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AIR TRANSPORT DEMAND AND ECONOMIC GROWTH IN ETHIOPIA (Cointegration and Causality Analysis)

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Preface

This thesis is submitted to the Faculty of Logistics at Molde University College – Specialized University in Logistics in partial fulfillment of the requirement for Msc. degree in logistics. This thesis has been written with the period of January to June 2017 with Professor Svein Bråthen, Molde University College, as a supervisor.

The study has been conducted on the relationship between air transport demand and economic growth in Ethiopia. The paper consists of an introduction, the rationale of the study, literature reviews, methodology, analysis, discussion, conclusion, and recommendation. From the discussions of this thesis, I believe that one can understand the air transport platform of Ethiopia.

Acknowledgements

First and foremost, I would like to thanks the Almighty God for giving me the strength, knowledge, and courage to endure all the difficulties that I went through in the pursuit of course studies and accomplishment of this paper.

My special gratitude and thanks would be extended to my supervisor, Professor Svein Bråthen, for his unfailing guidance, invaluable comments, unreserved intellectual and material supports in the realization of this thesis.

I am also indebted to Molde University College for giving me the academic admission which was the base for all benefits I enjoyed in Norway. Ethiopian Airports Enterprise and Ethiopian Airlines also deserve grateful thanks for providing me their invaluable data. My sincere thanks go to Mr. Yared Melaku who gave me a well organized and reliable data, thank you.

I would like to extend my heartfelt gratitude and appreciations to my wife Hiwot Melaku and my daughter Anna Tassew. Without your persistent love, prayers, understanding, and unfailing support, completing my study would have been difficult. I want to extend my profound gratitudes to my parents, sisters, brothers and all who support and encourage my family and me throughout the endeavor of my study. Thank you all.

Finally, I would like to thanks my intimate friends and classmates Andinet Asmelash, Gari Umeta and Tesfaye Belay for your joyful time and support. We spent memorable and unforgettable time together, thank you.

Abstract

The general objective of this study is to identify the long run and short run causal relationships between air transport demand (passenger and freight) and Ethiopian economy. This paper also aimed to establish the empirical evidence on short-run dynamics and long-run relationships that have been experienced and expected to exist between Ethiopian economy and air transport demands. To realize these objectives, appropriate estimations techniques (VECM, VAR, Granger causality test, and descriptive analysis) were employed for the data set 1981 to 2015.

Johansen cointegration analysis shows the existence of one cointegrated vector between economic growth and air transport expansion where the corresponding elasticities are positive. The findings of VECM showed that the coefficient of speed of adjustment between economic growth and air transport dynamics is about ($ECT = -0.25$). This figure indicates the speed of short run disequilibrium per year towards long run equilibrium. The results of VECM analysis also reveals that there are long run causalities which runs from air transport demand (passenger and freight) to economic growth and significant with three-year time lags. The three-year time lag appears plausible given that air passenger traffic demand needs time to filter through to economic growth.

The regression of results of VECM showed that a 1% increase in air passenger traffic demand, in the long run, will on average leads to a proportionately lower growth in economic growth about 0.77%. In terms of monetary values, suppose in the last ten years, per passenger per year contribution of air passenger demand to GDP of Ethiopia has been, on average, estimated to US$ 5,286. The following table summarizes the impacts of PAX and FRT change on economic growth of the country.

	$\Delta lnGDP$	
Explanatory factors	**Short run**	**Long-run**
$\Delta lnPAX$	0.4% (0.000)	0.77% (0.002)
$\Delta lnFRT$	0.018% (0.000)	0.62% (0.000)

Empirically, the magnitude of 1% increase of growth in air freight ton-kilometer would lead to roughly 0.6% per year economic growth in the long run. More specifically, one kilogram per kilometer per year contribution of air freight demand to the economic growth of the

country, in the long run, would be estimated to US$ 174. In the short run, an increase of 1% in passenger demand causes an increment of about 0.4% in the economic growth and 1% change in air freight traffic improves economic growth in the country with about 0.02%. Specifically, per passenger per year contribution of air passenger traffic to the local economic growth of the country could be estimated to US$ 2,973 and one kilogram per kilometer per year effects of air cargo demand enhances local economy with about US$ 5.9.

The empirical evidence obtained from the causality tests (long run, short run, and Granger Causality) showed that there is unidirectional causality going in a positive direction from air transport development (passenger and freight) to local economic growth. The study also shows impacts of positive changes like bilateral agreements and implementations of open sky policy on air transport demand which have significant implications in economic activities. But economic growth is more responsive towards the positive effects of air passenger demand than that of freight demand. The performance of economic growth in Ethiopia can be improved by strategically harnessing the contribution of air transport industry. The forward and backward linkages of the air transport sector with other industries could multiply and increase the benefits of economic interactions so that economic growth has been enhanced.

The empirical findings of the paper have some policy and management implications. First, the outcome of the study suggests that the long run benefits of Ethiopian economy would be enhanced by improving the performance of air transport sector. Second, the capital and infrastructure constraints of air transport sector should be minimized in order to boost the nation’s competitiveness. Third, to improve and motivate the local economic activity, domestic air transport services need to be supported and emphasized. Finally, maintaining and upgrading the fertile grounds for international air transport traffic in Ethiopia through providing the conditions for better air transport service will have long run considerable effects on economic growth of the country.

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Acronyms

ADF	Augmented Dicky -Fuller
AFCAC	African Civil Aviation Commission
AFRAA	African Airlines Association
ARMA	autoregressive moving average
ATAG	Air Transport Action Group
COMESA	Common Market for Eastern and Southern Africa
CSA	Central Statistics Agency
EAE	Ethiopian Airport Enterprise
ECAA	Ethiopian Civil Aviation Authority
ECT	Error Correction Term
EU	European Union
FSC	Full-Service Carriers
GTP	Growth and Transformation Policy
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
LCC	Low-Cost Carrier
LR	likelihood ratio
NBE	National Bank of Ethiopia
VECM	Vector Error Correction Model

1. Introduction

Air transport development is both a factor and an indicator of economic growth. On the one hand, it is a factor of progress as it facilitates transportation within extended countries or countries without good land transportation infrastructure. On the other hand, it is an indicator of development as its volume clearly depends on the level of economic activity as well as on the prosperity of the population. Additionally, it may also be an indicator of the structure of economic growth as a more outward-oriented economy may be associated with more intense passenger or freight air traffic. Concerning the dynamic relationship between air transport demand and economic growth (Bourguignon & Darpeix, 2016) stated that competitive air transportation has reasonable positive effects on economic growth, producing a direct and/or indirect causation.

Air transport development may have an impact on economic growth through different channels. Air transport is a source of significant foreign exchange (Van De Vijver, 2014) and has an important role in stimulating investments in new infrastructure. Given the complex mix of transport-related sectors, air transport stimulates other economic industries by direct, indirect, induced, and catalytic effects. Additionally, air transport contributes to the generation of employment opportunities and the rise in incomes (Özcan, 2013). Air transport causes positive economies of scale, helping to boost a country's competitiveness, and is an important factor in the diffusion of technical knowledge.

Economic growth of a country can also have tremendous impacts on air transport improvement. The development of the modern infrastructure such as airports boosts the opportunity to encourage activities like export, tourism, business operations and productivity which influences the company location and investment decisions (Halpern, 2011).

There have been a number of empirical studies, emerged recently and is still scarce (Green, 2007), on the relationship between air transport demand and economic growth. These studies were mostly conducted in developed countries (Baker, Merkert, & Kamruzzaman, 2015; Y. H. Chang & Y. W. Chang, 2009; Chi & Baek, 2013) and higher middle income countries (Bourguignon & Darpeix, 2016; Fernandes & Rodrigues Pacheco, 2010; Hakim & Merkert, 2016). These researchers reach different conclusions on the relationship between air transport demand and economic growth causalities for different income segmented

countries. Though the findings of these studies are different for various countries and regions, bidirectional causalities in developed countries and unidirectional causalities in higher middle-income countries are the common findings. In this paper, the causality analysis between air transport demand and economic growth in developing countries, Ethiopia, would be investigated.

The rest part of the paper would be organized as follows. The historical and current status of the aviation industry in Ethiopia presented in the second chapter. The theoretical and empirical literature would be analyzed and compiled in the third section. The model framework and method of analysis presented in the fourth chapter. In the fifth chapter, the nature of data and description of variables would be presented. In the sixth chapter, the descriptive analysis of the paper presented. The findings and interpretations of the econometric analysis could be discussed in the seventh section. In the final section, conclusion remark and recommendations would be forwarded.

1.1 Statement of the Problem

Ethiopian economy has experienced a significant growth rate over the past decade, averaging 10.8% per year in 2003/04 - 2014/15 compared to the regional average of 5.4% (World Bank, 2016). Generally, the Africa region is considered as a future economic powerhouse with significant potential for growth and could become a very lucrative success story for aviation and associated supply chain/logistics industries. This growth will materialize with the necessary aviation support infrastructure put in place in time which requires careful consideration of the spatial dimensions and very significant up-front investment (sunk cost) that involve risks and uncertainties around the forecasted growth numbers for aviation.

The causality analysis has become important to policy makers, airlines, airports, and other stakeholders in order to better understand whether there is a unidirectional, bidirectional or no relationship between economic growth and air transport expansions. In addition to this, causality analysis is popular in identifying whether there are any time lags in those relationships. To better understand which way, the causalities run can guide policy makers in answering whether it is better value to publicly support economic growth or aviation directly. Most empirical literature that has analyzed the causal relationship between air transport and economic growth has focused on high income and higher middle-income countries with very little attention on lower middle income and low-income countries like

Ethiopia. Specifically, there is no studies and no robust empirical evidence, to the best of my knowledge, on the causal relationship between air transport and economic growth in Ethiopia.

The objective of this paper is to investigate the short-run dynamics and long-run relationships between economic growth and air transport demands in Ethiopia. Air transport services generally comprised of passenger and freight services which have been analyzed in this study. After causality direction identified, the average impact of air transport demand and economic growth on each other could be analyzed both in short run and long run. Additionally, the responsiveness of economic growth to air transport demand or the sensitivity of air transport demand for economic growth of the country would be also investigated. Specifically, in this study the following research questions (RQ) have been analyzed and addressed;

> *RQ_1: What is the connection between air transport demand and economic growth in Ethiopia?*

The variables may have a short run and/or long-run relationships in their interactions. If the variables are cointegrated, they would have long run relationships.

> *RQ_2: What is/are causal direction between air transport demand and economic growth in Ethiopia?*

The causal direction/s between economic growth and air transport demand could be unidirectional or bidirectional depending on inherited economic features of the countries/regions. This question would be analyzed and discussed in the econometric section of this study.

> *RQ_3: What are the short-run dynamics and long-run relationships experienced and expected to exist between air transport demand and economic growth in Ethiopia?*

After the causal direction and connection between air transport demand and economic growth have been identified, the average impacts of theses variables on each other could be estimated. The short-run dynamics and long-run relationships would be analyzed and interpreted in chapter seven of the paper. In addition, to the estimated relationships, the expected dynamics and relationships could be also forecasted.

2. Overview of the Aviation Industry in Ethiopia

Aviation is the practical aspect or art of aeronautics, being the design, development, production, operation and use of aircraft, which could be categorized as civil aviation, military aviation, and air safety. Civil aviation includes air transport (commercial carriage by air), non-commercial flying (such as private flying), commercial non-transport (such as aerial crop dusting and surveying), infrastructure (such as airports and air navigation facilities), manufacturing (such as aircraft, engines, and avionics) and regulatory bodies (ICAO, 2016)[1]. But this study would give emphasis on civil aviation air transport including passenger and freight demands. In this context, aviation industry of Ethiopia refers to primarily about the Ethiopian Civil Aviation Authority (ECAA), Ethiopian Airports Enterprise (EAE), and Ethiopian Air Lines (EAL).

The Ethiopian aviation industry is progressing with a high technological development and technologies with the latest aircraft. For instance, Ethiopian Airlines took delivery of the 2 of 14 Airbus A350 XWBs on June 28, 2016, making it Africa's first operator of the type (Airbus, 2016). The company is becoming a leader of similar aviation companies in Africa. Ethiopian Airlines, the only airline in the country, is the largest airlines in Africa in terms of annual revenue and profit, noted the International Air Transport Association (IATA) in the 58th edition of World Air Transport Statistics (IATA, 2014). The national carrier has become the largest African carrier with revenue topping $2.3 billion in 2013. According to (TIA, 2016)[2], Ethiopian airlines wins the African Airlines Association (AFRAA) airline of the year award for the fifth year in a row. In addition to this, according to (The Economist, 2016)[3] Ethiopian airlines is Africa's largest and most profitable airline by earning more than its rivals on the continent combined. This airline is a global carrier currently serving 97 international destinations across 5 continents with over 200 daily departures and 20 domestic destinations (Ethiopian Airlines, 2016).

[1] http://www.icao.int/

[2] http://thisisafrica.me/ethiopian-airlines-wins-airline-year-award-fifth-year-row/

[3] http://www.economist.com/news/business/21709075-why-one-national-airline-bucking-continent-wide-trend-well-connected?fsrc=scn%2Ffb%2Fte%2Fpe%2Fed%2Fwellconnected

2.1. History of Aviation Industry in Ethiopia

History of aviation in Ethiopia goes back to 1929 when French made an airplane, Potez 25 flown by a French pilot Andre Milet landed on the western side of Addis Ababa enrooted from Djibouti. This was 26 years after the first attempted flight by the Wright brothers and two years after the famous flight across the Atlantic by Captain Lind burg. Although Millet piloted the first aircraft which marked the history of aviation in the country, soon came with his successors with other types of the airplane after one month time- in the month of September (ECAA, 2017)[4].

In 1930 five sweater airplanes like Farman-192 and others were purchased by the government for domestic postal, security and government services. In the same year, Gaston Vidal, a French instructor, established the first pilot training school in the town of Jigjiga, Eastern part of Ethiopia, which produced Mishka Babichief and Asfaw Ali who were certified to be the first Ethiopian pilots. The school at Jigjiga was not only limited to the pilot training but also added aircraft maintenance. From 1926-1936 new domestic routes were opened to Gefersa, Bishoftu, Janmeda and Akaki, and the country had also acquired twenty airplanes until the occupation of Italy (ECAA, 2017; Sofany, 2016).

In 1944, the United States of America invited the Ethiopian government to attend the Chicago conference of December 7, 1944 and signed the convention of the International Civil Aviation Organization. One year later in 1945 Ethiopian Airlines was founded with six-second world surplus DC-3/c-47 airplanes. In 1951 through the technical assistance provided by the International Civil Aviation Organization, aviation school was opened in Addis Ababa and trained first 60 trainees (Wyanie A. Bright & Habte, 2015).

2.2. Air Transport Service Development in Ethiopia

Ethiopian Airlines was established in 1945 in a joint venture with Trans World Airlines, an American airline that existed from 1925 and merged with American Airlines in 2001. Ethiopian Airlines has been a pioneer in African aviation industry which totally state-owned airlines and serves as the country's flag carrier (Ethiopian Airlines, 2016; Selamta, 2013).

[4] http://www.ecaa.gov.et/

Air transport service in Ethiopia established and has been operating around three major cornerstones: Ethiopian Civil Aviation Authority (ECAA), Ethiopian Airports Enterprise (EAE), and Ethiopian Air Lines (EAL) (Wyanie A. Bright & Habte, 2015). ECAA is the regulator under the Ministry of Transport's oversight: it regulates safety, licenses air transport service providers, inspects and licenses airports, licenses aviation personnel, and registers aircraft (ECAA, 2017). EAE controls, manages, administers, and maintains airports (EAE, 2016)[5], while EAL is the operator, is fully owned by the government and is one of the most competitive airline service providers on the continent (EAL, 2016)[6]. The following table summarizes the chronological developments of Ethiopian Airlines.

Table 1: Chronological development of Ethiopian Airlines

Key Dates	Activities
1945	Ethiopian Airlines established as 'Ethiopian Air Lines'
8th April 1946	Ethiopian Airlines began its first scheduled flight to Cairo via Asmara
1957	Network stretches north to Hamburg, Germany
1961	A new East-West service was inaugurated, linking Addis Ababa with Monrovia
1962	Boeing 720B, the first aircraft in Africa, was ordered
1963	The airline inaugurated its first jet service, from Bole to Nairobi
1965	The company changed its legal status from a corporation to share company and changed its name from Ethiopian Air Lines to Ethiopian Airlines.
1975	Introduces first direct flights between Africa and China
1998	Launch of a twice-weekly service to Washington and New York
2003	Construction begins on new cargo terminal and maintenance hangar
2008	The airline entered a codeshare agreement with Lufthansa
2010	Ethiopian Airlines has entered a code-share agreement with Scandinavian Airlines
2011	- Ethiopian Airlines joined Star Alliance on December 13, 2011 -The airline signed codeshare with Singapore airlines and Asiana Airlines
2012	Established its Second Hub in Lome - Togo
2014	Signed code share with ANA, Japan's airline, United Airlines and Austrian Airlines
2015	Signed a codeshare agreement with TAP Portugal (Portugal's leading airline)
2016	Ethiopian airlines launches Africa's first Airbus A350

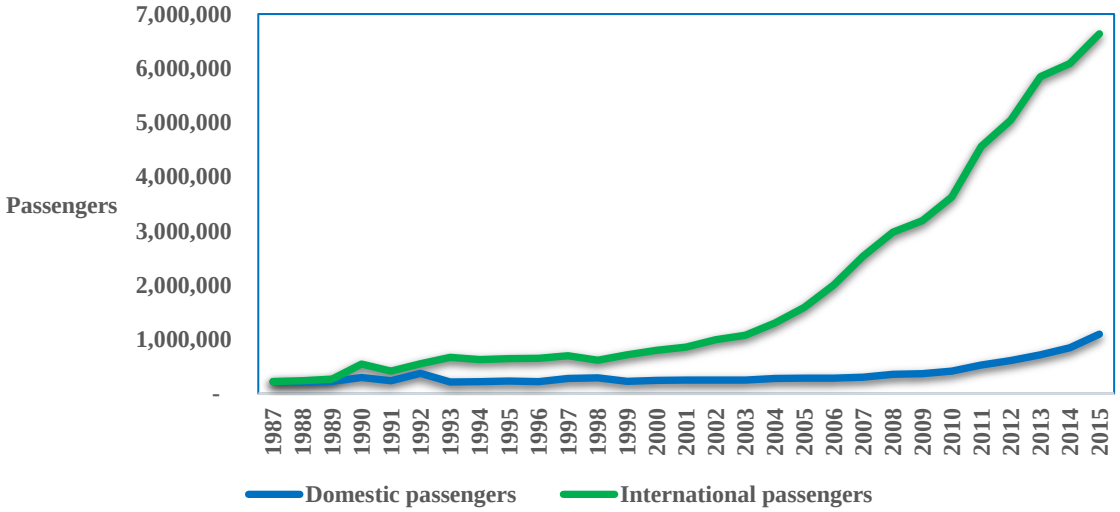
Source:(Airbus, 2016; EAL, 2016; IATA, 2014)

[5] http://www.ethiopianairports.gov.et/

[6] http://www.ethiopianairlines.com/

Ethiopia has signed more than 106 bilateral agreements with other countries regulating the conditions under which foreign airlines operate within Ethiopia and under which also EAL operates abroad (ECAA, 2017). The investment regulation (Ethiopian Council of Ministers, 270/2012) states that only Ethiopian citizens may provide air transport service with a capacity of not more than 50 seats, which used to be only 20. This provides EAL with a monopoly on flights having more than such capacity, be it domestic or international. According to this regulation, only the government is allowed to conduct passenger air transport services using aircraft with a capacity of more than 50 passengers. Additionally, only Ethiopian citizens can conduct passenger air transport services using aircraft with a capacity of fewer than 50 passengers. Moreover, air cargo service is open to non-nationals investors.

Figure 1: Air passenger trends in Ethiopia



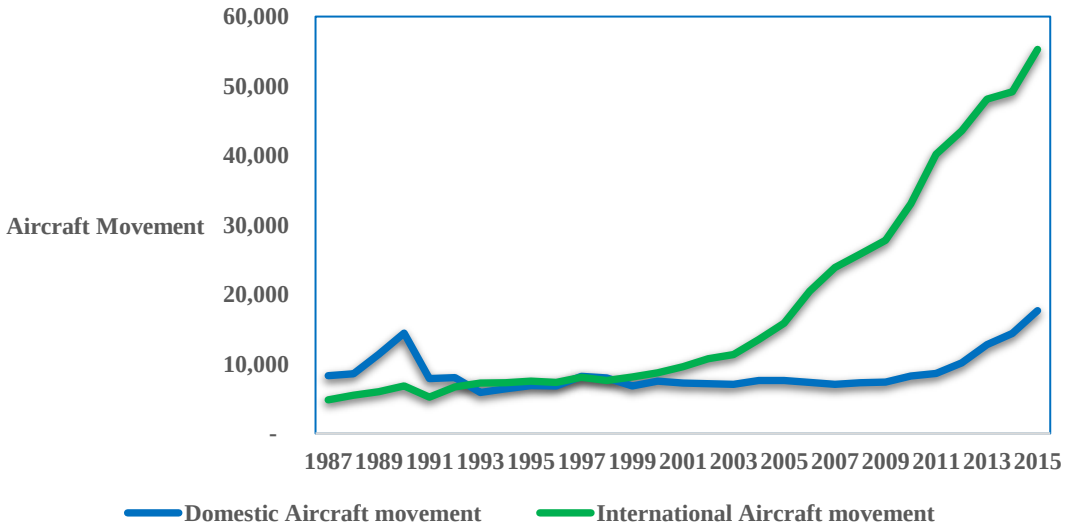
(source: (EAE, 2016))

From an unpublished dataset obtained from Ethiopian Airports Enterprise, one can observe that the total volume of passengers traveling to and from Ethiopian airports was close to 8 million in 2015. This number is a significant change when we analyze the trend of passenger number in the country. In Figure 1, the share of domestic and international passengers is illustrated, furthermore it is worth noting that about 88 % of all passengers in 2015 are international passengers.

Additionally, aircraft movement has also revealed similar growth trends with a total number of passengers even though before 1990's domestic aircraft movement was greater than that of international aircraft movement. The possible justification for this aircraft movement shift

could be that Ethiopia was in civil war from late 1970's to early 1990's. After overthrew of dictator government in 1991 and establishment of ethnic based federalism in 1994, international competitiveness and image of Ethiopian Airlines become flourished, (refer figure 2), and dominate the air transport sector of the continent for the last ten years.

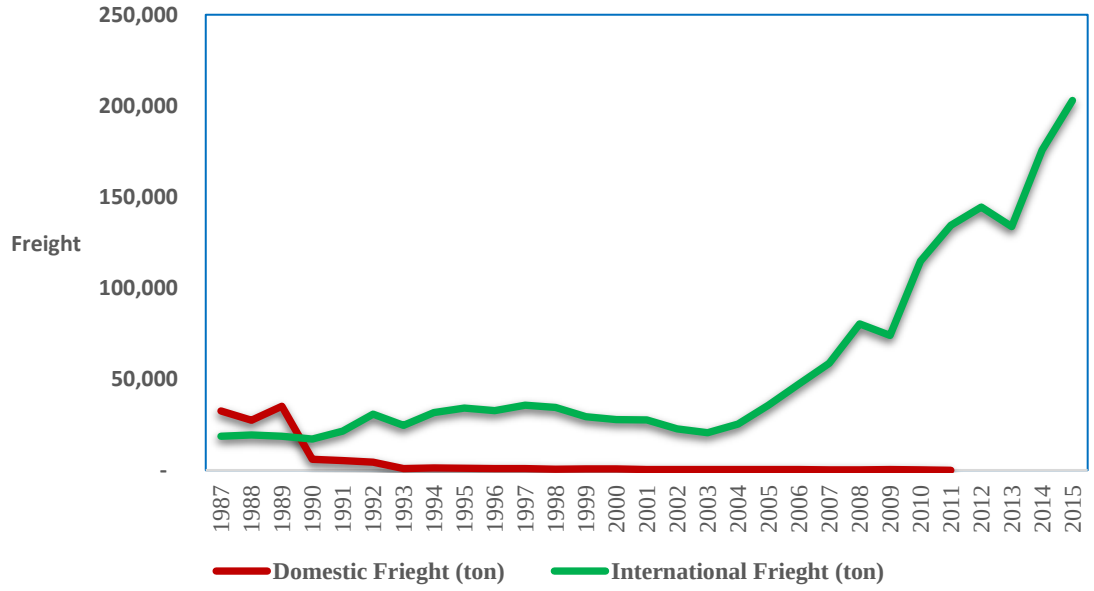
Figure 2: Trends of aircraft movements in Ethiopia



Source: (EAE, 2016)

Freight transport development trend indicates that after 1990's while international freight demand increased dramatically, domestic freight demand started to decrease and even become ceased since 2011 (see Figure 3). Though international air transport demand of Ethiopia reveals increasing trend at increasing rate, the domestic development trend of freight demand is slightly different from the trends of domestic passenger demand and domestic aircraft movement. While domestic passenger demand and domestic aircraft movement indicate slow raising trends, the domestic trend of freight demand decreases through time. But generally, one could conclude from these trends that air transport demands of Ethiopia mostly depends on international markets which indirectly indicates that the economic growth rate is behind air transport development rate in the country. It could be also possible to say that the growth of air transport service in the Ethiopia is not from domestic economic development, rather international factors like strategic location of the country (Horn of Africa which connects sub-Sahara Africa countries with Asia, Middle East, and Europe), conference industry and may be first mover advantage. Moreover, this causality analysis could be also conducted under empirical analysis parts of this study.

Figure 3: Domestic and international trends of freight development in Ethiopia



Source: (EAE, 2016)

At the regional level, however, Ethiopia has been an active and aggressive participant for the implementation of the Yamoussoukro Decision[7] as well as the ones revised and delegated to regional alliances such as COMESA[8]. Concerning air transport service, many African countries are protective of the sector, and plans of previous declarations have not been duly implemented by signatories (AFCAC, 1999; The Economist, 2015). In fact, the vision of African civil aviation commission (AFCAC) is not only the regional liberalization measures but also liberalization at the continental level. But the divisions amongst African countries, such as North Africa vs. Sub-Saharan, East vs. West, and Anglophone vs. Francophone, have become a challenge for integration. Countries also favor their own flag carriers, impending liberalization (AFCAC, 2017).

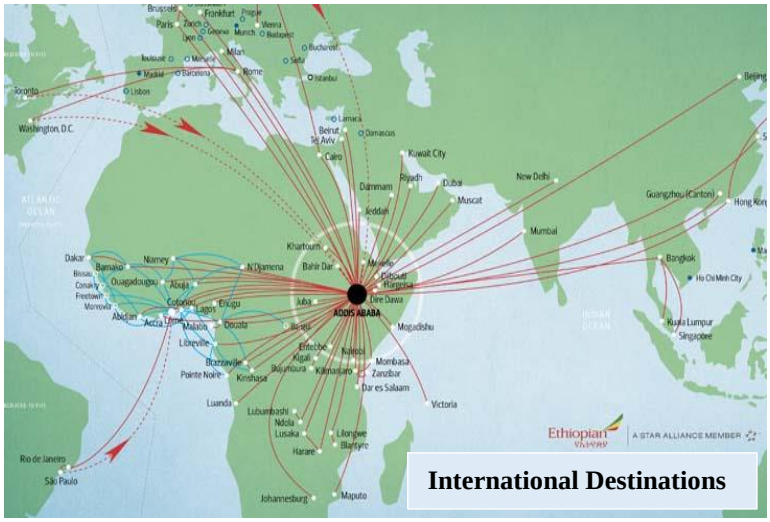
[7] The Yamoussoukro Decision is named after the Ivorian city in which it was agreed. It commits its 44 signatory countries to deregulate air services and promote regional air markets open to transnational competition. Historically, the Decision followed up on the Yamoussoukro Declaration of 1988, in which many of the same countries agreed to principles of air services liberalization. In 2000, the Decision was endorsed by heads of states and governments at the Organization of African Unity, and became fully binding in 2002 in pursuing its original intention of liberalizing air service among member states.

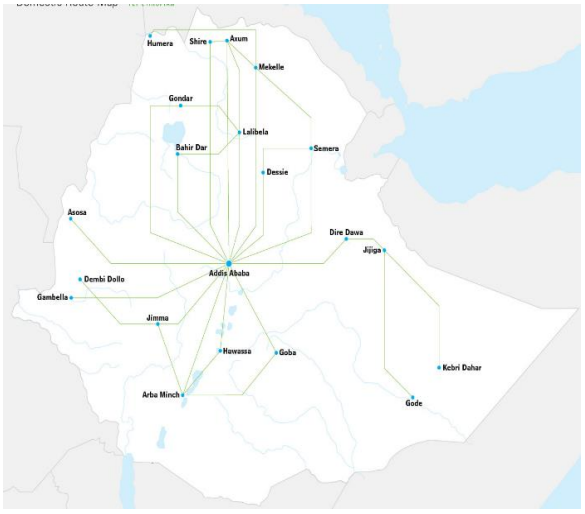
[8] Common Market for Eastern and Southern Africa

2.3. Current Status of Air Transportation in Ethiopia

The air transport service is an area of the global economy in which Ethiopia enjoys some notable comparative advantages. The air transport industry in Ethiopia is largely dominated by EAL. As of January 2017, Ethiopian Airlines serves 97 international destinations, of which 55 passenger destinations are in Africa, 18 destinations are in Europe and America, and 24 destinations are towards Gulf, Middle East & Asia. Currently, the airline also operates a cargo network of 30 destinations in Africa, the Middle East, Asia and Europe using six B777 and two B757 freighters. The Airline also carries freight in the belly of wide-body passenger aircraft to 92 destinations across the globe (EAL, 2016). Currently, Ethiopia has 20 airports of which 4 international airports (Addis Ababa Bole, Dire Dawa, Mekelle, and Bahir Dar). Figure 4 below shows the destination networks of Ethiopian Airlines by January 2017.

Figure 4: Domestics and international network of EAL





Domestic Destinations

Sources: (EAL, 2017)

Now Ethiopian Airlines operates with 88 aircrafts (80 passengers and 8 freighter planes) and offering services to 97 international and 20 domestic destinations (EAL, 2017). Protective policies have helped the airline maintain holds a monopoly power on domestic routes. According to (Tchouamou Njoya, 2013) although government-owned, the airline is well managed and has been able to raise its own debt and finance its own expansion without government cash which makes it unusual among state-owned African airlines. The following table summarizes the current inventory and ordered fleet sizes of Ethiopian Airlines.

Table 2: Operating and ordered fleet sizes of Ethiopian Airlines

Operating Fleet	
Long Range Passenger Services	4- Airbus A350-900XWB 17- Boeing B787-8 4- Boeing B777-300ER 6- Boeing B777-200LR 6- Boeing B767-300ER
Medium Range Passenger Services	16- Boeing B737-800 8–Boeing B737-700
Regional and Domestic Passenger Services	19- Q400 Bombardier
Cargo and Non-Scheduled Services	6 - Boeing B777-200LRF (cargo) 2 - Boeing B757-260F (cargo)
Total operating fleet	**88 Aircrafts**
Fleet on Order	
Long Range Passenger/Cargo Services	10- Airbus A350-900 4- Boeing B787-9 2- Boeing B787-8
Medium Range Passenger Services	30- Boeing B737 MAX 8s
Total fleet on order	**46 Aircrafts**

Sources: (EAL, 2017)

Ethiopia Airlines has thrived in the air transport services market, while numerous other African airlines have struggled or failed. In terms of revenue passenger kilometers (RPKs), EAL is Africa's largest and most profitable airline, earning more than its rivals on the continent combined. According to unaudited figures, it nearly doubled its profits in 2015 financial year (see figure 5 below) (The Economist, 2016).

Figure 5: Passenger number (in million) and net profit (in million) of Ethiopian Airlines

Different experts and researchers tried to justify the success trends of Ethiopian Airlines and the factors distilled into the following main concepts:

Geographical plum location: With a young population of more than 1 billion people, Africa is the second-fastest growing continent (World Bank, 2016). Ethiopia looks to capitalize on its African geography to realize revenues from the continent's rapidly rising economies. Ethiopia's East African locale serves as an ideal gateway to Africa from the Middle East and Asia, as a hub for the fastest growing trade lane: China–India–Africa–Brazil. Finally, Ethiopia's chief city and EAL's headquarters, Addis Ababa, is home to key international organizations, most notably the African Union (AU) and the United Nations Economic Commission for Africa (UNECA) (Bloomberg - December, 2016).

First Mover Advantage: When Ethiopia entered the air transport services market in the beginning of 1940s, most other African countries were still under colonial rule. The first-mover advantage has allowed EAL to gain brand recognition, establish customer loyalty, perfect their services, and gain market share. The same is true for many keys and new routes (Sofany, 2016). In addition, EAL has continued to be progressive instead of becoming complacent, as is often the case with many first movers.

Multi-Hub Operation Strategy: EAL's multi-hub strategy is currently being implemented through the airline's partnerships with two regional carriers, ASKY (Lomé, Togo) and

Malawian Airlines (Lilongwe Malawi). In addition to the regional hubs in Lomé and Lilongwe, EAL is also planning to add a hub in the Democratic Republic of Congo (Centre for Aviation, 2013). The airline sees this system of building African hubs as a means to win international passenger traffic beyond its base in Addis Ababa and take advantage of the economic growth and increased passenger traffic across the continent.

3. Literature Review

Air transport is an important enabler to achieve economic growth and development. Air transport facilitates integration into the global economy and provides vital connectivity on a national, regional, and international scale. It helps generate trade, promote tourism, and create employment opportunities. Air transportation is a major industry in its own right and it also provides important inputs into wider economic, political, and social processes. According to (Saheed & Iluno, 2015), the demand for its services, as with most transport, is a derived one that is driven by the needs and desires to attain some other final objective.

The International Air Transport Association (IATA) commissioned Oxford Economics (2012) to estimate the economic and social benefits of aviation in over 80 countries worldwide. The analysis includes the traditional economic footprint of the industry, measured by aviation's contribution to gross domestic product (GDP), jobs, and the tax revenues generated by the sector and its supply chain. Moreover, air transport enables foreign direct investment (FDI), business cluster development, specialization, and other spillover effects. The analysis produced by Oxford Economics is one of the first attempts to estimate these benefits of connectivity (Perovic, 2013). According to a report by (Air Transport Action Group (ATAG), 2016) aviation plays a vital role in facilitating economic growth, particularly in developing countries.

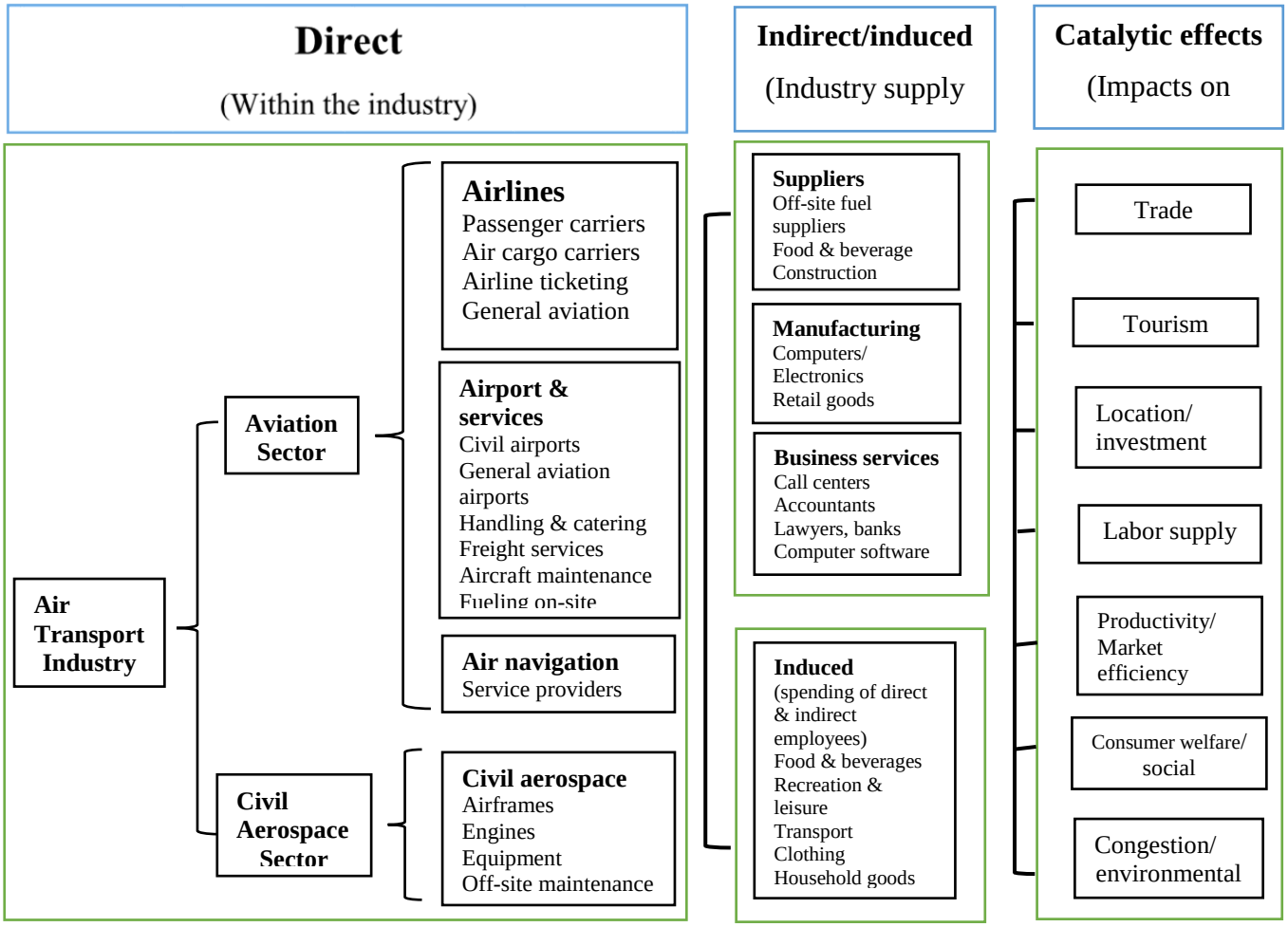
On the other hand, economic development also has had a significant impact in air transport demand (Bourguignon & Darpeix, 2016; Hakim & Merkert, 2016). In this section, the general economic impacts of air transport service on economic activities have been presented in the first sub-section followed by interaction between air transport demand and economic growth. The empirical evidence on the causal relationships between air transport and growth have been presented in the last part of this subsection.

3.1. Economic Impact of Air Transport

Air transport system allows for intercontinental travel of large volumes of passenger and cargo in relatively short periods of time. Access to markets around the world has resulted in the largest of communities reaping the extraordinary economic benefit (Tchouamou Njoya, 2013). The air transport becomes vital to the growth of business and industry in a community by providing air access for companies that must meet the demands of supply, competition and expand marketing areas. In 2015, nearly 3.6 billion passengers were carried by the

world's airlines. In the same year, air transport carries around 0.5% of the volume of world trade shipments, it's over 35% of a value which indicates that goods shipped by air are very high-value commodities, often time perishable or time-sensitive (ATAG, 2016). Additionally, ATAG strengthens the impact of air transport on the economy by stating that air transport industry contributes in 2014 nearly 63 million jobs and $2.7 trillion in global GDP.

Figure 6: Air Transport Industry and its Economic Impacts



Source: Adopted from (ATAG, 2005,; Oktal, Durmaz, Küçükönal, Sarılgan, & Ateş, 2006)

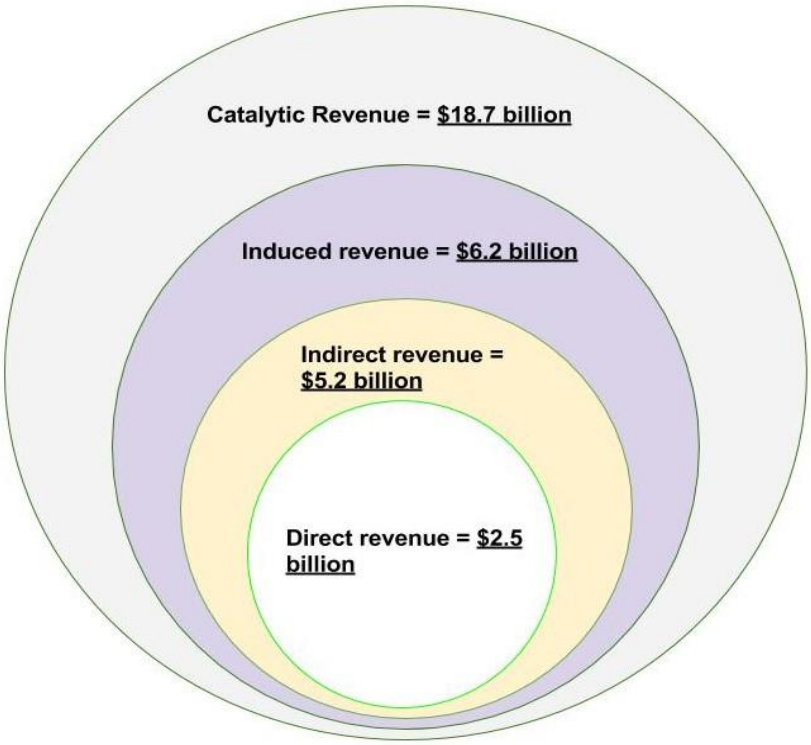
Various scholars and organizations tried to categorize the impacts of air transport on economic development into different sub-sections. However, most of them (ATAG, 2005; Ree, 2016; Wyanie A. Bright & Habte, 2015) categorize the contribution of air transport to direct, indirect, induced, and catalytic impacts (refer Figure 6) which are related to the total revenues of the air transport industry. In this paper, this categorization has been also considered and further discussed.

3.1.1. Direct Impacts

Direct impacts of airlines industry on economic activities refers to employment and activity within the air transport industry including airline and airport operations, aircraft maintenance, air traffic control and regulation, and activities directly serving air passengers, such as check-in, baggage handling, on-site retail and catering facilities (ATAG, 2005,; Ree, 2016). According to (Oktal et al., 2006) not all of these activities necessarily take place at an airport, with some taking place at the head office. Direct impacts also include the activities of the aerospace manufacturers selling aircraft and components to airlines and related businesses.

On aggregate, according to (ATAG, 2016), the world's airlines carry over three billion passengers in 2014 and 50 million tons of freight. Providing these services generates 9.9 million direct jobs within the air transport industry and contributes $664.4 billion to global GDP. Compared with the GDP contribution of other sectors, the global air transport industry is larger than the automotive industry, which accounts for 1.2% of global GDP, chemicals manufacturing (2.1%) and more than half the size of the global financial services industry, which accounts for 6.2% of GDP. In fact, if air transport were a country, its GDP would rank it 21st in the world, similar to that of Switzerland or Sweden. In the case of air transport industry in Ethiopia, according to (Wyanie A. Bright & Habte, 2015), employment directly generated by this industry is estimated at 16,000 full-time employees in 2012, served about 7 million passengers and directly contributed about $2.5 billion to Ethiopian GDP. The following figure summarizes the economic impacts of the airline industry to Ethiopian economy.

Figure 7: Economic impacts of air transport industry on Ethiopian Economy



Source: Compiled from (Wyanie A. Bright & Habte, 2015) - Ethiopian market and industry estimates based on 2012 actual data

Figure 7 above highlights the total estimated revenue generated by the air transport services sector in Ethiopia, including direct, indirect, induced, and catalytic impacts. Based on ATAG's estimates stated in (Wyanie A. Bright & Habte, 2015), the total annual impacts estimated for the air transport market is valued at $32 billion. This implies that the air transport services sector have a total impact on around 75% of Ethiopia's GDP. This inference holds when the role the sector plays in revenue production is considered. The air transport services sector is responsible for transporting business and tourism travelers, facilitating FDI, expediting the import and export of goods, reducing the costs of trade, accommodating international organizations, and facilitating humanitarian assistance (Sofany, 2016).

3.1.2. Indirect Impacts

Indirect impact includes revenues generated by employment and activities of suppliers to the air transport industry including aviation fuel suppliers; construction companies that build airport facilities; suppliers of sub-components used in aircraft; manufacturers of goods sold in airport retail outlets; distributors of aircraft parts, business processing services for the air transport industry and a wide variety of activities in the business services sector such as call

centres, information technology and accountancy (ATAG, 2005,). These indirect activities contributed approximately $761.4 billion to global GDP in 2014(ATAG, 2016). Figure 7 above reveals that based on Ethiopian market and industry estimates conducted by (Wyanie A. Bright & Habte, 2015), indirect revenue for air transport services in Ethiopia is estimated to be about $5.2 billion.

3.1.3. Induced Impacts

Induced impact can be defined as revenues generated by the spending of those directly or indirectly employed in the air transport services sector. Induced employment is counted as jobs that are generated based on the spending patterns of air transport personnel. The spending of those directly or indirectly employed in the air transport sector supports jobs in industries such as retail outlets, companies producing consumer goods and a range of service industries such as banks and restaurants (ICAO, 2016). In 2014, according to (ATAG, 2016), worldwide roughly $355 billion induced GDP impact globally is supported through employees in the air transport industry (whether direct or indirect) using their income to purchase goods and services for their own consumption. The induced contribution to Ethiopian GDP in 2014, according to (Wyanie A. Bright & Habte, 2015) is $ 6.2 billion.

3.1.4. Catalytic Impacts

The air transport industry's most important economic contribution is through its impact on the performance of other industries and as a facilitator of their growth. It affects the performance of the world economy, improving the efficiency of other industries across the whole spectrum of economic activity (ICAO, 2016). Air transport services facilitate economic growth, efficiency, poverty reduction, and employment creation through several catalytic impacts on the economy. The economic catalytic impacts tend to be challenging to measure, but are estimated to be significantly greater than the direct impacts. The catalytic effects of air transport services on the Ethiopian economy include (Centre for Aviation, 2013; EAL, 2016; ECAA, 2017):

- Air transport services facilitate the transport of business travelers to and from Ethiopia. The sector is notably important for Ethiopia, as it has adopted an outward-facing development strategy, which is heavily reliant on FDI.

- Air transport facilitates Ethiopia's growing tourism sector by bringing over 500,000 visitors into the country annually[9]. Related to this is the revenue generated through goods and services purchased by tourists while in Ethiopia.
- The sector facilitates the rapid shipment of goods, reducing the cost of trade, and enabling the development of new export markets such as cut flowers, live animals, and meat products.
- Convenient and reasonably priced air transport services make Ethiopia an accommodating location for international organizations, notably the African Union and the United Nations Economic Commission for Africa.

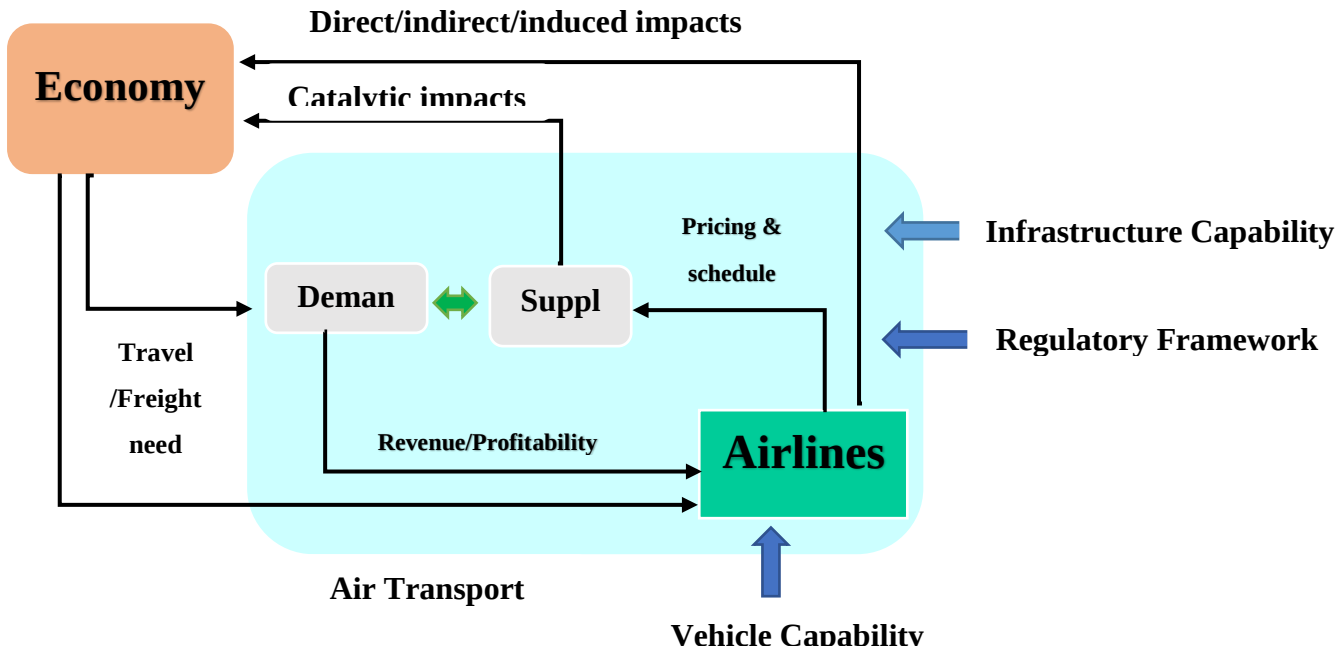
Generally, while air transport is a major employer in Ethiopia both, directly and indirectly, EAL take the lion share employer in the sector, of June 2016 created job opportunity for about 16,000 full-time employees (EAL, 2016). Additionally, trade in air transport services is two-dimensional, as air transport services are traded independently, and are intermediate services for other kinds of trade including tourism, distribution, and agriculture like flora (EHDA, 2016).

3.2. Interaction between Air Transportation and Economic Activity

Air transportation services and economic development interact with each other through a series of mutual causality feedback relationships. Air transportation provides employment in the aviation sector and creates wider socioeconomic benefits through its potential to enable certain types of activities in a local economy. As a result, the availability of air transportation services effectively increases the scope and cycle time of economic activity. The region's economic activity, in turn, generates the need for passenger travel and freight and drives the demand for air transportation services. This feedback relationship results in a general correlation between the amount of air travel and Gross Domestic Product (GDP) around the world. However, even though air passengers and GDP have been increasing in all regions during the last thirty years, there is substantial variability in the growth rates (M. Ishutkina & Hansman, 2008). This reflects the variability in the nature of the interaction between air transportation and economic activity.

[9] http://www.moct.gov.et/ Ethiopian Ministry of Culture and Tourism official website, 2016

Figure 8: Feedback-based interaction between Air Transportation System and an Economy



Source: Adopted from (M. Ishutkina & Hansman, 2008; M. A. Ishutkina, 2009)

The impact of air transportation on economic activity differs from other transportation modes because of its distinctive characteristics: speed, cost, flexibility, reliability, and safety. It is the only feasible long-distance transportation mode for high-value perishable commodities and time-sensitive people and is often the only means of access to geographically isolated areas. However, on the short-haul routes, air transportation provides little advantage over surface transportation modes, especially the high-speed rail (M. A. Ishutkina, 2009). Depending on the combination of unique economic and air transportation attributes, different mechanisms dominate the relationship between air transportation and economic activity. Because of these unique attributes, the nature of air transportation flows differs among the economies. In some countries, international visitors account for most of the travelers, while domestic traffic flows dominate in other economies.

Figure 8 is a high-level feedback model describing the interaction between air transportation system and an economy. The air transportation system is defined by its infrastructure capability, regulatory framework, vehicle, and airline capability. Internal to the air transportation system is the supply and demand relationship where airlines provide supply through pricing and scheduling of flights based on the revenues and profitability of a particular route (M. Ishutkina & Hansman, 2008). At the macroeconomic level, air transportation impacts the economy by providing employment and by enabling effects

including enabling access: to markets, to people, to capital, to ideas and knowledge, to labor supply, to skills, to opportunity, and to resources. The economy, in turn, provides capital and generates demand for passenger and freight travel. The economy's travel and freight needs are determined by the relative business and leisure attractiveness of that economy to the rest of the world (Porter, 2011). The causality direction of air transport and economic activity relationship could vary among different economic segments for which this study investigates for developing country, Ethiopia.

3.3. Air Transport and Economic Growth Causal Relationships

There are certain studies focused on the relationship between air transport and economic growth in the literature of academia, business, and government to understand the nature of rapid growing air transport industry with economic development. The results are relatively different due to using different data set, methodological approach, economic development level of the study region, and analyzing different time periods. Further studies should also need to conduct on the basic relationship between air transport industry and economic growth in the specified region. Because, according to, (Doganis, 2010), over the last five decades airline industry has been paradoxically characterized by continued and rapid growth for its service though it has remained only marginally profitable.

It is well established that there exists a strong correlation between air traffic and economic growth, however, the direction of causation is unclear (Green, 2007) and only a few causal analyses have been done so far in the air transportation field. The study conducted in Brazil (Marazzo, Scherre, & Fernandes, 2010) on the relationship between air passenger demand and economic growth (GDP) found that GDP and air passenger growth are cointegrated. They have shown for a middle-income context that there is a strong positive impact on air passenger numbers due to a positive change in GDP and impact of air passenger growth in GDP. Similarly, (Fernandes & Rodrigues Pacheco, 2010) examined the relationship between economic growth and national airline passenger transport in Brazil using Granger causality test in their study. GDP was considered as economic growth indicator and total national passenger- km values were regarded as airline access demand in the analysis. The study includes the period of 1966-2006 and comes up with the result which supports the hypothesis which claimed there is one directed Granger causality relationship from economic growth to national airline. The study conducted in South Asia eight countries (Hakim & Merkert,

2016) also support this unidirectional causality between economic activity and air transport development from GDP to demand of air traffic passenger and air cargo volumes.

The study conducted in Indonesia by (Dharmawan, 2012) investigated the relationship between airline traffic frequency and economic growth. The data which belong to the period of 2000-2010 were used for the analysis. After the analysis, there could find the results as thanks to tourism related sectors' contribution to airline usage, a positive relationship exists between airline transport and economic growth. In addition, (Van De Vijver, 2014) investigated causality between trade and air passenger travel by applying heterogeneous Granger causality tests to a number of Asia-Pacific country-pairs. Interestingly, they found all four types of causal relationship (independent, air traffic to trade, Trade to air traffic bi-directional) across the different country pairs. But contrary to this finding, the study conducted on the same topic in Italy, (J. G. Brida, Bukstein, & Zapata-Aguirre, 2016), and in Nigeria, (Saheed & Iluno, 2015), reach on unidirectional causality from Air transport to economic growth for the countries which are different in level of economic growth and regional configuration.

Closer to the Asia context and by using Augmented Dickey-Fuller tests (ADF), Johansen cointegration tests, Granger causality tests and the Vector Error Correction Model (VECM), (Y. H. Chang & Y. W. Chang, 2009) examined the causal longitudinal relationship between air cargo and economic growth in Taiwan over the period 1974–2006 and the results suggest a bi-directional causal relationship between air cargo and economic growth. Their results indicate that air cargo expansion plays a crucial role in promoting economic growth in that market. Another research conducted in the United State of America, (Chi & Baek, 2013), and Australia, (Baker et al., 2015), also conclude their finding with the bi-directional causal relationship between air transport demand and economic activity.

Similarly, the study conducted in Mexico which analyzed the dynamic relationship between Mexican air transport (from the perspective of passengers' movement) and long run economic growth conclude bi-directional relationship exists between the two variables. The researchers, (G. Brida, Lanzilotta, Brindis, & Rodríguez, 2014) applied nonparametric cointegration and non-parametric causality test is applied to quarterly data of GDP and air passengers in Mexico for the period 1995-2013. They compare the results of the nonlinear approach with those obtained by using the traditional linear and confirm bidirectional causality between air transport and economic growth in Mexico. The following table

summarizes the findings of some studies on the causal relationship between economic growth and air transport.

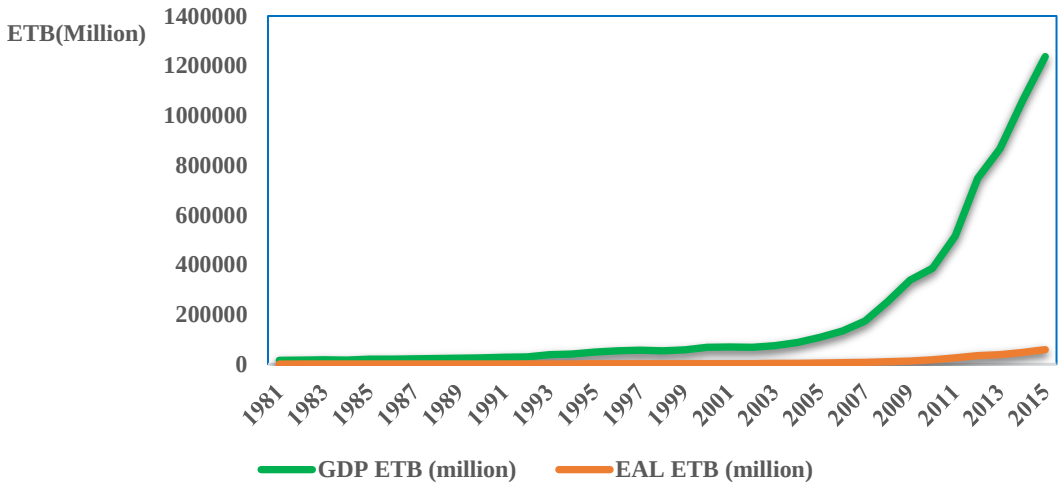
Table 3: Summary of empirical literature on causality of air transport and economic growth

Authors	**Study area**	**Causality type**	**Causality direction**
Brida, Daniel, Sandra, 2016	Italy	Uni-directional	Air transport ⟹ GDP
Hakim & Merkert, 2016	South Asia	Uni-directional	GDP ⟹ air passenger traffic and air freight volumes
Alexander, Saheed, S. & Iluno, 2015	Nigeria	Uni-directional	Air transport ⟹ economic growth.
Baker, Douglas, Merkert, Rico, Kamruzzaman, Md, 2015	Australia	Bi-directional	Regional economic growth ⟺ regional air transport
Brida, Lanzilotta, Brindis, & Rodríguez, 2014	Mexico	Bi-directional	Air transport ⟺ Economic growth
Chi & Baek, 2013	United States	Bi-directional	Air transport ⟺ economic growth
Marazzo, Fernandes & Scherre, 2009	Brazil	Uni-directional	Economic growth ⟹ National Airline
Chang, & Chang, 2009	Taiwan	Bi-directional	Air cargo ⟺ Economic growth

Source: Compiled from respective papers

According to (NBE, 2016) annual report, Ethiopian economy has been dominated by Service (47.1%) and agricultural (36.4%) sectors followed by industrial (16.5%) sector. From growing components of the service sector, according to this report, delivery of total transport service in the country constitutes about 10.7%. When we consider the relationship between air transport development and economic growth, direct revenue of Ethiopian Airline represents about 5% of Ethiopian GDP (EAL, 2016), which is almost half of transport sector growth in the country. Figure 9 shows the share of revenues of Ethiopian Airlines from the total gross domestic product of the country. In addition to Figure 9, Figure 24 also indicate the trends of percentage share of revenues of Ethiopian Airlines in Ethiopian GDP.

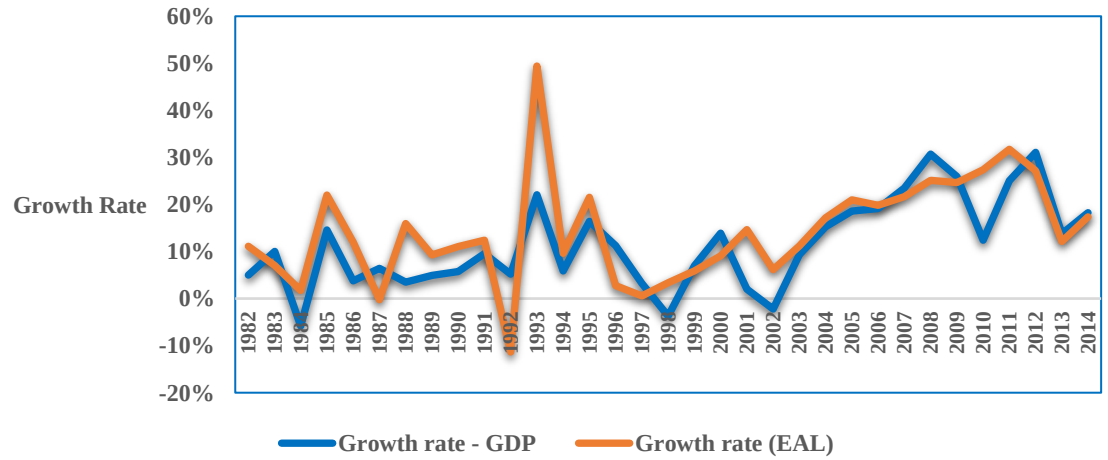
Figure 9: Trends of Ethiopian GDP and Revenues of Ethiopian Airlines (1981-2015)



Sources: (EAL, 2016; NBE, 2016)

Figure 10 below reveals that the trends of economic growth rate and air transport growth rate fluctuate almost in similar ranges. Thought in early 1990's, during regime change in the country, the growth rate of Ethiopian Airlines shows relatively high fluctuations, since late 1990's the fluctuation of growth rate for both variable indicates close trends. The figure also showed that on average the growth rate of revenues of the airline relatively better performed than that of the Ethiopian economy. The empirical investigation in (chapter 6) of this study would be indicated that the growth of air transport (especially passenger) is the cause factor for the economic growth of the country.

Figure 10: Growth rates of Ethiopian GDP and EAL



Source: (EAL, 2016; NBE, 2016)

Interestingly, most of the literature on causality analysis between air transport and economic growth focuses on high-income countries (with often matured aviation markets) and results suggesting bi-directional causality between air transport and economic growth which are limited to that context. In contrast, causality results from middle-income countries such as Brazil and South East Asian showed strong causality run from economic growth to air transport but weak causality run from air transport to economic growth. Most importantly, there is no literature on a causal analysis between air transport and economic growth for low-income countries (with potential for very strong growth of air transport demand), which is a fundamental gap in context appears to matter to these relationships. There is also no literature on African context, particularly Ethiopia, which not only a region with culturally different (which has an impact on travel and booking behavior of individuals) but despite its large populations it is on average characterized by relatively low income and also very low propensity of air travel. This study would be tried to investigate and analysis the relationship between air transport demand and economic growth in the low-income country, Ethiopia.

Generally, the empirical and theoretical literature indicates that there is a positive relationship between economic growth and air transport demand. Due to different inherited economic features of various countries /regions, the sensitivities of change of these variables to each other could also vary. The causal direction and marginal effects of these variables also different for different segments of economies. Most of this literature are available for developed economies and it is rare to find such studies in developing countries. This study would be analyzed the following research questions:

- What is the connection between air transport demand and economic growth in Ethiopia?
- What is/are causal direction between air transport demand and economic growth in Ethiopia?
- What are the short-run dynamics and long-run relationships experienced and expected to exist between air transport demand and economic growth in Ethiopia?

The empirical analysis part of this study would address these main questions based on the available data set. The finds would be also compared with similar studies conducted in different case studies. The comparison would be more convincing while compared with empirical evidence of case studies which have similar economic features with Ethiopia. But, such empirical evidence is rare in developing countries. In addition to the available empirical literature for developing economies, the evidence from developed economies could be also used to cross check with the findings of this study.

4. Methods of Analyses

The objective of the study could be addressed by the employment of appropriate methods of analysis with available data and variables. In this study, both descriptive and econometric analyses would be considered. Descriptive analyses would be conducted for reality checks between passenger and cargo demands with economic growth in the country. Moreover, econometric methods could mainly address the research question of the study.

4.1. Descriptive Analyses

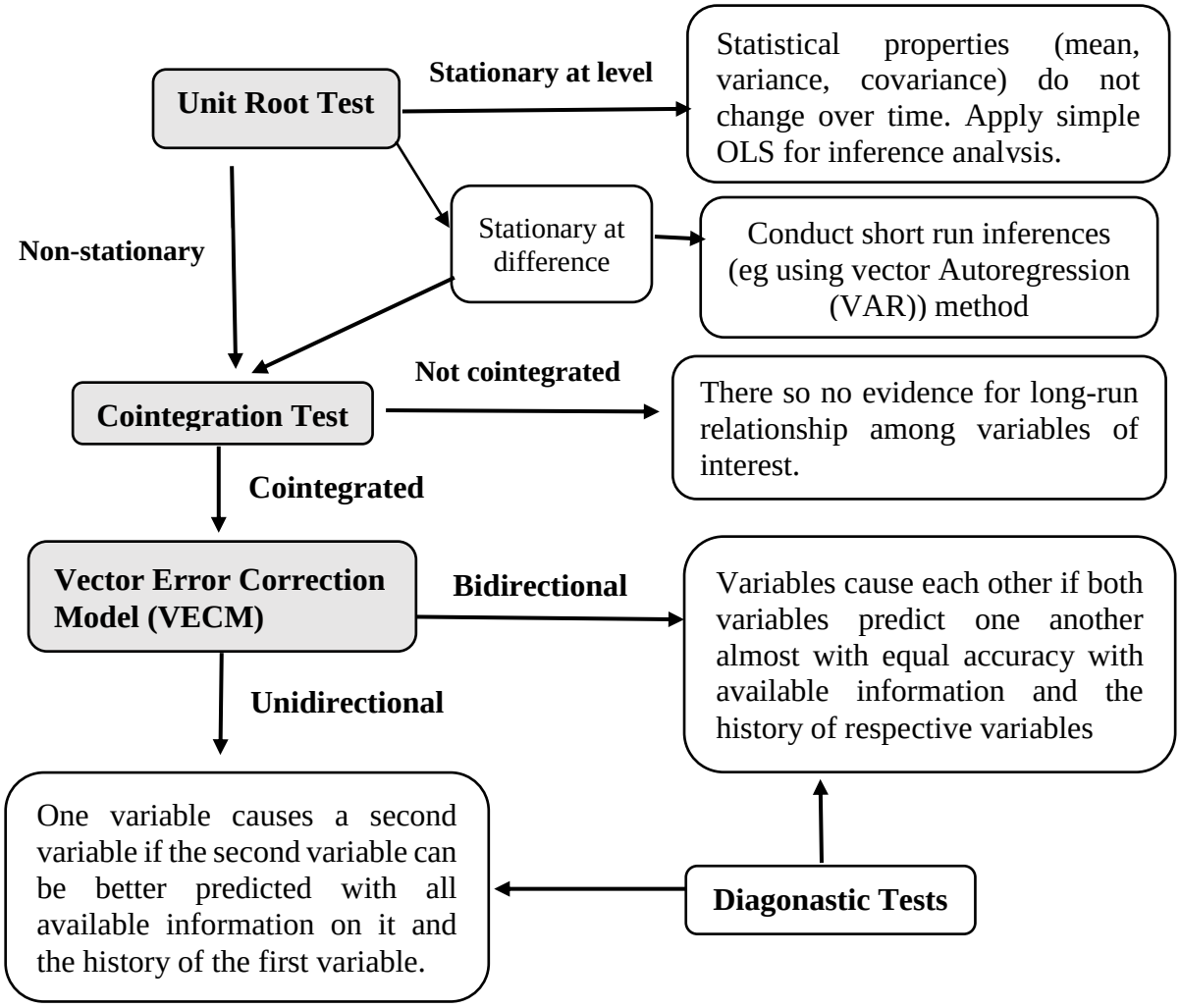
In this subsection, the relationship between air transport demand and economic growth would be presented using graphs, correlation coefficients, percentages, illustrative figures, and marginal changes of the variables. The demand for passenger (both domestic and international) and air freight demand have been compared and described. This subsection also figures out the competent airlines in Ethiopian air transport system with their respective market share, particularly international air transport demand. Though the domestic air transport demand is significantly lower, it has been fully occupied by Ethiopian Airlines without any competitor. The contribution of air transport development in the economic growth of the country could be also analyzed. This analysis complements the econometric analysis and provides some clues on the causality of air transport demand with economic growth.

4.2. Econometric Model Framework of Analyses

This paper applies a series of complementary econometric models to investigate cointegration vector and causality direction between air transport demand and economic growth in Ethiopia. The responsiveness of economic growth to air transport expansion would be also analyzed. As discussed in the introduction section, the causal relationship between air transport and economic growth could be unidirectional or bi-directional and it is also possible that there might not interdependency. The study would investigate causal relationship in all possible directions between (i) air passenger traffic and economic growth and (ii) air freight volumes and economic growth, which yields a total of four causality models.

The following diagram summarizes the main econometric methodological framework of this study.

Figure 11: Econometric methodological framework of the study



Source: Own Constructed

The above three-hurdle analysis techniques, which helps to avoid misleading conclusions from spurious results, would be presented in detail in the following section.

4.2.1. Unit Root Testing

The need to test for the presence of unit root is to avoid the problem of spurious regression. If a variable contains a unit root then it is non-stationary and unless it combines with other non-stationary series to form a stationary cointegration relationships, then regressions involving the series can falsely imply the existence of meaningful economic relationships (Harris, 1995). In principle, it is important to test the order of integration of each variable in

the model, to establish whether it is non-stationary and how many times the variables needs to be differentiated to result in a stationary series. The variable X_t is said to be stationary if,

$$E(X_t) = constant = \mu \quad ; \quad var(X_t) = constant = \sigma^2 \quad \text{and } cov(X_t, X_{t+j} = \sigma_j$$

Thus, the means and the variances of the process are constant over time, while the value of the covariance between two periods depends only on the gap between the periods, and not the actual time at which this covariance is considered. If one or more of the conditions above are not fulfilled, the process is nonstationary.

Before any sensible regression analysis can be performed, it is essential to identify the order of integration of each variable and the variable can be transformed into a stationary variable through differencing. A nonstationary series which can be transformed into a stationary series by differencing *d* times is said to be integrated of order d, I(d*)* (N.Gujarati, 2003). There are different methods of testing unit roots, but this study considers the method of Augmented Dickey–Fuller test (ADF). Because if there is a problem of serial correlation in the model, ADF adjusts it by including additional lags. To check whether the series carry one-unit root, the ADF test presents the following specification:

$$\Delta Y_t = \alpha + \beta T + \gamma Y_{t-1} + \sum_{i=1}^{k} \varphi_i Y_{t-i} + \varepsilon_t \qquad (1)$$

where Y_t and ΔY_t are respectively the level and the first difference of the series, α is a drift term which captures a possible stochastic trend, T is the time trend variable, and β, γ, and φ are parameters to be estimated. The k lagged difference terms are added to remove serial correlation in the residuals (with the number of lagged terms usually selected based on some information criterion) and ε_t a white noise error term with zero mean and constant variance.

Hereafter fitting the model, the test implies;

null hypothesis $H_0: \gamma = 0$ - the series has a unit root

alternative hypothesis $H_1: \gamma \neq 0$ - the series does not have a unit root

As (Johansen & Juselius, 1990) pointed out, it is not possible for I(1) variable to have a long run relationship with an I(0) variable, in that case, it is said that the equation does not balance. An equation balances when all the variables considered have the same order of integration.

4.2.2. Cointegration

After checking the order of integrations of series, one must check whether an economically meaningful relationship exists between the variables and then discard the spurious regression problems. When two variables with the same order of integration present a long run relationship, they are said to be cointegrated. Time series X_t and Y_t are said to be cointegrated of order *d, b* where $d \geq b \geq 0$, written as $X_t,\ Y_t \sim CI(d, b)$, if both series are integrated of order d and there is a linear combination of X_t and Y_t that is *I(0)* (W.Charemza & F.Deadman, 1997). Conceptually it means that there is a long run equilibrium linking the variables which implies they move together over time and although temporal shocks may drift them apart, in long run they return to their common path.

In this step, all series under investigation would be tested for cointegration and decide the existences of the long-run relationships between the variables. The results of these cointegration tests determine the type of causality tests that are going to be used in the subsequent next step. To evaluate the cointegrating relationship between the variables of interest, (Engle & Granger, 1987) and (Johansen & Juselius, 1990) proposed two related methods but with slightly different techniques. The former scholars proposed a two-step techniques to check for cointegration between X_t and Y_t that involves conducting the regression:

$$Y_t = \alpha + \beta X_t + u_t \qquad (2)$$

and check the order of integration of the residuals u_t by using the AGF test. If the residuals are *I(0)*, then X_t and Y_t are cointegrated.

A more recent approach is provided by (Johansen & Juselius, 1990) who suggested an alternative method which has been applied under the following specification:

$$\Delta Y_t = \mu + \prod Y_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \, \Delta Y_{t-1} + \beta X_t + \varepsilon_t \qquad (3)$$

Where,

$\Pi = \sum_{j=1}^{k} A_j - I_n, \qquad \Gamma_i = -\sum_{j=i+1}^{k} A_j,$ Y_t is a $Nx1$ vector of k non-stationary (I(1)) variables of interest, X_t is a vector of *d* deterministic variables and ε_t is a vector of random terms (zero mean and finite variance) which allows us to control for factors omitted by the deterministic part of the model, N represents number of variables, μ is vector of constant

terms, A_j are NxN matrices of parameters. Matrix Π conveys information about the long run relationship between the Y variables. The number of cointegration relations is represented by the rank of Π coefficient matrix, that is, the number of linearly independent and stationary linear combinations of the variables. The Johansen method relies on estimating the Π matrix in an unrestricted form and testing whether it is possible to reject the imposed restrictions when reducing the rank of Π. The maximum likelihood test, which checks the hypothesis of a maximum number of cointegration vectors, are called the trace test and maximum eigenvalue test. As the test results are sensitive to the number of *k*-1 lags used in the specification of the model, information criteria are usually used to select the best model. It should be highlighted that variables under cointegration analysis should reveal the same integration order.

4.2.3. Vector Error Correction Model (VECM)

If the tests show the existence of cointegration in equation (3), then there is at least one stationary variable that may be included in the model. This representation is known as Error Correction Model (ECM), specified as follows:

$$\Delta Y_t = \mu + \sum_{i=1}^{m} \alpha_i \, \Delta Y_{t-i} + \sum_{j=1}^{n} \beta_j \, \Delta X_{t-j} + \varphi Z_{t-1} + \varepsilon_t \qquad (4)$$

Where,

μ is the constant term, $\alpha, \beta, and \ \varphi$ are coefficients to be estimated, m and n are the required number of lags, ε_t is white noise and Z_{t-1} is the cointegration vector where $Z_{t-1} = Y_{t-1} - \delta X_{t-1}$, δ is a parameter to be estimated. In equation (4) all terms are *I(0)* and Z_{t-1} works as an error correction term (ECT) which provides valuable information about the short run dynamics between Y and X.

If the series do not have a long-run relationship (not cointegrated), the vector auto-regression (VAR) method is could be applied as the standard Granger causality test (Toda & Peter, 1993). In the context of this study, the $VECM$ can examine long-run causal relationships based on the error-correction term (ECT_1) which could be express as follows:

$$\Delta lnPAX_t = \mu_t + \beta_t ECT_{t-1} + \sum \gamma_t \, \Delta lnPAX_{t-1} + \sum \delta_t \, \Delta lnGDP_{t-1} + \alpha X + \varepsilon_t \qquad (5)$$

$$\Delta lnGDP_t = \mu_t + \beta_t ECT_{t-1} + \sum \gamma_t \, \Delta lnGDP_{t-1} + \sum \delta_t \, \Delta lnPAX_{t-1} + \alpha X + \varepsilon_t \qquad (6)$$

$$\Delta lnFRT_t = \mu_t + \beta_t ECT_{t-1} + \sum \gamma_t \, \Delta lnFRT_{t-1} + \sum \delta_t \, \Delta lnGDP_{t-1} + \alpha X + \varepsilon_t \qquad (7)$$

$$\Delta lnGDP_t = \mu_t + \beta_t ECT_{t-1} + \sum \gamma_t \, \Delta lnGDP_{t-1} + \sum \delta_t \, \Delta lnFRT_{t-1} + \alpha X + \varepsilon_t \qquad (8)$$

Where ΔPAX_t and ΔFRT_t denote the first difference in PAX_t and FRT_t variables which capture their short-run disturbances over periods $t = 1,2,\dots,T$ respectively,; α and X are vector parameter and vector variable for control variables respectively; ε_t is the white noise error term and ECT_{t-1} is the error correction term (ECT) that is resultant from the long-run cointegration association, and evaluates the extent of the past disequilibrium. The coefficient of the ECT determines the deviation of the dependent variables from the long-run equilibrium.

Once a long run equilibrium relationship among the variables detected, exogeneity must be tested to avoid misinterpretation of the estimated parameter. Following (Johansen & Juselius, 1990), weak exogeneity of the variable in the cointegrating equation can be tested by applying zero restrictions on β's in equation 4 above. The proposal is to verify if the estimated coefficients on X_t lags are statistically significant. The null hypothesis is $H_0: \beta_j's = 0$ $(j = 1, 2, \dots, n)$, which means that X_t does not Granger cause Y_t. If the null hypothesis cannot be rejected, then the variable X_t is said to be weakly exogenous in the estimation of long run relationship. Moreover, we can check if Y_t Granger cause X_t making X_t the dependent variable in equation (4) and observe if the estimated coefficients on the Y_t lags are statistically different from zero. According to (Harris, 1995), X_t is a Granger cause of Y_t (denoted as $X_t \rightarrow Y_t$), if present Y_t can be predicted with better by using past values of X_t rather than by not doing so, ceteris paribus.

Long-run causality: The coefficient of ECT states the long-run causality and shows the speed of adjustment. ECT is the one period lagged value of the error term. The significance of ECT suggests that the long- run equilibrium relationship is driving the dependent variable. The expected value of β_t should be significant and a negative number. The absolute value of β_t (between -1 and 0) indicates how quickly the equilibrium is restored.

Short-run causality: Short-run causality is tested in this study by evaluating the combined significance of the coefficients of the independent variables γ_t and δ_t. As discussed in (Hakim & Merkert, 2016), the combined significance indicates how the dependent variable is reacting to short-term dynamics.

Lastly, as a quality assurance diagnostic test like Ramsey RESET, Wald test, and standard Chi-square techniques could be considered. The robustness of the estimation results with respect to model assumption such as autocorrelation, non-normality and conditional heteroscedasticity in residuals would be tested to check whether the VECM is a proper representation of the area under investigation.

4.2.4. Impulse Response Function

Once the causation of the variables is identified in a well-specified model, the interesting issue remain is to know how the dependent variable reacts to changes of independent variables in the model. The detail discussion of this topic concerns with which effect is relatively the most important and how long, on average, it takes for the dependent variable to restore its equilibrium following the certain shock. The shock effects of air transport and economic growth on each other would be analyzed using the concepts of the impulse response function.

According to (W.Charemza & F.Deadman, 1997) impulse response functions show the effects of shocks on the adjustment path of the variables. The responsiveness of the dependent to changes of the other variables traced out with impulse response analysis. A shock to a variable in the model may not only directly affects that variable but also transmitted to all other endogenous variables in the system through the dynamic structure of the model. The impulse response analysis is applied on the VECM and, provided that the system is stable, the shock should gradually die away (Brooks, 2014). In this study, the Cholesky orthogonalization approach is used for performing impulse response analysis. This approach is preferred because, unlike other approaches, it incorporates small sample degrees of freedom adjustments.

5. Data and Variables

The selection of relevant variables and collecting a quality data are obviously crucial steps in conducting a scientific study. In addition to variables of interest, control and dummy variables are identified in this section. Contextual definitions of variables and their unit of measurements are also specified. The respective sources of data and the nature of data have been described.

The nature of data employed in this study are some panel data used for descriptive analysis and time series data used for econometric analysis. The of data of variables used in descriptive analysis includes the total number of domestic and international passengers, total air cargo demand (domestic and international), gross domestic product, the number of passenger traffic and cargo demand for all airlines used Bole International Airport (Addis Ababa) and export of cut flowers. The airlines used Bole International Airport regularly and considered in the descriptive analysis are Ethiopian Airlines, Egypt Air, Kenya Airways, Lufthansa, Saudi Arabian Airlines, Sudan Airways, Yemenia, Emirates, Turkish Airlines and other airlines which started to use the airport and withdraw in the specified period. Cut flower export data included in the descriptive analysis to emphasize the contribution of this sector in international cargo demand. The sources of these data are Ethiopian Airports Enterprise and Ethiopian Airlines for total passenger traffic and cargo demand, National Bank of Ethiopia and Word Bank for GDP, and UN Comtrade[10] database for cut flower.The period of data for these variables ranges from 2005 to 2015.

For econometric analysis, the time series data of gross domestic product, emigration size, official exchange rate with respect to US Dollar, foreign direct investment, total passenger traffic, total air cargo demand (ton-kilometer), dummy variable indicates the change of regime in 1991, trade balance of payment, population size and number of students enrolled in secondary school and higher educational institutions are compiled. This study considers 35 years' data ranging from 1981 to 2015. The data for air passenger demand (passengers carried) and air freight demand (ton-kilometer) are collected and combined from the Ethiopian Airports Enterprise and Ethiopian airlines. Gross domestic product (GDP) would be used as a proxy variable for economic growth of the country and extracted from world development indicator of World Bank data. To control the variation of dependent variable

[10] https://comtrade.un.org/data/

population size, number of enrolled student at secondary and tertiary level, balance of payment and official exchange rate of the country with US dollar have been used as control variable. The data for these control variables also obtained from the data base of World Bank. All variables expressed in natural logarithms and interpreted accordingly. Generally, the following table summarizes variables included in the analysis.

Table 4: Summarizes the variables used in the econometric model in this study

Variables	**Description of the variables**
Gross domestic product (GDP)	Gross domestic product (GDP) could be used as a proxy variable for economic growth of the country
Passenger (PAX)	Total number of passenger departing and arriving at Bole International Airport (domestic and international)
Freight (FRT)	Total air freight demand (ton-kilometer) for international and domestic customers
Foreign Direct Investment (FDI)	Foreign direct investment (FDI) is an investment made by a company or individual in another country interested in Ethiopia, in the form of either establishing business operations or acquiring business assets
Dummy	In 1991, Eritrea (which was the province of Ethiopia) become an independent country which made Ethiopia landlocked country. This critical year could be used us dummy variable.
Population size ($POPN$)	Total number of citizens inhabited within the country
Education ($EDUC$)	Number of students for vocational training school and undergraduate/graduate programs of higher education institutions
Emigration (MGN)	In this study, emigration refers to out-migration number of labor force from Ethiopia to different parts of the world
Balance of payment (BoP)	Balance of payment is the record of all economic transactions (trades) between the residents of the country and the rest of the world in a particular period
Official exchange rate (OER)	Official exchange rate of the country with US dollar would be used as a control variable

An important aspect of air transportation demand analysis is the fact that it is a derived demand. In other words, the demand for air transportation stems from factors other than the transportation itself. Individuals do not directly demand travel—their demand stems from the reason they desire to undertake the travel. The economic variables that have been used in this analysis are the one expected to create a reason for air transportation demand.

Gross domestic product (GDP) and **Foreign Direct Investment (FDI):** Different researchers reveal that there is a long-term relationship between GDP, FDI and air transportation demand. The findings are associated with domestic economic interests such as employment, flow of income that airport's operations put into the domestic economy. Furthermore, the government collects more taxation revenue and competition increases within the air transportation market. For this reason, the passengers find an opportunity to obtain cheaper flight ticket due to sharp competition within the market. According to (Kalayci & Yanginlar, 2016), the contribution of Turkish economy to civil aviation seems remarkable which is consistent with this paper's research results. Additionally, (Button & Taylor, 2000) also urges upon the benefits of the air logistics to USA's economy involving employment and collecting more taxes. They prove longer term impact between air transportation and economic growth. The empirical proof of this study demonstrates that, there is a long-term relationship among the variables of GDP, FDI and air transportation. According to the results of both papers, the effect of GDP is found to increase air transportation demand more than the FDI. However, considering the direction of the relationship in terms of FDI to air transportation, according to (Button & Taylor, 2000; Kalayci & Yanginlar, 2016), there is no direct impact of FDI on air transportation but there is significant impact of GDP on air transportation.

Population size ($POPN$) and **Education ($EDUC$):** The countries/ regions with higher population size may have higher air transport demand, *ceteris paribus*. This concept also considers not just population trends over the given years but also reflects the old-age dependency ratio. According to (IATA, 2014), typically, the nations with growing populations also have younger populations, and working-age groups are more likely to fly than nations with older populations. The nations with better literacy rate would have higher involvements in national and international businesses where air transportation is the sole feasible means of transport for timely business activities.

Balance of payment (BoP) and **official exchange rate (OER):** The balance of payments (BoP) is the international balance sheet of a nation that records all international transactions in goods, services, and assets over a year (Mankiw, 2014). Economies that record persistent deficits on the current account matched by surpluses on the capital account are net borrowers of funds from the rest of the world. By contrast, economies that experience regular current account surpluses and capital account deficits are net lenders of funds to the rest of the world.

The exchange rate is the rate at which one currency can be traded for another. The exchange rate affects the prices at which a country trades with the rest of the world and is integral to open economy analysis and policy formulation. Whenever the BoP registers a purchase of a foreign asset or a sale of a domestic commodity abroad, this implicitly indicates that there is a change in the demand for or in the supply of the foreign currency (Maurice & Kenneth, 2016). The international transaction cannot be completed unless one of the parties to the transaction is willing to exchange domestic currency for foreign currency. Therefore changes in any of the components of the BoP affect the supply of and demand for foreign currency.

While the BoP would have been balanced or surplus, the long run economy of the nation could be grown at a steady rate (Maurice & Kenneth, 2016). Obviously, the economic growth of the nation indicates the GDP is improving so that income per capita would be increased. According to (IATA, 2014), countries on a growth curve up to approximately US$20,000 per capita see correspondingly faster increases in the number of flights taken per person per year.

6. Descriptive Analyses

This section would describe the real appearances of variables in terms of their trends observed over time and trends of their marginal changes in specified periods. The nature of available data and patterns of relationship between air transport demand and economic growth could complement the econometric analyses part. The result of descriptive analyses could be also insights hints for the causal relationships of the variables presented in chapter seven. The growth of domestic and international air transport traffic (passenger and freight) has been investigated relative to economic growth in Ethiopia. The airlines which have been participating and competing in international air transport market in Ethiopia are also considered for comparison analysis. The relationship between air transport demand (passenger traffic and freight demand) and economic growth could be presented by correlation coefficients and graphical forms.

Table 5 below shows the summary of statistical descriptive of main variables. Mean and standard deviation of data provides general characteristics of their respective variables. Interpretations and conclusions based merely on the mean and standard deviation of variables may not convince for recommendations. Because by the nature of their calculation, mean and standard deviations are exposed to the effects of outliers. Graphical display of these variables (see figure 25 in chapter seven) presented their magnitude and trends more clearly. The statistical analysis of the relationship between economic growth and air transport demand has been parted into the relationship of air passenger traffic with economic growth and freight demands with economic growth. The contribution of air passenger traffic and air cargo demand on economic growth could be more understood through analyzing their effects separately.

Table 5: Descriptive Statistics – yearly Average

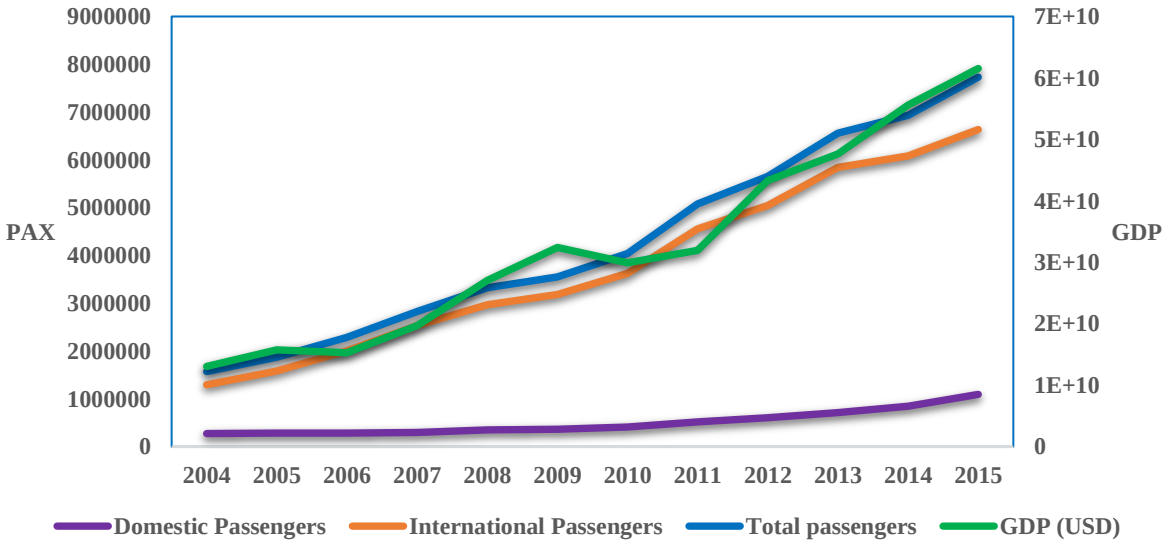
Variables	Mean	Std. Deviation
Total passenger	1,962,132	2,086,852
GDP (USD)	2,1717,593,660	14,986,272,568
Freight (ton-km)	220,092,714	284,429,372
FDI (USD)	292411727	516,379,532
Emigration	32,035	20,597
Official Exchange Rate to USD	7.71	5.7
Population size	64,248,566	19,381,104
Secondary & above student enrollments	1,818,013	1,465,229
Balance of Payment	-748,616,473	77,0720,869

Source :(EAE, 2016; EAL, 2016; NBE, 2016; World Bank, 2016)

6.1. Passenger Traffic and Economic Growth

The performances of air passenger traffic and economic growth in Ethiopia have been shown improvement, especially over the last one decade. At the end of 2015, the number of passengers and GDP of the country reached about 8 million and 62 billion US Dollar respectively. Compared to 2005, these figures are increased by more than four times over a decade. The following graph (figure 12) presents the trends of increasing air passenger demand and growth of the economy over the last decade. Though the bases of both passenger demand and economic growth are small, their trend displayed improvement over time.

Figure 12: Trends of total air passenger traffic and economic growth (2005-2015)



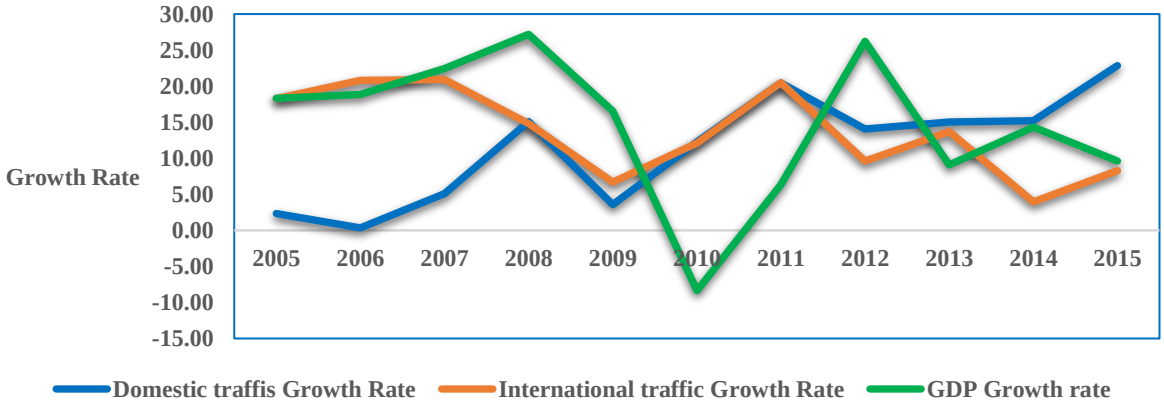
Source: (EAE, 2016; World Bank, 2016)

Over the indicated period, the domestic and international passengers comprise of, on average, 12 percent, and 88 percent of the total air transport demand in Ethiopia respectively. Figure 12 above showed that the growth of air transport industry in Ethiopia is highly dependent on international passengers and less on domestic traffic. Low share of domestic passenger traffic could be attributed to impoverished living standards and still low-income level (about 620 USD per capita in 2015), according to (World Bank, 2016), of the people in the country. Additionally, only about 20% of total population of the country are urban dwellers. The rest 80% of people are farmers inhabited in a rural area, relatively poor society than that of urban dwellers (NBE, 2016).

Though the base of domestic and international passenger traffic had been low, their marginal change over time has been growing at a steady rate. Figure 13 below and Figure 12 above,

showed that the amount and growth rate of air transport demand in Ethiopia have been improving over time. Since 2011 domestic passenger traffic has been growing at a better rate than international traffic. This might be the effect of slow recovery of Ethiopian economic growth rate since 2010 and built of five new airports (Shire, 2011; Kebridehar, 2012; Semera and Combolcha, 2014; Hawassa, 2015), (EAE, 2016), in different regions of the country.

Figure 13: Trends of domestic and international passenger growth rate with GDP growth rate



Sources: (EAE, 2016; World Bank, 2016)

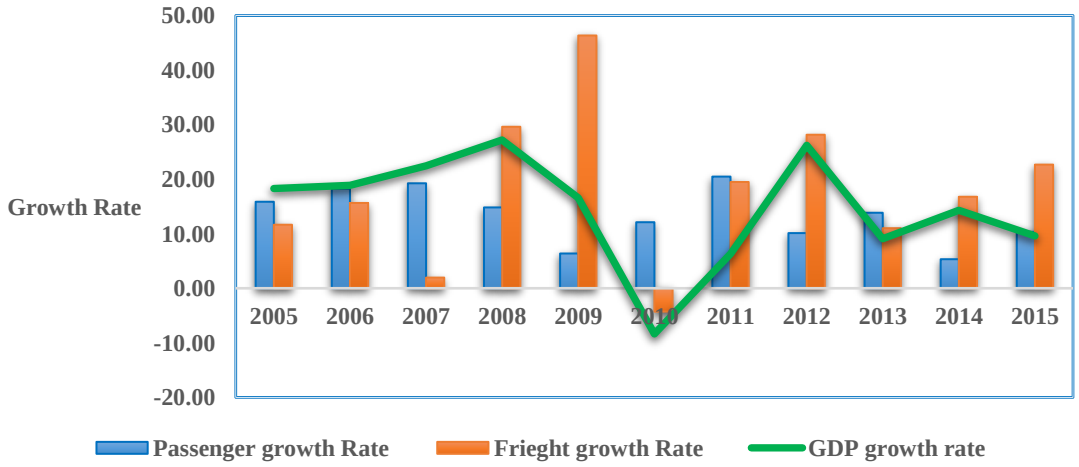
Compared to domestic air passenger demand, international air passenger demand showed better performances in terms of passenger numbers and marginal increase. One possible reason for this flow could be that Bole International Airport (Addis Ababa) has been serving as a hub airport for air transport traffic especially from the Middle East and South East Asia countries to sub-Saharan Africa. For most African countries which have no direct flight with them themselves, according to (Wyanie A. Bright & Habte, 2015), Addis Ababa has been serving as a hub airport. Another factor for increasing traffic of international passengers could be growing trends of conference industry in Addis Ababa, due to Addis Ababa hosts big institutions like the Africa Union (AU) and Economic Commission for Africa as headquarter. Additionally, Addis Ababa hosts about 111 embassies, and 3 consulates (Embassypages, 2017), the third embassy destination in Africa next to Cairo and Pretoria.

Ethiopia has 4 international and 17 domestic functional airports though the capacities of domestic airports are limited to Bombardier Q400 aircraft (EAE, 2016) which believed to hinder domestic air transport growth. Moreover, Ethiopian Airline has been using Bombardier Q400 due to the demand of domestic passenger traffic at each airport could be

satisfied with the capacity of this type of aircraft. On the other hand, economic growth in the country might not strong enough to generate more air passenger demands. As indicated in Table 6, on average the dwellers of cities in Ethiopia could not make a single air travel trip per year.

The improvement of PAX and GDP are more clearly understood when we consider their growth rate in the specified time range. Despite their respective small base, both PAX and GDP reveals increasing growth rate from 2005 to 2015. Figure 14 presented the growth rate of air passenger traffic, economic growth, and air freight demand. According to (EAE, 2016; World Bank, 2016), Ethiopia's passenger traffic grew on average at a robust rate of about 13% per year between 2005-2015. This growth rate is significant compared to average passenger growth rate of Africa (about 6.8%) and the world (about 5.3%) in the specified period (IATA, 2016). The rate of growth of air passengers in Ethiopia has picked up strongly since 2005, reflecting the boost to business and foreign direct investment provided by a more striving economy and more secure environments. This progress believed to contribute for economic growth of the country through direct, indirect or catalyst effects. The magnitude and margin of this contribution have been analyzed and presented in chapter seven. Moreover, Ethiopian economy has also experienced a steady growth rate over the past decade, averaging 10.8% per year. Compared to average economic growth rate of Africa, 5.4% (World Bank, 2016), Ethiopian economic growth rate is significant. But, according to the finding of this study in chapter seven, this infant economic growth is not strong enough to cause more air passenger demand in the country.

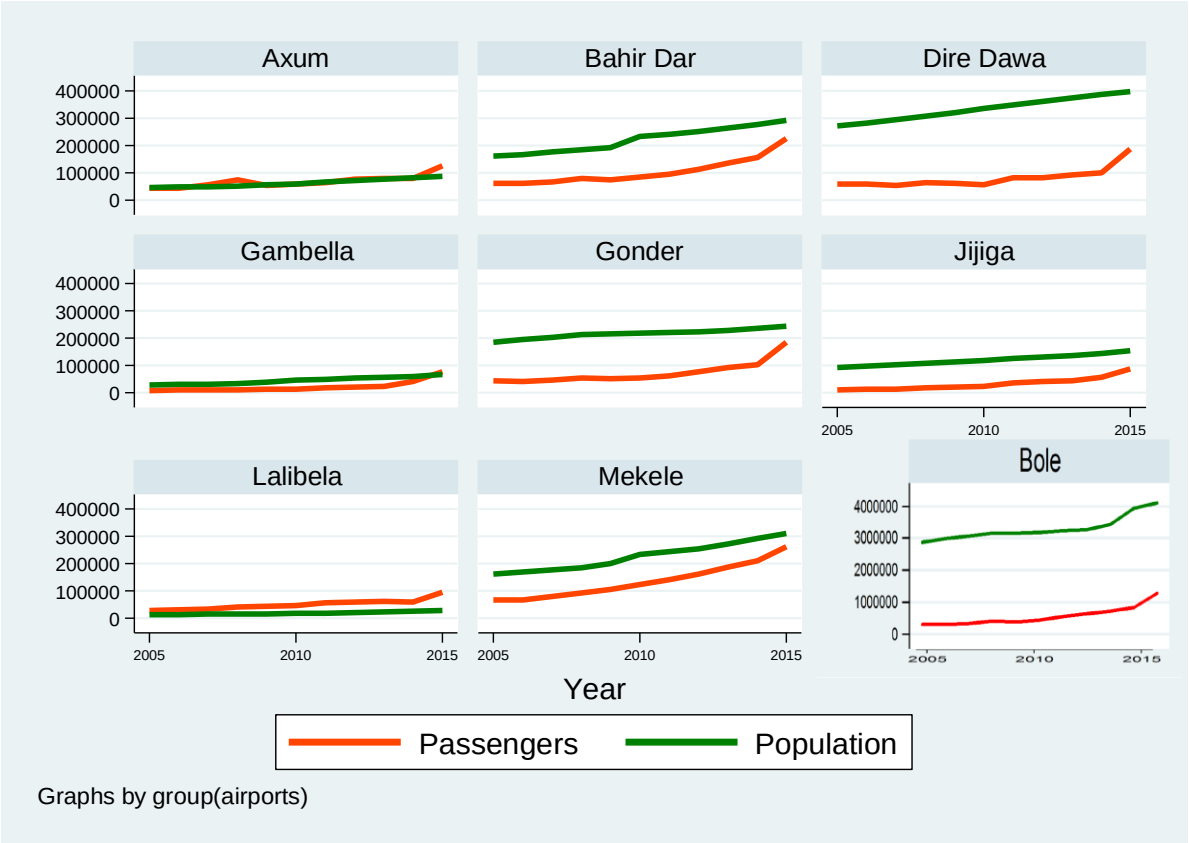
Figure 14: Growth Rates of GDP, Passenger and Cargo Traffic Between 2005 – 2015



Source: (EAE, 2016; World Bank, 2016)

Moreover, the quality and quantity of airport infrastructures in the country are also not proportional to the size of the population in the country. For more than 95 million people (World Bank, 2016), there are about 20 functional airports. This implies that the airport per-capita[11] of the country is about 0.3 (0.3 airports per 1 million people) which indicate that one airport believed to serve about 5 million people. This figure is very low compared to airport per-capita of sub-Saharan African countries (11.69 airports per 1 million people) and that of neighbor country Kenya (6.09 airport per 1 million people) (NationMaster, 2010). The economic implication of lower airport per-capita could be that the economic growth of the country is not strong enough to generate more air transport demand. Lower air passenger demand could be more visible when we compare domestic passenger traffic with the population of cities hosted functional airports in Ethiopia. Figure 14 presented domestic passenger traffic of airports and population size of their respective cities for randomly selected sample airports.

Figure 15: Domestic passenger traffic of airports and population size their cities (2005-2015), average yearly



Source: (CSA, 2016; EAE, 2016)

[11] Per-capita airport is number of airports per 1 million people

Except for Lalibela, Aksum and recently Gambella airports, the population size of hosting cities is by far outweighs the domestic passenger traffic of respective airports. Lalibela, Aksum and Gambella cities could be considered as exceptional passenger demands because these cities are top tourist destinations in Ethiopia. Including the capital Addis Ababa and other regional cities, the number of domestic travelers through air transport system could be considered as low relative to the population size of these cities.

According to (IATA, 2014), there are three demand drivers in air passenger traffic forecast; living standards, population and demographics, and price and availability. Countries on a growth curve up to approximately US$20,000 per-capita see correspondingly faster increases in the number of flights taken per person per year. But in Ethiopia per-capita income is around US$620 which by far very low compared to per-capita income forecasted by IATA. Hence, the status of economic development in Ethiopia is not in a position to derive air transport demand. Typically, the nations with growing populations also have younger populations, and working-age groups are more likely to fly than older populations. But having younger population is not sufficient demand driver without proportional per-capita income in Ethiopia. IATA also forecasted that greater liberalization of air markets has the potential to increase global air traffic growth by over 1 percentage point per year. In Ethiopia, domestic air transport service is allowed only for Ethiopian Airline. Since Ethiopian Airline has monopoly power over domestic air transport service, relatively higher fare rate could be expected and might be also considered as another factor for lower domestic passenger demand.

Table 6 presented domestic trips per person per year and average time travelers should wait before next trip, (data represents only for 2015). The domestic passenger trips per person and the average length of months before next trip of sample cities from a different region of Ethiopia reveal some clues about domestic passenger demand in the country. Cities like lalibella, Axum and Gambella could be considered as exceptional phenomena. Because these cities are top tourist destinations in the country. For other sample cities, on average a person could have to wait from 2 to 9 years to make a single trip per year. To compare this figure with the experiences of other African countries/regions, availability of such data is rare. But to make the analysis more sensible, these figures were compared with the experience of developed nations. According to (Worldatlas, 2014), the nations which made high domestic air transport trips (average trips per person per year) are United States (6.5), Finland (5.8), Sweden (4.4), Denmark (3.9) and Norway (3.2). Though these countries are

not comparable with Ethiopia, but it indicates how far Ethiopia is behind in domestic air transport demand. However, this figure may not represent the full picture of domestic air transport demand in Ethiopia, because more than 80% population of the country are rural dwellers which may not make a single trip throughout his/her life.

Table 6: Domestic trips per person per year and average months before next trip (based on 2015 data)

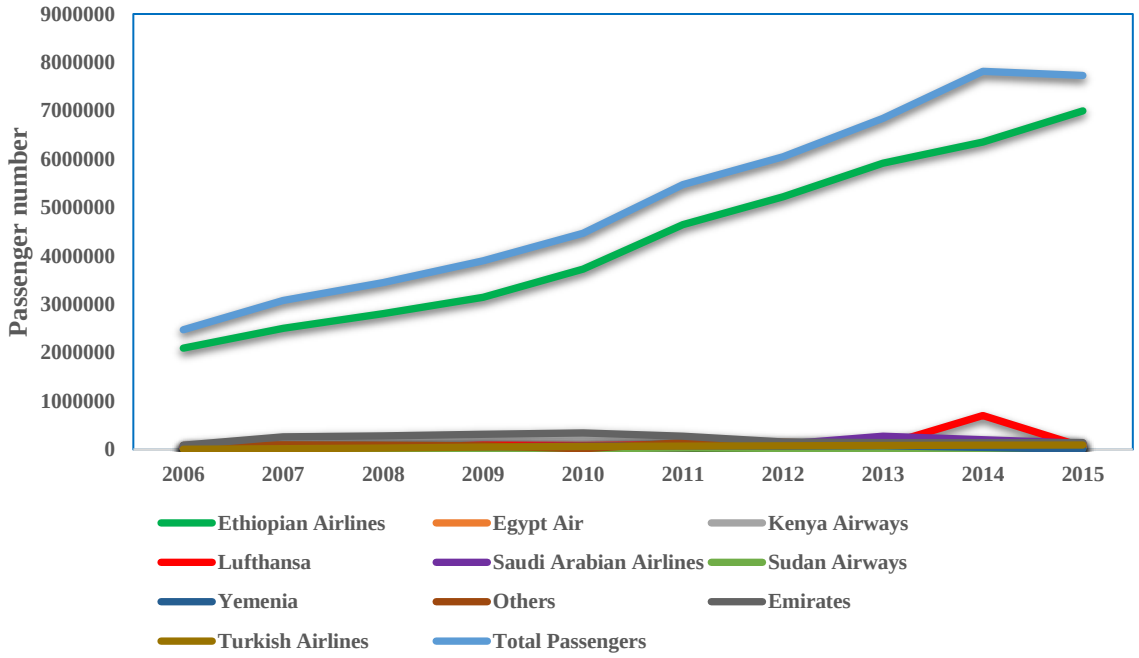
Airports	Total passengers	Population	Trips per person per year	Months before next trip
Arba Minch	41858	106910	0.39	31
Asosa	34161	34731	0.98	12
Axum	124372	86490	1.44	8
Bahir Dar	226260	290960	0.78	15
Gambella	78415	66898	1.17	10
Gode	11878	100136	0.12	101
Gondar	186054	243027	0.77	16
Jijiga	87073	154370	0.56	21
Jimma	45615	239655	0.19	63
Lalibella	95561	30104	3.17	4
Mekele	262973	311443	0.84	14
Addis Ababa	1194220	4111799	0.29	41
Dire Dawa	185761	396413	0.47	26
Average			**0.86**	**14**
Ethiopia	7731262	95990751	0.081	149

Sources: (CSA, 2016; EAE, 2016)

The investment regulation of Ethiopia (Ethiopian Council of Ministers, 270/2012) states that only Ethiopian citizens may provide domestic air transport service with a capacity of not more than 50 seats. This provides Ethiopian airlines with a monopoly power on domestic flights having more than such capacity. According to this regulation, only government can conduct passenger air transport services using aircraft with a capacity of more than 50 passengers. But for international air passenger demand, many airlines are delivering the service from Bole international airport.

The volume of international air transport services at Bole airport has been dominated by Ethiopian Airlines. Figure 16 showed the annual passenger volume of all airlines delivering international passenger transport service at Bole airport (Addis Ababa). According to (The Economist, 2016), Ethiopian Airlines is Africa's largest and most profitable airline, earning more than its rivals on the continent combined. Hence, it's not a big surprise if Ethiopian Airlines dominate air transport service at Bole airport, its main hub.

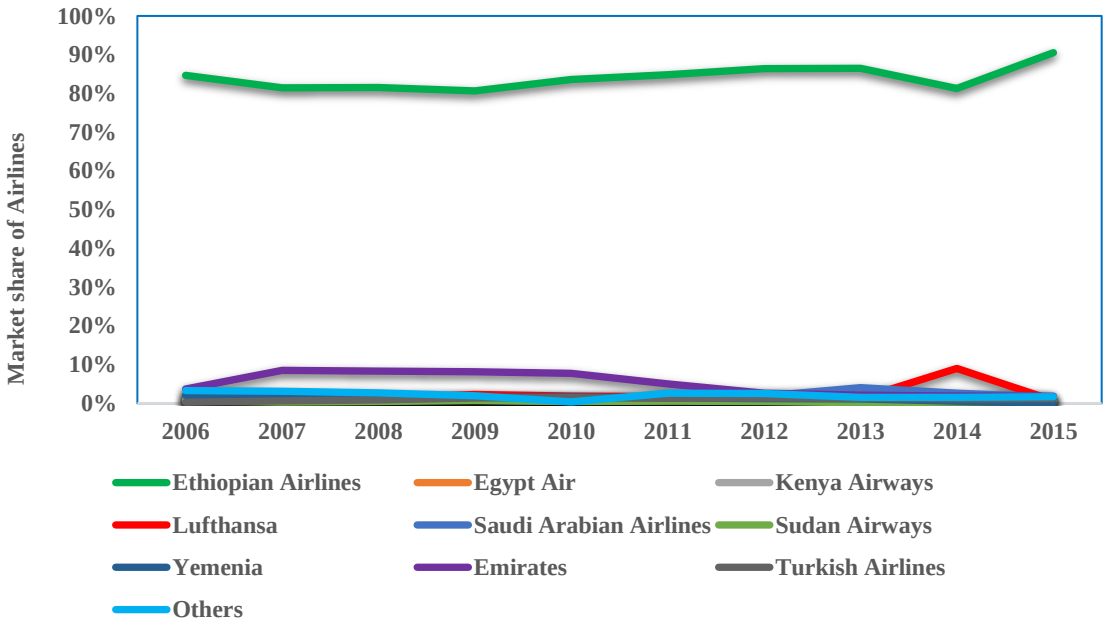
Figure 16: Volume of international air passengers at Bole airport (by airlines)



Source: (EAE, 2016)

According to (IATA, 2014) forecasts, eight of the ten fastest-growing air transport markets in percentage terms will be in Africa including Ethiopia alongside Central African Republic, Madagascar, Tanzania, and Burundi making up the five fastest-growing markets. According to this forecast, in terms of country-pairs United Arab Emirates (UAE) to Ethiopia travel will all grow by at least 9.5% on average for the next 20 years. From the past trends, this fast-growing air passenger demand has been dominated by Ethiopian airlines. Over the last one decade (2006 to 2015) Ethiopian Airlines took loin share (about 85%) of air passenger demand in Ethiopia (EAE, 2016) followed by Emirates (5%) and Lufthansa (2%) respectively.

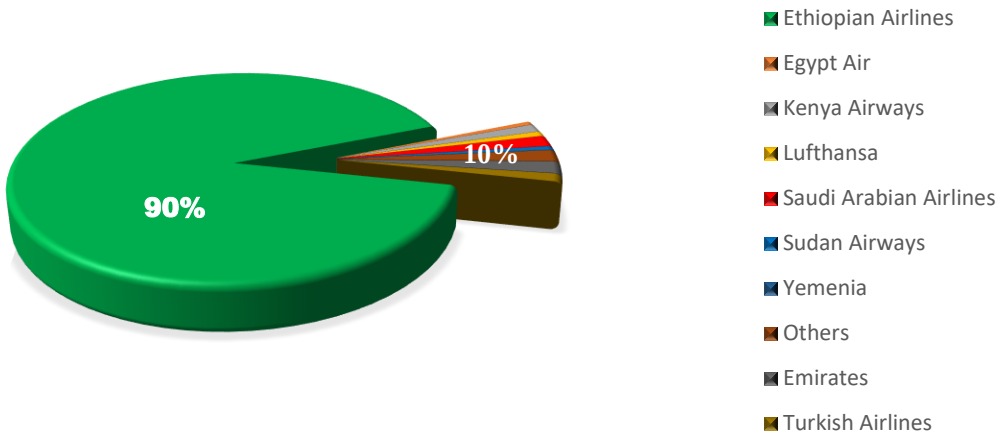
Figure 17: Market share of airlines in Ethiopian air passenger demand (2006-2015)



Source: (EAE, 2016)

As illustrated in the above two graphs (Figure 16 and Figure17), the market of air passenger demand in Ethiopia has been continued to be dominated by Ethiopia Airlines. If we consider the year 2015, the market share of Ethiopian Airlines grew to 90% (carried about 7 million passengers) and the other airlines share the rest 10% (carried about 0.73 million passengers) among themselves (see figure 18). Though the number of international passengers significantly outweigh the domestic passengers, the dominance of Ethiopia based state-owned airline in the market is an incentive for the economy of the country. As state-owned flag carrier airlines, Ethiopian Airlines has been contributing beyond profit-making benefits. Ethiopian Airlines is the only operator which connects the international passengers with domestic airports and tourist destinations. Offering services to all the country's major tourist destinations mean that Ethiopian Airlines is creating market opportunities for hotels and other businesses across Ethiopia, facilitating both business and leisure travels. Additionally, according to (Wyanie A. Bright & Habte, 2015), Ethiopian Airlines has created about 16,000 full-time job opportunities and annually contribute about $2.5 billion to Ethiopian economy.

Figure 18: Market share of airlines in international passenger demand of Ethiopia (2015)



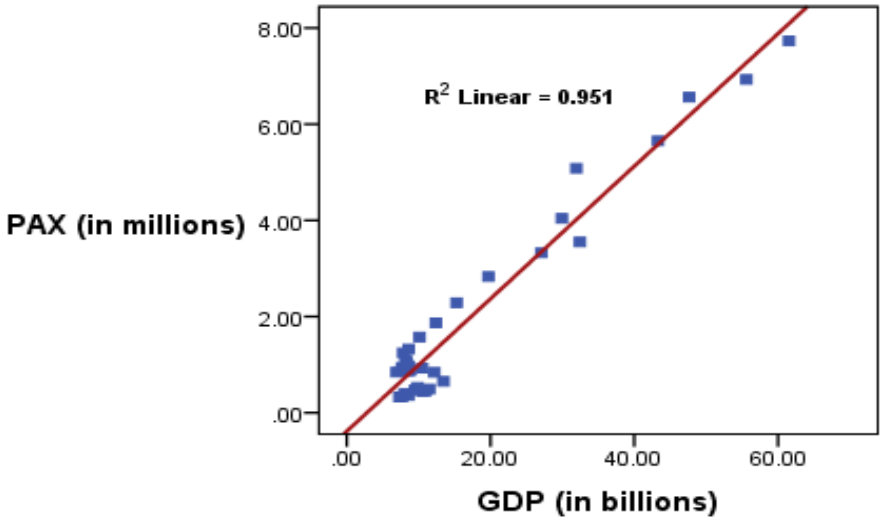
Source: (EAE, 2016)

On one hand, the passenger demands in the country have been dominated by Ethiopian Airlines, fully state owned, which obviously complements the economic growth of the country through direct, indirect, induced or catalytic routes. One could attribute much of this success to the carrier's benevolent owner, which does not demand dividends and, through state policies, can help keep down labor and financing costs. Ethiopian Airlines don't have to pay a dividend and can build up capital which supports the airline to get lower labor costs and higher productivity than its rivals. Additionally, Ethiopian Airline has been receiving indirect supports from government. As elaborated in Growth and Transformation Plan (GTP) (MoFED, 2010), the airline has been tax exempted until 2025, when the airline become globally strong competent. Moreover, to support this vision of Ethiopian Airlines, government facilitated loan at a favorable and non-commercial rate from state banks. The Ethiopian government is also preparing for this (part of GTP) as it started working on an eight-year project to build a US$4 billion, four-runway airport on the outskirts of Addis Ababa that will be able to handle 120 million passengers a year.

On the other hand, the volume of international passengers significantly higher than that of domestic passenger volume. Ethiopia typically acts as a hub for international transfers and connecting traffic. The benefits generated by increasing level of international transfer and connecting traffic of business and leisure traffic may not directly inject into Ethiopian economy. Of course, Bole International Airport generates revenues in different forms from these international transfers and connecting traffics.

Moreover, the growth patterns of air passenger demand (both domestic and international) and economic growth of the country (refer figure 13) showed almost similar wave fashion. Additionally, the data presented in figures 19 indicated that the economic growth and air passenger demand may be interdependent in Ethiopia. High correlation coefficients between air passengers and GDP imply that there is a strong linear relationship between the two variables. The air passenger and GDP data exhibit a correlation coefficient of about 0.95. This coefficient is positive and indicates a strong linear relationship between air passenger demand and economic growth in Ethiopia. In fact, Bole airport and Ethiopian Airlines are part of Ethiopian economy and connecting Ethiopia with rest of the world. Development of Bole airport and improvement of Ethiopian airlines strengthen economic growth of the country. Contrary to this, as discussed earlier in this section, economic growth in Ethiopia is not strong enough to generate more air passenger demands. Causality analysis conducted in chapter seven also conclude that there is a unidirectional relationship between air passenger demand and economic growth which runs from air passenger demand to economic growth.

Figure 19: Correlation between air passenger demand and economic growth



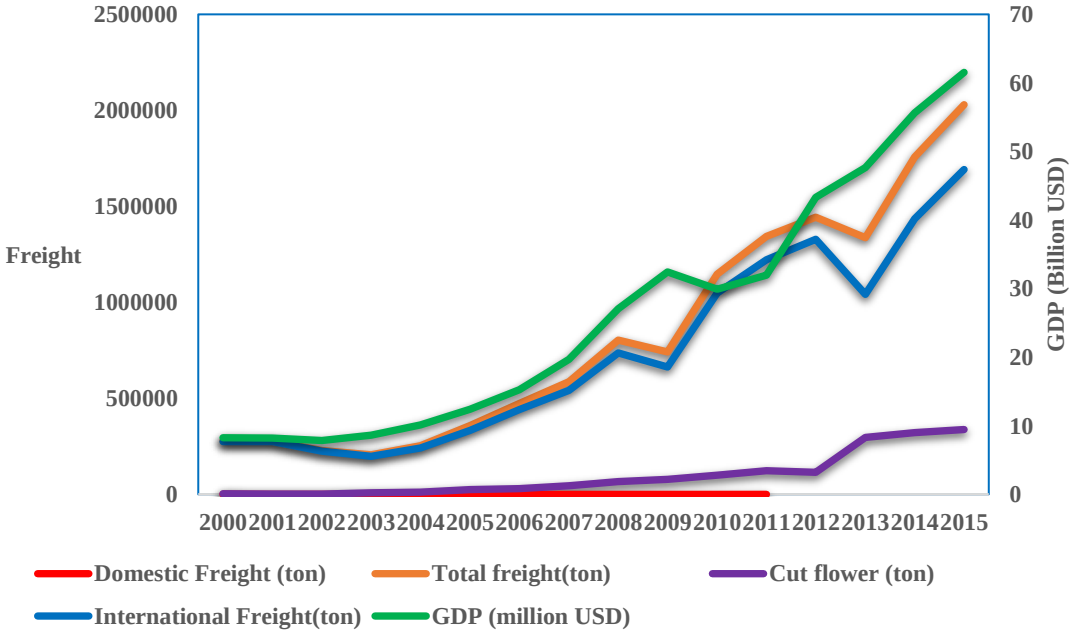
Source: SPSS output (EAE, 2016; World Bank, 2016)

Given the scale and accessibility of air transportation, it is important to understand how air transportation impacts economic activity and which factors affect the interaction between the two systems. Such an understanding may help to guide further development efforts, investment and policy decisions pertaining to air transportation usage and the resulting enabling impact on an economy. Further causal direction and the magnitude of the contribution have been presented in chapter seven.

6.2. Air Freight Demand and Economic Growth

Bole International airport is a competitive market for air freight and is the main gateway airport for Ethiopia, as well as being a transshipment point for other destinations in Africa. Airlines from the Middle East, Europe, South East Asia, and other African nations fly to this busy air cargo hub (EAE, 2016). According to world air cargo forecast team (Crabtree, Hoang, Tom, & Gildemann, 2015), Ethiopia is among top five African international air trade countries alongside South Africa, Egypt, Kenya, and Nigeria. Recently cut flower export takes central figures in Ethiopian international air trade growth, especially to Europe (UNcomtrade, 2016).

Figure 20: Air freight demand and economic growth (2000-2015)



Source: (EAE, 2016; UNcomtrade, 2016; World Bank, 2016)

Freight transport traffic (measured as ton-kilometer) grew with about 18% (see figure 14) from 2005 to 2015 with high fluctuations relative to passenger traffic movements. This fluctuation may be an indicator for variation of the export level of the country which affected by climate change and weather condition as the export items are primarily agricultural products like cut flowers and raw and processed meat products. Air freight development of Ethiopia is mostly dependent on international demands and domestic demand becomes decreasing and even ceased after 2011. Still, the factors mentioned for the low level of domestic passenger level could be considered as hindering elements for falling of domestic air freight demand. The above figure (figure 20) indicated increasing trends of air cargo

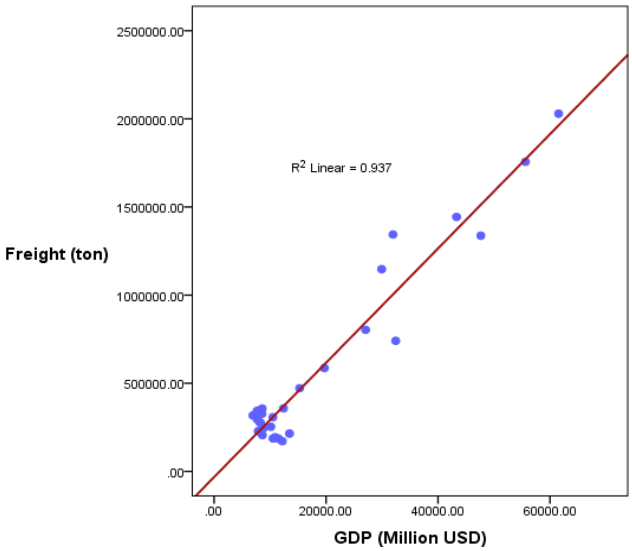
demand and economic growth in Ethiopia. Additionally, the flourishing contribution of cut flowers export in international air freight demand also depicted in the same figure.

Ethiopia has been landlocked country and seems focused on the export of timely consumed and perishable products. Today, much Ethiopian's cargo growth is being driven by the country's increasing perishables export market, including such time and temperature-sensitive goods as flowers, fruits, meat, and vegetables. The growing trend of the floral industry is one of these strategical movements in the country. Even though Ethiopia's floral industry's place as a major economic entity is a quite recent development, emerging in the late 1990's, the country is currently the largest flower exporter in Africa. According to (WTEx, 2017)[12], Ethiopia accounted for the highest dollar value worth of flower bouquet exports in Africa during 2015 with shipments amounting to $662.4 million or 8.4% of global flower exports. In the same year, Ethiopia ranked first in Africa in terms of flower bouquet exports and forth in the world next to Netherlands, Colombia, and Ecuador respectively. Ethiopia was also the first in Africa and second in the world next to Lithuania in terms of the fastest-growing flower bouquets exporters since 2011. In these export progress, the facilities and promotions of air freight transport are crucial. Ceteris paribus, the reliability of air freight transport service in Ethiopia hopefully attracted foreign investors, particularly to the cut flower industry.

Air freight development has been contributing to economic growth of the country through export promotion and revenue generation. Trends (see figure 20) of economic growth and improvement of air cargo demand changed (increased) closely in a similar manner through time which may give hints about the interdependence of both economic variables. The interdependence of air freight demand and economic growth of the country could be further illustrated using concept correlation coefficients. The correlation coefficient (about 0.94) of the economic variables revealed that, refer Figure 21, there is strong linear interdependence. This is because air freight and integrated air express are crucial to time-based competition and perishable products. Moreover, economic activity in the country also needs to produce a commodity to be exported. Like the unidirectional causality running from air passenger demand to economic growth, there is also a uni-directional causality running from air freight demand to economic growth in Ethiopia (refer chapter seven).

[12] http://www.worldstopexports.com/flower-bouquet-exports-country/

Figure 21: Linear interdependence between air freight demand and economic growth in Ethiopia



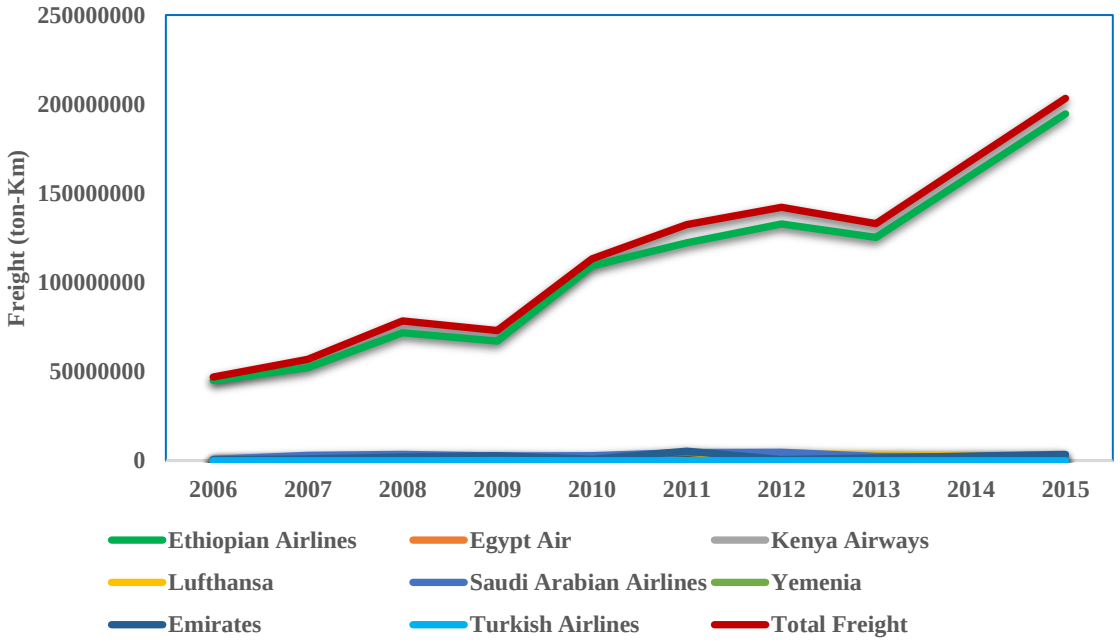
Source: SPSS output (EAE, 2016; World Bank, 2016)

Similar to air passenger transport, different airlines haven been participating and competing in international air cargo transport market at Bole airport. Still, Ethiopian Airlines is, by far, the dominant cargo carrier for international freight demand in Ethiopia. Ethiopian Cargo has its European hub at Liege Airport in Brussels and its second cargo hub in Africa, Togo Lomé (The Reporte, 2016). As explained earlier, Ethiopian Airlines is a flag carrier and has been getting economic, diplomatic, and moral support from the government. The goal of this airlines is, according to (EAL, 2016), to contribute positively to socio-economic development of Ethiopia in particular and the countries to which it operates in general by undertaking its corporate social responsibilities and providing vital global air connectivity,

To maintain and improve further, according to (EAL, 2017), Ethiopian Cargo is aiming to grow its freighter fleet to 18 aircraft by 2025 from the eight it operates today as it targets growth across the business. EAL's other targets by 2025 are to grow its cargo business are to increase revenue from $425 million it achieves today to $2 billion; up tonnage to 820,000 tons from the 350,000 it handles now and boosts the number of freighter destinations it serves to 37 from the 35 it does now. Ethiopian Airlines' plans to build a $98m world-class cargo terminal at Addis Ababa Bole International Airport has been already started in 2016 (EAL, 2017). It will be able to handle 600,000 tons of freight a year. Planning is also underway for a further expansion to 1.2 million tons a year, which will make the terminal one of the largest in the world. This cargo hub will be the largest trans-shipment terminal in Africa, and it is particularly geared to Ethiopia's economy, which is still predominantly

agricultural. It will be equipped with a cool storage area to allow the transport of perishable goods, such as cut flowers, meat, and vegetables to markets around the world. The development of Ethiopian airlines both in passenger and freight sector could contribute to economic growth of the country. The magnitudes of these contributions are empirically presented in the next chapter.

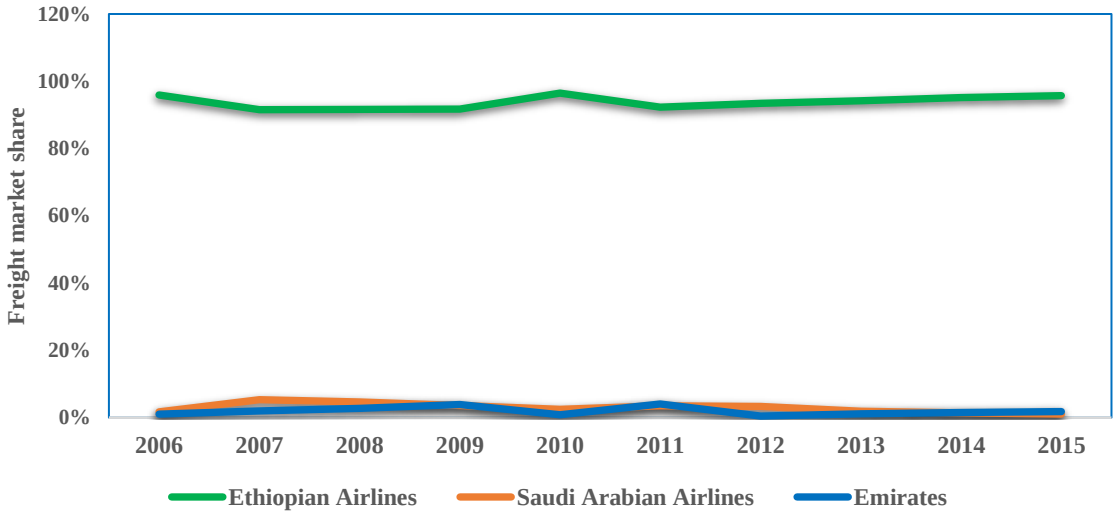
Figure 22: International cargo volumes at Bole airport (by airlines) 2006-2015



Source: (EAE, 2016)

To be more precise, Ethiopian cargo covers, on average from 2006-2015, about 94% of international freight transport demand in Ethiopia followed by Saudi Arabian Airlines (3%) and Emirates (2%) respectively. Besides promoting export and generating revenues, being dominated by Ethiopian Airlines magnifies the role of air freight transport in Ethiopian economy. As tried to explain earlier in this section, Ethiopian Airline is totally state owned and flag carrier which has been run by competent professionals. The growth of Ethiopian Airline may contribute to economic activities of the country through reducing the shortages of foreign currency and capital of the airline also circulate in the economy of the country. Suppose, according to (NBE, 2016) annual report for year 2015/16, about 19% of foreign currency of the country was reaped from revenue of Ethiopian Airlines.

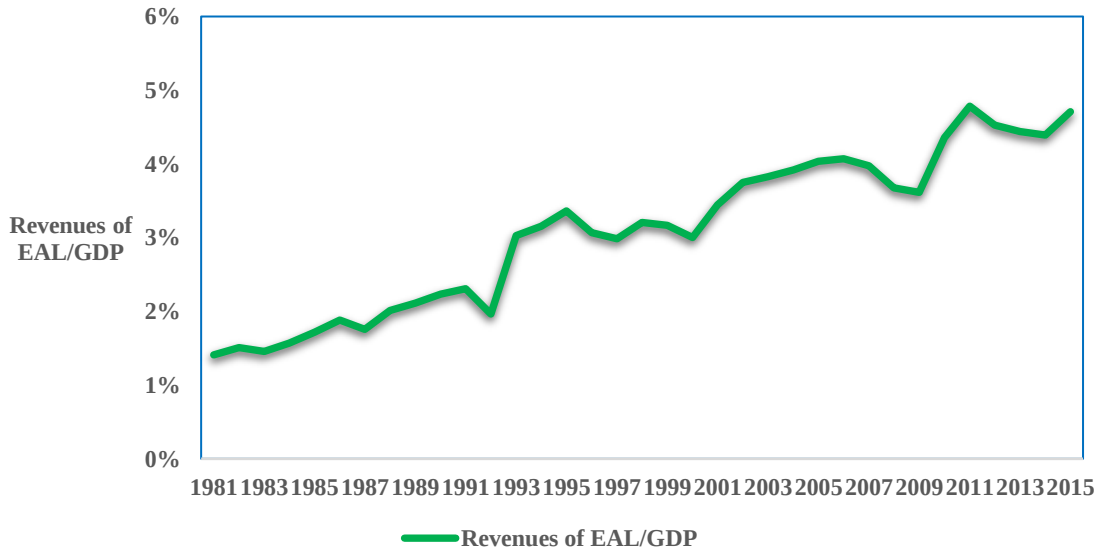
Figure 23: Cargo demand market share of airlines at Bole international airport



Source: (EAE, 2016)

Generally, the contribution of Ethiopian Airlines (both passenger and freight) on Ethiopian economy would be represented in figure 24 below. This graph showed that the share of annual revenues of Ethiopian Airlines in Ethiopian economy (GDP) over the last three and half decades. Accordingly, during the late 1980's, the annual revenue of Ethiopian Airlines had been contributing about less than 2% of GDP of the country. But since 2011, this share has been growing to around 5% of the economy of the country. Given the 2025 vision of the airline, this contribution of revenue of Ethiopian Airline will be expected to inflate the current figures.

Figure 24: Share of annual revenues of Ethiopian Airlines in Ethiopian GDP (1981-2015



Sources: (EAL, 2016; World Bank, 2016)

6.3. Discussions of The Results

The outcome of descriptive analyses could be insights some hints for the causal relationships of the air transport demand and economic growth. Air transport demand (passenger and freight) and economic growth in Ethiopia growths by more than four times over the last decade (2005-2015). In order to get a clear understanding of about the relationship between air transport expansion and economic growth, the analysis could be categorized into passenger demand and air freight demand with economic growth.

Though the bases of both air passenger traffic and economic growth are small, their trend displayed improvement over time. Ethiopia's air passenger traffic grew on average at a robust rate of about 13% per year between 2005-2015. This growth rate is significant compared to average passenger growth rate of Africa (about 6.8%) and the world (about 5.3%) in the specified period of time. This progress believed to contribute to the economic growth of the country through direct, indirect or catalyst effects. Moreover, Ethiopian economy has also experienced steady growth rate over the past decade, averaging 10.8% per year. Compared to the average economic growth rate of Africa, 5.4%, Ethiopian economic growth is considerable. But, according to the finding of this study in next chapter, this infant economic growth is not too strong enough to cause more air passenger demands. This could be attributed to impoverished living standards and still low-income level (about 620 USD per capita in 2015) of the people in the country. The quality and quantity of airport infrastructures in the country are also not proportional to the size of the population in the country. For more than 95 million people, there are about 20 functional airports. This implies that the airport per-capita of the country is about 0.3 (0.3 airports per 1 million people) which indicate that one airport believed to serve about 5 million people. This figure is very low compared to airport per-capita of sub-Saharan African countries (11.69 airports per 1 million people) and that of neighbor country Kenya (6.09 airport per 1 million people). Additionally, only about 20% of total population of the country are urban dwellers. The rest 80% of people are farmers inhabited in rural areas, relatively poor society than that of urban dwellers. This reality has been reflected by low share of domestic passenger demand in the country, constitute about 12% of total air passenger demand. The domestic passenger trips per person and the average length of months before next trip of sample cities from a different region of Ethiopia reveal some clues about domestic passenger demand in the country. In Ethiopia, on average a person could wait from 2 to 9 years to make a single trip per year. But international air passenger demand showed better performances in terms of passenger numbers and

marginal increase. One possible reason for this flow could be that Bole International Airport (Addis Ababa) has been serving as a hub airport for air transport traffic especially from/to the Middle East and South East Asia countries to/from sub-Saharan Africa countries. For most African countries which have no direct flight with them themselves, Addis Ababa has been serving as a hub airport.

The market of air passenger demand in Ethiopia is continuously dominated by Ethiopia Airlines. Over the last one decade (2006 to 2015) Ethiopian Airlines took loin share of (about 85%) of air passenger demand in Ethiopia followed by Emirates (5%) and Lufthansa (2%) respectively. Ethiopian Airlines, fully state owned and flag carrier is Africa's largest and most profitable airline earning more than its rivals on the continent combined. One could attribute much of this success to the carrier's benevolent owner, which does not demand dividends and, through state policies, can help keep down labor and financing costs. EAL don't have to pay a dividend and can build up capital which supports the airline to get lower labor costs and higher productivity than its rivals. Despite the volume of international passengers significantly higher than that of domestic passenger volume, the contribution of air transport demand to economic growth is considerable (refer chapter seven).

On the other hand, freight transport traffic (measured as ton-kilometer) grew with about 18% from 2005 to 2015 with high fluctuations than passenger traffic movements. This fluctuation may be an indicator for variation of the export level of the country which affected by climate change and weather condition as the export items are primarily agricultural products like cut flowers and raw and processed meat products. Due to the same factors mentioned for air passenger demand, air freight development of Ethiopia is mostly dependent on international demands and domestic demand becomes decreasing and even ceased after 2011. But international air freight volume of perishables commodities that are time and temperature-sensitive goods such as flowers, fruits, meat, and vegetables have been increasing. Ethiopia, landlocked country, seems focused on the exports of timely consumed and perishable products. Additionally, Ethiopian economy has been mainly depending on agricultural sector so that the items for exports are also agricultural products. The growing trend of the floral industry is one of these strategical movements in the country. Even though Ethiopia's floral industry's place as a major economic entity is a quite recent development, the country is currently the largest flower exporter in Africa. In these export progress, the facilities and promotions of air freight transport are vital. Ceteris paribus, the reliability of air freight

transport service in Ethiopia hopefully attracted foreign investors, particularly to the cut flower industry.

Like air passenger transport, various airlines haven been participating and competing in international air cargo transport market in Ethiopia. Again, Ethiopian Airlines is, by far, the dominant cargo carrier for international freight demand in Ethiopia. From 2006-2015, on average, about 94% of international freight transport demand in Ethiopia have been covered by Ethiopian Airlines followed by Saudi Arabian Airlines (3%) and Emirates (2%) respectively. As described earlier, Ethiopian Airlines is a flag carrier and has been getting economic, diplomatic, and moral support from the government. To maintain this dominance, Ethiopian Airlines has opened its European hub at Liege Airport in Brussels and its second cargo hub in Africa, Togo Lomé.

Generally, the growing share of Ethiopian Airlines could contribute to economic activities of the country through reducing the shortages of foreign currency and capital of the airlines also circulate in the economy of the country. Suppose, in the fiscal year of 2015/16, about 19% of foreign exchange of the country was reaped from revenue of Ethiopian Airlines. Additionally, by the end of 2015, the annual share of revenues of Ethiopian Airlines in GDP of Ethiopia had grown to about 5%. Ethiopian Airlines has created about 16,000 full-time job opportunities and annually contribute about $2.5 billion to Ethiopian economy. But Ethiopian economy is not too strong to reinforce air transport demand in the country mainly because of impoverished living standard of the people (about 620 USD per capita in 2015), low quantity and low quality of domestic airport infrastructures, and majority of the populations are living in rural areas (about 80%), only about 20% of the populations are urban dwellers.

7. Econometric Analyses

The main empirical analysis of this thesis would be presented in this section. Tests for the existence of unit roots would be investigated on the beginning of the chapter by employing Augmented Dicky Fuller (ADF), which paves the way for further analysis. Cointegration test and analysis of the long-run relationship between air transport demand and economic growth also discussed. The analysis of long run causality between air transport demand (passenger and freight) and economic growth presented in the next sub-sections using the concept of vector error correction model (VECM). The discussion of short-run dynamics and Granger causality analysis also provided in this section. The validity and appropriateness of the employed models checked through different diagnostics testing techniques. Based on the findings of the study and discussion of the finding, the annual and accumulated responses of economic growth to air transport demand (both passenger and freight) would be forecasted for about ten years ($t + 10$) using impulse response function (IRF) in the final section of this chapter. During the analysis, all the variables were transformed into their logarithmic form to benefit from the effect that after such a transformation all resulting coefficients can directly be interpreted as elasticities.

7.1. Unit Root Tests and Order of Integration

The need to test for the presence of unit root is to avoid the problem of spurious regression. Spurious regression is a regression that provides misleading statistical evidence of a linear relationship between independent non-stationary variables. If the variables in the regression model are not stationary, then it can be proved that the standard assumptions for asymptotic analysis will not be valid. In other words, the usual "t-ratios" will not follow a t-distribution, so we cannot validly undertake hypothesis tests about the regression parameters.

If a variable contains a unit root, then it is non-stationary and unless it combines with other non-stationary series to form a stationary cointegration relationships, then regressions involving the series can falsely imply the existence of meaningful economic relationships (Harris, 1995). In principle, it is important to test the order of integration of each variable in the model, to establish whether it is non-stationary and how many times the variables needs to be differentiated to result in a stationary series. The variable X_t is said to be stationary if the means and the variances of the process are constant over time, while the value of the covariance between two periods depends only on the gap between the periods, and not the

actual time at which this covariance is considered. If one or more of the conditions above are not fulfilled, the process is non-stationary.

As stated above, to achieve a meaningful regression output using time series data, it is necessary to test unit roots of all continuous variables involved in the model. The variables used in the analysis need to be stationary and/or should be cointegrated of the same level to infer a meaningful relationship from VAR (Vector Autoregressive) and VECM (Vector Error Correction Model) regressions. The unit root test provides the order of integration at which the variables can be stationary. To detect the existence of unit roots, informal and formal tests could be employed. The informal test for stationarity is the graphical display of time series data. A visual plot of the time series is important in such a way that it gives an idea of the trends and stationarity of the data set.

The first step in building dynamic time series models entails a detailed analysis of the characteristics of the time series variables involved. Such an analysis is important because the properties of the time series data sets have to be taken into account in modeling the data generation process of a system of potential variables. According to (Brooks, 2014), any time series can contain some or all of the following components: trend, cyclical, seasonal and irregular.

The trend is the long-term pattern of a time series. A trend can be positive or negative depending on whether the time series exhibits an increasing long-term pattern or a decreasing long-term pattern. If a time series does not show an increasing or decreasing pattern then the series is stationary in the mean. Any pattern showing an up and down movement around a given trend is identified as a cyclical pattern. Seasonality occurs when the time series exhibits regular fluctuations during the same month (or months) every year, or during the same quarter every year. A time series data set which exhibits regular fluctuations (seasonal variations) are time dependent and hence not considered as stationary. Concerning irregular time series data set, every time series has some unpredictable component that makes it a random variable and such data sets are stationary.

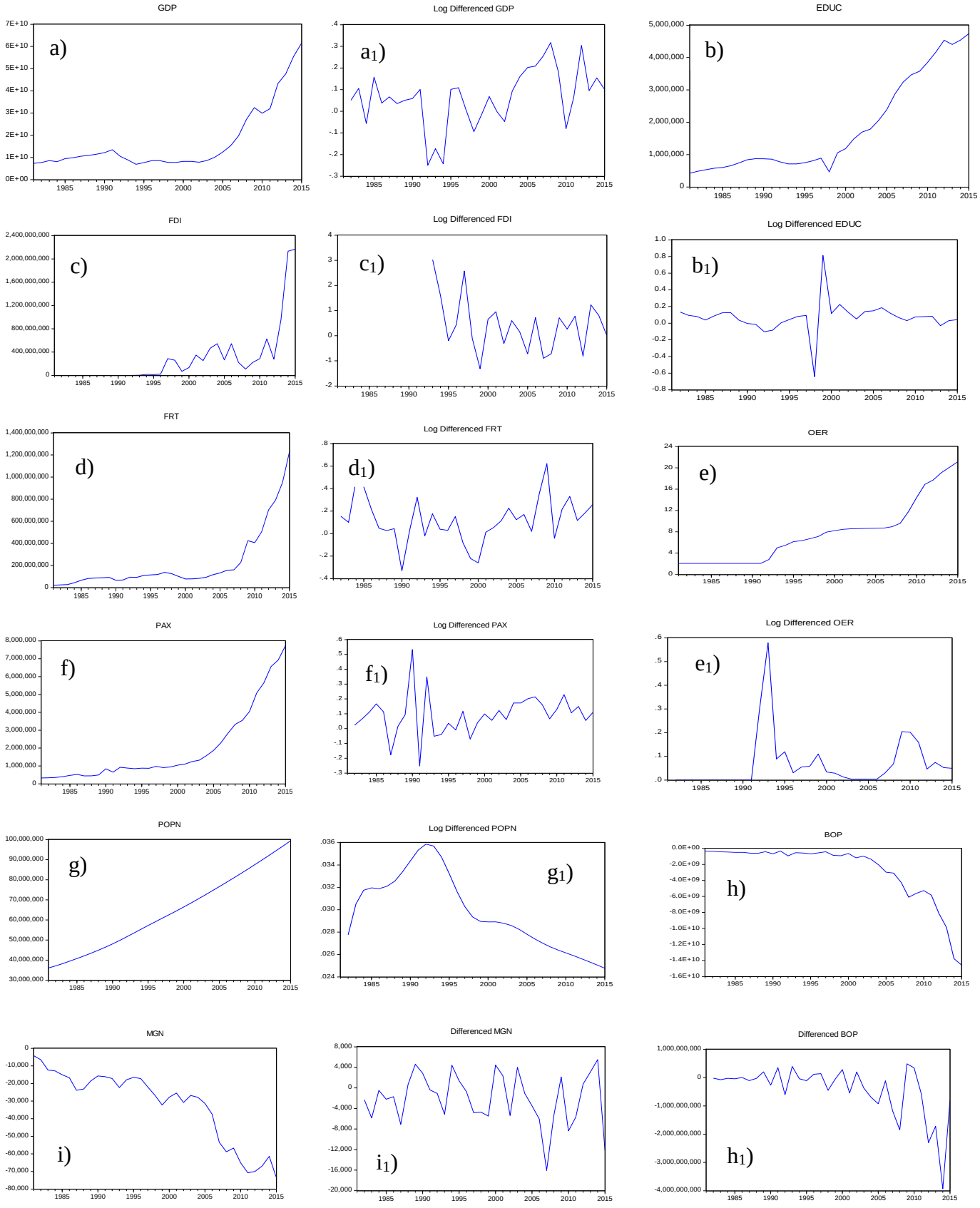
A stationary time series is one whose properties do not depend on the time at which the series is observed. So, time series with trends, or with seasonality, are not stationary - the trend and seasonality will affect the value of the time series at different times. On the other hand, a white noise series is stationary, it does not matter when you observe it, it should look

much the same at any period of time. A time series with cyclic behavior (but not trend or seasonality) is also stationary. That is because the cycles are not of fixed length, so before we observe the series we cannot be sure where the peaks and troughs of the cycles will be. In general, a stationary time series will have no predictable patterns in the long-term. Time plots will show the series to be roughly horizontal (although some cyclic behavior is possible) with constant variance.

From series plotted in figure 25 below, one can realize that none of the variables seem stationary at level (without differencing). Trend rules out series (a), (b), (c), (d), (e), (f), (g), (h), and (i). Increasing variance also rules out series (h_1). Transformations such as logarithms can help to stabilize the variance of a time series. Differencing can also help stabilize the mean of a time series by removing changes in the level of a time series, and so eliminate trend and seasonality. The log-differenced form of (a), (b), (c), (d), (e), (f), and (i) reveals that they are moving closely around their mean. The log-differenced variables have a time variant mean and variance suggesting that they might be stationary or closer to stationarity boundary as they seem to be hovering around their means. But the log difference of series (g) and (h) looks deviated from hovering around their mean.

Suppose, consider the plot of population (series (g) and (g_1)) and balance of payment (series (h) and (h_1)). Graphical display of population variable without differencing (at level) indicated an increasing trend (g) at increasing rate. As explained above, the variables with increasing/decreasing trends are not stationary. Log differenced form of this variable (POPN) looks also non-stationary. First differencing and detrending could not condense fluctuation of POPN data set around it mean because the successive values of the variable were varying with time and changing at increasing rate. As shown in Table 7, the series become condense around its mean after second differencing and detrending. Similarly, patterns of the balance of payment also continuously decreasing and could not be stationary at level (without differencing and detrending). First differencing of this variable (BoP) leads to an explosion of the trend through increasing the variances over time. But second differencing persuaded the values to hover around its mean and being to be stationary (refer Table 7). Hence, considering POPN and BoP for further analysis with variables which looks stationary at first difference may lead to spurious regression output.

Figure 25: Graphical displays of stationarity test



Source: Eviews output (CSA, 2016; EAE, 2016; World Bank, 2016)

We cannot be certain and consider whether the variables are stationary or not based on the above graphical analysis alone. To be sure about the stationarity status of these variables, following formal hypotheses testing procedure is necessary. In this study, the augmented Dickey-Fuller (ADF) test is used as a formal testing technique to detect unit roots and the order of integration of the variables. An important practical issue for the implementation of the ADF test is the specification of optimal lag length. If the lag length is too small, then the remaining serial correlation in the errors will bias the test. If the lag length is too large, then the power of the test will suffer. ADF tests use a parametric auto-regression to approximate the autoregressive moving average (ARMA) structure of the errors in the test regression, to get rid of the serial correlation. Concerning deterministic trend assumptions constant is included with no trend. Because, according to (Brooks, 2014), the option with no trend and no intercept produced explosive results, while the option with both a trend and intercept made test statistics less significant. But the alternative with constant and no trend provides us robust results. Table 7 presents the result of the ADF test of the series.

Table 7: Unit root tests (*I(0), I(1), I(2)*)

Variables	***ADF Specifications***		
	I(0)	***I(1)***	***I(2)***
	Constant	Constant	Constant
lnGDP	0.42	-5.59**	-3.39
lnEDUC	-0.13	-7.91**	-2.97
lnFDI	-3.13	-7.99**	-2-57
lnFRT	0.28	-7.25**	-3-53
lnOER	-0.49	-6.34**	-3.38
lnPAX	1.17	-6.61**	-3.15
lnPOPN	-2.56	-2.68	5.36**
BoP	1.57	1.70	-4.90**
lnMGN	0.05	-5.84**	-3.34
Test critical values: 1% = -3.618 5% = -2.942			

Notes: - Significance level: ** Rejection of null hypothesis at 1%

- Lag length selected based on Akaike Info Criterion(AIC)
- t-statistics reported

Source: Eviews output (CSA, 2016; EAE, 2016; World Bank, 2016)

The above table shows hypothesis tests of ADF results for variables taken in their levels, first and second differences. Accordingly, except for population(POPN) and balance of payment (BoP), the result rejected the null hypothesis of a unit root at 1% confidence level

suggesting that the variables are first order integrated process I(1). But the unit root of the balance of payment (BoP) and population(POPN) variables are integrated at the second difference. Hence, in the next step and further analysis of the study BoP and POPN variables could be excluded. POPN and BoP excluded from further analysis because they have a time-varying trend at first order differencing. In other words, the population growth and balance of payment had been showing a non-constant average trend in the specified range of time. If first differencing doesn't eliminate non-stationarity from these variables, still they are suffering from serial correlation problem. Obviously, running a regression with variables which did not rid of serial correlation problem leads to spurious regression output. Interpretations of spurious regression are not only misleading but also nullify recommendation of the finding. In addition to this, to employ VAR and VECM techniques, the order of integration needs to be the same and first order integrated process I(1) (Toda & Peter, 1993). Moreover, as (Johansen & Juselius, 1990) pointed out, it is not possible for I(1) variable to have a long run relationship with I(0) and I(2) variables, in that case, it is said that the equation does not balance. An equation balanced when all the variables investigated have the same order of integration which could be first order integrated process I(1) and otherwise produce spurious regressions. In general, an $I(d-1)$ process cannot adequately explain the behavior of an $I(d)$ process. Thus, if $d = 1$, we know that an $I(0)$ process (which has a constant mean and variance) cannot possibly explain all of the behavior of an $I(1)$ process whose mean and variance trend upward overtime.

7.2. Test for Cointegration: Test for Number of Cointegration Vectors

Once the result of stationarity test had been known, the next step is to check whether there is any I(0) linear combination. This condition is enough to accept that the series, although individually non-stationary, when combined, present an interesting element, i.e. there is a long-term relationship keeping them on a similar path. The null hypothesis (H_0) to be tested indicates the existence of a given number of co-integrating equations.

After confirmation of I(0), a linear combination of variables prevails, the subsequent step is to estimate the long run relationship between air transport demand and economic growth using the Johansen maximum likelihood method. This method is selected because it produces consistent estimates of the long-run parameter, which could be tested using likelihood ratio (LR) statistics. During unit root test the assumption of including constant but no trend was justified. Therefore, the deterministic trend assumption excludes trend and

includes constant. For the selection of the lag order, information criteria approach and theoretical facts are used as the guide. The following table shows the lag length chosen by different information criteria.

Table 8: VAR Lag Order Selection Criteria (Eviews output)

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-403.6761	NA	331.0472	25.66726	25.98789	25.77354
1	-229.8750	260.7017	0.000497*****	10.07910*****	17.13295*****	12.41725*****
2	-145.5241	89.62278	0.146288	17.86719	20.43222	18.71742
3	-7.265615	86.41156*****	0.025956	15.65776	20.46720	17.25195

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

The lag selection criteria, except LR, showed one as an optimal lag order. Though LR information criterion reveals conflicting lag length, (Brooks, 2014) attributes this problem to a small sample bias. In autoregressive (AR) process, lag length helps to know how many terms back down the process to test for serial correlation. Serial correlation is the relationship between a given variable and itself over various time intervals. Serial correlations are often found in repeating patterns when the level of a variable affects its future level. Economic activities in Ethiopia are not broad base developed to determine how well the past predicts the future economic growth. Often the lag length is dictated by the frequency of the data (as well as the sample size). For annual data, one or two lags usually suffice. For monthly data, we might include twelve lags. But there are no hard rules to follow in any case (Wooldridge, 2005). Besides the majority results of information criterion (refer table 8) and theoretical point of view, for a small base economic activity like Ethiopia, considering annual data with one lag order is reasonable lag order selection. Hence, Johansen cointegration test could be conducted under the assumption of no trend but a constant in the series with one lag order selection.

In a system of variables, there may be several linearly independent cointegrating vectors. In that case, linear combinations of these vectors are also cointegrating vectors because linear combinations of stationary variables are stationary. The concept of cointegration may also be applied to linear combinations of more than two I(1) variables. More formally, we say

that a set of I(1) time series variables is cointegrated if there exists a linear combination of these variables that is I(0). First order integrated series can present stationary linear combinations (I(0)), therefore, we have to study the possible existence of a cointegration relationship. A general approach is provided by (Johansen & Juselius, 1990). To determine if the variables are cointegrated and the number of cointegrating equations, this study used both trace test and maximum eigenvalue tests. The results of the Johansen cointegration tests are presented in table 9 and detected the existence of one cointegration vector.

Table 9: Results of tests for the number of cointegration vectors

Unrestricted Cointegration Rank Test (**Trace**) – Eviews output

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.707163	54.39516	29.79707	0.0000
At most 1	0.262391	13.86658	15.49471	0.0867
At most 2	0.109399	3.823328	3.841466	0.0505

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (**Maximum Eigenvalue**) – Eviews output

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.707163	40.52858	21.13162	0.0000
At most 1	0.262391	10.04325	14.26460	0.2091
At most 2	0.109399	3.823328	3.841466	0.0505

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

The above tables showed that the null hypothesis of no cointegrating vectors is rejected in favor of the existence of cointegrating vector. Both trace and maximum eigenvalues indicate the existence of one cointegrating relation between the variables. Once it is statistically supported that there is one cointegrating vector, the first column of the α - matrix[13] relevant coefficients to check weak exogeneity. As depicted in appendix-1 and Table 10 below, which of the variables has to be explained as a linear combination of others could be known from the result of weak exogeneity tests for all variables.

[13] Refer Appendix - 1

A test for weak exogeneity is conducted by imposing a zero restriction on coefficients of the variables using likelihood ratio (LR) test. According to Johansen (1992), if the speed of adjustment coefficients (α_i's) in the cointegration analysis approaches zero, then the corresponding variables can be considered weakly exogenous. A set of variables are said to be weakly exogenous if, when we condition on them, there is no loss of information about the parameters of interest. Weak endogeneity is sufficient for efficient estimation. Moreover, the theory is symmetric in its treatment of, suppose Y_t and X_t, so that there should also exist an error correction representation with ΔX_t as the left-hand side variable. Because at least one of the variables has to adjust to deviations from the long-run equilibrium, at least one of the adjustment parameters in the two error-correction equations has to be nonzero. If X_t does not adjust to the equilibrium error (has a zero-adjustment parameter), it is weakly exogenous for coefficients (Verbeek, 2008). This means that we can include ΔX_t in the right-hand side of the potential equation without affecting the error-correction term. That is, we can condition upon X_t in the error-correction model for Y_t. The representation theorem also holds conversely, i.e. if Y_t and X_t are both I(1) and have an error-correction representation, then they are necessarily cointegrated. The significance of the hypothesis of weak exogeneity in empirical analysis is that, if the variables are weakly exogenous, then it is legitimate to abandon the multivariate model and perform the analysis using the single equation approach by conditioning on these variables. This test does not reject the null hypothesis if all the variables are weakly exogenous.

Table 10: Test for zero- restrictions on adjustment-coefficients (Weak Exogeneity Test) Eviews output

Statistics	LNGDP	LNPAX	LNMGN	LNOER	LNFRT	LNFDI	LNEDUC
$\boldsymbol{\alpha}$ - Coefficients	-0.256961	0.035128	-0.02918	-0.051963	0.14629	0.19522	0.092225
LR-test $\chi^2(1)$	4.743610	0.211032	0.04974	0.524723	1.56170	0.75669	2.701071
Probability	0.029421*****	0.646019	0.82350	0.468809	0.21146	0.38448	0.100309

***** Indicates the rejection of null hypothesis at 0.05 significance.
Restrictions are linear in coefficients.

The rejection of weak exogeneity null hypothesis implies that $lnGDP$ is endogenous variable. The tests indicated that the null hypothesis, the variable is weakly exogenous, is rejected for the gross domestic product at 5% significance level. Number of passengers, number of secondary and above education student enrollments, air freight traffic, official exchange rate, injection of foreign direct investment and outflow of labor force from the country as emigrant are accepted to be weakly exogenous.

7.3. Estimation of the Vector Error-Correction Model

After the existence of long-run relationships has been identified, the next step would be the estimation of vector error correction dynamics which is a crucial section for policy implications. An error correction model would be incorporating the short-term interactions and the speeds of adjustment towards the long-run model. In the error correction model, the short-run disequilibrium is approximated by the first lag of the estimated long-run linear combination. The procedure adopted for estimation is the Hendry's approach of general-to-specific modeling (Adam & Hendry, 2000). In this approach, a large model is estimated first which includes as many of the explanatory variables and their lags as possible. Then all insignificant explanatory variables are continuously dropped until a parsimonious model with few explanatory variables but acceptable in terms of significance, economic interpretation and diagnostic validity are obtained. It is very important to specify how short-run adjustment of the variables took place and base fertile ground for policies analysis & implementations.

The VECM test does not only show the long-run causal direction but also the significance of the speed of adjustment (coefficient of ECT) and hence the robustness of the indication for the long-run equilibrium relationship. A significantly negative value but an absolute value between 0 and 1 suggests a long-run equilibrium relationship (Baker et al., 2015). Table 11 and Table 12 summarize the VECM results for the PAX-GDP and FRT-GDP causal relationships. It is worth noting that according to (Holtz-Eakin, Newey, & Rosen, 1988), lag length selection is critical for finding the causality directions and it should be less than one-third of the total time period as otherwise over identification problems may arise. Additionally, a further criterion for the lag length selection has been proposed by (Hurlin, 2004) as $T_i > 5 + 2k$, where T_i = time span, K = Lag length. This study considered a lag length of 3 years for all models based on the Akaike information criterion (AIC) and Schwarz information criterion (SIC). Since overall timespan is 35 years, the lag length selection also meets both the (Holtz-Eakin et al., 1988) and the (Hurlin, 2004) criteria. The results of VECM presented the long run causality directions between PAX and GDP and as well FRT and GDP with their marginal effects. For purpose simplicity, these discussions are presented in separate sub-sections as follows.

7.3.1. Discussion of Long-Run Causality between *PAX* and *GDP*

As indicated under cointegration sub-section, PAX and GDP have long run relationships. The causality direction of their relationship and marginal effects would be presented in this sub-section. Table 11 below illustrates the results of the long-run causality tests for air passenger models. The coefficient of long-run causality ($ECT = -0.25$) is negative and significant for the first model which confirms that there is a long-run causality running from air passenger traffic demand to economic growth. However, that relationship is only significant with three-year time lag (bold numbers in model 1) and there is no significant causality running from economic growth to air passenger traffic demand.

Table 11: Results of long-run causality for PAX and GDP – STATA output

Explanatory factors	Model 1: $\Delta lnGDP$	Explanatory factors	Model 2: $\Delta lnPAX$
1-year lag of $\Delta lnPAX$	0.1466256	1-year lag of $\Delta lnGDP$	0.0916902
2-year lag of $\Delta lnPAX$	-0.1079668	2-year lag of $\Delta lnGDP$	-0.4272013
3-year lag of $\Delta lnPAX$	**0.7695651****	3-year lag of$\Delta lnGDP$	0.3334798
4-year lag of $\Delta lnPAX$	3.563386	4-year lag of $\Delta lnGDP$	1.960158
Constant	-0.0944074	Constant	0.1217585
Long-run causality (ECT_1)	**-0.2490108****	Long-run causality (ECT_1)	0.0139722

****** Represent significant p-values at 5% significance level

The Ethiopian economy is not strong enough to create more air passenger demand, particularly domestic air passenger demand is at a low level. According to (World Bank, 2016), Ethiopia is still a country with impoverished living standards and still low-income level (about 620 USD per capita in 2015) and hence not in a position to boost more air passenger demand. The three-year time lag appears plausible given that air passenger traffic demand (especially international passengers) needs time to filter through to economic growth (i.e. via slow injection of revenues of state-owned airline, Ethiopian Airlines, and disposable income into the economy as economic theory would also suggest). In terms of the magnitude of the effect, the results suggest that in long run a 1% increase if air passenger traffic demand will on average lead to a proportionately lower growth in economic growth of about 0.77%.

When we convert this percentage changes into monetary values, suppose in the last ten years, per passenger per year contribution of air passenger demand to GDP of Ethiopia has been, on average, estimated to US$ 5,286 (refer Appendix 7). This figure includes not only direct

revenues from the sector but also includes indirect, induced and catalytic effects of air passenger demand on economic growth of the country. This figure looks inflated compared to other similar studies like (J. G. Brida, Bukstein, & Zapata, 2016) who conduct their investigation in Italy. According to these researchers, per passenger per year long run contribution of air passenger demand to the economic growth of Italy was about US$ 2,577. But these two countries have been in different economic and infrastructural situations which make difficult to make an absolute comparison. In Ethiopia, air passenger demand has been significantly dominated by international passengers with about 88% (see Figure 12) who had long haul trip compared to that of Italy that dominated by domestic passengers with about 62% (Assaeroporti, 2016). Additionally, in Ethiopian air transport service, all airlines are full-service carrier airlines (EAE, 2016) which have obviously higher fares then low-cost carrier airlines. But in Italy, according to (Assaeroporti, 2016), in 2015 the share of low-cost carrier (LCC) airlines gets closer to 50% of total air passenger demand. Hence, the estimated contribution of air passenger traffic to Ethiopian economy could be considered as reasonable estimation.

7.3.2. Discussion of Long-Run Causality between *FRT* and *GDP*

The results of the analysis presented in Table 12 suggest that there is a long-run uni-directional causality relationship which runs from air freight volumes to economic growth (significant ECT). Similar to the passenger models, the positive impact of air freight demand on economic growth is plausible (bold numbers in model 3) when allowing for a three-year time lag. It needs reasonable time (here three years) to observe the effects of air freight contributions in economic growth of the country. Air freight revenues (for airports and airlines), personal incomes of employees from the sector and all other related impacts need a plausible time to reveal their impacts on economic activity.

Table 12: Results of long-run causality for FRT and GDP – STATA output

Explanatory factors	Model 3: $\Delta lnGDP$	Explanatory factors	Model 4: $\Delta lnFRT$
1-year lag of $\Delta lnFRT$	0.3441736	1-year lag of $\Delta lnGDP$	0.147339
2-year lag of $\Delta lnFRT$	0.1506561	2-year lag of $\Delta lnGDP$	0.0397999
3-year lag of $\Delta lnFRT$	**0.6244278****	3-year lag of$\Delta lnGDP$	-0.0965009
4-year lag of $\Delta lnFRT$	0.6516843	4-year lag of $\Delta lnGDP$	-1.125293
Constant	-0.0944074	Constant	0.1313873
Long-run causality (ECT_1)	**-0.2490108****	Long-run causality (ECT_1)	-0.221329

**** Represent significant p-values at 5% significance level

Empirically, the magnitude of 1% increase of growth in air freight ton-kilometer would lead to roughly 0.6% per year economic growth in the long run. More specifically, one kilogram per kilometer per year contribution of air freight demand to the economic growth of the country, in the long run, would be estimated to US$ 174 (refer appendix 8). The fact that the demand for air freight is often driven by the value of commodity than the weight of the commodity, plausibly the effect is not only significant but also considerable. Additionally, since Ethiopia is landlocked country and has poor land transport infrastructure to neighbor countries, timely and high valued products are exported to Middle-East and Europe through air transport system. The benefit of improved air transport demand (passenger and freight) for developing countries like Ethiopia which suffer from a shortage of foreign currency would be beyond reap of revenues from the sector. The foreign currency generated from this system has been played a pivotal role in the international trade transaction.

Generally, the long-run impacts of air transport demand (passenger and freight) are consistent with works of (Krugman, 1996; Schmutzler, 1999) on new economic geography, "base multiplier" model. According to the findings of these researchers, the size of goods and services that are sold to elsewhere world 'base activities' assumed to depend on outside factors, like world demand, or on slowly changing regional advantages. The size of the non-base activities, by contrast, depends on the size of the local economy. If there is a gradual increase in the size of the 'base activities' starting at a low level, then the local economy will expand gradually. On the other hand, if there is a declining economy which starts very large, then local income will decline and leads to a self-reinforcing contraction.

Likewise, the long run relationship between air transport demand and economic growth in Ethiopia could be described with the following two points derived from the above concepts. The base for air transport demand in Ethiopia depends on international markets (the world and regional advantages) which eventually raises and benefits the expansion of local economy gradually. The local economy is at the lower base and not strong enough to reinforce itself to generate more air transport demands. Second, Small quantitative changes in the underlying factors that drive location advantage will have significant effects on the long-run economic output. The location of Ethiopia, the horn of Africa, has strategic air transport route benefits by connecting the Middle East and South East Asian countries with sub- Sahara African countries. The long run benefits of Ethiopian economy from this air transport traffic advantage is significant enough per passenger and per ton-Km each year as evidenced by the above empirical analysis. Indirectly this advantage also implies that the

local economy is still not considered as a centrifugal point for air transport demand in the country. But in both cases, the local economy has been benefited from increasing air transport demand of the world and the region.

7.4. Short Run Dynamics and Granger Causality

In addition to long-run causality, short-run dynamics and Granger causality test also affirm positive causal relationship between economic growth and air transport demand in Ethiopia. Table 13 presented the causal relationship of PAX and FRT with GDP in short run dynamics. The short run causality test showed that there is uni-directional causality run from air transport demand (both passenger and freight) to economic growth. In other words, similar to long run analysis, the short-run growth of air transport demand leads to economic growth, and economic growth is not strong enough to boost air transport demand in the country. As justified in long run analysis, the bases for air transport demand of Ethiopia is international customers (world and regional advantage) which are an incentive and encouragement for the local economy. The base of the local economy is too small to cause and underpin air transport demand. But as suggested by (Krugman, 1996; Schmutzler, 1999), the positive external economic injection to the small base local economy has multiplier effects in economic activity of the country such that the benefit of Ethiopia from this sector is not only significant but also substantial.

Table 13: Short-run dynamics between economic growth and air transport demand – STATA output

Variables	chi-square (χ^2) statistics	$Prob > chi2$
PAX ⟹ GDP	9.71	**0.0018****
GDP ⟹ PAX	3.07	0.2158
FRT ⟹ GDP	16.55	**0.0003****
GDP ⟹ FRT	1.29	0.5238

**** Represent significant p-values at 5% significance level

Since cointegration tests indicated a single cointegrating vector and gross domestic product statistically asserted as an endogenous variable of the model (see table 10), lnGDP could be explained by a linear combination of the explanatory variables. Figure 26 showed the short run effects of air transport demand on economic activities in the country. Accordingly, an increase of 1% in passenger demand associated with an increment of about 0.4% in the economic growth. Air freight demand has also a positive relationship with economic growth

in short-run. An increase of 1% in air freight traffic improves economic growth in the country with about 0.02%.

Specifically, the short run per passenger per year contribution of air passenger traffic to the economic growth of the country could be estimated to US$ 2,973. Concerning air freight contribution to the economy, one kilogram per kilometer per year effects of air cargo demand boosts the local economy with about US$ 5.9. Though these figures look inflated but they could perhaps be justifiable. In Ethiopia, both air passenger and air freight transport demands are dominated by international traffic which implies the passengers have long haul trip. For long haul trip, the fare per travelers are obviously higher and hence the airlines as a company and economic growth as a country would be better benefited. Moreover, all airlines which deliver air transport service in Ethiopia are a full-service carrier (FSC) (EAE, 2016) that charges higher fares. To sum-up, the international economic benefits from the international market have a multiplier effect, according to (Krugman, 1996; Schmutzler, 1999), on lower local economic base like Ethiopia. Hence the short run impacts of air transport sector to the economic growth of Ethiopia could be a reasonable contribution.

Figure 26: Results of short-run dynamics between air transport demand and economic growth – STATA output

```
Vector autoregression

Sample:  1982 - 2015                            No. of obs      =         34
Log likelihood =  35.28474                      AIC             = -1.546161
FPE            =   .012637                      HQIC            = -1.408373
Det(Sigma_ml)  =  .0073471                      SBIC            = -1.142125

Equation           Parms      RMSE     R-sq      chi2     P>chi2
------------------------------------------------------------------
lnGDP                  9      .09996   0.9734   1245.982   0.0000
------------------------------------------------------------------

------------------------------------------------------------------------------
       lnGDP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
lnGDP        |
       lnGDP |
         L1. |   .5756411   .1099612     5.23   0.000     .3601212     .791161
             |
       lnPAX |   .3959232   .0875922     4.52   0.000     .2242456    .5676007
       lnFRT |   .0188275   .0054511     3.45   0.001     .0081436    .0295114
       lnFDI |   .0108397   .0609169     0.18   0.859    -.1085553    .1302347
       lnMGN |  -.1657771   .0747176    -2.22   0.027    -.3122209   -.0193332
       lnOER |  -.0559196   .1220339    -0.46   0.647    -.2951017    .1832625
      lnEDUC |   .1451374   .0847644     1.71   0.087    -.0209977    .3112725
       Dummy |  -.4636703   .1206637    -3.84   0.000    -.7001669   -.2271737
       _cons |   5.455995   2.091881     2.61   0.009     1.355983    9.556007
------------------------------------------------------------------------------
```

The effects of air transport demand on economic growth have been more reasonable in long-run than short-run dynamic. Because it needs plausible time to transmit the impacts of air transportation demands into economic activities. Besides this, the effects of air passenger demand on economic growth outweigh the effects of air freight demand on economic growth. Table 14 illustrate the comparisons of these arguments with elasticities of respective variables. These elasticities are compiled from the estimation of a long run and short run dynamics stated earlier in this section. The values in parentheses represent the p-values of respective elasticities.

Table 14: Comparison of short-run and long-run results – compiled from STATA output

Explanatory factors	$\Delta lnGDP$	
	Short run	Long-run
$\Delta lnPAX$	0.4% (0.000)	0.77% (0.002)
$\Delta lnFRT$	0.018% (0.000)	0.62% (0.000)

Short run effects of air transport traffic on economic growth are the direct and immediate benefits. These are clear gains to the local community in terms of wage and other associated incomes of workers and companies subsequent spend in the area. But the long run effects are wider and have multiple perspectives. In addition to direct benefits, the long run benefits also include indirect effects due to the on-going flow of income that the airline's operation puts into the local economy. These effects could be important to a local economy in terms of employment, income and, for local government, taxation revenues. Long run effects of air transport traffic on economic growth involves stimulating the local economy through firms and individuals having air transport services in their business activities. From a local development perspective, it is often these types of firm that form the basis for economic growth because they are usually geographically mobile and represent a major growth sector. Additionally, air transport services may act to set in progress larger and longer term development process in a country and region. In the long run, air transport service development can lead to the crossing of important thresholds in terms of economies of scale, scope, and density of economic activities. An area can acquire a vital knowledge base that fosters local research and development and hence accelerate economic growth of the country. Therefore, the response of economic growth to change of air transport development in long run has been more reasonable than short-run dynamic.

Moreover, VEC Granger Causality/Block exogeneity Wald Test also applied in order to assess the direction of causality between economic growth and air transport demand. This technique involves checking whether an endogenous variable can be treated as exogenous by excluding the first difference term of the variable from the VECM equation. If a variable is correctly excluded from the model then it does not Granger causes the other variable. The null hypothesis of the test is a non-Granger causality of the variables. Rejection of null hypothesis is interpreted as evidence of variable Granger causing the other.

Table 15: Granger-Causality/block exogeneity Wild test – STATA output

Null hypothesis	Chi-square statistic	$Prob > chi2$
lnGDP does not Granger cause lnPAX	0.08548	0.958
lnPAX does not Granger cause lnGDP	7.65	**0.022****
lnGDP does not Granger cause lnFRT	0.20388	0.903
lnFRT does not Granger cause lnGDP	15.297	**0.000****

** Denotes rejection of null hypothesis at 5% significance level

Similar to the result of short run and long run causality tests, Granger causality test also revealed that there is uni-directional causality run from air transport demand (passenger and freight) to economic growth (GDP). As stated above, economic activities in the country are not strong enough to generate more air transport demand both in short run and log run situations.

Table 16 summarizes the direction of both long-run and short-run causal relationships of data series alongside Granger causality test. Granger causality results rejected the null hypotheses of (i) PAX does not Granger cause GDP and (ii) FRT does not Granger cause GDP as detailed in the previous section (Table 15). Thus, the results suggest that there is a causal direction running from air passenger traffic and from air freight volumes to economic growth. The significant chi-square statistics were obtained from the application of standard Wald tests and the results support the notion of a short-run uni-directional causal relationship run from air transport service improvement to economic growth. The results further confirm a long-run unidirectional causal relationship that runs from air passenger traffic and air freight volumes to GDP with three-year time lags.

Table 16: A summary of the causal relationships and direction of causality – STATA output

Causality directions	Long-run causality (ECT)	Short-run causality (Chi-square statistic)	Granger causality (Wald tests)
PAX ⟹ GDP	-0.2490108**	9.71**	7.65**
GDP ⟹ PAX	0.0139722	3.07	0.08548
FRT ⟹ GDP	-0.2490108**	16.55**	15.297**
GDP ⟹ FRT	-0.221329**	1.29	0.20388

** Denotes rejection of null hypothesis at 5% significance level

Generally, the causal relationship between economic growth and air transport demand has been analyzed by considering three different features: short-run, long-run and Granger causality test. The outcomes of these three aspects are similar by providing empirical evidence for unidirectional causality run from air transport development to economic growth. The unidirectional causality relationship from air transport to economic growth implies that air transport expansion would be support and stimulates economic growth. Additionally, this finding implies that a change in the rate of air transport does cause a significant change in economic growth with the specified confidence level. However, this result doesn't imply that economic growth has no impact on air transport growth. It just shows that economic growth at any point is not a reliable predictor of the amount of economic activity in the air transport sector at a later point in time.

7.5. Diagnostic Tests

To check the adequacy of VECM/VAR modeling frameworks, the necessary diagnostic tests were conducted for residual autocorrelation, non-normality, and heteroscedasticity. The stability conditions of the estimates and the specification error test for omitted variables have been also checked by applying eigenvalue condition (refer Appendix 11) and Ramsey RESET test (refer Appendix 12) respectively. all the eigenvalues lie inside the unit circle and satisfy the stability condition of the estimated model. Ramsey RESET test also fail to reject the null hypothesis and hence confirms that there is no problem of omitted variables in the construction of the model.

Table 17: Diagnostic tests for estimated VECM – STATA output

Test	Autocorrelation	Non-normality	Heteroscedasticity
Test Statistics	18.61	9.81	5.73
Distribution	$\chi^2(36)$	$\chi^2(12)$	$\chi^2(5)$
P-value	0.993	0.63	0.33

In order to check the problematic effect of autocorrelation/serial correlation, the test was performed using Langrage Multiplier method. Jarque-Bera based test was performed to detect the non-normality problem in the model framework. The violation of heteroscedasticity assumption was checked with Breusch- Pagan/Cook-Weisberg technique. In all three tests the null hypothesis is that the model is well specified, i.e., there is no autocorrelation/serial correlation, non-normality or heteroscedasticity in the residuals. As shown in Table 17 and appendix also, in all three tests the null hypothesis cannot be rejected implying that the model assumption holds and that the VECM properly represent the underlying data generating process.

7.6. Impulse Response Function

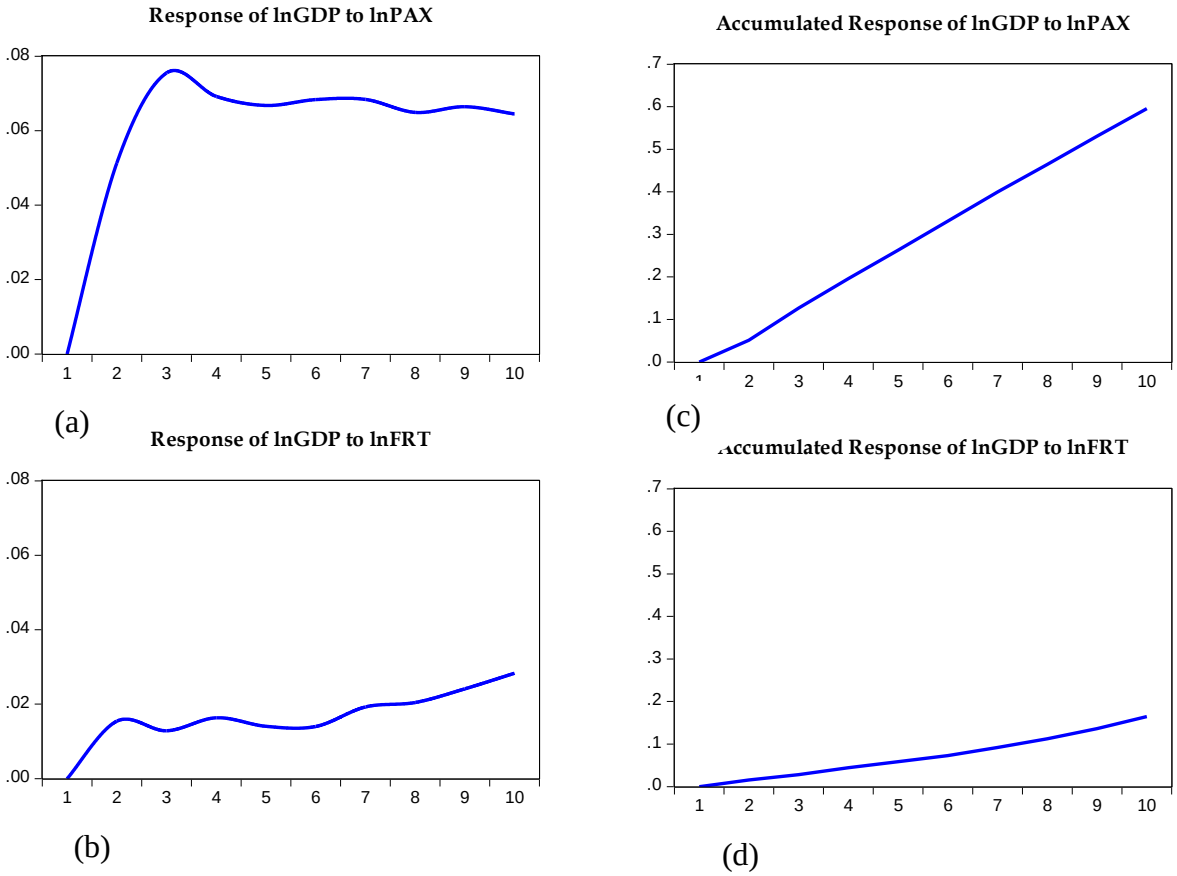
The results of the descriptive and econometric analysis in the previous sections confirm that there is a positive relationship between air transport demand (passenger & freight) and economic growth both in short run and long run interactions. Now, it is interesting to identify the intensity with which lnGDP reacts to effect of lnPAX and lnFRT changes, ceteris paribus.

To identify the time-span of the impact of air transport demand on economic growth the impulse response function (IRF) analysis has been employed. Because this technique helps to know the response of one variable to an impulse in another variable in a system that involves a number of further variables as well. We would study this type of relationships by tracing out the effect of an exogenous shock or innovation in one of the variables on some or all of the other variables.

Once lnPAX and lnFRT are treated as regressors, a shock on these variables do not only affect themselves but also transmitted to lnGDP through the VECM dynamic structures. Shocks could be defined as one standard deviation in the innovations. IRF tracks the effect of shocks on each innovation over endogenous variables in the system. If innovations are

simultaneously uncorrelated, IRF can be directly interpreted. In order to make inference about IRF, it is common to apply the Cholesky decomposition method. Because this method makes the innovations become orthogonal (uncorrelated). Figure 27 presents IRF analysis for a ten-period-horizon in a year by year fashion (see Fig. 27(a) and 27(b)) and also accumulated responses (see Fig. 27(c) and (d)).

Figure 27: Response to Cholesky one standard deviation innovations – STATA output



The finding of IRF analysis indicates that lnGDP responds to effects of lnPAX with maximum impact taking place after three years (t+3). The find also indicates that the level of the effect is permanent on the GDP as it almost remains the same from the third to the tenth year of analysis. Figure 27(c) shows the long run impact of lnPAX on lnGDP. The analysis results reveal that after ten years, positive changes in air passenger demand causes an increase in GDP by approximately 60%. This percentage change of economic growth caused by air passenger demand change over ten-year range seems significant figure. But comparing the trend of annual GDP of the country and 2025 vision of Ethiopian Airlines, the result of IRF could be reasonable. As stated in the previous sections the GDP of Ethiopia was about US$61 billion (World Bank, 2016) and air passenger traffic was close to 8 million

passengers (EAE, 2016) in 2015 fiscal year. Additionally, Based on ATAG's estimates stated in (Wyanie A. Bright & Habte, 2015), the total impacts (direct, indirect, induced and catalytic) estimated for the air transport traffic on Ethiopian economy was valued at $32 billion which is near to half the GDP of the country (the detail breakdown presented in section 3.1). According to 2025 visions of Ethiopian Airlines and Ethiopian Airports Enterprise which indicated in Growth and Transformation Plan (GTP) of the country (MoFED, 2010), they have the plan to become the most competitive and leading aviation group in Africa. To compliment these visions, Ethiopian government also started working on an eight-year project to build a US$4 billion, four-runway airport on the outskirts of Addis Ababa that will be able to handle 120 million passengers a year. By distilling the raised points and practical movements in the country, the IRF forecast results seems more reasonable. Thus, the impact of air passenger demand expansion on economic growth is substantial. The empirical results show that the long-term positive effect of the development of the aviation sector on the development of the economy, stressing the importance of the air passenger demand.

However, the response of economic growth to a sudden increase in air freights demand is in a slower and more moderated way. This may be because of the volumes of all domestic and most international cargo transports in this country have been done by other means of transport. Figure 27 (b) shows that lnGDP reacts positively to changes of lnFRT. The maximum impact occurs after two years (t + 2) and the level of the effect is permanent as it remains the same from second year to the tenth year though there is a slight increase from seventh to the tenth year. Figure 27 (d) reveals a cumulative response of lnGDP to change of lnFRT. Accordingly, after ten years, a positive effect (change) of air freight demand causes an increase in economic growth by approximately 11%. The increasing trends of cut flowers, fruits and vegetables and meat exports may compliment the forecasting results of this impulse response function.

7.7. Discussion of the Results

The analysis of time series data set needs to commence by checking the stationarity of individual variables and combined linearity (cointegration) of all variables for VECM/VAR modeling framework. Because conducting regression with nonstationary or non-cointegrated variables leads to spurious regression output. Interpretations of spurious regressions are not only misleading but also nullify recommendation of the finding.

The results of ADF tests showed that lnGDP, lnPAX, lnFRT, lnMGN, lnEDUC, lnFDI, and lnOER are first order integrated variables I(1). These variables are not only first differenced stationary but also linearly combined, cointegrated I(0). Cointegrated variables have a long-term relationship keeping them on a similar path. The whole analysis in this chapter involved these variables. But lnPOPN and lnBoP were neither stationary nor cointegrated so that they have been excluded from further analysis in this study. Because if the first differencing doesn't eliminate non-stationarity from these variables, still they are suffering from serial correlation problem. Obviously, running a regression with variables which did not rid of serial correlation problem leads to spurious.

To estimate the long run relationship between air transport demand (both passenger and freight) and economic growth, Johansen maximum likelihood method was employed. Accordingly, trace and maximum eigenvalues settle the existence of one cointegrating relation between the variables. The test also confirms that lnGDP is an endogenous variable such that gross domestic product could be represented as linear combination of other exogenous variables.

The outcome of VECM showed that the coefficient of speed of adjustment between economic growth and air transport dynamics was about $(ECT = -0.25)$. It's negative coefficient which lies between 0 and -1 and statistically significant at 5% significance level. This figure indicates the speed of short run disequilibrium per year towards long run equilibrium. The results of VECM analysis also reveals that there are long run causalities which runs from air transport demand (passenger and freight) to economic growth and significant with three-year time lags. The three-year time lag appears plausible given that air passenger traffic demand (especially international passengers) needs time to filter through to economic growth. Air freight revenues (for airports and airlines), personal incomes of employees from the sector and all other related impacts need a plausible time to magnify their impacts in economic activity.

The regression of results of VECM showed that a 1% increase in air passenger traffic demand, in the long run, will on average leads to a proportionately lower growth in economic growth about 0.77%. In terms of monetary values, suppose in the last ten years, per passenger per year contribution of air passenger demand to GDP of Ethiopia has been, on average, estimated to US$ 5,286. This figure includes not only represent direct impacts but also includes indirect, induced and catalytic impacts of air passenger demand on economic

growth of the country. This figure looks inflated compared to other similar studies like that of Italy which was about US$ 2,577 per passenger per year. But that does not mean this change could not be reasonable. Air passenger traffic in Ethiopia has been dominated with international passengers (about 88%) who make long haul trip so that per passenger fare has been higher. All airlines deliver air transport service in Ethiopia are full-service carriers (FSC) who charges higher fare than the low-cost carrier (LCC) airlines. Though the magnitude is different, the impacts of air freight traffic on the expansion of local economy and reasoning of these monetary contributions to economic growth in Ethiopia are also similar with that of air passenger contributions.

The long run impacts of air transport expansion on economic growth of Ethiopia would be consistent with the concepts of new economic geography, base multiplier. The air transport demand in Ethiopia is based on international markets (the world and regional advantages) which eventually raises and gradually benefits the expansion of the local economy. However, the local economy is at the lower base and not strong enough to reinforce itself to generate more air transport demands. According to the concepts of new economic geography, base multiplier model, the benefits from international markets have multiplier effects on local economies which have a lower economy base like Ethiopia. This implies that air transport expansion has a multiplier effect on local economies in Ethiopia which empirically evidenced above. Another concept of multiplier model is that small quantitative changes in the underlying factors that drive location advantage will have significant effects on the long run economic outputs. The location of Ethiopia, the horn of Africa, has strategic air transport route by connecting Middle East and South East Asian countries with sub-Sahara African countries. The long run benefits of Ethiopian economy from this air transport traffic advantage is significant enough per passenger and per ton-Km each year as evidenced by the above empirical analysis. This has also multiplier effects on narrow base local economies. Indirectly this advantage also infers that the local economy is still not considered as a centrifugal point for air transport demand in the country.

Like long-run causality, the outcomes of short-run dynamics and Granger causality tests have been also showed that there is a uni-directional causality running from air transport demand (both passenger and freight) to economic growth. Similar to long run analysis, the short-run growth of air transport traffic causes the growth of the local economy, and local economic activities are not strong enough to enhance air transport demand of the country. In the short run, an increase of 1% in passenger demand causes an increment of about 0.4%

in the economic growth and 1% change in air freight traffic improves economic growth in the country with about 0.02%. Specifically, per passenger per year contribution of air passenger traffic to the local economic growth of the country could be estimated to US$ 2,973 and one kilogram per kilometer per year effects of air cargo demand enhances local economy with about US$ 5.9. As explained in justifications of long run results, the base for air transport demand in Ethiopia is international customers (the world and regional advantages) which are an incentive and inspiration for the local economy. The base of the local economy is too small to cause and reinforce air transport demand. But as suggested by (Krugman, 1996; Schmutzler, 1999), the positive external economic injection to the small base local economy has multiplier impacts in economic activity of the country such that the benefit of Ethiopia from air transport development is not only significant but also substantial.

Though the causal directions between air transport demand economic growth are similar both in long run and short run analysis, the long run impacts outweigh the short run contribution (refer Table 14). The short-run impacts of air transport traffic on economic growth are the direct and immediate benefits. These are clear gains to the local community in terms of wage and other associated incomes of workers and companies subsequent spend in the area. However, the long-run impacts are broader and have multiple aspects. In the long run, the benefits are not only direct and immediate but also indirect, induced and catalytic benefits that injected into the local economy. In the long run, air transport service development can lead to the crossing of important thresholds in terms of economies of scale, scope, and density of economic activities. An area can acquire a vital knowledge base that fosters local research and development and hence accelerate economic growth of the country. Therefore, the response of economic growth to change of air transport development in long run has been more reasonable than short-run dynamic. Moreover, the effects of air passenger demand on economic growth have been more reasonable than the effects of air freight demand on economic growth. Because of the volumes of all domestic and most international cargo transports in this country have been done by other means of transport.

The impulse response function also confirms that air passenger demand is a better predictor of economic growth than air freight volume does. Economic growth has been also responded strongly and persistently to the effects of air passenger traffic than the effects of air freight demand (see Figure 27). The positive changes like bilateral agreements and open skies policy have stimulation effects on the air passenger demand by allowing more effective feed to the long-haul stage of transatlantic services through the concentration of traffic at

international hub airports, it increases the geographical market being serviced and also generates economies of scope and scale. The larger physical market demand, combined usually with the improved quality of the product that accompanies more integrated services, such as code sharing, interchangeable frequent flier programs, common lounges, and through baggage checking, raise the demand for international air services which triggers the economic growth of the nation.

The analysis results obtained from this study are consistent with the works of (J. G. Brida, Bukstein, & Zapata, 2016; Coto, Agüeros, Casares, & Pesquera, 2013; Saheed & Iluno, 2015) who found an evidence for positive influences of air transport development and airline consortia to the local economic growth of the country. Specifically, (J. G. Brida, Bukstein, & Zapata, 2016), investigated the dynamic relationship between air transport and economic growth in Italy for the period 1971-2012. They conclude that there was unidirectional causality running from air transport to economic growth and according to their estimation, an increase in 1% in air transport is associated with an increment of 0.17% in economic growth. Additionally, (Coto et al., 2013) also conduct their studies on the impacts of logistics on the world economic growth (2007-2012). They conclude that a 1% increase in the performance of logistics index and the most important sub-indexes can generate an increase of world economic growth ranging between 0.011% and 0.034%. Similarly, (Saheed & Iluno) analyzed the relationship between air transportation development and economic growth in Nigeria over the period 1981-2012. Their results support that air transport expansion Granger cause gross domestic product but the gross domestic product does not granger cause air transport. However, the result of their estimation seems unrealistic (an increase of 1 percent in air transport expansion will lead to 4557.89 per cent increase in GDP).

However, the finding of this study is not consistent with findings of (Baker et al., 2015; Y.-H. Chang & Y.-W. Chang, 2009; Hu, Xiao, Deng, Xiao, & Wang, 2015) who found bi-directional causality between economic growth and air transport expansion. Specifically, (Baker et al., 2015) provided an empirical evidence on the relationship between regional aviation and economic growth in Australia using cointegration and causality analysis techniques. They used the time series dataset covers 28 financial years ranging from 1986 to 2013. Thier result concludes that there is short and long run bidirectional causalities between regional aviation and economic growth. The study of (Y. H. Chang & Y. W. Chang, 2009) was conducted in Taiwan on the association between air cargo expansion and

economic growth over the period 1974-2006. The results of their analysis indicated that there were long run bidirectional relationship between air cargo expansion and economic growth in Taiwan. Similarly, (Hu et al., 2015) conducted their studies in China on the relationship between domestic air passenger traffic and economic growth for the period of 2006 to 2012. In their study, a long-run and strong bidirectional Granger causal relationship were found between these two series. Specifically, 1% increase in the air passenger traffic is found to lead to an increase of 0.943% in the real gross domestic product (GDP).

The finding of this paper is also not similar to the analysis outcomes of (Chi & Baek 2013; Fernandes & Pacheco 2010; Hakim & Merkert, 2016; Marazzo et al., 2010) who found unidirectional causality from economic growth to air transport expansion. Chi and Baek (2015) studied the dynamic relationship between air transport demand and economic growth in the United States. Thier finding suggested that there is unidirectional causality which runs from economic development to air transport expansion both in short run and long run. The result suggests that 1% increase in economic growth leads to 1.37% change in air transport demand. The investigation of (Fernandes & Pacheco 2010; Marazzo et al., 2010) was on the relationship between air transport demand and economic growth in Brazil. Thier causality analysis indicated that there is long-run unidirectional relationship running from economic growth to air transport demand. Empirically, 1% increase of economic growth leads to an increment of about 0.76% in air transport demand. Similarly, (Hakim & Merkert, 2016) investigated the causal relationship between air transport and economic growth in South Asian countries. They used a panel data over a period of 42 years (1973–2014) and employed Johansen cointegration test methods, Granger long-run and Wald short-run causality tests. The results of their study confirm a long-run unidirectional Granger causality which runs from GDP to air passenger traffic and also to air freight volumes. Their finding suggests that a 1% increase in GDP will on average lead to a proportionately larger growth in passenger numbers of 1.2%.

Generally, air transport demand and economic growth in Ethiopia have strong interaction links. Mostly, the analysis results of this study would have been consistent with the findings of case studies from developing nations.

8. Conclusions and Recommendations

This chapter would summarize the main findings of this thesis with their respective implications. Recalling some limitations of this study and depending on the results of the paper, potential research areas which need further investigation would be also recommended for future researchers.

8.1. Conclusions

The general aim of this study is to identify the long run and short run causal relationships between air transport development (passenger and freight) and Ethiopian economy. This paper also aimed to establish the empirical evidence on short-run dynamics and long-run relationships that have been experienced and expected to exist between Ethiopian economy and air transport demands. To accomplish these objectives of the paper, suitable techniques of estimations (VECM, VAR, Granger causality test, and descriptive analysis) were employed for the data set 1981 to 2015.

The empirical evidence obtained suggests the existence of cointegration relationship between air transport demand and economic growth indicating a long run relationship between them. Moreover, the outcome of causality tests (long run, short run, and Granger Causality) showed that there is unidirectional causality going in a positive direction from air transport development (passenger and freight) to economic growth. These results indicate that air transport development is an incentive and inducements for economic growth in Ethiopia. This finding is consistent with the works of (Beyzatlar, Karacal, & Yetkiner, 2014) who found statistically significant causalities running from transportation (in general, not only for air transport) to the economic growth of some EU countries. Specifically, the findings of these authors suggest that there would be unidirectional causality running from air transport development to economic growth for low and middle-income countries, but for high-income countries, there would be bi-directional causality or unidirectional running from economic development to air transport growth. Ethiopia is a low-income country where air transport expansion plays a crucial role in promoting economic growth.

The study shows that positive effects like bilateral agreements and open sky policy implementation on air transport demand (passenger and freight) cause a significant increase in economic activities. But, according to the result, economic growth is more responsive towards the effects of air passenger demand than that of freight demand. The performance

of economic growth in Ethiopia can be improved by strategically harnessing the contribution of air transport industry. The domestic air transport service constitutes low share (about 12%) of total transport demand in the country. In order to have more decentralized economic growth, it seems to be necessary to increase domestic air transport traffic through expanding and upgrading domestic airports. Besides this, the routes of remote airports need to get systematic and optimal subsidies to stimulate economic activities in these regions. At the national level, the provision of formal incentives to the air transport sector could motivate and increase its macroeconomic contributions to economic growth. The competent and comprehensive air transport development is likely to stimulate further economic growth in Ethiopia.

The presence of positive unidirectional causality running from air transport demand to economic growth could be attributed to different effects of air transport sector. Transportation of air passengers and freight demands could be the direct and immediate effects. The forward and backward linkages of the air transport sector with other industries could multiply and increase the benefits of economic interactions so that economic growth has been enhanced. Ethiopian airlines, fully state owned and flag carrier has been the dominant operator in air transport demand of Ethiopia which could be another incentive for air transport contribution to economic growth. The empirical evidence had been failed to show that the local economy could make a difference in air transport demand in Ethiopia but indicates that the development air transport sector has multiplier effects on the local economy.

The empirical findings of the paper have some policy and management implications. These implications may be important for government, airlines, airports, logistic companies, freight forwarders, policy makers, transport planners and Ethiopian civil aviation authority. First, the outcome of the study suggests that the long run benefits of Ethiopian economy would be enhanced by improving the performance of air transport sector. These benefits could be more comprehensive through making a solid connection within airlines and between businesses and access international capital markets. Second, the capital and infrastructure constraints of air transport sector should be minimized in order to boost the nation's competitiveness. This could be lead to an increase in domestic and foreign investments so that economies of scale would be promoted. Because the aviation industry is generally characterized by its need for large capital investment requirements and infrastructure projects are usually time intensive. Third, to improve and motivate the local economic activity, domestic air transport

services need to be supported and emphasized. This could be broadening the domestic base of air transport service where economic growth will enjoy the sustainable benefits. Finally, maintaining and upgrading the fertile grounds for international air transport traffic in Ethiopia through providing the conditions for better air transport service will have long run considerable effects on economic growth. Hence, the policymakers need to take into account that this sector is income elastic and has multiplier effects on economic activities.

8.2. Recommendations for Further Research

Based on the analysis and limitations of this paper, some important and related areas could be recommended for future further researches. In this study, the impacts of air transport development on economic growth of Ethiopia have been investigated from airlines aspects. The data sets considered for analysis also represents the effects of airlines contributions in economic growth. But the impacts of air transport demand on economic growth could include the contribution of airlines and airports together. The combined effects of airlines and airports on economic growth of the country will be an interesting area for future research. Another potential future research area derived from this paper is the relationship between air transport sector and other economic sectors, particular with tourism. Some researchers like (Duval, 2013) suggest that the growth of air transport sector is affecting the willingness to travel of higher yielding travelers so that the overall GDP contribution of tourism may be diminished and these may have implications on the contribution of air transport sector to economic growth. Another issue related to this argument is about the sustainability of air transport contributions to economic growth of the country. The future researchers on this relationship may shape present developments without compromising future growth by analyzing the links between air transport expansion, economic growth, and sustainability. Finally, the empirical findings of this paper could be assessed and validated by using innovative methodological approaches and including alternative variables that represent air transport sector. In the validation process of these empirical results, the future researcher may also consider a possible nonlinear relationship between air transport development and economic growth.

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Appendixes

Appendix -1: Unrestricted Adjustment Coefficients (**alpha**): (Eviews output)

D(LNGDP)	-0.256960	0.018287	0.034129	-0.007059	-0.006511	-0.048706	-0.000805
D(LNMGN)	-0.029183	-0.090050	0.005493	-0.043776	-0.007186	-0.021177	0.008159
D(LNOER)	-0.051963	0.001315	-0.010595	0.000699	0.018678	0.001681	0.002865
D(LNPAX)	0.035128	0.015418	0.055816	0.049406	0.015119	-0.015507	0.005581
D(LNFRT)	0.146292	-0.044823	0.009562	0.032472	-0.007142	-0.009609	-0.011078
D(LNFDI)	0.195221	-0.175174	0.694854	-0.197088	0.252124	0.297946	0.017811
D(LNEDUC)	0.092225	0.005962	-0.056713	0.034024	-0.042802	-0.006839	0.013145

Appendix – 2: Vector error correction model (Stata output)

```
Vector error-correction model

Sample:  1984 - 2015                            No. of obs      =         32
                                                AIC             = -9.983404
Log likelihood =  248.7345                      HQIC            = -8.632134
Det(Sigma_ml)  =  7.14e-15                      SBIC            = -5.906826

Equation           Parms      RMSE     R-sq      chi2     P>chi2
------------------------------------------------------------------
D_lnGDP               14      .10104   0.7123   44.57588   0.0000
D_lnFRT               14     .140765   0.6820   38.59977   0.0004
D_lnPAX               14     .150021   0.5563   22.56939   0.0676
D_lnMGN               14     .141411   0.5737   24.22379   0.0430
D_lnOER               14     .062109   0.8900   145.5911   0.0000
D_Dummy               14     .118685   0.7464   52.99176   0.0000
------------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
D_lnGDP      |
        _ce1 |
         L1. |  -.2490108   .0702155    -3.55   0.000    -.3866307   -.1113908
             |
       lnGDP |
         LD. |   .0858019    .176436     0.49   0.627    -.2600064    .4316102
        L2D. |  -.2637679    .166394    -1.59   0.113    -.5898941    .0623583
             |
       lnFRT |
         LD. |  -.0031786   .1268056    -0.03   0.980     -.251713    .2453559
        L2D. |   .6244278   .1573318     3.97   0.000     .3160631    .9327925
             |
       lnPAX |
         LD. |   .4994457    .175516     2.85   0.004     .1554406    .8434508
        L2D. |   .7695651   .2470023     3.12   0.002     .2854495    1.253681
             |
       lnMGN |
         LD. |  -.1835649   .1287828    -1.43   0.154    -.4359745    .0688448
        L2D. |   .4969275   .1307039     3.80   0.000     .2407526    .7531024
             |
       lnOER |
         LD. |   .1429658   .3347416     0.43   0.669    -.5131158    .7990474
        L2D. |  -.7071799   .2820172    -2.51   0.012    -1.259923   -.1544365
             |
       Dummy |
         LD. |  -.2778048   .1586447    -1.75   0.080    -.5887427    .0331332
        L2D. |   -.166336   .2255644    -0.74   0.461    -.6084341    .2757621
             |
       _cons |  -.0944074   .0497595    -1.90   0.058    -.1919343    .0031194
-------------+----------------------------------------------------------------
```

Appendix – 3: Granger-Causality/block exogeneity Wild test

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
lnGDP	lnPAX	7.65	2	0.022
lnGDP	lnFRT	.20388	2	0.903
lnGDP	lnMGN	1.5444	2	0.462
lnGDP	lnOER	1.8627	2	0.394
lnGDP	ALL	13.033	8	0.111
lnPAX	lnGDP	.08548	2	0.958
lnPAX	lnFRT	1.4276	2	0.490
lnPAX	lnMGN	.27532	2	0.871
lnPAX	lnOER	4.6199	2	0.099
lnPAX	ALL	7.2178	8	0.513
lnFRT	lnGDP	15.297	2	0.000
lnFRT	lnPAX	4.6688	2	0.097
lnFRT	lnMGN	5.7389	2	0.057
lnFRT	lnOER	21.008	2	0.000
lnFRT	ALL	35.697	8	0.000
lnMGN	lnGDP	4.0472	2	0.132
lnMGN	lnPAX	10.742	2	0.005
lnMGN	lnFRT	15.323	2	0.000
lnMGN	lnOER	7.7026	2	0.021
lnMGN	ALL	56.093	8	0.000
lnOER	lnGDP	1.8992	2	0.387
lnOER	lnPAX	23.791	2	0.000
lnOER	lnFRT	15.938	2	0.000
lnOER	lnMGN	9.3801	2	0.009
lnOER	ALL	36.091	8	0.000

Appendix -4: Test results for autocorrelation/serial correlation

Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	38.8741	36	0.34154
2	18.6098	36	0.99266
3	48.4383	36	0.08058
4	36.7116	36	0.43571

H0: no autocorrelation at lag order

Appendix – 5: Result of normally distributed disturbance tests

Jarque-Bera test

Equation	chi2	df	Prob > chi2
D_lnGDP	0.332	2	0.84685
D_lnFRT	2.351	2	0.30864
D_lnPAX	0.030	2	0.98532
D_lnMGN	0.458	2	0.79525
D_lnOER	5.654	2	0.05918
D_Dummy	0.979	2	0.61287
ALL	9.805	12	0.63306

Appendix – 6: Results of Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: lnOER lnMGN lnPAX lnFRT Dummy

         chi2(5)      =     5.73
         Prob > chi2  =   0.3335
```

Appendix - 7: Long-run monetary GDP contributions per PAX per year (2006-2015) in Ethiopia

Year	GDP	GDP 0.77% growth	PAX	PAX 1% growth	(GDP/PAX) Growth
2006	15280861835	117,662,636	2287544	22,875	5143.6229
2007	19707616773	151,748,649	2832762	28,328	5356.9149
2008	27066912635	208,415,227	3325618	33,256	6266.9623
2009	32437389116	249,767,896	3551972	35,520	7031.8093
2010	29933790334	230,490,186	4041365	40,414	5703.2756
2011	31952763089	246,036,276	5081750	50,818	4841.5659
2012	43310721414	333,492,555	5653555	56,536	5898.8115
2013	47648211133	366,891,226	6562023	65,620	5591.1298
2014	55612228234	428,214,157	6931044	69,310	6178.2057
2015	61537143095	473,836,002	7731262	77,313	6128.8313
				Average	**US$ 5,286**

Appendix - 8: Air freight Kg per Km per year contribution to economic growth in long run (2010-2015)

Year	FRT (Kg)	FRT 1 % Growth	GDP	GDP 0.6% Growth	GDP/FRT Growth
2006	47553276	475533	15280861835	91685171	193
2007	58892880.21	588929	19707616773	118245701	201
2008	80564654.19	805647	27066912635	162401476	202
2009	74469457.7	744695	32437389116	194624335	261
2010	114866491.9	1148665	29933790334	179602742	156
2011	134383906	1343839	31952763089	191716579	143
2012	144362653.2	1443627	43310721414	259864328	180
2013	133725739	1337257	47648211133	285889267	214
2014	175635580	1756356	55612228234	333673369	190
2015	202946280.6	2029463	61537143095	369222859	182
				Average	**US$ 174**

Appendix - 9: Short run contribution of air passenger demand (per PAX per year) to economic growth (2010-2015), yearly average

Year	GDP	GDP 0.4% growth	PAX	PAX 1% growth	(GDP/PAX) Growth
2010	29933790334	119,735,161	4041365	40,414	2962.7406
2011	31952763089	127,811,052	5081750	50,818	2515.0992
2012	43310721414	173,242,886	5653555	56,536	3064.3177
2013	47648211133	190,592,845	6562023	65,620	2904.483
2014	55612228234	222,448,913	6931044	69,310	3209.4575
2015	61537143095	246,148,572	7731262	77,313	3183.8084
				Average	**US$ 2,973**

Appendix - 10: Short run contribution of air freight demand (one Kg per Km per year) to economic growth (2010-2015), yearly average

Year	FRT(Kg)	FRT 1 % Growth	GDP	GDP 0.02% Growth	GDP/FRT Growth
2010	114866491.9	1148665	29933790334	5986758	5.2
2011	134383906	1343839	31952763089	6390553	4.8
2012	144362653.2	1443627	43310721414	8662144	6.0
2013	133725739	1337257	47648211133	9529642	7.1
2014	175635580	1756356	55612228234	11122446	6.3
2015	202946280.6	2029463	61537143095	12307429	6.1
				Average	**US$ 5.9**

Appendix - 11: Result of stability condition for VAR estimates

Eigenvalue stability condition

Eigenvalue	Modulus
.5756411	.575641

All the eigenvalues lie inside the unit circle.
VAR satisfies stability condition.

Appendix - 12: Result of Ramsey regression specific-error test for omitted variables

```
Ramsey RESET test using powers of the fitted values of GDP
       Ho:  model has no omitted variables
                  F(3, 24) =      1.96
                  Prob > F =      0.1466
```