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EXPLORING THE LINEAR AND NON-LINEAR EFFECT OF TOURISM ON ECONOMIC GROWTH IN CABO VERDE: EVIDENCE FROM ARDL AND NARDL MODELS

Rodolfo Varela Tavares

Dissertation

presented as partial requirement for obtaining the Master's Degree Program in Statistics and Information Management

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Instituto Superior de Estatística e Gestão de Informação
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By

Rodolfo Varela Tavares

Master Thesis presented as partial requirement for obtaining the Master's degree in Statistics and Information Management, with a specialization in Information Analysis and Management

Supervisor: Prof. Bruno Damásio, PhD.

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STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration. I further declare that I have fully acknowledge the Rules of Conduct and Code of Honor from the NOVA Information Management School.

Rodolfo Tavares

Praia City, 29th November 2023

DEDICATION

To my son Rafael Enzo Tavares (Raffa)

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ABSTRACT

Tourism plays an important role in the economic and social development of Cabo Verde. The purpose of this thesis is to investigate the linear and non-linear effects of inbound tourism on economic growth in Cabo Verde and, through this analysis, draw conclusions regarding the Tourism-Led Economic Growth hypothesis. We achieve this by relying on bonds test for cointegration and the Toda-Yamamoto approach to Granger Non-causality test through the Linear Autoregressive Distributed Lags model and Non-Linear Autoregressive Distributed Lags model. Using quarterly data over the period of first quarter of 2007 and second quarter of 2023, visitor arrival and real GDP as respective proxy for international tourism and economic growth, we examine the long-run association and report the elasticity coefficient of tourism and causality nexus, accordingly. Using Bai-Peron test for multiple breakpoints, we note three structural break periods (third quarter of 2011, third quarter of 2016 and first quarter of 2019) in the output series. In the autoregressive distributed lags model the break periods, third quarter of 2016 and first quarter of 2019, showed statistically significant estimates and, hence, were retained in the final estimation. Subsequently, the regression results show the two series are cointegrated. The short-run elasticity coefficient of tourism is estimated to be 0.067 and the long-run is 0.10, meaning that a 1% increase in visitor arrival (tourism) is expected to increase real GDP by 0.067% and 0.10% in the short-run and the long-run, respectively. From the linear perspective, a bidirectional causality between tourism and economic growth is noted for Cabo Verde which indicates that tourism expansion and output mutually reinforce each other. Expanding the analysis to non-linear perspectives, we conclude that although there is no evidence of long-run asymmetric effects of tourism expansion on economic growth in Cabo Verde, there is evidence of this asymmetry in the short run, indicating that the effect of tourism on economic growth is different for positive changes compared to negative changes. In response, socio-economic policies should prioritize expansive, inclusive, and income-generating tourism development projects, expected to yield significant feedback effects. These development strategies should integrate tourism into broader national development plans, emphasizing inter-sectoral linkages. Furthermore, expanding the issuing market should be a crucial endeavor for the sustainable and diversified advancement of tourism.

KEYWORDS

Autoregressive Distributed Lags model; Non-Linear Autoregressive Distributed Lags model; Asymmetric effects, Bonds test for cointegration; Toda-Yamamoto approach, Granger non-causality test; Tourism-Led Economic Growth; Cabo Verde.

Sustainable Development Goals (SGD):

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LIST OF ABBREVIATIONS AND ACRONYMS

I_d	Stationarity of order d.
$\boldsymbol{H_0}$	Null hypothesis in a regression.
$\boldsymbol{H_1}$	Alternative hypothesis in a regression.
$\boldsymbol{R^2}$	Goodness of Fit for a regression.
$\boldsymbol{p_j}$	Lag selection of fit for a regression.
χ^2	Qui-Quadrada.
ADF test	Augmented Dickey-Fuller test.
Adj-LR	Lag order adjusted sequential.
AIC	Akaike Information Criterion.
AR	Autoregressive.
ARDL	Autoregressive Distributed Lags.
BCV	Banco de Cabo Verde.
BLUE	Best Linear Unbiased Estimator.
BRIC	Group of developing countries composed for Brazil, Russia, India, and China.
CPI	Consumer Price Index.
CUSUM	Cumulative Sum of The Recursive Residuals.
CUSUMSQ	Sum Of Squared Recursive Residuals.
CVE	Cabo Verde Escudos.
Df	Degree of Freedon.
ECM	Error Correction Model
ECT	Error Correction Term.
ELTG	Economic-Led Tourism Growth.
FDI	Foreign Direct Investment.
FPE	Final Prediction Error.
GDP	Gross Domestic Product**.**

GMM	Generalized Method of Moments.
HDI	Human Development Index.
HQ	Hannan–Quinn information
INE	National Statistics Institute (Instituto Nacional de Estatísticas de Cabo Verde).
NARDL	Non-Linear Autoregressive Distributed Lags.
OLS	Ordinary Least Square.
PP test	Phillips-Perron test.
QQ	Quantile-on-Quantile.
RER	Real Exchange Rate.
RESET	Ramsey Regression Specification Error Test.
SIC	Schwarz Information Criterion.
SIDSs	Small Island Developing States.
SD	Standard Deviation
TDY	Toda–Yamamoto.
TLEG	Tourism-Led Economic Growth.
U. S dollar	United States dollar (official currency of the United States).
UN	United Nations
VA	Visitor Arrivals.
VAR	Vector Autoregressive.
VECM	Vector Error Correction Model.
WTTC	World Travel & Tourism Council.
$\boldsymbol{F-stat}$	F statistical test.
$\boldsymbol{n}$	Sample size.
$\boldsymbol{t}$	Time unit measured in quarters.
$\boldsymbol{t-test}$	t statistical test.

1. INTRODUCTION

Tourism has gained recognition over time as a critical sector that positively impacts the economy in multiple ways. Through its primary effects, also called direct effects, and secondary effects (indirect and induced effects), the development and expansion of international tourism, especially in developing countries, can help reduce poverty, alleviate balance of payments deficits, and promote economic growth and development in a particular region (Alcalá-Ordoñez et al., 2023; H. Liu et al., 2022; Nunkoo et al., 2020). Thus, international tourism promotes economic growth in developing countries by accumulating foreign exchange income, one crucial resource in the process of importing others goods and services, sustaining the level of international reserves, and, through its multiplier effects, contributes to generate employment, increase income, stimulating investments in various infrastructures (e.g., roads, transportation, hotels, restaurants, and telecommunications networks), while promoting economies of scale and stimulating investment in human capital (Brida et al., 2016; Dibeh et al., 2020; Dogru & Bulut, 2018). Additionally, tourism can drive growth and development in other important sectors of the economy through direct, indirect, and induced effects, including agriculture, fishing, retail, construction, manufacturing, and transportation, leading to economic growth in the host country (Dibeh et al., 2020; Mbulawa & Chingoiro, 2017). Effectively, Brida et al. (2016) notes that when tourism expenditure rises, it can trigger increased activity in associated industries and therefore, integrating tourism into the national economy through strong linkages with other sectors and utilizing local products and services can maximize economic benefits and generate additional income. Among other ways, tourism economics researchers claim that tourism can contribute to enhancing efficiency and competitiveness in developing countries through various mechanisms. It promotes competition in the domestic market, encourages local businesses to improve their products and services to meet tourists' demands, and exposes the local economy to foreign ideas and business practices. This exposure stimulates innovation, enhances the local workforce's skills, increases productivity, and ultimately boosts economic growth. Recognizing this dynamic, many countries have devised strategies to strengthen their tourism sectors, with the aim of taking advantage of the economic and social advantages it offers. Other countries, mainly island states, even consider tourism in the country's macro strategic plan as being the engine of economic growth (Tavares, 2020). This heightened interest has ignited substantial academic discourse on how international tourism can drive overall economic growth, fueling extensive discussions in this field (Nunkoo et al., 2020; Tang & Tan, 2015; Wong et al., 2023).

While there is a broad consensus on the importance and positive effects of the tourism sector in relation to economic growth, there is still an ongoing empirical debate on how the causal relationship between the two operates (Nunkoo et al., 2020). For some existing ones on this topic presented non-consensual conclusions, underscoring the necessity for additional empirical investigations (Opuala et al., 2022). The issue that still needs to be addressed, as noted by Lolos et al. (2021), is whether international tourism acts as a driver for economic growth, or if it is another way around, or whether there is a two-way causal relationship between the two variables, or even no causality relationship at all. In this regard, several studies have already validated the tourism-growth nexus, both from the perspective of tourism-led economic growth (TLEG), i.e., unidirectional causality from tourism to growth (e.g. Adnan Hye & Ali Khan, 2013; Balaguer & Cantavella-Jordá, 2002; Gunduz & Hatemi-J, 2005; N.N. Kumar et al., 2022; Lolos et al., 2021; Opuala et al., 2022; Sokhanvar et al., 2018; Tang & Lee, 2022; Surugiu & Surugiu, 2013) , as in the perspective of economic-driven tourism growth (EDTG), i.e. unidirectional causality from growth to tourism (e.g. Ahiawodzi, 2013; Oh, 2005; Payne & Mervar, 2010; Sokhanvar et al., 2018). There are also other studies that suggested a bi-directional causality between tourism and growth (e.g., Gounder, 2022; Kim et al. 2006; Massidda & Mattana 2013; Perles-Ribes et al., 2017; Phiri, 2015; Ridderstaat et al., 2014; Sokhanvar et al., 2018; Tang, 2013). However, one can also find a few authors who reported neutral causality between tourism and growth (e.g., Eyuboglu & Eyuboglu, 2019; Jackman & Lorde, 2010; Katircioglu, 2009).

Accordingly, the debate on tourism-growth nexus persists until this moment, encouraging the extension of empirical investigations that allow to bring new evaluations. Meanwhile, in the case of Cabo Verde, a small island state which has chosen tourism as the engine of economic growth (Tavares, 2020) and that whose economy largely depends on tourism (tourism represent 25% of GDP according to World Bank), there is a lack of existing studies on this topic. Even in the group of empirical research applied to groups of island countries (e.g., Alcalá-Ordóñez et al., 2023; Roudi et al., 2019; Seetanah, 2011), Cabo Verde has been neglected. Through research carried out and based on available information, the only effort made to analyse the dynamic link between tourism and economic growth in Cabo Verde is the work of Andrade (2020), work this entitled "The impact of tourism on economic growth: evidence from Cabo Verde" and published in the International Journal of Research in Commerce and Management Studies, where the objective was to analyse the impact of tourism on economic growth for the period 1990-2017. Through the Autoregressive Distributed Lags (ARDL) bounds testing approach and using variables such GDP, exchange rate, inflation rate and political stability, the author concludes that the results support the TLEG hypothesis in Cabo Verde and that there is a unidirectional association that goes from tourism receipts to GDP. Considering that this topic remains a subject of debate due to the inconsistencies and varying conclusions found in numerous empirical studies, which can obscure the policymaking process to harness the potential benefits of the tourism sector (Opuala et al., 2022), it is of paramount importance to conduct additional empirical research on tourism-growth nexus with a focus on Cabo Verde in order to provide a more diverse and credible set of information, aiding stakeholders in the tourism sector to make informed decisions. The significance of the Cabo Verde case in the context of tourism-growth nexus lies in its provision of fresh insights into how tourism dynamics intersect with economic growth, especially amidst challenges posed by the COVID-19 pandemic and also in the context of the ongoing challenges presented by "Ukraine crises". The scarcity of comprehensive and diverse empirical studies examining this relationship in Cabo Verde, despite its heavy reliance on tourism, underscores the critical importance and relevance of this research. In this way, this work intends to proceed from the TLEG hypothesis, the main theoretical basis of this investigation, to explore the influence of international tourism on economic growth from both linear and non – linear perspectives. Therefore, this investigation has two objectives: i) to examine the relationship between tourism and economic growth in Cabo Verde and, through this analysis, draw conclusions regarding the TLEG hypothesis; ii) to ascertain whether the relationship between tourism and economic growth in Cabo Verde exhibits asymmetry. The rest of this dissertation is organized as follows. The second section presents a brief overview of the economy and tourism dynamic in Cabo Verde. The third section presents a review of literature with related studies on this topic. Data and Methodology are outlined in Section 4. Empirical results and discussion are presented in Section 5. Finally, Section 6 concludes and presents policy implications.

2. A BRIEF OVERVIEW OF ECONOMY AND TOURISM DYNAMIC IN CABO VERDE

Cabo Verde is a ten-island archipelago, nine of which are inhabited, located approximately 500km off the west coast of Africa. With a population, according to the 2021 Census, of approximately 491 thousand people, the country is scarce in natural resources and only 10% of its territory is classified as arable land, while the country has experienced severe droughts (World Bank, 2023). Agriculture is made difficult by lack of rain and is restricted to only a few islands for most of the year. Cabo Verde has an economy based essentially on the services sector that is focused on commerce, trade, transport, and public services. According to the World Bank (2023), Cabo Verde's economic growth trajectory since the late 1990s, marked by its transition from UN's Least Developed Country category to a lower middle-income country in late 2007, is significantly supported by the rapid growth of its tourism industry. In fact, the tourism is so important for Cabo Verde that its gross revenues represent approximately 25% of the country's GDP (World Bank, 2023) while it is the sector that most contributes to service exports (more than 60%), being the major source of foreign exchange earnings and foreign direct investment (FDI) (Banco de Cabo Verde [BCV], 2023). From the end of the 90s of the last centuries until today, the country registered substantial growth in its per capita income, thus doubling its GDP per capita, going from 1,797.3 U.S. dollar in 1999 to 3,642.9 U.S. dollar in 2022. The World Bank recognized the country for its substantial advances in reducing poverty until 2019, a situation that was challenged by the repercussions of the COVID-19 pandemic and the crisis in Ukraine. This global scenario dramatically impacted the country's economy in 2020, recording a historic drop of 21% in GDP (National Statistics Institute [INE], 2023). However, the economy showed resilience in 2022, achieving growth of 17.1%, driven mainly by the resurgence of the tourism sector, surpassing pre-pandemic levels. Exports, private consumption, and key sectors such as accommodation, commerce and transport contributed significantly to this growth, while poverty reached the value of 29.1% (based on national poverty threshold), according to information from the World Bank.

Cabo Verde as an Island states, with strategic geographic location and its natural tourist attractions, mainly its extensive beaches, tourism is configured as a sector that plays and has played an extremely important role in the Country's economic progress. Despite being a poorly diversified sector, essentially characterized by the Sun and Beach model and dominated by the all-inclusive model (AIs), anchored in some international brands (particularly RIU and Meliá), with an emphasis on the Sal and Boa Vista Islands (Tavares, 2020; World Bank, 2019), the importance of the sector for the country's economy is substantial. In fact, the tourism sector in Cabo Verde is one of the biggest employers that provides direct and indirect employment for the workforce, with a substantial share of total GDP, visitor exports and investment (mainly FDI). Data from the World Travel & Tourism Council [WTTC] (2022) report even showed that in the year 2019 the total contribution of travel and tourism to GDP in Cabo Verde was 37.8%, a value that declined to 16.8% and 13.5% in 2020 and 2021, respectively, because of the COVID-19 pandemic. The same report records that the total contribution of travel & tourism to employment was 47.6%, 31.3% and 30.0%, respectively in 2019, 2020 and 2021. In terms of sector dynamics, Cabo Verde has witnessed an accelerated pace of international tourist demand in the last two decades, with international arrivals jumping from 115 thousand tourists in the year 2000 to 758 thousand tourists in 2019 (+559%). Despite the devastating decline of 76% in 2020 because of the effects of COVID-19, with the recovery, hotel establishments in Cabo Verde registered a historic figure of 785 thousand guests in 2022, a number higher than the pre-pandemic period (see Figure 2.1). Gross tourism revenue as a proportion of GDP also recorded positive developments, reaching 25% in

2019. However, the tourist outbound market for Cabo Verde is concentrated in a small number of countries on the European continent. The data from National Statistics Institutes (INE) shows that the top three dominating source markets based on visitor arrivals to Cabo Verde are United Kingdom (33%), Germany (12%) and Portugal (11%) (Table 2.1). From the same perspective, in terms of tourist offerings, the growth dynamics have been notable. Regarding the tourism industry's infrastructure, statistics obtained from INE's Annual Inventory of Hotel Establishments in 2022 report 296 active hotel establishments. This represented a substantial increase of 236% compared to values recorded in 2000. These hotel establishments provided an aggregate capacity of 15,257 rooms and 28,851 beds. Comparatively, in 2000, the respective capacity figures were 2,391 rooms and 4,475 beds.

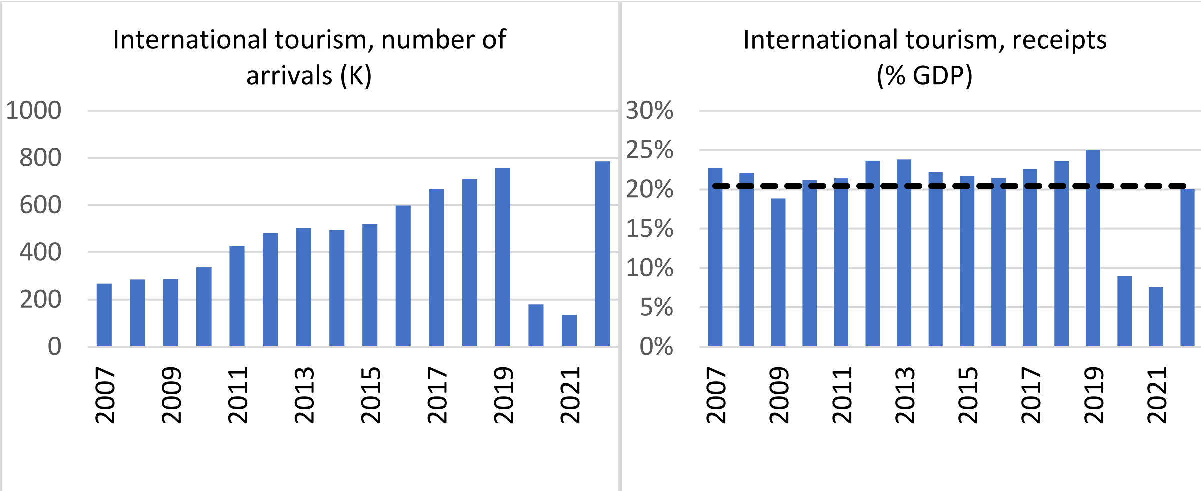

Figure 2.1 – Evolution of international tourism demand in Cabo Verde (2007-2022)

Source: INE, BCV, World Bank Data and Author own calculations. Note: (K) mean in thousands of tourists

Table 2.1 – Key source markets for international tourism demand in Cabo Verde (2000-2022)

Sources	2000-2014	2015	2016	2017	2018	2019	2020	2021	2022	Share (% in 2022)
United Kingdom	67	127	132	169	174	197	40	11	258	32.9%
Germany	51	76	71	80	90	92	23	17	96	12.2%
Portugal	65	62	65	68	71	80	13	28	88	11.2%
Belgium + Netherlands	20	60	62	70	77	80	21	11	88	11.2%
France	35	56	65	70	77	85	24	10	47	6.0%
Spain	10	9	11	12	14	18	3	3	15	1.9%
Italy	64	27	49	40	31	26	5	1	12	1.5%
United State	4	4	5	6	7	9	2	4	10	1.2%
Switzerland	4	5	7	11	10	14	3	2	8	1.0%
Austria	1	2	2	2	3	7	2	0	3	0.4%
Others	54	89	130	141	155	150	44	46	160	20.3%
Total	**375**	**520**	**598**	**668**	**710**	**758**	**180**	**135**	**785**	**100.0%**

Source: INE and Author own calculations.
Note: number in thousands of tourists. Average values over 2000–2014.

3. LITERATURE REVIEW

The relationship between tourism development and economic growth has been extensively studied in the last two decades (A. Liu et al., 2022; Brida et al., 2016; Fonseca & Sánchez-Rivero, 2020a, 2020b, 2020c; Nunkoo et al., 2020). Inbound tourism is commonly regarded as a form of export, and researchers have contended that exports can stimulate technological advancements and enhance total factor productivity, thereby leading economic growth (Song & Wu, 2022). This idea aligns with the export-led growth hypothesis (ELGH), which emphasizes that expanding exports can boost economic growth in addition to increasing labor and capital within the economy. Notably, Balaguer and Cantavella-Jordá (2002) were among the pioneering researchers to formalize and evaluate the TLEG hypothesis. The conclusion drawn was that international tourism is a vital driver of a country's economic growth. Taking Spain as a case study during the period 1975Q1-1997Q1, including variable such as real gross domestic product (GDP), international tourism earnings and real effective exchange rate, the authors, through Johansen's cointegration methodology and Granger causality tests, found a long-run stable relationship between tourism expansion and economic growth, as well as the unidirectional causality running from tourism to growth. With this framework, they established the underpinnings that substantiate the TLEG Hypothesis. This framework provided both the crucial theoretical and empirical groundwork, paving the way for subsequent studies in this field. Essentially, the TLEG hypothesizes that, over time, the growth and expansion of international tourism can lead to the development and improvement of the economy, with tourism as the driving force, or, as attested by Tan and Lee (2022, p.189), "TLEG means that from a positive long-run perspective, a unidirectional causality runs from tourism growth and increase to economic development". Brida et al. (2016) argues that, similarly to ELGH, the TLEG hypothesis aims to analyze the short and long run relationship between international tourism and economic growth over time and, consequently, their causalities. However, Nunkoo et al. (2020) observe that while the outcomes regarding the time-varying impact of tourism on economic growth remain inconclusive, it's improbable for economies to reap the complete benefits of tourism in the short run. Rather, these benefits are likely to be fully realized in the long run. Among other justifications, they support this assertion by explaining that "Tourism, through its multiplier effects, achieves its full potential in the long run by bringing in foreign exchange that facilitates the purchase of capital goods for producing other goods and services that are necessary for promoting economic growth" (Nunkoo et al., 2020, p.14).

Given the vital role of international tourism in a country or region's economic growth, and since the formulation and dissemination of TLEG hypothesis by Balaguer and Cantavella-Jordá in 2002,the empirical literature has witnessed a large volume of studies assessing the TLEG hypothesis through the application of a variety of econometric methods for cointegration and causality, including: - vector error correction model (VECM)—Johansen—Granger causality analysis, vector autoregressive model (VAR)—Johansen—Granger causality analysis, autoregressive distributed lag model (ARDL) — bonds tests—Granger causality analysis and Toda–Yamamoto (TDY) approach to Granger non-causality analysis, using distinct types of data (cross-sectional, time series, panel data), and data frequency (monthly, quarterly, annually), and taking as case studies, specific countries, or regions (Fonseca & Rivero, 2020a; Song & Wu, 2022). In this context, different proxies have been used to measure international tourism and economic growth. Most researchers have used proxy for "Tourism" like tourist arrivals, tourism exports, tourism receipts, or tourism expenditure while GDP, GDP per capita, real GDP, real GDP per capita, industrial production growth rate, or the growth rate of GDP per capita in the destination are the various metrics used to measure economic growth (Brida et al., 2016; Fonseca & Sánchez-Rivero, 2020a; Gounder, 2022; Nunkoo et al., 2020; Song & Wu, 2022). Although Brida et al. (2015) state that the number of arrivals is the most used, Lolos et al. (2021) adds that all the other indicators mentioned are suitable for empirical research due to the strong positive correlation among them. However, Song and Wu (2022) note that different proxies used to measure international tourism lack strong theoretical foundations and are often labeled as "tourism development," "tourism activity," "tourism growth," "tourism expansion," or just "tourism". The authors further argue that the Solow growth model (Solow 1956), which considers capital stock, labor stock, and technical progress as the primary drivers of economic growth, has been the predominant theoretical basis and framework in TLEG hypothesis studies. Nevertheless, empirical literature has seen significant adaptations in modeling approaches. Consequently, diverse results and conclusions have been reported. For example, Surugiu and Surugiu (2013) used the cointegration method and Granger causality analysis based on VECM model to study the long-run relationships between tourism expansion and economic growth in Romania during the period 1988–2009 and found evidence in support of the TLEG hypothesis. Mbulawa and Chingoiro (2017) applying Johansen cointegration method—Granger causality test based on VAR model specification of growth rate of GDP, trade openness, foreign direct investment (FDI) and consumer price index (CPI) support the TLGH hypothesis in Botswana for the period 1980–2015. In the context of ARDL framework and the Johansen-Juselius cointegration test, Adnan Hye and Ali Khan (2013) examined the long-run relationship between income from tourism and the economic growth in Pakistan by using the annual time series data of 1971–2008 and stated that income from tourism has led economic growth in Pakistan except in the years 2006, 2007, and 2008. R. R. Kumar et al. (2016) also validated the TLEG hypothesis for the Cook Islands using the ARDL approach. Using visitor arrival and output in per capita terms as respective proxy for tourism development and growth for the period 2009Q1–2014Q2, employing bonds test for cointegration and Toda-Yamamoto to Granger non-causality approach, they reported a long-run relationship between tourism and economic growth, as well as the bidirectional causality between the two variables. Solarin (2018) also using the Toda-Yamamoto to Granger non-causality test, validated the TLEG hypothesis for the period 1980–2011 in 6 of the 10 markets analyzed in Mauritius. In turn, Wong et al. (2023) examined the link between international tourism development and economic growth in Singapore, a global city-state, through the ARDL model and cointegration analysis. Using quarterly data over the period 1991Q1 - 2020Q4, their findings revealed that international tourism development leads economic growth by two quarters, implying that small countries, exemplified by Singapore, can use a robust tourism sector to drive economic growth and navigate challenges like those brought about by the COVID-19 pandemic. Within the context of panel data several studies also support the TLEG Hypothesis. Chou (2013) by applying the bootstrap panel causality approach examined the relationships between tourism spending and economic growth in 10 transition countries for the period 1988–2011 found results that support the TLEG Hypothesis for Cyprus, Latvia, and Slovakia. Etokakpan et al. (2019) also in a panel data approach found a bi-directional causality between the two indicators in a top four agricultural producing economies (Brazil, Russia, China, and the United States) over the period 1995-2015, thus supporting the TLEG hypothesis. The authors reached this conclusion by applying the bootstrap panel co-integration and Dumitrescu-Hurlin Granger causality test in a model specification of agricultural value added, effective exchange rate and international tourism receipt. Usmani et al. (2021) also applies Dumitrescu–Hurlin causality test in a panel data models to examine the impact of tourism arrivals and tourist expenditure on economic growth in BRIC countries (Brazil, Russia, India, and China) from the period 1995- 2016 and the results showed that the tourist expenditure has a positive impact on economic growth and the tourist arrivals do not have any significant effect on economic growth. In terms of causality direction, the results showed that tourist expenditure has bidirectional causality with economic growth, what validates TLEG and EDTG at the same time. For small economies, two research can be highlighted. On the one hand, Seetanah (2011) who assessed the dynamic economic impact of tourism on 19 island economies between 1990 and 2007 using Dynamic Panel Data Regression and GMM (Generalized method of moments) methodology and, on the other hand, Roudi et al. (2019) who applied the heterogeneous panel ARDL cointegration methods and Dumitrescu–Hurlin causality to examine the long-term equilibrium and Granger causality relationship between tourism and economic growth for small island developing states (SIDSs) between 1995 and 2014. The first included in the model control variables such as energy consumption and FDI and the last included proxy for investment in physical capital, human capital, openness of economy and economic freedom, and both report a bidirectional causality between tourism and economic growth (TLEG and ELTG). But also, recently Alcalá-Ordóñez et al. (2023), using a panel data approach and relying on Dumitrescu–Hurlin causality test, analyzed the tourism and economic development for some selected island countries. Using variables such as the number of international tourist arrivals (proxy for tourism), the Human Development Index (HDI) (proxy for economic development) and the total number of residents (proxy for Inhabitants) and the result reinforces the conclusion about bidirectional causality between tourism and economic growth presented in previous studies. They also concluded that in addition to tourism leading economic growth in economic islands, it is also a tool for economic development in these same countries. In contrast, there are other studies that invalidated the TLEG hypothesis and supported only the EDTG hypothesis. For example, Oh (2005) investigated the causal relations between tourism growth and economic expansion for the Korean economy for the period 1975Q1-2001Q1 and found a result that supports this hypothesis. Using the bivariate (real aggregate tourism receipts and real GDP) VAR model and Granger causality test, the author concluded that although there is no long-run equilibrium relation between the two variables there is the one-way causal relationship from growth to tourism. In the same vein, Payne, and Mervar (2010) using quarterly data from 2000Q1 to 2008Q3 and the Toda–Yamamoto long-run causality tests found positive unidirectional causality from real GDP to international tourism revenues, thus supporting the EDTG hypothesis for Croatia.

Recently non-linear, and asymmetric models have gained a lot of strength in this topic due to the possibility of a non-linear relationship between tourism and growth (Balsalobre-Lorente et al., 2021; N.N. Kumar et al., 2020; Lolos et al., 2021; Opuala et al. 2022). For example, Brida et al. (2015) points to the tourism degree of specialization of the country analyzed, which changes the effects of tourism growth, as one of the causes of non-linearity in this relationship. Business cycle effects and structural breaks are other possible factors suggested in the works of Chiou-Wei, Chen, and Zhu (2008) and, Smeral (2018) as possible factors of the nonlinearity in macroeconomic indicators and, consequently, in the relationship between tourism and growth. In this regard, Brida et al. (2013) warns that assuming only a linear relationship between the two indicators can lead to an inaccurate inference. Indeed, Wang (2012) using data for the period 1996–2006 on the top 10 countries in the 2008 Country Brand Index and investigated the threshold effects on the relationship between tourism development and economic growth, raising concerns about the findings of a linear relationship. Phiri (2015) using a linear and non-linear framework examined the cointegration and causal effects between tourism and economic growth in South Africa for the period of 1995-2014. In the non-linear framework, using threshold models, he reported a bi-directional causality between tourist receipts and economic growth and no causality between tourist arrivals and economic growth. Shahzad et al. (2017) employed the quantile-on-quantile (QQ) approach to examines the empirical validity of the TLEG hypothesis in the top ten tourist destinations in the world (China, France, Germany, Italy, Mexico, Russia, Spain, Turkey, the United Kingdom, and the United States) over the period 1990–2015, estimating the impact of tourism growth quantiles on output growth quantiles. Opuala et al. (2022) validated the TLEG hypothesis in Mauritius by relying on ARDL and the quantile ARDL model using annual time series between 1980 and 2018 to study the dynamic role of financial development in the N-Shaped TLEG hypothesis in Mauritius. They also warned of possible nonlinear effects in the tourism-growth nexus in that country. On the other hand, Lolos et al. (2021) applying quantile regression analysis through the application of a threshold cointegration and an asymmetric error-correction model and, investigated the TLEG asymmetries in Greece over the period 1977Q1-2020Q2 in a bivariate specification of GDP per capita and the number of international tourist arrivals and their results supported the TLEG hypothesis for that country. The non-linear ARDL (NARDL) model approach has also gained a lot of attention on this topic. It stands out, for example, Balsalobre-Lorente et al. (2021) who used the NARDL model, and non-parametric causality test validated the asymmetric long-run effect of air transport on economic growth assuming a process of social globalization in Spain between 1970 and 2015, within the context of the TLEG hypothesis. In turn, N.N. Kumar et al. (2020) and N.N. Kumar et al. (2022) also using the asymmetric nonlinear ARDL through bounds approach to cointegration and Toda–Yamamoto approach to Granger non-causality test estimated the long-run asymmetric effect of tourism on economic growth in the Cook Islands and Papua New Guinea, respectively. Using quarterly data in a bivariate specification of real GDP per capita and visitor arrival they found evidence of an asymmetric long-run relationship between visitor arrivals and economic growth, as well as causalities between them, thus supporting the TLEG hypothesis for both countries. Additionally, other modeling strategies such as structural equation methods, smooth transition regression (PSTR) or dynamic general equilibrium models have been applied to empirically test the TLEG hypothesis (Song & Wu, 2022).

Drawing insights from literature review studies on this topic that employed both a narrative and a quantitative approach (eg: A.Liu et al., 2022; Brida et al., 2016; Brida et al., 2013; Fonseca & Sánchez-Rivero, 2020a, 2020b, 2020c; Nunkoo et al., 2020; Pablo-Romero´s, 2013) the authors concluded that generally the TLEG hypothesis is supported by empirical studies. However, there is still a lack of consensus on this topic regarding the most appropriate methodological approach and the proxy's variables to measure tourism and economic growth, and consequently in conclusions reported (Nunkoo et al., 2020). Song and Wu (2022) goes further and states that most of these existing empirical studies suffer from a lack of robust theoretical underpinnings. In fact, differences in results and conclusions can be found in studies published even for the same countries. For example, Gunduz and Hatemi-J (2005) applying the leveraged bootstrap causality tests using annual data for the period of 1963–2003 in a trivariate model of real GDP, the number of tourist arrivals and real exchange rates, suggested that the TLEG hypothesis is supported empirically in the case of Turkey. Ongan and Demiroz (2005) also conducted a study on the impact of international tourism receipts on the long-run economic growth of Turkey using quarterly data for the period 1980Q1-2004Q2. Relying on Johansen technique to cointegration and Granger causality tests through VECM approach, their results suggest a bidirectional causal relationship between international tourism receipts and economic growth in both the short and the long run. In contrast, Katircioglu (2009) revisiting the TLEG hypothesis for Turkey using the bounds test and Johansen approach for cointegration for the period of 1960–2006 in a trivariate model of real GDP, total number of international tourists visiting and accommodating in

Turkey and real exchange rates, rejected the TLEG hypothesis for the same country. In turn, Dritsakis (2004) investigated the impact of tourism on the long-term economic growth of Greece for the period of 1960Q1-2000Q4 by using Granger causality tests based on Error Correction Models (ECMs) analysis, using variable such as: real GDP, real effective exchange rate and international tourism earnings and found evidence of bidirectional causality between international tourism and economic growth in the case of this country. By contrary, Kasimati (2011) investigated the economic impact of tourism on Greece's economy for the period 1960-2010 by applying Granger causality test based on VECM for cointegration, through trivariate model of real GDP, international tourist arrivals and real effective exchange rate, suggested that despite there is a cointegrating relationship between tourism and economic growth, there is no directional causality impact them, thus invalidate the TLEG hypothesis for Greece. Notably in these examples, the different authors chose to employ different methods, different proxy variables to measure international tourism and economic growth, as well as data time frequency of different natures (quarterly/annual). In fact, the empirical literature shows that the differences in results and conclusions are mainly related to the methodological approach employed and destinations characterization. Brida et al. (2013) in a critical review of the econometric literature on the causality between tourism and economics growth points out the use of different econometric methods, the differences regarding the proxy variables used to measure tourism and income and, also in the degree of tourism specialization of the destinations analyzed as being the possible cause of differences in results. This idea is also corroborated by Brida et al. (2016) who reviewed more than 100 studies in this topic published between 2002 and 2013. Pablo-Romero, and Molina (2013) suggest that whether the TLEG hypothesis holds true depends on the model specifications and the estimation techniques used in a study. They also argue that the degree of specialization of tourism in a destination is a crucial factor that influences whether a causal relationship exists between tourism and economic growth. Fonseca and Sánchez-Rivero (2020a) conducted a quantitative review of Granger causality studies on tourism and income, aligning with prior narrative reviews but challenging the notion that small countries inherently amplify the impact of tourism on economic growth. They argued that the TLEG hypothesis is more likely to be accepted to countries highly specialized in tourism with larger populations. For his part, Nunkoo et al. (2020) using meta-regression analysis noted methodological diversity and cautioned against potential publication biases, urging careful interpretation of results due to the varied approaches and findings in the field. In two additional research, Fonseca and Sánchez-Rivero (2020b, 2020c) employed meta-regression analysis to investigate biases in empirical publications on the Granger causality relationship between tourism and income. They emphasized that despite existing biases, studies identifying statistically significant effects still offer valuable policy or managerial insights for specific countries or regions. In short, the literature recommends methodological innovations, such as new estimation methods, application of non-linear models, diverse proxies for the tourism variable and growth, and extending studies to countries or regions less characterized by tourism specialization, as strategies to address potential publication biases on the TLEG hypothesis (Brida et al., 2016; Nunkoo et al., 2020). Wong et al. (2023) draws attention to the scarcity of country-specific research, particularly small nations such as island states, regarding the dynamic relationship between tourism development and economic growth. They note that when these small countries are studied, they are frequently analyzed within a cross-country framework, emphasizing the need for tailored analyses considering the unique circumstances of each small nation. N.N. Kumar (2022) further notes the limited application of the NARDL approach in Small Island Developing States (SIDS), which includes Cabo Verde. This research contributes to addressing this gap in literature.

4. DATA AND METHODOLOGY

4.1. Data description

To measure economic growth, real GDP at 2015 prices (indicated by y) is used. As a proxy for inbound tourism, we use the number of non-resident guests accommodated in hotel establishments in Cabo Verde (visitor arrivals, which we designate as VA), which is an official indicator used by the country to count the number of international arrivals. Moreover, as suggested by some authors in this topic, in the Robustness check section, we also use the real exchange rate (RER), which is a proxy variable for the country's relative competitiveness in relation to other tourist destinations (Brida et al. , 2015; Cantavella-Jorda, 2002) and often included in the model with the justification of dealing with the potential problem of omitted variables (Gunduz & Hatemi-J, 2005; Oh, 2005; N.N. Kumar et al., 2022). In this case, the real exchange rate is calculated by multiplying CVE per USD and the consumer price index in Cabo Verde, and then dividing it by the US consumer price index. The exchange rate (CVE per USD) and U.S. consumer price index are collected from the BCV and the U.S. Bureau of Labor Statistics, respectively. The remaining variables, including real GDP, visitor arrivals and the consumer price index in relation to Cabo Verde are collected from the National Statistics Institute (INE). Data is quarterly and covers the period 2007Q1-2023Q2.

4.2. Modeling framework

This section describes the econometric framework, which includes the econometric models and statistical tests necessary to achieve the established objectives. Therefore, to investigate the linear and nonlinear short-run and long-run effect of tourism on growth the linear autoregressive distributive lag (ARDL) model proposed by Pesaran et al. (2001) and the non-linear autoregressive distributive lag (NARDL) model proposed by Shin et al. (2014) are used. The nonlinear ARDL approach is utilized to assess and identify asymmetric effects in the analysis. The methodological procedures of these two approaches are explained in sub-section 4.2.4 and 4.2.5.

4.2.1. General frameworks

In terms of model specification, this investigation follows Stauvermann et al. (2016), R.R. Kumar et al. (2016), N.N. Kumar et al. (2020) and N.N. Kumar et al. (2022), and utilize the standard Cobb-Douglas type production function to define the equation for real GDP as follows:

$$y_t = VA_t^{\beta} \tag{1}$$

where y_t and VA_t were define in point 4.1 and the $\beta > 0$ is the share or elasticity coefficients of tourism. Once the logarithm is applied to Eq. (1), the resulting symmetric linear equation can be expressed as follows:

$$ln y_t = \pi + \partial T + \beta ln VA_t + \theta B + \varepsilon_{1t} \tag{2}$$

where, as explained in section 4.1, y_t and VA_t represent real GDP and visitor arrivals, respectively. The parameter $\beta > 0$ signifies the elasticity of tourism, π is the intercept or constant term, T is the time trend variable, B is the dummy variable which represents structural break in the y_t series identified through a break test and ε_{t1} represents the error term. Equation 2 is employed for estimating the long-run relationship once cointegration has been identified. The bivariate model is used to assess the TLEG hypothesis, examining how tourism affects economic growth. However, this model can yield spurious results due to omitted variables, as highlighted by N.N. Kumar et al. (2022). To address this issue, control variables like the real effective exchange rate are often introduced. However, Pesaran and Smith (2014) emphasize the value of a straightforward time-series bivariate model, especially when predictors are correlated with time-series data. This model allows for a comprehensive evaluation of the total effects of the explanatory variable, encompassing both direct and indirect impacts via control variables. The authors also caution against the deceptive nature of ceteris paribus assumptions in multivariate models when regressors are correlated. Their findings stress the importance of avoiding endogeneity bias in assessing total effects. One practical solution is the use of the ARDL-bounds procedure. This method ensures a robust and accurate examination of the relationship between tourism and economic growth.

4.2.2. Long-run relationship

The non-stationary nature of a time series doesn't render it useless for analyzing relationships with other non-stationary variables. This is because non-stationary series might share similar trends and seasonal components over time due to e.g., economic interconnections, forming a long-run relationship known as cointegration. As explained by Brooks (2014), cointegration represents a long-term or equilibrium relationship wherein cointegrated variables might differ in the short run but maintain an association in the long run. Therefore, if variables are cointegrated, they move together, suggesting similar stochastic trends between them.

From a mathematical standpoint, cointegration is defined as follows: suppose m_t represents a $k \times 1$ vector of variables, then the components of m_t are integrated of order (d, b) and cointegrated if:

1. All components in m_t are $I(d)$
2. There exists at least one coefficient vector $\beta \neq \vec{0}$, such that $\beta_{mt} \sim I(d-b)$

To simplify, two or more non-stationary variables (m_t) are said to be cointegrated if a linear combination of the variables (βm_t) are stationary and mean-reverting. As the linear combination becomes stationary one may avoid spurious regression. To summarize, cointegration allows a linear combination of non-stationary variables to be stationary and have a long-run relationship.

4.2.3. Unit roots tests and structural breaks

Following the econometric methodology framework of this type of investigation, the first step is to examine the behavior of the time series in question and determine whether it is stationary or not. This is achieved by conducting unit roots tests or stationarity tests, which helps determine the order of integration of the series. Performing unit root tests is essential for conducting a reliable causality evaluation, especially when employing the method introduced by Toda and Yamamoto (1995). But it is also fundamental when using ARDL and NARDL approach. In the empirical literature, the standard Augmented Dick Fuller (ADF) (Dickey & Fuller, 1979) and Phillips-Perron (PP) (Phillips–Perron, 1988) unit roots tests, which have a null hypothesis that the series contains a unit root, are commonly used.

The Kwiatkowski-Phillips-Schmidt-Shin test (KPSS) introduced by Kwiatkowski et al. (1992), with a null hypothesis that the series is stationary, is also used. However, for this research the ADF and PP tests for unit roots are applied. The general equations for these tests are specified as follows:

$$\Delta z_t = \mu_0 + \emptyset z_{t-1} + \varepsilon_{2t} \tag{3}$$

where z_t is a time-series variable, μ_0 is the deterministic part which includes intercept and trend, and $\emptyset$ is the autoregressive coefficient. The analysis involves conducting hypothesis tests related to unit roots. The null hypothesis (H_0) posits the presence of unit roots ($H_0: \emptyset = 0$), which is tested against the alternative hypothesis suggesting the absence of unit roots, that is:

$H_0: \emptyset = 0$, unit root is present i.e., the time series is non-stationary.
$H_1: \emptyset < 0$, no unit root is present i.e., the time series is stationary.

To conduct these tests, both the levels of the data and their first differences are examined. The Augmented Dickey-Fuller (ADF) test augments Eq. (3) with lagged differenced variables to address issues related to serially correlated residuals. Additionally, the Phillips-Perron (PP) test incorporates Newey-West standard errors to account for potential serial correlation. The lag length for the ADF test and the bandwidth for the PP test are determined using the Schwarz information criterion (SIC), a criterion used for model selection and specifying the optimal lag or bandwidth. The SIC criterion is specified as: $SIC = -2\ln(LH) + kln(n)$, where n is the number of observations and k is the number of regression parameters to be estimated partly defined by the lag p. LH is the maximum likehood of the model.

After conducting unit root tests, the next step is to identify structural breaks and incorporate them into Eq. (2). Damásio and Nicolau (2020) emphasized the importance of employing methodologies capable of detecting multiple structural breaks in time series, especially when using methods to determine relationships between economic variables, since ignoring this can distort conclusions and offer erroneous recommendations. In fact, recently, N.N. Kumar and Patel (2023) demonstrated that disregarding the impacts of structural breaks tends to impact both the determination of cointegration and the resulting effects on tourism demand's influence on growth. On the other hand, the ARDL and NARDL models may not inherently account for structural breaks (Cho et al., 2023; N.N. Kumar & Patel, 2023; Pesaran et al., 2001). Taking all this into consideration, for this investigation the Bai and Perron (1998, 2003a, 2003b) technique is utilized, and it offers several advantages. These include the ability to identify more than two breakpoints, easily estimate both the number and location of these breakpoints and associate them with real-world events (N.N. Kumar et al., 2022). Additionally, this technique addresses issues related to serial correlation and heteroscedasticity by incorporating Newey-West standard errors into the test equation. Furthermore, it provides flexibility by constraining the model so that the breaks influence specific regression coefficients. During this process, break dummies are assigned a value of 1 from the date of the break until one period before the next break date. These break dummies are retained if they are found to be statistically significant in the final estimation. Subsequently, the analysis proceeds to test for cointegration and estimate both the long-run and short-run parameters, as described in sections 4.2.4 and 4.2.5.

4.2.4. Linear ARDL approach

In linear approach to investigate short-run and long- run relationship between variables under consideration the Autoregressive Distributed Lags (ARDL) method introduced and developed by Pesaran and Shin (1998) and refined a few years later by Pesaran et al. (2001) is utilized. According to these authors, this framework has some advantages compared to other econometric approaches for assessing cointegration and short/long-run relationships. The first one is that the ARDL allows working with variables which is I (0), I (1), or mutually cointegrated and, consequently does not need that all the variables under study must be integrated of the same order. However, ARDL does not work with non-stationary variables integrated of order two I(2). Another advantage is that the ARDL method provides robust and consistent results for small sample sizes and leads to accurate estimates in the long-term.

To implement the bound testing approach for cointegration, we represent the relationship described in Eq. (2) by specifying the following ARDL (p, q) equation:

$$\Delta lny_t = \pi + \partial T + \sum_{i=1}^{p} \gamma_1 \Delta lny_{t-i} + \sum_{j=0}^{q} \gamma_2 \Delta lnVA_{t-i} + \varphi_1 lny_{t-1} + \varphi_2 lnVA_{t-1} + \theta B + \varepsilon_{3,t} \quad (4)$$

where the variables are previously defined and, ε_{3t} is the random errors that are uncorrelated and with mean zero and finite covariance and, p and q are the respective lags. The short-run effects are captured by the coefficients for the first difference variables i.e., γ_1 and γ_2 while the coefficients φ_1 and $\varphi_2$correspond to the long-run terms.

When assessing the significance of each variable, the primary emphasis is placed on their statistical significance, rather than the magnitude of the coefficients or the p-values (prob.). This implies that if the variables demonstrate a statistically significant relationship with growth, they are considered important. In Eq. (4) the bonds tests use the joint F-statistic to investigate the existence of long-run effects of tourism on growth. The first step involves estimating these equations using ordinary least squares (OLS[1]) method and tests for the presence of a long-run effects by conducting the $F-test$ to determine the joint significance of the coefficients of the lagged levels of the variables. In this procedure, it is necessary to determine the optimal lag for each variable, as indicated by Eq. (4). Various methods can be employed for this purpose. However, as confirmed by Pesaran and Shin (1998), the SIC criteria tend to yield slightly more accurate estimates than the Akaike Information Criterion (AIC) criteria, particularly in small sample sizes within the context of the ARDL framework. Consequently, to ensure the construction of a reliable and consistent model, the determination of lag lengths for both the ADF test and the ARDL model is guided by the SIC criteria.

The null hypothesis (H_0) of no cointegration is that the coefficients φ_1 and φ_2 are equal to zero, while the alternative hypothesis (H_1) is that they are not equal to zero, that is:

$H_0: \varphi_1 = \varphi_2 = 0$, there is no cointegration between variables.
$H_1: \varphi_1 \neq \varphi_2 \neq 0$, there is cointegration between variables.

[1] For more information see Wooldridge, Jeffrey M. (2009). Introductory econometrics: a modern approach, 4th ed. South-Western. ISBN 9780324585483.

To decide whether to reject the referenced null hypotheses, Pesaran et al. (2001) provided a set of critical values for this purpose. According to the same authors, the ARDL bounds approach uses both upper and lower bounds of critical values to test the hypothesis of cointegration and, if the computed $F-statistic$ (F_{PSS}) is greater than the upper bound, there is evidence of a long-run relationship between the variables. If it is below the lower bound, the presence of cointegration is not significant. Otherwise, if it falls between the upper and lower bounds, the test is inconclusive, and more information is needed. As suggested by Shahzad et al. (2017a), the $t-statistic$ (t_{BDM}) proposed by Banerjee et al. (1998) is a test equivalent to assessing the cointegration of variables and follows similar approach to what was described for F_{PSS}. It also employs a comparable null hypothesis and lower and upper bounds, as presented by Pesaran et al. (2001). The t_{BDM} serves as a complementary method, especially when the results of the F_{PSS} are inconclusive. Once the presence of cointegration has been established, the subsequent stage involves estimating the long-run and short-run parameter estimates.

To establish an Error Correction Model (ECM), which is the second step in the ARDL approach, certain assumptions need to be made. When the F-bound test produces satisfactory results, it is possible to establish the long-run equilibrium relationship without encountering issues of spurious regression. This is because the linear combination of the non-stationary variables becomes stationary in a simple OLS framework:

$$y_t = \alpha + \beta VA_t + \varepsilon_{4,t} \tag{5}$$

To capture the convergence of the model towards equilibrium an error correction term is defined by $ECM_{t-1} = y_{t-1} - \hat{\alpha} - \hat{\beta} VA_{t-1}$, where $\hat{\alpha}$ and $\hat{\beta}$ are the estimators from Eq. (5). Note that ECM_{t-1} is the residuals from Eq. (5). Furthermore, if the model is moving towards equilibrium in the long run the difference between the independent and dependent variables (ECM_{t-1}) cannot increase as that would impose divergence. Therefore, this difference must decrease over time. Additionally, since x_t; y_t; β_j are all obtained from the regression in Eq. (5), ECM_{t-1} becomes a new data series. In the final and third step, the short-run dynamics are estimated by using Eq. (4). by replacing the lagged variables y_t; VA_t with the error correction term ECM_{t-1}. The equation can be reformulated as follows:

$$\Delta lny_t = \pi + \partial T + \theta B + \sum_{i=1}^{p} \gamma_1 \Delta lny_{t-i} + \sum_{j=0}^{q} \gamma_2 \Delta lnVA_{t-i} + \lambda ECM_{t-1} + \varepsilon_{5,t} \tag{6}$$

The ECM coefficient (λ) must exhibit statistical significance and a negative value for the model to move toward equilibrium. Additionally, a significant ECM coefficient validates the presence of a stable long-run relationship and cointegration between VA and y_t. This coefficient also determines the speed of adjustment towards equilibrium.

4.2.5. Nonlinear ARDL approach

In this study, we employ the NARDL (Nonlinear Autoregressive Distributed Lag) approach developed by Shin et al. (2014) to investigate the potential asymmetric effects within the short- and long-run relationship between inbound tourism (visitor arrivals) and economic growth in Cabo Verde. The NARDL model extends the ARDL cointegration model introduced by Pesaran et al. (2001) and consists of a dynamic error-correction representation that allows for capturing asymmetries both in the short and long-run. This method, which has been used by several authors (e.g., Fousekis et al., 2016; N.N. Kumar et al., 2020; N.N. Kumar et al., 2022; Nusair, 2016; Shahzad et al., 2017a), presents a set of advantages. On the one hand, it enables jointly model cointegration and asymmetric nonlinearity in a single equation and performs better in small samples than other conventional cointegration techniques. On the other hand, as mentioned by Shahzad et al.(2017a), the NARDL framework enables testing for hidden cointegration, so that it avoids omitting any relationships which are not visible in a conventional linear setting. Thus, the NARDL modeling approach makes it possible to distinguish between linear cointegration, nonlinear (asymmetric) cointegration and lack of cointegration. It also provides insights into asymmetric dynamic multipliers, which reveal how the dependent variable responds differently to positive and negative changes in the explanatory variables (N.N. Kumar, 2020). Additionally, as in the ARDL model, the NARDL model is its greater flexibility as this method yields valid results regardless of whether the variables involved are I(0), I(1) or a combination of both. These advantages make the NARDL method a valuable tool for analyzing relationships between variables, especially in cases where the data may exhibit different forms of integration or nonlinearity (N.N. Kumar et al., 2020).

Following Shin et al. (2014) and based on specification in Shahzad et al. (2017a) and N.N. Kumar (2020), the non-linear (asymmetric) long-run model using partial sum decompositions, can be defined as follow:

$$lny_t = \pi + \partial T + \beta^{+} lnVA_t^{+} + \beta^{-} lnVA_t^{-} + \theta B + \varepsilon_{6t} \tag{7}$$

where $\beta^{+} = \beta^{-}$ indicates the symmetric effect of tourism on real GDP, while $\beta^{+} \neq \beta^{-}$ indicates the asymmetric effect and ε_{6t} is a stationary zero-mean error process that represents deviations from the long-run equilibrium. If $\beta^{+} > 0$ and $\beta^{-} > 0$, this implies that the tourism contributes to enhancing economic growth. In other words, an increase in $lnVA_t$ leads to an increase in real GDP, and a decrease in $lnVA_t$ results in a reduction of real GDP. In this context, N.N. Kumar et al. (2020) enumerates two potential scenarios:

- $\beta^{+} > \beta^{-}$: implies that the decrease in visitor arrivals has a larger negative effect on growth than the positive effect from an increase in tourism.
- $\beta^{-} > \beta^{+}$: implies that the positive income effect caused by an increased number of tourists exceeds the negative impact on income caused by a comparable decline of the tourists' number.

These scenarios help explain how changes in tourism can impact economic growth, and whether the effects are predominantly positive or negative.

The partial sum decompositions are given by the following equation:

$$\ln VA_t = lnVA_0 + lnVA_t^{+} + lnVA_t^{-} \tag{8}$$

where $lnVA_0$ is an arbitrary value, and $lnVA_t^{+}$ and $lnVA_t^{-}$denote the partial sum processes which accumulate positive and negative changes in $\ln VA_t$ (N.N. Kumar et al., 2020; N.N. Kumar et al., 2022; Shahzad et al., 2017a). The decompositions are defined as:

$$lnVA_t^+ = \sum_{j=1}^{t} \Delta lnVA_j^+ = \sum_{j=1}^{t} \max\left(\Delta lnVA_j, 0\right) \tag{9.1}$$

and

$$lnVA_t^- = \sum_{j=1}^{t} \Delta lnVA_j^- = \sum_{j=1}^{t} \min\left(\Delta lnVA_j, 0\right) \tag{9.2}$$

Shin et al. (2014) extends the symmetric ARDL bounds procedure developed by Pesaran et al. (2001) to analyze the joint issues of nonlinearity and asymmetric effects using the partial sum decompositions specified in equations (9.1) and (9.2) (N.N. Kumar et al., 2020; Shahzad et al., 2017a). In this way, the asymmetric error correction model for estimating the asymmetric long-run and short-run elasticities can be specified as follows:

$$\Delta lny_t = \pi + \partial_0 T + \partial_1 lny_{t-1} + \partial_2{}^{+} lnVA^{+}{}_{t-1} + \partial_3{}^{-} lnVA^{-1}{}_{t-1} + \sum_{j=1}^{p-1} \alpha_j \Delta lny_{t-j} + \sum_{j=0}^{q-1} \theta_j^+ \Delta lnVA_{t-j}^+ + \sum_{j=0}^{q-1} \theta_j^- \Delta lnVA_{t-j}^- + \theta D + \varepsilon_{7t} \tag{10}$$

where the variables are previously defined, the $lnVA_t^+$and ln $lnVA_t^-$are the positive and negative partial sum decompositions defined by equation (8) and $\partial_1(-1 < \partial_1 < 1)$ is the error correction term (ECT).

According to Shahzad et al. (2017a), the practical application of the NARDL method follows identical steps to those of the linear ARDL model, with the first step being to estimate the error correction model in Eq. (10) using the standard OLS. The second step involves testing for the presence of an asymmetric long-run relationship among the levels of the variables using a bounds testing approach. In this way, to assess cointegration in NARDL model (Eq. 10), the null hypothesis of no cointegration (H_0: $\partial_1 = \partial_2{}^{+} = \partial_2{}^{-} = 0$) is tested against the alternative (H_a : $\partial_1 \neq 0$; $\partial_2{}^{+} \neq 0$; $\partial_2{}^{-} \neq 0$). This hypothesis can be tested using both the F_{PSS} and the t_{BDM} mentioned in 4.24 and the decision follows the same logic. That is, if F_{PSS} is above the upper critical bound ($F_{PSS} > I(1)_{critical}$), it indicates the presence of cointegration. Conversely, if the F_{PSS} falls below the lower bounds ($F_{PSS} < I(0)_{critical}$), it suggests no cointegration; and if the F_{PSS} falls between the upper and lower bounds ($I(0)_{critical} < F_{PSS} < I(1)_{critical}$), the determination remains inconclusive. The third step consists of examining the short-run and long-run asymmetry in Eq.10. In this way, the null hypothesis of short-run symmetry of $\Delta lnVA_t$ ($H_0^{SR}: \sum_{j=0}^{q} \theta_j^+ = \sum_{j=0}^{q} \theta_j^-$) tested against the alternative of short-run asymmetry ($H_a^{SR}: \sum_{j=0}^{q} \theta_j^+ \neq \sum_{j=0}^{q} \theta_j^-$). Similarly, the long-run symmetry of $lnVA_t$ ($H_0^{LR}: \partial_2{}^{+} = \partial_3{}^{-}$) is tested against the alternative of long-run asymmetry ($H_a^{lR}: \partial_2{}^{+} \neq \partial_3{}^{-}$) using the standard Wald tests. The null hypothesis of symmetric effects is rejected if the respective p-values fall within the conventional significance levels.

It is important to highlight that in the NARDL approach, linear cointegration is considered a fundamental requirement. The existence of nonlinear cointegration indicates the presence of hidden cointegration, as demonstrated by Shin et al. (2014), providing more robust insights into the relationship between variables under consideration and in this case, more specifically between tourism and economic growth.

As N.N. Kumar (2020, 2022) observes, in the last stage of the NARDL methodology, the asymmetric cumulative dynamic multiplier for unit changes in $lnVA_t^+$ and $lnVA_t^-$ on of lny_t are calculated as follows:

$$m_l^+ = \sum_{j=0}^{h} \frac{\vartheta lny_{t+j}}{\vartheta lnVA_t^+}; \qquad m_l^- = \sum_{j=0}^{h} \frac{\vartheta lny_{t+j}}{\vartheta lnVVA_t^-}, h = 0, 1, 2, \dots.. \tag{11}$$

If h→ ∞, then m_h^+ and m_h^- approach the asymmetric long-run coefficients (Shin et al., 2014). Fousekis et al. (2016) and Shahzad et al. (2017a) note that analyzing the adjustment path and duration of disequilibrium, given a positive or negative shock, provides useful information about the long- and short-run patterns of asymmetric adjustment.

4.2.6. Diagnostic testing

The ARDL model aims to identify the best linear unbiased estimator (BLUE), and to achieve this, diagnostic tests are essential. These tests assess the robustness of the results by examining stability, serial correlation, heteroscedasticity, misspecification (Ramsey's RESET test), and the normality of the residuals.

4.2.6.1. Test for stability

The ARDL model is notably sensitive to structural breaks. Therefore, to evaluate the stability of both the long-run and short-run coefficients, CUSUM (cumulative sum of the recursive residuals) and CUSUMSQ (sum of squared recursive residuals) tests, as proposed by Brown et al. (1975), are employed. These tests have a graphical nature in which the residuals are continuously updated and plotted against the breakpoints with a 5% significance line. The long-run and short-run coefficients are considered stable if the CUSUM and CUSUMSQ plots remain within the 5% significance level. In essence, both tests assess whether the residuals significantly deviate from their mean value by employing parallel critical lines set at a 5% significance level.

4.2.6.2. Test for serial correlation

The Breusch-Godfrey test, introduced by Godfrey (1978), is employed to check for serial correlation if different lags of the residuals are correlated. In mathematical terms, the following condition should hold: Covariance $(\epsilon_i, \epsilon_j) = 0, \forall\, i, j$ otherwise, the series exhibits serial correlation. It's important to note that serial correlation doesn't impact the unbiasedness of the regression estimators but does affect their efficiency. In other words, the estimators are not BLUE (Wooldridge, 2009). Serial correlation can, for instance, influence the standard errors of the regression, which can invalidate significance tests. In practical terms, this means that incorrect inferences may be made regarding whether the independent variables are determinants of the variations in the dependent variable. The model of the residuals under the simplest form of the Breusch-Godfrey test is:

$$\epsilon_t = \rho\epsilon_{t-1} + v_t, v_t \sim N(0, \sigma_v^2) \tag{12}$$

The test has the following general null hypothesis and alternative hypothesis:

$H_0: \rho = 0$, No serial correlation in the model
$H_1: \rho \neq 0$, There is serial correlation in the model.

4.2.6.3. Test for heteroscedasticity

It's crucial to test whether all residuals exhibit a constant variance, which means Variance $(\epsilon_t) = \sigma^2 < \infty, \forall\, t$. In both regular OLS estimation and the ARDL model, it is assumed that the residuals have a constant variance, a condition known as homoscedasticity. When the model doesn't meet this condition and exhibits varying variances in the residuals (heteroscedasticity), the estimated coefficients are no longer BLUE and do not possess the minimum variance among unbiased estimators. This issue can lead to incorrect inferences, much like the consequences of serial correlation. In this investigation, the Breusch Pagan Godfrey test for which involves the following general null and alternative hypotheses is employed:

H_0: Constant conditional variance of the residuals - Homoscedasticity
H_1: Non-constant conditional variance of the residuals - Heteroscedasticity

4.2.6.4. Regression specification error test (RESET)

The Ramsey Regression Specification Error Test (RESET), introduced by Ramsey (1969) is used to assess the functional form of a model. It tests whether non-linear combinations of the fitted values can adequately explain the behavior of the explanatory variable. If non-linear combinations of the fitted values prove to be influential in explaining the explanatory variable, it indicates that the model is misspecified and requires adjustments. In essence, RESET helps identify whether the model's functional form is appropriate and suggests whether modifications are necessary for a more accurate representation of the data.

H_0: No misspecification.
H_1: Misspecification.

4.2.6.5. Test for normality of the residuals

The Jarque-Bera test is used to assess the normality of residuals, specifically if $\epsilon_t \sim N(0, \sigma^2), \forall\, t$. This assumption is essential when conducting hypothesis tests for model parameters. Therefore, non-normality in the residuals can lead to issues in statistical inference for coefficient estimates, such as significance tests and confidence intervals that rely on the normality assumption (Wooldridge, 2009). Typically, the null hypothesis of the JB test encompasses both skewness and excess kurtosis being zero. This is based on the expectation that samples drawn from a normal distribution exhibit an expected skewness of 0 and an excess kurtosis of 0, equivalent to a kurtosis of 3. This way we can perform this test evaluating the following general null and alternative hypotheses:

H_0: There is normality in the residuals.
H_1: There is non-normality in the residuals.

4.2.7. The Toda–Yamamoto Approach to Granger Non-causality Test

After estimating the ARDL and NARDL model and ensuring its stability through the tests mentioned above, as well as assessing the cointegration between the variables involved, the next step consists of analyzing the causality between them. For this, the Granger causality test proposed by Toda and Yamamoto (1995) is used. This test offers the advantage of exploring the presence of non-causality between variables, irrespective of whether they are integrated of order 0 (I (0)), 1 (I(1)), or 2 (I(2)), and whether they are cointegrated or not. This makes it a suitable tool for cases where there is no clear theoretical consensus or prior empirical evidence to suggest the direction of causality between variables (N.N. Kumar et al., 2020). In essence, the Toda - Yamamoto approach proposes using VAR framework with $\rho = (k + \ dmax)$ lag length to test for Granger non-causality between variables. This implies that it is essential to consider the integration and cointegration properties of the underlying data series (Toda & Yamamoto, 1995). The VAR system for conducting the Granger non-causality test for symmetric linear equation [Eq. (2)] can be specified as follow:

$$lny_t = \mu_{1,t} + \sum_{i=1}^{k} \alpha_{1i} \, lny_{t-i} + \sum_{j=k+1}^{dmax} \alpha_{2i} \, lny_{t-j} + \sum_{i=1}^{k} \delta_{1i} \, lnVA_{t-i} + \sum_{j=k+1}^{dmax} \delta_{2i} \, lnVA_{t-j} + \omega_{1t} \quad (13)$$

$$lnVA_t = \mu_{2,t} + \sum_{i=1}^{k} \beta_{1i} \, lnVA_{t-i} + \sum_{j=k+1}^{dmax} \beta_{2i} \, lnVA_{t-j} + \sum_{i=1}^{k} \theta_{1i} \, lny_{t-i} + \sum_{j=k+1}^{dmax} \theta_{2i} \, lny_{t-j} + \omega_{2t} \quad (14)$$

and for asymmetric model specified in Eq. (7), the following asymmetric VAR model to examine the asymmetric causality can be extended as follows:

$$lny_t = \mu_{3,t} + \sum_{i=1}^{k} \eta_{1i} \, lny_{t-i} + \sum_{j=k+1}^{dmax} \eta_{2i} \, lny_{t-i} + \sum_{i=1}^{k} \eta_{3i} \, lnVA_{t-i}^{+} + \sum_{j=k+1}^{dmax} \eta_{4i} \, lnVA_{t-i}^{+} + \sum_{i=1}^{k} \eta_{5i} \, lnVA_{t-i}^{-} + \sum_{j=k+1}^{dmax} \eta_{6i} \, lnVA_{t-i}^{-} + \omega_{3t} \quad (15)$$

$$lnVA_t^{+} = \mu_{4,t} + \sum_{i=1}^{k} \varphi_{1i} \, lny_{t-i} + \sum_{j=k+1}^{dmax} \varphi_{2i} \, lny_{t-i} + \sum_{i=1}^{k} \varphi_{3i} \, lnVA_{t-i}^{+} + \sum_{j=k+1}^{dmax} \varphi_{4i} \, lnVA_{t-i}^{+} + \sum_{i=1}^{k} \varphi_{5i} \, lnVA_{t-i}^{-} + \sum_{j=k+1}^{dmax} \varphi_{6i} \, lnVA_{t-i}^{-} + \omega_{4t} \quad (16)$$

$$lnVA_t^{-} = \mu_{5,t} + \sum_{i=1}^{k} \vartheta_{1i} \, lny_{t-i} + \sum_{j=k+1}^{dmax} \vartheta_{2i} \, lny_{t-i} + \sum_{i=1}^{k} \vartheta_{3i} \, lnVA_{t-i}^{+} + \sum_{j=k+1}^{dmax} \vartheta_{4i} \, lnVA_{t-i}^{+} + \sum_{i=1}^{k} \vartheta_{5i} \, lnVA_{t-i}^{-} + \sum_{j=k+1}^{dmax} \vartheta_{6i} \, lnVA_{t-i}^{-} + \omega_{5t} \quad (17),$$

where the variables are already defined, $\mu_{i,t}$ represents the deterministic component, which encompasses the intercept, time trend, and structural break dummies, $dmax$ is the maximum order of integration calculated by unit roots tests, k is the optimal lag length and ω_{it} is the error term. The null hypothesis of no-causality is rejected when the p-values fall within the conventional range percent significance level. Consequently, the causality decisions are made as follows:

- In Eq. (13), if $\delta_{1i} \neq 0 \forall_i$, then this implies that tourism Granger-causes growth and therefore, the TLEG hypothesis is supported by unidirectional Granger causality from international tourism to real GDP.
- In Eq. (14), if $\theta_{1i} \neq 0 \forall_i$, then this implies that growth Granger causes tourism and therefore, the EDTG hypothesis is confirmed by unidirectional Granger causality from real GDP to international tourism.

Neither the TLEG nor the EDTG hypotheses are supported if Granger causality is absent between real GDP and international tourism ($\delta_{1i} = 0\forall_i$ and $\theta_{1i} = 0\forall_i$) in Eq. (13) and Eq. (14). A feedback relationship exists between real GDP and international tourism if there is bidirectional Granger causality ($\delta_{1i} \neq 0\forall_i$ and $\theta_{1i} \neq 0\forall_i$) in the same equations.

Likewise, the asymmetric long-run causality is confirmed as follows:

- In Eq. (15), causality is confirmed, if η_{3i} $\forall_i \neq 0$, then implies that positive shock on tourism Granger-causes growth. Also, if η_{5i} $\forall_i \neq 0$, then implies that negative shock on tourism Granger-causes growth.
- In Eq. (16), causality is confirmed, if φ_{1i} $\forall_i \neq 0$, then implies that growth Granger-causes positive shock on tourism. Also, if $\varphi_{5i}\forall_i \neq 0$, then implies that negative shock on tourism Granger-causes positive shock on tourism.
- In Eq. (17), causality is confirmed, if $\vartheta_{1i}\forall_i \neq 0$, then implies that growth Granger-causes negative shock on tourism. Also, if $\vartheta_{3i}\forall_i \neq 0$, then implies that positive shock on tourism Granger-causes negative shock on tourism.

Finally, as observed by R.R. Kumar (2016), it's essential to analyze the properties of the inverse roots of the autoregressive (AR) characteristic polynomial diagram to ensure the dynamic stability of the ARDL and NARDL model. The authors further emphasize that when assessing the robustness of causality tests, it's important that the inverse roots, denoted as IR, fall within the range of -1 to 1, signifying the positive and negative unit circle, i.e., $-1 \leq I_R \leq 1$. However, if it is observed that the IR values lie outside the unit circle, this can be rectified by incorporating or excluding (a) appropriate lags greater than those of the endogenous variables, (b) a trend variable, and/or (c) structural break or "pulse" dummies as exogenous (instrumental) variables within the VAR system.

5. RESULTS AND DISCUSSION

5.1. DESCRIPTIVE STATISTICS, DATA EVOLUTION AND SEASONALITY TESTS

The descriptive statistics and correlation matrix are provided in Table 5.1. As noted, tourism (visitors' arrivals - VA) and real GDP (y) is positively correlated. Additionally, in Figure 5.1, the quarterly evolution of the two variables is displayed from the first quarter of 2007 to the second quarter of 2023. The two series suffered a major drop in the second quarter of 2020 due to the impact of the COVID-19 pandemic.

Table 5.1 – Descriptive statistics and correlation matrix (2007Q1–2023Q2)

Statistics	y	VA
Mean	44216.37	118620.8
Median	42876.90	122853.5
Maximum	56149.85	271695.0
Minimum	33302.89	170.0000
SD	4944.535	58793.45
Skewness	0.420489	0.080863
Kurtosis	2.607330	2.746876
Jarque-Bera	2.368942	0.248124
Probability	0.305908	0.883325
Correlation		
y	1.000000	0.820506
VA	0.820506	1.0000000

Source: INE and Author calculations. Note: Real GDP (y) measure in millions of CVE; VA=visitor arrivals

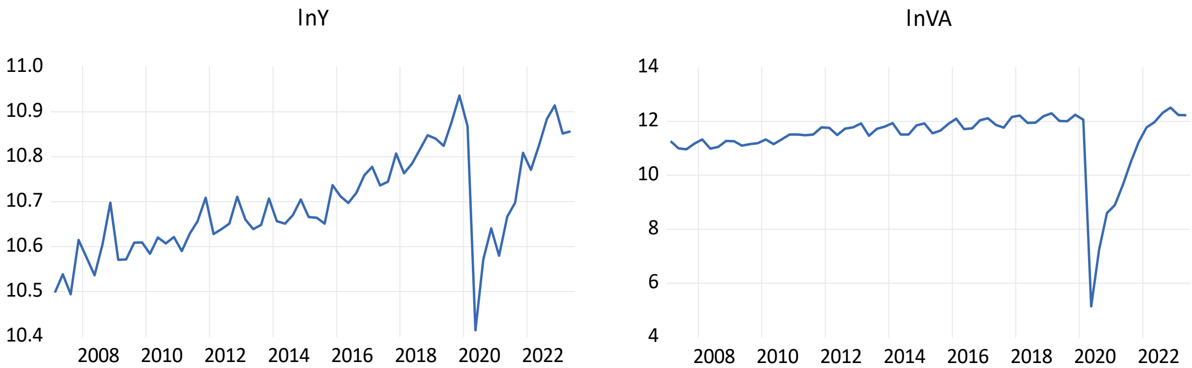

Figure 5.1 – Quarterly evolution of real GDP (y) and Visitors Arrivals (VA) (2007Q1 -2023Q2)

Source: INE and Author Calculation. Note: variables in natural logarithm.

N.N. Kumar et al. (2022) highlight the common practice in tourism economics of using both seasonally adjusted and unadjusted series in regression models. While seasonality dummy variables are often added in unadjusted series, Thomas, and Wallis (1971) argue that this might be unnecessary if the seasonality in the dependent variable is explained by that in the independent variable. To address this, we employ the U.S. Census Bureau's X-13 ARIMA-SEATS methodology for seasonality testing. Seasonality testing is crucial as seasonality dummies are relevant only when stable seasonality is identified. The analysis found evidence of stable and moving seasonality at the 0.1 percent level in the real GDP ($\boldsymbol{y_t}$) during the period 2007Q1-2023Q2. However, in the VA_t there is only evidence of moving seasonality at the 0.1 percent level (Table 5.2). Considering these results as well as the fact that there is concern about potential loss of information during seasonal adjustment (Oh, 2005), the analysis proceeding with the seasonally unadjusted series.

Table 5.2 – X-13 ARIMA-SEATS seasonality test (2007Q1-2023Q2)

Variable	**Stable seasonality**		**Moving seasonality**
	Parametric	Non-parametric	
lny	$F(3,62) = 16.219*$	$\chi 2(3) = 36.2864*$	$F(15,45) = 3.298*$
$lnVA$	$F(3,62) = 5.158$	$\chi 2(3) = 49.4771*$	$F(15,45) = 4.645*$

Source: Author calculation using EViews 11.

Note: Degrees of freedom in (.). (*) Seasonality present at the 0.1 per cent level

5.2. UNIT ROOTS TESTS, STRUCTURAL BREAKS AND LAG LENGTH TESTS

Table 5.4 presents the results of traditional unit root tests using the ADF and PP tests. It is essential to note that these tests show that the variables have a unit root at the level and become stationary when analyzed in their first differences. However, due to the significant impact of COVID-19, which led to a sharp decline in various macroeconomic indicators in early 2020, especially in GDP and tourism indicators (see Fig 5.1), additional analysis is conducted. Conventional unit root tests tend to be sensitive to time series data containing notable breaks or structural breaks, thereby diminishing their efficacy, and potentially resulting in the incorrect acceptance of the unit root null hypothesis (Shahzad et al., 2017a). In this context, we perform unit root tests by Perron (1997) and Zivot and Andrews (1992) to account for potential structural breaks in that period. Although the two tests revealed decreases in different quarters in 2020 (Perron test in 2020Q1 and, Zivot and Andrews test in 2020Q2, as indicated in Table 5.3), the test results were not found to be statistically significant. In other words, the decline observed at the beginning of 2020 does not seem to represent a structural break in the variables y and VA. However, this represents a significant break in that period that affects the traditional unit roots test and thus, Table 5.4 represents results up to 2019Q4.

Table 5.3 – Unit root tests assuming structural break in both intercept and trend (2007Q1–2023Q2)

Variable	**Perron (1997)**			**Zivot and Andrews (1992)**		
	PP-stat	P-value	BP	ZA-stat	P-value	BP
lny	-7.5641***	< 0.01	2020Q1	-11.2399***	0.000000	2020Q2
$lnVA$	-22.0334***	< 0.01	2020Q1	-17.1222***	0.000000	2020Q2

Source: Author estimation using EViews 11.

Note: (***) Significant at the 1%; (**) Significant at the 5%; (*) and Significant at the 10%. BP=breack period automatically identified by EViews 11. H_0: Z_t has a unit root with structural breaks.

Table 5.4 – Conventional unit roots tests (2007Q1–2019Q4)

Variable		**ADF**		**P-P**	
		Level	1st Diff.	Level	1st Diff.
With constant and Trend					
lny	Test-Statistic	-3.051706	-4.850300	-3.098158	-11.23735
	P-value	0.1289	0.0015***	0.1177	0.0000***
$lnVA$	Test-Statistic	-3.242040	-12.54892	-3.721548	-12.54892
	P-value	0.0894	0.0000***	0.0297	0.0000***
With constant only					
lny	Test-Statistic	1.688974	-9.652859	0.466898	-9.826224
	P-value	0.9995	0.0000***	0.9839	0.0000***
$lnVA$	Test-Statistic	-0.575541	-12.68235	-0.586836	-12.68235
	P-value	0.8666	0.0000***	0.8643	0.0000***
Without constant & trend					
lny	Test-Statistic	1.834333	-1.363233	2.918961	-9.224470
	P-value	0.9828	0.1579	0.9989	0.0000***
$lnVA$	Test-Statistic	3.056926	-1.367320	2.613305	-10.59063
	P-value	0.9992	0.1569	0.9974	0.0000***

Source: Author calculation using EViews 11.

Notes: (***) Significant at the 1%; (**) Significant at the 5%; (*) and Significant at the 10%. Lag Length based on SIC; Probability based on MacKinnon (1996) one- sided p-values. Estimated in EViews 11. The ADF and PP critical values are based on Mackinnon (1996). The optimal lag based on the SIC for ADF and bandwidth for PP are automatically determined by EViews 11. All variable seasonal adjusted.

Additional analyses and tests were applied to explore multiple breaks in the series, mainly in the dependent variable. Thus, before proceeding to model estimation and analyzing the long-run relationship between y and VA, the multiple break tests of Bai and Perron (2003) is applied. Table 5.5 presents the results of this test with two (2) statistically significant breaks, considering only the constant in the y_t series. However, the break identification approach in lny_t considering the relationship with $lnVA_t$ was also used. For this, a simple linear regression model was estimated using the BREAKLS – Least Squares with Breakpoints method (Break type: Bai-Perron tests of L+1 vs. L sequentially determined breaks) taking lny_t as the dependent variable and $lnVA_t$ as the non-breaking regressor and three (3) positive and statistically significant breakpoints were found in this relationship (third quarter of 2011, third quarter of 2016 first quarter of 2019Q1)[2]. In 2011 and 2016 the breaks may be related to the legislative elections held in Cabo Verde. Elections are normally times when there is large public spending that boosts households' consumption, which tends to positively impact economic growth. On the other hand, the third quarter of 2011 could be the period in which the country began to recover from the 2008/2009 financial crisis. In third quarter of 2016 it can also be explained by the period in which the negative effects of the Eurozone sovereign debt crisis (2011-2014) began to ease, which mainly affected Portugal and Spain, being two (2) of the country's main trading partners. The break in the first quarter of 2019 could be linked to a set of packages of measures announced by the Government that aimed at economic dynamics, thus encompassing measures to

[2] Consult the estimation in Appendix C.

improve the business environment such as strengthening the financing ecosystem for the economy, incentives for young start-ups , but also helped by monetary policy measures that allowed the credit market to accelerate, mainly to the private sector (Bano de Cabo Verde, 2019).

Table 5.5 – Bai-Perron break test

Break Test	F-statistic	F-statistic Scaled	Critical Value*
0 vs. 1 **	40.59410	40.59410	8.58
1 vs. 2 **	33.39713	33.39713	10.13
2 vs. 3	2.016905	2.016905	11.14

Source: Author calculation using EViews 11. Note: (**) Significant at 5% level. (*) Bai-Perron (Econometric Journal, 2003) critical values

After conducting a break test, the study proceeds to test for cointegration. To do so, the determination of the maximum lag length for analysis involving various criteria, including Adj-LR (lag order adjusted sequential modified LR test statistic), FPE (final prediction error), AIC (Akaike information criterion), SC (Schwarz information criterion), and HQ (Hannan–Quinn information criterion) are employed. The VAR model test results suggest a maximum lag length of 4 based on these criteria (Table 5.6). Additionally, the break periods, incorporated as exogenous variables in the VAR model, are considered in the analysis.

Table 5.6 – Lag length selection

Lag	LL	LR	FPE	AIC	SC	HQ
0	24.73445	NA	0.001874	-0.604337	-0.398486	-0.523515
1	42.51069	32.68533	0.001202	-1.048732	-0.705646	-0.914028
2	49.62814	12.62774	0.001088	-1.149295	-0.668974	-0.960709
3	55.40246	9.872230	0.001030	-1.206531	-0.588976	-0.964063
4	69.66809	23.46926*	0.000742*	-1.537680*	-0.782891*	-1.241331*

Note (*) the maximum lag length selected.

5.3. LINEAR ARDL ESTIMATES

In this section all main estimates of linear analysis are presented. The optimum lag structure of the short-run terms is determined by the Schwarz information criterion (SIC). It's crucial to note that an initial examination revealed notable findings regarding the break period dummy as detailed in section 5.2. Apart from 2011Q3, these dummies exhibited a positive coefficient that was statistically significant in the conditional ECM estimates. These breakpoints significantly impact the overall conclusions concerning the cointegration relationship, thus we keep it in final analysis. The outcomes of bonds test for cointegration are present in Table 5.7 and the outcomes of the short-run and long-run effects of tourism on economic growth within the ARDL model are summarized in panels A and B of Table 5.8, respectively. However, for the sake of clarity and comparative analysis, the estimation results of the ARDL model and cointegration without including the breaks periods can be found in appendix session (A2). Notably, in this model despite the bonds test revealing cointegration, the positive and significant ECT coefficient does not validate the presence of a stable long-run relationship and cointegration between VA and y_t (see Appendix B, Panel b). Likewise, the long run estimate is negative, but not statistically significant (see Appendix B, Panel a). The ARDL models, which do not account for structural breaks in their specifications, notably lack cointegration (Shahzad et al., 2017; N.N. Kumar et al., 2018). This result is also in line with recent research carried out by N.N. Kumar and Patel (2023), in which they validated cointegration and asymmetric effects on economic growth in Vanuatu only after accounting for structural breack.

5.3.1. Cointegration | short- run and long-run estimation.

The results of the bounds test (Table 5.7) strongly confirm the presence of cointegration at the 1 percent level. Specifically, the computed F-statistics is 9.265505, which is above the respective upper bounds of 5.58. So, the long run association between real GDP (lny) and visitor arrivals ($lnVA$) is confirmed.

Table 5.7 – Results of bounds test at 95 % confidence level

$\boldsymbol{lny \mid lnVA, Constant, B}$	**Computed stat.**	**Significance**	**Critical bonds**	
			I (0)	I (1)
F-statistic	9.265505	10%	3.02	3.51
		5%	3.62	4.16
		2.5%	4.18	4.79
		1%	4.94	5.58

Source: Author estimation using EViews 11. Note: B – *dummy* for Breaks periods.

Evidence from the ARDL model summarized in Table 5.8 indicates that tourism ($lnVA$) asserts a significant positive influence on economic growth in the context of Cabo Verde. Specifically, in the short and long run, the real GDP (y_t) is expected to increase, respectively, by 0.066 ($\Delta lnVA_t = 0.066$) and 0.10 percent ($lnVA_t = 0.104$) whenever tourism increases by 1 percent. It is also noted that the coefficients of the structural break periods are positive and significant both in the short-run and long-run effects. In comparison to other countries, Cabo Verde's short-run tourism elasticity is similar to Papua New Guinea (0.064; N.N. Kumar et al., 2022) but differs due to their distinct main economic sectors. Well, the economic structure of Papua New Guinea is dominated by the agricultural, forestry, and fishing sector and the minerals and energy extraction sector. However, this short-run elasticity is much lower than Cook Islands (0.73; R.R. Kumar, 2016), which is also a country relying on tourism. Additionally, while Cabo Verde's long-run tourism elasticity aligns with the average range (0.03–0.14) presented by Seetanah (2011) in a research in which he used panel data of 19 island economies (did not include Cabo Verde), it's relatively lower than island countries like Fiji (0.23; Kumar & Kumar, 2012), Cook Islands (0.83; R.R. Kumar et al., 2016), and Mauritius (0.78; Opuala et al., 2022). Conversely, this long-run elasticity is higher than countries like Portugal (0.01; Proença & Soukiazis, 2008), Taiwan (0.02; Kim et al., 2006), or Vietnam (0.03; R.R. Kumar; 2014a).
Furthermore, as noted from the short-run results (Table 5.8: Panel A), the negative and statistically significant coefficients for real GDP in lag periods (at the 1% level) suggest a delayed negative impact of income-related policies, aligning with R.R. Kumar et al. (2016) 's indication of weak macroeconomic policy effects.

Finally, the error correction term (ECT_{t-1}), which measures the speed of adjustment to the long-run equilibrium given the previous period shocks, is -0.51, ($ECT_{t-1} = -0.51$) and statistically significant at 1% level, negative, and as expected, $(-1 < ECT_{t-1} < 0)$ for the short-run dynamic equation. In other words, about 51**%** of any disequilibrium caused by shocks from the previous period is corrected in the current period (Table 5.8, Panel A). Subsequently the break adjusted CUSUM and CUSUMSQ plot is presented in Fig. 5.2 (Panels A and B) for the ARDL (4,4) lag estimates in Table 5.8 and show that the model parameters are dynamically stable over time. In general, the results indicate that the equation has performed reasonably well, as evidenced by normally distributed disturbance terms, serially uncorrelated data, no misspecification, and homoscedastic residuals, as shown in Table 5.9.

Table 5.8 – ARDL lag estimates with dependent variable (lny) (2007Q1–2023Q2)

Variable	**Coefficient**	**St. Error**	**t-Statistic**	**P-value**
Panel A. Short run estimates				
Δlny_{t-1}	-0.47327***	0.091859	-5.152145	0.0000
Δlny_{t-2}	-0.53912***	0.103526	-5.207554	0.0000
Δlny_{t-3}	-0.51615***	0.095116	-5.426508	0.0000
$\Delta lnVA_{t}$	0.06608***	0.003826	17.27282	0.0000
$\Delta lnVA_{t-1}$	0.01256(ns)	0.008343	1.505367	0.1385
$\Delta lnVA_{t-2}$	0.02293***	0.008101	2.829887	0.0067
$\Delta lnVA_{t-3}$	0.03183***	0.006967	4.568357	0.0000
$D_{2016Q3-20118Q4}$	0.05291***	0.010007	5.287089	0.0000
$D_{2019Q1-2023Q2}$	0.10094***	0.018669	5.406453	0.0000
ECM_{t-1}	-0.51214***	0.095253	-5.376651	0.0000
Panel B. Lon run estimates				
$lnVA_{t}$	0.10431***	0.014711	7.090696	0.0000
$Constant$	9.45544***	0.164379	57.52233	0.0000

Source: Autor estimation using EViews 11. Note: (***) Significant at the 1%; (**) Significant at the 5%; (*) Significant at the 10% and (ns) Not Significant.

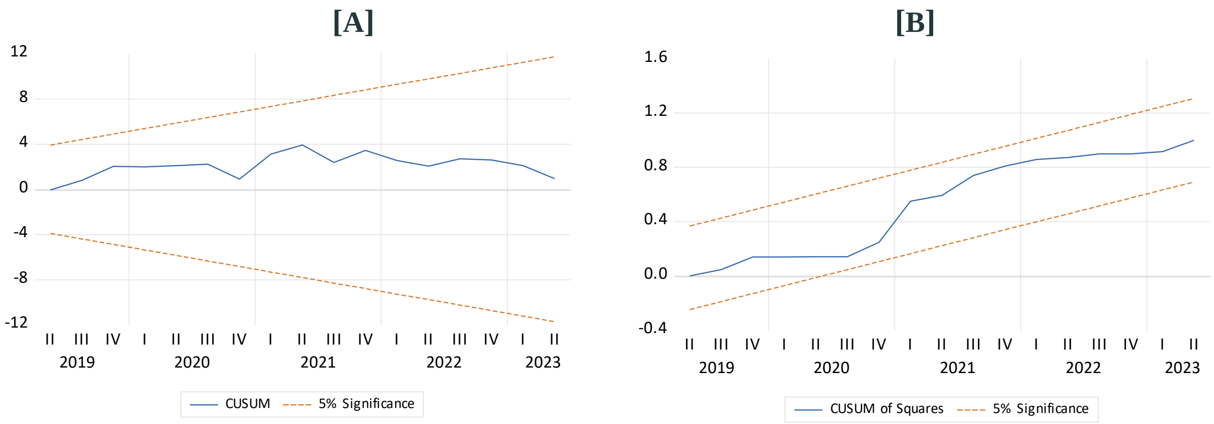

Figure 5.2 – ARDL CUSUM and CUSUMQ after adjusting for structural breaks. [A] Cumulative sum of recursive residuals (CUSUM), [B] cumulative sum of squares of recursive residuals (CUSUMQ)

Note: The straight lines represent critical bounds at 5% significance level.

Table 5.9 – ARDL diagnostic tests

Null hypothesis	Value of test statistic	p-value
No serial correlation	1.228538	0.3018
Homoscedastic residuals	1.539817	0.1531
Residual normality	2.220933	0.3294
Correct functional form	1.563969	0.2170

Source: Author calculation using EViews 11. Note: (***) Significant at the 10%; (**) Significant at the 5%; (*) Significant at the 1% and (no) Not Significant.

5.4. NON-LINEAR ARDL ANALYSIS

To explore the potential asymmetric effects of tourism on growth, the analysis is extended to the nonlinear domain. Table 5.11 summarizes the results of short-run and long-run estimates as well as the long run asymmetric test. However, as can be seen in Table 5.10, the long-run asymmetric growth effects of tourism are not confirmed. Therefore, the Wald test ($x_1^2 = 0.725132; P - value = 0.3986$) for long-run asymmetry is not statistically significant, indicating that there is no evidence of long-run asymmetry in the NARDL model, given that, the bonds test for cointegration thought NARDL (Table 5.11, Panel C) reconfirms that the cointegrated relationship between tourism and real GDP in Cabo Verde is symmetric. However, the apparent short-run asymmetry in the dynamic multiplier graph (Figure 5.3) can be observed and the statistic test in Table 5.10 confirms that. The graph shows the long- and short-run effects of positive and negative changes in tourism (visitor arrivals) on economic growth in Cabo Verde. The graph reveals an apparent symmetry in the long-run adjustment patterns following a shock to the visitor's arrivals. This finding is in line with the result of the long-run asymmetric effects test presented earlier. On the other side, in the short run the graph illustrates the opposite. From the solid black line in the dynamic multiplier graph (Figure 5.3), it can be deduced that at 1% increase in visitor arrivals results in a short-run real GDP growth of approximately 0.17%, which gradually converges to around 0.10% in the long run. Similarly, by examining the dashed black line, it's evident that a 1% decrease in visitor arrivals leads to a short-run economic growth decline of less than 0.1% (~-07%), and this effect tends to stabilize also around -0.10% in the long run. The overall impact of tourism (net effect), represented by the thick, red-dashed line, is negative in the short run but tends to become neutral (zero) in the long run. This makes it clear that, in the short run, the impact of tourism on economic growth in Cabo Verde is different for positive changes compared to negative changes.

The break adjusted CUSUM and CUSUMSQ plot for the NARDL estimation is displayed in Figure 5.4 and demonstrates that the model parameters exhibit dynamic stability over time. In summary, the results suggest that the equation has performed well, supported by normally distributed disturbance terms, serially uncorrelated data, no misspecification, and homoscedastic residuals, as indicated in Table 5.12.

Table 5.10 – Asymmetric effects test

Null hypothesis	Long run		Short run	
	Statistic test	p-value	Statistic test	p-value
Symmetric effect of tourism on real GDP	0.725	0.3986	30.344***	0.0000

Source: Autor calculation using EViews 11. Note: (***) Significant at the 1%; (**) Significant at the 5%; (*) Significant at the 1% and (no) Not Significant.

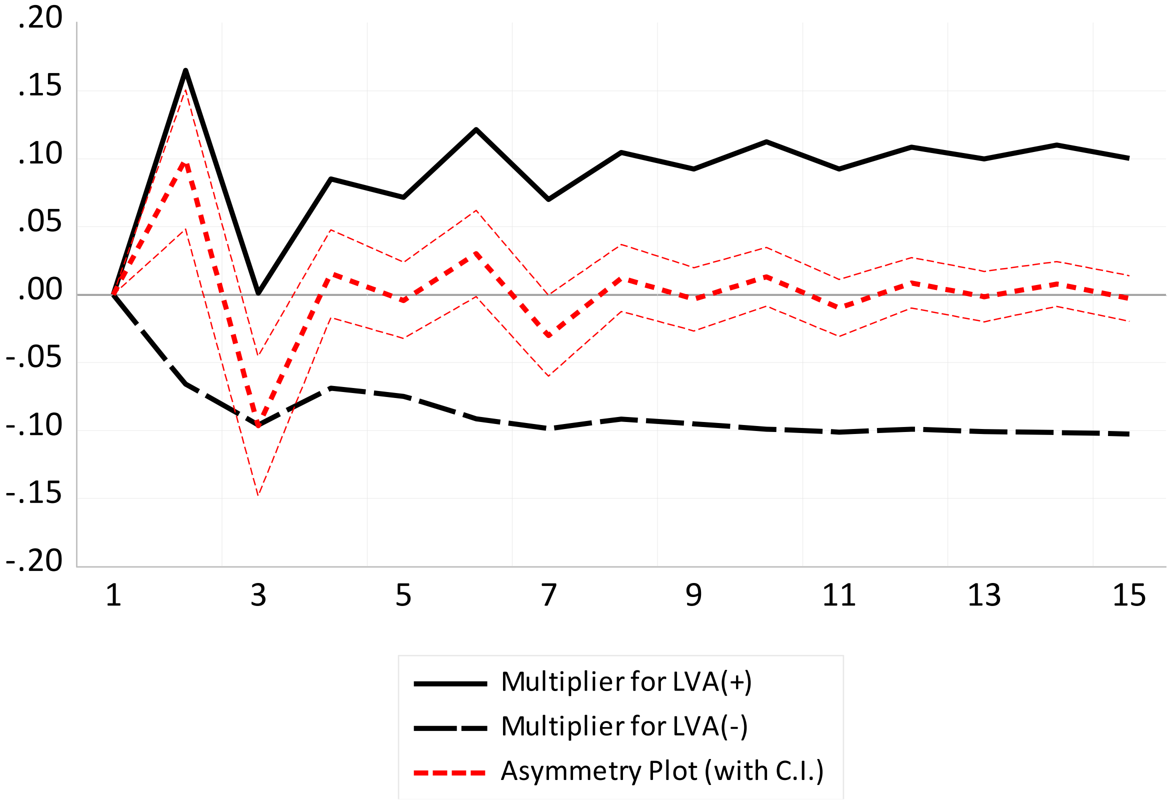

Figure 5.3 – Dynamic asymmetric multiplier

Note: The solid black (dashed) line indicates the response of the dependent variable with a unit increase (decrease) in the explanatory variables.

Table 5.11 – NARDL (4,2,2) lag estimates with dependent variable (lny) (2007Q1–2023Q2)

Variable	Coefficient	St. Error	t-Statistic	P-value
Panel A. Short run estimates				
Δlny_{t-1}	-0.36908***	0.091693	-4.025115	0.0002
Δlny_{t-2}	-0.31129***	0.058809	-5.293271	0.0000
Δlny_{t-3}	-0.27553***	0.061436	-4.484901	0.0000
$\Delta lnVA_t^+$	0.16410***	0.022009	7.478636	0.0000
$\Delta lnVA_{t-1}^+$	-0.06273***	0.018278	-3.432249	0.0012
$\Delta lnVA_t^-$	0.06581***	0.004118	15.98049	0.0000
$\Delta lnVA_{t-1}^-$	0.028671**	0.011110	2.580635	0.0129
$D_{2016Q3-20118Q4}$	0.05893***	0.010331	5.704329	0.0000
$D_{2019Q1-2023Q2}$	0.12003***	0.018133	6.619441	0.0000
ECM_{t-1}	-0.68865***	0.116341	-5.919252	0.0000
Panel B. Lon run estimates				
$lnVA_t^+$	0.10559***	0.012447	8.483342	0.0000
$lnVA_t^-$	0.10266***	0.013214	7.768810	0.0000
$Constant$	10.6179***	0.010255	1035.394	0.0000

Panel C. NARDL Bonds test

Bounds test statistic: F-test version: 8.25404*; 1 percent upper bound: 4.13; 1 percent lower bound: 5.00

Source: Autor estimation using EViews 11.
Note: (***) Significant at the 1%; (**) Significant at the 5% and (*) Significant at the 1%.

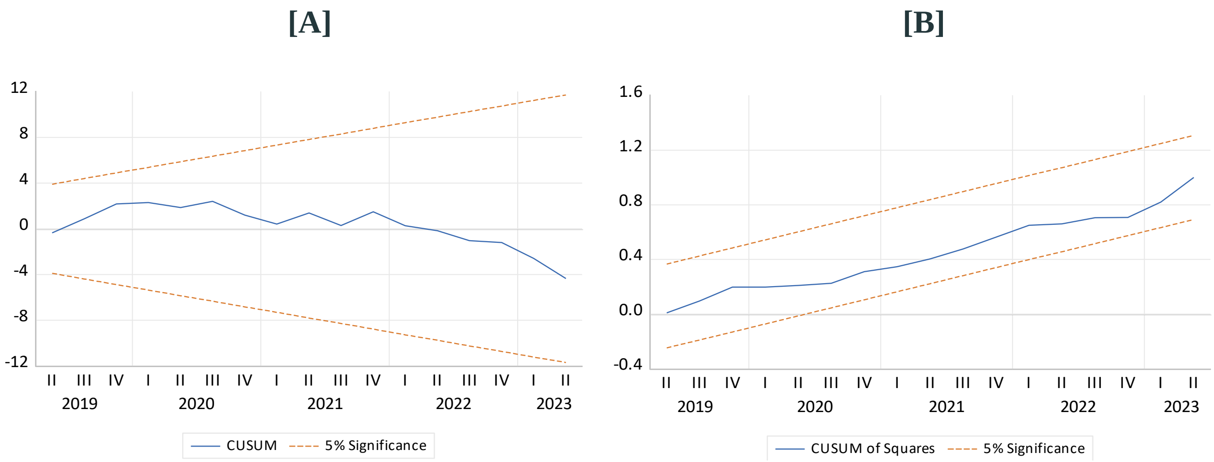

Figure 5.4 – NARDL parameter stability plot (A) and NARDL Inverse roots characteristic polynomial stability plot (B)

Note: The dashed lines represent critical bounds at the 5% significance level and Inverse roots within the unit circle indicate stable estimates. Estimated in EViews 11.

Table 5.12 – NARDL Diagnostic tests.

Null hypothesis	Value of test statistic	p-value
No serial correlation	1.158490	0.3228
Homoscedastic residuals	0.848683	0.6018
Residual normality	2.686392	0.2610
Correct functional form	0.198223	0.6582

Source: Author calculation using EViews 11.

5.5. Causality Assessment

The result of Toda – Yamamoto Granger non-causality test presented in Table 5.13, unveiling a bidirectional Granger causality relationship between tourism and economic growth, as indicated by the linear models. This bidirectional relationship suggests that tourism growth Granger-causes economic growth (TLEG) while economic growth also can Granger-causes tourism growth in the economy (EGDT). The dynamics of this relationship highlight that tourism expansion and income mutually can reinforce each other and emphasize substantial support for the TLEG hypothesis. This reciprocal causal relationship shows the importance of the tourism sector in Cabo Verde's economy, as tourism is one of the country’s main sectors. Certainly, the EGDT is substantiated by Cabo Verde's status as a relatively underdeveloped economy with limited diversity in its tourist attractions (dominated by the all-inclusive sun and beach model, supported by hotel accommodation infrastructure), which means that increased investment in tourist infrastructure positively impact other economic sectors, consequently promoting tourism economies. This premise aligns with the findings presented in the works of Lin et al. (2019) and further spotlighted by Wong et al. (2023). Cabo Verde's main sector for attracting foreign direct investment (FDI) is the tourism sector. FDI has played a key role in the country's economic growth and development over the years. Therefore, it is notable that increased investment supports the expansion of tourism. Seetanah (2011), who identified the bi-directional causality between tourism and economic growth in island economies, pointed out a positive correlation between tourism and private investment, suggesting that rising tourist numbers drive increased investment, especially in tourism infrastructure. He further adds that this dynamic relationship attracts substantial capital injection, including FDI, fostering tourism sector development, and contributing to overall economic growth with positive social implications. This conclusion, bi-directional causality between tourism and economic growth, was also reinforced in the study by Roudi et al. (2019) applied to small island developing states (SIDSs) and recently by Alcalá-Ordóñez et al. (2023) for Island countries. For individual countries, similar results were reported for Cook Islands (R.R. Kumar et al., 2016) and Mauritius (Gounder, 2022). As depicted in Figure 5.5, the inverse roots fall within the unit circle, providing assurance of stability and robustness mentioned.

Table 5.13 – Granger non-causality test based on Chi-squared test statistic (χ^2).

Causality direction	Chi-squared test statistic	P-Value
Linear		
$lnVA \rightarrow lny$	14.70360***	0.0021
$lny \rightarrow lnVA$	8.957377**	0.0299

Source: Author calculation using EViews 11. Note: Degrees of freedom (Df) = 3. (***) Significant at the 1%; (**) Significant at the 5%; (*) Significant at the 10%. $l = 4$ is chosen to ensure the causality model's dynamic stability.

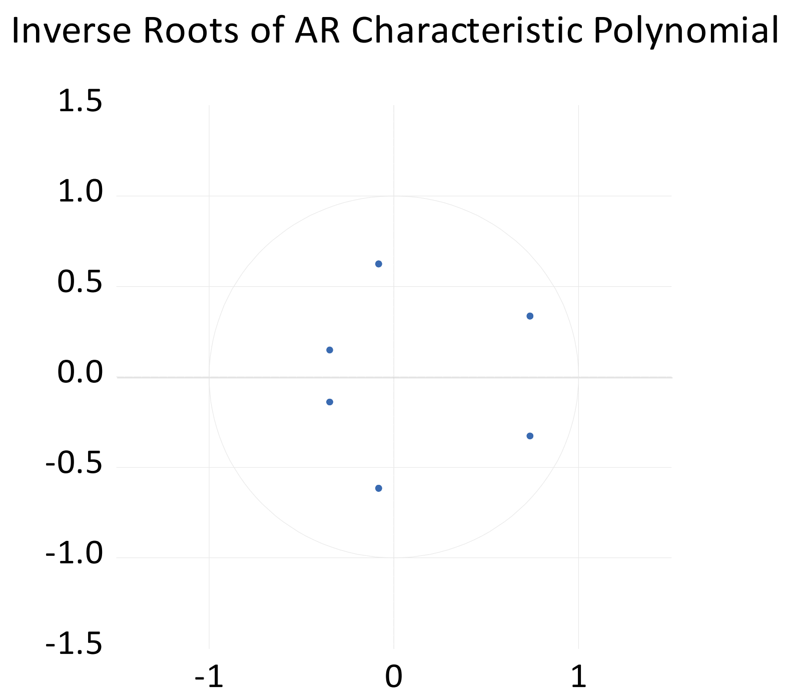

Figure 5.5 – Inverse roots of AR characteristic polynomial

5.6. ROBUSTNESS CHECK

Following what is described in the methodology section (4.1), in this section we extend the bivariate linear model specified in eq. (2) to incorporate the real exchange rate variable (RER), recognized as a crucial control variable in the existing literature (Brida et al., 2015; Cantavella-Jordá, 2002; Katircioglu, 2009; Oh, 2005; Payne, 2010). Despite inducing changes in the time periods of structural breaks within the y_t series, the inclusion of this variable does not substantially modify the coefficients or significance levels of tourism's short- and long-run elasticities, as detailed in Table 5.14 (Panel A and B). Consequently, even with this expansion, the presence of cointegration between tourism and economic growth remains evident, as indicated in Table 5.14 (Panel C). In terms of parameter stability (CUSUM and CUSUMSQ) (see appendix K) and diagnostic tests (Table 5.14, Panel D), the trivariate model generally performed well, though it encountered issues related to correct functional form.

Table 5.14 – Trivariate ARDL estimates with dependent variable (lny) (2007Q1–2023Q2)

Variable	Coefficient	St. Error	t-Statistic	P-value
Panel A. Short run estimates				
Δlny_{t-1}	-0.54919***	0.088299	-6.219753	0.0000
Δlny_{t-2}	-0.56730***	0.103481	-5.482187	0.0000
Δlny_{t-3}	-0.50818***	0.094572	-5.373504	0.0000
$\Delta lnVA_t$	0.06508***	0.003818	1.704515	0.0000
$\Delta lnVA_{t-1}$	0.01899**	0.007571	2.507778	0.0155
$\Delta lnVA_{t-2}$	0.02625***	0.007865	3.337810	0.0016
$\Delta lnVA_{t-3}$	0.03271***	0.006902	4.738487	0.0000
$\Delta lnRER_t$	0.28211***	0.094312	2.991218	0.0043
$D_{2017Q4-2023Q2}$	0.04410***	0.008743	5.044551	0.0000
ECM_{t-1}	-0.36098***	0.069389	-5.202289	0.0000
Panel B. Lon run estimates				
$lnVA_t$	0.106581***	0.029354	3630.823	0.0007
$lnRER_t$	0.246436**	0.106651	2.310683	0.0251
$Constant$	8.347196***	0.505042	1.652771	0.0000
Panel C. Result of bonds test for cointegration	Computed stat.	Sig.	Critical bonds	
$(lny \mid lnVA, lnRER, Constant, B)$			I(0)	I(1)
F-statistic	6.375610	1%	4.13	5.00

Panel D. Diagnostic tests		
Null hypothesis	Value of test statistic	p-value
No serial correlation	0.136357	0.8729
Homoscedastic residuals	0.993359	0.4352
Residual normality	0.739355	0.69096
Correct functional form	4.894357**	0.0317

Source: Author estimation using EViews 11. Note: model extension including real exchange rate variable. (***) mean Significant at the 1%; (**) Significant at the 5% and (*) Significant at the 10%. B – *dummy* variable *for* Breaks periods.

6. CONCLUSION, LIMITATION AND FUTURE WORKS

This empirical investigation explores the effect of tourism on the economic growth of Cabo Verde, a country relying on tourism, over the period 2007Q1-2023Q2. The bonds test to cointegration through linear ARDL and NARDL approach is used while controlling for structural breaks in series to examine the symmetric and asymmetric effects of tourism on economic growth. The short-run and long-run elasticity coefficients and the direction of causality relying on Toda –Yamamoto approach to Granger non-causality test, are examined. The results are as follows. First, the results show that visitor arrivals and real GDP (two proxies used for international tourism and economic growth) are cointegrated, that is, there is a long-run linear relationship between both. For the linear perspective, the elasticity of real GDP with respect to tourism in the short-run and long-run are 0.067% and 0.10%, respectively. The causality nexus shows evidence of bidirectional causality between tourism and growth duly confirming the tourism-led growth hypothesis in Cabo Verde. But it also confirms that tourism and output mutually can reinforce each other. Second, by expanding the analysis to a non-linear approach to explore the asymmetric effects of tourism, the results invalidated the long-run asymmetric effects of tourism on economic growth in Cabo Verde. This result reinforces the long-term symmetric effect of tourism on economic growth in Cabo Verde. However, in the short run, there are signs of asymmetric effects.

It is essential to acknowledge several limitations before delving into the policy implications of these findings, similarly, as underlined by N.N. Kumar et al. (2020). First, this study offers a macro-level perspective, focusing on the effects of visitor arrivals on economic growth in Cabo Verde. This limitation is due to the challenge of constructing more extensive variables. Additionally, the analysis of the asymmetric relationship is based on a relatively short 17-year period. To gain a more accurate understanding of the tourism-growth nexus, future research could incorporate additional variables such as, investment, capital stock, labor etc., and extend the analysis over a more extended timeframe to ensure the robustness of the results presented in this study. Similarly, it might be valuable to explore the utilization of alternative non-linear models like threshold autoregressive models or smooth transition autoregressive models, which are appropriate to capture short-run non-linear relationships and asymmetries. Future research also can make an effort on time varying, that is, detect the specific period that occurs TLEG or EDTG and analyze how long it takes to make the tourism-growth nexus work and how long the nexus remains effective. Having said that, the cointegration and causality result of Cabo Verde supports empirically the TLEG hypothesis which are in line with studies done for other countries, with emphasis on small countries/islands countries like Cabo Verde such as Mauritius (Durbarry, 2004; Gounder, 2022; Opuala et al., 2022), Cook Islands (R.R. Kumar et al., 2016), Papua New Guinea (N.N. Kumar et al., 2022) or Singapore (Wong et al., 2023). Thus, despite the mentioned limitations, the results of this study carry significant policy implications. They indicate that tourism has a positive and predictive influence on economic growth, aligning with the tourism-led growth hypothesis. This adds to the limited scientific literature on this subject in small island states as highlighted by Wong et al. (2023). The conclusions reached by Seetanah (2011) are still valid and can be adapted here as final considerations. Leveraging tourism as a development strategy is particularly relevant for islands, given their distinctive natural, cultural, and social attractions. These unique features serve as valuable assets that can mitigate challenges associated with small size, remoteness, geographic dispersion, vulnerability to natural disasters, and susceptibility to external shocks such as economic/financial shock or shocks of diseases like COVID-19 pandemic. Thus, as policy recommendations for Cabo Verde, this research suggests that, in addition to traditional growth drivers like investments in physical, human capital and trade, strategic emphasis on the contribution of the tourism industry can enhance economic growth. The development strategies should prioritize tourism but integrating it into broader national development plans with a focus on inter-sectoral linkages. Cabo Verde, as a small island economy, faces similar tourism development and sustainability challenges. The country is today heavily dependent on international tourism as its main source of income and concentrates its issuing market in a small number of countries belonging to Europe (as provided in Table 1), which makes the country vulnerable to economic developments and the policies of these countries as per demonstrated the research on determinants of international tourist demand for Cabo Verde carried out by Tavares (2020). This means that even if Cabo Verde's economy and government perform effectively, its development will still depend on the economic and social development of the countries of origin. Therefore, it is important to define clear strategies for expanding the market to other regions in order to mitigate the sector's vulnerability. Consequently, this should drive more assertive, more consistent and sustainable investment in the national air transport sector. Therefore, transport, which is an area inherent to the development and expansion of international tourism, has been a major challenge for national public decision-makers over the years. In this context, it is very important that the country thinks about expanding its issuing market. However, it is necessary to be aware that moving to emerging markets such as Africa or Asia requires, among other things, substantial political efforts to establish and maintain consistent air connections. This can be achieved through robust economic diplomacy, as well as clear strategies, with sustainability and consistency in air interconnection with these regions. At the same time, investments in key infrastructure, in addition to having robust transport and communication systems, including road, financial services and security measures are crucial to support comprehensive tourism development and are expected to persist. It is necessary to explore alternative strategies, focusing on destination marketing and diversifying market segmentation. This includes serving segments of tourists looking for experiences beyond the traditional all-inclusive Sun and Beach tourism, which is the current cornerstone of Cabo Verde's tourism industry. Such strategies will be fundamental for the advancement of the country's tourism sector in a sustainable and diversified manner.

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APPENDIX

Appendix A

Table A1: Lag length selection for the model without breack periods

Lag	LL	LR	FPE	AIC	SC	HQ
0	-32.41615	NA	0.010404	1.110198	1.178816	1.137139
1	29.98891	118.7709	0.001581	-0.773836	-0.567984	-0.693013
2	40.38192	19.10973	0.001287	-0.980062	-0.636976	-0.845358
3	46.90504	11.57328	0.001188	-1.061453	-0.581132	-0.872867
4	61.45105	24.86898*	0.000847*	-1.401647*	-0.784092*	-1.159179*

Note: Include $Ly\ and\ lVA$. (*) the maximum lag length selected.

Appendix B

Tabble A2: ARDL (4,4) short, long-run estimates and bonds test (model without breack periods)

Variable	**Coeficient**	**Std.Error**	**t-Statistic**	**P-value**
a. Long run estimates				
$lnVA_t$	-0.741249(ns)	1.770370	-0.418697	0.6772
$Constant$	18.56302(ns)	18.88550	0.982924	0.3302
b. ECM estimates (short run)				
Δlny_{t-1}	-0.784889***	0.108582	-7.228534	0.0000
Δlny_{t-2}	-0.712243***	0.125827	-5.660498	0.0000
Δlny_{t-3}	-0.543600***	0.107435	-5.059819	0.0000
$\Delta lnVA_t$	0.068237***	0.004266	15.99507	0.0000
$\Delta lnVA_{t-1}$	0.037924***	0.007884	4.810421	0.0000
$\Delta lnVA_{t-2}$	0.039058***	0.008751	4.463180	0.0000
$\Delta lnVA_{t-3}$	0.038404***	0.007463	5.146155	0.0000
ECM_{t-1}	0.021769***	0.004851	4.487650	0.0000
b.1. ECM additional info				
R-squared	0.880524	Mean dependent var		0.003900
Adjusted R-squared	0.865036	S.D. dependent var		0.077840
S.E. of regression	0.028596	Akaike info criterion		-4.151158
Sum squared resid	0.044159	Schwarz criterion		-3.876689
Log likelihood	136.6859	Hannan-Quinn criter.		-4.043394
Durbin-Watson stat	1.966648			
c. Bonds test			Critical bonds	
F-test	6.464370	Signif.	I(0)	I(1)
		1%	4.94	5.58

Source: (***) Significant at the 1%; (**) Significant at the 5%; (*) Significant at the 10% and (ns) Not Significant.

Appendix C

Table A3 –Bai-Perron tests of L+1 vs. L sequentially determined breaks

Break Periods	**Coeficient ©**	**Std. Error**	**t-Statistic**	**Prob.**
2007Q1 - 2011Q2 -- 18 obs	9.844029	0.047514	207.1830	0.0000
2011Q3 - 2016Q2 -- 20 obs	9.896228	0.049511	199.8804	0.0000
2016Q3 - 2018Q4 -- 10 obs	9.980875	0.051268	194.6823	0.0000
2019Q1 - 2023Q2 -- 18 obs	10.05108	0.045887	219.0389	0.0000
Non-Breaking Variables				
VA_t	0.066174	0.004162	15.90001	0.0000
R-squared	0.898030	Mean dependent var		10.69079
Adjusted R-squared	0.891343	S.D. dependent var		0.110623
S.E. of regression	0.036465	Akaike info criterion		-3.712205
Sum squared resid	0.081111	Schwarz criterion		-3.546322
Log likelihood	127.5028	Hannan-Quinn criter.		-3.646657
F-statistic	134.3033	Durbin-Watson stat		1.685492
Prob(F-statistic)	0.000000			

Note: Dependent Variable: ly; Method: Least Squares with Breaks
Break type: Bai-Perron test of L+1 vs. L sequentially determined breaks. Breaks: 2011Q3, 2016Q3, 2019Q1

Appendix D

Table A4 –Conditional ECM estimates – ARDL (4,4) (with three breakpoint)

Variable	**Coeficient**	**St. Error**	**t-Statistic**	**P-value**
lny_{t-1}	-0.031963	0.121624	-0.262805	0.7938
lny_{t-2}	-0.104434	0.112484	-0.928430	0.3577
lny_{t-3}	-0.031440	0.116318	-0.270293	0.7881
lny_{t-4}	0.479469	0.103320	4.640637	0.0000
$lnVA_t$	0.064694	0.004293	15.06963	0.0000
$lnVA_{t-1}$	0.002268	0.009441	0.240237	0.8111
$lnVA_{t-2}$	0.012547	0.009053	1.385872	0.1721
$lnVA_{t-3}$	0.012509	0.008909	1.404171	0.1666
$lnVA_{t-4}$	-0.029110	0.007513	-3.874528	0.0003
$D_{2011Q3-2016Q2}$	0.017061	0.012353	1.381153	0.1735
$D_{2016Q3-20118Q4}$	0.078807	0.024881	3.167411	0.0026
$D_{2019Q1-2023Q2}$	0.140043	0.040089	3.493255	0.0010
$Constant$	6.597389	1.988155	3.318348	0.0017
R-squared	0.950540	Mean dependent var		10.70078
Adjusted R-squared	0.938427	S.D. dependent var		0.105879
S.E. of regression	0.026273	Akaike info criterion		-4.256529
Sum squared resid	0.033823	Schwarz criterion		-3.810517
Log likelihood	144.9524	Hannan-Quinn criter.		-4.081413
F-statistic	78.47444	Durbin-Watson stat		2.041753
Prob(F-statistic)	0.000000			

Appendix E

Table A5 – Conditional ECM estimates – ARDL (4,4) (with two breakpoint)

Variable	Coeficient	St. Error	t-Statistic	P-value
lny_{t-1}	0.014585	0.117917	0.123689	0.9021
lny_{t-2}	-0.065843	0.109943	-0.598883	0.5520
lny_{t-3}	0.022967	0.110434	0.207974	0.8361
lny_{t-4}	0.516149	0.100750	5.123054	0.0000
$lnVA_t$	0.066084	0.004211	15.69262	0.0000
$lnVA_{t-1}$	-0.000101	0.009368	-0.010808	0.9914
$lnVA_{t-2}$	0.010366	0.008995	1.152385	0.2546
$lnVA_{t-3}$	0.008902	0.008594	1.035850	0.3053
$lnVA_{t-4}$	-0.031827	0.007317	-4.349982	0.0001
$D_{2016Q3-20118Q4}$	0.052909	0.016501	3.206395	0.0023
$D_{2019Q1-2023Q2}$	0.100935	0.028636	3.524716	0.0009
$Constant$	4.842527	1.542996	3.138392	0.0028
R-squared	0.948614	Mean dependent var	10.70078	
Adjusted R-squared	0.937309	S.D. dependent var	0.105879	
S.E. of regression	0.026510	Akaike info criterion	-4.250595	
Sum squared resid	0.035139	Schwarz criterion	-3.838892	
Log likelihood	143.7685	Hannan-Quinn criter.	-4.088950	
F-statistic	83.91192	Durbin-Watson stat	2.032210	
Prob(F-statistic)	0.000000			

Appendix F

Table A6 – X-13 ARIMA-SEATS seasonality test (2007Q1-2019Q4)

Variable	Stable seasonality		Moving seasonality
	Parametric	Non-parametric	
lny_t	$F(3,48) = 33.938$***	$\chi2(3) = 30.4726$***	$F(12,36) = 1.715$
$lnVA_t$	$F(3,48) = 88.902$***	$\chi2(3) = 40.5849$***	$F(15,45) = 2.504$

Note: (***) mean Seasonality present at the one percent level

Appendix G

Table A7 – VAR estimates to perform Granger Causality/Block Exogeneity test

Variables	lny_t	$lnVA_t$
lny_{t-1}	0.173976	2.411964
	(0.5403)	(0.5383)
lny_{t-2}	-0.649782	-8.836355
	(0.0105)	(0.0117)
lny_{t-3}	-0.197951	-3.343009
	(0.4551)	(0.3609)
$lnVA_{t-1}$	0.031128	0.472565
	(0.1613)	(0.1237)
$lnVA_{t-2}$	0.050378	0.605488
	(0.0171)	(0.0372)
$lnVA_{t-3}$	0.025342	0.248770
	(0.2205)	(0.3825)
$Constant$	9.181433	65.65779
	(0.0137)	(0.1963)
lny_{t-4}	0.753885	3.597513
	(0.0022)	(0.2800)
$lnVA_{t-4}$	-0.053504	-0.328024
	(0.0026)	(0.1728)
$D_{2016Q3-20118Q4}$	0.100398	0.718621
	(0.0117)	(0.1857)
$D_{2019Q1-2023Q2}$	0.154033	0.803496
	(0.0268)	(0.3974)
R-squared	0.695530	0.552584
Adj. R-squared	0.635831	0.464855
Sum sq. resids	0.208206	39.63020
S.E. equation	0.063894	0.881512
F-statistic	11.65045	6.298788
Log likelihood	88.61298	-74.10036
Akaike AIC	-2.503645	2.745173
Schwarz SC	-2.126250	3.122568
Mean dependent	10.70078	11.40888
S.D. dependent	0.105879	1.205015

Note: p-value in (). Using for linear ARDL causality test.

Appendix H

Table A8 – Conditional ECM estimates – NARDL (4,2,2)

Variable	Coeficient	St. Error	t-Statistic	P-value
lny_{t-1}	-0.057727	0.124643	-0.463138	0.6453
lny_{t-2}	0.057785	0.112091	0.515515	0.6085
lny_{t-3}	0.035760	0.066797	0.535347	0.5948
lny_{t-4}	0.275532	0.064798	4.252152	0.0001
$\Delta lnVA_t^+$	0.164598	0.029078	5.660625	0.0000
$\Delta lnVA_{t-1}^+$	-0.154617	0.038659	-3.999517	0.0002
$\Delta lnVA_{t-2}^+$	0.062733	0.023400	2.680903	0.0100
$\Delta lnVA_t^-$	0.065813	0.004590	14.33847	0.0000
$\Delta lnVA_{t-1}^-$	0.033554	0.014222	2.359313	0.0223
$\Delta lnVA_{t-2}^-$	-0.028671	0.012554	-2.283845	0.0268
$D_{2016Q3-20118Q4}$	0.058929	0.015742	3.743503	0.0005
$D_{2019Q1-2023Q2}$	0.120030	0.027720	4.330119	0.0001
$Constant$	7.312070	1.566626	4.667399	0.0000
R-squared	0.949218	Mean dependent var		10.70078
Adjusted R-squared	0.936782	S.D. dependent var		0.105879
S.E. of regression	0.026621	Akaike info criterion		-4.230159
Sum squared resid	0.034726	Schwarz criterion		-3.784147
Log likelihood	144.1349	Hannan-Quinn criter.		-4.055044
F-statistic	76.32588	Durbin-Watson stat		2.055962
Prob(F-statistic)	0.000000			

Appendix I

Table A9 – Conditional ECM estimates – ARDL (4,0,0) (Include RER and 2 breackpoint)

Variable	Coeficient	St. Error	t-Statistic	P-value
lny_{t-1}	-0.048398	0.070456	-0.686924	0.4951
lny_{t-2}	-0.018485	0.065513	-0.282156	0.7789
lny_{t-3}	0.113408	0.065448	1.732798	0.0889
lny_{t-4}	0.121029	0.059068	2.048963	0.0454
$lnVA_t$	0.064086	0.004124	15.53869	0.0000
$lnRER_t$	0.199214	0.050792	3.922114	0.0003
$D_{2011Q2-2017Q3}$	0.015111	0.012281	1.230409	0.2240
$D_{2017Q4-2023Q2}$	0.100780	0.018332	5.497366	0.0000
$Constant$	7.233518	0.732381	9.876721	0.0000
R-squared	0.929045	Mean dependent var		10.70078
Adjusted R-squared	0.918335	S.D. dependent var		0.105879
S.E. of regression	0.030257	Akaike info criterion		-4.024683
Sum squared resid	0.048522	Schwarz criterion		-3.715905
Log likelihood	133.7652	Hannan-Quinn criter.		-3.903449
F-statistic	86.74375	Durbin-Watson stat		1.799762
Prob(F-statistic)	0.000000			

Appendix J

Table A10 – Conditional ECM estimates – ARDL (4,4,1) (Include RER and 1 breakpoints)

Variable	Coeficient	St. Error	t-Statistic	P-value
lny_{t-1}	0.089819	0.115593	0.777029	0.4409
lny_{t-2}	-0.018106	0.110830	-0.163370	0.8709
lny_{t-3}	0.059121	0.113488	0.520945	0.6048
lny_{t-4}	0.508182	0.106237	4.783486	0.0000
$lnVA_t$	0.065082	0.004405	14.77351	0.0000
$lnVA_{t-1}$	-0.007621	0.009070	-0.840272	0.4048
$lnVA_{t-2}$	0.007267	0.008916	0.814979	0.4190
$lnVA_{t-3}$	0.006452	0.008738	0.738345	0.4638
$lnVA_{t-4}$	-0.032705	0.007656	-4.271857	0.0001
$lnRER_t$	0.282108	0.100415	2.809410	0.0071
$lnRER_{t-1}$	-0.193148	0.104983	-1.839815	0.0719
$D_{2017Q4-2023Q2}$	0.044103	0.018928	2.330098	0.0240
$Constant$	3.013203	1.561004	1.930298	0.0594
R-squared	0.948618	Mean dependent var	10.70078	
Adjusted R-squared	0.936034	S.D. dependent var	0.105879	
S.E. of regression	0.026778	Akaike info criterion	-4.218405	
Sum squared resid	0.035137	Schwarz criterion	-3.772393	
Log likelihood	143.7706	Hannan-Quinn criter.	-4.043289	
F-statistic	75.38626	Durbin-Watson stat	1.865659	
Prob(F-statistic)	0.000000			

Appendix K

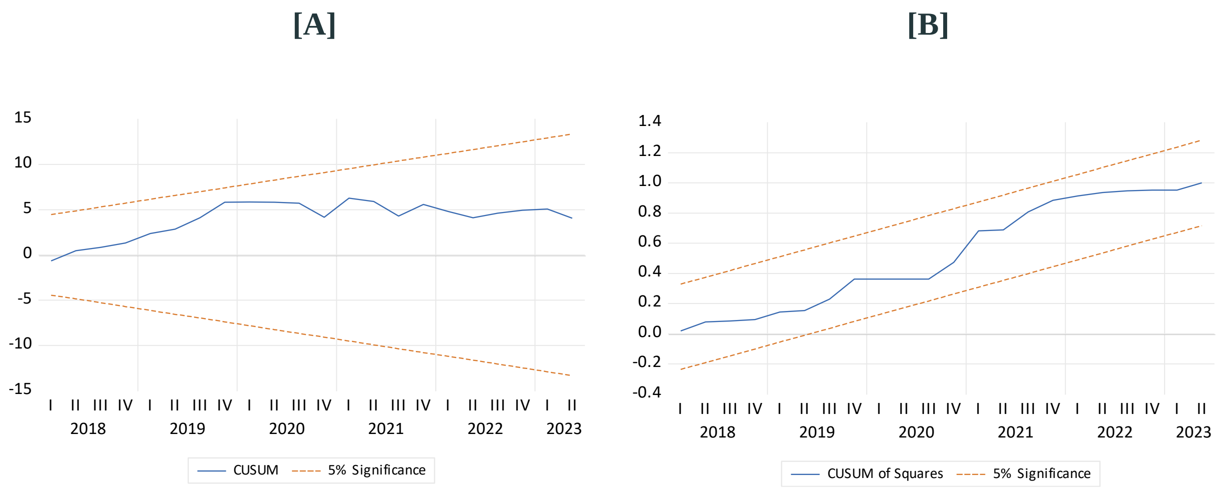

Figure A1 – ARDL (4,4,1) CUSUM and CUSUMQ after adjusting for structural breaks. [A] Cumulative sum of recursive residuals (CUSUM), [B] cumulative sum of squares of recursive residuals (CUSUMQ)

Note: The straight lines represent critical bounds at 5% significance level. Model Includes RER variable and dummy "$D2017Q4–2023Q2$" for breack period.

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