



Master's degree thesis

LOG950 Logistics

**Determinants of Demand for Domestic Air transport
Services in Norway**

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Preface

This thesis was prepared as part of the fulfillment of Master of Science degree in logistics at Molde University College, Norway. The paper assesses factors that determine demand for domestic air transport demand in Norway using time series data. Aviation in general and aviation economics in particular is becoming a fascinating area of research. It is even more interesting when econometrics is applied to it. I have developed passion toward transport demand during my undergraduate study. The fact that existing research output is still scanty further motivated me to choose this thematic area.

The research process was difficult. Finding the data over long period of time was challenging. Diagnostic analysis of data and the process of selecting appropriate model was also another hurdle. Despite all these facts utmost effort was made to produce quality report.

The paper is organized into five chapters. The first one discusses background to the study and states the problems to be investigated. The second chapter deals with theoretical framework. Data and methods employed are treated in chapter three followed by estimation results and discussions in chapter four. The conclusive remarks is made in chapter five.

The thesis has been conducted under the supervision of Mr Tassew Dufera to whom I would like to extend deepest gratitude for guidance, and encouragement both as supervisor and as a friend. The Government of Norway is highly appreciated for providing financial support for my study. Throughout the process the support of Ms. Ragnhild Brakstad, International/Quota program coordinator has been unwavering. I would like to say “Tusen takk” –thousand thanks for your counsel and guidance which are beyond expression. I am always grateful to my families (My dad-Tura, My mam Like, My sisters Bunguli, Warknesh, Hirphe, Bayise and Damitu, my brother Shallama) and my special friends, Hika, the two Messays , Andy and others who has been with me with their love, support and prayers.

Above all, I am thankful to God, who is caring and loving me despite of all my weakness.

Motuma Tura Giraba

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Summary

Demand for air transport has been of great interest concern for government policy makers as well as airline operators. However, the study of air transport demand in Norway is scanty. This study is therefore, initiated to fill this gap in knowledge. The central objective the study is to investigate factors affecting domestic air transport demand in Norway.

It is hypothesized that demand for air transport is affected by its own price, price of substitute mode of transport, income and other external factors. The study is aggregate in nature. It takes the country as whole as a unit of analysis. The data utilized are all time series. All necessary statistical tests were made including stationarity and co-integration and found that all variables are integrated of order 1. Autoregressive regressive distributed lag (ARDL) is employed as a method of analysis.

It is found that the variables are co-integrated. In other words, they have long run relationship. The estimation result shows that income and price of substitute affects demand positively while own price affects it negatively. The responsiveness of air transport demand to both prices are found to be less than unity both in the long run and short run though it is higher in the long run. The elasticity of demand to income is higher than unity in both time horizons. This shows that demand relatively elastic with respect to demand and inelastic with respect to price. Demand for air transport in Norway found to be influenced by external actors such 9/11 terrorist attack. It is discovered that 9/11 attack reduced domestic demand significantly at least for short run.

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1.0 Introduction

1.1 Background of the Study

The demand for air transport is of great interest to both business managers and government policy makers. Information about demand is helpful not only for strategic decision, but also for day to day operation of airlines. Capacity management, pricing decisions, entry strategies all depend on demand information. Government policy makers are interested in demand for air transport to control and regulate the market and expand necessary infrastructure.

Air transport is the major mode of transport for passenger in the world when it comes to international travel. Its role in freight transport is also increasing from time to time due to emergence of just in time production philosophy. The role of air transport in domestic travel varies from country to country. In countries like Norway it plays an indispensable role in economic and social activities of the country. This is mainly attributed to physical, geographical and demographic feature of the country. Norway is characterized by long coastal lines, mountainous terrain, and long snowy winters which hinder the development and use of surface based transport. The sparse population is also an impediment for road and rail transport development(Lian, 2010).

Historically the modern air transports in Norway started in the 1960s. It is believed that the industrial development and oil discovery boosted the development of the sector. Following worldwide air transport deregulation, Norway has deregulated its aviation industry starting from 1994. The 1997 deregulation was a landmark in Norwegian aviation industry. It has allowed new firms to enter into the market that come up with low price and better quality service that can increase demand(Muñoz, 2012)

Currently, the Norwegian air transportation system is supported by 52 airports with scheduled flights and dozens of small airports located in different parts of the country. Most of these airports are operated by AVINOR, which is a state owned profit making enterprises. It accounts for 98% of domestic and 86% of international passenger movements. Domestic travel is mainly provided by three airlines. These are Scandinavian Airlines (SAS), Norwegian Air Shuttle and Wordroe.

The number of passengers transported domestically is estimated to be 10 million in 2017. The trend shows a variable degree of growth. Based on data from Statistics Norway (2018) it can be seen that air transport demand measured in terms of number of passengers transported has been increasing rate up until 2000. However, the rate of growth slowed down in the last decade. It has not shown any significant growth since 2010.

This poses a question as to what explains this variation in demand for air transport. It calls for research to investigate factors that facilitates/retards the growth of air travel demand which this paper is aimed at.

1.2 Problem statement

As it is mentioned above, information regarding air travel demand is essential for both public policy makers and airline operators. Government formulates policies and strategies and operators make decisions based on demand forecasts. In order to forecast air travel demand, factors that influence should be identified and their impact need to be quantified. This requires depth study on the determinants of air travel demand.

There are studies conducted in this manner, but they are country specific or subject specific. The literature on demand for air transport in Norway is however scanty. As to the writer's knowledge, there is no study that has made comprehensive treatment of air travel demand determinants except Fridström and Thune-Larsen (1989) which is in fact too old to explain current developments. The study used a gravity model to estimate the parameter of interest which has its own limitation. The model is static in nature. Aviation industry however is characterized by a high degree of dynamism. Moreover, variables like fare in other alternative routes were not included in the model. Study by [Yusuyin & Sun \(2012\)](#) mainly focused on the impact of distance to airport, and is limited in its geographical coverage.

This study is therefore initiated to fill these gaps. It is going to address questions like

- What factors affect the demand for air travel in both short run and long run?
- What the elasticity of price and income elasticity of air travel demand?
- Is there relation between price of another mode of transport and air travel demand?
- How is it going to be after say five years?

1.3 Objective of the study

The main objective of this study to investigate factors that could affect demand for domestic air transport services in Norway. The study will estimate the magnitude of the impacts of factors such as income and price. In effect, the income and price elasticity of air travel demand will be estimated. An attempt will be made to forecast air transport demand.

1.4 Significance of the Study

The study contributes a lot to both theory and practice. It adds value to existing literature on air transport demand and serve as a resource for future research. Its practical significance is also unquestionable. Airline operators, Airport managers, transport policy makers will find this research useful in their undertakings.

1.5 Scope and limitation of the study

The study focuses on domestic passenger air transport services in Norway. This means passenger movement to and from Norway is not covered by this study. It is also aggregate in nature. It does not investigate the inter-cities or inter-air ports passenger movements.

It used aggregate data spanning from 1979-2017 which covers forty years of data. Thus, one can see limitation from sample size. Another challenge was lack of price data. Perhaps the most important challenge was inconsistency of data from Statistics Norway and Transport Economics Institute with regard to passenger-kilometer for some data points. Since. Another problem is was data was available in round to nearest number which rises to same values from year to year. Nevertheless, utmost efforts have been made to maintain the quality of the research.

1.6 Organization of this paper

The paper is organized into five chapters. As shows above the first chapter deals with introduction in which background and rationales for study among others are presented. Theoretical and empirical literatures were reviewed and presented in chapter two. This is followed by methodological approach which is well treated in chapter three. In this chapter

source and nature of data, estimation procedures are discussed. Chapter four deals with presentation and discussion of estimation results. Here results were interpreted inline with economic theory and previous research. Conclusive remarks are made at the end chapter. The report also includes list of references, annex and appendices. In annex parts some methodological rigors which are not implemented in the study are annexed for comparison purpose are presented. Appendices includes some long graphs and tables which not critical to put in the main part of the study

2.0 Literature Review

2.1 Theoretical Framework

2.1.1 The Notion of Transport demand

Demand for a good or service generally shows the quantity that consumers are willing and able to buy. Transport service is demanded not for its own sake, but as a means to fulfil the demand of goods and services at a place of destination. Air travel demand is not an exception to this. Consequently, air travel demand is generally considered as a derived demand. As a demand for goods and services increases, so is the demand for transport. Peoples travel to satisfy their need for health, leisure, work at particular location (O'Connor, 1995).

Air travel demand has also many other peculiarities such as cyclicality, peaking and perishability. The demand for air transport is characterized by a high degree of fluctuation in time. It goes with economic business cycle. Peaking is another major characteristic of air-transport demand. The most common form of peaking is seasonality, where demand increases during the summer months and holy days and then declines during the winter months. This is mainly because the weather is more favorable, and individuals have more time off during summer. Thirdly demand for air transportation is perishable. Any unsold seat cannot be kept as inventory for sale on another day. It is lost as revenue-generating products (Vasigh, Fleming, & Tacker, 2008)

2.1.2 The motivation for air travel

Generally, air travel is either for business or for leisure purpose. Business travel involves a journey necessitated by one's employment and paid for by the employer. The leisure market contains two broad categories, holiday travel and travel whose primary purpose is visiting friends or relatives (often referred to as VFR). Leisure travelers, unlike those travelling on business, invariably pay their own fares out of their own pockets. There is, finally, a small proportion of air passengers who do not fit into the business, holiday or VFR categories. These include students travelling to or from their place of study, those travelling for medical reasons, and migrants moving to another country. They may be grouped together as a miscellaneous or 'other' category(Doganis, 2002).

2.1.3 Factors influencing Air Travel demand

There are multiple factors that influence demand for air transport. It depends on a host social, economic and transport specific factors. Own price, the price of alternative modes of transport, consumer's income, taste or preference of the consumer are among the major determinants of demand. These factors are extensively discussed in most of air transport economics and management textbooks such as (Doganis, 2002; Holloway, 1997; O'Connor, 1995; Vasigh et al., 2008).

Price of Air transport service

Price is one of the most important factors that affect the air transport demand (Doganis, 2002; Vasigh et al., 2008). Price change has two effects. It changes the purchasing power of the consumers' income (income effect) and the relative expressiveness/cheapness of the service (substitution effect). Assuming air transport is normal good both effects make the demand of air transport to rise as the price falls. It is important to note that the price of air transport services embraces considerably more than the simple money cost paid out fares and other fees. It should also include time costs, waiting, insecurity and so on which are combined to form a generalized cost index (Button, 2010).

Price of related services

The demand for air transport service can also be influenced by the price of other modes of transport. Train, bus and cruise ship transport can substitute air transport in short hauls. Thus, when the price of the alternative mode of service change, say increase, travelers tend to substitute air transport for other modes and vice versa.

Communication technologies such as computer links, conference telephone calls and video telephone have emerged as an alternative to airline trips, particularly business travel. During economic downturn most businesses rely on facsimile machines, electronic mail, and video conferences in place of air travel. Tourist travel is likely least affected by these electronic techniques (O'Connor, 1995).

Air transport demand can also be affected by the price of complimentary product or services, which are usually used jointly with air transport. A typical example in this regard is hotels, rental cars and tourism related services. Since many leisure and business travelers have to stay in hotels while on their trip, the price of the hotel will affect the demand for air travel. For example, if the average price of a night's stay in a given destination is to increase, fewer people would want to take a vacation in that place. Thus the demand for travel to that place will be reduced. This implies that the price of a complement has negative effect on demand for air transport(Holloway, 1997)

Income or GDP

Income is another most important factor that influence the ability to travel(Doganis, 2002). It has both direct and indirect effects. Assuming air travel is normal good, rise in income increases the purchase of the travel and vice versa. Higher income individuals likely have more holidays and more likely to travel as part of a job, particularly with multinational, city financial and legal organizations(Cole, 2005). In addition, as it is mentioned above transport demand is derived demand. Hence, the increase in income increases the demand for all goods which in turn increases demand for air travel. This can be considered as an indirect effect of income. The overall economic and business activity is measured by GDP among other measures. An increase in GDP therefore accompanied by increased transaction and traffic movements.

Population

Population is the major source of demand for any good and service. There are two conflicting hypothesis on its effect of population. While increase in populations increases the size of the market, it also reduces the per capita income which could reduce demand for travel(Doganis, 2002).

Taste

Taste or preference refers to the appetite that a consumer has toward a good/service. It shows the orientation and attitude toward air transport. It is influenced by the environment where the consumers live. The major problem with this variable is the difficulty of measurement. In the neoclassical demand theory, it is mainly reflected in the shape of utility and demand function and assumed to be given. So change in taste can also affect the underlying form of the relationship between air travel demand and other variables (Button, 2010). But taste can also change with time.

The socio-economic environment

The social environment is also important in all markets since it determines the number of days of holiday available for travel or leisure and social attitudes towards travel. In some countries the number holidays are limited. Moreover, workers like in Japan, do not take all the holidays they are entitled to but stay at work. In some societies social attitudes to women holiday making on their own is not acceptable. These imposes constraints on air transport demand (Doganis, 2002).

Supply Factors: Comfort, Safety, Convenience

Demand also depends on supply factors. Both quantity and quality of supply influence demand by changing real cost and tastes of the consumer. According to Taneja (1971) comfort, Safety, Convenience are among the major determinates of air travel demand. Comfort is related to the comfort in the aircraft such as in flight services and seat density, as well as comfort at the airport such as lounge services. Safety refers to the likelihood of fatality in travelling. It can be measured by the absolute number of passenger deaths due to aircraft accidents. Convenience is associated with excess capacity, an increased number of flights in any given market, increasing number of origins and destinations, more and more direct flights, city-center baggage check-in locations, etc.

The problem of these type of variables is that it is extremely difficult, if not impossible, to quantify.

Random Factors

Air transport demand is also affected by many other external shocks such as such act or threat of terrorism, outbreak of epidemics such as SARS. For instance the terrorist attacks of 11 September 2001 reduced demand for air travel for quite some time (Vasigh et al., 2008)

2.1.4 Air transport demand models

We can generally classify air travel demand models as micro or disaggregated and macro or aggregated model. The micro models explain how individuals make travel decisions and factors affecting demand at the individual household level. This model depends on optimization behaviors of individual travelers.

The demand of air travel between two air ports or city pairs can also be considered as disaggregated model. The typical model used in this aspect is gravity model (Verleger, 1972). It is the extension of gravitational law of physics discovered by Newton. Mathematically it is expressed as

$$T_{ij} = \beta_0 \frac{P_i^{\beta_1} P_j^{\beta_2}}{D_{ij}^{\beta_3}}$$

β_0 is any constant

T_{ij} is traffic movement between any two points

P_i, P_j is population of the two places i and j respectively

D_{ij} distance between the two

The model states that travel between two cities or countries is inversely proportion to distance between them. This principle is obvious for surface transportation but with air transport the matter becomes more complicated (O'Connor, 1995). In a very closer cities, say 100 kilometers apart, they may not be any air travel at all. The time cost and uncertainties of the whole process of getting to and from airports, standing in check in lines, and waiting out operational delays outweighs the benefit of time saving from air travel in short distances. O'Connor (1995) argued that the basic law of gravity, the inverse relationship ship between demand and distance, may apply for longer distances. But this preposition can be challenged. As distance continues to rise air transport becomes the most relevant if not the only possible

mode of transport. Thus, one can hypothesize that the effect of distance on travel could be positive in short distances, negative in long distance, and may become positive in very long distances.

The other factor included in the basic gravity model is population. The model states that population is directly proportional to volume of air traffic. In larger cities the demand for goods and services are high attracting more people to travel to them.

The simple model may be extended accommodating more variables like income or GDP. Income is directly proportional to air transport demand.

The type of city whether predominantly manufacturing, commercial, tourist or institutional city is a factor that can be considered in the extended model. Commercial cities are those cities that serve as hub of finance, insurance, transport activities while institutional cities refers to the capital of national or state government or college town. Predominantly manufacturing city will be likely to generate less traffic than a city in other classification, *ceteris paribus* (O'Connor, 1995).

The model is mainly used to understand demand for new routes where historical data is lacking. Generally since cities are stationary, the model has been applied to cross-sectional models of travel (Verleger, 1972). However, it also lends itself for dynamic time series and panel data approach.

As discussed in Verleger (1972) the other most frequently used model in the literature on the demand for travel is aggregate model. This model treats all air travel, usually measured in revenue passenger miles, as a homogenous commodity and bears a strong kinship with many other aggregate demand functions such as for copper. However, while models for commodities have a strong connection to some underlying microeconomic relationship, the aggregate travel demand model has almost no connection to the underlying micro-travel demand functions. This model has been useful for accounting purposes and revenue forecasting.

In most aggregate works the aggregate measure of demand is postulated to be a function of some measure of price, a measure of average national income, and perhaps some measure of an alternative method of travel.

$$RPK_t = \beta_0 F_t^{\beta_1} Y_t^{\beta_2}$$

Where RPK is revenue passenger kilometer, Y represents per capita disposable income and F is index of fare.

In this study, the aggregate air travel demand model will be applied in line with the objective of study. The detailed econometric specification and other methodological issues will be treated in chapter 3.

2.2 Empirical Literature

Various scholars have conducted studies on air transport demand in different context and from different perspectives. Some the studies like Chi (2014) and Abed, Ba-Fail, and Jasimuddin (2001) and many others have focused on international air travel demand. There are also studies which dealt with demand for domestic air transport services. In this short survey of literatures some studies on domestic air travel model will be reviewed.

Kopsch (2012) has conducted a study on air transport demand in Sweden based on monthly aggregated data. It employed Prais-Winsten regression model which is used to correct for serial correlation in linear models. The study found that air transport demand is inelastic with respect to price in the short run but elastic in the long run. It is also found that leisure travelers are more sensitive to price change than business travelers. We can also see from the study that the cross-price elasticity between air and railway travel is positive justifying their substitutability.

In another study population and government expenditures are found to be the major determinants of domestic air travel demand in Saudi Arabia (Ba-Fail, Abed, & Jasimuddin, 2000). The study applied a simple linear regression model to come up with this conclusion. The major limitation of this study is that it suffers from the small sample data. It used annual data ranging from 1971 to 1994 which makes the total observation of 22. This is too small to apply econometric models.

The study by Marazzo, Scherre, and Fernandes (2010) investigated the relationship between air transport demand and economic growth in Brazil. The study differs from others in its

application of Vector error correction model and Granger causality test. The major finding of the study is that economic growth and air transport demand measured by the number of passengers are co-integrated. That is, they have long-term relationship. The causality test also shows air transport demand responds to economic growth. However, it is not without limitations. It did not control for other variables that can affect air transport demand.

A similar study with the aim of investigating the short- and long-run effects of economic growth and market shocks such 9/11 terrorist attacks, the Iraq war, SARS epidemic and 2008 financial crisis on passenger transport demand was conducted in USA by Chi and Baek (2013). By using an autoregressive distributed lag (ARDL) approach, economic growth, 9/11 terrorist attack, SARS epidemic found to have an effect on passenger air transportation services in both in the short run and long run.

Demirsoy (2012) has analyzed analyze air transport model based on data collected from Turkey, UK; France and Brazil. The data structure was panel consisting of 20 years of observation from each country. It investigated factors that determine domestic air transport service demand using fixed effect model of panel data approach. Population and income are found to be the most significant factors that explained the variation in demand for air transport. Explanatory variable like crude oil price, the number of passengers in a high speed railway, deregulation dummy were included but all are found to be insignificant. The major problem of the model is that it includes some irrelevant variables that may lead to biased and inconsistent estimates.

Availability of alternative mode of transport can influence the demand for air transport. In this regard Park and Ha (2006) studied the potential impact of development of the speedy railway on demand for air transport. The study differs in its approach from other air transport demand studies. It measures demand based on the stated preference rather than the revealed preference approach which is mostly used in most of the other researches. It is microeconomic approach in the sense that data were collected from individual households using survey. Based on the data collected from 830 households, the study found that demand for air transport would decline if high speed rail road are developed.

In Norway one would pick the work of Fridström and Thune-Larsen (1989). The study was conducted some 25 years back, but laid an important foundation in air travel demand study

in Norway. It investigates the demand for air transport using gravity model. It combined cross sectional and time series data relating to an entire transportation network in Norway. Medium and long-term demand elasticities with respect to price and income were estimated and found to be in line with economic theory. The study is, however, may not reflect the current reality of Norwegian aviation industry.

The most recent study was made by Yusuyin and Sun (2012) which deals with the relationship between distance to airport and air travel demand. Based on the data obtained from four airports found in Møre and Romisdal county of Norway, distance to airport was found to be insignificant in affecting air travel demand.

3.0 Methodology

In this chapter the methods that were used to investigate the problem are discussed. These includes how the data are obtained, examined, estimated and analyzed among others. Different alternative models will be specified and discussed. The problems of time series analysis like stationarity along with remedial measures is going to be discussed in this chapter. It also reviews methods of testing cointegration among variables. Evaluation of different alternative models is the main theme of this chapter.

3.1 The Data

The study is based on secondary data sources. Most of the data are retrieved from the Statistics Norway which is responsible for official statistics collection and compilation in the country. Passenger kilometers, air travel price index, rail travel price index and per capita income were obtained from Statistics Norway. Some data were also triangulated against data from other sources like Transport Economics Institute. In addition, some missing data points on number of passenger and passenger transport were obtained from Institute of Transport Economics, Norway.

The data covers the period from 1979 to 2017. Air transport demand is measured Passenger kilometer (PKM), a variable which is commonly used in similar studies. Real Gross domestic Product per capita (RGDP per capita) and air travel price index were chosen as explanatory variables. All variables were transformed into logarithms as it is usually the case in most of Econometric study. Logarithmic transformation also solves potential heteroscedasticity problem.

3.2 Stationarity analysis

The first step in a time series analysis is to check if the data are stationary. The standard regression analysis assumes that all variables are stationary. As defined by Gujarati (2010),

a given random variable or process, y_t is said to be stationary¹ when its moments are time invariant. In other words,

- i. Its mean or expected value is constant over time i.e $E(y_t) = \mu$
- ii. Its variance is constant over time i.e $V(y_t) = \sigma^2$
- iii. The auto-covariance between any two time periods depends only on the distance or gap between the two time periods (h) and not on the actual time at which the covariance is computed (t) that is. $Cov(y_t, y_{t+h}) = \sigma_h^2$

If a variable is stationary in level, it is said to be integrated of order zero, symbolically denoted as $y_t \sim I(0)$. The typical example of I (0) process is white noise process (error term). Some variables become stationary after first differencing, $\Delta y_t = y_t - y_{t-1}$. A variable that becomes stationary after first differencing, $\Delta y_t \sim I(0)$ is termed as integrated of order one, I(1). For instance random walk process which has the form of $y_t = y_{t-1} + \varepsilon_t$ is I(1). In the same fashion a variable which is stationary after second differencing is I (2) etc.

In practice, most of the economic variables are not stationary in level, which poses the major challenges to econometric analysis. Regressing one non-stationary time series upon another non-stationary variable may lead to the so called spurious regression where estimators and test statistics are misleading (Verbeek, 2008). One often obtains a high R^2 and a significant relationship even though there is no meaningful relationship between the variables. Non-stationary can also be the source of serial correlation(Gujarati, 2010).

There are several methods that can be used to test stationary of a given time series. They are widely discussed in almost all standard econometric textbooks like Verbeek (2008). Intuitively looking at the graph of the variable, one can see if the variable is stationary or

¹ This is a type of stationarity known as weak or covariance stationary. Strict stationarity requires that all moments of the variable are time invariant. In most practical situations, however, weak stationarity often suffices. Furthermore, if a stationary process is normal, the weakly stationary stochastic process is also strictly stationary.

not. If the variable depicts some sorts of upward/downward trending, we should suspect for non-stationary. Such a trending may suggest that the mean is changing from time to time. Another method of detecting stationary is using autocorrelation function (ACF) which is the ratio of covariance at lag k and the variance which is defined as

$$\rho_k = \frac{\gamma_k}{\gamma_0} \quad [1]$$

$$\text{where } \gamma_k = E(y_{t+k} - \bar{y})^2 \text{ and } \gamma_0 = E(y_t - \bar{y})^2$$

High level of autocorrelation coefficients at various lags up to certain lags is an indication of non-stationarity.

The formal methods of testing stationarity was first developed Dickey and Fuller (1979) as cited in Verbeek (2008). This section is mainly based on discussion by Verbeek (2008) unless mentioned otherwise. Non-stationarity can arise from presence of unit root, trend or both. The Dickey Fuller method tests the presence of unit root or stochastic trend in the process. The method is based on one of the following three specification of Autoregressive models depending on the nature of the data generating process.

$$y_t = \theta y_{t-1} + e_t \quad [2]$$

$$y_t = \delta + \theta y_{t-1} + e_t \quad [3]$$

$$y_t = \delta + \theta y_{t-1} + \gamma t + e_t \quad [4]$$

The first specification is pure random walk model. The second adds an intercept term/drift while the third includes both intercept and linear time trend².

In all cases we are interested in testing if there is unit root that is If $\theta = 1$ or not. Thus we test $H_0 : \theta = 1$ (unit root) against the alternative $H_0 : |\theta| < 1$ (stationary). However, the critical value is different under each scenario.

In practice, it is convenient to conduct hypothesis testing by setting a parameter to zero under null hypothesis. Accordingly, the model in Equation [5], [3] and [4] can be transformed into the following specifications by deducting (y_{t-1}) from both sides

$$\Delta y_t = \pi y_{t-1} + \varepsilon_t \quad [6]$$

$$\Delta y_t = \delta + \pi y_{t-1} + \varepsilon_t \quad [7]$$

² If we find clear positive or negative trend it is recommended to conduct DF test with trend.

$$\Delta y_t = \delta + \pi y_{t-1} + \gamma t + \varepsilon_t \quad [8]$$

Where $\pi = (\theta - 1)$

Now we test for the hypothesis $H_0 : \pi = (\theta - 1) = 0$ which is equivalent to testing for $\theta = 1$.

The test statistics is calculated by

$$DF = \frac{\hat{\theta} - 1}{se(\hat{\theta})} = \frac{\hat{\pi}}{se(\hat{\pi})} \quad [9]$$

The critical values cannot be obtained from standard t-distribution. This is because $\hat{\theta}$ does not have t-distribution under null hypothesis ($\theta = 1$ i.e non-stationary) even asymptotically. Non-stationary by its nature invalidate the standard results of OLS estimator $\hat{\theta}$. Consequently, we need to use critical values of other appropriate distribution of Dickey-Fuller statistics which is skewed to the left. As a result, the critical values are less than the one obtained from t-distribution. For instance, for very large T, the 5% critical value are -2.86 as compared to -1.95 under t distribution.

The Dickey- Fuller test can be extended to the situation where errors are correlated and unit roots of higher order autoregressive models. In this case it is called Augmented Dickey Fuller test.

This procedure can easily be generalized to testing of a single unit root in an AR(p) process which can be written as

$$\Delta y_t = \delta + \pi y_{t-1} + \sum_{j=1}^p \phi_j \Delta y_{t-j} + \varepsilon_t \quad [10]$$

Where $\pi = \sum_{j=1}^p \theta_j - 1 = (\theta_1 + \theta_2 + \dots + \theta_p - 1)$ and $\phi_j = - \sum_{k=j+1}^p \theta_k$ for all $j = 1, 2, 3, \dots, p$

As mentioned before the deterministic elements (constant and linear time trend) can be dropped or added depending on the choice of the specification. The lag length p is determined based well established criteria such as Akaike information criterion (AIC) and Bayesian information criterion (BIC) or Schwarz criterion which will be briefly discussed latter in this chapter.

As alternative to augmented Dickey Fuller test is Phillips-Perron (PP) tests named after Peter C. B. Phillips and Pierre Perron who have developed the strategy. While augmented Dickey-

Fuller test includes lags of the first differences in the regression, the Phillips–Perron test makes a correction to the test statistics of the coefficient θ from AR (1) regression to account for serial correlation. It is robust to serial correlation. KPSS is another alternative method of testing stationarity. It differs from others in that it is mainly used to test non-stationarity that arises from trend and it is based on the null hypothesis of stationarity.

Remedial Measures

Once non stationarity is discovered a given time series process, a remedial measure must be taken. Researchers have been using de-trending and differencing to solve the problem of non-stationarity. But differencing is not without problem. Firstly differencing y_t , which is in effect differencing the error term, produces noninvertible MA error process which is problematic in estimation. Secondly there is no unique model solution for long-run (Asteriou & Hall, 2011)

As it is mentioned above non-stationarity in general leads to spurious regression. But, there are exceptional cases. If the variables are cointegrated, the regression will be no longer spurious. What do we mean by cointegration? When do we say that variables are cointegrated and how cointegration is tested? These are issues that are going to be addressed in following section.

3.3 Analysis for Cointegration

As it is mentioned if the variables are cointegrated, the regression will be no longer spurious even if the variables are not stationary. In fact the estimators are super consistent, converges to true value as T increases faster than it usually does under regression with stationary data.

As indicated in Asteriou and Hall (2011), cointegration refers to the situation where a linear combinations of the variables are stationary. For instance, for two variables y_{1t} and y_{2t} where $y_{1t} \sim I(1)$ and $y_{2t} \sim I(1)$ if their linear combination like $\alpha_1 y_{1t} + \alpha_2 y_{2t} \sim I(0)$ for any non-zero values of α_1 and α_2 then the variables are said to be cointegrated of order of 1, denoted as CI (1, 1).

Generally the time series y_{1t}, y_{2t} are said to be cointegrated of order (d, b) , that is, $\{y_{1t}, y_{2t}\} \sim CI(d, b)$ where $d \geq b \geq 0$, if both are integrated of order d and there exists a linear combination of the two variables which is integrated of $d - b$, that is, $\alpha_1 y_{1t} + \alpha_2 y_{2t} \sim I(d - b)$.

Special case of interest is when $d = b$ where the linear combination is integrated of order 0. In this case the vector of cointegration coefficients can be identified as parameters of long run relationship or equilibrium relationship. Cointegration implies that variables may drift away from each other in short run, but they move together over time and the difference between the two remain constant or stationary.

There are at least three broad approaches for testing cointegration. The first one is Engle and Granger method which is based on assessing whether single-equation estimates of the equilibrium errors appear to be stationary. The second approach is known by Johansen procedure, which is based on the vector auto regressive (VAR) approach and determine the rank of coefficient matrix. The third one is bound testing which is based Autoregressive distributed lag model. In all the approaches the first step involves testing the variables for stationarity and thereby determine their order of integration using ADF and/or other relevant testing procedure. By default, one call upon cointegration when variables are not stationary. Moreover, some procedure specifically Jensen approach requires the variables are integrated of the same order.

3.3.1 Engle Granger Method

Engle-Granger method is the simplest to implement and understand. As discussed in Asteriou and Hall (2011), Enders (2009) it involves two steps. First, we estimate the long run relationship between the variables indicated below assuming there are only two variables such as y_{1t} & y_{2t} .

$$y_{1t} = \beta_0 + \beta_1 y_{2t} + e \quad [11]$$

Then we obtain the residual, $\hat{e}_t = y_{1t} - \hat{\beta}_0 - \hat{\beta}_1 y_{2t}$, which is a linear combination of the variables and test if it is stationary by running the following model in the second stage

$$\Delta \hat{e}_t = \delta + \pi \hat{e}_{t-1} + \sum_{p=1}^p \phi_j \Delta \hat{e}_{t-p} + v_t \quad [12]$$

The hypothesis to be tested is $H_0 : \pi = 0$ against $H_1 : \pi < 0$. It is one sided hypothesis test, where the null hypothesis is no cointegration or non-stationarity of the residual. A rejection of null hypothesis indicates that the variables are cointegrated.

The constant is included to ensure that the residual has zero mean, $E(\hat{\epsilon}) = 0$. The time trend may also be included. Failing to include the time trend, if one or more of the series have a deterministic trend components, will possibly lead to a failure of rejection of null hypothesis of no cointegration, even though the variables might be cointegrated. When testing whether the original series have a unit root or not, prior to testing for cointegration, the results suggests that the deterministic trends should be included in the regressions. If this is the case for only one of the variables it is important to include in the cointegration relationship in Equation[11]. If there is more than one variable with deterministic trend it is possible that these cancel each other out (Bjørnland & Thorsrud, 2014).

In testing the stationarity of the residual, it is not appropriate to use critical values from the usual Dickey Fuller tables, since the residual are obtained from regression equation. Engle and Granger have developed alternative tables known by Engle–Granger and augmented Engle–Granger tests which is used by most researchers.

3.3.2 Johansen Procedure: Cointegration in Multivariate Setting

EG approach is simple to implement and easy to understand. However, it has its own drawbacks. In estimating long-term relationship to obtain residual, the regressors are arbitrarily determined. In other words, it does not say anything about which variables should be a regressors and why. Regressing y_{1t} on y_{2t} and regressing y_{2t} on y_{1t} gives different residuals particularly for small samples. The second problem of the method is that it cannot treat the possibility of having more than one relationship which is common when the number of variables are more than two.

In the situation where the number of variables are more than two, there may exist more than one equilibrium relationship among the variables. Given n variables, it is possible to have up to $n-1$ vectors of cointegration. In this case, Johansen procedure is the appropriate method.

Johansen approach is a system-based approach that work based Vector autoregressive (VAR) methodologies. VAR models treats all variables as endogenous. A more complete treatment of VAR model is given at the annex

The VAR model has a number of advantages. It is simple to formulate and estimate. It does not require to distinguish exogenous variables. Estimation can be made by simple OLS. Forecast from VAR model are better in most cases than most complex simultaneous equation model. However, it is not without limitations. It is theoretic since it is not based on any economic theory. It results in loss of degrees of freedom. Finally, the regression coefficients are difficult to interpret since they totally lack theoretical background. In order to overcome this problem, researchers have developed impulse response functions methodology.

If variables are stationary and there is simultaneity problem we adopt VAR models. We can also use VAR when they are stationary after differencing but there is no cointegration.

3.3.3 ARDL and Bound Testing approach

The system which is based Johansen procedure of testing cointegration requires that all variables to be integrated of the same order which may not possible all the time. Consequently, Pesaran, Shin, and Smith (2001) have developed an alternative method commonly known as bound testing which is based autoregressive distributed lag model. It does not require the variables with same order of integration. Moreover, it is considered as more appropriate methods when the sample size is small as opposed to Johansen cointegration which requires large sample. It is easy to implement and interpret since it depends only on single equations.

Bound testing is based on standard F- and t-statistics used to test the significance of the lagged levels of the variables in a univariate equilibrium correction mechanism which is specified as

$$\Delta y_t = c + \sum_{i=1}^p b_i \Delta x_{t-i} + \sum_{i=0}^q c_i \Delta x_{t-i} + \theta_1 y_{t-1} + \sum \theta_i x_{it-1} + \varepsilon_t \quad (13)$$

If θ s are jointly different from zero we say that there is cointegration among the variables.

If they are cointegrated $\Delta y_t = \Delta x_t = 0$. This implies that the long run coefficients can be calculated as $-\theta_i / \theta_1$. The short run effects are obtained from the conventional ECM model

The bound testing approach involves the following steps (Giles, 2013)

In the first step the order of integration of the variables is checked using conventional testing methods such as ADF. Bound testing can only be used with I(1) and/or I(0) variables. In the second step, we determine the appropriate lag structure and estimate the model specified in Eq (13) above. Thirdly the serial correlation and dynamic stability of the model will be tested since the bound testing depends on the assumption that there is no serial correlation. In the fourth step we perform the test if there is evidence of a long-run relationship between the variables. In other words we test if θ s are jointly significant using F test or Wald test. The asymptotic distributions of this test statistics is non-standard under the null hypothesis. Thus we cannot use the critical from standard F distribution. Persan has two sets of asymptotic critical values bounds. The upper bound is associated with the situation when all regressors are purely I(1) and the other if they are all purely I(0). If the computed F-statistic falls below the lower bound we would conclude that the variables are I(0), which implies that cointegration analysis is not relevant. If the F-statistic exceeds the upper bound, we conclude that we have cointegration. If the F-statistic falls between the bounds, the test is inconclusive. A conclusive inference cannot be drawn without needing to know the integration/cointegration status of the underlying regressors. Finally if the test result is positive that is there is cointegration, we proceed with the estimation of both long run level model and restricted ECM model using lagged residual obtained from the long run level model. Finally we measure the long run equilibrium relationship and short run dynamic effects.

3.4 Error Correction Mechanism

The concept of cointegration is associated with Error/Equilibrium correction model, which is one of the dynamic econometric models. They are related through a theorem called Granger representation theorem which states that two variables are cointegrated if and only if there exists an error correction form model for either of the two variables or both (Bjørnland & Thorsrud, 2014). The converse is also true in that cointegration is necessary condition for error correction models to hold.

To show this consider the simple model

$$y_{1t} = \beta_0 + \beta_1 y_{2t} + e_t \quad [14]$$

In this model $y_{1t} = \beta_0 + \beta_1 y_{2t}$, long run equilibrium relationship and $e_t = y_{1t} - \beta_0 - \beta_1 y_{2t}$ is the disequilibrium error term.

Let assume e_t follows AR(1) processes, that is

$$e_t = \theta e_{t-1} + v_t \quad [15]$$

If the variables are cointegrated the error term is stationary by definition and stationarity requires $|\theta| < 1$. Ignoring the intercept for simplicity and if we insert the expression for long run relationship between variables into the time series process of error term i. e in Eq [15], we get

$$\begin{aligned} \Rightarrow y_{1t} - \beta_1 y_{2t} &= \theta_1 (y_{1t-1} - \beta_1 y_{2t-1}) + v_t \\ \Rightarrow y_{1t} &= \beta_1 y_{2t} + \theta_1 (y_{1t-1} - \beta_1 y_{2t-1}) + v_t \end{aligned} \quad [16]$$

Adding and subtracting y_{1t-1} and $\beta_1 y_{2t-1}$ on both sides of the last part of equation [16] gives us the Error Correction Model which is specified as

$$\begin{aligned} \Delta y_{1t} &= \beta_1 \Delta y_{2t} - (1 - \theta_1)(y_{1t-1} - \beta_1 y_{2t-1}) + v_t \\ \Delta y_{1t} &= \beta_1 \Delta y_{2t} - \lambda e_{t-1} + v_t \end{aligned} \quad [17]$$

Where $\Delta y_t = y_t - y_{t-1}$, $e_{t-1} = y_{1t-1} - \beta_1 y_{2t-1}$ is error correction term and, λ is speed/rate of adjustment and v is disturbance term.

In the short run, the variables could deviate from the long run equilibrium relationship. But it adjusts itself to maintain long run equilibrium relationship, if they are cointegrated. For instance if the error term in the previous year i.e. $e_{t-1} > 0$, the equilibrium is maintained or adjustment is made either by decreasing y_{1t} or increasing y_{2t} or both. Similarly, if $e_{t-1} < 0$, y_{1t} has to increase or y_{2t} has to decrease or both to restore the equilibrium. Thus, change in y_1 is inversely proportional to previous year error term or disequilibrium. As a result the rate of adjustment λ should be negative and less than unity for stability condition.

Large value of λ , say 1, implies that y_1 responds (adjusts) to the deviation from equilibrium in year $t-1$ fully. On the other hand if it is zero, y_1 has an incentive to adjust to the deviation from equilibrium in period $t-1$ and Δx_t does not granger cause Δy_t (that is no cointegration at all). The coefficient, λ , is also called Granger causality.

3.5 ARDL model and ECM

As indicated Asteriou and Hall (2011) and Enders (2009) ECM model is simply parametrization of Autoregressive distributed lag model.

Consider the simplest ARDL model

$$y_{1t} = \alpha_0 + \alpha_1 y_{1t-1} + \phi_0 y_{2t} + \phi_1 y_{2t-1} + e_t \quad [18]$$

The short run effect/multiplier is ϕ_0 which measures the current change in y_{1t} due to current change in y_{2t} on y_{1t} that is $\frac{\partial y_{1t}}{\partial y_{2t}}$. The long run effect measures the cumulative effects of one

time change in y_{2t} on y_{1t} or the effect of the permanent change in y_{2t} on y_{1t} . It is obtained by summing the effects of change in y_{2t} on each y_{1t-i} in subsequent periods, that is

$$\frac{\partial y_{1t}}{\partial y_{2t}} + \frac{\partial y_{1t-1}}{\partial y_{2t}} + \dots + \frac{\partial y_{1t-n}}{\partial y_{2t}}. \text{ This is equals to } \frac{\phi_0 + \phi_1}{1 - \alpha_1}.$$

Alternatively, we can derive long run multiplier using the condition of the long run equilibrium relationship.

At steady state/ equilibrium, $y_{1t} = y_{1t-1} = \dots = \bar{y}_{1t}$ and $y_{2t} = y_{2t-1} = \dots = \bar{y}_{2t}$. By using this definition, ARDL model in Eq[18] can be reduced to

$$\bar{y}_{1t} = \frac{\alpha_0}{1 - \alpha_1} + \frac{\phi_0 + \phi_1}{1 - \alpha_1} \bar{y}_{2t} \quad [19]$$

Thus the long run/equilibrium effect is again equal to $\frac{\phi_0 + \phi_1}{1 - \alpha_1}$. This is equivalent to β_1 in

the long run regression model specified in Eq[14].

By subtracting y_{1t-1} from both sides of Eq[18] we can get

$$\Delta y_{1t} = \gamma_0 \Delta y_{2t} - (1 - \alpha_1) \left[y_{1t} - \frac{\alpha_0}{1 - \alpha_1} - \frac{\gamma_0 + \gamma_0}{1 - \alpha_1} y_{2t} \right] + e_t \quad [20]$$

Which is the same ECM model as indicated above, where $(1 - \alpha_1)$ is the speed of adjustment.

Thus, as long as $|\alpha_1| < 1$ which implies $(1 - \alpha_1) > 0$ the ARDL model corrects the same manner as ECM. Moreover, both can show short run and long run effects can be obtained

from ARDL. Thus both can be used where the equilibrium property is defined. But ECM has superiority over ARDL in many aspects.

Firstly, assuming that *the variables* are cointegrated, the ECM incorporates both short-run and long-run effects. Secondly since all the terms in the model are stationary so standard regression techniques are valid. The third advantage of ECM over ARDL is that it is closely bound up with the concept of cointegration.

The simple ECM depicted above can be generalized to capture more complicated dynamic processes. ECM can easily be extended for lags of higher order as well as more variables (more Xs).

$$\Delta y_{1t} = \delta_0 + \sum_{i=0}^p \delta_1 \Delta y_{2t-i} + \sum_{j=1}^q \mu_j \Delta y_{1t-j} - \lambda(y_{t-1} - \alpha - \beta y_{t-1}) + v_t \quad [21]$$

These models assume that there is only one vector of cointegration. But in reality there could be many possible linear relationship between or among variables. This is particularly evident when the number of variables are more than two.

It can also be extended to multivariate situation, in which case it is called Vector error. Correction model (VECM). In this case we use matrix. We can start with bivariate case and present the extension latter.

The Bivariate ECM is

$$\begin{aligned} \Delta y_{1t} &= \delta_1 \Delta y_{2t} - a_1 (\beta_1 y_{t-1} - \beta_2 y_{2t-1}) + v_{1t} \\ \Delta y_{2t} &= \delta_2 \Delta y_{1t} - a_2 (\beta_1 y_{t-1} - \beta_2 y_{2t-1}) + v_{2t} \end{aligned} \quad (22)$$

In matrix form

$$\begin{pmatrix} \Delta y_{1t} \\ \Delta y_{2t} \end{pmatrix} = \begin{pmatrix} \delta_1 \\ \delta_2 \end{pmatrix} \begin{pmatrix} \Delta y_{1t} \\ \Delta y_{2t} \end{pmatrix} + \begin{pmatrix} a_1 \\ a_2 \end{pmatrix} (\beta_1 \quad \beta_2) \begin{pmatrix} y_{1t-1} \\ y_{2t-1} \end{pmatrix} + \begin{pmatrix} v_{1t} \\ v_{2t} \end{pmatrix} \quad (23)$$

Thus

$$\Delta y_t = \delta \Delta y_{2t} - a \beta' y_{t-1} + v_t \quad (24)$$

Where $\Pi = \alpha \beta'$

This can be extended to more than two variables which will be discussed in the section this follows.

3.6 Variables and Measurements

Based air transport demand model and empirical studies the variables which are going to be used in this study are identified. These are

Dependent variable(PKM)

The dependent variable is demand for air travel which can be the number passengers transported per year or Passenger kilometer. In this study passenger kilometer will be used.

Independent variables

Airfare: It is the price of using air transport. The effect of airfare is hypothesized to be negative. Annual airfare index compiled by Statistics Norway will be used.

Income (GDP): Income is one of the determinants of demand. In this study Real Gross domestic product per capita is used a measure of income.

Own price (Px): Another single important factor that is believed to determine demand of a good or service is its own price. The study uses price index of air transport services as measure of price.

Price of substitute (Py): Price of substitute assumed to affect demand positively. In this case rail transport is taken as substitute to air transport. Price index of rail way transport is used to as another explanatory variable.

3.7 Estimation Procedure

As indicated in Greene (2008) the testing procedures discussed above involve actually estimating the cointegrating vectors. In the Engle and Granger framework, at a second step after the cointegration test, we can use the residuals from the static regression as an error correction term in a dynamic, first-difference regression.

As to the software, the estimation was made by using E-views 10 , the most widely used econometric software.

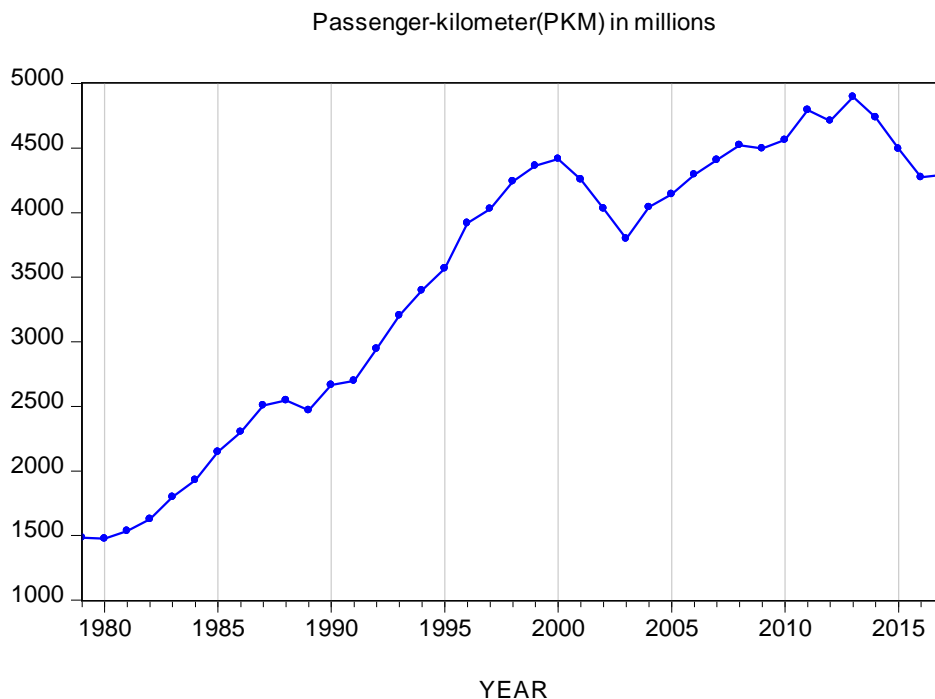
4.0 Results and Discussion

This chapter deals with presentation of econometrics estimation results. The results will be discussed and elaborated and in line with economic theory and similar studies. Tables and graphs will be used when necessary. The study is based on annual data observed from 1979 to 2017 which means that the total number of observations is 39. Though it's not too small it is not large enough to use certain models like vector auto regressive (VAR) models. Accordingly, other alternative approaches were pursued instead. The more suitable model is found to be Autoregressive distributed lag model (ARDL). The results were obtained by using EVIEWS 10 econometrics software. We begin our analysis with some basic description of the data with emphasis on the air travel demand variable.

4.1 Descriptive Statistics

Domestic air transport in Norway has gone through tremendous change over the last four decades. As the report from Norwegian Transport Economics Institute shows the number of passengers transported per year increased from about 3 million passengers in 1979 to about 10 million in 2017. If we look at the passenger kilometer which is more appropriate measure of transport performance, it increased from 1482 million passenger kilometers in 1979 to 4293 million in 2017 which is more than double. There is significant variation over all these years however. It has increased throughout 1980's up until 1988 and 1989 where it decreases by about 3%. This is could be attributed to the deadliest crash of Widerøe Flight 710 in Northern Norway that killed all 36 passengers and crew on board in May 1988.

Figure 4.1. Trend of Passenger-kilometer 1979-2017



Source: own calculation

It increased consistently throughout 1990's. This could be largely because of liberalization and deregulation of airline industry in Norway. The significant change in air transport demand is observed in 2001 and 2014. As we all know the year 2001 was the year when there was a major terrorist attack on USA by crashing airplanes to world trade center in New York and other establishments in USA. Many studies have shown that 9/11 attack inflicted reduction in air transport demand both at global and national level. This is explained due to safety measures taken by authorities which increases time cost of travel and negative perception toward developed due to risk of terrorist attack.

In Norway, air transport demand has continually and sharply reduced after 9/11 terrorist attack. This has to do with taste/preference in demand theory. Such act negatively influences preference to ward air travel. Consumers tends to find other alternatives. The other cases where change in the trend was observed was in 2014. Figure 4.1 depicts that the global financial crises seems to have insignificant impact on Norwegian domestic air transport. However, the oil price collapse of 2014 has contributing factor for slowdown of the demand since 2014. The fact that alternative means becoming more popular can also be a factor.

Though traditional descriptive summary statistics such as arithmetic mean and variance are less meaningful in time series data, it is good to present and discuss them to some extent. The summary statistics of the variables under investigation are given in the table 4.1 below. The maximum passenger kilometer consumed/produced is 4.8 billion which was recorded in 2013. The cost of air travel has also been growing on average by 4.4%.

Table 4-1 Descriptive statistics

Statistics	Passenger kilometer (in million)	RGDP (in mill Nok)	Air transport Price index (2015= 100)	Rail transport price index (2015=100)
Mean	3753.282	1639537	71.7666	62.7589
Median	4029.000	1694376	74.5000	60.0000
Maximum	5918.000	2339952	114.1000	101.5000
Minimum	1475.000	921961.0	22.2000	16.4000
Std deviation	1420.781	455046.4	26.7705	25.0928
Av. Growth rate	3.36%	2.50%	4.26%	4.96%

Source: Own calculation

4.2 Unit root tests

As it is mentioned in the previous chapter, the first and foremost step in almost all time series econometric analysis is testing stationary or non-stationarity of the data. Non-stationarity could arise from presence of unit root and/or trend in the data generating process. There are a number of methods available such as Augmented Dickey Fuller(ADF), Phillips-Perron (PP) test, Kwiatkowski-Phillips-Schmidt-Shin(KPSS) to test presence of the unit roots in a given data series. In this study, however. we apply Augmented Dikey-Fuller (ADF) test which is commonly used in most of the empirical works.

The ADF test is based the following general specification

$$\Delta y_t = c + \alpha t + \delta y_{t-1} + b_1 \Delta y_{t-1} + b_2 \Delta y_{t-2} + \dots + e_t \quad [25]$$

The null hypothesis is that there is a unit root in data generating process. In other words, the data is not stationary which is true when $\delta = 0$.

There are three possible specifications of ADF models based on the equation specified above. These are

- i) model without constant (c) and without trend (αt)
- ii) the model with constant but without time trend and
- iii) he model with both constant and time trend.

The descriptive statistics of all the variables shows that that the data have deterministic components which implies that model (i) is not relevant. But estimation results from all the three models are and presented for comparison purpose.

The optimal lag length should be determined before running the models. We apply the general approach that are applied in selecting any model (Verbeek, 2008). The most commonly used ones are Akaike information criteria (AIC) and Schwarz information criteria (SIC). These metrics generally measures the amount of information lost in using certain model specification. Thus, the lower the value of AIC and/or SIC the better the model is. Fortunately, EViews automatically select optimal lag length for a given selection criteria.

The results of ADF unit root tests of all the variables given in table 4.2 below.

Table 4-2 ADF unit test in levels

Variables	Without constant and trend		With constant		With constant and trend	
	T-statistic	P-value	T-statistic	P-value	T-statistic	P-value
LOGPKM	4.5272	1.0000	-2.3309	0.1679	-1.9608	0.6028
LOGGDP	2.5238	0.9964	-1.3076	0.6158	-1.2672	0.8805
LOGPx	3.2752	0.9995	-2.9133	0.0534	-2.0217	0.5706
LOGPy	1.7641	0.9792	-8.0857	0.0000	-2.5824	0.2900

The 5% critical values for each model is (-1.95) (-2.943) (-3.536) respectively.

H_0 : The variable has a unit root (is non-stationary)

The ADF stationarity test assumes that the variable under consideration is non-stationary. In other words, the null hypothesis is that the variable is non-stationary. As mentioned above model 1 (model without constant) is not relevant in this case. The ADF test statistics from model 2 shows that GDP and PKM are not stationary. When we come to price variables, while they are stationary under model 2 specifications there is evidence of non-stationarity under model 3 (model with constant and time trend) shows that the variables are nonstationary. We fail to reject the null hypothesis even at 10%. Thus, we cannot conclude that the variables are stationary.

Non-stationarity can be solved by differencing data. Accordingly, the data were differenced and investigated for the presence of unit root. The result is given in the table below. We can reject the null hypothesis even at 1% level of significant. It is found all variables are stationary after first differencing. In other words the variables are integrated of order 1, I(1).

Table 4-3 ADF test for Differenced data

Variables	Without constant and trend		With constant		With constant and trend	
	T-statistic	P-value	T-statistic	P-value	T-statistic	P-value
ΔLOGPKM	-3.0467	0.0033	-4.2409	0.0019	-4.7919	0.0023
ΔLOGGDP	-1.9855	0.0463	-3.3307	0.0205	-3.5054	0.0536
ΔLOGPx	-3.7718	0.0004	-4.4278	0.0012	-4.7905	0.0024
ΔLOGPy	-4.1755	0.0001	-4.4189	0.0012	-4.3924	0.0068

4.3 Estimation results of ARDL model

As it can be seen above the variables are integrated of order 1. This means we cannot apply classical regression techniques to investigate determinants of demand. The variables must be transformed otherwise the regression results would be spurious. However, thanks the works of Engle and others transformation is not necessarily the case if the variables are cointegrated. Thus, the natural step that follows is to test for cointegration. There are at least three tools available to test cointegration. These are Engle-Granger, Johansen procedure, bound testing. The difference between the three were fairly discussed in chapter three. Engle granger is limited to two variables model while Jonsen procedure which depend on VAR model requires large sample size data.

The relevant approach with small sample size data such as like this is Bound testing which depends on ARDL model. In this approach, first the model estimated based on ARDL model. Accordingly, ARDL model is estimated using EViews. The dependent variable is LOGPKM(logarithms of passenger kilometer) while the independent variable or dynamic regressor logarithms of Real GDP (LOGGDP), log of air transport service price index(LOGPx), Logarithims of rail transport price index (LOGPy) . The 9/11 dummy was also used as exogenous regressor.

The appropriate lag length is selected based on Schwarz information criteria. Though the data is annual data, the maximum lag length is set to four (2) to accommodate all the possible

lag effects . The best model with lower AIC value is found to be ARDL (1, 1, 0, 0). This is automatically selected by Eviews.

The results of the estimated model is given as follows

Table 4-4 ADRL model estimation results

Dependent Variable: LOGPKM				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGPKM2(-1)	0.619341	0.102328	6.052492	0.0000
LOGGDP1	1.059779	0.354870	2.986383	0.0055
LOGGDP1(-1)	-0.532122	0.395233	-1.346348	0.1880
LOGPx	-0.148674	0.064863	-2.292127	0.0288
LOGPy	0.221570	0.058244	3.804143	0.0006
D2001	-0.090780	0.031676	-2.865939	0.0074
C	-4.652298	1.777451	-2.617398	0.0136

R-squared = 0.9948

Adj R-squared: 0.9939

F-statistic = 1005.97

Prob(F-statistic) = 0.0000

Durbin-Watson stat = 1.9195

Source: own estimation

As prerequisite we can only proceed to testing of cointegration only if the model is free from serial correlation and stability

Table 4-5. ADRL model estimation results

Dependent Variable: LOGPKM				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGPKM2(-1)	0.619341	0.102328	6.052492	0.0000
LOGGDP1	1.059779	0.354870	2.986383	0.0055
LOGGDP1(-1)	-0.532122	0.395233	-1.346348	0.1880
LOGPx	-0.148674	0.064863	-2.292127	0.0288
LOGPy	0.221570	0.058244	3.804143	0.0006
9/11 dummy	-0.090780	0.031676	-2.865939	0.0074
C	-4.652298	1.777451	-2.617398	0.0136

R-squared = 0.9948

Adj R-squared: 0.9939

F-statistic = 1005.97

Prob(F-statistic) = 0.0000

Durbin-Watson stat = 1.9195

Source: own estimation

4.4 Model Checking and Diagnostic analysis

Testing for Serial Correlation

Before proceeding with the use of results from ARDL model, estimation, it is imperative to check for serial correlation and stability. Serial correlation is a situation where the residuals are correlated. If residuals are correlated the estimations are biased and inconsistent. There are generally two approaches to test serial correlation. These are Durbin Watson (DW) test and Breusch–Godfrey test or Lagrange Multiplier (LM) test. These and others are well discussed in most standard econometrics text books like Verbeek (2008). DW tests has a number of limitations. Among others it cannot be used for serial correlation of higher order and when the lagged dependent is used as regressor. It implies that DW by default cannot be used in ARDL models. Thus, LM test remains to be the one which is relevant in this approach. It is based the null hypothesis of no serial correlation. The results is given in the table below. As one can easily see from the table the p-value of LM statistics that is the probability of rejecting the true null is about 68%. This means we cannot reject the null. Thus, there is no problem of serial correlation in the model.

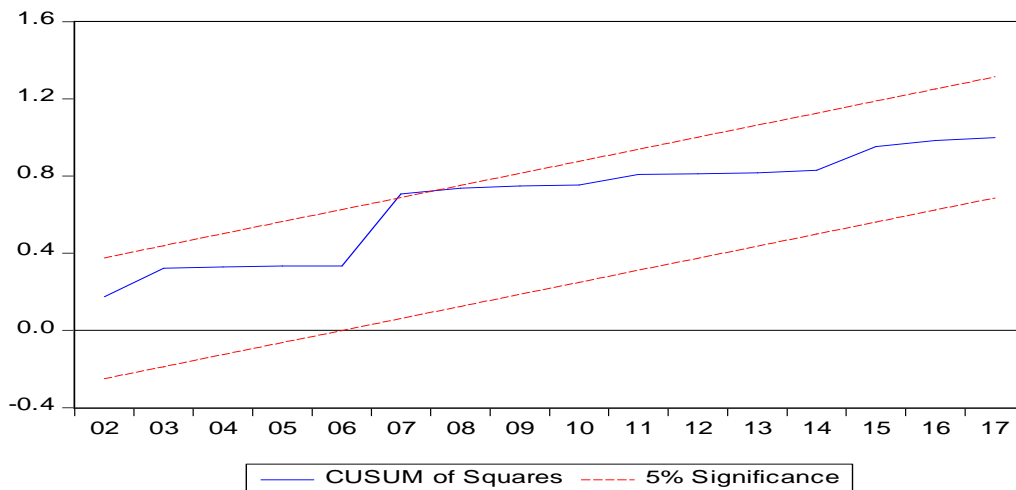
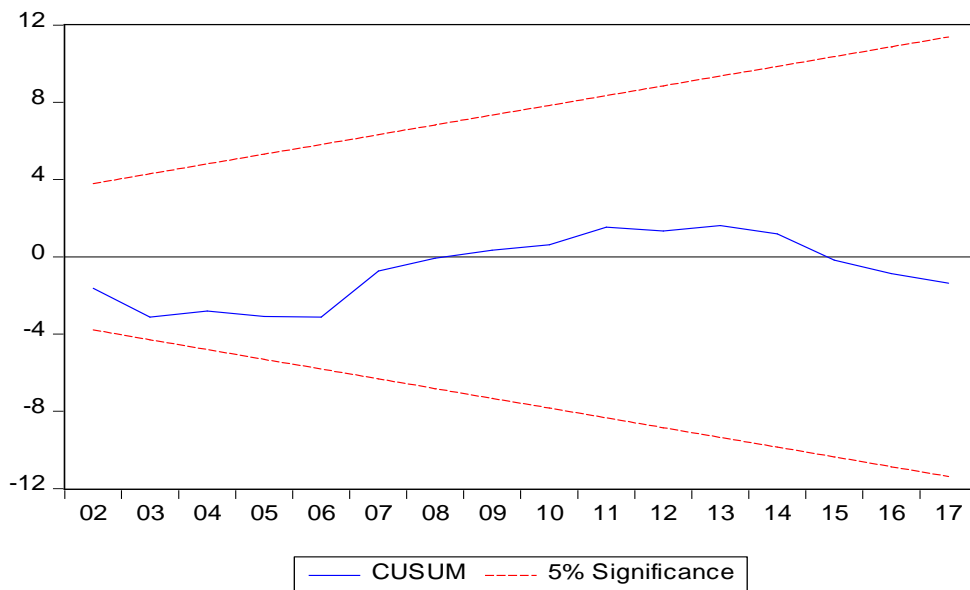
Table 4-6 Breusch-Godfrey test for Serial Correlation

Breusch-Godfrey Serial Correlation LM Test:			
Null hypothesis: No serial correlation at up to 1 lag			
F-statistic	0.032179	Prob. F(1,30)	0.8588
Obs*R-squared	0.040716	Prob. Chi-Square(1)	0.8401
Null hypothesis: No serial correlation			

Test of stability of the parameters

Another fundamental assumption of classical regression model is that the parameters remain constant across sample. In other words, the model is stable. The stability of the model is also another prerequisite for the results to be dependable. According to (Heij, Boer, Franses, Kloek, & Dijk, 2004) Stability refers to the situation where the parameters remain constant over time. In some sense stability is related to structural change. There are many methods available of testing stability. They are generally Chow test and predictive failure tests. Chow

test is the easiest and most commonly used approach. But in this particular test the CUSUM (cumulative sum) and CUSUMSQ (Cumulative sum square) which is based on recursive regression were used. The CUSUM test plots both sequences of CUSUM and the critical lines for conducting CUSUM test. The graphs below show plots of the CUSUM and CUSMSQ tests. It indicates that both CUSUM and CUSMSQ are within 5% significance interval. Therefore, we can conclude that the model is stable.



4.5 Cointegration analysis: Bound testing approach

As it can be seen above the variables are integrated of order 1. This means we cannot apply classical regression techniques to investigate determinants of demand. The variables should be transformed otherwise the regression results would be spurious. However, thanks the works of Engle and others transformation is not necessarily the case if the variables are cointegrated. Thus, the natural step that follows is to test for cointegration. There are at least three tools available to test cointegration. These are Engle-Granger, Johansen procedure, bound testing. The difference between the three were fairly discussed in chapter three. Engle granger is limited to two variables model while Jonsen procedure which depend on VAR model requires large sample size data.

The relevant approach with small sample size data such as like this is Bound testing which depends on ARDL model. In this approach, first the model estimated based on ARDL model. Accordingly, ARDL model is estimated using EViews. The dependent variable is LOGPKM(logarithms of passenger kilometer) while the independent variable or dynamic regressor logarithms of Real GDP (LOGGDP), log of air transport service price index(LOGPx), Logarithms of rail transport price index (LOGPy) . The 9/11 dummy was also used as exogenous regressor.

The appropriate lag length is selected based on Schwarz information criteria. By taking into account this tradition, the maximum lag length is set to two (2). It is customary to set lag length to 1 in models that use annual data. The best model with lower SIC value is found to be ARDL (1, 1, 0, 0). This was automatically selected by Eviews.

Bound testing approach is based on F-statistics and two critical values which are called I(0) and I(1) bound. If the F-statistics is greater than I(1) bound, the variables are cointegrated. On the hand if they are less than I(0), they are not cointegrated. If it falls in between the two it is said to be inconclusive. As it is shown in the table below the F-statistics from the regression in levels is above I(1) even at 1% level of significance for sample size of 38. Thus, we can conclude that the variables are cointegrated. It implies that they have long run relationship.

Table 4-7 Bound tests and Critical values

Sample size (n)	Significance level					
	10%		5%		1%	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
1000	2.37	3.2	2.79	3.67	3.65	4.66
40	2.592	3.454	3.1	4.088	4.31	5.544
35	2.618	3.532	3.164	4.194	4.428	5.816

F-statistics = 6.0396 K= 3, actual sample size = 38

4.6 Analysis of Long run Dynamics

As it is indicated above the variables have long run equilibrium relationship. The direction of the relationship is predetermined by the researcher based on existing economic theory and common sense. PKM is treated as effect variables and others as cause or explanatory variables. Thus, the causality test is not considered in this study.

As it is indicated in table below, GDP and price of railway transport affects demand positively while price of air transport affects demand negatively in the long run. all the variables are found to be statistically significant. GDP is and price of rail way transport are significant at 1% level of significance while price of air transport is significant at 10%. The responsiveness of demand to theses variables varies. It is more responsive to income than prices. When income increases demand increases by more than proportionate. On the other hand when prices changes demand changes by less than proportionate. Specifically, a 1% increase in GDP leads to a 1.3% increase in demand. As for prices when price of air transport rises by 1%, demand decreases by 0.39%. On the other hand, when price of alternative mode

of transport in this case Rail transport rises, demand for air transport rises by 0.58%. It is responsive but less. It implies that though we can conclude that Rail transport is substitute for air transport it is not good substitute in this case.

Table 4-8 Long run coefficients

Levels Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGGDP	1.386165	0.273725	5.064088	0.0000
LOGPx	-0.390569	0.220985	-1.767403	0.0870
LOGPy	0.582069	0.192837	3.018448	0.0050
C	-12.22168	3.265969	-3.742130	0.0007

$$EC = LOGPKM2 - (1.3862*LOGGDP1 - 0.3906*LOGP1 + 0.5821*LOGP2 - 12.2217)$$

4.7 Analysis of Short run dynamics

By running the condition regression, we can also obtain the short run coefficient. As it is evident from the table below, demand for air transport is negatively affected by its own price and positively affected by income and price of the substitute. It is found that all variables are statistically significant at 1% level. The result indicates that as price of air transport increases by 1%, demand decreases by 0.14%. This means air transport demand is price inelastic.

When it comes to income, a 1% percent increase in income leads to a 1.05% increase in demand. This shows that demand for air transport is elastic with respect to income. But it is not practically different from one. The low responsiveness of air transport demand in Norway shows that air transport is necessity. In some parts of the country it is the only means of transport available. This is true for many islands. The mountainous nature of the country makes alternative mode of transport less attractive if not impossible.

The impact of price of substitute is positive but significant but the elasticity is less than unity. This is again partly explained by the fact that air transport has no substitute in Norway.

The result is in line with economic theory and previous researches. The demand theory predicts that demand of for a good or service is positively related to income and negatively related to its own price.

The other factor investigated in the model is external factors. Among the external factors the impact of 9/11 terror attack was investigated. It is found that 9/11 terror attack has reduced demand for air transport. The impact was significant. It has shifted the intercept of the demand equation down ward.

Table 4-9 Short run effects

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGGDP1)	1.059779	0.354870	2.986383	0.0055
D(LOGP1)	-0.148674	0.064863	-2.292127	0.0288
DLOGP2)	0.221570	0.058244	3.804143	0.0006
9/11 dummy	-0.090780	0.031676	-2.865939	0.0074
C	-4.652298	1.777451	-2.617398	0.0136

4.8 Speed of adjustment.

Table below shows the error correction model estimation where we can find cointegration coefficient or speed of adjustment. The ARDL model cointegration analysis helps us not only to estimate the long run and short run effects but also to find the speed of adjustment. This measures the short-run adjustments of the deviations of the dependent variable (Y) from their long- run equilibrium values. If it deviates from the values that corresponds to long run equilibrium values, it will tend to move downward or upward toward its equilibrium value.

As it is discussed in methodology section, change in dependent variables arises from change in X and/or deviation from the equilibrium relationship/equilibrium error. If the variables are cointegrated the error is corrected, and the variables returns to its equilibrium level. This requires that the error term is negative and significant. In this particular case, the error correction term is negative as expected and significant. It shows that the speed of adjustment is 38%. It indicates that it corrects 38% of the deviation the previous year deviation. In other words, it takes about three years to fully correct for the deviation.

Table 4-10 Error Correction model estimation

ECM Regression				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGGDP)	1.059779	0.191331	5.538991	0.0000
D2001	-0.090780	0.016356	-5.550179	0.0000
CointEq(-1)*	-0.380659	0.065192	-5.839057	0.0000

5.0 Conclusive remarks

Demand for air transport and its determinants are of great interest for business managers and government policy makers and academic researchers. Airline and airport operators develop strategies based on demand though sometimes they try to change/endogenize the demand itself. It helps government to make policies and set priorities. Study of demand for air transport is fascinating by itself. It has its own intrinsic value as any other knowledge. Researches in the area particularly in the case of Norway is limited and it has much dynamics in the industry. This study is initiated with the aim of filling this gap.

It investigates factors affecting domestic demand for air transport in Norway. In this study demand is measured by passenger kilometer. Three potential variables for which data are available were identified. These are income as measured by GDP, own price that is price of air transport as measured by air transport service price index and price alternative mode of transport, Railway, as measured by price index of rail transport services. The data were mainly obtained from Statistics Norway.

The econometric model selected for investigation is Autoregressive Distributed lag model. It is dynamic time series model. All necessary tests were conducted and both long run and short run effects were estimated.

The study found that all the variables under considerations passenger kilometers, real GDP, Air transport price index and rail transport price index are not stationary in levels. They are found to be integrated of order 1. The bound testing which is based on ARDL shows that there is cointegration among these variables. There exists long run equilibrium relationship. The dependent variable adjusts to equilibrium level when there is deviation. The speed of adjustment is found to be 38%. It indicates that it corrects 38% of the deviation of the previous year. This implies that it takes about two years to fully correct the deviation.

In the long run demand is positively affected by GDP and price of rail transport and negatively by its own price. This is in line with economic theory as well as many other previous researches. The responsiveness of demand is however low. Demand for air

transport is responsive to income but less responsive to prices. In other words, it is elastic to income and inelastic to prices.

Similarly, GDP and price of substitute affects demand positively while own price affects demand negatively. However, the magnitude of the effects is lower for all variables. It is true that in short run demand is less responsive since there is short time make adjustment. transport demand both in short run and long run.

This study adds value to existing body of knowledge. Studying from different perspective and use of different approaches can further enrich the knowledge in this area. Use of panel data, intercity/inter-port demand studies, microlevel behavioral approach are some potential areas of research in the future.

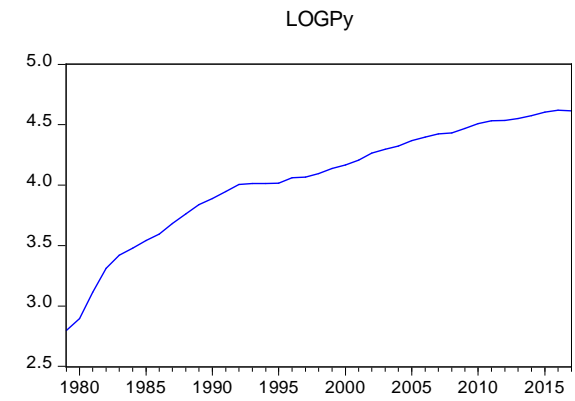
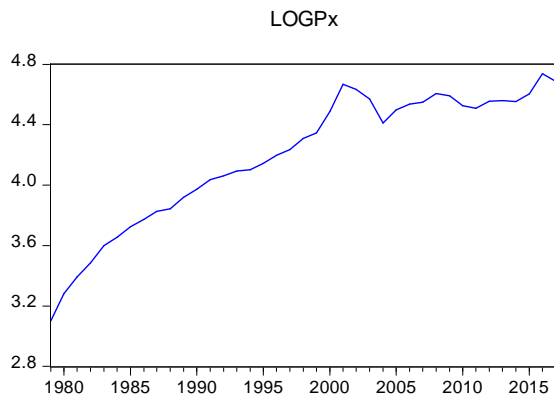
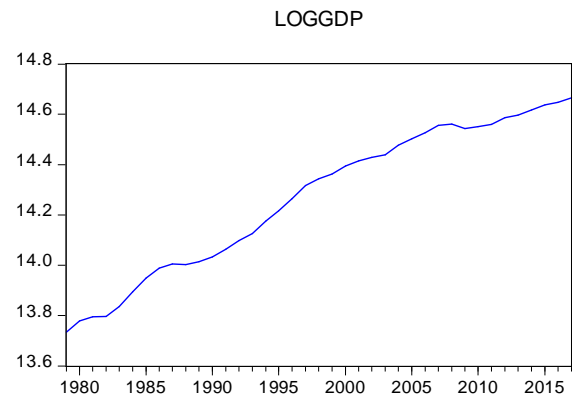
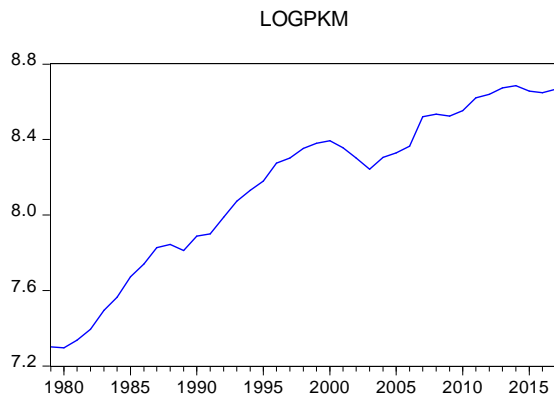
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7.0 Appendices

7.1. Time plots of Explanatory variables



7.2. Regression output

ARDL Long Run Form and Bounds Test
 Dependent Variable: D(LOGPKM2)
 Selected Model: ARDL(1, 1, 0, 0)
 Case 2: Restricted Constant and No Trend
 Date: 05/24/19 Time: 10:22
 Sample: 1979 2017
 Included observations: 38

Conditional Error Correction Regression				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.652298	1.777451	-2.617398	0.0136
LOGPKM2(-1)*	-0.380659	0.102328	-3.719986	0.0008
LOGGDP1(-1)	0.527657	0.174320	3.026950	0.0049
LOGP1**	-0.148674	0.064863	-2.292127	0.0288
LOGP2**	0.221570	0.058244	3.804143	0.0006
D(LOGGDP1)	1.059779	0.354870	2.986383	0.0055
D2001	-0.090780	0.031676	-2.865939	0.0074

* p-value incompatible with t-Bounds distribution.
 ** Variable interpreted as $Z = Z(-1) + D(Z)$.

Levels Equation Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGGDP1	1.386165	0.273725	5.064088	0.0000
LOGP1	-0.390569	0.220985	-1.767403	0.0870
LOGP2	0.582069	0.192837	3.018448	0.0050
C	-12.22168	3.265969	-3.742130	0.0007

EC = LOGPKM2 - (1.3862*LOGGDP1 -0.3906*LOGP1 + 0.5821*LOGP2 -12.2217)

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
Asymptotic: n=1000				
F-statistic	6.039613	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66
Finite Sample: n=40				
Actual Sample Size	38	10%	2.592	3.454
		5%	3.1	4.088
		1%	4.31	5.544
Finite Sample: n=35				
		10%	2.618	3.532
		5%	3.164	4.194
		1%	4.428	5.816

7.3. Error correction term

ARDL Error Correction Regression
 Dependent Variable: D(LOGPKM2)
 Selected Model: ARDL(1, 1, 0, 0)
 Case 2: Restricted Constant and No Trend
 Date: 05/24/19 Time: 11:00
 Sample: 1979 2017
 Included observations: 38

ECM Regression				
Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGGDP1)	1.059779	0.191331	5.538991	0.0000
D2001	-0.090780	0.016356	-5.550179	0.0000
CointEq(-1)*	-0.380659	0.065192	-5.839057	0.0000
R-squared	0.603255	Mean dependent var		0.035961
Adjusted R-squared	0.580584	S.D. dependent var		0.047002
S.E. of regression	0.030440	Akaike info criterion		-4.070484
Sum squared resid	0.032430	Schwarz criterion		-3.941201
Log likelihood	80.33920	Hannan-Quinn criter.		-4.024486
Durbin-Watson stat	1.919514			

* p-value incompatible with t-Bounds distribution.

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	6.039613	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66