ANALYSIS OF THE RELATIONSHIP BETWEEN AIR TRANSPORT AND ECONOMIC GROWTH IN SUB-SAHARAN AFRICA

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ABSTRACT

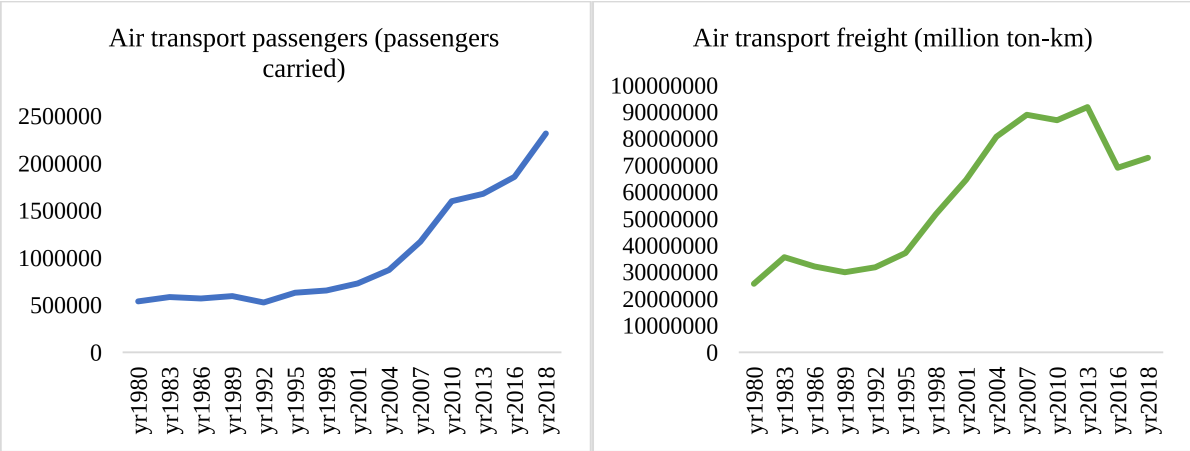
The economic role of air transport progressed over the past decades, following factors such as increased globalisation. Despite the economic importance of air transport, Sub-Saharan Africa (SSA) lagged behind other regions concerning air passenger traffic and freight levels. This may inhibit the region's economic growth. While literature shows that air transport can stimulate economic growth, this has been lacking in SSA and how the relationships differ in the short-run and long-run. The direction of causality between air transport and economic growth also remained questionable. This study investigated the short-run and long-run relationships between air transport (air passenger traffic and air freight) and economic growth in SSA using the autoregressive distributed lag model (ARDL) and Dumitrescu Hurlin Panel Causality approach. The findings show a bi-directional causality between air transport and economic growth. Air passenger traffic showed a positive long-run effect, whereas air freight suggested a negative long-run effect. Economic growth improves both air passengers and freight in the long-run. There was no evidence of short-run effects. A bi-directional causality implied that air transport and economic growth could be influenced simultaneously. These findings are paramount to the effective implementation of aviation and growth strategies.

1. INTRODUCTION

The role that air transport plays in economic development has gained prominence, notably in the sight of intensified globalisation. An increase in population, industrialisation and urbanisation may likewise influence the demand for air transport (Hu *et al*., 2015). Becken and Carmignani (2020) express that the desire to travel by air and visit faraway places has increased because of improved education, higher discretionary incomes, urbanisation and population growth, among others. Air transport is used in many types of businesses and is recognised among the engines of economic growth (Chang and Chang, 2009). It is crucial to investigate the extent of the economic growth contribution that emerges from air transport.

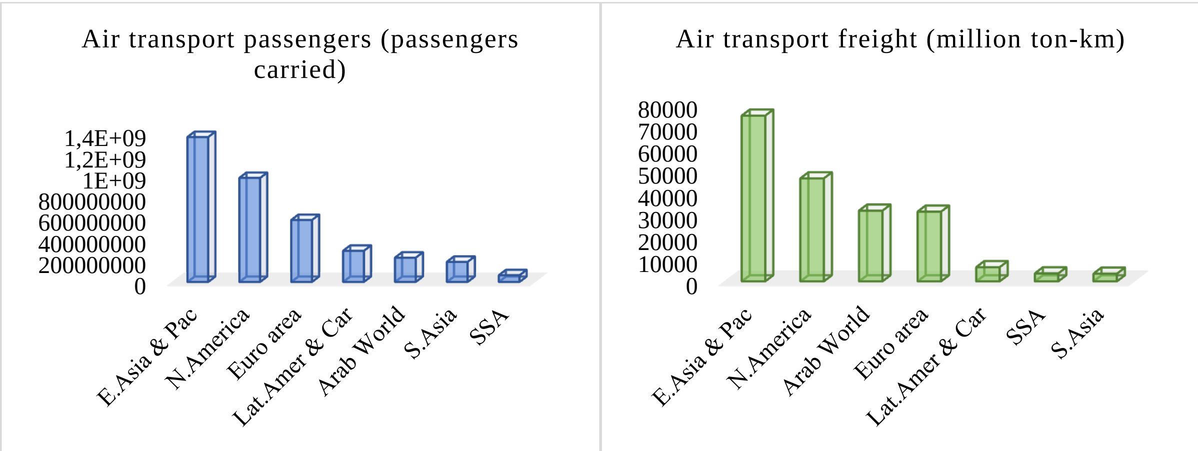
Demand for air transport services has been rising in Sub-Saharan Africa (SSA). Based on twenty SSA countries, Figure 1 presents the trends in air transport demand since 1980. Regardless, SSA countries typically encounter the lowest air passenger traffic levels and air freight relative to other regions (Figure 2) based on the 2018 statistics. SSA is far behind many other regions. This may impede the region's integration with the international market. Low levels of economic growth (Figure A2 in the appendix) compared to other regions may explain why SSA's air passenger traffic and air freight are below other regions. Enhancing the air transport sector in SSA may represent an opportunity to stimulate economic growth, which in reverse may boost the demand for air transport services (bi-directional causality scenario).

SSA has made strides to enhance air transport services over the past two decades. Growth in the gross domestic product (GDP) per capita in the past two decades (Figure A1 in the appendix) may have raised the demand for air transport services. Air transport demand may actively respond to changes in economic growth (Marazzo, Scherre & Fernandes, 2010). Causality between air transport and economic growth might exist, which requires a detailed instigation. This cannot be deduced from trends since trending in the same direction or a strong relationship between variables does not necessarily suggest a causal relationship (Yoo, 2006). Hence, there is a need for a robust investigation into causality. In this study, it is plausible to assume that air transport and economic growth influence each other, but causality tests lacking in the existing literature must confirm the nature of the relationship.



Source: Authors' plots using World Development Indicators

Figure 1: Air transport passengers and air transport freight – Trends



Source: Authors' plots using World Development Indicators

Figure 2: Air passenger transport and air transport freight (2018 statistics) – regional statistics

Against this backdrop, detailed knowledge about the relationship between air transport and economic growth must reveal the direction of causality as well as the short-run and long-run relationships. This kind of inquiry yields vital policy inferences.

1.1 Statement of the Problem

Enhancing the air transport industry has been central to the development of Africa. Among other considerations, having been convinced that air transport is critical for spurring economic and social development in Africa, forty African nations agreed to a declaration of a new African air transport policy, dubbed the Yamoussoukro Declaration, in November 1988 (Campbell, 2018). Had this been implemented, this would have opened the African air transport market to Africa's airlines at a continental level instead of the current networks of bilateral agreements. The Single African Air Transport Market (SAATM) was launched in 2018. The aim was to develop air services and harmonise associated regulations on the continent and promote private capital movement in the sector. However, no clear implementation framework exists, which is an obstacle.

Overcoming obstacles to the development of Africa's air transport is important for economic expansion. Empirical research supports the fundamental economic role of air transport, for example, as shown by Nwaogbe *et al*. (2013) in the Nigerian context. A feedback effect may also happen from economic growth to air transport (Hu *et al*., 2015). Nevertheless, literature on the causation between air transport and economic growth is wanting. As mentioned by Hakim and Merkert (2016), many empirical studies on causality between air transport and economic growth have investigated the developed and middle-income economies. There could be a uni-directional (Fernandes & Pacheco, 2010) or bi-directional causality (Chang & Chang, 2009). The critical question is which indicator should take precedence? Does the demand for air transport induce economic growth, or does economic growth result in an increased demand for air transport? Attention has been drawn to the research and policies on the role of air transport as a tool for stimulating economic growth.

In the past, there were no positive statements about a technique to test for causality due to the lack of commonly accepted procedures and a lack of a universally preferred definition of the concept (Granger, 1980). Nowadays, there are many approaches to causality analysis. It is, therefore, crucial to perform causality tests to establish the direction of causality between air transport and economic growth.

Besides the causality issue, there is insufficient knowledge about the relationships between air transport and economic growth in the short-run and long-run. Evidence of both short-run and long-run relationships between air transport and economic growth can be found (Hu *et al*., 2015); however, contrary evidence does exist (Hakim & Merkert, 2016). Limited understanding of the short-run and long-run relationships between air transport and economic growth is another knowledge gap.

Furthermore, only a few studies have analysed SSA (for example, Profillidis & Botzoris, 2015; Nwaogbe *et al*., 2013). SSA may show different results concerning the direction of causation, and short-run and long-run relationships. Several underlying factors may lead to diverse outcomes across regions, for instance, the level of air transport, the level of GDP and the channels through which the effects pass.

Inspired by the above significant knowledge gaps, the present study contributes to the body of literature by being one of the first of its kind conducted in SSA to disclose not only the direction of causality between air transport and economic growth, but also how the causal relationships vary depending on whether they are short-run or long-run analyses. Thus, paramount to this study is the potential feedback effects (causality) and the different time horizons (short-run and long-run) in SSA.

This paper is organised as follows: Section 2 reviews previous literature, Section 3 provides the context of air transport in Africa, Section 4 describes data and methods, Section 5 presents and discusses the empirical results, and Section 6 concludes and presents critical policy implications.

2. CONTEXT OF AIR TRANSPORT IN AFRICA

The African continent has a large population size (1 350 678 777), with Eastern Africa having the largest population (445 405 606) and followed by Western Africa (401 861 254), Northern Africa (246 232 518), Middle Africa (179 595 134) and Southern Africa (67 503 635) (Worldometers, 2020). This affords an excellent opportunity for the air transport sector. Abate (2013) claims that whereas these conditions look favourable for air transport, low per capita income and several years of economic stagnation have made commercial aviation in the continent the least developed in the world. The continent has been accounting for only 2% of the global air traffic, with most African states relying on a few African and foreign airlines for air services. The biggest airlines in the continent have been Ethiopian Airlines (over 3.3 million passengers in the 12 months to the end of May 2019), EgyptAir (almost 8.9 million passengers in the year to May 2019), Moroccan national carrier, Air Algerie, Comair Limited, Kenya Airways, South African Airways, Tunisair, Mango Airlines, and FlySafair (The Africa Logistics, 2020).

South African airlines have traditionally held the role of being a prime provider of intercontinental services, but now this crucial role is also held by the Ethiopian and Emirates airlines (ICAO, 2019). Similarly, Johannesburg has been the major intercontinental gateway to SSA by far, but Addis Ababa has also emerged as a prime gateway and hub (Bofinger, 2018). ICAO (2019) showed that the top seven economies (South Africa, Ethiopia, Egypt, Kenya, Algeria, Morocco and Tunisia) in the continent accounted for more than 90% of the total number of fleets of Africa, while the majority of African countries have a small capacity. The load factors of African airlines have been below the world average and hence they need to optimise the airlines' capacity utilisation in the continent. There are other parts with no direct flights in Africa. ICAO (2013) presented top international origin and destination city pairs in Africa with no direct flight. These include: Harare-Cape Town; Lusaka-Cape Town; Mombasa-Dar es salaam; Victoria Falls-Cape Town; Lagos-Cape Town; Nairobi-Cape Town; Mombasa-Entebbe; Livingstone -Cape Town; and Dakar-Abuja.

Although the African air transport sector is still underdeveloped, it has been improving over the past two decades. For instance, according to Bofinger (2018), domestic traffic in SSA has been rising gradually (e.g. from 10.3 million seats in 2001 and to 22.7 million in 2015), and at the same time, there has been an increase in direct international connectivity measured in airport pairs served between SSA. The top international destination regions from Africa have been Europe (41%), followed by intra Africa (27%) and Middle East (19%) (ICAO, 2019). SSA has been making progress despite still having a low overall volume in comparison to other regions. South Africa is by far the largest domestic air transport market, followed by Nigeria (Bofinger, 2017). Over 40 African countries have less than 2 million international passengers per annum; South Africa has the most international passenger numbers.

One key area African countries have been involving is the liberation of the air transport sector. The Deloitte (2018) report indicates that the opening up of civil aviation in Africa as an impetus to Africa's economic integration agenda has resulted in the launch of the SAATM in 2018. The initial open skies initiative was launched in 1992 between the USA and the Netherlands, which allowed both countries to have unrestricted landing rights in each of the countries. In Africa, the Yamoussoukro Decision of November 1999 was considered to liberalise international travel among African nations by lifting capacity and frequency restraints, encouraging free pricing and permitting fifth freedom flights (Bofinger, 2017). This is a crucial step, as the aircraft capacity could be spread across many international destinations on a single marketed flight. Flights can originate from airport A (country A), land in other airports, other countries before reaching the final destination.

The International Civil Aviation Organisation (ICAO) indicated that it would continue supporting the implementation of the Yamoussoukro Decision, which is also crucial for African integration of trade and travel under the Continental Free Trade Area (ICAO, 2013). Notwithstanding the adoption of the Yamoussoukro Decision in 1999, restrictive air service agreements persistently obstruct intra-African services, affecting routing, capacity, frequency and fares (AfDB, 2019).

Bofinger (2017) maintains that although many African countries have made attempts to privatise the air transport sector, several governments have been reluctant to entirely hand over airlines to private players. Consequently, it has been difficult for the African air transport sector to implement modern approaches of airline management and ownership. The continent has remained with few established carriers (e.g. Kenyan, South African, and Ethiopian). Some are fragile, national flag-owned airlines, such as Zimbabwean Airways, while some are recently developing, such as RwandAir. The liberalisation of air transport will facilitate the continental provision of air transport services.

In terms of competition, Bofinger (2017) indicates that intercontinental routes in SSA reveal 80% of the routes in a monopoly state, whereas in North Africa, the percentage fell from 70% to slightly over 60%, based on 2016 data. Additionally, despite an increase in the total number of international routes from 300 routes in 2003/2004 to 440 routes in 2012, the share of routes in a monopolised condition rose from 69.5% in 2001 to 81.5% in 2015. The launch of the SAATM in 2018 could be a promising step towards enhancing competition, which often leads to improved services and charges, ceteris paribus.

To strengthen air transport in Africa, the issues to be addressed include improving the extent of safety and security regulatory oversight, high cost of tickets as a result of taxes, charges and operation costs, low traffic and poor air connectivity on some of the routes, and improvements of the current aviation infrastructure to be in line with the ICAO Global Air Navigation Plan and policies (ICAO, 2013). Heinz and O'Connell (2013) maintain that carriers in Africa experience higher costs than in other parts of the world. For example, the fleet size of African carriers lacks sufficient scale to negotiate favourable rates with the suppliers of fuel, while the practice of fuel hedging is not endorsed, leaving airlines prone to volatile price fluctuations. The AfDB (2018) report mentions that the main safety problem encountered is as a result of poor regulatory oversight, human factors in air and ground operations, and deficient infrastructures. According to Bofinger (2018), the new problems for air transport development in Africa are not so much around liberalisation but instead the issue of affordability and increasing airport charges.

Addressing the above problems may improve air traffic volume, which is still low compared to the rest of the regions. For instance, Bofinger (2017) reveals that the density of air traffic as measured in seat capacity is relatively small, with approximately 104 million seats on all types of routes. The region is far behind, for example, Brazil with 120 million seats. It is vital to understand the driving factors of air transport demand that are relevant to SSA countries, which is beyond the scope of this study.

Irrespective of the challenges encountered by air transport in Africa at large, the outlook seems promising. According to ICAO (2019), the projected annual growth of passenger traffic in 2015-2035 will be 4.3% for Europe-North Africa, 2.9% for Europe-Sub-Saharan Africa, and 5.8% for intra Africa. The projected annual growth of cargo traffic will be 3.8% for the African region in the same period. According to Deloitte (2018), "Africa is considered a growing aviation market with IATA forecasting a 5.9% year-on-year growth in African aviation over the next 20 years, with passenger numbers expected to increase from 100 million to more than 300 million by 2026 and SAATM is a way to tap into this market". Nonetheless, it is not clear how the effects of the COVID-19 pandemic could influence the future air traffic level.

3. LITERATURE REVIEW

Many studies have verified the linkage between air transport and economic growth. Hakim and Merkert (2016) studied the causal relationship between air transport and economic growth in South Asia. Their results suggested a long-run, one-way Granger causality from GDP to air freight and air passenger traffic but could not detect short-run causality. In the same region, Hakim and Merkert (2019) discovered that per capita income, jet fuel prices, flight frequency, and foreign direct investment (FDI) influence air passenger demand. Moreover, jet fuel price, FDI, industrialisation and income were found to be significant factors that determine air freight demand. The authors could not find short-run effects of the independent variables on air freight but air passengers. Chang and Chang (2009) identified a long-run equilibrium and a two-way causal relationship between air cargo expansion and economic growth in Taiwan.

Given the deregulation of the Association of Southeast Asian Nations (ASEAN) air transport market, Laplace and Latgé-Roucolle (2016) showed that the economic benefits of liberalising air transport were not trivial. Likewise, Abate's (2016) analysis suggested that there was up to a 40% surge in the departure frequency of routes that had some liberalisation compared to those governed by restrictive bilateral air service measures. However, there was evidence of a diminishing marginal effect of progressive liberalisation, and that liberalisation had no fare reducing effect.

Based on 29 Chinese provinces, Hu *et al*. (2015) proved that a 1% increase in air passenger traffic increased real GDP by 0.94%. They also established a robust long-run bi-directional Granger causality between the two series. However, there was a one-way short-run causality from air passenger traffic to economic growth. Yao and Yang (2012) also found economic growth to positively impact air transport in China.

Marazzo *et al*. (2010) revealed evidence of cointegration between air transport and economic growth in Brazil. Air transport demand reacted strongly to a change in economic growth, while economic growth slowly or moderately reacted to change in air transport demand. However, evidence by Fernandes and Pacheco (2010) showed a one-way causality from economic growth to a demand for domestic air transport in Brazil. In the United States, Chi and Baek (2013) disclosed that air passenger and air freight services increased with economic growth in the long run. Thus, economic growth played a role in developing air transport, but in the short-run, only air passenger travel reacted to economic growth.

In a study by Klophaus and Grosche (2020), a consumer surplus approach was used to measure the economic benefit of selected long-haul air transport routes connecting Germany with California and China. The authors found total annual revenues from business and leisure nonstop travel on selected origin destinations (OD) to be €571.1 million and the corresponding consumer surplus amounts to be €760.5 million. Thus, based on the selected routes between Germany and Asia or North America, their findings indicated that air transport offered economic welfare.

Dobruszkes, Lennert and Van Hamme (2011) found an impact of GDP on air travel demand in Europe. Dimitriou, Mourmouris and Sartzetaki (2017) revealed that the catalytic impact of air transport was more than double for a tourism country like Greece, with air transport stimulating economic growth, reinforcing social values and generating employment. Likewise, in Greece, Dimitrios and Maria (2018) concluded that air transport had a significant effect, both through its undertakings and as an enabler of other industries. Jankiewicz and Huderek-Glapska's (2016) analysis also indicated that tourism had a significant role in generating traffic. Moreover, air transport was sensitive to seasonal fluctuations, the influence of employment and GDP levels.

In the analyses by Park, Seo and Ha (2019) of the performance of numerous transport infrastructure types in the Organisation for Economic Co-operation and Development (OECD) and non-OECD states, air and land transport were often found to be irrelevant or negatively affected growth, especially in developing economies. According to the authors, these results could be linked to the fact that the application of million ton-kilometres is a weak estimation of the air and land infrastructure stock or a poorer variable specification that led to the negative economic growth effect of transportation.

Few studies have focused on Africa. Profillidis and Botzoris (2015) examined the correlations between air passenger transport and economic activity in the world and several geographical areas, including Sub-Saharan Africa. Their findings suggested a causal correlation between air passenger transport and economic growth. Njoya (2019) analysed the tourism and broader economic effects of price-reducing reforms in Egyptian air transport services. The author's findings indicated that although some agents experienced negative direct effects of the reforms, the economy-wide gains surpassed the costs experienced by the reforming sector. Nwaogbe *et al*. (2013) proved that air transport supports economic growth (GDP) and employment in Nigeria through four different routes: direct route, indirect route, induced route and catalytic route. The airlines contributed at least NGN58 billion to the Nigerian economy and supported 61 000 jobs in the country.

Bourguignon and Darpeix (2016) concluded that (i) it seems there were no significant differences between developing regions nor between them and developed economies in the way economic activity impacted air traffic. This is true even for less advanced economies in SSA, (ii) economic growth-elasticity of air traffic seemed to be significantly less than the popularly held view that it should be around 2, as soon as the economy's specific autonomous time trends were taken into consideration.

Overall, causal relationships between air transport and economic growth in short-run and long-run have not been clear because of mixed findings. Further investigation is important, especially in SSA, with limited literature on the topic.

4. RESEARCH METHODS

This research aimed to investigate the short-run and long-run relationships between air transport and economic growth in SSA. Based on data availability, this was a longitudinal research design of 20 countries: Angola, Botswana, Burkina Faso, Cabo Verde, Cameroon, Congo Republic, Gabon, Ghana, Kenya, Madagascar, Malawi, Mauritania, Mauritius, Mozambique, Nigeria, South Africa, Sudan, Tanzania, Uganda and Zambia.

4.1 Data

This paper applied annual data from 1980 to 2018. Air transport passengers (ATP_{it}) and the air transport freight in million ton-km (ATF_{it}) represented the air transport variables and change in GDP per capita, current US dollars (ΔGDP_{it}) was a proxy for economic growth. The 2019 World Development Indicators file was the key source of data.[1] All variables were transformed into logarithms and hence interpreted the coefficients as elasticities.

4.2 Unit Root Test

This study performed unit root tests to determine the stationary properties of the variables. The unit root results allowed us to ensure that no variable was I(2) before estimating the ARDL models. The Im, Pesaran and Shin's (2003) unit root test was used to determine the stationarity of the variables. Unlike other tests (e.g. Breitung, 2001; Levin, Lin and Chu, 2002) that assume a common unit root process, the Im-Pesaran-Shin (IPS) test assumes an individual unit root process and hence captures heterogeneity.

4.3 The ARDL Models

Apart from other cointegration tests (Kao, 1999; Pedroni, 1999), the ARDL model by Pesaran and Shin (1998) also accommodates variables that are I(0). The re-parameterised ARDL model provides short-run and long-run relationships of the variables in a single model. This study considered three ARDL models. The first model was for the effects of air passenger traffic and air freight on economic growth, with the following re-parameterised ARDL (p, q1, q2):

$$\Delta lnGDP_{i,t} = \emptyset_{\boldsymbol{i}}\left[lnGDP_{i,t-1} - \boldsymbol{\acute{\delta}_i} lnA\acute{I}R_{i,t}\right] + \sum_{j=1}^{p-1} \sum p - 1\psi_{i,j} \Delta lnGDP_{i,t-j} + \sum_{j=0}^{q-1} \boldsymbol{\acute{\beta}_{i,j}} \Delta lnA\acute{I}R_{i,t-j} + \alpha_i + \varepsilon_{i,t} \tag{1}$$

where:

- $lnA\acute{I}R_{i,t}$ is a vector of two air transport measures (i.e. $lnATP_{i,t}$ and $lnATF_{i,t}$) for any country i at time t, and $lnGDP_{i,t}$ is defined in equation (1).
- $p,\ q$ are the lag-order of the dependent and independent variables, respectively. The optimal lag order was determined using the Akaike information criterion (AIC) and Schwarz information criterion (SIC); the former is commonly applied (Asteriou, 2006:71). The SIC penalises more heavily than the other criteria. Nevertheless, in this analysis, these criteria selected the same ARDL models.
- $\emptyset_{\boldsymbol{i}}$ shows the speed of adjustment (expecting $\emptyset_i < 0$).
- $\boldsymbol{\acute{\delta}_i}$ is the vector of long-run relationships.
- The ECT $\left[lnGDP_{i,t-1} - {}'_{\boldsymbol{i}} lnA\acute{I}R_{i,t}\right]$ term shows the long-run information in the model.
- $\psi_{i,j}, \boldsymbol{\acute{\beta}_{i,j}}$ are short-run dynamic parameters; j is the lag count.

The second and third models were for the effects of economic growth on both air passenger traffic and air freight, with the following ARDL (p, q):

[1] Only Tanzania's GDP per capita was based on IMF data, given the WDI had missing observations from 1980-1987.

$$\Delta lnATP_{i,t} = \emptyset_{\boldsymbol{i}}\left[lnATP_{i,t-1} - \acute{\boldsymbol{\delta}}_{\boldsymbol{i}} lnGDP_{i,t}\right] + \sum_{j=1}^{p-1} \psi_{i,j} \Delta lnATP_{i,t-j} + \sum_{j=0}^{q-1} \acute{\boldsymbol{\beta}}_{\boldsymbol{i,j}} \Delta lnGDP_{i,t-j} + \alpha_i + \varepsilon_{i,t} \quad (2)$$

$$\Delta lnATF_{i,t} = \emptyset_{\boldsymbol{i}}\left[lnATF_{i,t-1} - \acute{\boldsymbol{\delta}}_{\boldsymbol{i}} lnGDP_{i,t}\right] + \sum_{j=1}^{p-1} \psi_{i,j} \Delta lnATF_{i,t-j} + \sum_{j=0}^{q-1} \acute{\boldsymbol{\beta}}_{\boldsymbol{i,j}} \Delta lnGDP_{i,t-j} + \alpha_i + \varepsilon_{i,t} \quad (3)$$

where the variables are defined in equation (2). The significance of the ECT implies that the long-run equilibrium relationship is driving the dependent variable (Hakim & Merkert, 2016). The long-run coefficients suggest the equilibrium effects of the explanatory variables on the dependent variable; the negative speed-of-adjustment coefficient indicates the response of the dependent variable to the deviation from an equilibrium relationship in one period, while the short-run coefficients account for fluctuations that are not a result of a deviation from long-run equilibrium.

Among the advantages, the ARDL model is dynamic, whereby the effects of the explanatory variables on the dependent variable happen over time instead of all at once. The ARDL method does not only integrate the short-run dynamics with the long-run equilibrium without losing long-run information, but also circumvents challenges, such as spurious relationships due to non-stationary series (Shrestha & Bhatta, 2018). This method follows a general specification model that handles several economic issues like misspecification and autocorrelation. Using the ARDL model, causality can be inferred by looking at the significance of ECT (for joint causality), long-run coefficients (for long-run causality), and short-run coefficients (for short-run causality) (Adeleye, 2018).

4.4 Dumitrescu Hurlin (D-H) Panel Causality Tests

This study performed the D-H tests to detect the direction of causation. This approach is suitable in heterogeneous panels. Dumitrescu and Hurlin (2012) demonstrated the benefits of this approach as: (i) controlling for both the heterogeneity of the regression model and heterogeneity of causal relationships, (ii) a test that is based on average individual Wald statistics of Granger non-causality, converging sequentially to a standard normal distribution; and (iii) even in the existence of cross-sectional dependence, the standard panel statistics show good small sample properties using Monte Carlo simulation. The D-H test proposes the null hypothesis of no causal relationship from x to y for all cross-sections.

5. RESULTS AND DISCUSSION

The objective of this study was to investigate the short-run and long-run relationships between air transport (air passenger traffic and air freight) and economic growth. Descriptive statistics, correlation and unit root tests were the preliminary tests performed before the key tests.

5.1 Preliminary Tests

Table 1 shows the descriptive statistics and correlations of the variables. Between 1980 and 2018, the 20 SSA countries had an average annual GDP per capita of US$1630 (US$136 monthly), and an average annual growth per capita ($d.GDP_k$ or g) of $51.32. Note that the $d.GDP_k$ is a crude indicator of the economic welfare in SSA over the last decades.

Table 1: Descriptive statistics and correlations

Variable summary					
	Average	Std. Dev.	Obs (N)	No. of years (T)	No. of countries (n)
GDP_k	$1630.31	$2072.08	780	39	20
d.GDP_k or g	$51.32	$342.38	760	39	20
ATP	973351.40	2489980	780	39	20
ATF	5.74 m	1.53m	780	39	20
Correlation matrix					
	lnGDP	d.GDPk or g	lnATP		lnATF
lnGDP	1.0000				
d.GDPk or g	0.1187***	1.0000			
lnATP	0.4189***	-0.0247	1.0000		
lnATF	0.2015***	-0.0179	0.6070***		1.0000

Note: *** denotes significance at 1% level. d.GDP_k or g stands for economic growth, which is a change in GDP_k.

The annual average number of air passengers was 973 351, while the average air freight volume was 5.74 million ton-km. High standard deviations suggested that the values in the data sets were further away from their averages.

The correlation coefficient between lnGDP and air lnATP was 0.42, i.e. almost a half comovement between these series. The correlation coefficient for lnGDP and lnATF (0.20) was relatively low. Positive correlations implied that the variables moved in the same direction. However, the correlation coefficients of economic growth (d.GDPk) and the two air transport indicators are not statistically significant, implying no linear relationship. Correlations provided an initial picture of the potential relationships between air transport and economic growth. However, the ARDL and D-H causality tests were needed to generate firm evidence of the relationships between air transport and economic growth. Before using these methods, one must conduct unit root tests. Table 2 shows the unit root results with and without a trend.

Table 2: IPS panel unit root test

Variable	**Deterministic**	**W-t-bar Statistic**	
		Level	**1st Difference**
lnGDP	Intercept	3.2783	-18,5353***
	Intercept & Trend	-0,6054	-16,8609***
lnATP	Intercept	-0,0840	-21,8102***
	Intercept & Trend	0,0433	-20,6895***
lnATF	Intercept	1.2515	-18,7334***
	Intercept & Trend	2,3527	-17,9463***

Note: Lag selected based on AIC. *** denotes significance at the 1% level.

All test statistics are not significant in the levels but are significant in the first differences. This suggests that all the variables become stationary in the first differences. It was good that none of the variables was I(2), as ARDL F-statistics will not be valid (Chi & Baek, 2013). To have an appropriate ARDL model, one needs to identify optimal lags. For each of the three models, this study ran a Stata code for optimal lag selection based on the AIC and SIC. These two information criteria chose the same optimal lags for the ARDL models (Table 3).

Table 3: Optimal lags

			AIC	SIC
Model	**Dependent Variable**	**Independent Variable**	**ARDL (p q q)**	**ARDL (p q q)**
1	lnGDP	lnATP, lnATF	ARDL (1 0 0)	ARDL (1 0 0)
2	lnATP	lnGDP	ARDL (1 0)	ARDL (1 0)
3	lnATF	lnGDP	ARDL (1 0)	ARDL (1 0)

Note: Optimal lag selection based on AIC and SIC.

5.2 ARDL Cointegration, Short-Run and Long-Run Estimates

The ARDL approach began with the Hausman test, which was used to determine an appropriate estimator between the pooled mean group (PMG) and the mean group (MG). Pesaran, Shin and Smith (1999) proposed these different estimators to address the bias due to heterogeneity in dynamic panels. The null hypothesis is that the PMG estimator is the most appropriate. Based on the Hausman test, the null hypothesis was not rejected, and hence this study used the PMG across all models. The PMG estimator combines pooled estimates' efficiency while circumventing the challenge of inconsistency, which emerges from pooled heterogeneous dynamic relations.

Table 4 shows the long-run effects, the speed of adjustment (as demonstrated by an ECT) and the short-run effects from estimating the ARDL models (Equations 1, 2 & 3). The fundamental assumption is that the countries share common long-run parameters, and hence the long-run effects are the key parameters of interest. However, the short-run estimates for the panel are presented as well. Owing to dynamic heterogeneity, the ARDL also generates the key short-run estimates for the individual countries (Table 5). Model 1 is for the effects of lnATP and lnATF on lnGDP, Model 2 shows the effects of lnGDP on lnATP, and Model 3 shows the effects of lnATF on lnGDP.

Table 4: Relationships between air transport and economic growth

		Model 1: lnGDP		Model 2: lnATP		Model 3: lnATF
	Regressors		**Regressors**		**Regressors**	
Long-run	lnATP	0,8420***	lnGDP	0,7420***	lnGDP	0,1930***
	lnATF	-0,1600***				
Short-run	lnATP	0,0296	lnGDP	-0,0205	lnGDP	0,0894
	lnATF	-0,0097				
	Constant	-0,1366**	Constant	1,2333***	Constant	1,6619**
	ECT	-0,0886***	ECT	-0,1630***	ECT	-0,1198**
	Obs	760	Obs	760	Obs	760
	Groups	20	Groups	20	Groups	20

Notes: *** and ** denote significance at 1% and 5% level, respectively. Model 1, Model 2 and Model 3 dependent variables

The findings suggested a bilateral joint causal relationship between air passenger traffic and economic growth exhibited by the negative and significant ECTs for Models 1 and 2. Likewise, a bi-directional joint causal relationship is suggested between air freight and economic growth (see the ECTs of Models 1 and 3). Based on Model 1, there is a cointegrating relationship between lnGDP, lnATP and lnATF. The ECTs show that there is cointegration between air transport and economic growth. Any deviation from long-run equilibrium is corrected at 8% adjustment speed in Model 1, 16% (Model 2) and 12% (Model 3).

The findings revealed that a percentage increase in air passenger traffic increased economic growth by 0.84% as for the long-run relationships. Thus, air passenger traffic plays a vital role in promoting economic growth in SSA. Our estimated economic growth impact of air passengers is slightly below the 0.94% obtained by Hu *et al*. (2015) in the case of China. Among probable explanations, air transport facilitates the growth of the tourism industry, which is a crucial component of the region's service sector. Effective air services enable trade and global competitiveness, which are essential for economic growth. While this study does not statistically affirm the ways through which air transport can stimulate growth, tourism and trade are reasonably among the ways through which air transport can boost economic growth. A 2017 report by the International Air Transport Association (IATA) showed that the air transport sector in South Africa provided significant economic value, supported 490 000 jobs, including tourism-related employment, and contributed US$12 billion or 3.5% to the economy's GDP (IOL, 2017). While no short-run effects were found, the significance of the long-run effects may entail the time lag that exists until the economic impact of increased air passenger traffic becomes significant.

Despite the long-run growth contributions of air passenger traffic, it was suggested that air freight had a negative impact on economic growth. Hakim and Merkert (2016) also obtained a negative coefficient in South Asia; however, their coefficients were insignificant. Hakim and Merkert (2016) made an important argument that air freight is usually driven by the value instead of the weight of commodities. In developing regions, such as SSA, the volume of commodities may increase while the value remains low due to poor currency values. Inflation and the depreciation of the exchange rate in some countries diminished the value of freight, leading to negative pressure on economic growth. Consequently, air freight's insignificant or negative growth effects might be linked to the freight measurement, as argued by Park *et al*. (2019).

Besides the measurement issue, from this study, it is thought that with increased globalisation, the nature of international air freight (exports versus imports) plays a role. Based on the World Bank data for the past four decades, the average export volume (value) index for the SSA countries was generally less than the average import volume (value) index. When air freight has more imports than exports, it may exert negative pressure on growth, ceteris paribus.

In Model 2 and Model 3 (Table 4), the findings show that economic growth has a positive long-run effect on both air passenger traffic and air freight. Economic growth signals improved economic activity in a country, which increases the demand for air transport services. Income per capita growth allows more people to afford air travel and air freight services. Moreover, the proceeds of economic growth may be used to enhance aviation services, which further attract the usage of the services. Statistically significant long-run coefficients infer long-run causality between the air transport indicators and economic growth. However, consistent with Hakim and Merkert's (2016:126) results, the short-run effects of both ATP and ATF are insignificant, suggesting no short-run causality in the panel. It takes time for air transport to significantly impact economic growth. It takes time for economic growth to have a significant impact on air transport. However, the major concern is on short-run effects for the individual countries, which accounts for dynamic heterogeneity.

Table 5 presents the short-run effects for individual countries. In Model 1, the short-run effects of lnATP on lnGDP are significant only for Nigeria. The effect of lnATF on growth is only significant for the Congo Republic, but negative.

Table 5: Short-run relationships for individual countries

	Model 1: lnGDP			Model 2: lnATP		Model 3: lnATF	
Country	lnATP	lnATF	ECT	lnGDP	ECT	lnGDP	ECT
1. Angola	0,0576	0,1086	0,0381	-0,0862	-0,1396**	0,3533*	-0,5497***
2. Botswana	0,1102	0,0369	-0,0936	0,1716	-0,2417***	0,8570	-0,2667**
3. Burkina Faso	0,0466	0,0079	-0,0136	-0,0630	-0,1758**	0,0101	0,0007
4. Cabo Verde	-0,0659	0,0125	-0,0709	0,0224	-0,1135	-0,0061	-0,1389**
5. Cameroon	-0,1068	-0,0113	-0,1026*	-0,2385	-0,1492	-0,2756	0,4604***
6. Congo, Rep,	0,0950	-0,2740*	0,0261	-0,2084	-0,2384***	-0,3230**	-0,0295
7. Gabon	-0,0497	-0,0954	-0,0406	-0,1189	-0,0209	-0,1259	0,2226***
8. Ghana	-0,0230	-0,1143	0,0500	-0,4434	-0,2717***	-0,5112	0,0122
9. Kenya	-0,1160	-0,0347	-0,2046***	-0,0090	0,0016	0,0937	-0,0457
10. Madagascar	0,0939	-0,0764	-0,1540**	0,3457	-0,2898***	-0,4358	-0,3123***
11. Malawi	-0,3075	0,1932	-0,0313	0,2131	0,0017	0,6539	-0,0168
12. Mauritania	-0,0991	0,0365	-0,2435***	0,0269	-0,2893***	0,4262	-0,0415
13. Mauritius	0,2212	-0,0564	-0,0650	0,2827	-0,1455***	0,3975	-0,0999***
14. Mozambique	0,0765	0,0125	-0,3673***	-0,0464	-0,2209***	0,0226	-0,1465*
15. Nigeria	0,1958*	0,0515	-0,0886	0,2022	-0,1340	-0,4383	-0,4286***
16. South Africa	0,2258	0,1029	-0,2775***	0,1932*	0,0067	0,0743	-0,0697
17. Sudan	0,2337	-0,1257	-0,1120*	0,2224	-0,1040	-0,1101	-0,0833
18. Tanzania	0,0362	-0,0087	0,0259	-0,1327	-0,1853**	-0,5879	-0,6373***
19. Uganda	0,0081	0,0147	-0,0431	0,1815	-0,3452***	1,0085	-0,0989
20. Zambia	-0,0417	0,0266	-0,0035	-0,9258	-0,2042*	0,7055	-0,1258

Note: ***, ** and * denote significance at 1%, 5% and 10% level, respectively.

Increased GDP showed a positive and significant short-run effect on lnATP only in South Africa (Model 2). Accordingly, South Africa is the only country whose economic growth has short- and long-run effects on air passenger freight. South Africa's relatively high economic activities that encourage air travelling could explain this. It has been by far the largest domestic air transport market in Africa (Bofinger, 2017). Economic growth showed a significant and positive short-run effect on air freight only in Angola but a negative effect in the Congo Republic (Model 3).

5.3 The Direction of Causality: D-H Causality Analysis

Table 6 shows the results regarding the direction of causality between the air transport indicators and economic growth. Going back two years (2 lags), it was found that air passenger traffic resulted in economic growth. This observation is important when quantifying the contribution of increased air passenger traffic in an economy, since the region could not only gain from the current air traffic levels, but also the changes that happened two years back would still have an effect.

There is also evidence that economic growth caused air passenger traffic across all four lags. Moreover, the findings showed that air freight caused economic growth across the four investigated lags. Changes in air freight volumes that occurred four years back could still cause current economic growth. Economic growth also caused air freight demand to change.

Overall, based on the D-H causality tests, there was a bidirectional causality between the two air transport measures (ATP and ATF) and economic growth. Despite detecting the direction of causality, the D-H approach does not estimate the size of the effects, which the ARDL approach achieved. An important observation was that while causality was suggested by the D-H tests, the ARDL showed that the effects were not significant in the short-run, but significant and substantial in the long-run.

Table 6: D-H causality result

	Direction of causality	Direction of causality
Air passenger traffic and economic growth		
Lag	ATP to GDP	GDP to ATP
1	Yes	Yes
2	Yes	Yes
3	None	Yes
4	None	Yes
Air freight volume and economic growth		
Lag	ATF to GDP	GDP to ATF
1	Yes	Yes
2	Yes	Yes
3	Yes	Yes
4	Yes	None

6. IMPLICATIONS

Bidirectional causality between air transport and economic growth implies that these two indicators influence each other. This suggests that aviation (economic growth) policies may not be taken without influencing economic growth (aviation sector). Practically, for example, policymakers in the African aviation industry may not continue maintaining restrictive air service agreements without jeopardising economic growth. The AfDB (2019) indicates that restrictive air service agreements persistently impede intra-African services, affecting routing, capacity, frequency and fares. This will delay the development of the aviation sector in Africa and slow the economic contribution of this sector. Apart from the remaining restrictive air service agreements, causality from air transport to economic growth also entails that the high cost of air tickets, increased airport charges and poor air connectivity do not reduce the demand for air transport but also its contribution to economic growth. The previous literature raised these problems (ICAO, 2013; Heinz & O'Connell, 2013; Bofinger, 2018), which the African aviation sector is still experiencing.

On a positive note, causality from air transport to economic growth shows that policies that are meant to improve the efficiency of the aviation sector will automatically affect economic growth. In this case, it is our belief that the launch of the SAATM in 2018 will improve the aviation sector's contribution to economic growth in Africa. The benefits of the SAATM include job creation, improved international trade leading to growth in GDP and reduced travel costs (Deloitte, 2018). This initiative may improve competition among airlines and the delivery of services. The intercontinental routes in SSA that are currently monopolised may realise increased airlines. In this regard, Abate (2016) argues that liberalisation has the potential to elicit competition among African airlines, which would decrease fares. Speeding up the full implementation of the SAATM is strongly endorsed.

The positive effect of economic growth on air transport implies that as African economic growth rises, it causes a greater demand for air transport services. Bidirectional causality between air transport and economic growth shows that it is possible to simultaneously improve air transport and economic growth. While this nexus seems favourable, it also means any adverse shocks to economic growth will jeopardise the performance of the air transport sector. The ARDL results indicate that the effect of economic growth on air transport freight and passengers will materialise in the long run. From a policy perspective, at the moment, this suggests that policy decisions to address the adverse effects of the

COVID-19 pandemic on air transport should be taken, in cognisance of how the affected economic growth may come to haunt the demand for air transport, especially in the long term. The income per capita in Africa has already been low and taken as one of the reasons why commercial aviation in the continent remains the least developed (Abate, 2013). This current paper stresses that the COVID-19 challenge and the associated lockdowns that occurred in 2020 may exert downward pressure on income per capita in Africa, further weakening demand for aviation services. Unless the governments make appropriate and adequate post-COVID-19 policies to stimulate domestic aggregate demand, production levels and economic growth, the future outlook of air transport performance is fragile.

Linked to previous implications, our results show that the adjustment speed to correct any deviation from long-run equilibrium relationships between economic growth, air transport passengers and air transport freight was slow. Subsequently, when a shock happens, policymakers should expect a longer period to pass before a full adjustment in the equilibrium relationship between air transport and economic growth is restored. The suspensions of flights due to the COVID-19 challenge that hit the aviation industry hard may have distorted the steady long-run relationship between air transport and economic growth, and it may take time to resolve the distortions.

Also, in the interest of improving air transport provision and connectivity and ultimately the aviation sector's contribution to economic growth, policymakers in Africa should not be overprotective of the numerous fragile national flag-owned airlines. A good example is the troubled Air Zimbabwe, whose operations are intermittent. This study concurs with an argument by Bofinger (2017) that these fragile, national, flag-owned (often state-owned but not always) carriers are not economically sustainable, lead to lower service standards and impede competition. Protecting state-owned carriers and maintaining restrictive measures while the population is denied access to quality air transport services may not be an effective strategy. Perhaps as argued in Abate’s (2013) paper, it is not necessarily that every nation should own an airline to yield the benefits of an efficient air transport service. Many African economies may continue to be both players and beneficiaries of the sector through enhanced competition.

Another important implication drawn from the results is that policymakers should not expect the effect of their aviation policies to immediately have an effect on economic growth. For instance, this suggests that the SAATM initiative may yield significant economic growth for African economies in the long run and not in the short run.

Finally, it is imperative to consider heterogeneity among countries, as the relationship between air transport and economic growth may differ between individual countries. In this study, while the short-run effects of air transport on economic growth in most countries were not relevant, a few countries (Nigeria, Congo Republic) showed significant effects. For the short-term effects of economic growth on air transport, only South Africa (positive effect) and Congo Republic (negative effect) show significant effects. This study recommends that the regional aviation policies account for heterogeneity among African countries to ensure that all signatories have benefitted. In this case, country-specific factors such as having domestic airlines, wars, whether landlocked or not, population size, level of income per capita may cause anomalies in the findings regarding the air transport – economic growth nexus.

7. CONCLUSION

This study focused on the short-run and long-run relationships between air transport and economic growth in SSA. It was concluded that a bidirectional causality existed between air transport and economic growth, which the ARDL model suggested it happened only in the long-run. The variables were cointegrated. The adjustment speed to correct any deviation from long-run equilibrium relationships between GDP, ATP and ATF was slow. While ATP had a positive long-run effect on economic growth, ATF suggested negative growth effects. Nevertheless, the findings showed no evidence of short-run effects. Even for the individual countries, this study found few short-run effects and hence, concluded that the relationship between air transport and economic growth in SSA existed in the long-run.

Our analysis was limited to SSA countries due to the unavailability of data. There should be various channels through which air transport influences economic growth, which requires a detailed investigation. Tourism and trade could be channels in the relationship between air transport and economic growth. Further research may broaden the scope of this study by considering tourism and trade as mediators in the relationship between air transport and economic growth. While this study focused on economic growth, future studies may instead consider the role of air transport in socio-economic development (accounting for poverty and inequality).

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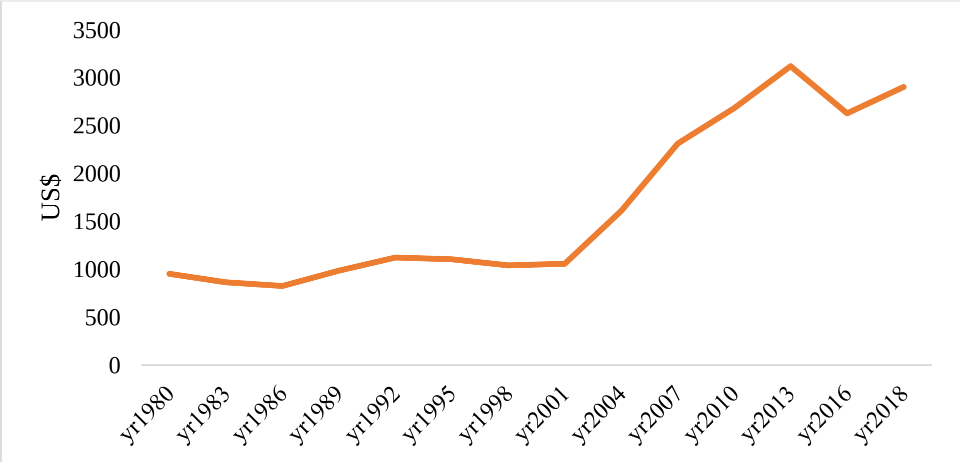
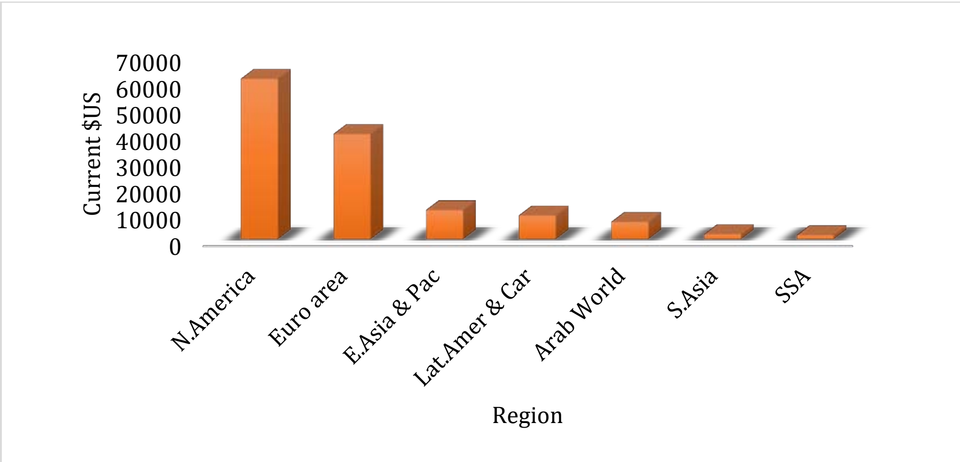
APPENDIX



Source: Authors' plots using World Development Indicators

Figure A1: Trend – GDP per capita



Source: Authors' plots using World Development Indicators

Figure A2: Regional comparison – GDP per capita (2018 statistics)