Urban population refers to people living in urban areas.	[15]

3.2. Methodology

This study used the nonlinear autoregressive distribution method to explore the nexus between the variables. Following Balsalobre-Lorente et al. [33] and Shin et al. [51], a functional equation of the model is formulated as:

$$\mathbf{GDP=f\ (AT, EC, FD, SG, UG)} \tag{1}$$

We extend the equation into the natural logarithm form except urban population growth specified by the following equation:

$$lnGDP = lnAT_t + lnEC_t + lnFD_t + lnSG_t + UG_t + \varepsilon_t \tag{2}$$

Further, following Majeed et al. [52], we examine only the variable of interest positive and negative shock to the dependent variable. In other words, in this step, we generate the positive and negative variation of air transport as we want to examine the asymmetric impact of AT on GDP with other variables as control variables. These positive and negative changes in the partial sum can be stated as follows:

Positive:

$$lnAT_t^+ = \sum_{i=1}^{t} \Delta AT_i{}^+ = \sum_{i=1}^{t} \mathbf{max}(\Delta AT_i, \mathbf{0}) \tag{3}$$

Negative:

$$lnAT_t^- = \sum_{i=1}^{t} \Delta AT_i -^{=} \sum_{i=1}^{t} \mathbf{min}(\Delta AT_i, \mathbf{0}) \tag{4}$$

3.3. Unit Root Test

This study used a unit root test to analyse the first stage of time-series analysis of the stationarity of the variables. Because of economic instability, a structural change occurs in the time-series analysis. Perron [53] demonstrated that it is essential to examine the structural break because ignoring the structural break can lead to producing biased empirical results. Thus, we use the ADF test with a structural break [54] to obtain the order to integrate the desired variables. In addition, the AO and IO proposed by Clemente et al. [54] are used to check the sudden (AO) and gradual changes (IO) in the time-series analysis.

3.4. BDS Test

The Brock–Dechert–Scheinkman–LeBaron test (BDS) test is statistically highly effective in providing information about the linearity and nonlinearity of the model [55]. The BDS test follows the null hypothesis, which states that data are independent and identically distributed (iid) or nonlinear dependencies [56]. Thus, if the data are nonlinear, we apply NARDL to investigate the relationship between the variables [57].

The following equation examines the BDS test:

$$\mathbf{BDS}_{\in,m} = \frac{\sqrt{N}\ [C_{\in,m} - (C_{\in,1})^{m}]}{\sqrt{V_{\in,m}}} \quad (5)$$

where $[C_{\in,m} - (C_{\in,1})^{m}]$ an asymptotic normal distribution with zero is the mean; $V_{\in,m}$ is a variance; and m is the number of consecutive points which is used in the set or embedding dimension.

3.5. NARDL Model

The conventional ARDL model is unable to offer linearity and systematic adjustments among the variables that the model expects. Thus, the NARDL model is used to investigate how changes in shocks or both positive and negative changes in the independent variables affect the time-series dependent variables [58]. Because of its exact and precise results when the variables are at a level I(0), the first difference I(1), or a combination of both I(0) and I(1), NARDL is a widely used method. In addition to this, the short-run and long-run effects of independent variables on the dependent variable are distinguished [59].

According to the critical bounds proposed by Pesaran et al. [60], a long-term association between the variables exists if the estimated F-statistics are greater than the upper bound's critical value at a 5% level of significance.

Combining equations 3 and 4 and following the econometric approach of Shin et al. [51], Villanthenkodath et al. [61], and Ahmad et al. [62], we framework NARDL long-run and short-run estimates as follows:

$$\begin{aligned} \Delta lnGDP_t = {} & \beta_0 + \beta_1 lnAT_t^{+} + \beta_2 lnAT_t^{-} + \beta_3 lnEC_t + \beta_4 lnFD_t + \beta_5 lnSG_t \\ & + \beta_6 UG_t + \sum_{i=1}^{n} \propto_6 \Delta lnGDP_{t-i} + \sum_{i=0}^{n} \propto_7 \Delta lnAT_{t-i}^{+} \\ & + \sum_{i=0}^{n} \propto_7 \Delta lnAT_{t-i}^{-} + \sum_{i=0}^{n} \propto_6 \Delta lnEC_{t-i} + \sum_{i=0}^{n} \propto_6 \Delta lnFD_{t-i} \\ & + \sum_{i=0}^{n} \propto_6 \Delta lnSG_{t-i} + \sum_{i=0}^{n} \propto_6 \Delta UG_{t-i} + \alpha \mathbf{ECM_{t-1}} + \varepsilon_t \end{aligned} \quad (6)$$

NARDL examines the linear relationship between the variables where β_i = long-run coefficients; $\propto_i$ = short-run coefficients; Δ denotes difference operator; and ε_t is the white noise term.

4. Results

Table 2 presents the descriptive statistics for the chosen variables. The findings of the Jarque-Bera test indicate that the distributions of lnGDP, lnAT, lnEC, lnFD, lnSG, and UG are normal. The minimum and highest values of lnGDP are 10.176 and 10.954, respectively, with 10.575 serving as its mean value. Similar to this, the mean of the logarithm value for AT is 17.088, with a minimum and maximum of 15.807 and 18.157, respectively.

Table 2. Descriptive analysis.

	lnGDP	lnAT	lnEC	lnFD	lnSG	UG
Mean	10.575	17.088	5.416	4.145	4.329	1.494
Median	10.548	17.177	5.451	4.248	4.314	1.445
Maximum	10.954	18.157	5.566	4.959	4.480	3.572
Minimum	10.176	15.807	5.105	3.163	4.200	0.769
Std Dev.	0.257	0.711	0.118	0.625	0.105	0.487
Skewness	0.012	−0.022	−0.781	−0.240	0.184	1.808
Kurtosis	1.548	1.698	2.807	1.519	1.426	8.541
Jarque–Bera	4.305	3.463	5.058	4.951	5.339	89.385
Probability	0.116	0.177	0.080	0.084	0.069	0.000

Table 2. *Cont.*

	lnGDP	lnAT	lnEC	lnFD	lnSG	UG
Sum	518.173	837.323	265.366	203.082	212.139	73.209
Sum Sq. Dev.	3.181	24.292	0.664	18.773	0.531	11.365
Observations	49	49	49	49	49	49

4.1. Unit Root Test

In contrast to the alternative hypothesis, which states that the series is produced by a stationary process, ADF unit root tests, which were utilised in this work, are predicated on the null hypothesis that the variables have a unit root. The outcomes of the ADF test with a structural break with AO and IO are shown in Table 3. The outcomes show a combination of I(0) and I(1) in the variables, but they are all stationary at the first difference.

Table 3. Results of the ADF test with structural break: AO and IO.

Variables	ADF Test Statistic (IO)	*p*-Values	Breaking Point	ADF Test Statistic (AO)	*p*-Values	Structural Break
At Level						
lnGDP	−2.933	0.721	1993	−2.346	0.938	1982
lnAT	−3.157	0.593	1989	−1.862	0.989	1991
lnEC	−4.305 *	0.074	1993	−4.008	0.154	1993
lnFD	−4.798 **	0.018	1984	−2.594	0.871	1981
lnSG	−3.025	0.672	1992	−1.877	0.988	1989
UG	−7.358 ***	0.000	2007	−6.733 ***	0.000	2009
At First Difference						
lnGDP	−6.982 ***	0.000	1983	−6.415 ***	0.000	2009
lnAT	−7.501 ***	0.000	1991	−7.667 ***	0.000	1991
lnEC	−5.789 ***	0.000	1979	−5.997 ***	0.000	1974
lnFD	−6.404 ***	0.000	1989	−6.527 ***	0.000	1989
lnSG	−6.107 ***	0.000	1984	−6.261 ***	0.000	2007
UG	−10.242 ***	0.000	1993	−10.325 ***	0.000	1974

Note: *** 1% level of significance; ** 5% level of significance; * 10% level of significance.

4.2. BDS Test

The BDS test results are given in Table 4. The estimated results show that all the values are significant at a 1% critical level. The results indicate the acceptance of the alternative hypothesis and that the variables are nonlinear.

Table 4. Results of BDS test.

Variable	m = 2	m = 3	m = 4	m = 5	m = 6
lnGDP	0.193 ***	0.323 ***	0.412 ***	0.473 ***	0.519 ***
lnAT	0.194 ***	0.323 ***	0.412 ***	0.473 ***	0.517 ***
lnEC	0.182 ***	0.319 ***	0.418 ***	0.483 ***	0.524 ***
lnFD	0.199 ***	0.336 ***	0.429 ***	0.493 ***	0.537 ***
lnSG	0.193 ***	0.323 ***	0.410 ***	0.469 ***	0.508 ***
UG	0.085 ***	0.141 ***	0.171 ***	0.180 ***	0.171 ***

Note: *** 1% level of significance.

4.3. Bounds Test

After the BDS test, we used the bounds test for nonlinear cointegration to explore the nexus between the dependent and independent variables. The estimated F-statistics were substantially over the upper critical bound, as shown in Table 5. The findings showed that the factors had a long-run association. The results revealed that there exists a long-run relationship among the variables.

Table 5. Results of the bounds test for the nonlinear cointegration.

Series	F-Statistics	LCB I(0)	UCB I(1)	Conclusion
lnGDP = f (lnAT, lnEC, lnFD, lnSG, UG)	11.94296 ***	2.88	3.99	Cointegrated

Note: *** 1% level of significance.

4.4. Results of NARDL Test

The NARDL model was used to determine the long-run and short-run asymmetric relationships among the desired variables after the long-run relationship between the variables had been verified using the NARDL bounds testing method. The nonlinear (NARDL) estimate outcomes for Australia from 1971 to 2019 are displayed in Tables 6 and 7.

Table 6. Results of long-run estimation.

Long-Run Estimation		
Variable	**Coefficient**	**t-Statistic**
$lnAT^{+}$	0.158	3.096 *
$lnAT^{-}$	0.382	2.935 ***
lnEC	0.675	3.861 *
lnFD	0.080	0.945
lnSG	0.586	1.789 ***
UG	0.015	1.056
C	3.930	3.187 *

Note: *** 1% level of significance; * 10% level of significance.

Table 7. Results of short-run estimation.

Short-Run Estimation		
Variable	**Coefficient**	**t-Statistic**
C	1.413	2.530 **
lnGDP (−1)	−0.340	−5.557 *
$lnAT^{+}$ (−1)	0.057	2.775 **
$lnAT^{-}$	0.138	3.144 *
lnEC	0.243	4.787
lnFD (−1)	0.029	0.937
lnSG	0.211	1.613
UG	0.006	0.999
D(lnGDP (−1))	−0.174	−1.554
D(lnGDP_PC (−2))	−0.234	−1.930 ***
D(lnAT_POS)	−0.004	−0.107
D(lnAT_POS (−1))	−0.084	−2.780
D(lnFD)	0.094	2.590
D(lnFD (−1))	0.124	3.567
ECM (−1)	−0.360	−10.790 *

Note: *** 1% level of significance; ** 5% level of significance; * 10% level of significance.

In both the short and long run, we observed statistically significant asymmetric impacts of air transport on economic growth. According to the asymmetric long-run results presented in Table 6, a 1% increase in AT boosts economic growth by 0.158% ($lnAT^{+}$ 0.158), whereas a 1% drop in AT decreases GDP by 0.382% ($lnAT^{-}$ 0.382). The positive shocks in AT propel the long-term growth of Australia's economy. Additionally, according to the findings, negative shocks of AT have a stronger detrimental impact on economic development than positive shocks.

In terms of the relationship between energy consumption and economic growth, we identified a positive correlation, showing that a 1% rise in energy consumption results in a 0.675% increase in economic growth in Australia. In addition, financial development and urbanisation have a positive but insignificant effect on GDP. Interestingly, we found that socialisation had a positive effect on economic growth, with a 1% surge in socialisation soaring economic growth in Australia by 0.586%.

In Table 7, the short-run dynamics are displayed. The results of short-run estimation shows that although the parameters' magnitudes and levels of significance altered, the relationship's long-run and short-run directions remained the same. The variables adapt to the equilibrium at an adjustment speed of −0.36 per year, which is revealed by the fact that the error correction term is negative and statistically significant at the 1% critical level. In the short run, the positive shocks of AT have a significant positive impact on GDP, implying that a 1% rise in AT surges GDP by 0.057%. Thus, the short-run results also confirm the ALGH in the context of Australia by demonstrating that the positive shock of the lagged value of air transportation has a positive and statistically significant influence on economic growth. To validate the NARDL model, we tested for autocorrelation (Durbin–Watson), serial correlation (Breusch–Godfrey LM), heteroskedasticity (Breusch–Pagan–Godfrey test and Harvey test), the model functional form (Ramsey Regression Equation Specification Error Test), and the normality test (Jarque–Bera). Table 8 confirms that the model does not have the problem of autocorrelation, serial correlation, and heteroskedasticity, and it is normally distributed.

Table 8. Diagnostic tests.

Variable	Coefficient
R^2	0.741
Durbin–Watson test	2.053
Jarque–Bera test	5.676 (0.059)
Breusch–Godfrey LM test	0.302 (0.824)
Breusch–Pagan–Godfrey test	1.876 (0.073)
Harvey test	1.079 (0.409)
Ramsey test	0.319 (0.576)
Wald test	5.981 (0.001)

Further, we tested the model for parameter and variance stability by the CUSUM and CUSUMQ plots. Figures 3 and 4 confirm the stability of the model and are within the range of the 5% level of significance.

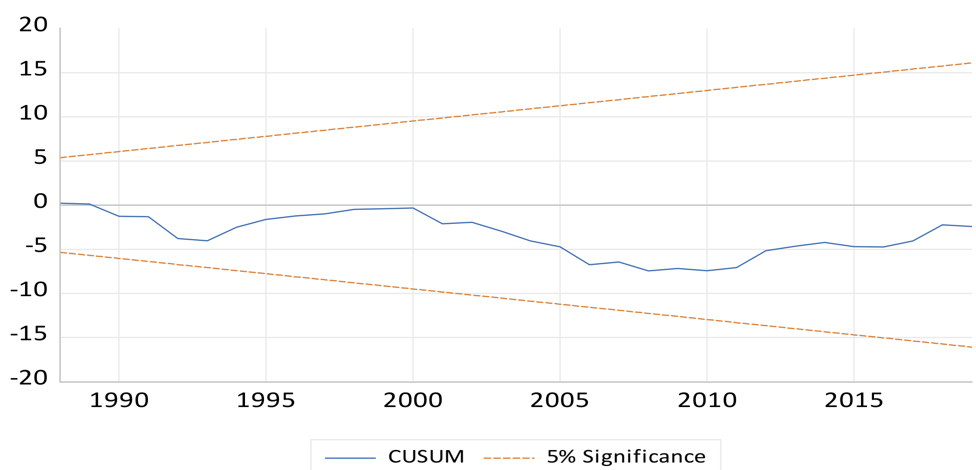

Figure 3. CUSUM test.

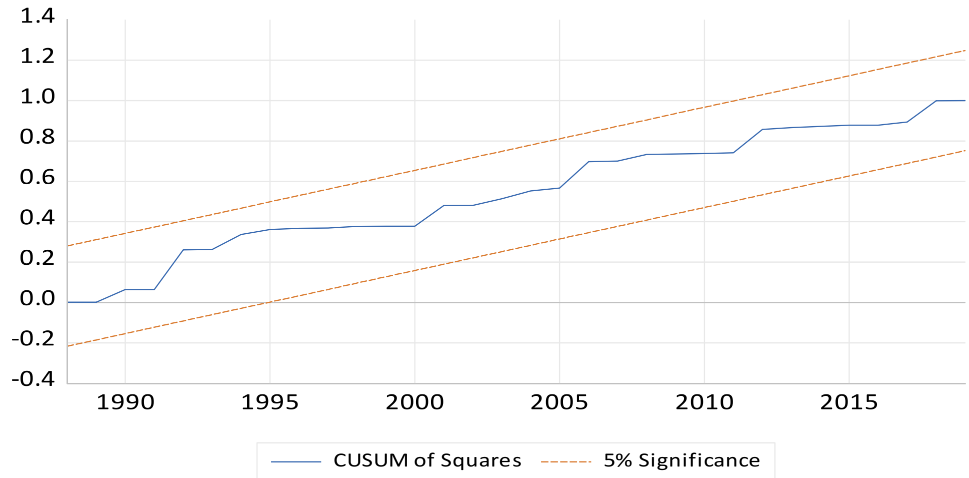

Figure 4. CUSUMQ test.

Figure 5 shows the asymmetric NARDL dynamic multiplier effects, which highlight the impact of both positive and negative air transportation shocks on economic development. The solid black line in Figure 5 shows the positive impact of AT on GDP, whereas the dotted black line shows the negative effect of air travel on economic growth. This NARDL multiplier effects figure demonstrates the large asymmetries between the positive and negative shocks to AT and GDP.

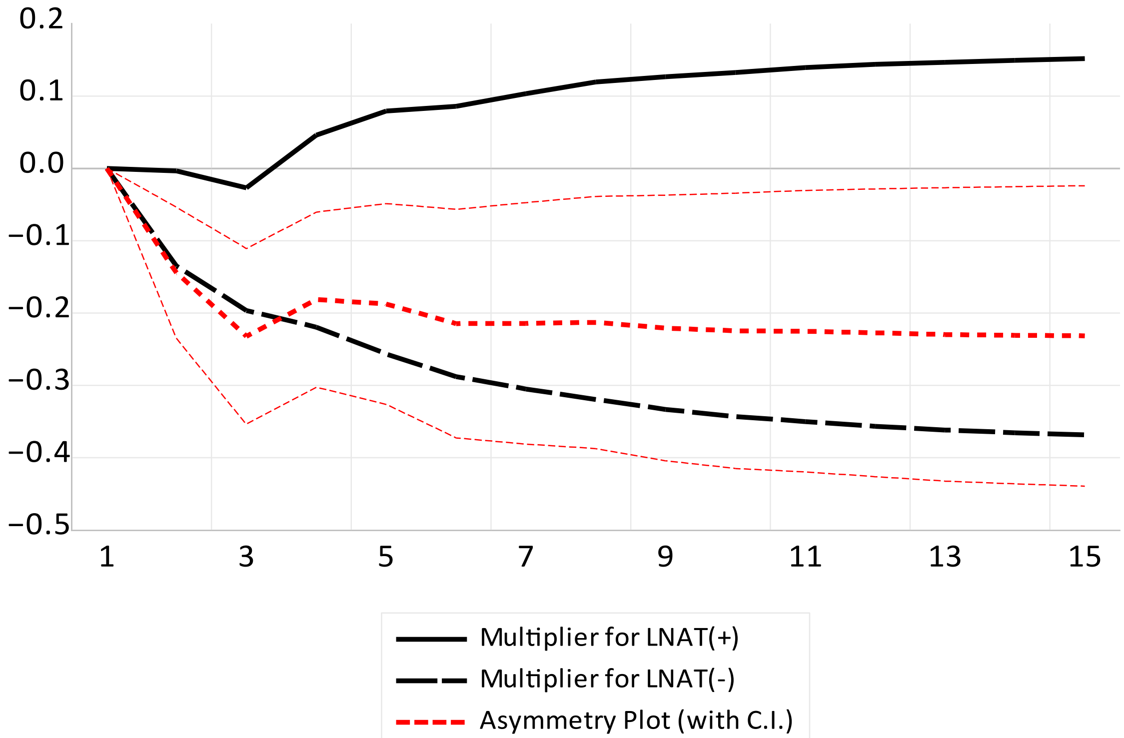

Figure 5. NARDL multiplier effects.

Figure 6 provides an overview of the positive and significant effect of the asymmetric behaviour of air transport on economic growth, confirming the ALGH in the Australian context.

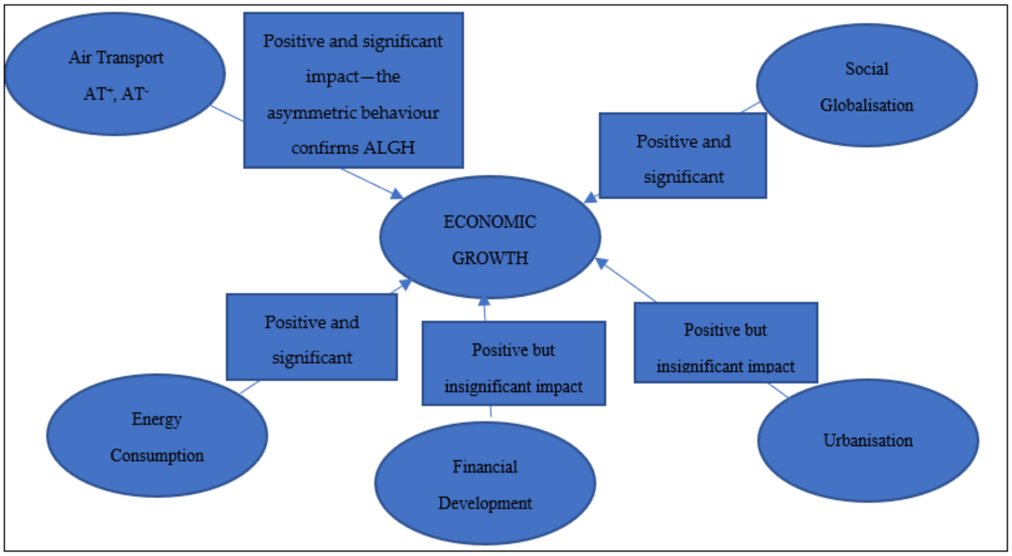

Figure 6. Based on NARDL econometric estimation, the empirical scheme confirming ALGH.

5. Discussion

The effect of tourism arrivals, tourism receipts (revenue), and expenditure on economic growth has been extensively analysed through the TLGH in the tourism literature. However, only a few studies have explored the impact of air transport on economic growth. Air transport plays a significant role in a nation's economic development. The aviation industry carries passengers and cargo from local and international destinations, generating revenue and creating employment opportunities. Conversely, economic growth shoots up demand for air transport in both the passenger and freight sectors [63]. However, recently, COVID-19 has significantly disrupted air transport and tourism.

To reach its goal of examining how air transport affects economic growth, this research used a variety of econometric methodologies. The ADF test was utilised in the study to check the series' stationarity. The variables are stationary at the first difference, per the findings of the ADF unit root test with AOs and IOs. The BDS test results revealed that the series is nonlinear, examining the long-run relationship using NARDL. The Bounds test revealed a long-run relationship between the variables. To validate ALGH, we utilised the asymmetries or nonlinear method to find significant results. The long-run NARDL results revealed that any positive shock in air transport causes higher economic growth in the long run. In both the long run and short run, statistically significant asymmetric impacts of air transport on economic growth are observed. According to the asymmetric long-run results, a 1% increase in AT boosts economic growth by 0.158% ($\ln AT^{+}$ 0.158), whereas a 1% drop in AT decreases GDP by 0.382% ($\ln AT^{-}$ 0.382). The positive shocks in AT propel the long-term growth of Australia's economy. Additionally, according to the findings, negative shocks of AT have a stronger detrimental impact on economic development than positive shocks. These results are consistent with Chi et al. [27] and Balsalobre-Lorente et al. [33]. Thus, increased air transport generates more money for the government in the form of taxes and levies, which may be utilised to upgrade and build new aviation infrastructure. According to the growth hypothesis, energy consumption is a critical determinant of growth, either wholly or partly [64]. As a result, a reduction in demand for energy consumption can cause a decline in economic growth. Thus, economic growth cannot be achieved without the consumption of energy [64]. Our findings reveal that, in the long run, energy consumption affects economic growth positively and significantly. This result is in line with the empirical evidence found by Selvanathan et al. [65], Rahman [66], and Rahman et al. [67]. Thus, the air transportation sector using renewable energy as its primary source of energy would help to decrease environmental degradation. In addition, civil aviation must adopt environmentally clean or green technologies in their operations [68] to ensure better environmental outcomes in the future.

Further, socialisation, financial development, and urbanisation growth are also contributors to economic growth. As a multidimensional concept, globalisation is primarily concerned with three aspects of human activity: economic, social, and political. Social globalisation includes interpersonal, informational, and cultural globalisation [39]. To gain from the overall process of market integration and globalisation, any country must take advantage of its international connections, economic, trade, technology transfers, or information flows, that is, socialisation, in its economic growth process. As a result, socialisation supports economic growth in the context of globalisation. This study's findings are consistent with those of Balsalobre-Lorente et al. [33] in that social globalisation has a positive and significant impact on economic growth.

Likewise, researchers on empirical growth are increasingly favouring the view that financial development is a key driver of growth [46]. They also show that investment is a crucial pathway via which financial advancement fuels economic growth. Our findings revealed that while financial development does increase economic growth, the effect is not significant. This result contradicts Adu et al. [46], who claim they found a statistical and significant effect in Ghana to support the positive effect of financial development on growth. Similarly, urbanisation, measured by the population residing in the urban area, is an essential variable in the analysis of economic growth. A structural change in which resources are transferred from agricultural to industrial activities, and people relocate from rural to urban regions has been connected to the growth of urbanization [69]. Our findings from the NARDL long-run estimations showed that while urbanisation does have positive coefficients, it does not significantly affect economic growth. According to Castells-Quintana et al. [69], nations with high population expansion may see rapid urbanisation and declining productivity (i.e., urbanisation without growth).

6. Conclusions

This study explored the relationship between air transport and economic growth, considering energy consumption, financial development, socialisation, and urbanisation as control variables over the period 1971–2019 in Australia. The results from cointegration analysis revealed that there exists a long-run relationship among the variables. The results from NARDL long-run estimates revealed that the positive shocks in the AT increase GDP, whereas the negative shocks decrease GDP. The size of the long-run positive and negative changes in air transport also confirmed the long-run asymmetric association between AT and GDP in Australia. This outcome reveals that the more travellers are carried by air transport, the more that economic growth will increase. Thus, to conclude, air transportation is a crucial determinant of growth, and the ALGH is validated through the number of air passengers carried in the context of Australia.

The results from this study support notable policy recommendations. Prior to the COVID-19 pandemic, the air transportation sector was one of the most substantial growth areas. Appropriate planning will help to ensure the robust redevelopment of Australia's aviation industry. The findings of this study indicate that air transport can strengthen the national economy over the long run by improving its degree of networks, which will allow business to be conducted globally. Moreover, air transport infrastructure should be promoted through the level of investment.

For a nation to continue its growth and financial advancement, an efficient, safe, and cost-effective air transport business must be developed. Governments, policymakers, civil authorities, airline companies, and travel and tourist agencies should have assertive and essential policy plans. This will ensure that the importance of the tourism industry will be more broadly recognised, particularly in nations such as Australia. Moreover, dependable partners have some cushion time to develop appropriate spatial framework strategies to promote the anticipated development in air transport after the pandemic. Thus, policymakers should use the findings of this study to implement an effective policy that would promote international trade and tourism to drive economic growth through growing the air transportation industry.

One of the limitations of this study is that it used the number of passengers carried to measure the airline transportation industry. However, future research could measure this using alternative variables such as the amount of freight (million tonnes per kilometre) and registered carrier departures worldwide. In addition, monthly or quarterly data could be considered to conduct research on the relationship between air transport and economic growth throughout different periods.

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2.2 Links and implications

Air transport plays a vital role in facilitating economic growth, in both developed and developing countries. Thus, the significance of this paper is that it examined the link between air transport and economic growth in Australia. The findings of the cointegration study showed that the variables had a long-run connection. This result shows that economic growth will increase in direct proportion to the number of passengers transported by air transportation. So, to sum up, air travel is a critical factor in determining growth in Australia.

While this chapter (Chapter 2) utilised air transport as an economic determinant, however, employment which is crucial variable for economic growth is utilised in the next study (Chapter 3) to test whether tourist arrivals affect service sector employment. In addition, to avoid omitted variable bias, some additional explanatory variables i.e., market capital (listed domestic companies in current US$), financial development (domestic credit to the private sector as a percentage of GDP) and trade (percentage of GDP) are also incorporated.

CHAPTER 3: THE ROLE OF TOURISM IN SERVICE SECTOR EMPLOYMENT: DO MARKET CAPITAL, FINANCIAL DEVELOPMENT AND TRADE ALSO PLAY A ROLE?

3.1 Introduction

In addition to being a significant driver of economic growth and development, tourism also creates job opportunities. Thus, this chapter examines the symmetric and asymmetric effects of tourism, market capital, financial development, and trade on employment in the service sector in Australia from 1991 to 2019. The outcomes of the cointegration test, particularly the ARDL and NARDL tests, demonstrate a long-term connection between the variables. The long-run estimates from both ARDL and NARDL approaches confirmed the positive and significant effect of tourist arrivals on Australian service sector employment.

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RESEARCH ARTICLE

The role of tourism in service sector employment: Do market capital, financial development and trade also play a role?

Avishek Khanal*, Mohammad Mafizur Rahman, Rasheda Khanam, Eswaran Velayutham

School of Business, Faculty of Business, Education, Law and Arts, University of Southern Queensland, Toowoomba, Australia

* avishek_khanal@yahoo.com, avishek.khanal@usq.edu.au

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Abstract

Workers' living standards have recently deteriorated in the service sector throughout the world, although a few decades ago, service was among the fastest growing sectors in industrialised nations. However, in recent years, in service sectors tourism especially has been drying up. This paper examines the symmetric and asymmetric effects of tourism, market capital, financial development, and trade on service sector employment in Australia from the period 1991–2019. The results of the cointegration tests, notably the ARDL and NARDL bound tests, reveal that the variables are related in the long run. The positive effect of tourist arrival on service sector employment in Australia is confirmed by long-run estimates from both ARDL and NARDL approaches. Similarly, both approaches also confirm the long-run positive relation of financial development. However, while ARDL shows long-run negative and positive associations of market capital and trade, respectively, the opposite is found in the case of the NARDL approach. As a result, policy proposals like planning and initiating tools for ensuring consistent international arrivals and easing of entry requirements have been recommended by this study to assist Australia in enhancing service sector employment, thus promoting economic development.

Introduction

The industrial revolution strengthened manufacturing units by easing and enhancing the volume of production, and thus the manufacturing sector is known as the engine of growth. However, over time, the contribution of manufacturing sectors globally has constantly been declining in terms of national income and employment, while the contribution of the service industry has been increasing. The service sector in an economy includes diverse industries and accounts for a substantial contribution to the country's growth and development. In developed countries, the service sector accounts for around 70% of the gross domestic product (GDP), while according to an earlier estimate, around 79% of Australia's economic activities were from the service sector [1]. Service sector employment in Australia was 78.4% in 2019, a decline from 85% in 2006, and an increase from 76% in 1985, indicating a fluctuation in

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sectoral employment [1]. Australia's key services include education and tourism, recreational trade, FinTech and environmental services, while the most significant service exports are professional services, and business travel services [1].

Although workers' living standards deteriorated in a service economy, a few decades ago service was among the fastest growing sectors in industrialised nations [2, 3]. The argument Fuchs [4] made long back that economic development contributed to the rise of service employment seems valid today since higher family income influences more spending on various services.

Tourism dynamics are not confined to a particular area. Although Europe attracted many visitors in 2014, the Asia Pacific and Africa have enjoyed the highest growth during the decade that ended 2014 [5]. International tourism directly impacts both the economy and employment [5, 6]. Tourism has attracted researchers to find its association with numerous factors and determinants, including emission and environment [7], energy consumption [8], foreign exchange rate [9], and economic development [10]. The tourism industry is predominantly resource-based and is influenced by the climate and landscape of the destination, heritage, and cuisine. Performance of the labour-intensive industries, including hotels, transports, and restaurants, amplifies the potential travellers' motivation [6]. The hotel, transport, and other facilities use energy consumption which impacts the environment [11, 12].

Despite such advancement in research, evidence about the service industry, employment, and related factors is inadequate, particularly from the Australian perspective, while this sector can potentially influence growth [13–15]. Against this backdrop, this research aims to investigate the influences of tourist arrival, market capital, financial development, and volume of trade on service sector employment in Australia. The research findings are likely to contribute to the existing body of literature in two ways: first, by compiling seemingly different determinants in the analysis of employment in the service sector, as this research acknowledges the importance of various service-oriented industries. Second, using an established dataset to recognise the impact of multiple service industries on service sector employment as this is not readily available in the existing literature.

Background and literature review

Sectoral shifts in employment over time are viewed as structural transformation [16], and this field of research has gained attraction. For instance, in the Chinese context, Wang and Zhang [17] found that better transportation infrastructure results in employment density in the service sectors. They also found that road transportation promoted service sector employment more than railway and inland water transport. Walmsley, Koens and Milano [18] have found that overtourism, excessive numbers of tourists in a particular tourist spot, has the potential to impact wage and to divide labor market. In the Indian context, R&D, legal, media and broadcasting services have all been identified as potential sectors for future growth [19]. Education, health, growth in population, and inflation positively influence service sector employment, while the impact of political conflict is the reverse, as found in Nepal [20]. Nonetheless, the impact of various service-oriented industries on this sectoral employment is rarely investigated.

The travel and tourism industry plays a vital role in the global economy. In 2010, more than 235 million employees were linked to this sector. Later, although it was with a minor decline in 2008–09, it grew consistently until the end of 2019, when COVID impacted the whole world. According to International Labour Organisation (ILO), tourism was expected to grow around nine per cent of total GDP [21] but tourism has been one of the sectors that is most harshly impacted from the spread of COVID-19. During the harshest impact of COVID-19, many sectors including tourism were subject to restrictions and anti-pandemic measures due to their higher potential to spread COVID-19 [22]. However, during post-COVID investigation, Scarlett [23] found that tourism has a significant positive impact on economic growth. The author has also found that a relative increase in tourism to GDP is likely to positively impact FDI inflow. In Australia, the Australian Bureau of Statistics (ABS) confirmed that since September 2020, only three months (from May to July 2021) have welcomed more than 60 thousand overseas arrivals, while some months have seen 20–40 thousand arrivals [24]. Tourism-dependent nations, particularly the small island developing states (SIDS), experience a higher proportion of employment in the service industry. In the case of a decline in tourism, substantial migrated labour and a small proportion of indigenous labour can be found redundant as was the case in Malaysia from 2007 to 2009 [6]. Hence, it is assumed that a boom or recession in tourism impacts employment in the sector, and an inferential statistical analysis is likely to provide a piece of evidence. Fig 1 shows the upward increasing trend of tourist arrivals and employment in services (% of total employment) (modeled ILO estimate).

Concerning the contribution or impact of the stock market on economic development, many investigations have been conducted across the world, for instance, in Belgium [26], in parts of Africa [27], and in many developing countries [28]. It has been found that a structured stock market in the long run results in the economic growth of a country [27], and stock market-based funding is a determinant of economic growth [26]. Irani, Katircioglu and Gokmenoglu [29] have found that the tourism stock price is impacted by foreign tourist arrivals and the price is more sensitive to changes in tourist arrival. Growth in the service sector as well eventually impacts the sustained growth of an economy [30]. However, the influence of the structured and the developed stock market on service sector employment in general and from the Australian perspective is an underexplored area of research.

Among many other indicators, the volume and quality of domestic credit to the private sector is also an indicator of an increase in investment and financial development [31–34]. Isaeva et al. [35] argue that higher receipts from tourism result in a higher share of domestic credit to private sector and vice versa. Moreover, well-structured financial systems enhance the tourism

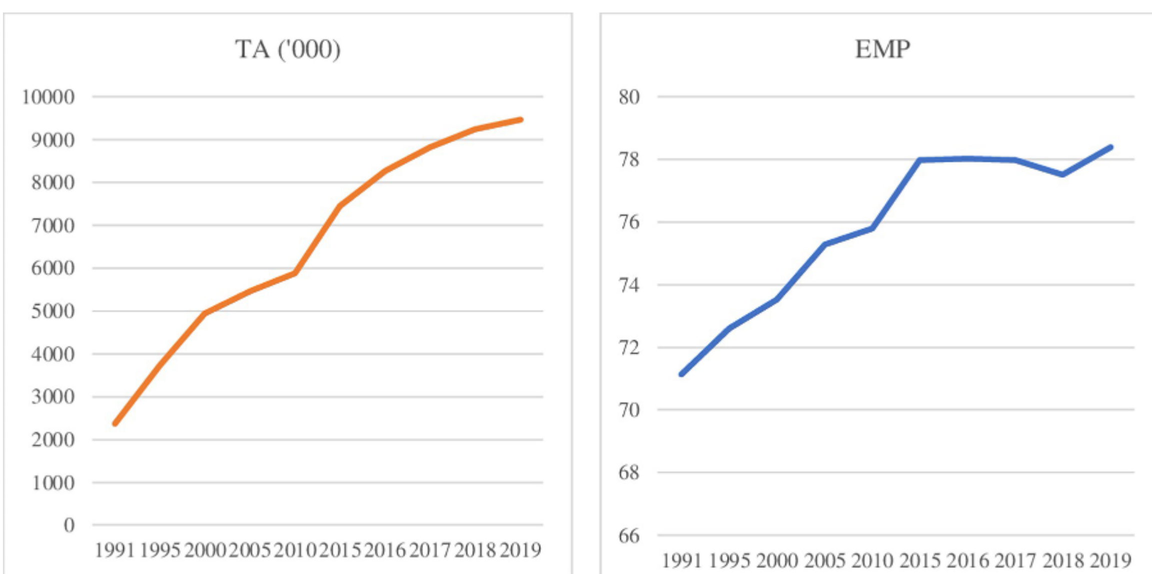

Fig 1. Tourist arrivals and employment in service in Australia. Source: World Bank [25].

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development of a nation [35]. However, other studies have ascertained that domestic credit may not boost economic growth [36, 37]. Many researchers across the world have investigated the causal relationship between economic growth and domestic credit, for instance, China [38], Kenya [39], Tunisia [40], and Brazil, Russia, India, China, and South Africa (BRICS) [41]. In addition, domestic credit has also been investigated for trade [42]. Yousaf et al. [43] have found that board capital positively impacts the performance of tourism service providers. In the context of the Gulf region, tourism sectors are found to rely more on short-term than long-term debt [44]. However, a causal relationship regarding service sector employment, particularly focusing on Australia, is under explored.

The other variable considered for this research is trade, which generally results in employment and income in the global economy [45]. In 2005, more than 70% of the industrialised nations' employment was in a service sector consisting mostly of non-tradable activity [46]. Trade policies impact employment, labour market institutions, and policies. While trade and trade liberalisation may be the reason for company closures and thereby job losses in one part, start-ups or new firms start to commence operations in other parts of an economy requiring more labour [46, 47]. Hence, trade policies have attracted numerous researchers in the last couple of decades. However, most researchers concentrated on manufacturing employment [46], and provided sufficient reasons for further studies to focus on service sector employment. Trade, in general, results in employment and income in the global economy. Trade policies impact employment, labour market institutions and policies. While trade and trade liberalisation are the reason for company closures and thereby job losses in one part, start-ups or new firms start to operate in other parts of an economy requiring more labour [46, 47]. Ehigiamusoe [48] has identified that the individual causality between tourism and growth shows a bidirectional connection. It is also found that tourism is a significant predictor of financial development and economic growth [48].

In one of the earlier studies, Armah [49] showed varied trade-related employment gains with the proportion of women the minority of labour. A recent investigation identified that volume of service exports plays a pivotal role to optimise service sector employment, particularly in the case of China [50]. Trade openness and other variables positively affect sectoral shift towards service industries [51]. In the German context, service sector employment has grown while manufacturing jobs are declining; however, these were not attributed to the rising trade with other nations [52]. In the case of Cambodia, trade shock was found to impact different manufacturing industries differently, while there was no impact on the informal sector [53].

There are at least two reasons identified by Kelle and Kleinert [54] for the growing importance of service trade: service is becoming increasingly vital in modern economies, and technological advancement has made service increasingly tradable. In the case of Australia, a limited volume of trade involves the advanced producer services sector, which is well proportioned [55]. The absence of suitable host conditions is a reason for such low volume. The services sector in Australia employs 80% of Australians and accounts for more than 70% of GDP. According to Australian Government's department of foreign affairs and trade (DFAT), the involvement of international service trade with countries resulted in around 22% of total exports in 2016 [56].

Dignity in the tourism industry is another field that has attracted numerous researchers. Tourism employment has resulted in violation of dignity of indigenous people [57]. Tourism and sustainability nexus has become another dimension in the recent literature, while it has been argued that research should be carried out on the integration of work and workers focusing dignity [58]. Tosun et al. [59] argued that in the developing world considering tourism as a developmental instrument and thereby benefitting from it would be difficult. However, in the perspective of develop world, the condition may be different.

Data and methodology

Data

The study examined the association of international tourism in Australia and service sector employment. In addition, to avoid omitted variable bias, some additional explanatory variables i.e., market capital (listed domestic companies in current US$), financial development (domestic credit to the private sector as a percentage of GDP) and trade (percentage of GDP) were also incorporated. The data extracted in this paper was created from time series observation in Australia from 1991 to 2019. All the data were collected from World Development Indicators (WDI) [25]. The data source and variables description are presented in Table 1.

Empirical model

The following model has been developed to assess the effect of tourist arrival, market capital, and financial development on service sector employment in Australia following Rahman, Shahbaz and Farooq [45].

$$\text{LN } EMP_t = \beta_0 + \beta_1 \text{ LN } TA_t + \beta_2 \text{ LN } MC_t + \beta_3 \text{ LN } FD_t + \beta_4 \text{ LN } TR_t + \varepsilon_t \quad (1)$$

Where ε_t is the error term, while LN EMP_t, LN TA_t, LN MC_t, and LN FD_t are the natural logarithms of employment in the service sector, tourist arrivals, market capital and financial development, respectively. This study used the logarithmic forms of the variables of interest to stabilise the variance of the series [60].

Unit root test

The stationarity of time-series data is important since the results of causality tests rely on it, and macroeconomic variables frequently have a unit root. If the first and second moments of a stochastic process are time-invariant, the process is said to be stationary in which statistical qualities do not change [61].

If a variable's first difference is stationary, it is integrated of order I(1) [62, 63]. The auxiliary equation below was taken from Lütkepohl, Krätzig and Phillips [61].

$$\Delta y_t = \mu + \propto_i y_{t-1} + \sum_{i=1}^{k} \pi_i \Delta y_{t-i} + \varepsilon_t \quad (2)$$

Table 1. Variable's description.

Variable	Description	Definition	Source
Employment (EMP)	Employment in services (% of total employment)	Employment is defined as persons of working age who were engaged in any activity to produce goods or provide services for pay or profit, whether at work during the reference period or not at work due to temporary absence from a job, or to working-time arrangement. The services sector consists of wholesale and retail trade and restaurants and hotels; transport, storage, and communications; financing, insurance, real estate, and business services; and community, social, and personal service	WDI
Tourist Arrivals (TA)	Number of international tourist arrivals	International tourist arrivals; short-term visitors arriving	WDI
Market Capital (MC)	Market capitalisation of listed domestic companies (current US$)	Market capitalisation (also known as market value) is the share price times the number of shares outstanding (including their several classes) for listed domestic companies. Investment funds, unit trusts, and companies whose only business goal is to hold shares of other listed companies are excluded. Data are end of year values.	WDI
Financial Development (FD)	Domestic credit to the private sector (% of GDP)	Domestic credit to the private sector refers to financial resources provided to the private sector by financial corporations.	WDI
Trade (TR)	Trade (% of GDP)	Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product.	WDI

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Where *it* denotes the relevant time-series variable, t denotes a linear deterministic trend, Δ is the first difference operator, $\propto_i$ denotes the parameter of interest, *k* denotes the maximum lag order, and ε_t denotes the error term. If $|\propto i| < 1$, the series is trend stationary; conversely, when |∝i | ⍰ 1, the series has the unit root and is thus not stationary. For more information on the time-series unit root test, see here. For further information on the time-series unit root test, see Hamilton [64] and Lütkepohl, Krätzig and Phillips [61].

BDS test

The BDS test compares the null hypothesis that the data is distributed independently and identically (iid) to an unspecified alternative [65]. Its null hypothesis is that data in a time series is linearly dependent. The test is unique because it can determine non-linearities without being influenced by linear data dependencies. The BDS test is a two-tailed test, and the null hypothesis is rejected if the BDS test statistic is greater than or less than the critical values (e.g. if a = 0.05, the critical value = ±1.96).

Cointegration analysis

This study utilised the Pesaran cointegration test, namely the autoregressive distributed lag (ARDL) bound test, to explore the long run and short run association among the dependent and explanatory variables, [66]. However, because of the possible asymmetric association among the variables, this study also used a nonlinear autoregressive distributed lag (NARDL) model developed by Shin, Yu and Greenwood-Nimmo [67].

The symmetric analysis: ARDL bound testing technique. The paper also uses the cointegration technique developed by Pesaran, Shin and Smith [66], particularly the ARDL bound test. The ARDL approach has gained popularity among scientists due to its benefits compared to other standard cointegration methods for identifying the symmetric association of service sector employment and other explanatory factors [68–70].

The bound test provides two asymptotic critical values when the independent variables are I (0) or I (1). If the F-statistic value is greater than the upper critical bound, I (1), it can be concluded that the variables are cointegrated and that there is a long-run relationship among them. The empirical expression of the ARDL bound test for cointegration is presented as follows:

$$\begin{aligned}\Delta \mathrm{LNEMP}_t &= \beta_0 + \beta_1 \mathrm{LN}EMP_{t-1} + \beta_2\,\mathrm{LN}TA_{t-1} + \beta_3\,\mathrm{LN}MC_{t-1} + \beta_4\,\mathrm{LN}FD_{t-1} + \\ &\beta_5\,\mathrm{LN}\,TR_{t-1} + \sum_{i=1}^{p}\alpha_1\,\Delta\mathrm{LN}EMP_{t-i} + \sum_{i=1}^{p}\alpha_2\,\Delta\mathrm{LN}TA_{t-i} + \sum_{i=1}^{p}\alpha_3\,\Delta\mathrm{LN}MC_{t-i} + \\ &\sum_{i=1}^{p}\alpha_4\,\Delta\mathrm{LN}FD_{t-i} + \sum_{i=1}^{p}\alpha_5\,\Delta\mathrm{LN}TR_{t-i} + \varepsilon_t\end{aligned} \quad (3)$$

Where *p* is the lag length, β_0 is constant and ε_t indicates the white noise error term. While β_1 to β_5 and α_1 is α_5 represented the long- and short-term dynamic, respectively. We investigated the long-run relationship between the series after getting the F-statistic value using the ARDL bound testing equation. The following hypotheses for the model were used to determine the long-run relationship between variables:

H0: $\beta 1 = \beta 2 = \beta 3 = \beta 4 = \beta 5 = 0$ (no cointegration)

H0: $\beta 1 \neq \beta 2 \neq \beta 3 \neq \beta 4 \neq \beta 5 \neq 0$ (cointegration)

We ran the long-run and short-run dynamics if there was cointegration identified among the variables that are H0: β1, β2, β3, β4, β5, β6 $\neq 0$.

The following equations specify the long-run and short-run models of the ARDL specification:

Long run

$$\text{LN}EMP_t = \beta_0 + \sum_{i=1}^{p}\beta_1\ \text{LN}EMP_{t-i} + \sum_{i=1}^{p}\beta_2\ \text{LN}TA_{t-i} + \sum_{i=1}^{p}\beta_3\ \text{LN}MC_{t-i} + \sum_{i=1}^{p}\beta_4\ \text{LN}FD_{t-i} + \sum_{i=1}^{p}\beta_5\ \text{LN}TR_{t-i} + \varepsilon_t \quad (4)$$

Short-run

$$\Delta\text{LN}EMP_t = \alpha_0 + \sum_{i=1}^{p}\alpha_1\ \Delta\text{LNEMP}_{t-i} + \sum_{i=1}^{p}\alpha_2\ \Delta\text{LN}TA_{t-i} + \sum_{i=1}^{p}\alpha_3\ \Delta\text{LN}MC_{t-i} + \sum_{i=1}^{p}\alpha_4\ \Delta\text{LN}FD_{t-i} + \sum_{i=1}^{p}\alpha_5\ \Delta\text{LN}TR_{t-i} + \mu\text{ECM}_{t-1} + \varepsilon_t \quad (5)$$

Where β and α is the long run and short run dynamics coefficient, respectively; while μ is the coefficient of the speed of adjustment and ε_t is the disturbance term.

The asymmetric analysis: NARDL. This paper also employs the NARDL technique developed by Shin, Yu and Greenwood-Nimmo [67] to determine the probable asymmetric association among the variables ignored by the linear ARDL model. The NARDL model, like the ARDL model, has criteria for the integration order of the variables. Thus, the following Shin, Yu and Greenwood-Nimmo [67], Eq 3 can be restated in the following form:

$$\Delta\text{LNEMP}_t = \beta_0 + \beta_1\text{LN}EMP_{t-1} + \beta_2^{+}\text{LN}TA_{t-1} + \beta_3^{-}\text{LN}TA_{t-1} + \beta_4^{+}\ \text{LN}MC_{t-1} + \beta_5^{-}\ \text{LN}MC_{t-1} + \beta_6\ \text{LN}FD_{t-1} + \beta_7\ \text{LN}TR_{t-1} + \sum_{i=1}^{p}\theta_i\ \Delta\text{LN}EMP_{t-i} + \sum_{i=1}^{p}\theta_i^{+}\Delta\text{LN}TA_{t-i} + \sum_{i=1}^{p}\theta_i^{-}\Delta\text{LN}TA_{t-i} + \sum_{i=1}^{p}\theta_i^{+}\Delta\text{LN}MC_{t-i} + \sum_{i=1}^{p}\theta_i^{-}\Delta\text{LN}MC_{t-i} + \sum_{i=1}^{p}\theta_i\Delta\text{LN}FD_{t-i} + \sum_{i=1}^{p}\theta_i\Delta\text{LN}TR_{t-i} + \varepsilon_t \quad (6)$$

From Eq 6, β_i^{+}, β_i^{-} and $[\sum_{i=1}^{p}\theta_i^{+}]$, $[\sum_{i=1}^{p}\theta_i^{-}]$, captures the long- and short-run positive and negative impact of tourist arrival (TA) and market capital (MC) on service sector employment (EMP). Like the ARDL model, the bound test is restored to determine whether the variables are asymmetrically cointegrated or not. Furthermore, the Wald-test is used to assess the long (short-run) asymmetric linkage $\beta = \beta^{+} = \beta^{-}$ $(\theta = \theta^{+} = \theta^{-})$ for both tourist arrival and market capital. The short-run asymmetric association can be provided via the dynamic multiplier effect in the following method, given the validation of the non-linear relationship.

$$D_S^{+} = \sum_{j=0}^{s}\frac{\omega\ LN\ EMP_{i-j}}{\omega\ LN\ TA_{t-i}^{+}},$$

$$D_S^{-} = \sum_{j=0}^{s}\frac{\omega\ LN\ EMP_{i-j}}{\omega\ LN\ TA_{t-i}^{-}},$$

s = 0, 1, 2, 3, ... nothing that $s \to \infty$, $D_S^{+} = \beta_2^{+}$, $D_S^{-} = \beta_3^{-}$,

$$D_S^{+} = \sum_{j=0}^{s}\frac{\omega\ LN\ EMP_{i-j}}{\omega\ LN\ MC_{t-i}^{+}},$$

$$D_S^{-} = \sum_{j=0}^{s}\frac{\omega\ LN\ EMP_{i-j}}{\omega\ LN\ MC_{t-i}^{-}},$$

s = 0, 1, 2, 3, ... nothing that $s \to \infty$, $D_S^{+} = \beta_4^{+}$, $D_S^{-} = \beta_5^{-}$

Results

The study represented the descriptive statistics and correlations of the variables, as shown in Table 2. According to Jarque–Bera statistics, the series of employment, tourism arrivals,

Table 2. Descriptive analysis.

	LNEMP	LNTA	LNMC	LNFD	LNTR
Mean	4.317028	15.46061	27.16119	4.605408	3.693505
Median	4.320151	15.51351	27.37794	4.689457	3.714279
Maximum	4.361569	16.0632	28.04211	4.958803	3.824238
Minimum	4.26465	14.67861	25.62967	4.098294	3.473672
Std. Dev.	0.027998	0.348517	0.788039	0.281508	0.084236
Skewness	-0.20182	-0.30729	-0.45122	-0.43954	-0.89907
Kurtosis	2.097516	2.862972	1.798964	1.7853	3.599484
Jarque-Bera	1.181036	0.479087	2.727051	2.716663	4.341166
Probability	0.55404	0.786987	0.255758	0.257089	0.114111
Sum	125.1938	448.3576	787.6746	133.5568	107.1117
Sum Sq. Dev.	0.021949	3.400997	17.38817	2.218901	0.198682
Observations	29	29	29	29	29

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market capital, financial development, and trade are normally distributed. The low standard deviation values for all variables indicate that the data are spread around the mean rather than widely dispersed, validating the normal distribution results as determined by Jarque–Bera values.

Unit root test

The study exhibited the ADF unit root test to determine the order of integration, whether the study's variables were stationary at the first difference I (1). The result of ADF in Table 3 shows that all the variables were stationary at first difference I (1). Hence, the series of variables is shown to have a valid long-run relationship.

BDS test results

Table 4 illustrates the result of the BDS test for non-linearity. For all levels, P-value is found to be less than 0.05, thus the null hypothesis is rejected, implying that the series are linearly dependent. The results suggest that Australia's employment, tourism arrivals, market capital, financial development, and trade are non-linearly dependent.

Bound testing results

The study employed the ARDL bound test to examine the association between variables. As shown in Table 5, the F-statistics in the bound test is larger than 5% critical value, showing

Table 3. ADF test with structural break: Additive and innovative outliers.

	Augmented Dickey-Fuller test statistic			
Variable	**Level**	**Probability**	**1st difference**	**Probability**
LNEMP	-1.104	0.699	-7.304	0.000***
LNTA	-2.034	0.272	-3.251997	0.028**
LNMC	-1.56965	0.484	-5.70256	0.000***
LNFD	-2.58472	0.108	-2.65109	0.096*
LNTR	-2.55841	0.113	-5.68376	0.000***

Note: ***1% level of significance, ** 5% level of significance and * 10% level of significance.

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Table 4. BDS test results.

Variable	m = 2	m = 3	m = 4	m = 5	m = 6
LNEMP	0.182***	0.316***	0.406***	0.464***	0.502***
LNTA	0.173***	0.287***	0.355***	0.402***	0.450***
LNMC	0.156***	0.276***	0.359***	0.424***	0.469***
LNFD	0.201***	0.338***	0.431***	0.496***	0.547***
LNTR	0.134***	0.206***	0.267***	0.297***	0.298***

Note

***1% level of significance.

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that the null hypothesis of no level relationship is rejected at the significance level. This indicates a cointegration relationship between variables at least at 1% significance level. Therefore, the result allows us to apply the ARDL and NARDL cointegration approaches. The implementation of cointegration across variables allows us to examine the impact of tourist arrival, market capital, financial development and trade on service sector employment in the short and long run.

Long-run results

In the long run ARDL model, outlined in Table 6, it is evident that that tourist arrivals affect service sector employment significantly and positively. With 1% growth in tourist arrivals, employment in the service sector increases by 0.037%. As for an asymmetric TA-EMP linkage, the NARDL model shows that a positive shock in TA (LNTA+) increases employment in the service sector while a negative shock TA (LNTA-) reduces employment. Market capital significantly and negatively affects service sector employment in a symmetric linear model (ARDL); however, in the asymmetric model (NARDL), positive shock in MC ($LNMC^{+}$) can lead to an increase in employability in the long run. In the long run, the symmetric ARDL model both financial development and trade, show a significant positive impact on service sector employment while no significant and negative association is found for financial development and trade, respectively, in the NARDL model.

Short-run results

The short-run linear (ARDL) and non-linear (NARDL) dynamics are presented in Table 7. In the short run, linear (ARDL) dynamics revealed that tourist arrival, market capital, and trade volume exposed a statistically significant positive coefficient of 0.095, 0.005 and 0.041. However, financial development showed a negative coefficient -0.013. As for asymmetric EMP-tourist arrival linkage, while a positive shock in TA ($\Delta LNTA^{+}$) increases employment, a negative shock in tourist arrival decreases employment in the service sector. A positive shock in

Table 5. Bounds test for the nonlinear cointegration.

Series	F-statistics	LCB I (0)	UCB I (1)	Conclusion
ARDL: LNEMP = f (LNTA, lnMC, lnFD, lnTR)	23.950***	3.29	4.37	Cointegrated
NARDL: LNEMP = f ($LNTA^{+}$, $LNTA^{-}$, $lnMC^{+}$, $lnMC^{-}$, lnFD, lnTR)	19.016***	2.88	3.99	Cointegrated

Note

***1% level of significance, LCB = Lower Critical Bound, and UCB = Upper Critical Bound

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Table 6. Long run result of ARDL and NARDL.

Variable	ARDL (linear) Results		NARDL (non-linear) Results	
	Coefficient	T-statistics	Coefficient	T-statistics
C			4.295***	96.124
LNTA	0.037***	172.268	-	-
$LNTA^+$	-	-	0.057***	24.483
$LNTA^-$	-	-	-0.083**	-3.337
LNMC	-0.019***	-388.601	-	-
$LNMC^+$	-	-	0.005**	2.761
$LNMC^-$	-	-	0.006	1.953
LNFD	0.098***	578.139	0.011	1.924
LNTR	0.028**	24.229	-0.024*	-2.574

Note

***1% level of significance

** 5% level of significance and

* 10% level of significance.

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MC can increase service sector employment in the short run; however, no significant association is found if there is any negative shock.

Diagnostic tests

As shown in Table 8, diagnostic tests were used to assess the estimates' reliability. The diagnostic tests using the log transformation of time-series data are shown in the table. The Breusch-Godfrey Lagrange multiplier test found no serial connection, indicating unrelated observations. The Breusch-Pagan-Godfrey heteroscedasticity test demonstrated that the observation had no regression errors. The series was shown to be normally distributed by the Jarque-Bera normality test, and finally, the Ramsey RESET stability test confirmed the model as correctly specified.

Table 7. Short-run results of ARDL and NARDL.

Variable	ARDL (linear) Results		NARDL (non-linear) Results	
	Coefficient	T-statistics	Coefficient	T-statistics
C	5.449***	176.639	12.579**	5.415
ΔLNTA	0.095**	133.997	-	-
$ΔLNTA^+$	-	-	0.168**	5.153
$ΔLNTA^-$	-	-	-0.243**	-2.800
ΔLNMC	0.005**	69.468	-	-
$ΔLNMC^+$	-	-	0.015**	3.077
$ΔLNMC^-$	-	-	0.018	2.061
ΔLNFD	-0.013**	-19.683	0.033	1.629
ΔLNTR	0.041**	52.785	-0.170***	-8.294

Note

***1% level of significance

** 5% level of significance and

* 10% level of significance.

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Table 8. Diagnostic test.

Variable	P-value	Result
Breusch-Godfrey Serial Correlation LM Test	0.3694	No serial correlation
Breusch-Pagan-Godfrey (Hetroscedasticity Test)	0.8576	No evidence of heteroskedasticity
Jarque-Bera (Normality Test)	0.343	Residuals are normally distributed
Ramsey RESET Test (Stability Test)	0.6977	Model is correctly specified

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Stability test

The CUSUM and CUSUM of squares tests on the recursive residuals are used in this paper to assess the consistency of short-run beta coefficients in the ARDL method. The CUSUM test identifies orderly fluctuations in regression coefficients, whereas the CUSUM squares test identifies rapid fluctuations in regression coefficients that may change their stability. Figs 2 and 3 display the CUSUM and CUSUM square test results, indicating that all values were within the critical boundaries at a 5% significant level.

Dynamic multiplier graph

A dynamic multiplier graph for NARDL is presented in Figs 4 and 5 to analyse the adjustment of asymmetry in the existing long-run equilibrium after passing to a new long-run equilibrium due to negative and positive shocks. The asymmetry curves depict a linear mixture of dynamic multipliers resulting from positive and negative shocks of tourist arrival and market capital.

Discussion

The present study aimed to investigate the symmetric and asymmetric relationship of service sector employment with tourist arrival, market capital, financial development, and international trade in Australia. To check the stationarity of the variables, the ADF unit root was implemented. In addition, the ARDL bound testing approach was used to check the symmetric dynamic linkage among the variables, while NARDL bound testing was implemented to investigate the asymmetric dynamic linkages. Tourist arrival, financial development and trade were found to be positively cointegrated; however, market capital showed an inverse association

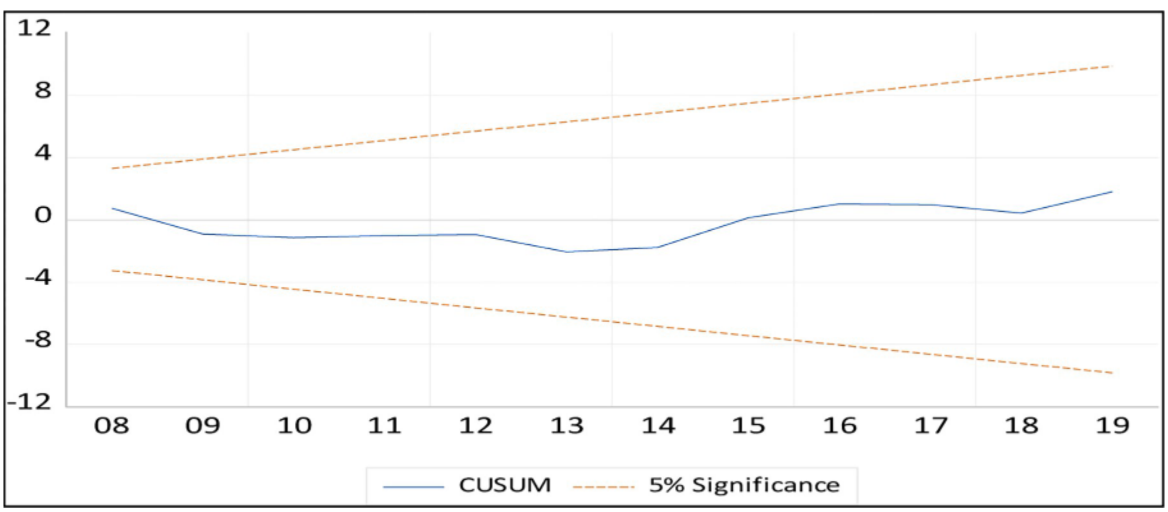

Fig 2. CUSUM test.

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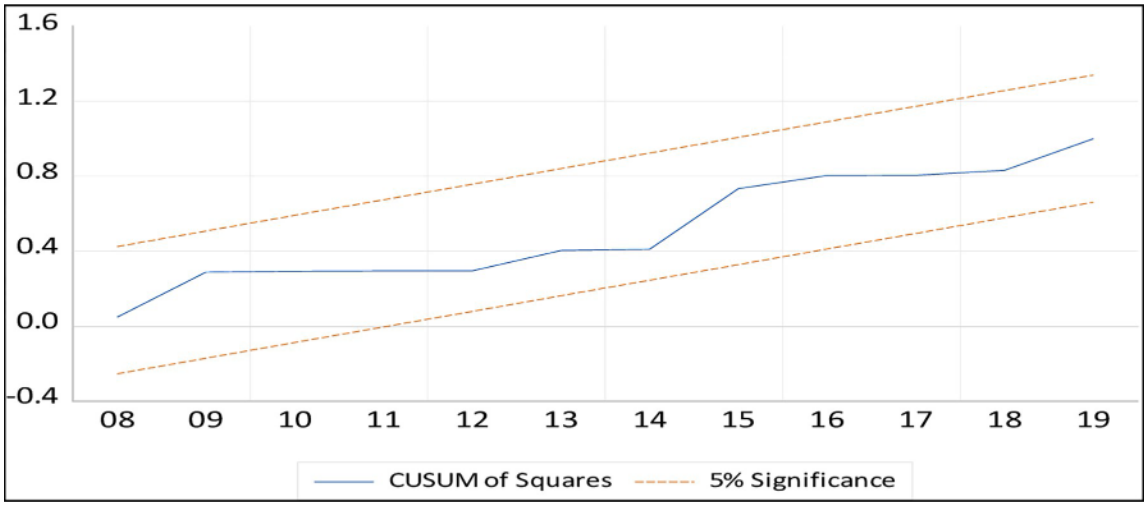

Fig 3. CUSUMQ test.

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with service sector employment in the long run ARDL dynamics. A long run asymmetric NARDL relationship reaffirmed the service sector employment and tourist arrival linkage, while a positive shock in TA increased employment, and a negative shock decreased employment in the service sector. In addition, in the long run NARDL dynamics, trade was found to be negatively cointegrated with employability in the service sector.

This study finds a significant positive short and long-run effect between tourist arrival and service sector employment in Australia. This finding is consistent with similar studies conducted in Pakistan [70], India [71], and Africa [5], in all of which it has been observed that international tourism directly impacts the economy and therefore employment. Tourism is a critical component of the service industry since it contributes to the development of hotels, restaurants, transportation, and other associated services [70]. Thus, tourism contributes to

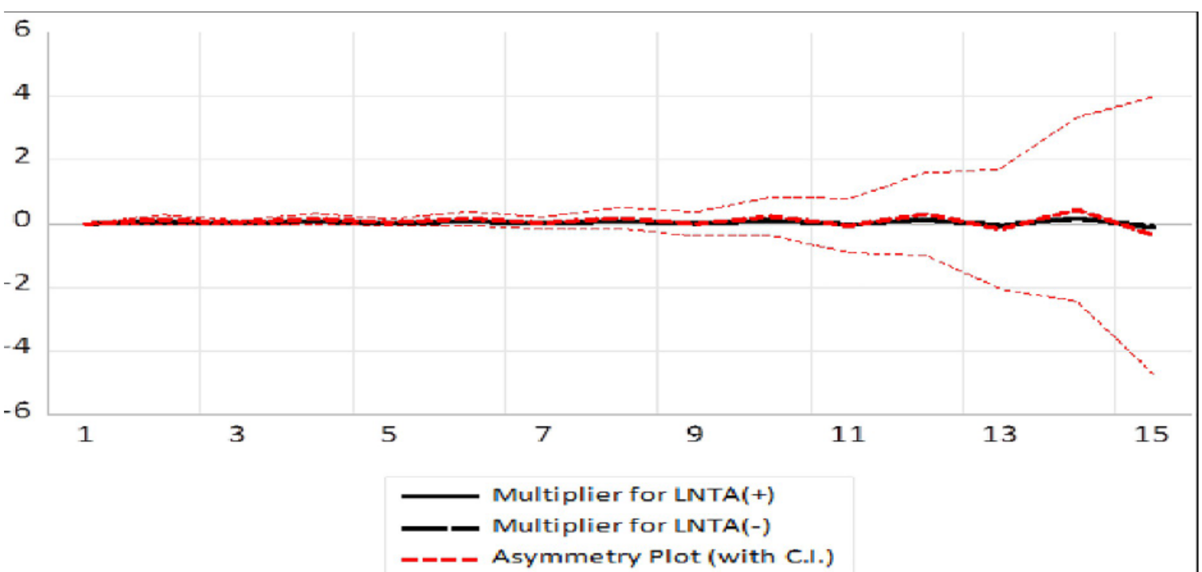

Fig 4. NRDL dynamic multiplier graph for tourist arrivals.

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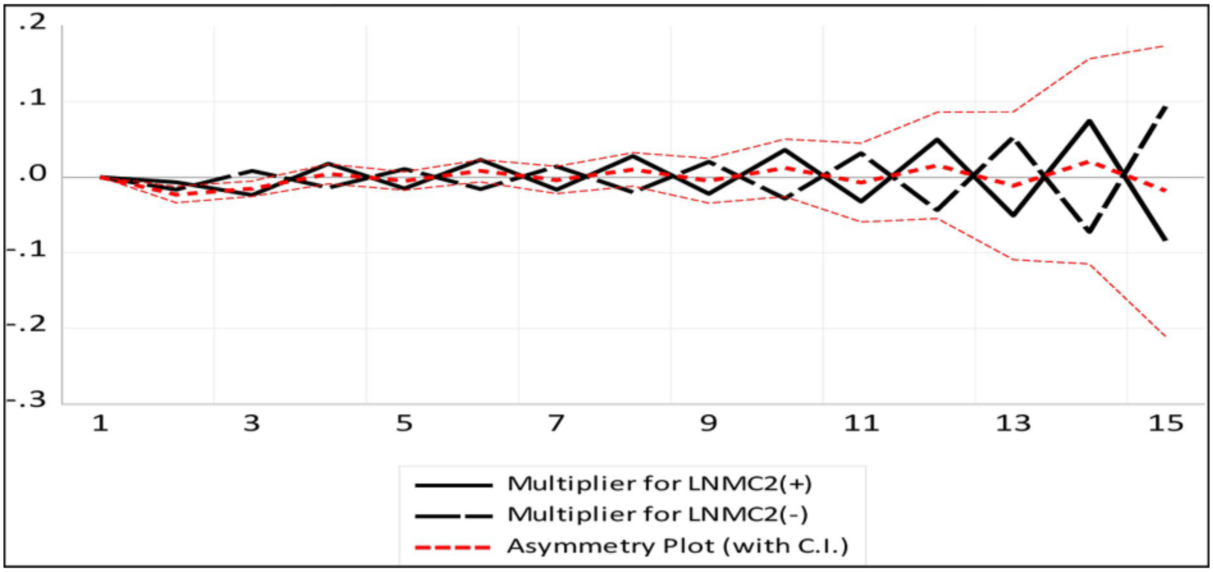

Fig 5. NRDL dynamic multiplier graph for market capital.

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the economy by creating jobs and boosting GDP [71]. Tourism has had a large indirect impact on economic development, contributing to the market, improving human living standards, raising government revenue through income and taxation, and even expanding the production of goods and services in Hong Kong, in addition to its direct benefits [72].

Furthermore, this study explored the relationship between market capital and employability in the service sector and found a negative association in ARDL long-run dynamics. Notably, no existing studies have previously used Australian data; therefore, this is the first study to conclude that tourism affects service sector employment in Australia. However, a study conducted on nine European countries found that a fall in capital stock increased overall unemployment [73]. In some other studies, the relationship between the stock market and economic growth has been analysed. For example, a structured stock market has been found to result in a country's economic growth in the long run, and stock market-based finance is a determinant of economic growth [26, 27]. The possible explanation of the negative relationship between market capital and service sector employment in Australia might be due to the difference in volume of stocks in manufacturing and service-oriented firms. The presence of banking and non-banking financial institutions and telecoms are dominant in various stock exchanges, while the contribution of other service-oriented industries is insignificant. Hence, the rise in market capital is more clearly linked with the entrance of the manufacturing industry in the stock market; thus, employability increase in this sector is more likely.

Financial development was found to affect service sector employment positively in Australia. Although earlier studies in Australia explored the dynamic, positive relationship between financial development and economic growth [45, 74], research focused on financial development impact on service sector employment was limited. It is expected that since financial development affects economic growth, the service sector, which is a part of GDP, will also increase.

The findings of this study, concerning trade, is aligned with the findings of Jansen and Lee [46] and Vandenberg [47] in which a bidirectional impact of trade on employment was found. However, employment in the service sector requires explicitly further investigation. Concerning service sector employment, the case of Australia is somehow similar to the case of China as found by Yu and Meng [50]. Inter-country trade, as found in the case of Germany, does not influence the rise of service sector employment [52], which may remain true for Australia; however, it also requires further investigation.

Conclusion and policy implications

This study examined the symmetric and asymmetric relationships of tourist arrival, market capital, financial development and international trade with Australian service sector employment using annual data from 1991 to 2019. Unlike prior research on Australia, this was among the primary attempts to separately examine the impact of the mentioned variables on service sector employment separately. The linear ARDL results imply that tourist arrival, financial development and trade has a long-term positive effect on service sector employment, whereas market capital negatively affects service sector employment in Australia. However, the NARDL results show that a rise in tourist arrival intensifies service sector employment in the long run, whereas a fall shrinks employability. Further investigations may be conducted to assess the impact of inter-country trade, especially with the countries from Asia and the Pacific countries.

Based on the findings, a few policy recommendations are suggested. The government should plan and initiate tools to ensure consistent tourist arrivals throughout the year to keep service sector employment predictable. Reduction of visa restrictions and/or easing entry requirements may be some initiatives to promote tourist arrivals. In addition, credit towards the service industry, especially in tourism sector, should be supported since domestic credit to private sectors results in higher service sector employment [35]. The national government should also promote service exports to other countries to enjoy a higher level of employment in overall service sector. Proper attention should be given for financial development as it can positively contribute to employment level. The federal government should also ensure the dignity of the indigenous people. For all these measures, both short and long-term plans should be undertaken and executed carefully in Australia.

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Author Contributions

Conceptualization: Avishek Khanal, Mohammad Mafizur Rahman, Rasheda Khanam, Eswaran Velayutham.

Data curation: Avishek Khanal, Eswaran Velayutham.

Formal analysis: Avishek Khanal, Mohammad Mafizur Rahman, Eswaran Velayutham.

Investigation: Avishek Khanal.

Methodology: Avishek Khanal, Eswaran Velayutham.

Project administration: Avishek Khanal.

Resources: Avishek Khanal.

Software: Avishek Khanal.

Supervision: Mohammad Mafizur Rahman, Rasheda Khanam, Eswaran Velayutham.

Validation: Avishek Khanal.

Visualization: Avishek Khanal.

Writing – original draft: Avishek Khanal.

Writing – review & editing: Avishek Khanal, Mohammad Mafizur Rahman, Rasheda Khanam, Eswaran Velayutham.

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3.2 Links and implications

Despite advances in research, there is still insufficient knowledge regarding the employment situation in the service sector, particularly from the viewpoint of Australia, even though this sector has the capacity to affect growth. Thus, the significance of this paper is that it examined the link between the symmetric and asymmetric effects of tourism, market capital, financial development, and trade on service sector employment in Australia. In contrast to earlier studies on Australia, the main efforts to study the effects of the stated variables on employment in the service industry individually.

Through the generation of earnings and job opportunities, as we can see from Chapter 2 and Chapter 3 respectively, tourism helps an economy thrive. However, due to numerous tourist activities like hotel accommodations and transportations, tourism also leads to higher energy usage. Thus, Chapter 4 examines the long-term cointegrating relationship between international tourist arrivals and primary energy consumption in Australia.

CHAPTER 4: ARE TOURISM AND ENERGY CONSUMPTION LINKED? EVIDENCE FROM AUSTRALIA

4.1 Introduction

While Chapter 2 and Chapter 3 examines the positive impact of the tourism industry, this chapter examines the long-term cointegration link between international visitor arrivals and primary energy usage in Australia. Furthermore, the effects of GDP, gross fixed capital creation, financial development, and total population on energy consumption are investigated. The results revealed that tourist arrivals are significant contributor to primary energy consumption and have long-run relationship between them.

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Article

Are Tourism and Energy Consumption Linked? Evidence from Australia

Avishek Khanal *, Mohammad Mafizur Rahman , Rasheda Khanam and Eswaran Velayutham

School of Business, University of Southern Queensland, Toowoomba, QLD 4350, Australia; mafiz.rahman@usq.edu.au (M.M.R.); rasheda.khanam@usq.edu.au (R.K.); Eswaran.Velayutham@usq.edu.au (E.V.)
* Correspondence: Avishek.khanal@usq.edu.au

Abstract: Tourism contributes to the growth of an economy via earning foreign currencies and employment opportunities. However, tourism also contributes to greater energy consumption because of various tourist activities such as hotel accommodations and transportation. This study investigates the long-term cointegrating relationship between international tourist arrivals and primary energy consumption in Australia. In addition, the roles of gross domestic product, gross fixed capital formation, financial development, and total population on energy consumption are also examined. The study covered the last four decades (1976–2018) using data from the Australian Bureau of Statistics, BP Statistical Review, and the World Development Indicators. Augmented Dickey-Fuller, Phillips-Perron, Autoregressive distributed lag (ARDL) bound tests, Johansen and Juselius, Bayer-Hanck cointegration test, and several key diagnostic tests have been conducted to assess the relationship. The estimated results indicate that tourist arrivals, gross domestic product, and financial development have a significant long-run cointegrating relationship with energy consumption. Policy measures are suggested based on the findings of this study.

Keywords: energy consumption; international tourist arrivals; financial development; ARDL; Australia

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1. Introduction

Tourism is regarded among the most prominent of the service sectors and vital global industry. According to the World Travel and Tourism Council [1], in 2019, the tourism industry was responsible for creating 330 million jobs worldwide and contributed US$8.9 trillion to the world's gross domestic product (GDP), representing 10.3% of the global GDP. Tourism helps create jobs, partly due to tourists arrival, generate revenues (e.g., earnings from foreign currencies), and eventually [2] impacts the economic growth of a country, including during the period of economic crisis [3,4] The growth in domestic and international tourist arrivals boosts a country's income while simultaneously leads to the growth in energy consumption, for instance, by increasing tourism activities such as a hotel stay and the use of transportation facilities [5–7]. Among these activities, the transportation sector, especially air transportation, significantly contributes to the increase of energy consumption [7], and therefore emission. Thus, the relationship between tourism and energy consumption is a topic of interest for academic researchers and economic policymakers.

Tourism has a negative environmental impact, as found in the case of Greece [8]. Tourism also has both positive and negative effects on the emissions found in different countries [9]. Moreover, China and Turkey have experienced tourism-led growth, while Spain and Russia have enjoyed growth-led tourism [10]. Change in international trade and the changing pattern of globalization have attracted many researchers to examine the relationship among energy, emission and trade in different regions, globalization and energy source [11], and economic growth and energy consumption [12,13] in different regional settings. The impact of tourism and energy on carbon dioxide (CO_2) emission has also been investigated in G7 countries [8]. Empirical studies to test various theories related to tourism are also available in the literature [14,15]. However, there is limited research about the nexus between tourism and energy consumption from a single developed country perspective. Against this backdrop, this research aims to examine the linkage between tourism in Australia and energy consumption.

Recent literature argues that technological innovation, economic condition, urbanization, regional environmental planning, and industrial structure are a few of the factors impacting the tourism industry [16]. Wilson et al. [17] suggested that unless the entrepreneurs involve themselves directly or indirectly, rural tourism would not be flourished. Focusing on entertainment tourism, Luo et al. [18] identified quality of tourism service, logistic support, advertising and security concerns as the success factor. However, the factors vary according to the new directions of tourism development. Some countries are promoting medical tourism, while some countries or regions attract agricultural or rural tourism [19,20]. However, the impact of tourism on national and regional energy consumption is an underexplored area of study.

From a policy perspective, energy consumption has a significant effect on economic growth, as it is the basis for modern industrial societies. Energy provides facilities for household consumption, resource mining, industrial production, and transportation. Thus, development and economic growth cannot be achieved without a more significant use of energy [21]. However, there are serious environmental consequences to high energy consumption [22,23], including the increased concentration of carbon gases (e.g., carbon dioxide emissions) in the atmosphere, resulting in climate change [24,25]. The natural ecosystems that influence economic activity and human wellbeing are diminishing because of climate change. The significant environmental consequences of energy use have increased atmospheric concentrations of greenhouse gases, such as CO_2. In Australia, greenhouse gas emissions continue to be a major issue in the energy sector, rising from 74% of net emissions in 2011 to 76% in 2015 [26]. Moreover, the country has experienced severe natural disasters in recent times (e.g., bushfires, droughts and floods) [27]. In addition, Australia has seen a massive surge in international tourism and energy consumption over the past three decades (see Table 1).

Table 1. Trend of Tourist Arrivals, Energy Consumption and GDP in Australia.

Year	EC	TA	GDPPC	GFCF	TP	FD
1976	192.80	531,900	27,944.23	64,585,780,433.57	14,033,000	27.89
1980	207.31	904,700	29,907.79	78,679,518,637.01	14,692,000	27.88
1985	205.04	1,142,700	32,045.32	99,241,086,962.29	15,758,000	37.10
1990	224.38	2,214,900	35,912.21	126,738,577,854.89	17,065,100	60.68
1995	233.07	3,725,900	38,095.13	137,948,490,238.46	18,072,000	69.95
2000	248.98	4,931,300	44,334.39	187,230,705,595.27	19,153,000	87.73
2005	250.74	5,463,000	48,813.89	244,248,599,456.41	20,394,800	108.79
2010	248.14	5,871,600	52,022.13	310,545,230,335.59	22,031,750	125.49
2015	243.89	7,449,900	55,079.90	349,074,648,712.05	23,815,995	136.31
2018	240.81	9,245,800	56,864.30	353,055,394,684.73	24,982,688	139.42

Note: Presents data for the selected number of years to avoid a large size table. EC = primary energy consumption in gigajoule per capita; TA = international tourism number of arrivals; GDPPC = GDP per capita (constant 2010 US$); GFCF = gross fixed capital formation (constant 2010 US$); TP = total population; FD = financial development as % of GDP.

Australia welcomed 9.2 million international tourists in 2018, representing more than one-third of the country's population. However, no empirical research has examined the long-run cointegration relationship between international tourist arrivals and energy consumption in Australia. Without understanding the crucial effect of tourism (one of Australia's major economic activities) on energy consumption, it is improbable that the Australian government will devise policies to reduce tourism-related carbon emissions. Consequently, this study's primary objective is to examine the long-run cointegration relationship between tourist arrivals and energy consumption in Australia. The secondary aim is to estimate the effect of tourist arrivals on energy consumption while holding other key variables constant (e.g., economic growth, energy consumption, foreign direct investment, capital, financial development and total population). The findings will help policymakers of both Australia and other countries. Given that the carbon emissions or environmental pollution related to tourism activities depend on the source of energy (e.g., renewable or non-renewable) [5], the outcomes will also indicate whether Australia's tourism industry should take measures to improve energy efficiency and productivity. The findings will also signify whether energy-efficient technologies may be implemented in tourism-related activities to decrease energy consumption. However, it has to be noted that the exact relevance of this research findings would be subject to the presence of COVID-19.

The spread of COVID-19 has impacted the tourism industry substantially globally [28]. A sharp decline in international air traffic, empty sea-beaches, and football matches without spectators are the visible indications. Moreover, mandatory vaccination is not acceptable to all, and inadequate or false information about COVID related rules and regulations also impact the industry [29]. However, after the COVID-19 pandemic, the world is likely to witness a considerable rise in tourism growth, which could help nations recover from economic crises. Hence, a study combining tourism and energy consumption has the potential to address the national development aspects of a country such as Australia and also has the prospect to be used as background information in shaping national policies focusing on the Paris Agreement.

2. Tourism, Energy Consumption, and GDP in Australia

Australia became a popular tourist destination during the 1970s and 1980s. Table 1 presents Australia's number of tourist arrivals, energy consumption and economic growth from 1976 to 2018. During the period, the number of international tourist arrivals increased from 531,900 to 904,700. The original Crocodile Dundee film paved the way for Australia to be included on the tourism map for Americans [30]. The surge in tourism during the 1980s progressed regarding the extent, position and significance of tourism in Australia [31]. Australia's tourism industry experienced growth in the number of tourist arrivals in the 1990s, resulting in tourism being the largest earner of foreign currency during this time [32]. During the 2000 Sydney Olympic Games, the number of arrivals skyrocketed to nearly half a million. This number steadily gained increasing momentum until 2018.

Australia's primary energy consumption shows an upwards trend of per capita energy use from 1976 to 1995, increasing from 192.80 to 233.07 gigajoules of energy consumption. In the 2000s, primary energy consumption abruptly increased to 2535.01 gigajoules per capita. One reason for this increase was the 2000 Sydney Olympics, which directly affected electricity demand and consumption [33]. After 2005, a downwards movement of energy use was seen in Australia. Furthermore, Ryan et al. [34] demonstrated that Australian primary energy consumption has declined since 2008. Improved appliance efficiency and fuel switching are significant causes of such decline in energy use [34]. However, Ryan et al. [34] projected that this decline will continue only until the 2020s and then will increase, as no new regulatory-driven changes will occur to drive further significant energy efficiency improvement.

The trend of economic growth in Australia's economy, as seen in Table 1, shows that per capita GDP was US$27,944.23 and US$29,907.79 in 1976 and 1980, respectively. There was a steady rise in GDP from 1985 to 1995. In 2000, the growth was more than 14% compared with the growth observed in 1995, and GDP reached US$44,334.39 per capita. Each year from 2005 to 2018 also showed an increasing GDP trend in the Australian economy. Figure 1 presents the trend for the log forms of all variables from 1977 to 2018. Logarithms were chosen to obtain a more stable variance [35]. It is clear that the variables displayed no linear trend, and none had an evident seasonality.

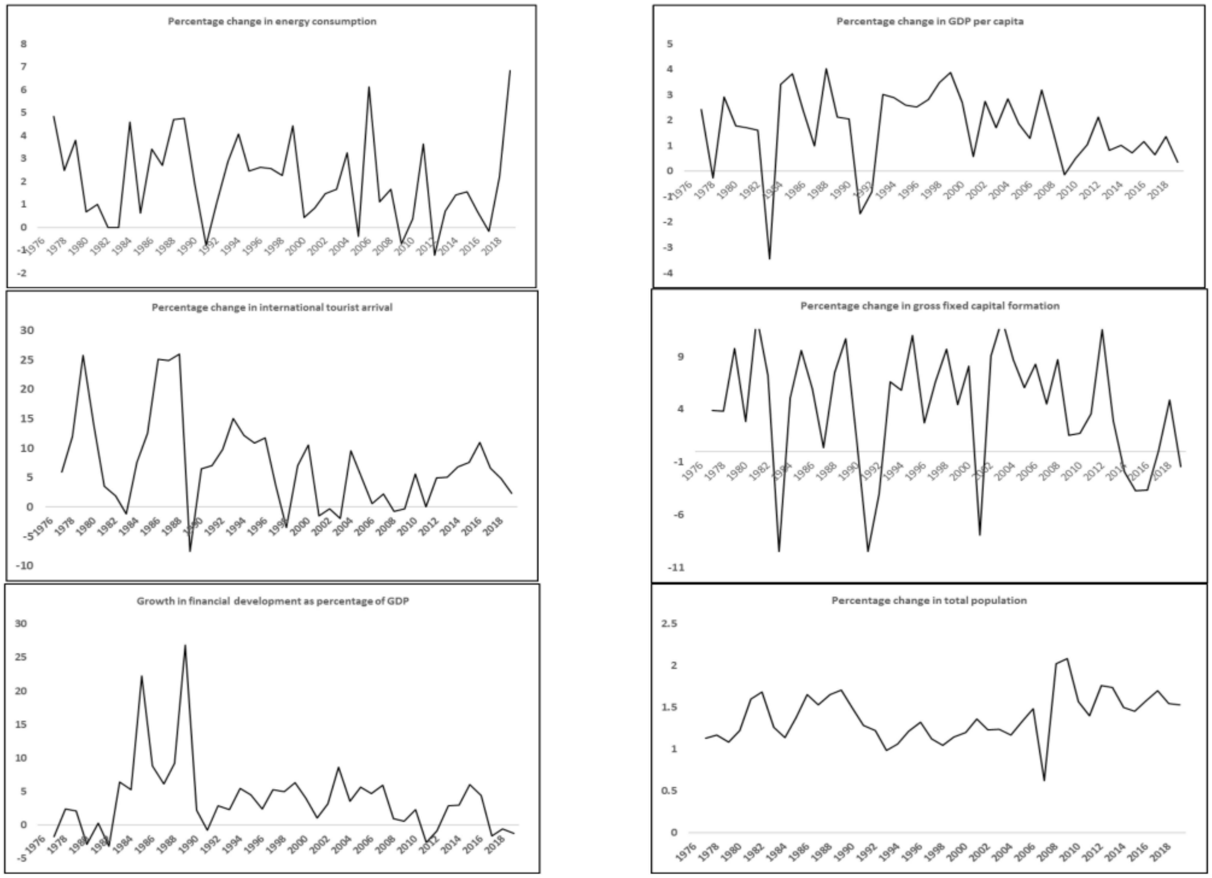

Figure 1. Trend lines for variables of interest.

3. Literature Review

The existing literature on energy economics generally focuses on the link between economic growth, energy, tourism, and carbon emissions [36–46]. The nexus between tourism and energy has been a neglected topic, with a relatively smaller strand of literature studying the relationship between energy consumption and the tourism sector ignoring CO_2 [47–49]. Tourism is considered one of the biggest drivers of economic growth for many countries. Energy consumption creates a crucial connection between tourism and environmental quality, as pollution and greenhouse gas emissions are mainly caused by energy consumption [41]. Zhang et al. [46] explored the effects of international tourism on China's economic growth, energy consumption and carbon emissions using panel data between 1995 and 2011, based on the environmental Kuznets curve (EKC) hypothesis and panel cointegration modeling techniques. Their estimated outcomes indicated that tourism causally affects economic growth and CO_2 emissions in China's eastern, western and central regions.

In the same way, in the Malaysian context, Solarin [50] investigated the determinants of CO_2 emissions, emphasizing tourism development from 1972 and 2010, and found a short-run unidirectional causality running from tourism to energy consumption. These findings were further supported by Alola et al. [51], who found a unidirectional relationship between tourist arrivals and energy consumption in 16 coastline Mediterranean countries between 1995 and 2014. In another research, Katircioglu et al. [39] argued that a 1% change in tourism resulted in a 0.033% change in CO_2, and the effect was more remarkable for energy consumption with a 0.619% change. The study based its analysis on autoregressive distributed lag (ARDL) and the Granger causality test over data of 39 years. It concluded that tourism had a direct and statistically significant effect on energy consumption in the long term and was a catalyst for energy consumption. Katircioglu [40] estimated the relationship between tourism and energy with impulse responses and variance decomposition analyses. The results showed that energy consumption increased by tourism development predominantly in the longer term.

In another study, the feedback hypothesis used by Ben Jebli et al. [37] supported that there was a short-run Granger causality between development of the economic sectors of touristic zones and energy consumption. The vector error correction model (VECM) results showed a unidirectional long-run causality from energy use to international tourism. A short-run Granger showed a bidirectional causality between them. Tang et al. [52] explored the dynamic causal and inter-relationships among India's tourism, economic growth, and energy consumption using data from 1971 to 2012. They used the bounds testing approach to cointegration and the Gregory–Hansen test for cointegration with a structural break. The result revealed that economic growth and tourism together explained most of the forecast error variance in energy consumption. However, energy consumption only explained less than 9% of the economic growth and tourism variations. Thus, in the long run, tourism and economic growth strongly affected energy consumption. Ali et al. [53] conducted a study with 19 Asia Cooperation Dialogue member countries using data from 1995 to 2015. They demonstrated that the existence of a feedback hypothesis between renewable energy consumption and tourism for higher-income countries implied that these variables significantly affected each other.

However, using ARDL and Granger causality tests for a developing country, Nepal et al. [43] conducted a study to explore the short-run and long-run relationship between tourist arrivals, per capita economic output, emissions, energy consumption and capital formation in Nepal. Interestingly, they found a unidirectional causality between primary energy consumption and the number of tourist arrivals, where a 1% increase in energy consumption decreased tourist arrivals by 3.84%. This demonstrated that energy consumption negatively affected tourist arrivals because of firewood consumption and lessening dependence on fossil fuels in Nepal in particular and the developing countries in general. Similarly, no causality was found between tourist arrivals and energy consumption in the European Union and the candidate countries [5]. Furthermore, in another panel study, Naradda Gamage et al. [42] examined whether energy consumption and tourism supported the EKC hypothesis. Their investigation revealed that tourism development was not a threat to environmental quality in Sri Lanka in the long run.

In recent years, there has been considerable interest in examining the relationship between tourism and energy consumption. Gokmenoglu et al. [49] investigated the role of international tourism on Turkey's energy consumption with data spanning 55 years (1960 to 2015). Using Hacker and Hatemi-J's bootstrap corrected causality results, the key findings indicated unidirectional causality from tourist arrivals to energy consumption. They concluded that international tourism was a significant contributor to energy consumption in Turkey. Similarly, Amin et al. [47] examined the tourism–energy nexus for selected South Asian countries using data from 1995 to 2015. The results indicated unidirectional causality running from tourist arrivals to energy consumption in the long run. Selvanathan et al. [44] too investigated the inter-relationships between tourism, energy consumption, carbon emissions and GDP for South Asian countries. The research applied panel ARDL and VECM frameworks with data from 1990 to 2014 and concluded that tourism positively affected energy consumption in Bangladesh, India, Nepal and Pakistan. However, with increased energy consumption because of tourism development activities in South Asia, there are significant risks for environmental quality through increased CO_2 emissions. Ali et al. [36] inspected the effect of tourist arrivals, structural change, economic growth and energy use on carbon emissions in Pakistan using data from 1981 to 2017. This study employed ARDL, Bayer and Hanck, VECM and the Granger causality test to conclude that increasing tourist arrivals caused a 0.06% increase in CO_2 emissions in the long run. The authors also suggested that tourist arrivals pollute the environment by consuming energy in transportation, accommodation and shopping. A recent study conducted by Shi et al. [54] deduced that over the long term, for upper-middle-income countries, one-way causality ran from tourists' expenditure per capita and the net inflow of international tourism to primary energy consumption. For the high-income countries panel, unidirectional short-run causality ran from primary energy consumption to inbound tourists' expenditure per capita. Thus, the results showed that the effects of tourism on energy consumption varied because of income differences in the countries concerned. The paper included the carbon emissions nexus while measuring tourism's impact on energy consumption. However, a limited number of studies examined the relationship between tourism and energy consumption without carbon emissions. Isik et al. [50] explored the nexus between tourism development, renewable energy consumption and economic growth using panel data from 1995 to 2012. This study used a Lagrange multiplier, panel cointegration test and Emirmahmutoglu-Kose bootstrap Granger causality test. They identified four main results: (i) tourism-led energy was seen in Italy, Spain, Turkey and the United States; (ii) energy-led tourism was seen in China; (iii) two-way causality was seen in a panel of T7 most-visited countries; and (iv) no causality was seen in France and Germany.

Additionally, GDP—usually a proxy for economic growth and energy consumption—is co-dependent with energy use—that is, an increase in energy use causes economic growth to increase, and vice versa [55–59]. Likewise, gross fixed capital formation [60] and financial development [61,62] stimulate energy consumption. An increase in population also increases energy use [63]. There are limited studies on the tourism and energy consumption relationship in the literature, and no empirical evidence exists for Australia. Moreover, there is no cointegration tests for Australia in the literature using large-scale country-specific time-series data regarding the relationship between tourist arrivals, economic growth, energy consumption, capital, financial development and total population. Finally, only limited research has used total population as a control variable to investigate the relationship between tourism and energy consumption. Therefore, this study aimed to fill the omitted variable bias gap. Accordingly, additional variables have been chosen since energy consumption is struck by the volume of national business and agricultural and industrial activities, which in turn impact capital and financial development.

4. Materials and Methods

4.1. Data

The main objective of this study was to investigate the long-run and short-run effects of international tourist arrivals on energy consumption in the Australian context. This study employed annual time-series data for the duration from 1976 to 2018. Data on international tourist arrivals were gathered from the Australian Bureau of Statistics [64], while the other data were collected from the World Development Indicator [65] and BP Statistical Review [66]. Table 2 presents variable descriptions and data sources.

Table 2. Variable Description and Data Sources.

Symbol	Variable	Definition	Source
EC	Energy consumption	Primary energy consumption	BP Statistical Review
TA	Tourist arrivals	International tourism, number of arrivals; number of movements; short-term visitors arriving	ABS
GDP	GDP per capita	GDP per capita (constant 2010 US$)	WDI
CAP	Gross fixed capital formation	Gross fixed capital formation (constant 2010 US$)	WDI
TP	Total population	Total population based on de facto definition of population with mid-year estimates	WDI
FD	Financial development	Domestic credit to private sector (% of GDP)	WDI

4.2. Econometric Methods

This study built its framework following the study of Amin et al. [47], who investigated the tourism (TA) and energy (EC) nexus with economic growth (GDP) in selected South Asian countries. In addition, this study included capital formation, total population and financial development to avoid omitted variable bias. Gokmenoglu et al. [49] emphasized the importance of population in determining energy use. Omri et al. [67] empirically investigated the relationship between capital formation and FD, and found that capital and FD have a positive and significant effect on EC. The following empirical model was used to test the link between international tourist arrivals and energy consumption in Australia:

$$LNEC_t = \beta_0 + \beta_1\ LNTA_t + \beta_2\ LNGDP_t + \beta_3\ LNCAP_t + \beta_4\ LNTP_t + \beta_5\ LNFD_t + \varepsilon_t \quad (1)$$

where LN is the log form, t indicates time, ε_t denotes the error terms, EC is per capita energy consumption, TA is the number of international tourist arrivals, GDP is per capita GDP, CAP is gross fixed capital formation, TP is total population and FD is financial development as a percentage of total GDP. The initial expectation was that all these variables would positively affect energy consumption. To stabilize the variance of the series, this study used the logarithmic forms of the variable of interest [68].

4.3. Unit Root Test

The stationarity of time-series data is critical, as the causality test outcomes rely on the stationarity of the data and, often, the macroeconomic variables contain a unit root. According to Lütkepohl et al. [35], a stochastic process is termed stationary if it has time-invariant first and second moments. In other words, statistical properties remain constant. In this analysis, the unit root test was based on both the augmented Dickey-Fuller (ADF; [69,70]) and Phillips-Perron (PP; [71]) tests.

If the first difference of a variable is stationary, it is considered to be integrated of order I (1) [70,71]. The following auxiliary equation was used from Lütkepohl et al. [35]:

$$\Delta y_t = \mu + \propto_i y_{t-1} + \sum\nolimits_{i=1}^{k} \pi_i \Delta y_{t-i} + \varepsilon_t \quad (2)$$

where $_{it}$ is the relevant time-series variable, t indicates the linear deterministic trend, Δ is the first difference operator, $\propto_i$ is the parameter of interest, k is the maximum lag order and ε_t is the error term. If $|\propto_i| < 1$, the series is trend stationery; conversely, when $|\propto_i| \geqslant 1$, the series has the unit root and is thus not stationary [72]. For further details on the time-series unit root test, see Hamilton [73] and Lütkepohl et al. [35]. The PP model tests equations as given below:

$$\Delta y_t = \pi y_{t-1} + \beta_i D_{t-i} + \varepsilon_t \quad (3)$$

where ε_t is a I (0) with zero mean and D_{t-i} is a deterministic trend component.

4.4. Cointegration Analysis

A further phase of the analysis was to examine the cointegration among the variables. We checked the existence of the long-run relationship among the variables using three different cointegration techniques: ARDL bound, Johansen cointegration and Bayer-Hanck cointegration tests.

4.5. Bound Testing Technique

This study used the ARDL bound test technique to examine the cointegration between Australia's energy consumption and other explanatory variables. The ARDL bound test developed by Pesaran et al. [74] provides two asymptotic critical value bounds when the independent variables are either I (0) or I (1). It is assumed that the *F*-statistic value exceeds the upper critical bound—that is, I (1)—so it can be concluded that there is cointegration between the variables, and a long-run relationship among the variables exists. The ARDL model for the estimations was as follows:

$$\begin{aligned}\Delta LNEC_t = \ & \beta_0 + \beta_1 LNEC_{t-1} + \beta_2 LNTA_{t-1} + \beta_3 LNGDP_{t-1} + \beta_4 LNCAP_{t-1} \\ & + \beta_5 LNTP_{t-1} + \beta_6 LNFD_{t-1} + \sum_{i=1}^{p} \alpha_1 \Delta LNEC_{t-i} \\ & + \sum_{i=1}^{p} \alpha_2 \Delta LNTA_{t-i} + \sum_{i=1}^{p} \alpha_3 \Delta LNGDP_{t-i} \\ & + \sum_{i=1}^{p} \alpha_4 \Delta LNCAP_{t-i} + \sum_{i=1}^{p} \alpha_5 \Delta LNTP_{t-i} \\ & + \sum_{i=1}^{p} \alpha_6 \Delta LNFD_{t-i} + \varepsilon_t \end{aligned} \quad (4)$$

where β_0 is constant and ε_t is the white noise error term. After obtaining the F-statistic value by the ARDL bound testing equation, we investigated the long-run relationship among the series. The long-run relationship that exists between variables was based on the following hypotheses for the model:

Hypothesis 1 (H1). $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$ *(no cointegration).*

Hypothesis 2 (H2). $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq 0$ *(cointegration).*

If there was cointegration identified among the variables—that is, H_0: $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6 \neq 0$—then we ran the long-run and the short-run dynamics.

4.6. Johansen-Juselius Cointegration Testing Approach

The second approach of the cointegration test was Johansen et al.'s [75] cointegration method, which also estimates the long-run relationship among the series. The Johansen and Juselius cointegration technique is based on Trace statistics (λ_{trace}) and maximum eigenvalue (λ_{max}) statistics. Trace statistics examine the null hypothesis of r cointegrating relations against the alternative of N cointegrating relations and is computed as:

$$\lambda_{trace} = -N \sum_{i=r+1}^{n} \log(1 - \lambda_i) \quad (5)$$

where N is the number of observations and λ is the ordered eigenvalue of matrices. The maximum eigenvalue statistic tests the null hypothesis of r cointegrating relations against the following:

$$\lambda_{max} = -N \log(1 - \lambda_r + 1) \quad (6)$$

where N is the number of observations and λ is the ordered eigenvalue of matrices.

4.7. Bayer-Hanck Cointegration Testing Approach

Bayer et al.'s [76] test is one of the most recently advanced cointegration tests and combines various test statistics, such as those by Engle et al. [77], Johansen [78] and Banerjee et al. [79]. The current study also used the Bayer and Hanck (BH) cointegration test to assess possible cointegration between the variables. Bayer et al. [76] proposed combining the computed significance level (*p*-value) of the individual cointegration test with the following formulas:

$$EG \text{ “}-\text{” } JOH = -2[\log(pEG) + (pJOH)] \quad (7)$$

$$EG\text{-}JOH\text{-}BO\text{-}BDM = -2[\log((pEG) + (pJOH)] + (pBO) + (pBDM)] \quad (8)$$

where pEG, pJOH, pBO and pBDM are the *p*-values of the cointegration tests of Engle et al. [77], Johansen [78], Boswijk [80] and Banerjee et al. [79], respectively. According to Bayer and Hanck [76], if the calculated Fisher statistics are greater than the critical values, the null hypothesis of no cointegration can be rejected.

4.8. Lag Length Selection

We employed Akaike information criterion (AIC) lag order selection, indicating the best selection model. The AIC criteria for lag length selection were suitable for the nature of this study [81].

4.9. Autoregressive Distributed Lag Long-Run and Short-Run Dynamics

The next econometric step of this study was the estimation of the long-run and short-run relationships between the variables. Initially, the series cointegration among variables was tested using a bound testing approach. If even one cointegration was identified, the ARDL model was estimated to obtain long-run relationship and short-run dynamics results among the variables of a single model. The ARDL long and short-run is viewed as the most appropriate methodology in the case of stationarity [82]. The ARDL model has several advantages. First, it is suitable for studies where the variables are stationary at level or first differences or a combination of both. Second, the ARDL model is best as it can be used to measure both long- and short-run coefficients simultaneously [83]. Third, this method is simple to approach because of its single equation set-up. Fourth, ARDL [84] provides the long-run relationship and long-run parameters with unbiased estimation [85]. The reliability of the test depends on factors that the variables should be integrated at order one [I (1)], and selection of lag length using AIC. The long-run and short-run models of ARDL specification in the following equations:

Long run:

$$\begin{aligned} LNEC_t = {} & \beta_0 + \sum_{i=1}^{p} \beta_1 LNEC_{t-i} + \sum_{i=1}^{p} \beta_2 LNTA_{t-i} + \sum_{i=1}^{p} \beta_3 LNGDP_{t-i} \\ & + \sum_{i=1}^{p} \beta_4 LNCAP_{t-i} + \sum_{i=1}^{p} \beta_5 LNTP_{t-i} + \sum_{i=1}^{p} \beta_6 LNFD_{t-i} + \varepsilon_t \end{aligned} \tag{9}$$

Short run:

$$\begin{aligned} \Delta LNEC_t = {} & \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta LNEC_{t-i} + \sum_{i=1}^{p} \alpha_2 \Delta LNTA_{t-i} + \sum_{i=1}^{p} \alpha_3 \Delta LNGDP_{t-i} \\ & + \sum_{i=1}^{p} \alpha_4 \Delta LNCAP_{t-i} + \sum_{i=1}^{p} \alpha_5 \Delta LNTP_{t-i} \\ & + \sum_{i=1}^{p} \alpha_6 \Delta LNFD_{t-i} + \mu ECM_{t-1} + \varepsilon_t \end{aligned} \tag{10}$$

where β is the long-run dynamic coefficient; α is the short-run dynamic coefficient; μ is the coefficient of the speed of adjustment, which is expected to have a negative sign; Δ denotes the difference operator; LNEC, LNTA, LNGDP, LNCAP, LNTP and LNFD are the log values of energy consumption, tourist arrivals, GDP, gross fixed capital formation, total population and financial development, respectively; and ε_t is the disturbance term.

5. Results

Table 3 shows the variable descriptive statistics, where the findings reveal that the variables have a normal distribution. This study also found that all variables reflected minimal deviation from the mean.

Table 3. Descriptive Statistics.

	LNEC	LNTA	LNGDP	LNCAP	LNTP	LNFD
Mean	5.440	14.902	10.609	25.815	16.736	4.228
Median	5.476	15.243	10.600	25.741	16.734	4.324
Maximum	5.566	16.040	10.948	26.635	17.034	4.959
Minimum	5.262	13.184	10.238	24.891	16.457	3.299
Std dev.	0.089	0.837	0.234	0.556	0.169	0.578
Skewness	−0.386	−0.644	−0.050	0.062	0.052	−0.423
Kurtosis	1.742	2.109	1.554	1.670	1.907	1.763
Jarque-Bera	3.901	4.396	3.765	3.199	2.160	4.021
Probability	0.142	0.111	0.152	0.202	0.340	0.134
Sum	233.929	640.783	456.199	1110.036	719.628	181.814
Sum sq. dev.	0.330	29.401	2.299	12.999	1.199	14.040
Observations	43	43	43	43	43	43

5.1. Analysis of Unit Root Tests

The time-series properties were examined using ADF and PP test statistics. Table 4 presents the stationarity test results of energy consumption (EC), tourist arrivals (TA), GDP (GDP), gross fixed capital formation (CAP), total population (TP) and financial development (FD) in level and first differences. The unit root tests results indicated the data were stationary in first difference and not in the level.

Table 4. Unit Root Analysis.

	ADF Test Statistic		PP Test Statistic	
	Level	First Difference	Level	First Difference
LNEC	−2.245	−6.033 ***	−2.245	−6.033 ***
LNTA	−2.702	−3.982 ***	−2.589	−3.865 ***
LNGDP	−0.732	−5.612 ***	−0.730	−5.574 ***
LNCAP	−0.981	−5.274 ***	−1.008	−5.181 ***
LNTP	1.109	−4.212 ***	1.437	−4.097 ***
LNFD	−1.123	−4.565 ***	−1.027	−4.532 ***

Note: *** denote 1% levels of significance.

5.2. Lag Length Selection Criteria

In the ARDL approach, the optimal lag length selection is crucial. Table 5 displays the lag length selection criteria for vector autoregression lag order. Results from the AIC and Hannan-Quinn (HQ) information criterion suggested that lag 4 was the appropriate lag for the analysis.

Table 5. Lag Length Selection Criteria for Vector Autoregression Lag Order.

Lag	LL	LR	FPE	AIC	SC	HQ
0	331.004	–	2.3×10^{-15}	−16.669	−16.411	−16.575
1	645.683	629.36	1.5×10^{-21}	−30.958	−29.166 *	−30.315
2	682.745	74.124	1.6×10^{-21}	−31.0126	−27.686	−29.819
3	732.512	99.534	1.2×10^{-21}	−31.719	−26.856	−29.974
4	812.786	160.55 *	2.9×10^{-22} *	−33.989 *	−27.591	−31.693 *

Note: * indicates lag order selected by criterion; LL = likelihood; LR = likelihood ratio; FPE = final prediction error; SC = Schwarz information criterion, HQ = HQ information criterion.

5.3. Analysis of Cointegration Tests

After the unit root test, we further checked the existence of the long-run relationship among the variables using three different cointegration techniques: ARDL bound tests, Johansen cointegration and BH cointegration test.

5.3.1. Bound Testing Technique

To examine the long-run nexus between variables, we employed the ARDL bounds test. The cointegration results are presented in Table 6. As seen from the table, the *F*-statistic value (i.e., 11.013) for the given model [LNEC = f (LNTA, LNGDP, LNCAP, LNTP, LNFD)] was broadly higher than all upper bound I (1) critical values at 1%, 5% and 10%. Thus, it could be concluded that a long-run relationship existed among the variables.

Table 6. Results of ARDL Bounds Test for Cointegration.

LNEC = f (LNTA, LNGDP, LNCAP, LNTP, LNFD)			
F-Statistic	**11.013 *****		
Critical values	1%	5%	10%
Lower bound I (0)	3.060	2.390	2.080
Upper bound I (1)	4.150	3.380	3.000

Note: *** indicates statistical significance at the 1% level. Critical values were obtained from Pesaran et al. (2001). Critical values were for the case of an unrestricted intercept and no trend.

5.3.2. Johansen-Juselius Cointegration Test

After ARDL bound testing for cointegration, we further checked for cointegration using the JJ test [75] to determine whether it showed that any combinations of the variables were cointegrated. The results are presented in Table 7.

Table 7. JJ Cointegration Test.

Rank	Trace Statistic	5% Critical Value	Max-Eigen Statistic	5% Critical Value
0	117.412	94.15	52.996	39.37
1	64.416 *	68.52	28.091	33.46
2	36.324	47.21	19.842	27.07
3	16.482	29.68	7.458	20.97
4	9.024	15.41	6.058	14.07
5	2.9665	3.76	2.967	3.76

Note: * shows the number of cointegration on 5% critical value.

Here, the trace statistics were less than the 5% critical value; thus, we accepted the null hypothesis, meaning that there was one cointegration in both the trace and max-eigen statistic, and this guided a substantial long-run relationship among the series of variables. JJ cointegration has a null hypothesis that if the trace and max value is greater than the 5% critical value, we reject the null hypothesis of no cointegration. The results from the JJ cointegration test revealed a minimum of one cointegration among the variables.

5.3.3. Bayer-Hanck Cointegration Test

The third approach of cointegration test for this study was the BH cointegration test. To enhance the power of cointegration, the newly developed cointegration test suggested by Bayer and Hanck [76] was used to check the presence of cointegrating relationships among the variables suggested by Shahbaz et al. [85].

The results of the BH test (Table 8) of combined cointegration showed that the calculated test statistic values of EG-J and EG-J-BG-BO of 55.376 and 115.298 were higher than the 5% critical value (i.e., 10.419 and 19.888), respectively. Hence, we rejected the null hypothesis of no cointegration. Thus, from the ARDL bound, JJ and BH cointegration tests, the results revealed the presence of a long-run relationship between the study variables.

Table 8. BH Cointegration Test.

Model Specification	Fisher Type Test Statistics				Cointegration Decision
	EG-J	5% Critical Value	EG-J-BG-Bo	5% Critical Value	
LNEC = f (LNTA, LNGDP, LNCAP, LNTP, LNFD)	55.376	10.419	115.298	19.888	Cointegrated

5.4. ARDL Long-Run and Short-Run Dynamics

After confirming the existence of the long-run relationship between variables, we used the ARDL approach to obtain the long-run and short-run dynamics between the variables. The optimal lag selected from the AIC selection criteria was 1 2 1 1 2 2. The long-run ARDL cointegrating model results revealed that tourism, GDP and financial development positively and statistically significantly affected energy consumption at a 1% critical level. The results (Table 9) showed that a 1% increase in tourist arrivals boosted energy use by 0.062%. Similarly, economic growth and financial development increased energy consumption by 0.569% and 0.09%, respectively. However, the results confirmed that the total population had a negative effect on per capita primary energy consumption, with a 1% increase in the former leading to a 1.063% decrease in the latter. The capital formation did not significantly affect energy use—a 1% increase in capital increased energy use by 0.033%.

Table 9. Long-run ARDL Cointegrating Model (1 2 1 1 2 2).

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
C	20.727	3.332	6.22 ***	0.000
LNTA	0.062	0.012	5.08 ***	0.000
LNGDP	0.569	0.079	7.20 ***	0.000
LNCAP	0.033	0.028	1.18	0.249
LNTP	−1.063	0.062	−17.04 ***	0.000
LNFD	0.094	0.021	4.55 ***	0.000

Note: *** indicate statistical significance at 1% level of significance. Maximum lag used was four. Optimal lag structure was chosen by AIC.

In the short run, the results, as shown in Table 10, were different to the long-run case. The ARDL cointegrating short-term error correction model revealed that all independent variables negatively affected per capita energy consumption in Australia. Notably, the error correction model (ECM) was negative and statistically significant at a 1% critical level, suggesting that about 1.377% (speed of adjustment) would be corrected caused by the previous year's shock in the current year.

Table 10. ARDL Cointegrating Short-term Error correction Model.

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
ΔLNTA	−0.103	0.034	−3.05	0.005 ***
ΔLNGDP	−0.053	0.246	−0.05	0.963
ΔLNCAP	−0.031	0.056	−0.56	0.582
ΔLNTP	−1.439	0.824	−1.75	0.092 *
ΔLNFD	−0.109	0.046	−2.37	0.026 **
ECM (−1)	−1.377	0.206	−6.70	0.000 ***

Note: *, ** and *** indicate statistical significance at 10%, 5% and 1%, respectively. Maximum lag used was four. Optimal lag structure was chosen by AIC.

5.5. Diagnostics Tests

The reliability of the estimates was examined using diagnostic tests, displayed in Table 11. The table shows the diagnostic tests conducted with the log transformation of time-series data. The Durbin-Watson test and Breusch-Godfrey Lagrange multiplier test indicated no serial correlation, meaning the observations were independent of one another. The Jarque-Bera normality test revealed the series to be normally distributed, and the Breusch-Pagan-Godfrey heteroscedasticity test showed that the observation had no errors in regression. Thus, the model did not suffer from any misspecification.

Table 11. Diagnostics Tests.

***R* Squared**	**0.991**
Adjusted *R* squared	0.987
F-statistics	281.021 (0.000)
Durbin-Watson test	2.103
Breusch-Godfrey serial correlation Lagrange multiplier test	0.124 (0.884)
Jarque-Bera normality test	0.628 (0.731)
Breusch-Pagan-Godfrey heteroscedasticity test	0.448 (0.920)

5.6. Cumulative Sum Test

To predict the presence of a stable long-term relationship, we applied the cumulative sum (CUSUM) test developed by Brown et al. [86]. The regression coefficients and residuals were observed using the CUSUM test and cumulative sum of squares (CUSUMSQ). Here, the plots of coefficients (Figure 2.) of the regression were well inside the critical bounds of 5% significance, and no line crossed the critical bound throughout. Thus, the coefficients were stable.

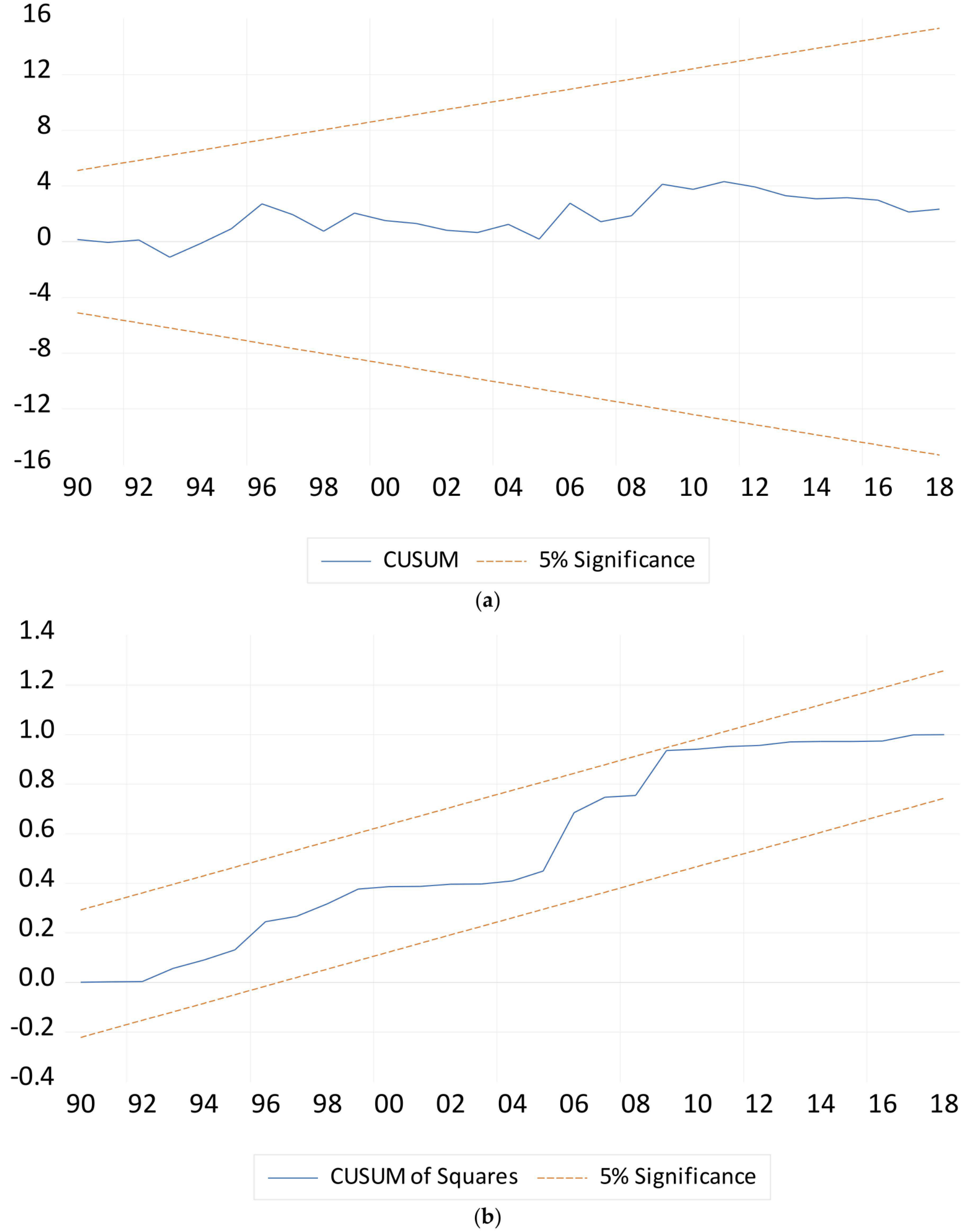

Figure 2. (**a**) Plot of CUSUM of recursive residuals. (**b**) Plot of cumulative sum of recursive squares (CUSUMSQ).

5.7. Robust Analysis

We also checked the robustness using fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS). The results of FMOLS and DOLS are displayed in Tables 12 and 13, respectively. Both results revealed that tourist arrivals, GDP and *FD* had a positive and significant effect on energy consumption. In addition, the total population from both results had a negative impact on energy use in Australia, consistent with the ARDL model.

Table 12. Results of FMOLS.

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
C	15.516	0.625	24.821 ***	0.000
LNTA	0.087	0.010	8.662 ***	0.000
LNGDP	0.699	0.072	9.654 ***	0.000
LNGFCF	0.012	0.024	0.500	0.620
LNTP	−1.156	0.057	−20.117 ***	0.000
LNFD	0.058	0.018	3.132 ***	0.003

Note: *** indicate statistical significance at 1%

Table 13. Results of DOLS.

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
C	15.188	0.886	17.133 ***	0.000
LNTA	0.045	0.016	2.742 **	0.013
LNGDP	0.519	0.077	6.742 ***	0.000
LNGFCF	0.065	0.037	1.738 *	0.098
LNTP	−1.076	0.095	−11.266 ***	0.000
LNFD	0.111	0.023	4.924 ***	0.000

Note: *, ** and *** indicate statistical significance at 10%, 5% and 1%, respectively.

6. Discussion

The number of tourist arrivals, economic growth, and primary energy in Australia has increased many times over the last five decades (Table 1). For example, the number of tourist arrivals during 2018 was 17 times greater than that in 1976, and GDP per capita doubled during the same period. Furthermore, per capita energy consumption surged by 25%. Although this study's primary variable of interest was the number of tourist arrivals, this study also included other key control variables that affect energy consumption levels based on the existing literature. The study investigated whether tourist arrivals have a long-run cointegrating relationship with per capita energy consumption. Furthermore, this study conducted several diagnostic tests to estimate the model's validity, along with the cointegration test. Subsequently, this study also employed FMOLS and DOLS regression further to analyse the relationship between the variables of interest. According to the diagnostic tests, the time-series data (log form of variables) did not have heteroscedasticity or serial correlation problems. The residual of the model was normally distributed, and the model passed the stability test. The ADF and PP unit root tests indicated that the variables had unit roots at the level and were stationary on their first difference. As reported in Table 4, the null hypothesis of no unit root could not be rejected at levels for all variables in the ADF test using both trend and no trend intercept options.

This study conducted multivariate cointegration tests. The multivariate cointegration test included a log of energy consumption as the dependent variable and all other variables as the explanatory variables. Given that the estimated variables of this study had a common stochastic trend (stationary at the same level), it was possible that they were cointegrated [87]. The multivariate cointegration test demonstrated at least one cointegrating relationship among the variables using the JJ test. To further explore the long-run association, ARDL bound tests, and BH cointegration tests were employed. The results indicated that tourist arrivals have a long-run cointegrating relationship with per capita energy consumption in Australia. Several past studies conducted with data from other comparable countries concluded that an increasing number of tourist arrivals leads to higher energy consumption or CO_2 emissions [5,43,52,87].

Using the ARDL technique, this study further established long-run and short-run dynamics between tourist arrivals and energy consumption. The signs of the coefficients were adherent to the economic model. Hence, this study concluded that international tourism has a positive and statistically significant effect on energy consumption. This is understandable because increased tourist arrivals increase economic activities and production (both goods and services), leading to higher energy consumption. For example, Tang et al. [52] commented that tourism-related infrastructures, facilities and activities necessitate additional energy, such as oil and electricity, for smooth operations, and Liu et al. [88] and Nepal et al. [43] also stated that tourism-related transportation is a significant contributor to energy consumption. Therefore, an increase in tourist arrivals increases energy demand. However, tourism in remote areas for instance, for hiking or for exploring the forest, may not require as much energy for electricity as required for tourism in the built environment. For example, tourism in the UAE may result in more energy consumption than the same tourist visiting the Mount Kilimanjaro. This also implies that weather along with the type of tourism attraction impacts energy consumption in a varied level. Other variables GDP per capita, CAP, and FD positively correlated with increased production; hence, it was reasonable to deduce a long-run cointegration with energy consumption [89]. Identical findings are available from studies from other comparable economies [90–92]. Growth in output (i.e., GDP) requires higher energy consumption, leading to environmental pollution [93], and FD develops new industries and production lines while also impacting emission and pollution.

After establishing the long-run association and ensuring the stability of the model, FMOLS and DOLS tests were performed. The results indicated a positive and significant relationship between international tourist arrivals and energy consumption in Australia. Noticeably, no existing studies used Australian data; therefore, this is among the preliminary studies to conclude that tourism affects energy consumption in Australia. In the pre-COVID years, the number of tourist arrivals was around one third of the total population of Australia. The increases both in energy consumption and population were roughly aligned. Past literature has commented that population growth increases urbanization, which increases the demand for energy consumption [63]. However, this research shows that the population does not affect primary energy consumption per capita in either the long or short run. This result aligns withLiu et al. [94], who has found that the negative elasticity of population to energy consumption in China was 0.211. Their results revealed that a 1% rise in population would decline energy use by 0.211% on a national scale. Similarly, the authors found that population density decreased energy use by 0.239% in the central, 0.218% in the western and 0.065% in the eastern regions of China. Azam et al. [95] found that population growth had a negative coefficient, implying decreased energy consumption in Thailand and Indonesia. The negative coefficient for the total population is logical because, if the total population increases, all other things being constant, per capita energy consumption would reduce. This result is consistent with previous findings conducted in China and Indonesia [94,95] as the total population would decrease the average energy demand.

No significant long-run relationship was observed between gross fixed capital formations and energy consumption. It is to note that Australia's industry structure, energy consumption and nature of FD are significantly different from other developed nations. The estimated causal relationships of this study are authentic only in terms of Australia. Hence, generalization of the study results requires some cautions. According to our knowledge, no studies have yet examined the long-run relationship between total population, FD and energy consumption for Australia with time-series data.

7. Conclusions and Policy Implications

This study examined the effect of tourist arrivals on energy consumption by controlling GDP, capital, total population and financial development. This study used data from 1976 to 2018 in Australia. Three cointegrating techniques—ARDL bound, JJ and BH tests—were employed to confirm the long-run relationship between the variables. This study's findings demonstrated a long-run cointegrating relationship between international tourist arrivals and energy consumption in Australia. Moreover, the results revealed that GDP, gross fixed capital formation and financial development contributed to Australia's rising energy consumption.

The outcomes of this research have several policy implications. Given that rising energy consumption is significantly associated with climate change and carbon emissions, appropriate policies are required to reduce tourism-induced energy consumption in Australia. One of the potential requirements could be that policymakers provide an incentive to the tourism industry's key stakeholders to adopt cleaner energies, carbon-neutral transportation and hybrid energies to achieve the desired level of carbon emission reductions. Hotels and other similar facilities could be encouraged to generate power from renewable sources. The government could provide tax rebates or low-cost (e.g., interest-free) financing opportunities for purchasing and installing environment-friendly technologies. Further studies may be conducted to examine the effectiveness of policies aiming at switching to renewable energy sources for Australia's tourism industry and the cost-effectiveness of establishing green-energy-designed tourism in Australia to minimize the use of energy. Furthermore, researchers are urged to test the robustness of the conclusions using multiple econometric models on the same sample data. Further research is needed for policy makers, government authorities and tourism relalated officials to examine the impact of tourism and energy relationship in the context of current COVID-19 situation using air transport, travel and tourism sector. This review of disruption by COVID would help to cope with the economy and can be expanded to heal the economic crisis.

This study has filled up an important research gap by examining the linkage between tourism and energy consumption in the case of Australia because this is the first ever study in Australia context as per the author's knowledge. Our main contribution is that we have found significant effect of tourist arrivals on energy consumption that has potential detrimental effects on the environment which policy makers should consider seriously in formulating and executing energy- and tourism-related policies. Our findings have implications not only for Australia but also for other countries.

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4.2 Links and implications

From a policy standpoint, energy use significantly affects economic growth because it is the foundation of our industrial society. High energy use, however, has negative environmental effects consumption, including an increase in the atmospheric concentration of carbon gases (such as carbon dioxide emissions), causes climate change. Thus, the significance of this paper is that it examined the link between tourism and energy consumption in Australia. The results of this study showed that energy consumption in Australia and foreign visitor arrivals had a long-term cointegrating connection.

While this paper utilised energy consumption as an environmental determinant, however, carbon dioxide emissions which is crucial variable for zero-carbon achievement is utilised in the next study to test whether tourist arrivals affect environment. Thus, the next chapter (Chapter 5) examines connections between tourism and carbon emissions to investigate the impact of tourism on the environment of Australia.

CHAPTER 5: DOES TOURISM CONTRIBUTE TOWARDS ZERO-CARBON IN AUSTRALIA? EVIDENCE FROM ARDL MODELLING APPROACH

5.1 Introduction

Chapter 4 investigated the nexus between tourism and energy consumption. This chapter investigated the long run cointegration link between international tourist arrivals and environmental deterioration to achieve zero-carbon. This study applied recent advances of econometric techniques and complemented the conventional cointegration tests with the autoregressive distributed lag bounds testing technique which is used to derive long- and short-run coefficients. According to the estimated results tourism is a barrier to achieve zero-carbon in Australia.

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Does tourism contribute towards zero-carbon in Australia? Evidence from ARDL modelling approach

Avishek Khanal [*,1], Mohammad Mafizur Rahman, Rasheda Khanam, Eswaran Velayutham

School of Business, Faculty of Business, Education, Law and Arts, University of Southern Queensland, Toowoomba, Australia

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A B S T R A C T

Climate change is an increasingly serious problem, resulting in significant environmental degradation, and various policies and regulations have been adopted to achieve zero-carbon with the goal of ameliorating this issue. To end this, along with economic growth, governments should consider human activities such as tourism and energy consumption, which are responsible for raising CO_2 emissions, a proxy for environmental degradation, in the atmosphere. Tourism may contribute to climate change through various adverse activities such as transportation and hotel stays. Thus, this study investigates the long-run cointegrating relationship between tourism and environmental degradation, focusing on some other specific factors. Using data from 1976 to 2019, the autoregressive distributed lag bounds test approach is applied to obtain both long-run and short-run coefficients. The estimated results indicate that tourism obstructs the achievement of zero-carbon in Australia. Along with tourist arrivals, energy consumption and gross domestic product are also significant contributors which have a positive and statistically significant long-run relationship with carbon emissions. This study provides policy implications for zero-carbon and sustainable tourism growth in Australia.

Author contribution

Methodology, Software, Writing – review & editing. Avishek Khanal: Conceptualization, Writing – original draft, Data curation. Mohammad Mafizur Rahman: Conceptualization, Supervision, Validation. Rasheda Khanam: Conceptualization, Supervision, Validation.Eswaran Velayutham: Methodology, Software, Writing – review & editing.

1. Introduction

Climate change is one of the most serious problems currently facing the world, with significant environmental degradation resulting from greenhouse gas (GHG) emissions, such as carbon dioxide (CO_2) [1]. Among the various GHGs such as nitrous oxide, methane and chlorofluorocarbons; CO_2 emissions alone contribute 74.4% to the total [2] and have thus emerged as the most significant contributor to global warming and subsequent environmental degradation. To prevent such damage, every country has pledged to limit carbon emissions. While considerable progress has been made towards shorter-term emission reduction objectives, the longer-term emissions trend continues to cause concern.

After dragging its feet on climate change, the Australian Federal Government, like much of the rest of the world, has now committed to achieving zero-carbon by 2050 [3]. Almost all industrialised economies have tightened their 2030 objectives and pledged to reduce emissions by about half this decade [4]. Achieving a zero-carbon or low-emissions goal requires considerable reductions in energy consumption [5] across a variety of contexts because all human activities—including transport, housing, industrial production and tourism—are responsible for raising CO_2 emissions in the atmosphere [5–9]. Tourism is the largest industry in the services sector in Australia and in many other countries, including developing countries with often-fragile economies [10]. According to the World Travel and Tourism Council (WTTC), in 2019 (before COVID19), travel and tourism accounted for US$8.9 trillion (10.3%) of global gross domestic product (GDP) [11]. Tourism contributes to the economy of both developed countries, such as Australia, and developing countries, with businesses associated with tourism creating employment opportunities in a range of ways (including hospitality, accommodation, and catering), which helps to alleviate unemployment and advance manufacturing and service sectors [12]. In 2019, tourism created 330 million jobs, or one job in 10, around the

* Corresponding author.
E-mail addresses: avishek_khanal@yahoo.com, avishek.khanal@usq.edu.au (Avishek Khanal).
[1] Current address: School of Business, Faculty of Business, Education, Law and Arts, University of Southern Queensland, Toowoomba, Australia.

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world [11]. Thus, tourism contributes significantly to economic growth and resumption will be necessary to recover from the economic crises caused by the COVID19.

Tourist arrivals—an essential component of tourism—positively boost the economy and thus play a vital role in a nation's economic growth and development [13]. However, although it brings economic benefits, a high level of tourism is likely to exert negative environmental effects, such as larger CO_2 emissions from using the maximum energy resources available during transportation, hotel stays, theme park attendance and other activities [14]. Given that energy consumption is directly linked with carbon emissions [15,16], tourism activities directly affect the environment in developed nations [17]. In comparison to other economic sectors, tourism consumes a lot of energy [18].

Policymakers in Australia have proposed a path to net zero-carbon, motivated by the need to minimise local contributions to global GHG emissions. The Morrison government took what it described as 'practical and reasonable steps to achieve zero emissions by 2050', while safeguarding Australian employment and creating new possibilities for industry and regional Australia. To achieve zero-carbon overall, zero-carbon energy, has shown promising results, with an 80% reduction in carbon emissions [19]. In addition, decarbonisation policies such as the climate solutions fund, national energy efficiency measures, national energy production plan, energy performance, and refrigeration and air conditioning measures are in effect in Australia [20]. Direct electrification is used to decarbonise electricity generation for residential and commercial buildings, industry, mining, and land transportation [19]. Australia can quickly adopt zero-emissions technologies, such as renewable energy and electric cars, in sectors including power, transportation, and buildings [21]. However, as per our knowledge, tourism has been omitted when considering how to achieve zero-carbon in Australia.

This study investigates the long-run cointegrating relationship between international tourist arrivals and environmental degradation in Australia. In addition, the effects of energy consumption, GDP, financial development, gross fixed capital formation (GFCF) and total population on environmental degradation are analysed using annual data from 1976 to 2019. The novel contribution of this study is that it combines tourism growth and pollution into a single framework, allowing for consideration of tourism's negative impacts (pollution) against its positive influence (economic growth) in a single framework, while also accounting for other factors such as energy, financial development, capital and population. This research also adds to the growing body of knowledge about the possibility for decarbonisation to aid in emission reductions and to achieve zero-carbon by using the autoregressive distributed lag (ARDL) methodology. Because ARDLs are utilised to simulate the environmental degradation function regardless of the series' mixed integration (i.e. I (0)/I (1)) in modelling a long-run connection, this ARDL model outperforms other standard cointegration approaches [22]. Last, to avoid bias in our results, we have added energy consumption to allow for more conclusive findings. The results of our study confirm the presence of cointegration between the variables of the study. Furthermore, the ARDL results also suggest that tourism has a positive and significant impact on carbon emissions. The paper concludes by indicating policy implications of the findings; in particular, that environmentally friendly transportation (e.g. push bikes) and adventure-based tourism such as trekking and scuba diving should be promoted to reduce energy consumption and achieve zero-carbon.

1.1. Trends in CO_2 emissions, tourist arrivals, and energy consumption in Australia

Both as a measure of economic and social growth and as a fundamental humanitarian necessity, energy plays a crucial role in everyday life and economic activity. For instance, Magazzino [23] claimed that energy consumption is important for all industries across the globe, and aids in development of a country. However, it is generally accepted that energy consumption is responsible for environment degradation with tourism also exerting negative impacts. Thus, this section assesses trends in CO_2 emissions, tourism and energy consumption to examine the relationships between them. The volume of CO_2 emissions in Australia has increased over the last four decades (see Table 1). In 1976, carbon emissions were 14.14 per capita. This increased over the three decades until 2010, before declining, perhaps in line with the introduction of solar energy and a reduction in the use of fossil fuels in Australia [24]. The country is responsible for one of the highest CO_2 emissions in the world, accounting for 16.88 per capita carbon emissions in 2019 [25].

The graphs below present the trends in CO_2 emissions and tourist arrivals in Australia from 1974 to 2019. Fig. 1 demonstrates that carbon emissions followed an increasing trend until 2008, and then declined until 2019. In contrast, tourist arrivals have gradually increased over time.

In 1976, Australia welcomed more than half a million international tourists. The 1980s and 1990s saw a significant rise in numbers, which was most evident in the 1990s, where the number of tourists increased from 2,214,900 in 1990 to 3,725,900 in 1995 (see Fig. 2). A marked increase in visitor numbers was observed during the 2000 Sydney Olympics, with arrivals skyrocketing to nearly five million. This number steadily gained momentum until 2019, when Australia greeted 9.4 million international tourists. Similarly, Fig. 3 shows that there was a gradual rise in primary energy consumption throughout the four decades from 1976 to 2019.

2. Literature review

Climate change and the resulting environmental degradation are serious global issues. To overcome further degradation, many researchers have examined different contributors to carbon emissions. While the consumption – carbon emissions – economic growth nexus is examined extensively by extant literature, the impact of economic policy uncertainty and human activities such as tourism on a carbon function has yet to be explored, particularly in Australia. Among a variety of causes, analysts have found that tourism contributes significantly to environmental pollution. Thus, policymakers and researchers have recently displayed interest in investigating the effect of tourism on the environment. For example, Pigram [26] examined the tourism–environment relationship and found that tourism may influence environmental quality in three ways: significantly negatively, moderately negatively, and positively [26]. Numerous studies have found a positive and significant effects of tourism on CO_2 emissions (i.e. tourism increases CO_2 emissions) [6,7,10,17,27–32]; in contrast, some have argued that tourism does not harm the environment [13,33–35].

Tourism has been found to be degrade the environment in countries such as Malaysia as confirmed by Solarin [32], who studied the determinants of CO_2 emissions with a particular emphasis on tourism development. The findings from cointegration and causality tests indicated that a 1% increase in financial development leads to a 0.19% increase in CO_2 emissions, and a 1% increase in arrivals lead to a 0.22%

Table 1
Trends in tourist arrivals, carbon emissions and GDP in Australia.

Year	CO_2 per capita	International tourist arrivals	Energy consumption
1976	14.14	531,900	192.8
1980	15.24	904,700	207.7
1985	15.07	1,142,700	201.1
1990	16.53	2,214,900	218.6
1995	17.24	3,725,900	230.3
2000	18.70	4,931,300	246.9
2005	18.78	5,463,000	250.6
2010	18.28	5,871,600	240.5
2015	17.27	7,449,900	237.0
2019	16.88	9,465,800	233.2

Note: Data for a select number of years are presented to avoid a large table size.

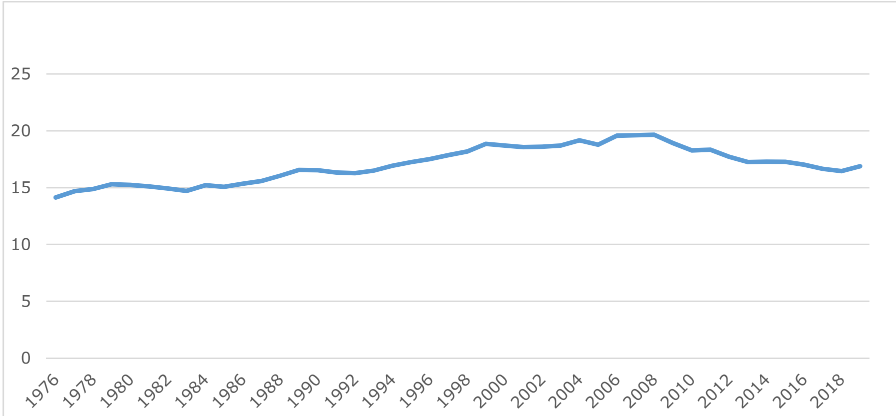

Fig. 1. Trends in CO_2 emissions in Australia.

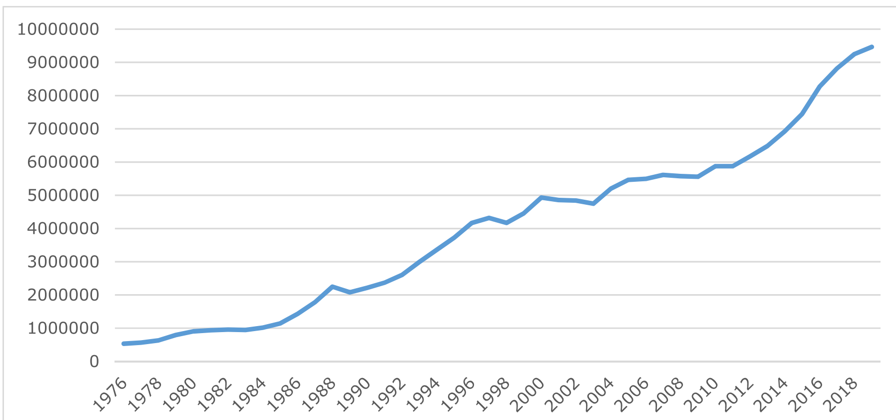

Fig. 2. Trends in tourist arrivals in Australia.

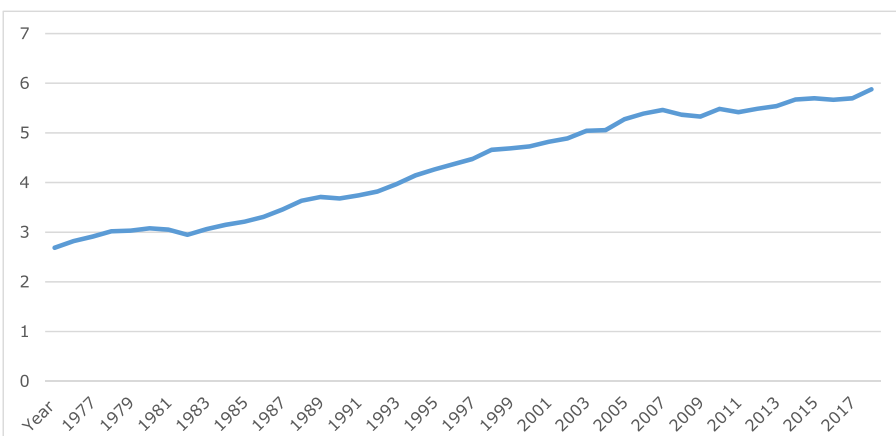

Fig. 3. Trends in energy consumption in Australia.

increase in air pollution in the long run. Similarly, Katircioglu [29] investigated the long-run equilibrium relationship between tourism, energy consumption and CO_2 emissions using ARDL, variance decomposition and impulse responses. The variance decomposition analysis and impulse responses confirmed that tourism development leads to significant variations in CO_2 emissions in both the short and long run. This was further supported by Katircioglu et al. [30], who studied the long-run equilibrium relationship between tourism and CO_2 emissions in Cyprus. They used bounds tests, conditional error correction models and conditional Granger causality tests from 1970 to 2009, and found that tourist arrivals and carbon emissions were cointegrated, suggesting that tourism affects CO_2 emissions in the long run. They concluded that tourist arrivals have a positive and statistically significant effect on CO_2 emissions.

Tourism like other economic activities, has a close relationship with environmental quality, as it increases CO_2 emissions by increasing energy consumption. León et al. [17] investigated the link between tourism and carbon emissions in 14 developed countries and 31 less-developed countries from 1998 to 2006. The results showed that a 1% increase in tourist arrivals raised CO_2 emissions by 0.13% and 0.04% in developed and less-developed countries, respectively. The results also demonstrated that population growth increased carbon emissions in developed and developing countries, with a 1% rise in the population resulting in a 0.87% rise in CO_2 emissions in developed countries and a 0.49% rise in less-developed countries [17]. Likewise, Durbarry and Seetanah [7] reviewed the effect of tourism and travel on climate change in Mauritius, and found that a 1% increase in tourist arrivals was associated with a 0.08% increase in CO_2 emissions in the long run. The ARDL model long- and short-run results showed that an increase in tourist arrivals significantly and positively affected CO_2 emissions.

A study conducted in Southeast Asia by Sherafatian-Jahromi et al. [31] analysed a linear and nonlinear nexus between tourism and CO_2 emissions, using the panel cointegration and pooled mean group techniques, and found that tourist arrivals and carbon emissions are cointegrated, suggesting that tourism increases CO_2 emissions in the long run. Additionally, in Pakistan, tourist arrivals significantly affect carbon emissions, with a 1% increase in tourist arrivals increasing carbon emissions by 0.14% in the long run [10]. Turkey has been a popular location for which to investigate the relationship between CO_2 emissions and tourist arrivals. In a study using three cointegration tests (Bayer--Hanck, Fourier ADL and ARDL), Eyuboglu and Uzar [28] found that a 1% increase in tourism and GDP caused a 0.099% and 0.766% increase in carbon emissions, respectively. For the Brazil, Russia, India, China and South Africa (BRICS) economies, the tourism sector has been found to significantly encourage economic growth, but also degrade environmental quality [27]. The above studies each demonstrated that tourist arrivals are a source of environmental degradation.

A recent study by Koçak et al. [8] using an advanced panel data estimation that focused primarily on how CO_2 emissions reacted to tourism developments found that tourism arrivals have an increasing effect on CO_2 emissions, while tourism receipts have a reducing effect on the environment. Using data from 31 selected OECD countries from 1995 to 2016 and a panel quantile approach, Alola et al. [6], revealed that the effect of international tourism arrivals is significant and damaging to environmental quality.

In contrast to the above research demonstrating that tourism leads to environmental degradation, other research has found that tourism decreases CO_2 emissions. A study by Lee and Brahmasrene [13] using cointegration tests examined the influence of tourism on economic growth and CO_2 emissions, using panel data from European Union (EU) countries from 1988 to 2009, and found that a 1% increase in tourism arrivals reduced CO_2 emissions by 0.105%. The findings argued that tourism directly affects economic growth and reduces CO_2 emissions in the EU. This was further supported by Shakouri et al. [35] for 12 Asia-Pacific countries from 1995 to 2013. Using a panel generalised method of moments (GMM) and panel Granger causality test, the findings revealed that tourism arrivals resulted in a decrease in CO_2 emissions in these Asia-Pacific countries. Further, Dogan and Aslan [34] explored the relationship between CO_2 emissions, real GDP, energy consumption and tourism in the EU and candidate countries, using panel models robust to heterogeneity and cross-sectional dependence. The results from ordinary least squares (OLS) with fixed effects, fully modified OLS (FMOLS), dynamic OLS (DOLS) and the group-mean estimator indicated that tourism lessens CO_2 emissions. Balsalobre-Lorente et al. [33] inspected the long-run relationship between economic growth, international tourism, globalisation, energy consumption and CO_2 emissions in developed countries, and concluded that international tourism leads to environmental improvements once economies have reached a specific improvement phase in their tourism industry.

Modelling the transition to a decarbonised environment or to achieve zero-carbon is crucial. Several studies have been conducted regarding renewable energy policies at the national and regional levels in Australia, including those examining zero-carbon housing in Victoria [5], contributions to regional decarbonisation [36], a zero-carbon, reliable and affordable energy future [19], and zero-emission housing policy development [37]. However, though tourism is a significant contributor to carbon emissions, it was ignored in all these studies.

The increased use of renewable energies has contributed to a decrease in worldwide emissions growth [38]. According Magazzino et al. [38] empirical research suggests that renewable energy consumption is an effective policy tool for reducing CO_2 emissions without hurting GDP growth. Financial development can also significantly negatively affect the environment. Rjoub et al. [39] investigated the effects of financial development, political institutions, urbanisation and trade openness on CO_2. Using FMOLS, DOLS and canonical cointegrating regression, they found that financial development significantly increases CO_2. In a cross-sectional weighted estimated generalised least squares methodology, Arellano-Bond GMM and orthogonal-deviation GMM, Yasin et al. [40] found that a 1% rise in financial development increases CO_2 by 0.82%. In accordance, GFCF is among the main contributors to CO_2 emissions, with a 1% increase in GFCF causing an 8.5% increase in CO_2 [41]. Thus, GFCF has a positive long-run effect on CO_2 emissions [42]. Tourism and GFCF homogeneously cause CO_2 emissions [43]. Generally, total population increases carbon emissions [44]; however, Shi et al. [45] found that an increase in total population leads to decreased carbon emissions in upper-middle-income and high-income countries, and this was supported by Khanal [46] in the Australian context.

Although various studies have explored the energy–-growth–environment relationship [34,41,42,47], few have investigated the effect of tourism on the carbon emissions growth nexus [10,28]. As noted earlier (see Table 1), Australia welcomes a high number of tourists, and also discharges a high level of CO_2. Thus, an assessment of the connection between international tourist arrivals and environmental degradation is crucial. A large body of literature has investigated the effect of tourism on carbon emissions in various including Mauritius [7], Cyprus [30], Malaysia [32], Pakistan [10] and Turkey [28,29,48].

This research differs from earlier effort in two ways, allowing us to address gaps in the existing literature. To our knowledge, this is the first study to use the recently established ARDL technique to examine the factors driving CO_2 emissions to achieve zero-carbon in Australia. Moreover, the Zivot-Andrews unit root test approach is used to account for the break in the time series, offering a novel component of the research as previous studies have ignored such a possibility in zero-carbon analysis. The innovation and scientific contribution of this study lies in examining the nexus between carbon emissions, tourism, energy, economic growth, financial development, capital and total population using the ARDL modelling approach. The findings of this paper will help policymakers to analyse tourism and energy policies from a broader environmental perspective.

3. Empirical model and econometric methods

Following previous studies, this study estimates the nexus between tourist arrivals and the environment, while controlling energy consumption, GDP, financial development, GFCF and total population. The linkages between these variables are tested from yearly time-series data for 1976 to 2019. GDP data were available only from 1976, and tourism data only until 2019; thus, the selection of the sample period was based on the availability of annual data before the COVID-19 pandemic to analyse the long-run relationship between the variables. We used the dependent variable of CO_2 emissions per capita [10,28] as a proxy for environmental pollution, and the main independent variable of tourist arrivals (TA) as a proxy for tourism. The control variables are energy consumption (primary energy consumption), GDP per capita (constant 2010 US$) [29,32] for economic growth, financial development (FD) (% of GDP) [39,40], GFCF (constant 2010 US$) [41–43] and total population (*TP*) [15,44–46].

The data for tourism are collected from the Australian Bureau of

Statistics [49]; GDP, GFCF and TP are obtained from the World Development Indicators [50] and data on CO_2 emissions and energy consumption are acquired from BP Statistical Review [51]. CO_2 is multiplied by one million to attain million tons, which we then divide by total population to attain per capita figures. Table 2 presents the variable descriptions and data sources.

3.1. Theory and model

The theoretical background for this study begins with the hypothesis that tourist arrivals may be a significant contributor to carbon emissions. Many studies have highlighted GDP as a key contributor to climate change, in addition to energy usage. Several papers have attempted to establish a relationship between energy, the environment and economic growth [52–54], with Katircioglu [29] and Eyuboglu and Uzar [28] also adding tourist arrivals to this. We follow Katircioglu [29] and Eyuboglu and Uzar [28] to generalise an empirical model to examine the effect of tourism on the environment. Their specified time series model states that CO_2 emissions are affected by international tourist arrivals, economic growth, and energy consumption. Therefore, the estimated model of our study is justified in light of the literature by following the study of Katircioglu [29] and Eyuboglu and Uzar [28]. The general form of tourism-energy-growth-environment equation is modelled as follows:

$$CO_2 = f\ (TA,\ EC,\ GDPpc,\ FD,\ GFCF,\ TP) \quad (1)$$

where CO_2 is carbon emissions per capita, *TA* is tourist arrivals, EC is energy consumption, *GDPpc* is gross domestic product per capita, *FD* is financial development, *GFCF* is gross fixed capital formation, and *TP* is total population. All variables are used in their logarithm form in the above econometric analysis to gain the growth effects of the regressors on the dependent variable:

$$logCO_2 = f\ (logTA,\ log\ EC,\ logGDPpc,\ logFD,\ logGFCF,\ logTP) \quad (2)$$

To investigate the long-run relationship between CO_2, *TA*, *EC*, *GDP*, *FD*, *GFCF* and *TP*, we employ the following equation derived from Equation (1):

$$CO_{2t} = \beta_0 + \beta_1 TA_t + \beta_2 EC_t + \beta_3 GDP_t + \beta_4 FD_t + \beta_5 GFCF_t + \beta_6 TP_t + \varepsilon_t \quad (3)$$

Table 2
Variable description and data source.

Symbol	Variable	Definition	Source	Article source
CO₂	CO_2 emissions	CO_2 emissions per capita	BP Stats	[10,28]
TA	Tourist arrivals	International tourism, number of arrivals. Number of movements; short-term visitors arrivals	ABS	[10,28]
EC	Energy consumption	Primary energy comprises commercially traded fuels, including modern renewables used to generate electricity	BP Stats	[14]
GDPpc	GDP per capita	GDP per capita (constant 2010 US$)	WDI	[29,32]
FD	Financial development	Financial development (% of GDP)	WDI	[39,40]
GFCF	Gross fixed capital formation	GFCF (constant 2010 US$)	WDI	[41–43]
TP	Total population	Total population-based on de facto definition of the population with mid-year estimates	WDI	[15, 44–46]

Note: ABS = Australian Bureau of Statistics, WDI = World Development Indicators, BP Stats = BP Statistical Review.

To obtain the direct elasticities of coefficients and make the estimation process smooth, we take the logarithm of the variables, which helps select suitable time series models derived from Equation (2):

$$logCO_{2t} = \beta_0 + \beta_1 logTA_t + \beta_2 logEC_t + \beta_3 logGDP_t + \beta_4 logFD_t + \beta_5 logGFCF_t + \beta_6 logTP_t + \varepsilon_t \quad (4)$$

where $\beta_0,\ \beta_1,\ \beta_2,\ \beta_3,\ \beta_4,\ \beta_5$ *and* β_6 are the slope coefficients, ε_t is the error term, t is the time period, and log is the logarithm function.

3.2. Stationarity and unit root test

Before analysing the given data, the stationarity properties should be assessed to meet the requirements of an appropriate model for the analysis. To check the stationarity of the data, we employ Augmented Dickey-Fuller (ADF) [55] and Phillips-Perron (PP) [56] unit root tests. The null hypothesis is that a series has a unit root (non-stationarity), while the alternative is that there is stationarity. We apply the ADF unit root test to determine the maximum number of integrations. However, as this test may be a non-robust test for the unit root to ensure certainty regarding stationarity among the variables, an additional test for the unit root, the PP test, is implemented. As a non-parametric statistical method, the PP test considers serial correlation without using the lagged differences of the dependent variable [57]. In time series, the PP test allows for milder assumptions on the distribution of errors, with an opportunity to control for higher-order serial correlation, as well as being robust against heteroscedasticity [58]. Hence, we apply both ADF and PP tests to check the stationarity of our variables. The ADF model tests the unit root as follows:

$$\Delta y_t = \mu + \delta y_{t-1} + \beta_t + \sum_{i=1}^{k} d_i \Delta y_{t-i} + e_t \quad (5)$$

where k = number of lags, $t - i = 1 \ldots k$, $\delta = \alpha - 1$, α = coefficient of y_{t-1}, Δy_t = first difference of y_t and e_t = white noise disturbance. The null hypothesis for ADF is that $\delta = 0$, against the alternative hypothesis of $\delta < 0$. If we do not reject the null, the series is non-stationary, whereas rejection means the series is stationary. The PP model tests the unit root as follows:

$$\Delta y_t = \mu + \delta y_{t-1} + \beta_t + e_t \quad (6)$$

3.3. ZA unit root test

The ADF test and PP test can sometimes provide biased and spurious results in the presence of unaccounted for structural breakpoints in the series [59]. Thus, we apply the ZA structural break unit root test before cointegration [60]. Zivot and Andrew's technique is performed by running the following equation, adapted from Ertugrul et al. [61]:

$$\Delta y_t = c + cY_{t-1} + \beta t + dDU_t + dDT_t + \sum_{j=1}^{k} d_j \Delta Y_{t-j} + \varepsilon_t \quad (7)$$

where DU_t is the shift dummy variable showing the shift that occurs at each point break date, and DT_t is the trend of the shift dummy variables [61], which may be identified as:

$$DU_t = \begin{cases} 1\ if\ t > TB \\ 0\ if\ t < TB \end{cases} \quad \text{and} \quad DT_t = \begin{cases} t - TB\ if\ t > TB \\ 0 \quad if\ t < TB \end{cases}$$

The null hypothesis of the unit root break date is $c = 0$, which suggests that the series is not stationary with a drift not containing information regarding the structural breakpoint, while the $c < 0$ hypothesis implies that the variable is trend-stationary, with one unknown time break.

3.4. Cointegration analyses

The long-term relationship between tourism and the environment in this study is investigated by using three cointegration approaches: the ARDL bounds test and the Johansen-Juselius test.

3.4.1. ARDL bounds test approach

After testing the stationarity properties of the series, the ARDL bounds test approach is applied to test the existence of cointegration between the variables for long-run relationships between the variables. The ARDL bounds test, developed by Pesaran et al. [62] provides two asymptotic critical value bounds when the independent variables are either I (0) or I (1). We accept that the test statistics surpass the upper critical bound (UCB) and thus conclude that a long-run relationship among the variables exists. The following equation is used to estimate cointegration relationships among variables:

$$\begin{aligned}\Delta logCO_{2t} = \beta_0 + \beta_1 logCO_{2t-i} + \beta_2 logTA_{t-i} + \beta_3 logEC_{t-i} + \beta_4 logGDP_{t-i} \\ + \beta_5 logFD_{t-i} + \beta_6 logGFCF_{t-i} + \beta_7 logTP_{t-i} + \sum_{i=1}^{p} \beta_8 logCO_{2t-i} + \sum_{i=1}^{p} \beta_9 \Delta logTA_{t-i} \\ + \sum_{i=1}^{p} \beta_{10} \Delta logEC_{t-i} + \sum_{i=1}^{p} \beta_{11} \Delta logGDP_{t-i} + \sum_{i=1}^{p} \beta_{12}\, \Delta logFD_{t-i} + \sum_{i=1}^{p} \beta_{13}\, \Delta logGFCF_{t-i} \\ + \sum_{i=1}^{p} \beta_{14}\, \Delta logTP_{t-i} + \varepsilon_t\end{aligned} \tag{8}$$

where ε_t is white noise, Δ denotes the first difference and $t-i$ indicates the optimal lags chosen by the Akaike information criterion (AIC). The bounds test procedure is based on the joint F-statistic to determine the joint significance of the coefficient of the lagged variables. In this regard, the null hypothesis is $H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = 0$, which implies that a cointegrating relationship does not exist among the regressors, against the alternative of $H_1 : \beta_r \neq 0$, where $r = 1, 2, 3, 4, 5, 6,7$.

3.4.2. Johansen-Juselius cointegration testing approach

The second approach of cointegration test is the Johansen and Juselius [63] cointegration method, which also estimates the long-run relationship among the series. The Johansen and Juselius cointegration technique is based on trace statistics (λ_{trace}) and maximum eigenvalue (λ_{max}) statistics. Trace statistics examine the null hypothesis of r cointegrating relations against the alternative of N cointegrating relations, and are computed as:

$$\lambda_{trace} = -N \sum_{i=r+1}^{n} log(1-\lambda_i) \tag{9}$$

where N is the number of observations and λ is the ordered eigenvalue of matrices. The maximum eigenvalue statistics tests the null hypothesis of r cointegrating relations against the alternative:

$$\lambda_{max} = -N \ \log \ (1-\lambda_r + 1) \tag{10}$$

where N is the number of observations and λ is the ordered eigenvalue of matrices.

3.5. Lag length test

We employ AIC lag order selection to determine the best model to select, as the AIC criteria were deemed suitable for lag length selection given the nature of this study [64].

3.6. Long- and short-run dynamics

After testing the stationarity properties of the series and the three different cointegration approaches, we apply ARDL testing to examine the long- and short-run coefficients. The ARDL approach to cointegration helps to identify cointegrating vector(s). That is, each of the underlying variables stands as a single long-run relationship equation. If one cointegrating vector (the underlying equation) is identified, the ARDL model of the cointegrating vector is reparametrised into an error correction model (ECM). The reparametrised result gives long-run relationships and short-run dynamics (traditional ARDL) among the variables of a single model [65]. After the cointegration is confirmed among the variables, the long-run and short-run elasticity according to the ARDL specification are determined via the equations below.

3.6.1. Long-run

$$\begin{aligned}logCO_2 = \beta_0 + \sum_{i=1}^{q} \beta_1 logCO_{2t-i} + \sum_{i=1}^{q} \beta_2 logTA_{t-i} + + \sum_{i=1}^{q} \beta_3 logEC_{t-i} \\ + \sum_{i=1}^{q} \beta_4 logGDP_{t-i} + \sum_{i=1}^{q} \beta_5\, logFD_{t-i} + \sum_{i=1}^{q} \beta_6 logGFCF_{t-i} + \sum_{i=1}^{q} \beta_7 logTP_{t-i} + \varepsilon_t\end{aligned} \tag{11}$$

Here, β reflects the variance in the long-run variables, while $t-i$ indicates the optimal lags chosen by AIC for the long-run estimates. The following ECM is used for the short-run ARDL model.

3.6.2. Short-run

$$\begin{aligned}logCO_2 = \alpha_0 + \sum_{i=1}^{q} \alpha_1 \Delta logCO_{2t-i} + \sum_{i=1}^{q} \alpha_2 \Delta logTA_{t-i} + \sum_{i=1}^{q} \alpha_3 \Delta logEC_{t-i} \\ + \sum_{i=1}^{q} \alpha_4 \Delta logGDP_{t-i} + \sum_{i=1}^{q} \alpha_5 \Delta logFD_{t-i} + \sum_{i=1}^{q} \alpha_6 \Delta logGFCF_{t-i} + \sum_{i=1}^{q} \alpha_7 \Delta logTP_{t-i} \\ + \mu ECT_{t-i} + \varepsilon_t\end{aligned} \tag{12}$$

Table 3
Descriptive statistics.

	$logCO_2$	logTA	logEC	logGDPpc	logFD	logGFCF	logTP
Mean	1.23	6.48	0.62	4.61	1.84	11.22	7.27
Median	1.23	6.63	0.65	4.61	1.89	11.20	7.27
Maximum	1.29	6.98	0.77	4.76	2.15	11.57	7.40
Minimum	1.15	5.73	0.43	4.45	1.43	10.81	7.15
Std deviation	0.04	0.37	0.11	0.10	0.25	0.24	0.08
Skewness	−0.12	−0.64	−0.28	−0.08	−0.45	0.02	0.06
Kurtosis	1.89	2.14	1.59	1.55	1.78	1.64	1.91
Jarque-Bera (chi^2)	2.38(0.30)	4.41(0.11)	4.18(0.12)	3.90(0.14)	4.20(0.12)	3.39(0.18)	2.22(0.33)
Observations	44	44	44	44	44	44	44

Here, α reflects the variance in the short-run variables and the coefficient of the ECT is denoted by μ, which shows the speed of adjustment of the variables towards long-run convergence. Further, $t-i$ represents the optimal lag lengths using the AIC criteria for short-run dynamics.

3.7. Robustness check

We also used the FMOLS (fully modified OLS)and canonical cointegrating regression (CCR) on the provided model as a sensitivity check to examine the long-run influence of explanatory factors on the dependent variables.

4. Empirical results and analysis

Given the timeframe of 1976–2019 with annual observations, there were 44 observations for each variable selected in this study. The descriptive statistics for the variables (measured in natural logarithms) were found to be normally distributed within a reasonable range (see Table 3). Thus, the data are unlikely to provide spurious findings. The Jarque-Bera statistics indicate that all series have zero mean and finite covariance. All variables were transformed to logarithms before estimation to avoid heteroscedasticity and calculate elasticities.

This study applies three unit root test (ADF, PP and ZA) and two cointegration tests (ARDL bounds test and Johansen-Juselius test), as discussed below.

4.1. ADF and PP unit root and ZA structural break test

We examined three different kinds of unit root tests—ADF, PP and ZA—to avoid any spurious relationship. The results of the unit root tests are reported in Table 4. The ADF and PP tests indicate that the variables are stationary at first differences, I (1). The AIC and Newey-West lags were used to determine the lag length for the ADF and PP.

We also apply the Zivot and Andrews [60] structural break unit root test (see Table 5) to examine the status of the unit root test and the presence of a structural break in our series.

These results suggest that we can reject the null of unit root at a 1% significance level. Given that the calculated *t*-statistics value at the level is below the critical values, the variable is non-stationary. The null hypothesis can be rejected when the critical value (1%, 5% and 10%) is greater than the test statistic value. After first difference, all *t*-statistics values, which are above the critical values, show evidence of

Table 5
ZA structural break trended unit root test.

Variable	At level		At first difference	
	t-statistics	Time break	t-statistics	Time break
$logCO_2$	−3.28(0)	2009	−6.32(0)*	2009
logTA	−4.34(1)	1986	−5.51(2)*	1997
logEC	−2.66(0)	2009	−5.932(0)*	1984
logGDPpc	−2.63(0)	1997	−6.59(0)*	1993
logFD	−3.33(1)	1985	−6.23(0)*	1983
logGFCF	−2.42(0)	2002	−6.04(0)*	1993
logTP	−2.16(1)	2012	−6.53(0)*	2008

Note: Lag order shown in parentheses. Critical values: 1%: −5.34, 5%: −4.80, 10%: −4.58, where * is 1% level of significance.

Table 6
Results of lag order selection criteria.

Lag	LL	LR	AIC	HQIC	SBIC
0	682.58	NA	−33.78	−33.67	−33.48
1	1035.80	565.14**	−48.99	−48.14	−46.63**
2	1087.67	64.84	−49.13	−47.53	−44.70
3	1145.80	52.29	−49.59	−47.24	−43.09
4	1256.78	61.05	−52.69**	−49.59**	−44.12

Note:* Indicates lag order selected at 5% level of significance. LL: likelihood, LR: likelihood ratio, HQIC: Hannan and Quinn information criterion and SBIC: Schwarz Bayesian information criterion.

Table 7
Bounds test for cointegration.

Model	*F*-statistics	LCB [I_0]	UCB [I_1]
$logCO_2 = f$ (logTA, logEC,logGDPpc, logFD, logGFCF, logTP)	6.25*	2.88	3.99

Note: * 1% critical value for the bounds test. LCB = lower critical bound.

Table 4
Unit root tests.

Tests	$logCO_2$	logTA	logEC	logGDPpc	logFD	logGFCF	logTP
ADF							
At level I (0) Constant	−1.57 (−2.93)	−2.82*** (−2.93)	−1.81 (−2.93)	−0.92 (−2.93)	−1.33 (−2.93)	−1.17 (−2.93)	1.16 (−2.93)
At level I (0) Constant & Trend	−0.42 (−3.52)	−1.46 (−3.52)	−0.88 (−3.52)	−1.08 (−3.52)	−0.29 (−3.52)	−2.01 (−3.52)	−0.86 (−3.52)
At first difference I (1)	−5.00* (−2.93)	−3.99* (−2.93)	−5.09* (−2.93)	−5.61* (−2.93)	−4.48* (−2.93)	−5.30* (−2.93)	−4.26* (−2.93)
PP							
At level I (0)	−2.02 (−2.93)	−2.70*** (−2.93)	−1.81 (−2.93)	−0.91 (−2.93)	−1.19 (−2.93)	−1.18 (−2.93)	1.58 (−2.93)
At level I (0) Constant & Trend	−0.53 (−3.52)	−1.49 (−3.52)	−1.08 (−3.52)	−1.08 (−3.52)	−1.08 (−3.52)	−1.74 (−3.52)	−0.66 (−3.52)
At first difference I (1)	−4.97* (−2.93)	−3.80* (−2.93)	−5.07* (−2.93)	−5.57* (−2.93)	−4.47* (−2.93)	−5.18* (−2.93)	−4.26* (−2.93)

Note: * is 1% and *** is 10% significance level. AIC criteria are selected to find optimal lags. 5% critical values (CV) are given in parentheses.

Table 8
Johansen-Juselius cointegration test.

Rank	Trace statistic	5% critical value	Max. eigen. statistic	5% critical value
0	158.14	124.24	54.44	45.28
1	103.70	94.15	41.99	39.37
2	66.58**	68.52	31.53**	33.46
3	40.93	47.21	17.84	27.07
4	22.15	29.68	8.56	20.97
5	9.41	15.41	6.10	14.07
6	2.66	3.76	2.34	3.76

Note: ** the number of cointegration at 5% critical value.

stationarity. The results of the ZA reveal that all series are first difference stationary—I (1)—in the presence of a single structural break in the series. Carbon emissions in Australia declined in 2009, reflecting the impact of the 2008 recession on industrial production and overall energy use.

4.2. ARDL bounds test results and lag order selection

The ARDL bounds test of cointegration examines the cointegration between variables. To obtain the bounds tests, we select AIC to estimate the lag length of the considered variables to examine the long-run relationship between the series (see Table 6).

After selecting lag (4), in line with the AIC criterion, we use this to determine the cointegration among the variables using the ARDL bounds test (see Table 7).

The empirical results for the bounds test for cointegration are shown in Table 7. The null hypothesis is that if the *F*-statistics are lower than the lower critical bound series, there is no cointegration; if the *F*-statistics are higher than the UCB series, there is cointegration. In our case, there exists a long-run nexus between the variables because the calculated *F*-statistic (6.25) is higher than the UCB [I_1] (3.99) at 1% critical value.

4.3. Johansen-Juselius cointegration test

After the ARDL bounds test for cointegration, we further check for cointegration using the Johansen and Juselius [63] test to determine whether this shows that any combination of the variables are cointegrated. The results are presented in Table 8.

Here, the trace statistics are less than the 5% critical value; thus, we accept the null hypothesis, implying that there is one cointegration in both the trace and maximum eigenvalue statistic, and this guides a substantial long-run relationship among the series of variables. The Johansen-Juselius cointegration test has a null hypothesis that if the trace and maximum value is greater than the 5% critical value, we reject the null hypothesis of no cointegration. The results from the Johansen-Juselius cointegration test reveal t a minimum of one cointegration among the variables.

Table 9
Long-run dynamics using ARDL (1, 3, 1, 2, 0, 0, 0) model coefficients.

Variables	Coeff.	t-stats	Prob.
Constant	9.99	16.70	0.00*
logTA	0.13	3.33	0.00*
logEC	0.46	2.56	0.02**
logGDPpc	0.51	2.01	0.06***
logFD	0.01	0.12	0.91
logGFCF	0.04	0.73	0.47
logTP	−1.74	−11.32	0.00*
Diagnostic test			
Serial correlation (Breusch-Godfrey LM test for autocorrelation)	0.41 (0.67)	Heteroscedasticity (Breusch-Pagan/Cook-Weisberg test for heteroscedasticity)	0.88 (0.58)
Normality Jarque-Bera	0.87	*F*-stat (prob.)	292.26
R^2	0.99	Adjusted R^2	0.99

Note: * is significant at 1% critical level, ** is significant at 5% critical level and ***is significant at 10% critical level.

Table 10
Short-run dynamics using ARDL approach.

Variables	Coeff.	t-stats	Prob.
ΔlogCO2	−0.58	−3.44	0.00*
ΔlogTA	0.07	3.22	0.00*
ΔlogEC	0.27	2.04	0.05**
ΔlogGDPpc	0.30	1.91	0.07***
ECM (−1)	−0.58	−7.93	0.00*

Note: * is significant at 1% critical level, ** is significant at 5% critical level and ***is significant at 10% critical level.

4.4. ARDL (long- and short-run) approach

Table 9 presents the long-run equilibrium relationship among variables estimated using the ARDL (1, 3, 1, 2, 0, 0, 0) approach using ECM. The results for the long-run coefficient estimates show that tourist arrivals have a positive and significant effect on CO_2 emissions with a 1% increase in tourist arrivals, associated with a 0.13% surge in CO_2 emissions in the long run at a 1% significance level. Energy consumption has long been held responsible for environmental degradation. The results from the long-run ARDL model shows that a 1% increase in energy use results in 0.46% rise in CO_2 emissions. Similarly, GDP, FD, and GFCF have a positive effect on carbon emissions, where FD and GFCF have a positive yet non-significant effect. The findings reveal that a 1% increase in GDP leads to a 0.51% surge in carbon emissions implying that economic activity plays an important role in generating CO_2 emissions in Australia. Moreover, the total population has a negative coefficient −1.74, with 0.00 probability (*p*) value.

An ECM, which measures the speed of adjustment, is required to obtain the short-run dynamics of the series and its coefficient given the existence of a cointegrating nexus between the variables [66]. The estimated ECM adjustment term, ECM (−1), is negative (−0.58) and statistically significant at a 1% critical level. Table 10 presents the short-run results, and the impact of the independent variable (tourist arrivals) on the dependent variable (CO_2 emissions) in Australia. The results show that tourist arrivals have a significant positive effect (coefficient = 0.07 and *p*-value = 0.00) on the environment in Australia. Likewise, the results reveal that energy consumption and economic growth also affect the environment in the short-run with a 1% increase in energy consumption associated with 0.27% increase in CO_2 emissions

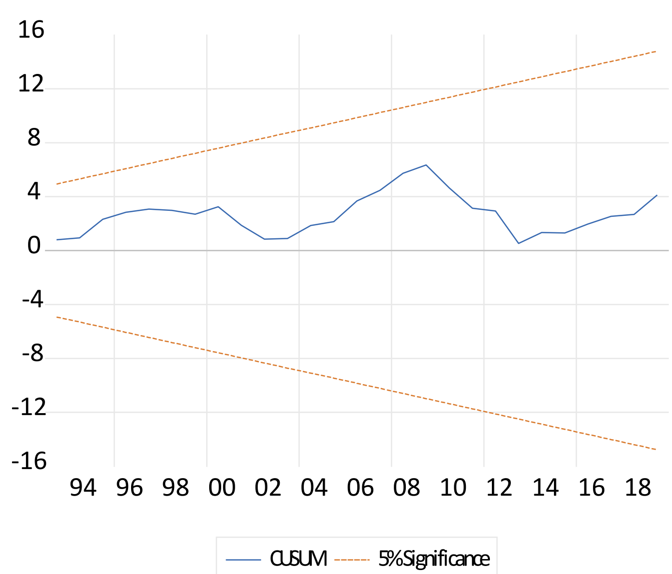

Fig. 4. Plot of CUSUM of recursive residuals.

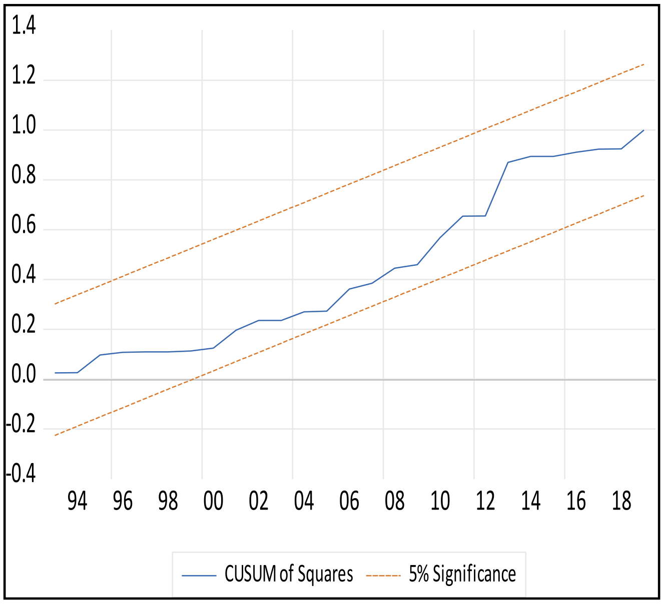

Fig. 5. Plot of CUSUMQ of recursive residuals.

Table 11
Results of the FMOLS and CCR regressions.

Fully Modified Least Squares (FMOLS)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
logTA	0.06	0.02	3.29	0.00*
logEC	0.75	0.14	5.42	0.00*
logGDPpc	0.14	0.19	0.72	0.48
logFD	0.06	0.03	2.01	0.05**
logGFCF	0.05	0.04	1.30	0.20
logTP	−1.52	0.10	−15.58	0.00*
C	10.12	0.44	23.04	0.00*
Canonical Cointegrating Regression (CCR)				
logTA	0.06	0.02	3.34	0.00*
logEC	0.76	0.15	5.12	0.00*
logGDPpc	0.13	0.20	0.64	0.53
logFD	0.06	0.03	2.12	0.04**
logGFCF	0.05	0.04	1.45	0.15
logTP	−1.53	0.11	−13.29	0.00*
C	10.15	0.46	21.91	0.00*

Note: * is significant at 1% critical level, and ** is significant at 5% critical level.

at the 5% critical level, and a 1% increase in GDP associated with 0.30% surge in CO_2 emissions at the 10% significance level.

4.5. Diagnostic test results

Diagnostic tests were undertaken to check serial correlation, heteroscedasticity and normality using the Breusch-Godfrey LM test for autocorrelation, the Breusch-Pagan/Cook-Weisberg test for heteroscedasticity and the Jarque-Bera test for normality. The Breusch-Godfrey LM test shows no serial correlation, the Breusch-Pagan/Cook-Weisberg test indicates no heteroscedasticity in the data, and the Jarque-Bera test reveals that the residuals are normally distributed.

4.6. Stability of the short-run model

The stability of the model is checked using the cumulative sum of recursive residuals (CUSUM) and CUSUM of squares (CUSUMQ) [67]. The results presented in Figs. 4 and 5 indicate the absence of any instability in the coefficients, as the CUSUM and CUSUMQ statistics fall inside the critical bands of the 5% confidence interval of parameter stability.

4.7. Robustness check

To further validate the robustness of the long-run results of the ARDL framework, fully modified least squares (FMOLS) and canonical cointegrating regression (CCR) were applied (see Table 11). The long-run estimations from both the FMOLS and CCR are similar and generate the same sign. The results reveal that the long-run coefficient of TA has the expected positive sign (0.06) in the FMOLS and CCR, with a 1% significance level, the same as those derived from the ARDL estimations.

5. Discussion

Energy saving and emissions reduction initiatives are putting pressure on Australia's economic growth. A feasible roadmap to decarbonisation in Australia is crucial. In the process of decarbonisation, tourism-related environmental consequences are unavoidable, because most tourism-related activities rely on fossil fuels for energy, resulting in considerable CO_2 emissions. Thus, this study investigates whether tourism contributes to zero-carbon emission. To achieve this objective, we employ ADF, PP and ZA unit root tests and long-run and short-run ARDL econometric techniques. According to the results obtained from the ADF, PP and ZA tests, the logarithm forms of the analysed variables of CO_2 emissions, tourist arrivals, energy consumption, GDP per capita, financial development, GFCF and total population were stationary at first difference. Next, the long-run cointegration between variables was examined, with the ARDL bounds test approach and Johansen-Juselius cointegration test indicating at least one cointegrating relationship.

The long-run ARDL test results show that growth in tourist arrivals significantly affect CO_2 emissions in Australia in the long run. This further suggests that international tourist arrivals are playing a substantial role in degrading the Australian environment. These findings align with those of previous studies [7,8,10,28]. Because of the extensive use of transportation, the tourist industry has a considerable impact on climate change, as a result increased CO_2 emissions driven by energy consumption. The relationship between increased carbon emissions and energy consumption and economic development is one of the most critical aspects of the global warming debate. Economic growth and energy use, as major transmission routes, are the primary causes of environmental degradation. According to our long-run results, EC, GDP, GFCF and FD are also responsible for contributing CO_2 to Australia's environment. These results for Australia might be explained by the country's rapid economic growth in recent years, but are also driven by its high energy consumption, which places it among the top 10 emitters. The Australian energy industry is heavily reliant on fossil fuels, which serve as its primary source of electricity generation. These findings align with those of Khanal [15] and Majeed et al. [68]. Furthermore, Australia faces a trade-off between economic expansion and CO_2 emissions because economic growth currently implies concomitant in CO_2 emissions. Our result that GDP increases carbon emissions aligns with Zmami and Ben-Salha [69] while our result on GFCF align with the results of Rahman and Ahmad [41], Petrović and Lobanov [42], Zaman et al. [43] and financial development with Solarin [32], Rjoub et al. [39], and Yasin et al. [40]. Thus, capital formation and financial development also contribute to the degradation of the Australian environment. Moreover, the coefficient of total population is negative in the long run. This result contradicts Hashmi and Alam [44], yet aligns with Shi et al. [45], who argued that a 1% increase in total population causes a decline of 0.182% and 0.147% in carbon emissions in upper-middle-income and high-income countries, respectively. In addition, our result is consistent with Khanal [46], who revealed that a higher total population decreases carbon emissions in the long run in Australia.

According to our estimated results, tourist arrivals and the other explanatory variables (EC and GDP) also have a positive and significant effect on carbon emissions in the short run in Australia. This is understandable, as the effect of tourism, energy and economic growth on CO_2 emissions and climate change is both a long-term and short-term phenomenon. Hence, this study concludes that tourism, energy and GDP exerts a positive and statistically significant effect on CO_2 emissions in Australia, both in the long run and the short-run. This supports previous studies that also found both a short-run and long-run effect [29,31].

Thus, Australia must make a significant effort to modify its industry/trade structure, to moderate tourism growth to reduce pressures on the environment arising from that source, and to invest in low-carbon technologies to meet existing emissions objectives and proceed towards decarbonisation or a zero-carbon economy.

6. Conclusion

Climate change has become a major issue affecting people all over the world as a result of rising GHGs in the atmosphere. The research on climate change and tourism has mostly concentrated on the effects of a changing climate on tourist demand. Evaluating tourism industry emissions and measures to decarbonise through international tourist arrivals has received little attention. Thus, this study used time series data of 44 years (1976–2019) to examine the nexus between international tourist arrivals, energy consumption, and CO_2 emissions controlling other variables. To estimate the relationship, this study used the unit root test, ARDL bounds test approach and Johansen-Juselius cointegration test. The results from the unit root tests indicate that all series are integrated at the first difference. The bounds test and the Johansen-Juselius cointegration test revealed that there exists a long-run relationship among the variables. According to the long-run coefficients estimated from the ARDL model, tourism, energy usage and GDP have a positive and significant impact on the environment. Moreover, the FMLOS and CCR results support the ARDL results, revealing that international tourist arrivals, primary energy consumption and economic growth are significant contributors to CO_2 emissions in Australia.

The findings of this study have several policy implications. The first is that policymakers in Australia should focus on building a more sustainable tourism industry, such as by promoting tourism-related infrastructure that uses green energy instead of fossil fuels, and by developing a transport system that uses clean energy through subsidies and other forms of assistance. Thus, supporting the use of environmentally friendly transportation and technologies is crucial, including encouraging the use push bikes for short distances. Policies should be implemented to develop a carbon-neutral tourism sector, which is particularly important for Australia, as it possesses many important natural tourist attractions (such as the Great Barrier Reef). Moreover, the results from this study also suggest implementing more efficient alternatives to attract green tourism including cleaner energy for land transportation, such as hybrid engines or even carbon-neutral transportation solutions, is one of them. The development of a sustainable tourism model would not only assist in preserving the world-renowned natural environment of Australia, but would also ensure continuous international tourist arrivals, as maintaining and improving the environment, biodiversity and ecosystems are key to future tourist arrivals. Adventure-based activities such as scuba diving and hiking should be promoted to minimise energy consumption and lessen environmental degradation. Development in solar, wind, hydrogen, and other technologies would help Australia to achieve zero-carbon, which is increasingly needed, given the country's emission reduction targets. The overall policy implications are a cautionary indicator and should serve as a warning call to the government and officials who are more concerned with changing how policies appear than how they function to achieve zero-carbon. To achieve the sustainable development goals and the zero-carbon mission, resource allocation needs to be enhanced. Tourism growth plans and associated market sectors must be re-assessed in light of the possibility for emission reductions in Australia. Imposing a carbon tax on tourism might help to achieve low-carbon tourism development.

To reduce the effect of tourism on CO_2 emissions, the Australian federal and state governments should focus on converting the carbon-intensive tourism industry into a more sustainable, 'green' industry. For example, strategies should be implemented to promote bicycle-oriented tourism (where possible) to replace motorised and fossil-fuel transport [34]. Further research and funding for the development of environmentally friendly technologies, especially those in relation to the tourism sector, should be provided by Australian governments.

Several factors contribute to the aforementioned long-run relationship between tourist arrivals and CO_2 emissions. Previous empirical studies have indicated that tourism-related transportation services contribute a significant amount of CO_2 emissions [70]. A large portion of tourism-related CO_2 emissions (nearly 95%) is associated with transport services, such as the aviation sector [71]. Further, increasing tourist arrivals contribute to growth in infrastructure development (e.g. accommodation, airports and roads), which contributes to CO_2 emissions [13]. Thus, the air transportation sector's (proxy for tourism) effect on GHGs seems to be neglected, which is an area for future research. Further research is also required to understand which types of tourism affect CO_2 emissions the most, and which tourist destinations in Australia are most affected. Moreover, a study on the impact of COVID-19 on tourism, and the consequences for the environment, could be a good focus for future research. The limitation of this study is that it focused on only one environmental element (carbon emissions) while disregarding other elements that may also be important.

Data availability statement

The data generated during and/or analysed in the current study are available in the ABS, BP Statistical Review of World Energy, and WDI repositories. The tourism data were collected from the ABS (2020) Overseas Arrivals and Departures (Cat. No.3401.0), https://www.abs.gov.au/Ausstats/abs@.nsf/glossary/3401.0. The GDP, GFCF and TP data were obtained from the World Development Indicators (2021) (https://datacatalog.worldbank.org/dataset/world-development-indicators). The data on CO_2 emissions and EC were acquired from BP Statistical Review of World Energy (2022). Retrieved from https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html.

Author contribution

Methodology, Software, Writing – review & editing. Avishek Khanal: Conceptualization, Writing – original draft, Data curation. Mohammad Mafizur Rahman: Conceptualization, Supervision, Validation. Rasheda Khanam: Conceptualization, Supervision, Validation.Eswaran Velayutham: Methodology, Software, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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5.2 Links and implications

Like other economic activity, tourism is closely related to environmental quality since it boosts energy use and therefore CO_2 emissions ingestion. This study's unique addition is that it combines tourism growth and pollution into a single framework, allowing for consideration of tourism's negative impacts (pollution) against its positive influence (economic growth) in a single framework, while also accounting for other factors such as energy, financial development, capital and population. This study also contributes to the expanding corpus of understanding the potential for decarbonisation to reduce emissions in Australia.

Thus, this thesis put efforts to accomplish four studies which examines the impact of tourism on earnings (Chapter 2), employment (Chapter 3), energy consumption (Chapter 4) and environment (Chapter 5). In the next chapter, the concluding discussion and policy implications have been presented based on these study findings.

CHAPTER 6: SUMMARY OF FINDINGS, POLICY IMPLICATIONS, AND DIRECTIONS FOR FUTURE RESEARCH

This research was motivated by the emergence of tourism policies in developed countries like Australia, and the debate on its implications for economic issues, such as earnings and EMP. In particular, empirical studies were scarce in this context to strengthen the policy framework or to put an impetus to the ongoing debate.

Tourism is considered to be one of the most important aspects of the Australian economy. Research shows that tourism can play a significant role in the economic development of a country, including the rise in income and EMP generation, where the effect of tourism on EMP is undeniable. This research explores and shows the changes in the economy as a result of international tourism activities impacting the 4E's (earnings, employment, EC, and the environment), where these aspects of tourism can bring either POS or negative changes in Australia.

The focus of this thesis dovetail with theoretical underpinning that is on the energy–growth–environment nexus because the tourism industry booms the economic growth through earning and employment and is strongly connected to EC and the environment. Fundamentally, the role of energy in the growth–environmental degradation plays a crucial role.

6.1 Key Findings

The main objective of this research is to empirically investigate the impacts of tourism on earnings (Chapter 2), EMP (Chapter 3), EC (Chapter 4), and the environment (Chapter 5). Based on the study's research questions (RQs) in Chapter 1, the key findings from the estimating method are summarised here:

RQ1: Does tourism have long-run impact on earnings (GDP)?

The empirical findings of RQ1 have been outlined in Chapter 2. This chapter investigates the impact of tourism on earnings. To conduct the study, we analyse the asymmetric long-run and short-run impacts of air passengers carried (a proxy for tourism) on GDP in Australia. The NARDL modelling approach is used to examine the nexus between the variables. We also examine the effects of some control variables (i.e., EC, FD, socialisation, and urbanisation) on economic growth. The findings reveal the POS and negative effects of air transportation on GDP and that the control variables have a POS effect on GDP in the long run.

RQ2. Does a long-run relationship between tourism and employment exist?

The empirical evidence from Chapter 3 suggests that a long-run relationship exists between tourism and EMP. This chapter examines the impact of international TAs on service sector EMP considering other determining factors. Here, international TAs are used as a proxy for tourism. The findings imply that TA has a long-term POS effect on service sector EMP and that a rise in TA intensifies service sector EMP in the long run, whereas a fall in TA shrinks employability. The findings support the tourism-driven EMP opportunities in Australia.

RQ3: Are tourism and energy consumption linked with each other?

This research examines the impact of tourism on EC, which is presented in Chapter 4. The long-term co-integration link between foreign visitor arrivals and primary energy usage in Australia is investigated in this study. Furthermore, the effects of GDP, gross fixed capital creation, FD, and TP on EC are investigated. To analyse the link, Dickey–Fuller, PP, ARDL bound, co-integration, and other major diagnostic tests are applied. TAs, GDP, and FD all have a considerable long-run co-integrating link with EC, according to the obtained results.

RQ4: Do tourist arrivals impact the environment?

The empirical evidence presented in Chapter 5 reveals the existence of environmental degradation due to international TAs in Australia. The findings contribute to a better understanding of the possible detrimental environmental consequences of large-scale tourist visits to Australia. The study looks at the relationship between foreign visitor arrivals and CO_2 emissions over a 44-year period (i.e., from 1976 to 2019). The ARLD bound test approach is applied to obtain both long-run and short-run coefficients. The estimated results indicate that tourism obstructs the achievement of zero carbon in Australia. Along with TAs, EC and GDP are also significant contributors that have a POS and statistically significant long-run relationship with carbon emissions. This study provides policy implications for zero carbon and sustainable tourism growth in Australia.

6.2 Policy Recommendations

The link between tourism and the environment, energy, and economics has been studied extensively in previous research. In addition to this, because tourism, economic growth, EC, and the environment are all interlinked, multiple studies have combined these four factors into an integrated framework to investigate their link in diverse tourism locations and provide appropriate policy suggestions.

Pollution and climate change caused by tourism are major concerns for nations worldwide, with significant implications for health, well-being, and economic growth. A high level of EC has aided the expansion of the Australian economy in the long term. Though Australia is one of the fastest-growing economies and popular tourist destinations, tourism has caused major environmental degradation.

The findings of this study support several important policy suggestions. Prior to the COVID-19 pandemic, the earnings from tourism, particularly, the air transportation industry, were one of the fastest growing. Appropriate planning will aid the aviation industry's revitalisation in Australia. Expanding the degree of networks in air transportation will enhance the national economy in the long term, allowing global business to be done. Furthermore, investment in air transportation infrastructure should be encouraged. For a country's continuous development and financial advancement, it is vital to build a secure, dependable, and cost-effective air transportation business. Governments, politicians, civil authorities, airlines, and travel and tourism firms should all have firm policy strategies in place. This will guarantee that the tourism industry's value is better understood, especially in countries like Australia. Furthermore, trustworthy partners have some leeway to create acceptable spatial framework methods to support the predicted growth in air transportation following the pandemic. As a result, policymakers should use the findings of this study to develop an effective strategy that promotes international commerce and tourism while also developing the air transportation industry to fuel economic growth.

To make service sector EMP predictable, the government may design and implement methods to assure steady arrivals throughout the year. Some strategies to boost tourism might include lowering visa restrictions and/or relaxing entry criteria. Furthermore, credit to the service industry, particularly tourism, should be encouraged. The national government may also encourage service exports to other nations in order to boost EMP in the service industry as a whole.

Given that growing EC is strongly linked to climate change and carbon emissions, Australia's tourism-induced EC must be reduced through proper regulations. To attain the necessary level of carbon emission reductions, regulators may need to give an incentive to the tourism industry's main stakeholders to use cleaner energy, carbon-neutral mobility, and hybrid energies. Hotels and other similar establishments should be encouraged to use renewable energy sources. For acquiring and installing environmentally friendly technology, the government might offer tax refunds or low-cost (e.g., interest-free) financing options. When compared to comparable economies, Australia's emission intensity is greater. Given the current trends in decomposition factors, improving energy efficiency will be important in the future to lower Australia's overall contribution to emission intensity. Tourism may contribute to the reduction of greenhouse gases, the mitigation of climate change, and the accessibility of energy for all by encouraging investments in clean energy sources.

Policymakers in Australia may emphasis on sustainable tourism business by encouraging green-energy-based tourism infrastructure and developing a clean energy transportation system through subsidies and other assistance. Policies to establish a carbon-neutral tourism industry should be enacted, which is especially vital for Australia because the country has many major natural tourist attractions (such as the Great Barrier Reef). To encourage green tourism, more efficient options are advised by a sustainable tourism model. The establishment of a sustainable tourism model will not only aid in the preservation of Australia's world-renowned natural environment, but also secure continued international visitor arrivals, as the environment, biodiversity, and ecosystem are critical to future TAs.

Furthermore, the Australian federal and state governments should work on turning the carbon-intensive tourism industry into a more sustainable green tourism business to lessen the impact of tourism on CO_2 emissions. For example, to substitute motorised and fossil-fuel transportation, policies should be undertaken to encourage bicycle-oriented tourism (where possible). Australian governments should offer more research and financing for the development of ecologically friendly technology, particularly in the tourism sector.

6.3 Key Contributions to the Literature

The outcome of this research will give an insight into the effects of tourism on earnings, EMP, EC, and the environment. The information will be helpful for tourism businesses and the government through an improved ability to make informed decisions on developing better strategies for the growth of the country and a better environment by understanding the trade-off between EMP and earnings on the one hand, and negative environmental impacts on the other hand. The results of this research will provide information to stakeholders, such as tourism business, Australian tourism enterprises, tourism leaders, and the government; these will be helpful to make informed decisions and strategies.

Many tourism stakeholders seek to know more about the economic impact of tourism. Some stakeholders for this research are policymakers, government treasuries, and project developers. Moreover, hotels or other tourism businesses may be interested in the economic and environmental aspects of tourism activities. How the study will contribute to the knowledge and a better understanding of the phenomena and the contribution to the academic literature is further discussed in detail.

The research contributes to the academic literature by addressing the current gap in explaining the effects of tourism on earnings in Australia. The purpose of this study is to extend the TLGH literature by analysing the relationship between tourism and earnings. The study aims to report the fit of theory and test its applicability to the tourism effects by ALGH. The findings of this study will help to close the gap in Australia's tourism–economic growth nexus and will improve ALGH policy by providing strong evidence for this concept based on credible data. The ALGH is investigated using the NARDL method. The discovery of a considerable beneficial influence of air transportation on economic growth in Australia over the research period is the study's main contribution. When formulating and implementing air transportation (tourist) and sustainable economic development strategies, policymakers should take into account the evidence offered here.

The research expects to contribute to policymakers who will have information about the earnings from tourism and can thus enhance the tourism growth. This study adds to the current literature in three significant ways. First, the study looks at a larger variety of tourism factors that are proxied by air travel, as well as other tourism-related variables. Second, this research shows the unequal impacts of air transportation and passengers on Australia's economic development. Third, the study incorporates the variable FD into the model, which has only been included in a few previous studies.

Despite research advances, knowledge concerning the service industry, EMP, and associated issues is lacking, particularly from an Australian viewpoint, even though this sector has the capacity to affect growth. Considering this, the purpose of this study is to investigate the effects of TAs, MC, FD, and trade volume on service sector EMP in Australia. The findings of this study are likely to contribute to the existing body of literature in two ways: first, by compiling seemingly disparate determinants in the analysis of EMP in the service sector, as this study recognises the importance of various service-oriented industries; and second, by combining seemingly disparate determinants in the analysis of EMP in the service sector.

This work has addressed a critical research gap by analysing the relationship between tourism and EC in the context of Australia, as this is the first study of its kind in the country, according to the authors. Our key contribution is that we have discovered a considerable influence of TAs on energy usage, which has potential negative environmental consequences that policymakers should take into account when developing and implementing energy and tourism regulations. Our findings have ramifications not just for Australia, but for other nations as well.

Policymakers, government authorities, local government, and tourism leaders will benefit from the analysis of tourism's impact on the environment. This research adds to the current body of knowledge in the following ways. First, the study aims to present fresh empirical evidence based on the most recent data available in the literature on the tourism–environment nexus. Although several studies have looked into the energy–growth–environment nexus, only a few have looked into the influence of tourism on carbon emissions in isolation from the energy–carbon–tourism nexus. Second, as previously indicated, Australia attracts a large number of visitors, and their travel emits a large amount of CO_2. As a result, it is very important to analyse the link between tourism and the environment. The impact of tourism on carbon emissions in various nations has been studied extensively in the literature. To our knowledge, however, no study has looked at the link between tourism and carbon emissions in Australia, mainly to achieve 'zero carbon'.

Third, unlike previous studies, the link between TAs and CO_2 is investigated in this study by using three different stationarity properties, namely ADF, PP, and Zivot-Andrews (ZA). The ARDL co-integration test is used to determine the long-run relationship between the variables. This research also covers the gap of omitted variable bias.

6.4 Limitations and Direction of Future Research

Tourism is an economic activity that provides the opportunity of stimulating global economic growth. It has the potential to increase earnings, create job opportunities, and influence the socioeconomic framework of a nation. Tourism facilitates the earnings from foreign exchange, and thus plays an important role in the advancement of economic development; this development, therefore, leads to the growth of the country. In this study, every effort was made to employ as many observations as possible, but there should be some caution to the interpretations due to the size of the sample. Though, this research has covered the economic and environmental effects of tourism, there are various limitations to this study that might be investigated further in future studies.

Firstly, the study's limitation is that it measures the air transportation industry by the number of passengers carried. Future study might use different variables, such as the volume of freight (million tonnes per kilometre) and recorded carrier departures throughout the world to measure this. Furthermore, data collected on a monthly or quarterly basis might be used to assess the link between air travel and economic growth over time. In addition to this, this research primarily examines the topic from a macroeconomic standpoint and only gives a broad overview of passengers carried by Australia's air transportation. As a result, it is advised that future research re-examine the issue utilising micro-level data, such as inbound visitor survey data. In comparison to research based on macro data, such conclusions would be more exact and insightful.

Secondly, this study investigates the EMP in services (% of total EMP) to examine the impact of tourism on EMP in Australia. Hence, it is advised that in future, the effects of tourism on EMP can be examined by utilising the aggregate total EMP. The second restriction relates to the tourism category. This study solely looks at inbound tourism in Australia and ignores local tourism. As a result, the importance of domestic tourism in economic growth and domestic tourist demand behaviour in Australia are beyond the scope of this study. When such data becomes accessible, future research should analyse the influence of domestic tourism on EMP sector and demand for domestic tourism in Australia.

Thirdly, policymakers, government officials, and tourism-related officials will need further study to investigate the impact of tourism and energy relationships in the context of the present COVID-19 scenario, which includes air travel, travel, and tourism. COVID-19's disruption analysis would aid in coping with the economy and might be broadened to assist the economy recover. However, the absence of a variable bias, which has different priorities in each country, as well as political, social, and institutional variables that may affect the tourism and its impact on environmental sustainability because of maximum energy usage, is a limitation of this study.

Future study will need to estimate these dynamics in order to assess the EC in the presence of the EKC framework.

Lastly, the impact of GHGs on the air transportation industry (a proxy for tourism) appears to be overlooked, and this is an area where additional research is needed. More study is needed to determine which forms of tourism have the most impact on CO_2 emissions, as well as which tourist sites in Australia are the most affected. In addition, the study's flaws might be attributed to the fact that it only looks at one type of environmental issue (i.e., carbon emissions), while disregarding others, such as methane and nitrous oxide. Meanwhile, this research is restricted to current time periods and the use of advanced econometric methodologies. Future research can be reconsidered while addressing these limitations. Although this study has provided some new insights into the factors affecting CO_2 emissions in Australia, in particular the relationship between tourism and the environment, this remains a new area of research and further study is needed to add to a fuller understanding of all the related issues. In addition, emission calculator can be used to determine what different air carriers (proxy to tourism) contribute what percent of CO2 emissions if this opportunity available. However, it does show where new avenues of research can be conducted to show ongoing trends.

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