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AIRLINE DEMAND GROWTH AND FORECASTING USING AN ECONOMETRIC MODEL: A COMPARATIVE EMPIRICAL ANALYSIS AMONG BRAZIL, CHINA AND INDIA

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AIRLINE DEMAND GROWTH AND FORECASTING USING AN ECONOMETRIC MODEL: A COMPARATIVE EMPIRICAL ANALYSIS AMONG BRAZIL, CHINA AND INDIA

A THESIS APPROVED FOR THE
SCHOOL OF INDUSTRIAL AND SYSTEMS ENGINEERING

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I would like to dedicate this thesis to my parents, Abraham Mathew, and Ansamma Abraham.

I thank my Lord for everything.

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Glossary

Gross Domestic Product: Gross domestic product (GDP) is the monetary value of all the finished goods and services produced within a country's borders in a specific time period. Though GDP is usually calculated on an annual basis, it can be calculated on a quarterly basis as well. GDP includes all private and public consumption, government outlays, investments and exports minus imports that occur within a defined territory.

GDP Growth Rate: Real economic growth rate is the rate at which a nation's Gross Domestic product (GDP) changes/grows from one year to another. GDP is the market value of all the goods and services produced in a country in a particular time period.

GDP per Capita: GDP per capita is a measure of average income per person in a country. This measure National income / National Output and National expenditure. GDP per capita divides the GDP by the population.

Inflation GDP Deflator: The GDP price deflator is an economic metric that accounts for inflation by converting output measured at current prices into constant-dollar GDP. The GDP deflator shows how much a change in the base year's GDP relies upon changes in the price level. Also known as the "GDP implicit price deflator".

Consumer Price Index: The consumer price index (CPI) is a measure that examines the weighted average of prices of a basket of consumer goods and services, such as transportation, food and medical care. The CPI is calculated by taking price changes for each item in the predetermined basket of goods and averaging them; the goods are weighted according to their importance. Changes in CPI are used to assess price changes associated with the cost of living.

Exchange Rate Fluctuation: The price of a nation's currency in terms of another currency. An exchange rate thus has two components, the domestic currency and a foreign currency, and can be quoted either directly or indirectly. In a direct quotation, the price of a unit of foreign currency is expressed in terms of the domestic currency. In an indirect quotation, the price of a unit of domestic currency is expressed in terms of the foreign currency.

Oil prices: Crude oil is a naturally occurring, unrefined petroleum product composed of hydrocarbon deposits and other organic materials. World crude oil prices are established in relation to three market traded benchmarks (West Texas Intermediate [WTI], Brent, Dubai), and are quoted at premiums or discounts to these prices. The OPEC basket price and the NMEX futures price are also sometimes quoted.

Population, total: Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship--except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of their country of origin.

Population 15-64 (% of total): Population ages 15 to 64 is the percentage of the total population that is in the age group 15 to 64.

Abstract

Aviation Industry is growing in an unprecedented pace in the twenty first century. Today, over 1000 commercial airlines operate more than 15,000 aircrafts, carrying 3.1billion people and 51.7m tons of freight every year. Therefore air traffic analysis is a critical exercise for both airlines and the concerned civil aviation authority. China, India and Brazil are the three countries closely watched by economists, sociologists and political observers, seen as key indicators of the new world economic order. Air traffic growth and air transportation networks in these three countries is amplifying every day. The fundamental research question being asked in this thesis, is what are the major aviation activity parameters and measures of forecast in these three countries and how can an econometric model be developed to forecast the air traffic demand? In response to the research question, this thesis addresses analyzing and forecasting air travel market in China, India and Brazil using econometric models. Historic air traffic demand data from the year 1970 to 2014 is used to analyze and understand the key demand factors affecting scheduled aviation market in India, China and Brazil. With the decisive factors determined, an attempt is made to develop diverse econometric models for the air travel demand with different combinations of explanatory variables utilizing stepwise regression technique. Multiple regression analysis is performed on the different econometric models developed in order to find the most appropriate model using $adjusted\ R^2\ value$. A five year forecast (short term) is executed using the most appropriate model econometric model to estimate scheduled air traffic demand in the three countries. The forecasting

results can be used by OEM (Original Equipment Manufacturer) like Airbus and Boeing or concerned civil aviation authorities and airlines to perform market study and thereby ensuring the air traffic demand is well matched with the supply.

1. CHAPTER ONE AIRLINE DEMAND GROWTH AND FORECASTING USING AN ECONOMETRIC MODEL: A COMPARATIVE EMPRICIAL ANALYSIS AMONG BRAZIL, CHINA AND INDIA

In this chapter, the importance, current practices and requirements regarding the problem of developing an econometric model are addressed. Then, the research gap is highlighted, followed by defined research question and expected contributions. Then, the proposed methodology for air traffic forecasting is explained.

The organization of Chapter 1 is shown in Figure 1. The importance of air traffic demand forecasting in the twenty first century is discussed in Section 1.1. This section is followed by the expansion and surge in air traffic in the emerging economies like Brazil, China and India in Section 1.1.1. From the perspective of air traffic demand, the major demand factors that affect the global aviation industry is addressed in Section 1.2, and the demand factors associated with Brazil, China and India are discussed in Section 1.2.1. The different types of air traffic demand forecasting currently used in the industry is discussed in Section 1.3. The gap analysis is discussed in Section 1.4, and research questions and corresponding hypotheses are established in Section 1.5. The methodology used is explained briefly in Section 1.6.

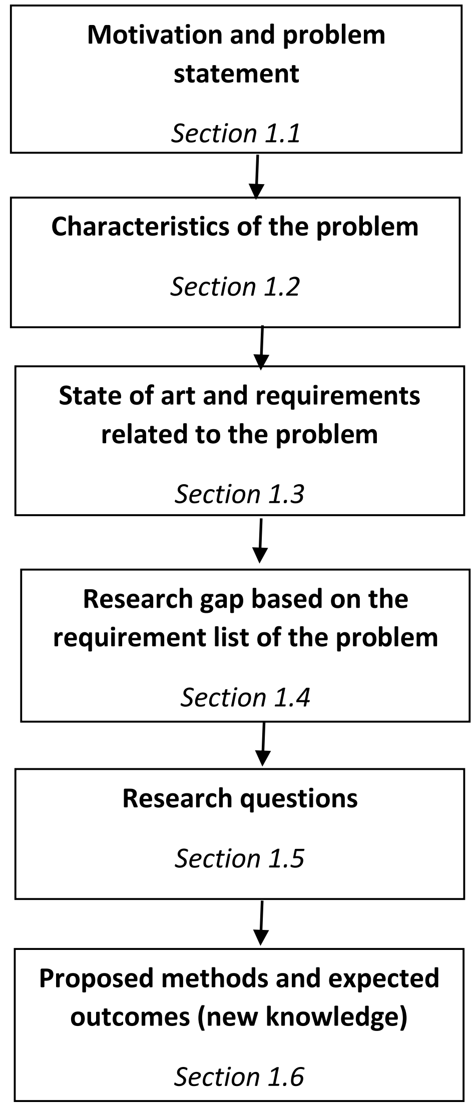


Figure 1 Structure and connectivity between different sections in Chapter 1

1.1. IMPORTANCE OF THE AIR TRAFFIC DEMAND FORECASTING IN THE TWENTY FIRST CENTURY

The global airline industry continues to grow rapidly, consistently and with robust profitability. Measured by revenue, the industry has doubled over the past decade, from US$369 billion in 2004 to a projected $746 billion in 2014, according to the International Air Transport Association (IATA)[1]. According to IATA's Vision 2050 report released in 2011 "The global economy has also seen reasonably steady growth over the past 40 years, with the GDP of the G20 countries increasing from $38 trillion in 2009 to $170 trillion today. China became the world's largest economy just over 15 years ago and today China, India, Brazil, Russia and Mexico account for just over 50% of the GDP of the G20 countries. Indonesia, Philippines, Vietnam, Iran, Turkey, Chile, and South Africa are not far behind[2]". Forty years ago the industry's two largest markets were the United States and Europe. But this has not been the case for a long time. The shift eastward started early in the century supported by strong growth in economy in China and India. When Indians started travelling with the same propensity as North Americans, that scheduled air transportation market alone jumped to three billion passengers. Yet it's one of the sustaining ironies of the industry that the companies that actually transport passengers from one destination to another, the most critical link in the chain, struggle to break even. Given these unique situation, airlines need to focus on gross sales or revenue because their limited profitability depends almost solely on revenue gains, while increasing productivity in order to shore up and perhaps even increase margins [2].

1.1.1. Air Traffic Demand in Emerging Economies (Brazil, China, and India)

Experts from industry say that aviation industry is moving towards a saturated point in the United States and Western Europe, the industry's low margins are driven by its fragmentation, and resulting in overcapacity in these markets which suggests that the general growth rate will be limited to 2.2% CAGR (Compounded Annual Growth Rate) [3]. However, at the same time the world's leading aircraft manufacturers are forecasting blue skies ahead for the aviation industry over the next two decades. The 2014 market-outlook reports from Boeing, Airbus, Bombardier and Embraer predict the world's aircraft fleet to double in size over the next 20 years [4]. Well, then the natural question that arises is if not US and Europe then who are Boeing, Airbus and other OEM's talking about. Yes, it is Brazil, China and India. The aviation industry in these three countries are growing in pace unprecedented. India's civil aviation industry is on a high-growth trajectory. India aims to become the third-largest aviation market by 2020 and the largest by 2030. Despite questions reverberate regarding the China's economy and slowing growth, nothing really seems to affect the robust aviation industry, with surging growth rate of 13% during Q1 2015 and surpassing 100 million passengers for the first time. Brazil has seen passenger growth jump by 39% over the past five years with the economies expected to double over the next 10 years with the upcoming Olympics helping to drive growth. Aviation Industry in India and China have gone through a lot of changes in the past several decades, with new companies coming into business and few airlines going out to business, stiff competition from low-cost airlines and much more. With the changing economic environment in both these countries, it would be interesting to look into the several factors that would drive passenger traffic demand and other auxiliary industries [5]. Given the situation, factors like economic growth, GDP and all other macroeconomic and microeconomic variables will play a major role in determining number of passengers preferring to travel by air in Brazil, China and India. Hence there is a great need of some serious study in order to help both airlines and civil aviation authorities to cater to this growing number of passengers [6].

1.2. MAJOR DEMAND FACTORS AFFECTING THE GLOBAL AVIATION INDUSTRY

The air traffic demand factors fall into two categories. The first category contains factors that directly affect the air transportation on a day to day basis. Some of them are: exogenous demand shocks, economic downturns, political and economic sanctions, competition from other transportation modes and civil unrest. The second category, contains demand factors that indirectly affect the air traffic demand. Those are the country's economic attributes like Gross Domestic Product (GDP), GDP per capita, GDP growth rate, supporting infrastructure investment, exchange rate fluctuations, political and macroeconomic stability, and growing consumer demand [7]. In addition to these indirect factors, other general factors that help stimulate air passenger development worldwide are changes in management practices, and liberalization and globalization of trade in manufacturing and services.

1.2.1. Direct factors affecting global aviation

The various demand factors being discussed in this thesis are detailed below:

- <u>Exogenous Demand Stocks</u>: These include acts of terrorism, perceived health risks, natural disasters, aviation accidents, and oil shocks. Since airline demand is driven by conditions in the particular economy and the rest of the world, external factors affect both sides of the economy [7].

- <u>Economic downturn</u>: Airline demand is directly affected by the economic downturn in a particular country and the rest of the world. It impacts both the in-bound and out-bound travel needs of the region. In some countries airline demand is solely based on international consumers, both for business and leisure, so the travel demand in these countries will depend on the economic situation around the world [7].
- <u>Political and Economic Sanctions</u>: This plays a great role if serious travel restrictions are imposed on the citizens of a country or changes in visa requirements that may constrain or promote both inbound and outbound travel needs [7].
- <u>Competitions from other modes of transport</u>: Demand for short-haul and medium-haul air services is subject to competition from surface transportation modes such as roadways and railways. In particular, improvements in non-aviation transport infrastructure may lead to unsustainable competition on certain routes [7].

1.2.2. In-Direct Factors affecting global aviation

The in-direct factors being discussed in this thesis is detailed below:

- <u>Economic Liberation</u>: Economic liberation can be achieved in a variety of ways including economic liberalization, institutional reforms, investment into supporting infrastructure, and educational reforms which increase the economy's skilled labor stock. Specifically, decrease in the number of government regulations and restrictions enabled the flows of foreign direct investment. All these leads to economic prosperity, thereby making air travel affordable to major sections of the society.

- Institutional & Political Reforms: The economies of China and India were effectively isolated from the global economy until the institutional and political reforms were implemented over the last several decades. As a result of these reforms, manufacturing and services came to play a more prominent economic role. Similarly, air transportation demand increased in China and India after the government decided to pursue international economic integration in the early 1980s and 1990s respectively.
- Supporting Infrastructure Investment: Changes in the institutional framework and supporting infrastructure investment stimulated the growth of foreign investment flows into China, India, United Arab Emirates and Qatar. China began encouraging foreign investments and market-oriented economic developments in the early 1980s and quickly became an attractive investment location due to its good physical infrastructure, availability of low-cost labor and a large domestic market size. India's software export industry has been expanding since the 1990s due to further economic liberalization and development of local supporting infrastructure, including telecommunications, which increased the level of foreign direct investment into the Information Technology sector.
- Exchange Rate Fluctuations: The demand for goods and services produced by the economy is influenced by the exchange rates and trade agreements with the rest of the world. Fluctuations in exchange rate

changes the relative price of imports and exports. Local currency appreciation makes the country more expensive compared to other economies. The economic literature suggests that exchange rate regimes have an impact on trade flows, thereby impacting air passengers flow and cargo flow destined for international destinations [8].

- Political and Macroeconomic Instability: Political and macroeconomic instability may suppress both the economic and air transportation system developments as was demonstrated in Bulgaria and Zimbabwe. In both of these countries, the policies implemented by the ruling political parties resulted in deteriorating economic and social conditions decreasing the number of inbound air passengers.
- Consumer Price Index: Strong economic growth can stimulate private consumer demand which includes the air travel demand. The growth of domestic demand in India, Turkey and Indonesia was affected by the changes in the air transportation industry. The low-cost demand stimulation effect following deregulation helped stimulate the air passenger travel, particularly the leisure markets, in India and Indonesia. In China, while the majority of air passengers still travel for business purposes, the demand for leisure services which provide access to tourism destinations increased with an increase of China's middle class.
- Change in Management Practices: Other general economic trends which contribute towards changes in air mobility and air cargo usage include the general worldwide trend toward globalization of trade in manufacturing and

services, changes in management practices, such as, progressive economic and trade liberalization reforms between countries and political changes. Changes in economic attributes in competing economies may also influence the demand for air transportation services.

- Environmental Issues: Like any other form of public mass transport that relies on finite planetary resources, aviation (in its present form) cannot be considered sustainable in the very long term. Because of the finite nature of the resources upon which aviation relies, it is more realistic in the medium term to think how best to improve the sustainability of air transport rather than it achieving sustainable development.

1.2.3. Demand factors associated with Brazil, China and India

a) In this section, the demand factors closely associated with Brazil is discussed.

Figure 2 Air travel passengers in Brazil in recent years

[9]

Figure 3 GDP growth in Brazil in recent years[9]

Brazil is the largest country, in terms of size and population, in South America. Brazil’s aviation sector is comprised of multiple local and international airlines. Brazil has approximately 2,500 airports (including landing strips). São Paulo-Guarulhos International Airport is the largest and busiest airport, with Congonhas and Campo de Marte serving as regional airports in São Paulo. TAM Airlines is the biggest Brazilian airline followed by GOL and Azul which operate regionally with some international services.

In 2011 Brazil became the sixth-largest economy in the world [10]. With substantial oil and gas reserves continuing to be discovered off Brazil's coast in recent years, the country is now the world's ninth largest oil producer. The country is enjoying an economic boom because of high oil prices, which in turn has led to rapid growth. Brazil is also the largest Latin American economy and one of the so-called BRIC nations together with Russia, India and China, with growth far outpacing the US and Western Europe. From Figure 2 and Figure 3, a swift increase is seen in no of passengers travelling through Brazilian airports and the

GDP growth is also seen to be on the rise since 2006. This rapid growth makes it an attractive destination for foreign investors. The economy of Brazil was only marginally impacted by the global financial crisis in 2009 in which a growth rate of -0.6% year-on-year was recorded. Air travel in Brazil is expected to double over the next decade, driven by an average economic growth rate of approximately 4% per year which in turn will see the average level of disposable income rise across the country, driving demand for air travel. Due to the large size of the country air transportation is a crucial link in Brazil’s infrastructure. The National Civil Aviation Agency (Agência Nacional de Aviação Civil), or ANAC, is the regulatory body in the country. The Brazilian aviation industry has experienced a significant capacity growth of 39% over last five years driven mainly by the introduction of low cost carriers into the region [11]. As the region’s economies grow, Brazil presents opportunities for international carriers and the aviation industry as a whole.

The Brazilian aerospace industry is dominated by Embraer and its suppliers, now the third largest commercial aircraft producer in the world. Added to this, the nation’s over-200 million population and vast geographic area, air travel will continue to grow [11]. The civil aviation industry is an important link in the continuing growth of Brazil and to connect the most populous cities across the country. The dependence on this system, along with the country’s policy to improve the industry, makes the aviation sector an excellent area for investment. The Brazilian aviation industry is going through a period of rapid growth, with a growth in passenger demand for travel combined with greater domestic and international investment into the country. Brazil has seen passenger growth jump by 39% over the past five years with the economies expected to double over the next 10 years with the upcoming Olympics helping to drive growth. The rapid growth has presented a challenge to the airports and surrounding infrastructure as they try to keep pace. But investment continues into the country as Brazil's economy and the rest of South America's economy strengthens, presenting new opportunities for growth for US and European carriers looking for strong yielding routes.

Brazil: Change Factors Summary

- Gross Domestic Product
- GDP per Capita
- GDP Growth rate
- Inflation GDP Deflator
- Exchange Rate Fluctuation
- Consumer Price Index
- Population
- Population ages 15-64
- Oil Prices
- Accidents Deaths
- No of Accidents

b) In this section, the demand factors closely associated with China is discussed.

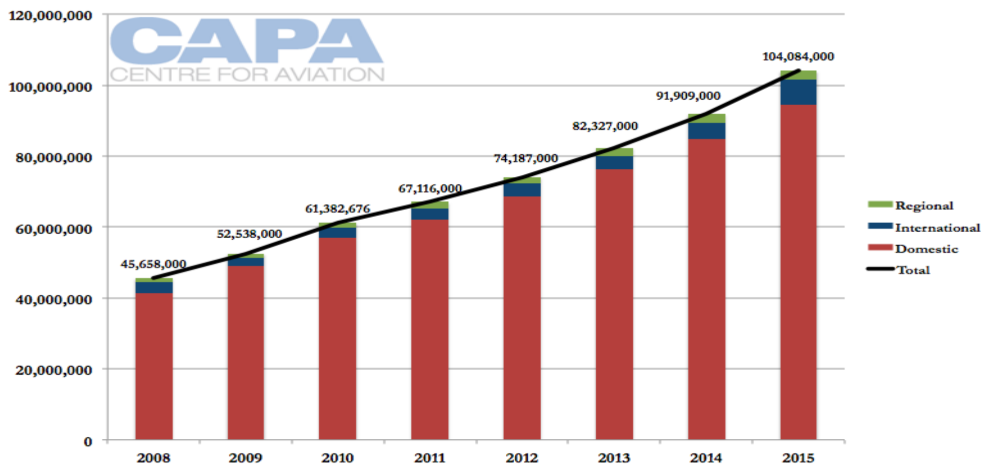


Figure 4 Air travel passengers in China in recent years[9]

Figure 5 GDP growth in China in recent years[9]

On analyzing Figures 4 and 5, China's air transportation sector and economy have seen rapid expansion in the last decade. Between 1985 and 2015, the average growth rates for the number of passengers carried by China's airlines and GDP were 14.8% and 9.85% [12]. During these years, the air transportation industry underwent several changes both in the regulatory framework and infrastructure capability. These changes allowed for the development of both international and domestic aviation markets. In particular, China's rapid economic growth and increase of the discretionary income of the emerging middle class fueled the development of domestic air travel demand. In particular, air transportation aided in the development of the manufacturing sector because it provided access to foreign capital and knowledge and enabled flows of goods to major global markets. Ready access to air transportation has enabled these high-skill professionals to maintain cross-border networks abroad while taking advantage of the local opportunities in China. While the majority of air passengers from China still travel for business purposes, as the country's economy continues to grow, air transportation has come to play an important role in providing access to tourism destinations for China's growing middle class.

The regulatory changes in China's air transportation system reflect the general economic reforms in the country which started in the late 1970s. The first regulatory change occurred in 1980 when the Civil Aviation Administration of China was separated from the Air Force and came under the direct supervision of the state council [13]. Since then, deregulation, privatization and airline consolidation were encouraged by the government to increase operational efficiency and profitability of the airline industry. However, many of the industry's operational aspects still remain under governmental control. China began deregulating its air transportation sector in 1987 when it separated the Civil Aviation Administration of China from direct management of airlines and airports and proceeded with further deregulation and privatization reforms in 1997.

The growth in air traffic has put a strain on the existing aviation infrastructure and the country has been investing into new airports, runways, terminals, and surveillance infrastructure. China's airport infrastructure consists of 230 civil airports by the end of 2015.

China's growing consumer markets and interaction with the rest of the world resulted in rapid development of both air passenger and cargo services over the last twenty years. The growth was in part stimulated by the reforms initiated in the mid-1980s which deregulated the domestic airline industry and resulted in expansion of the domestic network following the creation of new airlines. To accommodate the rapid growth in demand, the government has been investing into the aviation infrastructure with particular emphasis on development of regional airport and aviation infrastructure to promote economic development away from Eastern hubs. In addition to development of regional airport infrastructure, infrastructure expansion projects were conducted in major centers including Beijing, Guangzhou and Shanghai. Limited liberalization of passenger markets in recent years has also allowed the low-cost international carriers to extend their operations to China.

In addition to factors which have stimulated the growth of air transportation supply, China has had strong growth in air travel demand both for passengers and cargo. In particular, China's growing middle class and tourism awareness have helped stimulate domestic and outbound air travel demand. In addition, inbound travel demand has been growing following the institutional and political reforms in the 1990s which have resulted in greater knowledge and investment flows both from foreign nationals and returning Chinese expatriates. In addition to the institutional reforms, physical supporting infrastructure played an important role in the growth of these flows and the development of export-based manufacturing and services industries. The enabling impact of air transportation plays a significant role in China's economic development and reflects the country's unique factor conditions: growing market-oriented economy, well-developed supporting physical infrastructure, low-cost labor, and government support of foreign investment. The availability of air passenger services allows China to access foreign investors, it enables the flows of remittances, knowledge and investment from the diaspora, and helps enable inbound tourism as well as develop the domestic and outbound tourism industries.

China: Change Factors Summary

- Gross Domestic Product
- GDP per Capita
- GDP Growth rate
- Inflation GDP Deflator
- Exchange Rate Fluctuation
- Consumer Price Index
- Population
- Population ages 15-64
- Oil Prices
- Accidents Deaths
- No of Accidents

c) In this section, the demand factors closely associated with India is discussed.

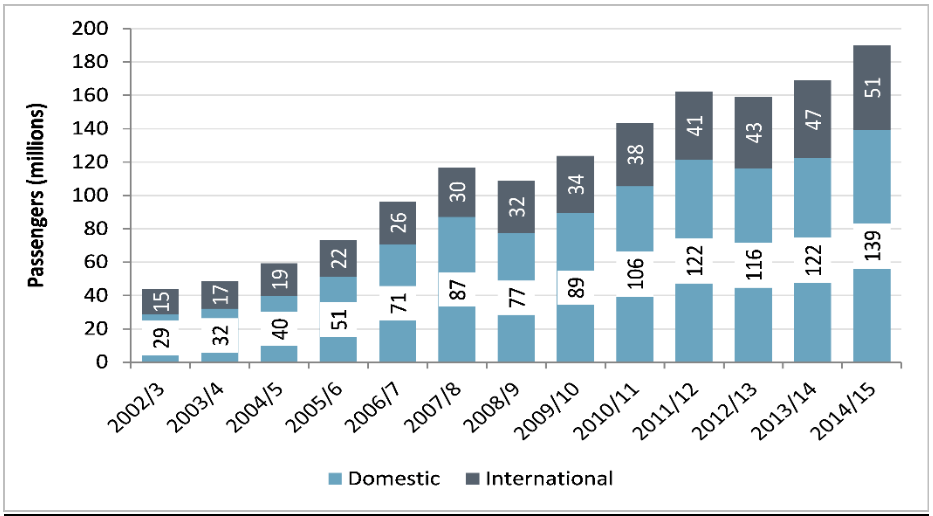


Figure 6 Air travel passengers in India in recent years[9]

Figure 7GDP growth in India in recent years[9]

On analyzing Figures 6 and 7, air transportation development in India has been surging with economic development since the air passenger traffic experienced unprecedented growth starting in 2003. India is the largest country in South Asia and the world's second most populous country. While the change in the growth rate of air passenger traffic is relatively recent, the country's economy has experienced steady growth over the last two decades with an average rate of 6.41% between 1985 and 2015 [12].

The recent increase in the air passenger growth rates has been primarily due to domestic deregulation and the ensuing development of low-cost carriers which led to a sharp drop in prices and enabled personal air travel for the country's growing middle class. In addition to domestic air passenger growth, India's international aviation flows have increased substantially in recent years following the signing of bilateral aviation agreements which enabled international airlines to gain access to India's aviation markets. India's economic liberalization also helped stimulate air passenger demand. Over the years, business passenger travel and foreign investors in particular have come to play an important role as India has continued to develop its services-based industries for international consumer markets. In addition to foreign investors, air transportation has enabled access to the extensive diaspora community affecting inward flows of capital, knowledge and remittances.

Until the early 1990s Indian aviation needs were served by two inefficient state-owned carriers. The government started deregulating the industry in 1988 when it authorized operation of domestic charter flights by private companies. By 1993 private operators had a 30% domestic market share [14]. However, it was only after 2003 that India's domestic aviation has experienced unprecedented growth rates following the entry of the first low-cost carrier Air Deccan which led to a sharp drop in prices and enabled personal air travel for the country's growing middle class[15].

Domestic air services deregulation and introduction of low-cost carriers in 2003 were the major stimulating factors behind India's air transportation growth. In particular, poor level of other transportation infrastructure, growing consumer demand and reduced fares provided by the low-cost carriers enabled rapid growth of the domestic air transportation industry.

From Figure 6, the GDP growth has been experiencing an upward trend. Therefore, stimulating factors included India's economic liberalization and privatization reforms in the early 1990s which affected both air transportation supply and demand. In particular, these reforms enabled both investment into the aviation infrastructure and development of export-oriented industries which rely on access to foreign capital and markets. Gradual liberalization of international passenger services has also stimulated the growth of international passenger traffic. In particular, it allowed foreign airlines to carry passengers on routes where the demand growth was suppressed prior to liberalization because India's national carriers had insufficient capacity to satisfy the potential demand levels.

In general, deficiencies in aviation and airport infrastructure have negatively influenced India's air transportation development. However, recent ownership and privatization reforms have enabled the flow of private funds into the aviation sector and resulted in the construction of several new airports in major urban areas. Specifically, new investments included the construction of green field airports in Cochin in 1999, Hyderabad and Bangalore in 2008, and a second international airport to serve the Mumbai catchment area.

India: Change Factors Summary

- Gross Domestic Product
- GDP per Capita
- GDP Growth rate
- Inflation GDP Deflator
- Exchange Rate Fluctuation
- Consumer Price Index
- Population
- Population ages 15-64
- Oil Prices
- Accidents Deaths
- No of Accidents

1.3. DIFFERENT TYPES OF AIR TRAFFIC DEMAND FORECASTING

There are numerous forecasting techniques used in the airline industry to forecast future volume of air traffic. Some of which are discussed below. However, this is not an exhaustive review, since some of the forecasting tools little used by airlines are not examined. The forecasting methods discussed in this thesis are Qualitative Methods, Time Series Projections,

1.3.1. Qualitative methods

1.3.1.1. Executive judgment

Executive judgement is based on the insight and assessment of a person, who often may not be a forecaster, but who has special knowledge of the route or market in question. Their knowledge will include an understanding of the recent and current traffic growth and of other social/economic developments likely to affect future demand.

1.3.1.2. Market research

Market research techniques are used to analyze the characteristics of demand for both passenger and freight. These techniques will include attitudinal and behavioral surveys of passengers. Such studies might be commissioned from specialist market research companies.

1.3.1.3. Delphi method

Delphi method requires the building up a consensus forecast based on the views of individuals who are considered to have sufficient expertise to be able to anticipate future trends. The process is an iterative one, possibly involving several rounds of consultation.

1.3.2. ` Time Series Projections

Time-series methods make forecasts based solely on historical patterns in the data. Time-series methods use time as independent variable to produce demand. In a time series, measurements are taken at successive points or over successive periods. The measurements may be taken every hour, day, week, month, or year, or at any other regular (or irregular) interval[16].

1.3.2.1. Average rate of growth

The forecast for the value of Y at time t+1 is made at time t equals the simple average of the most recent 'm' observations:

$$\widehat{Y_{t+1}} = \frac{Y_1 + Y_{t-1} + \cdots . + Y_{t-m+1}}{m}$$

1.3.2.2. Moving average growth

The simple moving average model treats the last k observations equally and completely ignores all preceding observations. In order do this, normally three (or more) observations are added together and the average is calculated

$$\widehat{Y_{t+1}} = \frac{Y_1 + Y_{t-1} + Y_{t-2} + Y_{t-3}}{3}$$

1.3.2.3. Exponential smoothing

The most recent observation with a little more weight than the 2nd most recent, and the 2nd most recent should get a little more weight than the 3rd most recent, and so on.

$$y + 1 = \alpha y + \alpha(1-\alpha)y_{-1} + \alpha(1-\alpha)^2 y_{-2} + \alpha(1-\alpha)^3 y_{-3} \ldots ..$$

Let α denote a "smoothing constant" (a number between 0 and 1). Y is the number of passengers in year y and y_{t+1} is the first year forecast.

1.3.2.4. Simple trend

The underlying assumption of this method is that a straight line best represents the trend of the traffic over time and that traffic increases by a constant amount with each unit of time. The technique involves drawing a straight line through the times series so as to produce a best fit. This is normally done by least square method.

1.3.2.5. Moving average trend

Large variations in the past traffic volumes can be reduced by calculating moving average and establishing a new time series. This would contain the trend component in the traffic and it should be easier to fit to a trend line.

1.3.3. Econometric or causal models

Changes in any one of the variable will affect demand. Causal models attempts to measure that causal relationship so that by forecasting or even implementing change in any one of the variables, one can predict the consequent impact on demand levels[16].

1.3.3.1. Regression models

Forecasts from a simple linear model are easily obtained using the equation

$$\hat{y} = \widehat{\beta_0} + \widehat{\beta_1} x$$

Where, x is the value of the predictor that require a forecast. That is, if one input a value of x in the equation one obtain a corresponding forecast $\hat{y}$.

1.3.3.2. Gravity models

Gravity models can be explained with a simple formulation that air traffic between two points is proportional to the product of their populations and inversely proportional to the distance between them; so that:

$$T_{ij} = K \frac{P_i P_j}{D_{ij}}$$

Where, T_{ij} is the traffic between two towns i and j, K is a constant, P_i and P_j are the populations of the towns and D_{ij} is the distance between them.

1.4. RESEARCH GAP

There are several studies done on the topic of airline demand forecasting in the past several years. Most of the studies focus on the time-series method forecasting method and casual forecasting methods, including regression analysis. Moreover, most of the earlier forecast focuses on Western aviation markets including United States, Europe etc. The forecasted surge in air traffic in global aviation has been characterized by a greater use of macro-economic variables, making the exercise even more relevant for airline strategy formulation. However, these studies have mainly addressed the US and European market. Hence, demand for the air travel services assumes prime importance and airlines have to be aware of their demand on respective sectors prior to operations. Airline demand forecast is a very important task for air companies to operate an existing airline or open a new airline.

Earlier econometric works did not fully incorporate the role of macro-economic demand factors in airline demand forecasting, nor did they recognize the air accidents statistics in decision variables required in a market model. There is a serious lack of study on emerging markets like Brazil, China and India, where a large chunk of growth is going to take place in the next 20-30 years. Moreover, the existing literatures only focuses on determining the traffic estimates of western markets and did not really care about the air traffic estimates in the emerging economies.

1.5. RESEARCH QUESTIONS AND CORRESPONDING HYPOTHESES

In this section, the research questions and their corresponding research hypotheses are explained in detail.

Research Questions No: 1

How to develop an econometric statistical model that predicts the number of passengers travelling in the scheduled aviation sector in Brazil, China and India over the next 5 years?

Research Hypothesis

A correlation matrix analysis seems to be an effective method to identify the major driving factors. $'R\ values'$ from a Correlation matrix can help to find major potential factors that have a significant effect on the dependent variable using R Studio software. This result will help to to identify the major demand factors required to develop the econometric model.

Expected Outcome

The major demand factors that really affect the air traffic demand in Brazil, China and India are determined

Research Questions No: 2

How to relate the potential demand factors to future demand and there by develop a predictive statistical econometric model to forecast future demand?

Research Hypothesis

A stepwise regression method (forward or backward) can be used to develop the predictive statistical econometric model using R Studio software.

Expected Outcome

Develop a predictive statistical model that forecast future demand.

Why Econometric model?

Decided to do forecasting using econometric models because, econometric model is one of the tools economists use to forecast future developments in the industry. It helps to understand and measure past relationships among different variables and will also help to forecast how changes in some variables will affect the future course of others. Econometric model guides in figuring out how different factors interact with one other. Econometric forecasting supports economic judgment that can be used to determine values for exogenous variables and also to reduce the likely size of model error.

1.6. METHODOLOGY

In the above context, this thesis aims to discuss a methodology to develop a scheduled air traffic forecasting model for airlines operating on sectors from Brazil, China and India. This study provides a comprehensive picture of the factors affecting airline demand, factors that could play an important role in demand growth and also aims at forecasting passenger demand in the Indian Chinese and Brazilian scheduled aviation industry in the short term. Thereby helping the airlines to make improved decisions for efficient revenue management. With the developed statistical econometric model, one can perform forecast and estimate demand growth. The first question that is addressed is "What are various demand factors that drives passenger demand in these three countries"? The factors can range from various macroeconomic variables like Gross Domestic Product (GDP), Inflation rate, Consumer price index, Population (Between 15 to 64), Exchange rate fluctuations etc. and safety/maintenance variables like No of Air accidents, No of deaths in air accidents etc. The primary objective is to study what are the potential factors that drives airline demand and what impact will each of these factors have on demand growth. In order to do so, one plan to develop a correlation matrix using all the explanatory variables and the dependent variable using historic data of the various factors mentioned above. The correlation matrix would give $'R\ values'$ using which one could identify the significant factors that has an effect on the dependent variable. After identifying the major demand factors, the factors are divided into different groups in different combination of demand variables. This is done to avoid multi-collinearity among the demand variables. Hence, more than one econometric model is developed for each country. Multiple regression analysis is then performed on all the models to identify the most appropriate model to perform forecasting. Multiple regression analysis would give R^2 and adjusted R^2 values, based on which one would be able to finalize on the decisions on the econometric forecast model. Forecasting would then be performed for 5 years ahead to determine the demand estimates. Forecasting plays a major role in logistic planning and it is an essential analytical tool in countries' air traffic strategies.

This study would definitely have a profound impact on the changes need to be implemented in Indian and Chinese aviation industry.

Figure 8 Methodology to study, develop and forecast air travel demand

2. CHAPTER TWO CRITICAL EVALUATION OF THE LITERATURE AND JUSTIFICATION OF RESEARCH QUESTIONS

In this chapter, a critical evaluation of the literature, and expansion of the research gap, presented in Section 1.2, 1.3 and 1.4, are presented. This chapter is organized based on the four aspects of the considered problem i) the literature related to the first aspect of the problem, the scheduled air transportation demand factors, is presented in Section 2.1, ii) the literature related to the second aspect of the problem, types of airline forecasting and multiple regression, is addressed in Section 2.2, and, the literature of the third forecasting using an econometric model is presented. In each section (Sections 2.1, 2.2, and 2.3), first, the fundamental concept and definitions related to each aspect is presented, then it is followed by the critical evaluation of the literature.

2.1. SCHEDULED AIR TRANSPORTATION DEMAND FACTORS

During the last three decades, the study of air travel demand has attracted considerable attention of researchers and academics. An extensive literature has emerged to explain the determinants of air travel demand. Pioneering work in this area includes, among others, that by Ghobrial (1992) [17], Alperovich and Machnes (1994) [18] and Bafail et al. (2000) [19]. Some of the research done in this area will be reviewed in this section.

An examination of the current economic situation and a consideration of projections during the next decade is of crucial importance. As will be seen later, macro-economic indicators are linearly related with growth and extensively used in forecasting future demand. These indications include such variables as inflation, GDP and oil prices [17]. Thus economic trends and an overall appraisal of the current economic environment are helpful in understanding the assumptions for forecasting future growth [20].

The use of a sophisticated model to develop an equation giving the amount of air travel as a function of factors such as GDP and average income does not eliminate judgment from the estimates of future conditions. The procedure just shifts it from air travel to those other quantities, the future of which may be less uncertain but still difficult to assess. To avoid this dependency of gross judgment, statistical analysis often focusses on assessing the change of traffic caused by key variables which planners may control or at least estimate more readily. Thus it is convenient to calculate the elasticity of demand. This is according to Bafail et al. (2000) [19]

Three sorts of impacts are typically measured:

Direct – employment or economic output affected by the business activities or a proposed development of the industry. For aviation, direct impacts are employment and output in the aviation sector [21].

Indirect – employment or economic output caused by inter-industry purchases of goods and services as they respond to changes in industry activity. For aviation, indirect impacts include employment and activity generated in the industry's supply chain [21].

Induced – employment or economic output created through household spending of those employed directly and indirectly through the industry's business activities [21].

Elasticities may be constant or can change and thus reflect existing or changing trends. Recent indications are that the demand elasticity of air travel is generally low, partly because the consumers' relative position in relation to travel costs has improved along with his increased affluence. There is a natural rate of annual traffic growth that reflects the stage of development composition and consumer behavior generally conducive to spending on activities such as recreational travel

[22]. Macroeconomic indicators have generally been used in the models as the independent variables while elasticities have been checked to reveal how, and to what extent, those economic factors influence traffic. According to X Fu, TH Oum, A Zhang (2010) The most commonly used indicators entering the equations as explanatory variables have been GDP, Passenger Yield, Consumer Price Index (CPI), and Income [23].

2.2. TYPES OF AIRLINE FORECASTING

Another study by Faraway et al. (1998) presents an econometric model that estimates the aggregate demand for an airline. The demand is expressed in terms of airline network structure, operating characteristics and firm specific variables. A number of model formulations with different combinations of explanatory variables are estimated using the two-stage-least-squares procedure. The results suggest that the airline aggregate demand is elastic with respect to yield, and inelastic with respect to network size and hub dominance [24].

In the book “The Airline Business in 21st Century” by Rigas Doganis[25], techniques for forecasting air travel demand can be broadly classified into three categories: judgmental, mechanical, and analytical. When using the judgmental method, the analyst makes an educated guess of the travel demand for the forecast period [26].

The mechanical method assumes that future travel demand is a time function of past experience. The application of the mechanical method varies from the simple extrapolation of historical trends to the use of complex mathematical growth curves, such as the Logistic and Gompertz curves [27]. These are known as intrinsic models. In a study conducted by Nam (1995) [28] time is taken to be the only predictor variable, reflecting the interplay of economic, industry, and government activities. In other words, the mechanical method assumes that the demand generated over time is a function of time alone. The use of direct extrapolation, is not considered a satisfactory method for forecasting. It merely indicates that parameters exist which have influenced the demand in the past at a rate which is a function of time. It is, therefore, difficult to project the demand based on time alone unless one knows these time-based parameters and the extent of their influence. It is also difficult to forecast the time at which these influences may cease to operate or their effects will change [26].

The analytical method explores and analyzes parameters which have affected the historical travel demand pattern and those parameters which may influence the future travel demand. This method utilizes past relationships between travel volume and other variables such as income and fares. These are known as the regression techniques of projecting travel volumes [26].

Ghobbar, at al (2003) [29]has conducted that states that although time can enter the relationship as a predictor variable, it cannot be the sole predictor variable, for then the model would be intrinsic, a time-series model. The analytical method employs the dependent variable traffic as it relates to the logically relevant independent variables through a mathematical expression. It must be emphasized, however, that statistical correlation does not by any means imply cause and effect [29].

Various methods are available, ranging from econometric modeling to time series techniques, for representing the air travel market. Time series approaches are the most common methods for forecasting the traffic demand. These methods are handicapped by their inability to identify the causes of market growth and to link the future growth with expected developments of causative factors. They cannot, however, explain the impact of a reduction in fares, the introduction of new aircraft, an economic recession, or the uncertainties with regard to future regulatory conditions [30]. Such questions can only be answered if the forecaster has specified and calibrated a formal model that shows the influence and interaction of all the relevant variables and not just one (i.e., time). Because of the complex nature of air transportation industry, the past records of air traffic forecasters (using mostly trend extrapolation) has not been impressive. In recent years, therefore, the trend has been to develop causal models that not only predict traffic but also determine the impact of changes within the economic environment on traffic [22].

2.3. FORECASTING USING ECONOMETRIC MODEL

The econometric model is by far the most frequently used method for forecasting aviation demand. It is a mathematical representation of air traffic or its constituent parts and those independent variables of the national economy which are thought to influence traffic growth[30]. Econometrics is the statistical technique used to quantify these relationships. The mathematical equations of the model relate economic factors to the level of aviation activity, based on observation of past behavior of both the economy and the aviation industry. The equations may also be constructed so as to reflect the effects of specific factors within the air transportation industry itself, such as fare levels, route configurations, fuel costs, etc. [31].

Models mainly use macro-economic indicators as their explanatory variables. They have been found reasonably satisfactory in describing and explaining air traffic growth behavior. The most commonly used factors were GNP/GDP, CPI and yield.

In a number of papers there has been an attempt to assess the extent to which air travel is to be affected by current economic conditions. Profillidis (2000)[32] , for example, estimate a model in which they include GDP growth, fuel prices and some dummy variables to reflect events such as SARS, 9/11 and Asian financial crises. They use aggregate data from 1980 to 2008 to examine how these factors listed affected total air travel – domestic plus international. They find the elasticity of air travel with respect to GDP is 1.58, but argue this value is inflated because it captures influences which were not included in the model, such as increased services and new routes [32].

The results differ considerably from the model of Oum et al. (2008)[33], but this model was estimated on only international air passengers, whereas their model was estimated on total world air traffic. The model was composed of a panel data set with 8 cross sections (regions) and 12 years for each region. The variables are in logs so the coefficients can be interpreted as elasticities. Note the GDP elasticity is quite low, a mere 0.06, which is sensible in that the amount of international travel will be influenced but only in a small way by domestic growth.

Also having trade, foreign investment and connectivity in the equation takes a good deal away from the magnitude of the coefficient [32].

According to Fildes et al (2011)[34], this paper had the objective of trying to understand “what international air passenger travel will look like in five, ten or fifteen years and what were the underlying drivers”. This required answering two questions; to identify what will be the more important determinants of international passenger travel in the future and secondly to translate the impact of these factors into expected changes in future passenger growth. Identifying the drivers was relatively successful in determining which are most relevant and how large each of the effects would be on traffic growth was less successful [34, 35].

3. CHAPTER THREE A METHOD FOR STUDYING DEMAND FACTORS

Here, one intend to use Multiple Regression analysis to study the significant scheduled air transportation demand factors out of the different potential demand factors selected for the study. The methodology is explained in detail in this chapter [36].

3.1. MULTIPLE REGRESSION

Multiple Regression is a quantitative method that has a wide range of application today and is one of the most widely used modelling technique in business.

The main three advantages of multiple regression are as follows:

- Structure analysis: Estimation of the impact of variables (demand factors) that influence demand as measured by elasticities

- Policy evaluation: The ability to measure the impact of policies that may affect consumer demand, such as GDP changes using what-if analysis
- Forecasting: More accurate demand forecasting for particular items in the short, medium and long range

With multiple regression, as with simple regression, there is one target variable, Y (also known as the dependent variable) to be predicted (e.g., demand). However, unlike simple regression, multiple regression uses two or more explanatory variables (independent variables).

The general ordinary least square form of multiple regression is:

$$\hat{Y} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \dots \dots + \beta_n X_n$$

Where $\hat{Y} = target, or\ dependent\ variable\ to\ be\ forecasted$

$$\beta_0 = constant\ or\ intercept\ (\alpha)$$
$$\beta_n = parameter\ estimates\ or\ coefficients\ (b)$$
$$X_n = explanatory\ or\ independent\ variables$$

One of the initial steps when applying a multiple regression model requires the identification of those variables that are associated with changes in the dependent variable. A certain number of variables are identified as possibly having an impact on the dependent variable, but only a small number of them actually have any real value as predictors in the regression model. This thesis plan to study the scheduled air traffic demand factors of the three major emerging economies in the world Brazil, China and India. In order to find the major demand factors in each market, historic data is collected for certain macroeconomic and safety factors for a period of 45 year from 1970 to 2014. The factors are selected based on literature review. The dependent variable being studied here is ‘No of

Passengers' travelled during a year. The number of passengers carried include both domestic and international aircraft passengers of air carries registered in the country.

3.2. DATA SOURCES

Econometric model is invaluable tool for increasing the understanding of the way an economic system works and for testing and evaluating alternative policies. However, such model are useless if it operates on poor quality historical data or faulty knowledge of the causative factors underlying traffic growth. The availability of a consistent data set allows the use of annual data for the period 1970-2014. The data used in the estimation of the model originate from two sources. Macro-economic and demographic data of the Brazil, China and India are taken from the World Bank data bank (http://databank.worldbank.org/data/home.aspx)[37]. The data related to number of air accidents and number of deaths in air accidents are taken from Aviation Safety Network (https://aviation-safety.net/database) [38].

Table 1 Selected air traffic demand factors for Brazil, China and India

Brazil	**China**	**India**
Gross Domestic Product	Gross Domestic Product	Gross Domestic Product
GDP Growth rate	GDP Growth rate	GDP Growth rate
GDP per Capita	GDP per Capita	GDP per Capita
Inflation GDP Deflator	Inflation GDP Deflator	Inflation GDP Deflator
Exchange Rate Fluctuation	Exchange Rate Fluctuation	Exchange Rate Fluctuation
Population (Total)	Population (Total)	Population (Total)
Population, ages 15-64 (% of total)	Population, ages 15-64 (% of total)	Population, ages 15-64 (% of total)
Oil Prices (USD)	Oil Prices (USD)	Oil Prices (USD)
Accident Deaths per year	Accident Deaths per year	Accident Deaths per year
No of Accidents per year	No of Accidents per year	No of Accidents per year
		Consumer Price Index

Table 2 Data set for Brazil for Gross Domestic Product, GDP per Capita, Inflation GDP Deflator, Exchange Rate Fluctuation (1970-2014)[37]

Years	Gross Domestic Product	GDP per Capita	GDP Growth Rate	Inflation GDP Deflator	Exchange Rate Fluctuation
1970	42327600098.241	440.993	8.770	17.092	1.98785E-12
1971	49204456700.452	500.034	11.295	20.254	2.28822E-12
1972	58539008786.368	580.488	12.053	19.144	2.56796E-12
1973	79279057730.829	767.310	13.979	22.665	2.65094E-12
1974	105136007528.760	993.290	9.042	34.800	2.93836E-12
1975	123709376567.890	1140.901	5.209	33.862	3.51684E-12
1976	152678020452.829	1374.536	9.790	47.627	4.61871E-12
1977	176171284311.761	1548.398	4.606	46.180	6.12087E-12
1978	200800891870.164	1723.137	3.232	41.060	7.81975E-12
1979	224969488835.181	1885.091	6.766	56.481	1.16607E-11
1980	235024598983.261	1923.283	9.111	87.307	2.28123E-11
1981	263561088977.129	2106.679	-4.393	107.214	4.03001E-11
1982	281682304161.041	2199.702	0.580	104.832	7.76854E-11
1983	203304515490.795	1551.773	-3.410	140.196	2.49718E-10
1984	209023912696.839	1560.456	5.269	212.786	7.99741E-10
1985	222942790435.299	1629.265	7.946	231.723	2.68324E-09
1986	268137224729.722	1919.865	7.988	145.272	5.90968E-09
1987	294084112392.660	2064.654	3.600	204.103	1.69763E-08
1988	330397381998.489	2276.241	-0.103	651.114	1.13548E-07
1989	425595310000.000	2879.500	3.279	1209.121	1.22639E-06
1990	461951782000.000	3071.628	-3.102	2700.442	2.95573E-05
1991	602860000000.000	3942.404	1.512	414.236	0.000175961
1992	400599250000.000	2578.207	-0.467	968.184	0.001953024
1993	437798577639.752	2774.174	4.665	2001.348	0.038276611
1994	558111997497.263	3482.530	5.335	2302.841	0.664683514
1995	785643456467.255	4827.152	4.417	93.522	0.917666667
1996	853504128942.394	5163.266	2.190	16.434	1.0051
1997	886330241187.384	5279.111	3.388	7.728	1.077991667
1998	866854803963.809	5083.701	0.355	4.915	1.160516667
1999	601904998071.307	3476.144	0.490	8.048	1.813932847
2000	657216179283.957	3738.719	4.383	5.458	1.829423122
2001	559611852733.611	3136.497	1.279	8.094	2.349631709
2002	508779896959.978	2810.231	3.072	9.908	2.920363018
2003	559008449788.755	3044.255	1.223	13.955	3.077475118
2004	669642735042.735	3597.979	5.661	7.773	2.92511945
2005	892103187643.773	4733.164	3.149	7.491	2.434390036
2006	1107802142233.260	5809.189	3.999	6.695	2.175326667
2007	1395938061732.830	7240.924	6.006	6.400	1.947058333
2008	1694585014723.520	8700.455	5.019	8.866	1.833766667
2009	1664586375912.770	8462.508	-0.236	7.354	1.999428173
2010	2209433265120.510	11124.246	7.572	8.565	1.759226711
2011	2615234935437.590	13042.422	3.916	8.312	1.672828755
2012	2413135528134.760	11922.513	1.762	5.868	1.953068611
2013	2392082463707.620	11711.004	2.744	6.508	2.156089151
2014	2346076315118.550	11384.415	0.145	6.897	2.353568604

Table 3 Data set for Brazil for Population, Population ages 15-64 (% of Total), Oil Prices (USD), Accident Deaths, No of Accidents, No of Passengers (1970-2014)[37]

Years	Population	Population ages 15-64 (% of total)	Oil Prices (USD)	Accidents Deaths	No of Accidents	No of Passengers
1970	95982453.000	54.081	1.120	42	5	3339800
1971	98402200.000	54.443	1.700	48	3	3911000
1972	100844391.000	54.768	1.820	37	8	4671400
1973	103320787.000	55.092	2.700	52	10	5842400
1974	105846274.000	55.468	11.000	40	7	6855500
1975	108431284.000	55.910	10.430	23	6	7772900
1976	111076063.000	56.266	11.600	20	7	8799000
1977	113776467.000	56.676	12.500	19	5	9514400
1978	116532153.000	57.111	12.790	16	7	10621300
1979	119341444.000	57.530	29.190	25	6	11856900
1980	122199721.000	57.910	35.520	74	5	13008100
1981	125107382.000	58.139	34.000	11	4	12594600
1982	128054757.000	58.372	32.380	197	8	13168300
1983	131014337.000	58.604	29.040	9	2	12605900
1984	133950551.000	58.844	28.200	41	6	12948400
1985	136836428.000	59.107	27.010	30	6	13402900
1986	139664639.000	59.313	13.530	6	2	17194700
1987	142437479.000	59.575	17.730	43	8	17068600
1988	145150468.000	59.884	14.240	8	4	17010900
1989	147801816.000	60.229	17.310	47	5	19410800
1990	150393143.000	60.610	22.260	48	5	19149600
1991	152916852.000	61.035	19.448	42	6	19153100
1992	155379009.000	61.470	19.036	26	8	16388500
1993	157812220.000	61.930	16.787	12	7	16535600
1994	160260508.000	62.427	15.948	33	9	17898600
1995	162755054.000	62.951	17.204	3	5	20196100
1996	165303155.000	63.444	20.373	133	9	22011500
1997	167893835.000	63.928	19.268	11	10	24307000
1998	170516482.000	64.399	13.074	23	6	28091100
1999	173153066.000	64.848	17.981	7	7	28205300
2000	175786441.000	65.268	28.234	0	4	31287784
2001	178419396.000	65.538	24.331	13	10	34285574
2002	181045592.000	65.821	24.950	29	9	35889538
2003	183627339.000	66.100	28.892	1	9	32372040
2004	186116363.000	66.366	37.760	36	3	35263795
2005	188479240.000	66.624	53.354	2	3	37661733
2006	190698241.000	66.875	64.273	173	4	40945038
2007	192784521.000	67.144	71.128	209	4	45286990
2008	194769696.000	67.420	97.035	3	5	58763225
2009	196701298.000	67.690	61.776	40	5	67945578
2010	198614208.000	67.942	79.032	2	5	74627064
2011	200517584.000	68.257	104.008	30	5	87860363
2012	202401584.000	68.494	105.008	9	5	94752568
2013	204259377.000	68.691	104.069	5	3	95591641
2014	206077898.000	68.898	96.246	7	4	100403628

Table 4 Data set for China for Gross Domestic Product, GDP per Capita, Inflation GDP Deflator, Exchange Rate Fluctuation (1970-2014)[37]

Years	Gross Domestic Product	GDP Growth Rate	GDP per Capita	Inflation GDP Deflator	Exchange Rate Fluctuation
1970	91506211306.375	19.400	111.823	-2.643	2.462
1971	98562023844.181	7.000	117.182	0.664	2.462
1972	112159813640.376	3.800	130.111	-0.020	2.245
1973	136769878359.668	7.900	155.078	0.142	1.989
1974	142254742077.706	2.300	157.999	0.231	1.961
1975	161162492226.686	8.700	175.866	-1.165	1.860
1976	151627687364.405	-1.600	162.921	-0.191	1.941
1977	172349014326.931	7.600	182.679	1.089	1.858
1978	148382111520.192	11.882	155.185	1.894	1.684
1979	176856525405.729	7.600	182.514	3.567	1.555
1980	189649992463.987	7.807	193.277	3.793	1.498
1981	194369049090.197	5.172	195.565	2.320	1.705
1982	203549627211.606	9.016	201.808	-0.126	1.893
1983	228950200773.115	10.752	223.735	1.172	1.976
1984	258082147252.256	15.207	248.916	4.968	2.320
1985	307479585852.339	13.553	292.548	10.166	2.937
1986	298805792971.544	8.926	280.098	4.692	3.453
1987	271349773463.863	11.720	250.315	5.081	3.722
1988	310722213686.031	11.301	282.057	12.111	3.722
1989	345957485871.286	4.215	309.263	8.596	3.765
1990	358973230048.399	3.934	316.224	5.696	4.783
1991	381454703832.753	9.268	331.475	6.733	5.323
1992	424934065934.066	14.276	364.760	8.181	5.515
1993	442874596387.119	13.938	375.814	15.185	5.762
1994	562261129868.774	13.078	471.761	20.636	8.619
1995	732032045217.766	10.994	607.569	13.651	8.351
1996	860844098049.121	9.925	707.030	6.512	8.314
1997	958159424835.340	9.227	778.944	1.603	8.290
1998	1025276902078.730	7.853	825.548	-0.915	8.279
1999	1089447108705.890	7.618	869.655	-1.273	8.278
2000	1205260678391.960	8.429	954.552	2.031	8.279
2001	1332234719889.820	8.298	1047.478	2.049	8.277
2002	1461906487857.920	9.091	1141.758	0.588	8.277
2003	1649928718134.590	10.020	1280.603	2.583	8.277
2004	1941745602165.090	10.076	1498.174	6.912	8.277
2005	2268598904116.280	11.352	1740.097	3.876	8.194
2006	2729784031906.090	12.688	2082.183	3.902	7.973
2007	3523094314820.900	14.195	2673.294	7.832	7.608
2008	4558431073438.200	9.623	3441.221	7.808	6.949
2009	5059419738267.410	9.234	3800.475	-0.107	6.831
2010	6039658508485.590	10.632	4514.941	6.938	6.770
2011	7492432097810.110	9.485	5574.187	8.139	6.461
2012	8461623162714.070	7.750	6264.644	2.392	6.312
2013	9490602600148.490	7.684	6991.854	2.235	6.196
2014	10354831729340.400	7.268	7590.016	0.853	6.143

Table 5 Data set for China for Population, Population ages 15-64 (% of Total), Oil Prices (USD), Accident Deaths, No of Accidents, No of Passengers (1970-2014)[37]

Years	Population	Population, ages 15-64 (% of total)	Oil Prices (USD)	Accidents Deaths	No of Accidents	No of Passengers
1970	818315000	55.664	1.120	0	1	500000
1971	841105000	55.556	1.700	0	2	550000
1972	862030000	55.498	1.820	0	0	600000
1973	881940000	55.491	2.700	29	1	650000
1974	900350000	55.597	11.000	0	0	710000
1975	916395000	55.865	10.430	0	0	1000000
1976	930685000	56.326	11.600	40	1	1050000
1977	943455000	56.906	12.500	0	1	1110000
1978	956165000	57.609	12.790	0	0	1540000
1979	969005000	58.421	29.190	44	2	2519000
1980	981235000	59.311	35.520	26	1	2568000
1981	993885000	60.338	34.000	0	0	3236000
1982	1008630000	61.326	32.380	137	4	3942000
1983	1023310000	62.283	29.040	19	3	3836000
1984	1036825000	63.192	28.200	0	1	5000000
1985	1051040000	64.010	27.010	38	3	7300000
1986	1066790000	64.542	13.530	6	2	10000000
1987	1084035000	64.976	17.730	0	1	12500000
1988	1101630000	65.308	14.240	150	2	17000000
1989	1118650000	65.574	17.310	35	2	11080000
1990	1135185000	65.816	22.260	128	6	16596100
1991	1150780000	65.722	19.448	0	0	19520000
1992	1164970000	65.837	19.036	262	3	27345000
1993	1178440000	66.048	16.787	70	6	31312500
1994	1191835000	66.228	15.948	160	3	37601000
1995	1204855000	66.343	17.204	0	1	47564500
1996	1217550000	66.788	20.373	2	3	51770100
1997	1230075000	67.049	19.268	36	6	52277000
1998	1241935000	67.275	13.074	0	1	53234000
1999	1252735000	67.663	17.981	69	7	55853100
2000	1262645000	68.284	28.234	49	3	61891807
2001	1271850000	68.966	24.331	14	2	72660653
2002	1280400000	69.797	24.950	115	6	83671798
2003	1288400000	70.723	28.892	0	3	86040642
2004	1296075000	71.623	37.760	62	4	119789024
2005	1303720000	72.419	53.354	0	1	136721623
2006	1311020000	72.966	64.273	42	2	158013351
2007	1317885000	73.486	71.128	0	0	183613132
2008	1324655000	73.918	97.035	3	2	191001220
2009	1331260000	74.208	61.776	3	2	229062099
2010	1337705000	74.339	79.032	44	1	266293020
2011	1344130000	74.353	104.008	3	1	292160158
2012	1350695000	74.219	105.008	2	1	318475924
2013	1357380000	73.956	104.069	1	3	352795296
2014	1364270000	73.612	96.246	0	1	390878784

Table 6 Data set for India for Gross Domestic Product, GDP per Captiva, Consumer Price Index, Inflation GDP Deflator, (1970-2014)[37]

Years	Gross Domestic Product	GDP Growth Rate	GDP per Capita	Consumer Price Index	Inflation GDP Deflator
1970	63517182000.000	5.157	114.664	4.752	1.562
1971	68532271313.229	1.643	120.952	4.898	5.325
1972	72716595884.312	-0.553	125.417	5.215	10.840
1973	87014945186.316	3.296	146.625	6.098	17.830
1974	101271489826.241	1.185	166.717	7.842	16.668
1975	100199514365.231	9.150	161.169	8.292	-1.649
1976	104518118776.804	1.663	164.289	7.659	5.982
1977	123617837582.482	7.255	189.916	8.296	5.637
1978	139708688961.553	5.713	209.793	8.505	2.460
1979	155674337010.019	-5.238	228.476	9.037	15.728
1980	189594121351.874	6.736	271.925	10.064	11.508
1981	196883474523.345	6.006	275.917	11.384	10.828
1982	204234366470.486	3.476	279.657	12.281	8.096
1983	222090283347.207	7.289	297.160	13.739	8.553
1984	215878233650.679	3.821	282.318	14.882	7.923
1985	236589100981.279	5.254	302.511	15.709	7.194
1986	253352444883.275	4.777	316.846	17.081	6.789
1987	283926977522.458	3.965	347.425	18.584	9.328
1988	301790951204.236	9.628	361.450	20.328	8.233
1989	301233728792.841	5.947	353.255	20.991	8.437
1990	326608014285.316	5.533	375.152	22.874	10.668
1991	274842161318.346	1.057	309.328	26.047	13.752
1992	293262722482.422	5.482	323.525	29.117	8.965
1993	284194018792.066	4.751	307.411	30.970	9.862
1994	333014993709.730	6.659	353.292	34.132	9.980
1995	366600193391.349	7.574	381.527	37.622	9.063
1996	399787263892.645	7.550	408.242	40.999	7.575
1997	423160799040.860	4.050	424.086	43.937	6.476
1998	428740690379.961	6.184	421.822	49.750	8.010
1999	466866720520.974	8.846	451.089	52.073	3.068
2000	476609148165.173	3.841	452.414	54.161	3.645
2001	493954161367.563	4.824	460.826	56.157	3.216
2002	523968381476.715	3.804	480.621	58.623	3.716
2003	618356467437.027	7.860	557.897	60.854	3.868
2004	721584805204.777	7.923	640.601	63.147	5.725
2005	834214699568.140	9.285	729.001	65.828	4.237
2006	949116769619.215	9.264	816.734	69.874	6.423
2007	1238699170077.860	9.801	1050.025	74.325	5.756
2008	1224097069460.460	3.891	1022.578	80.532	8.665
2009	1365371474048.930	8.480	1124.519	89.292	6.064
2010	1708458876830.180	10.260	1387.880	100.000	8.984
2011	1835814449585.350	6.638	1471.658	108.858	6.399
2012	1831781515472.090	5.081	1449.665	118.995	7.626
2013	1861801615477.860	6.899	1455.102	131.975	6.250
2014	2048517438873.540	7.286	1581.511	140.359	3.036

Table 7 Data set for India for Exchange Rate Fluctuation, Population, Population ages 15-64 (% of Total), Oil Prices (USD), Accident Deaths, No of Accidents, No of Passengers (1970-2014)[37]

Years	Exchange Rate Fluctuation	Population	Population ages 15-64 (% of total)	Oil Prices (USD)	Accidents Deaths	No of Accidents	No of Passengers
1970	7.500	553943226.000	55.832	1.120	62	6	2671600
1971	7.492	566605402.000	55.890	1.700	52	9	2554000
1972	7.594	579800632.000	55.972	1.820	103	3	3285800
1973	7.742	593451889.000	56.082	2.700	52	6	3391600
1974	8.102	607446519.000	56.235	11.000	0	2	3037300
1975	8.376	621703641.000	56.437	10.430	0	5	3839900
1976	8.960	636182810.000	56.485	11.600	95	2	4534000
1977	8.739	650907559.000	56.605	12.500	15	3	5147500
1978	8.193	665936435.000	56.770	12.790	303	5	6099600
1979	8.126	681358553.000	56.950	29.190	73	4	6546800
1980	7.863	697229745.000	57.124	35.520	55	3	6603100
1981	8.659	713561406.000	57.165	34.000	0	2	7574500
1982	9.455	730303461.000	57.214	32.380	41	4	8391700
1983	10.099	747374856.000	57.280	29.040	3	3	9164800
1984	11.363	764664278.000	57.386	28.200	0	2	10125700
1985	12.369	782085127.000	57.540	27.010	3	3	10993800
1986	12.611	799607235.000	57.556	13.530	3	5	11785200
1987	12.962	817232241.000	57.659	17.730	0	4	12668600
1988	13.917	834944397.000	57.826	14.240	191	11	12863100
1989	16.226	852736160.000	58.023	17.310	11	1	12740100
1990	17.504	870601776.000	58.237	22.260	97	6	10862200
1991	22.742	888513869.000	58.380	19.448	97	3	10717400
1992	25.918	906461358.000	58.550	19.036	9	6	11127100
1993	30.493	924475633.000	58.754	16.787	65	10	9441600
1994	31.374	942604211.000	59.005	15.948	29	3	11518400
1995	32.427	960874982.000	59.304	17.204	0	2	14260600
1996	35.433	979290432.000	59.546	20.373	380	6	13394600
1997	36.313	997817250.000	59.832	19.268	2	1	16039800
1998	41.259	1016402907.000	60.154	13.074	9	1	16521000
1999	43.055	1034976626.000	60.500	17.981	29	3	16005400
2000	44.942	1053481072.000	60.861	28.234	65	3	17299483
2001	47.186	1071888190.000	61.134	24.331	0	0	16862737
2002	48.610	1090189358.000	61.436	24.950	15	5	17633019
2003	46.583	1108369577.000	61.758	28.892	0	0	19455085
2004	45.316	1126419321.000	62.093	37.760	0	0	23934074
2005	44.100	1144326293.000	62.437	53.354	0	2	27879461
2006	45.307	1162088305.000	62.718	64.273	0	3	40288794
2007	41.349	1179685631.000	63.014	71.128	0	2	51897450
2008	43.505	1197070109.000	63.322	97.035	0	1	49877935
2009	48.405	1214182182.000	63.648	61.776	16	5	54446373
2010	45.726	1230984504.000	63.992	79.032	158	1	64374254
2011	46.670	1247446011.000	64.295	104.008	0	2	73996912
2012	53.437	1263589639.000	64.627	105.008	0	3	72151829
2013	58.598	1279498874.000	64.970	104.069	0	0	75589079
2014	61.030	1295291543.000	65.299	96.246	5	4	82751555

The five key considerations that were made sure regarding each variable are as follows:

Adequate Data: There must be adequate data available for each proposed independent variable to measure the true relationship with the dependent variable. In fact, the amount of data must be greater than the number of variables in the model. A suggested ratio followed here is that there should be at least four periods of data for each independent variable in the equation. Therefore 10 independent variables of Brazil and China each and 11 independent variables for India are selected. In total data for a total 45 years are taken for study.

Data periodicity: Not only is it important to have sufficient historical data, but the data must be available in the same periodicity. All the independent variables and the dependent variable are in per year basis. I.e. there are in the same time period

Future projections for independent variables: Since the independent variables are used to shape and forecast demand, there will be a need for accurate estimates of future values for each explanatory variable. Those future estimated values for all the independent variables must also exist for the same time horizon into the future that one plan to forecast demand. The dependent variable forecasted are in the same time horizon as the future projections for the independent variable.

Likelihood the relationship between the variables continues into the future: The regression coefficient (β_n) measures the amount of change that occurs with the dependent variable for every unit change in the independent variables. If the β_n value is going to be a significant predictor of changes in the corresponding independent variable, then that relationship must be consistent over time.

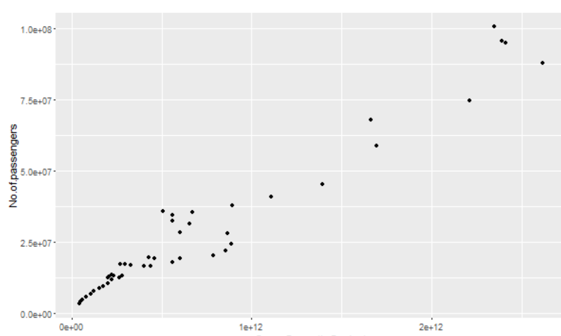
Linear explanatory with the dependent variable: There must be a linear relationship between the dependent variable and the independent variables. If a linear relationship does not exist initially, the data can be transformed using a log/log or semi-log form of the initial equation.

3.3. DATA VISUALIZATION USING SCATTER PLOTS

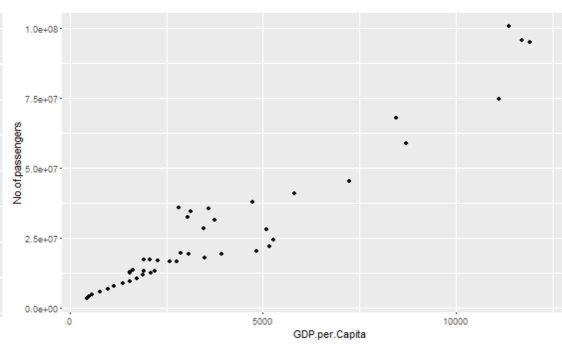
A scatter plot can suggest various kinds of correlations between variables with a reasonable level of confidence. Those correlations can be linear positive (rising from left to right), linear negative (falling from left to right), or neither (no correlation). A line of best fit (also called a trend line) can be drawn in order to study the correlation between the variables. The most powerful aspect of a scatter plot is its ability to show nonlinear relationships between variables. Scatter plots are similar to line graphs in that they use horizontal and vertical axes to plot data points. However, they have a very specific purpose. Scatter plots show how much one variable is affected by another, or correlation. Scatter plots usually consist of a large number of data points. The more those data points converge when plotted forming a straight line, the stronger the correlation between the two variables. Scatter plots can also help to identify potential outliers.

3.3.1. SCATTER PLOTS BETWEEN THE VARIOUS INDEPENDENT VARIABLES AND THE DEPENDENT VARIABLE FOR BRAZIL

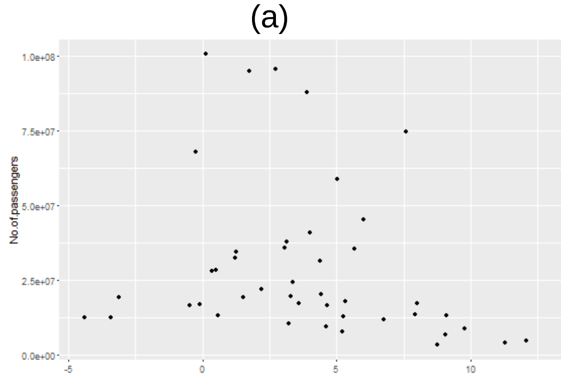
Here, scatter plots for Brazil are plotted for all the independent factors against the dependent variable i.e. the No of Passengers. After plotting all the scatter plots using the R Studio software, one see a positive linear relationship between the dependent variable (No of passengers) and the following independent variables which are Gross Domestic Product, GDP per Capita, Population, Population ages 15-64 and Oil Prices. From this one can conclude that the above mentioned factors have strong correlations with the dependent variable. However, one can see a non-linear relationship between No of Passengers and GDP Growth rate, Inflation GDP Deflator, Exchange rate Fluctuation, No of Accidents and Accident Deaths. These plots suggests that there are no correlation between the mentioned variables and the dependent variable.



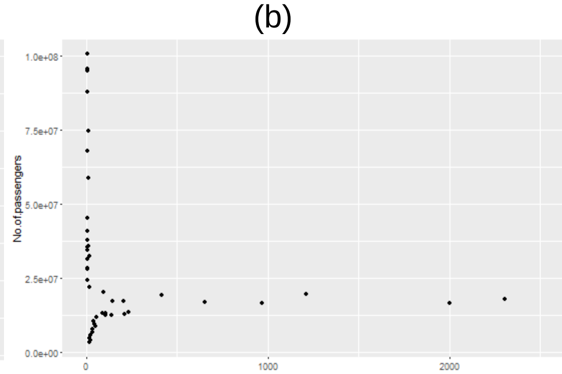
(a)



(b)



(c)



(d)

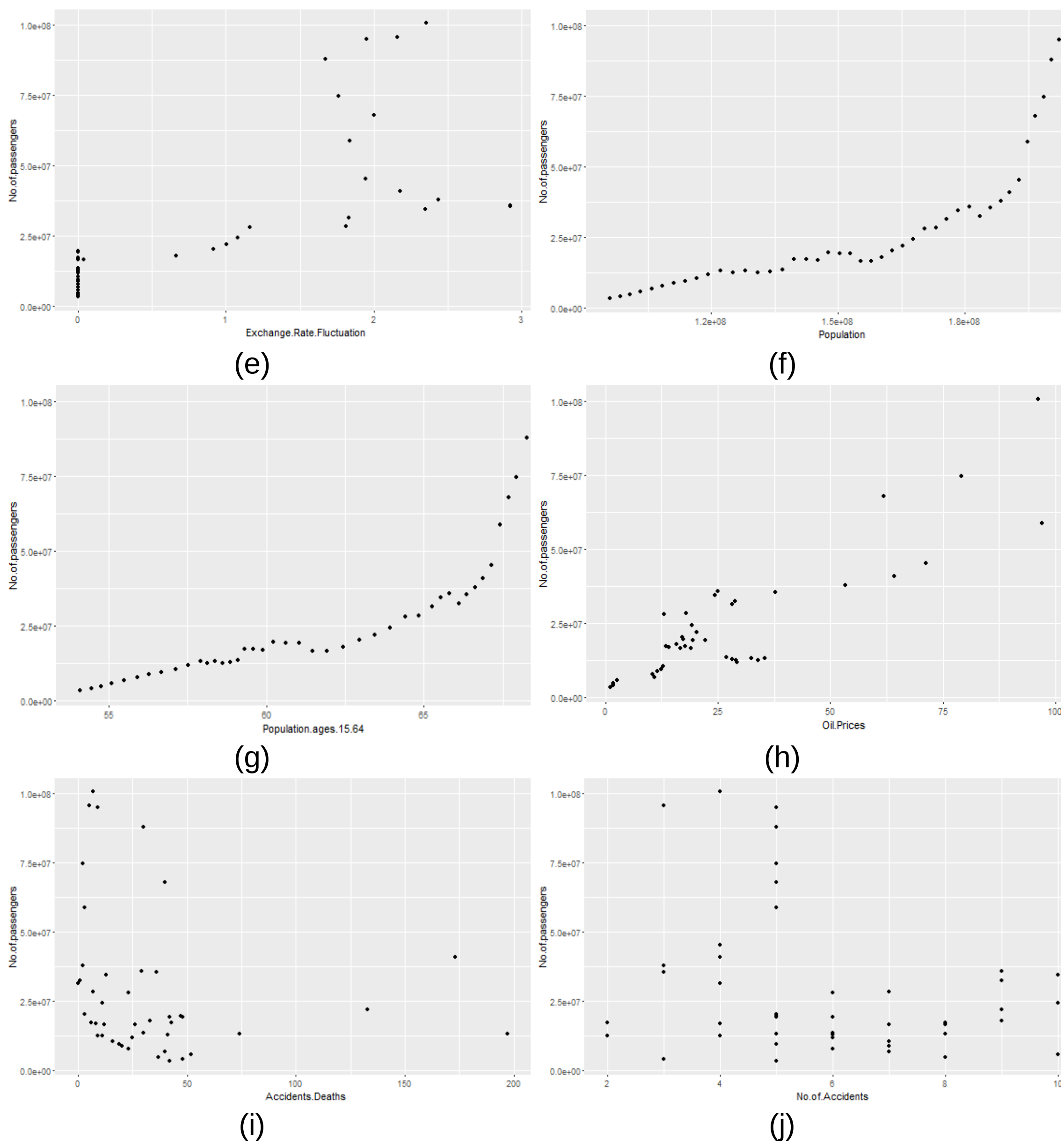
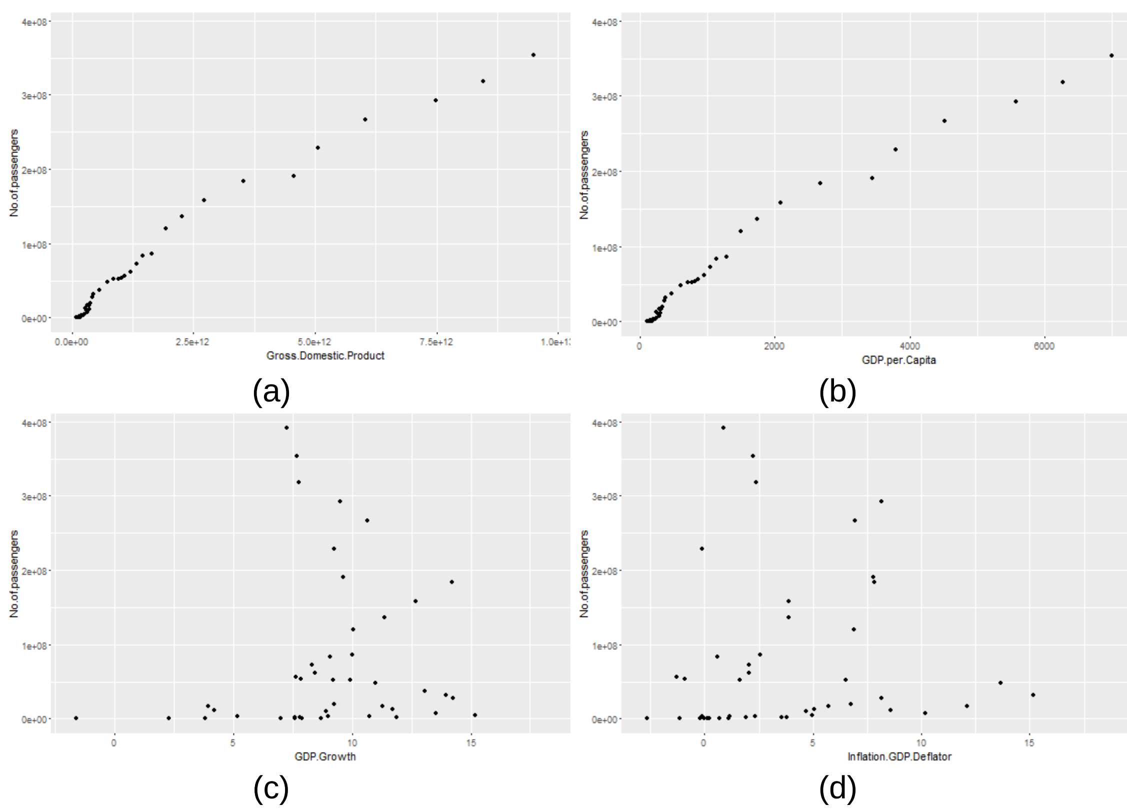


Figure 9 Results showing the linear relationship between No of Passengers and (a) Gross Domestic Product,(b) GDP per Capita,(c) GDP growth rate, (d) Inflation GDP Deflator,(e) Exchange Rate Fluctuation,(f) Population,(g) Population ages15-64,(h) Oil Prices,(i) Accidents Deaths, (j) No of Accidents

3.3.2. SCATTER PLOTS BETWEEN THE VARIOUS INDEPENDENT VARIABLES AND THE DEPENDENT VARIABLE FOR CHINA

Here, scatter plots for China are plotted for all the independent factors against the dependent variable i.e. the No of Passengers. After plotting all the scatter plots using the R Studio software, one can see a positive linear relationship between the dependent variable (No of passengers) and the following independent variables which are Gross Domestic Product, GDP per Capita, Population, Population ages 15-64 and Oil Prices. From this one conclude that the above mentioned factors have strong correlations with the dependent variable. However, one can see a non-linear relationship between No of Passengers and GDP Growth rate, Inflation GDP Deflator, Exchange rate Fluctuation, No of Accidents and Accident Deaths. These plots suggests that there are no correlation between the mentioned variables and the dependent variable.



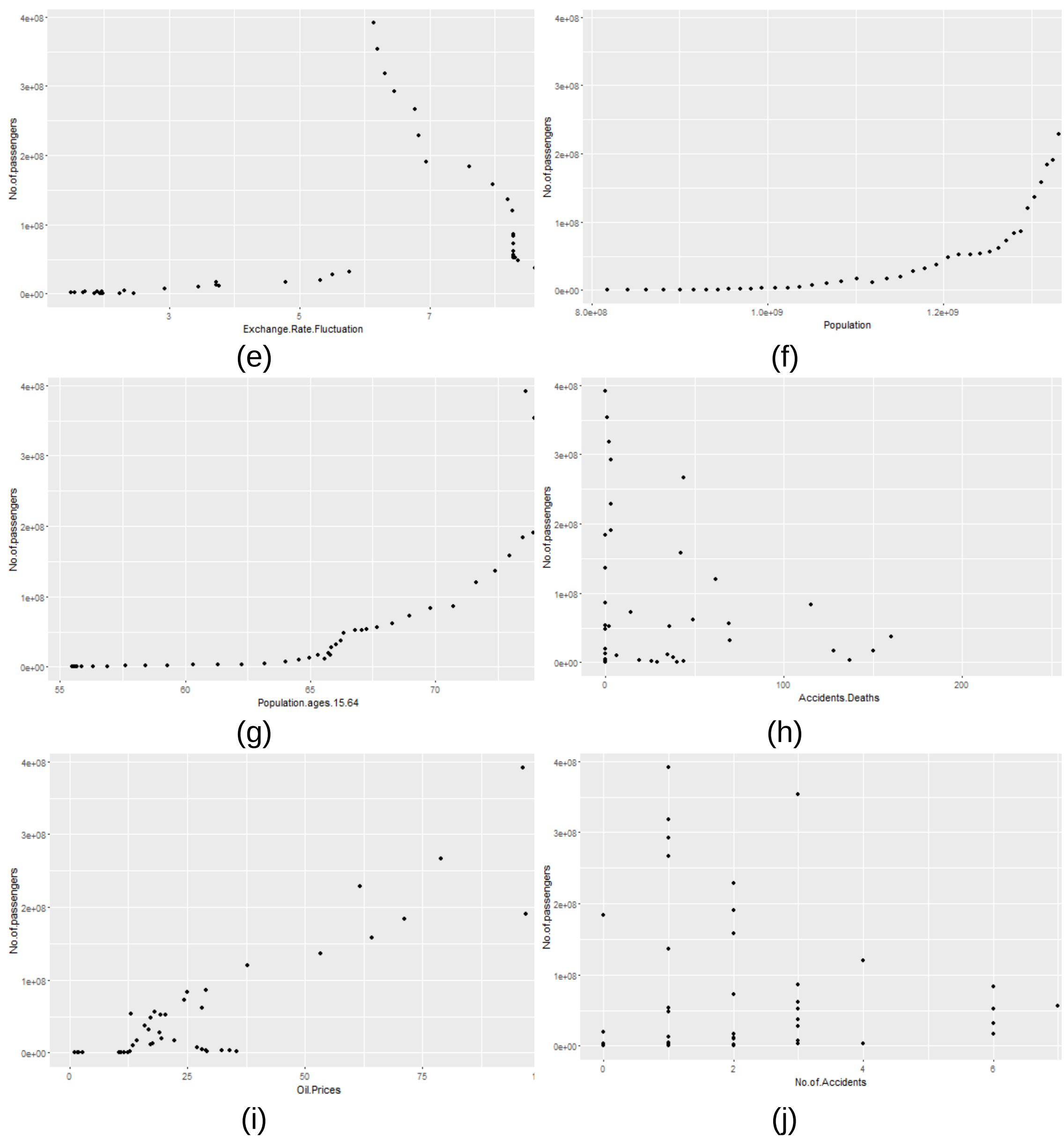
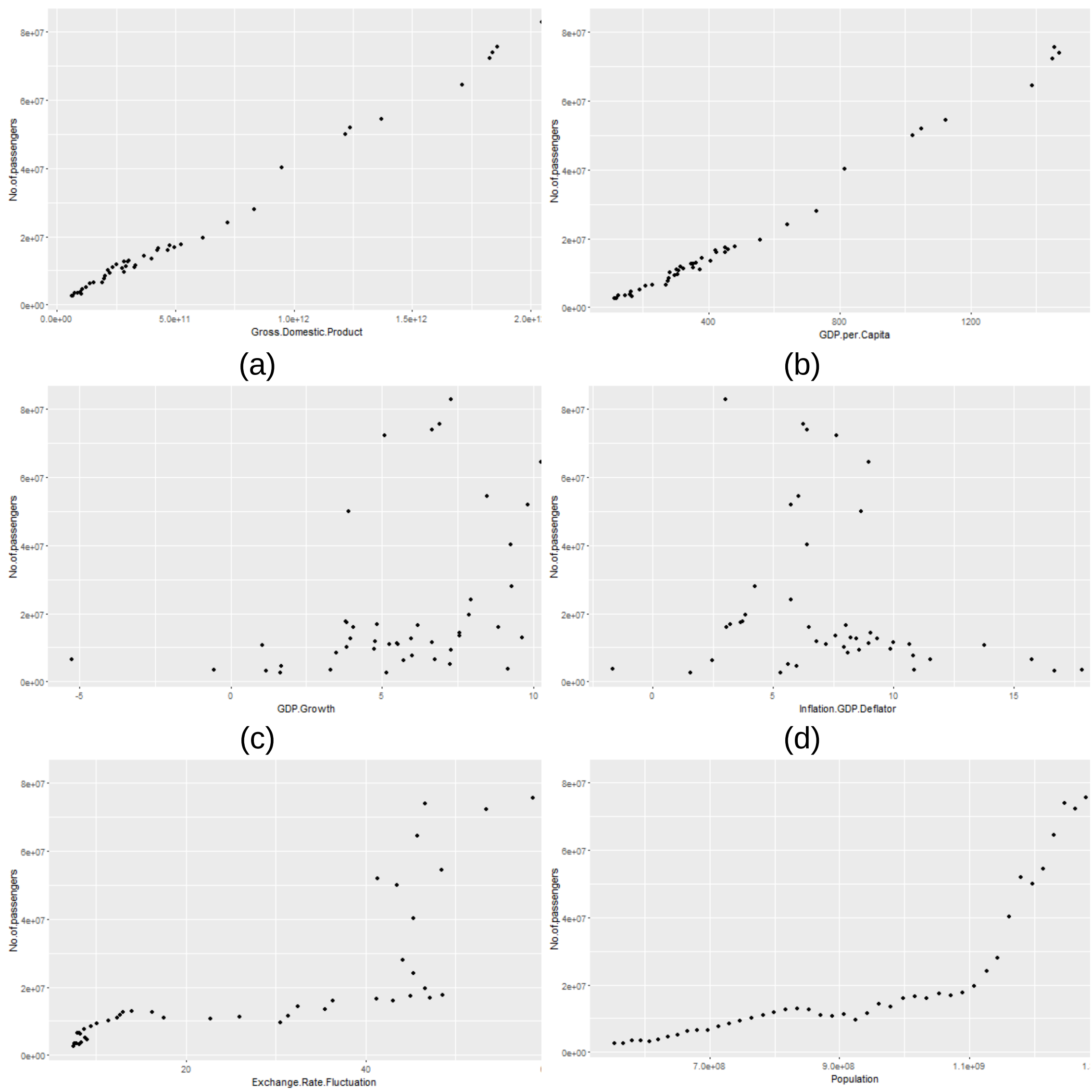


Figure 10 Results showing the linear relationship between No of Passengers and (a) Gross Domestic Product, (b) GDP per Capita,(c) GDP growth rate, (d) Inflation GDP Deflator,(e) Exchange Rate Fluctuation,(f) Population,(g) Population ages15-64,(h) Accident Deaths, (i)Oil Prices,(j) No of Accidents

3.3.3. SCATTER PLOTS BETWEEN THE VARIOUS INDEPENDENT VARIABLES AND THE DEPENDENT VARIABLE FOR INDIA

Here, scatter plots for India are plotted for all the independent factors against the dependent variable i.e. the No of Passengers. After plotting all the scatter plots using the R Studio software, one can see a positive linear relationship between the dependent variable (No of passengers) and the following independent variables which are Gross Domestic Product, GDP per Capita, Consumer Price Index, Exchange rate Fluctuation, Population, Population ages 15-64 and Oil Prices. From this one can conclude that the above mentioned factors have strong correlations with the dependent variable. However, one can see a non-linear relationship between No of Passengers and GDP Growth rate, Inflation GDP Deflator, No of Accidents and Accident Deaths. These plots suggests that there are no correlation between the mentioned variables and the dependent variable.



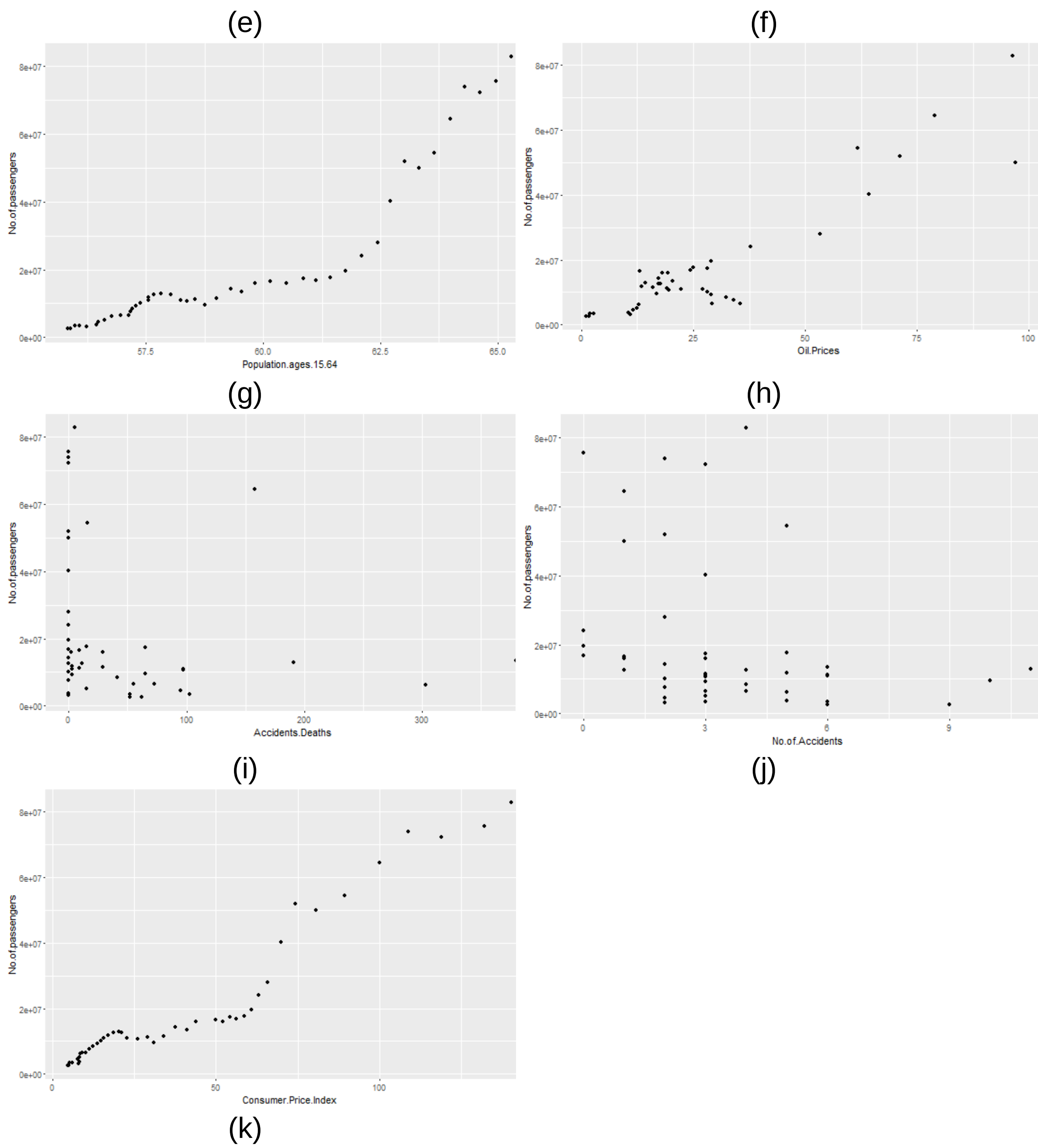


Figure 11 Results showing the linear relationship between No of Passengers and (a) Gross Domestic Product,(b) GDP per Capita,(c) GDP growth rate, (d) Inflation GDP Deflator,(e) Exchange Rate Fluctuation,(f) Population,(g) Population ages15-64,(h) Accident Deaths,(i) Oil Prices, (j) No of Accidents,(k) Consumer Price Index

3.4. CORRELATION MATRIX

The most widely accepted way of determining which independent variables are correlated to the dependent variable is a correlation matrix. A correlation matrix identifies the correlation coefficients (r values) between all the independent variables collected for the model. The r values are correlation coefficients, not coefficients of determination (R^2). Table 2, Table 3 and Table 4 shows the degree of correlation between each independent variable and the dependent variable, which is unit demand for the No of Passengers for Brazil, China and India respectively.

Subsequently, those independent variables with an 'r value' greater than 0.7000 or greater are highly correlated to the dependent variable demand, and are considered as primary candidates in the regression model

- **Brazil**

The correlation matrix table for Brazil is shown in Table 2. From the table one can see that the R values for Gross Domestic Product = 0.974, GDP per Capital = 0.962, Exchange Rate Fluctuation = 0.708, Population =0.840, Population.ages.15.64=0.845, Oil. Prices =0.927. These variables are highly correlated to the dependent variable demand when compared to other independent variables which have r values less than 0.7000.

Table 8 Correlation matrix for all candidate explanatory variables and air travel for Brazil

	Gross Domestic Product	***GDP per Capita***	***GDP Growth***	***Inflation GDP Deflator***
Gross Domestic Product	1.000			
GDP per Capita	0.998	1.000		
GDP Growth	-0.229	-0.253	1.000	
Inflation GDP Deflator	-0.165	-0.147	-0.217	1.000
Exchange Rate Fluctuation	0.641	0.623	-0.221	-0.305
Population	0.829	0.832	-0.428	-0.035
Population ages 15-64	0.832	0.834	-0.411	-0.081

Oil Prices	0.923	0.914	-0.224	-0.212
Accidents Deaths	-0.046	-0.037	0.077	-0.036
No of Accidents	-0.254	-0.244	0.107	0.111
No of passengers	0.974	0.962	-0.260	-0.193

	Exchange Rate Fluctuation	***Population***	***Population ages 15-64***	***Oil Prices***
Gross Domestic Product				
GDP per Capita				
GDP Growth				
Inflation GDP Deflator				
Exchange Rate Fluctuation	1.000			
Population	0.848	1.000		
Population ages 15-64	0.874	0.997	1.000	
Oil Prices	0.600	0.755	0.760	1.000
Accidents Deaths	-0.042	-0.032	-0.033	0.042
No of Accidents	-0.053	-0.143	-0.132	-0.373
No of passengers	0.708	0.840	0.845	0.927

	Accidents Deaths	***No of Accidents***	***No of passengers***
Gross Domestic Product			
GDP per Capita			
GDP Growth			
Inflation GDP Deflator			
Exchange Rate Fluctuation			
Population			
Population ages 15-64			
Oil Prices			
Accidents Deaths	1.000		
No of Accidents	0.076	1.000	
No of passengers	-0.109	-0.269	1.000

- **China**

The correlation matrix table for China is shown in Table 3. From the table one can see that the R values for Gross Domestic Product = 0.987, GDP per Capital = 0.988, Population = 0.761, Population ages 15-64=0.794, Oil. Prices =0.927. These variables are highly correlated to the dependent variable demand when compared to other independent variables which have r values less than 0.7000.

Table 9 Correlation matrix for all candidate explanatory variables and air travel for China

	Gross Domestic Product	*GDP Growth*	*GDP per Capita*	*Inflation GDP Deflator*
Gross Domestic Product	1.000			
GDP Growth	-0.014	1.000		
GDP per Capita	1.000	-0.013	1.000	
Inflation GDP Deflator	-0.027	0.361	-0.026	1.000
Exchange Rate Fluctuation	0.394	0.217	0.398	0.288
Population	0.682	0.169	0.686	0.283
Population, ages 15-64 (% of total)	0.717	0.230	0.721	0.296
Oil Prices (USD)	0.921	0.054	0.923	0.070
Accidents Deaths	-0.216	0.143	-0.217	0.374
No of Accidents	-0.085	0.063	-0.084	0.127
No of passengers	0.987	0.038	0.988	0.011

	Exchange Rate Fluctuation	*Population*	*Population, ages 15-64*	*Oil Prices*
Gross Domestic Product				
GDP Growth				
GDP per Capita				
Inflation GDP Deflator				
Exchange Rate Fluctuation	1.000			
Population	0.875	1.000		
Population, ages 15-64 (% of total)	0.810	0.980	1.000	
Oil Prices (USD)	0.361	0.701	0.760	1.000
Accidents Deaths	0.104	0.062	0.037	-0.188

No of Accidents	0.389	0.300	0.251	-0.096
No of passengers	0.502	0.761	0.794	0.927

	Accidents Deaths	***No of Accidents***	***No of passengers***
Gross Domestic Product			
GDP Growth			
GDP per Capita			
Inflation GDP Deflator			
Exchange Rate Fluctuation			
Population			
Population, ages 15-64 (% of total)			
Oil Prices (USD)			
Accidents Deaths	1.000		
No of Accidents	0.522	1.000	
No of passengers	-0.194	-0.051	1.000

- **India**

The correlation matrix table for China is shown in Table 4. From the table one can see that the R values for Gross Domestic Product = 0.996, GDP per Capital = 0.996, Exchange Rate Fluctuation=0.775, Consumer Price Index = 0.954, Population =0.837, Population ages 15-64=0.910, Oil. Prices =0.949. These variables are highly correlated to the dependent variable demand when compared to other independent variables which have r values less than 0.7000.

Table 10 Correlation matrix for all candidate explanatory variables and air travel for India

	Gross Domestic Product	***GDP per Capita***	***GDP Growth***	***Inflation GDP Deflator***
Gross Domestic Product	1.000			
GDP per Capita	0.999	1.000		
GDP Growth	0.400	0.413	1.000	
Inflation GDP Deflator	-0.217	-0.206	-0.492	1.000

Exchange Rate Fluctuation	0.807	0.802	0.429	-0.349
Consumer Price Index	0.969	0.964	0.415	-0.288
Population	0.862	0.868	0.485	-0.278
Population, ages 15-64	0.931	0.932	0.463	-0.300
Oil Prices	0.944	0.949	0.314	-0.126
Accidents Deaths	-0.181	-0.180	-0.018	0.045
No of Accidents	-0.315	-0.319	-0.076	0.052
No of passengers	0.996	0.996	0.382	-0.205

	Exchange Rate Fluctuation	***Consumer Price Index***	***Population***
Gross Domestic Product			
GDP per Capita			
GDP Growth			
Inflation GDP Deflator			
Exchange Rate Fluctuation	1.000		
Consumer Price Index	0.922	1.000	
Population	0.963	0.934	1.000
Population, ages 15-64	0.953	0.978	0.980
Oil Prices	0.687	0.882	0.781
Accidents Deaths	-0.192	-0.201	-0.196
No of Accidents	-0.366	-0.352	-0.371
No of passengers	0.775	0.954	0.837

	Population, ages 15-64	***Oil Prices***	***Accidents Deaths***	***No of Accidents***	***No of passengers***
Gross Domestic Product					
GDP per Capita					
GDP Growth					
Inflation GDP Deflator					
Exchange Rate Fluctuation					

Consumer Price Index					
Population					
Population, ages 15-64	1.000				
Oil Prices	0.858	1.000			
Accidents Deaths	-0.213	-0.228	1.000		
No of Accidents	-0.390	-0.360	0.408	1.000	
No of passengers	0.910	0.949	-0.190	-0.301	1.000

3.5. MULTICOLLINEARITY AMONG EXPLANATORY VARIABLES

In addition to indicating the correlation between the dependent and independent variables, the correlation matrix also identifies the correlation with the independent variables themselves. If two or more independent variables are highly correlated ($\pm$.7000 or greater), severe multicollinearity is present. Multicollinearity is common in regression models due to the fact that many of the independent variables are related to one another or implemented during the same time periods. When the independent variables are highly correlated with one another, they tend to explain the same variance in demand, making it difficult to determine the specific impact of each independent variable. In order to avoid multicollinearity among the highly correlated variables, the variables are grouped in several groups. While per capita income is the gross domestic product divided by the population size, gross domestic product and per capita income are not necessary to exist together as independent explanatory variables of the same model. The same thing can be said about population size and per capita income. Based on the above discussion, the model that represents the demand for international air travel will consist of a subset of one of the following groups of variables.

- **<u>Brazil</u>**

Group 1 (Gross Domestic Product, Exchange Rate Fluctuation, Population, Oil Prices)

Group 2(GDP per Capita, Exchange Rate Fluctuation, Population ages 15-64, Oil Prices)

Group 3 (Gross Domestic Product, Population, Oil Prices)

Group 4 (GDP per Capita, Population ages 15-64, Oil Prices)

Group 5 (Gross Domestic Product, Exchange Rate Fluctuation)

Group 6 (GDP per Capita, Exchange Rate Fluctuation)

Group 7 (Gross Domestic Product, Population)

Group 8 (GDP per Capita, Population ages 15-64)

- **<u>China</u>**

Group 1(Gross Domestic Product, Population, Oil Prices)

Group 2 (GDP per Capita, Population ages 15-64, Oil Prices)

Group 3 (Gross Domestic Product, Population)

Group 4 (GDP per Capita, Population ages 15-64)

- **<u>India</u>**

Group1 (Gross Domestic Product, Consumer Price Index, Exchange Rate Fluctuation, Population, Oil Prices)

Group 2(GDP per Capita, Consumer Price Index, Exchange Rate Fluctuation, Population ages 15-64, Oil Prices)

Group 3(Gross Domestic Product, Population, Oil Prices)

Group 4 (GDP per Capita, Population ages15-64, Oil Prices)

Group 5 (Gross Domestic Product, Consumer Price Index, Exchange Rate Fluctuation)

Group 6 (GDP per Capita, Consumer Price Index, Exchange Rate Fluctuation)

Group 7 (Gross Domestic Product, Population)

Group 8 (GDP per Capita, Population ages 15-64)

3.6. BUILDING AN ECONOMETRIC MODEL

Now, one have divided the highly correlated variables into different groups. A sequence of regression equations is computed by using different combination of the group's variables through stepwise regression procedure for selecting independent variables. At each step, an independent variable is either added or deleted until the prediction of the dependent variable (international air travel demand) does not significantly improve. The stepwise regression is performed in R studio using the leaps function.

Identify those suspected explanatory (independent) variables that may influence the dependent variable. The following questions are asked before performing the step-wise regression analysis.

a) Is there enough past historical data?
b) Is the past historical data in the appropriate periodicity?
c) Are there available forward forecasts (projections) for each explanatory variable?

d) Is the relationship of the explanatory variable and the dependent variable likely to continue into the future?

e) Is there a linear relationship between the explanatory variable and the dependent variable?

All the data are gathered for the variables, including the dependent variable, to be included in the initial regression model.

The data is entered into the R Studio software, and the appropriate step-wise regression function method is selected. Evaluate each explanatory variable based on available forecasting software output.

Here are seven key activities or guidelines for building effective multiple regression models. The activities are listed in sequential order, and each must is executed take place to ensure the model performs effectively.

a) Review scatter plots.

b) Review the correlation matrix to identify significant predictor variables and highly correlated explanatory variables

c) Review the F-test results to determine the overall fit of the model based on the selected predictor variables.

d) Review the R^2 and the adjusted R^2 to determine how much variability is being explained by the explanatory variables selected.

e) Review the t-tests for all the explanatory variables and corresponding P-values to determine each individual variable's significance.

These models or regression equations were developed using R Studio software. The R Studio output shows the relevant variables in every group that best specify the model as follows:

- **Brazil**

Group 1: (Gross Domestic Product, Exchange Rate Fluctuation, Population, Oil Prices): the subset of the group's variables which appear most relevant and best specify the model is (Gross Domestic Product, Exchange Rate Fluctuation, Oil Prices)

Group 2: (GDP per Capita, Exchange Rate Fluctuation, Population ages 15-64, Oil Prices): the subset of the group's variables which appear most relevant and best specify the model is

(GDP per Capita, Exchange Rate Fluctuation, Population ages 15-64, Oil Prices)

Group 3: (Gross Domestic Product, Population, Oil Prices): the subset of the group's variables which appear most relevant and best specify the model is (Gross Domestic Product, Population, Oil Prices)

Group 4: (GDP per Capita, Population ages 15-64, Oil Prices): the subset of the group's variables which appear most relevant and best specify the model is (GDP per Capita, Population ages 15-64, Oil Prices)

Group 5: (Gross Domestic Product, Exchange Rate Fluctuation): the subset of the group's variables which appear most relevant and best specify the model is (Gross Domestic Product, Exchange Rate Fluctuation)

Group 6: (GDP per Capita, Exchange Rate Fluctuation): the subset of the group's variables which appear most relevant and best specify the model is (GDP per Capita, Exchange Rate Fluctuation)

Group 7: (Gross Domestic Product, Population): the subset of the group's variables which appear most relevant and best specify the model is (Gross Domestic Product, Population)

Group 8: (GDP per Capita, Population ages 15-64): the subset of the group's variables which appear most relevant and best specify the model is (GDP per Capita, Population ages 15-64)

- **China**

Group 1: (Gross Domestic Product, Population, Oil Prices): the subset of the group's variables which appear most relevant and best specify the model is (Gross Domestic Product, Population)

Group 2: (GDP per Capita, Population.ages.15.64, Oil. Prices): the subset of the group's variables which appear most relevant and best specify the model is (GDP per Capita Population ages 15-64)

Group 3: (Gross Domestic Product, Population): the subset of the group's variables which appear most relevant and best specify the model is (Gross Domestic Product, Population)

Group 4: (GDP per Capita, Population ages 15-64): the subset of the group's variables which appear most relevant and best specify the model is (GDP per Capita, Population ages 15-64)

- **India**

Group1: (Gross Domestic Product, Consumer Price Index, Exchange Rate Fluctuation, Population, Oil Prices): the subset of the group's variables which appear most relevant and best specify the model is (Gross Domestic Product, Exchange Rate Fluctuation)

Group2: (GDP per Capita, Consumer Price Index, Exchange Rate Fluctuation, Population ages 15-64, Oil Prices): the subset of the group's variables which appear most relevant and best specify the model is (GDP per Capita, Consumer Price Index, Population ages 15.64, Oil Prices)

Group 3: (Gross Domestic Product, Population, Oil Prices): the subset of the group's variables which appear most relevant and best specify the model is (Gross Domestic Product, Population, Oil Prices)

Group 4: (GDP per Capita, Population ages 15-64, Oil Prices): the subset of the group's variables which appear most relevant and best specify the model is (GDP per Capita, Population ages 15-64)

Group 5: (Gross Domestic Product, Consumer Price Index, Exchange Rate Fluctuation): the subset of the group's variables which appear most relevant and best specify the model is (Gross Domestic Product, Exchange Rate Fluctuation)

Group 6: (GDP per Capita, Consumer Price Index, Exchange Rate Fluctuation): the subset of the group's variables which appear most relevant and best specify the model is (GDP per Capita Consumer Price Index, Exchange Rate Fluctuation)

Group 7: (Gross Domestic Product, Population): the subset of the group's variables which appear most relevant and best specify the model is (Gross Domestic Product, Population)

Group 8: (GDP per Capita, Population ages 15-64): the subset of the group's variables which appear most relevant and best specify the model is (GDP per Capita, Population ages 15-64)

From the Stepwise regression technique the following econometric models are being developed

- **Brazil**

Model 1: (Gross Domestic Product, Exchange Rate Fluctuation, Oil Prices)

Model 2: (GDP per Capita, Exchange Rate Fluctuation, Population ages 15-64, Oil Prices)

Model 3: (Gross Domestic Product, Population, Oil Prices)

Model 4: (GDP per Capita, Population ages 15-64, Oil Prices)

Model 5: (Gross Domestic Product, Exchange Rate Fluctuation)

Model 6: (GDP per Capita, Exchange Rate Fluctuation)

Model 7: (Gross Domestic Product, Population)

Model 8: (GDP per Capita, Population ages 15-64)

- **China**

Model 1: (Gross Domestic Product, Population)

Model 2: (GDP per Capita Population ages 15-64)

- **India**

Model 1: (Gross Domestic Product, Exchange Rate Fluctuation)

Model 2: (GDP per Capita, Consumer Price Index, Population ages 15-64, Oil Prices)

Model 3: (Gross Domestic Product, Population, Oil Prices)

Model 4: (GDP per Capita, Population ages 15-64)

Model 5: (GDP per Capita Consumer Price Index, Exchange Rate Fluctuation)

Model 6: (Gross Domestic Product, Population)

4. CHAPTER FOUR ACTIVITIES FOR BUILDING EFFECTIVE MULTIPLE REGRESSION MODELS

4.1. F-TEST

The F statistic is used to measure the overall fit of the regression model or statistical significance of the regression model. The *F* statistic is defined as the ratio of two variables (or mean squares). The F statistic is written as:

$$F = \frac{MSR}{MSE} = \frac{\sum \frac{(\hat{Y} - \overline{Y})^2}{k}}{\sum \frac{(Y - \hat{Y})^2}{(n - k - 1)}}$$

Note that the F-test is sensitive to the relative strengths of the numerator and the denominator. If the unexplained mean squared (MS) (variance of the errors) is large, then the regression model is not doing well, and F becomes smaller. If the MS is large relative to the unexplained MS, the F becomes larger. F table that is used to determine the optimal F value. The rule of thumb is that at a .05 (95 percent) significance, the F statistic should be +4.00 or higher for the overall fit of the model to be good. In other words, if F = 4.0 or greater, there is a significant relationship between the dependent and independent variables. The regression output for the is being evaluated for F- test

- **Brazil**

Table 11 F-Value for all different econometric models for Brazil

Model Number	F-Value
Model 1	376.3
Model 2	226.9
Model 3	307.8
Model 4	236
Model 5	505.6
Model 6	357.9
Model 7	414.8
Model 8	284.9

- **China**

Table 12 F-Value for all different econometric models for China

Model Number	F-Value
Model 1	1805
Model 2	2034
Model 3	1805
Model 4	2034

- **India**

Table 13 F-Value for all different econometric models for India

Model Number	F-Value
Model 1	4427
Model 2	2060
Model 3	2702
Model 4	3494
Model 5	4427
Model 6	2587
Model 7	3849
Model 8	3494

4.2. ADJUSTED R SQUARE

From the table 8, one have the $R^2 and\ adjusted\ R^2$ values for the eight models developed for Brazil. Model 1 gives a R^2 value of 0.965, which means the three explanatory variables chosen for Model 1 are explaining 96.5 percent of the variance in demand (dependent variable). Similarly Model 2 gives a R^2 value of 0.957 meaning the four explanatory variables chosen for Model 2 are explaining 95.7 percent of variance in demand. Likewise, the remaining models for Brazil, China and India can be interpreted from Table 8, 9 and 10 respectively. Although one wants the model that gives the highest R^2 and contains all the explanatory variables, each additional explanatory variable added to the model increases R^2. As a result, one must mention some notes of caution regarding R^2.

R^2 is a non-descending function of the number of explanatory variables present in the model. As one add more historical data points to all the variables, both Ys and Xs, and add more explanatory variables (or Xs), R^2 almost always increases and never decreases. This statistical phenomenon occurs because adding more explanatory variables to the model causes the prediction errors to be small, hence reducing sum of squares residuals (SSR).

The main problem with R^2 is the fact that it does not take into account degrees of freedom. *Degrees of freedom* is defined as the number of observations included in the formula minus the number of parameters estimated using the data. To overcome this problem, adjusted R^2 is introduced as:

$$Adjusted\ R^2 = 1 - (1 - R^2)\frac{(n-1)}{(n-k-1)}$$

The greater the difference between R^2 and adjusted R^2, the poorer the fit obtained for the model.

Table 14 R Square and Adjusted R Square for all different econometric models for Brazil

Model Number	R Square	Adjusted R Square
Model 1	0.9650	0.9624
Model 2	0.9578	0.9536
Model 3	0.9575	0.9544
Model 4	0.9453	0.9413
Model 5	0.9601	0.9582
Model 6	0.9446	0.9419
Model 7	0.9518	0.9495
Model 8	0.9314	0.9281

Table 15 R Square and Adjusted R Square for all different econometric models for China

Model Number	R Square	Adjusted R Square
Model 1	0.9885	0.9880
Model 2	0.9898	0.9893

Table 16 R Square and Adjusted R Square for all different econometric models for India

Model Number	R Square	Adjusted R Square
Model 1	0.9953	0.9951
Model 2	0.9952	0.9947
Model 3	0.9950	0.9946
Model 4	0.9940	0.9937
Model 5	0.9947	0.9944
Model 6	0.9946	0.9943

4.3. PARAMETER COEFFICIENTS

The constant β_0 $or\ \alpha\ intercept$ is simply the anchor point on the y-axis where the line is defined by the regression equation. Subsequently, it may or may not have a managerial interpretation. However, it does aid in a better prediction. In this case Model 1 for Brazil from table 11, the constant is positive, which means if one hold all the explanatory variables at zero, the dependent variable would be 2077000. In this case, the constant is positive, which means it could suggest that the 2077000 number of passengers who would have travelled in Brazil regardless of any of the air traffic demand factors. A negative constant is more difficult to explain. The recommended strategy is not to discuss the constant if it is negative. Since the independent variables parameter estimates (β coefficients) are often in different units of measure (dollars, percentages, etc.), it is difficult to compare them to determine their relative importance, or contribution to the forecast. The parameter coefficients for all the remaining models for Brazil, China and India can be interpreted similarly from table 11, 12 and 13 respectively.

Table 17 R Square and Adjusted R Square for all different econometric models for Brazil

Model Number	**Parameter Coefficients (intercept)**
Model 1	2077000
Model 2	48934386
Model 3	-8098000
Model 4	-47070000
Model 5	3038000
Model 6	-1258295
Model 7	-6426000
Model 8	-45910449

Table 18 R Square and Adjusted R Square for all different econometric models for China

Model Number	**Parameter Coefficients (intercept)**
Model 1	-104200000
Model 2	-173262563

Table 19 R Square and Adjusted R Square for all different econometric models for India

Model Number	Parameter Coefficients (intercept)
Model 1	862100
Model 2	113141704
Model 3	4454000
Model 4	53679999
Model 5	-2587985
Model 6	5258000

4.4. T-TEST

After determining the overall significance of the regression model, it is important to understand the significance of the individual explanatory coefficients. The most important thing to remember is that the t-test is a test of the significance for each individual explanatory variable in the presence of all the other explanatory variables. This significance test determines whether each explanatory variable is helping in the prediction of Y (dependent variable) in the presence of the other explanatory variables. The sign ($\pm$) indicates the direction of the relationship.

A coefficient is significantly different from zero at the 95 percent confidence level if the absolute value of the computed t-test is greater than the corresponding value from the t-table, which is generally $\pm$2.0. However, empirical testing has proven that a t-test of $\pm$1.65 or greater is also structurally significant at the 90 percent confidence level. So, one can lower the confidence level to 90 percent without losing the structural integrity of the model. Note that the size of the t-test has nothing to do with the significance of the explanatory variable's magnitude or impact on the dependent variable Y. It indicates only whether it is correlated or not.

Table 20 T-Test for all different econometric models for Brazil

Model Number	Intercept	X1	X2	X3	X4	X5	X6
Model 1	1.7890	9.0540	NA	NA	NA	3.6450	2.3780
Model 2	1.4470	NA	6.9680	NA	-1.4920	3.4440	2.9250
Model 3	-1.4080	7.1290	NA	1.9370	NA	NA	2.3400
Model 4	-2.1870	NA	5.4320	NA	2.1410	NA	3.2270
Model 5	2.6470	21.9900	NA	NA	NA	3.5230	NA
Model 6	-0.8550	NA	18.3330	NA	NA	3.8060	NA
Model 7	-1.0710	14.6520	NA	1.7390	NA	NA	NA
Model 8	-1.9280	NA	11.5270	NA	1.8990	NA	NA

Table 21 . T-Test for all different econometric models for China

Model Number	Intercept	X1	X2	X3	X4	X5	X6
Model 1	-6.7260	38.6510	NA	7.2920	NA	NA	NA
Model 2	-7.3210	NA	38.4680	NA	7.5310	NA	NA

Table 22 T-Test for all different econometric models for India

Model Number	Intercept	X1	X2	X3	X4	X5	X6	X7
Model 1	1.9160	59.2640	NA	NA	NA	-4.6550	NA	NA
Model 2	4.7410	NA	13.8870	NA	-5.0140	NA	1.3540	3.0660
Model 3	2.7020	23.9400	NA	-3.3500	NA	NA	1.7920	NA
Model 4	3.7340	NA	NA	34.2080	-4.1810	NA	NA	NA
Model 5	-2.6830	NA	9.4630	NA	NA	-4.5370	NA	3.5510
Model 6	3.2320	47.6480	NA	-3.6610	NA	NA	NA	NA

4.5. P-VALUES

There is a direct relationship between confidence intervals (t-tests) and P-values. The P-value measures the probability of obtaining a sample result that is more unlikely than the observed sample result in this case, the t-test. P-values describe the exact significance level associated with each explanatory variable. If the P-value is 0.05 or less at a 95 percent confidence interval, then the explanatory variable is significant in predicting Y. If the P-value is relatively large (above 0.05), then it is not consistent with the null hypothesis. The important thing to remember about P-values is that they provide additional evidence that the t-test is valid at a 95 percent confidence interval if the P-value is 0.05 or less.

Table 23 P-Value for all different econometric models for Brazil

Model Number	Intercept	X1	X2	X3	X4	X5	X6
Model 1	0.0811	0.0000	NA	NA	NA	0.0007	0.0222
Model 2	0.1557	NA	0.0000	NA	0.1436	0.0014	0.0057
Model 3	0.1666	0.0000	NA	0.0596	NA	NA	0.0242
Model 4	0.0345	NA	0.0000	NA	0.0382	NA	0.0025
Model 5	0.0114	< 2e-16	NA	NA	NA	0.0010	NA
Model 6	0.3972	NA	< 2e-16	NA	NA	0.0005	NA
Model 7	0.2905	<2e-16	NA	0.0894	NA	NA	NA
Model 8	0.0607	NA	0.0000	NA	0.0645	NA	NA

Table 24 P-Value for all different econometric models for China

Model Number	Intercept	X1	X2	X3	X4	X5	X6
Model 1	0.0000	< 2e-16	NA	0.0000	NA	NA	NA
Model 2	0.0000	NA	< 2e-16	NA	0.0000	NA	NA

Table 25 P-Value for all different econometric models for India

Model Number	Intercept	X1	X2	X3	X4	X5	X6	X7
Model 1	0.0622	< 2e-16	NA	NA	NA	0.0000	NA	NA
Model 2	0.0000	NA	< 2e-16	NA	0.0000	NA	0.1832	0.0039
Model 3	0.0100	< 2e-16	NA	0.0017	NA	NA	0.0805	NA
Model 4	0.0006	NA	< 2e-16	NA	0.0001		NA	NA
Model 5	0.0105	NA	0.0000	NA	NA	0.0000	NA	0.0010

Model 6	0.0024	< 2e-16	NA	0.0007	NA	NA	NA	NA

4.6. REGRESSION MODEL RESULTS

Regression analysis offers much more than improvement in explaining the variation in demand and forecast accuracy. Regression provides the means to identify and measure key demand signals that influence demand. Forecast accuracy is the final by-product of the efforts, but it is far from the true nature of the analytic benefits that helps to understand the dynamics of the business.

Figure 12 Annual passenger movements on scheduled flights in Brazil (1970-2014)

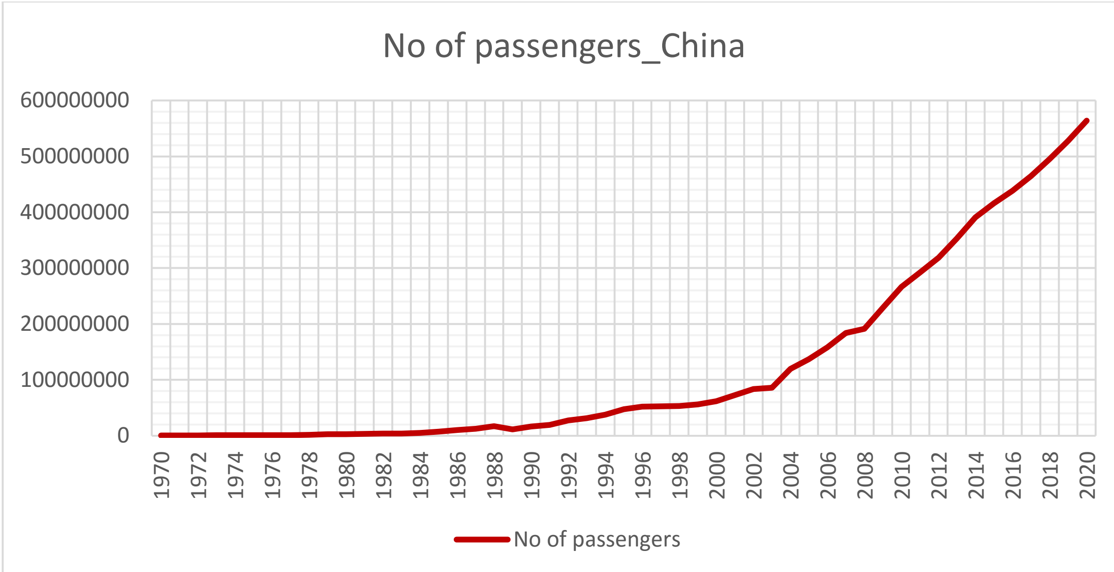


Figure 13 Annual passenger movements on scheduled flights in China (1970-2014)

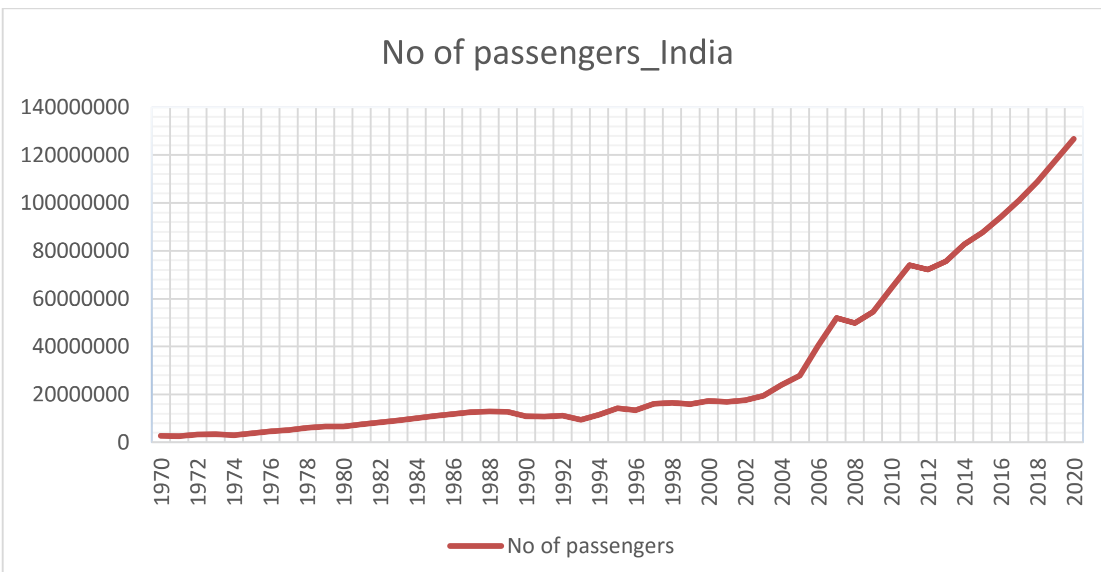


Figure 14 Annual passenger movements on scheduled flights in India (1970-2014)

5. CHAPTER FIVE FORECASTING DEMAND USING THE ECONOMETRIC MODEL

5.1. FORECASTING RESULTS FOR BRAZIL

Model developed for Brazil: No of passengers (y) = 2.077e+06 +GDP (2.610e-05) + Exchange Rate Fluctuation (3.422e+06) +Oil Prices (1.585e+05)

Model 1

Table 26 Regression output parameters for Model 1 for Brazil

F Value	R Square	Adjusted R Square	Parameter Coefficients
376.3	0.9650	0.9624	2077000

Intercept	X1	X2	X3	X4	X5	X6
1.7890	9.0540	NA	NA	NA	3.6450	2.3780

P-Value	X1	X2	X3	X4	X5	X6
0.0811	0.0000	NA	NA	NA	0.0007	0.0222

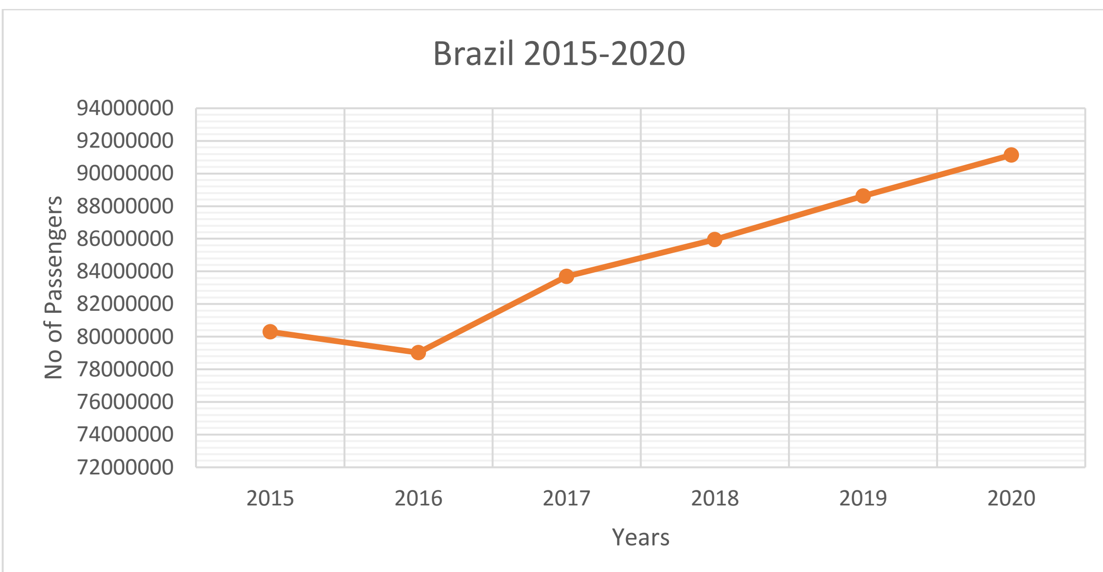


Figure 15 Forecasted passenger movements on scheduled flights in Brazil (2015-2020)

Table 27 Forecast Output for Brazil 2015-2020

Year	Intercept	Gross Domestic Product	Exchange rate Fluctuation	Oil Prices	No of Passengers
2015	2.08E+06	2.28E+12	3.28	48	80304774.07
2016	2.08E+06	2.25E+12	3.71	34.4	79026677.93
2017	2.08E+06	2.30E+12	4.24	43.9	83698526.06
2018	2.08E+06	2.36E+12	4.37	46.2	85951634.37
2019	2.08E+06	2.42E+12	4.59	48.6	88624819.23
2020	2.08E+06	2.48E+12	4.74	51.2	91128662.71

5.2. FORECASTING RESULTS FOR CHINA

Model developed for China: No of passengers (y) = -173262563 +GDP per Capita (46950) + Population.ages.15.64 (2848744)

Model 2

Table 28 Regression output parameters for Model 2 for China

F Value	R Square	Adjusted R Square	Parameter Coefficients
2034	0.9898	0.9893	-173262563

Intercept	X1	X2	X3	X4	X5	X6
-7.3210	NA	38.4680	NA	7.5310	NA	NA

P-Value	X1	X2	X3	X4	X5	X6
0.0000	NA	< 2e-16	NA	0.0000	NA	NA

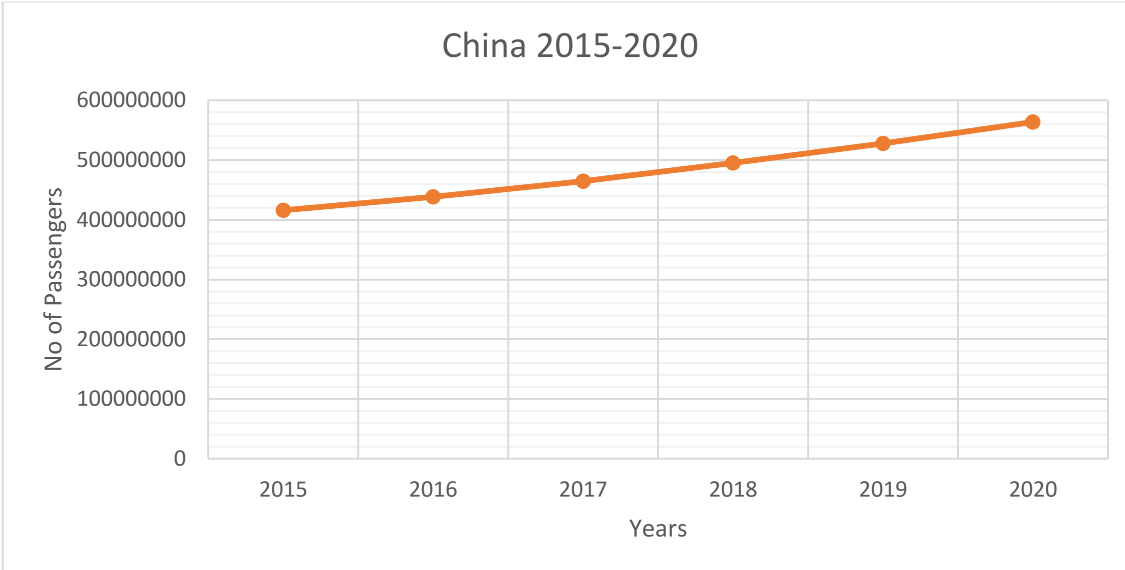


Figure 16 Forecasted passenger movements on scheduled flights in China (2015-2020)

Table 29 Forecast Output for China 2015-2020

Year	Intercept	Gross per capita	Population ages 15-64	No of Passengers
2015	-173262563	8154.38	72.38366223	415788101
2016	-173262563	8659.39	71.91342033	438158722
2017	-173262563	9259.34	71.40460668	464876895
2018	-173262563	9935.69	70.89647171	495183981
2019	-173262563	10662.3	70.44008727	527998198
2020	-173262563	11449.16	70.06604935	563875737

5.3. FORECASTING RESULTS FOR INDIA

Model developed for India: No of passengers (y) = 8.621e+05 +GDP (4.257e-05) - Exchange Rate Fluctuation (1.058e+05)

Model 1

Table 30 Regression output parameters for Model 1 for India

F Value	R Square	Adjusted R Square	Parameter Coefficients
3494	0.9953	0.9951	862100

India	Intercept	X1	X2	X3	X4	X5	X6	X7
Model 1	1.9160	59.2640	NA	NA	NA	-4.6550	NA	NA

India	Intercept	X1	X2	X3	X4	X5	X6	X7
Model 1	0.0622	< 2e-16	NA	NA	NA	0.0000	NA	NA

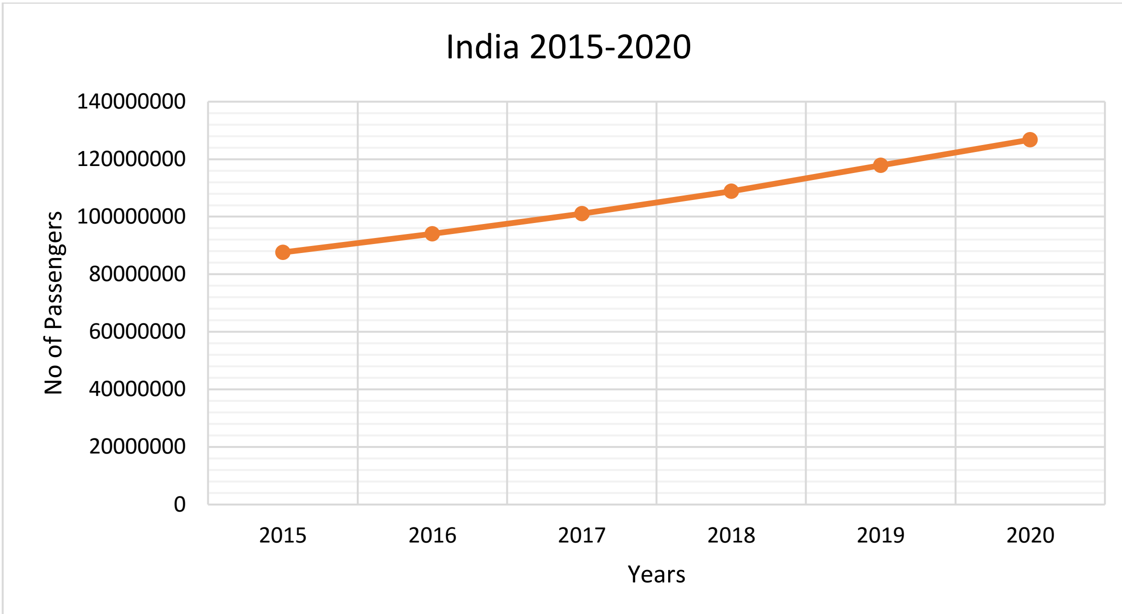


Figure 17 Forecasted passenger movements on scheduled flights in China (2015-2020)

Table 31 Forecast Output for India 2015-2020

Year	Intercept	Gross Domestic Product	Exchange Rate Fluctuation	No of Passengers
2015	8.62E+05	2.20E+12	64.45	87614670.65
2016	8.62E+05	2.36E+12	68.58	94101998.82
2017	8.62E+05	2.53E+12	72.48	101025562.2
2018	8.62E+05	2.72E+12	73.36	108804183
2019	8.62E+05	2.93E+12	74.56	117817805.1
2020	8.62E+05	3.14E+12	75.02	126757916.1

6. CHAPTER SIX CONCLUSION

6.1. ASSESSING THE READINESS OF THE DEMAND FORECASTING MODEL

By looking into the results of regression analysis for Brazil, it is found that the Gross Domestic Product, Exchange Rate Fluctuation and Oil Prices has a positive effect on international air travel demand holding other things the same. As the Gross Domestic Product goes up by one unit, on the average demand for air travel goes up by 2.610e-05 passengers. Likewise, if the total exchange rate fluctuation goes up by one unit point, on the average demand for air travel goes up by 3.422e+06 passengers. Furthermore, if the Oil Price in (USD) goes up by one unit, on the average demand for air travel goes up by 1.585e+05 passengers, other things keeping the same.

Similarly, for China, it is found that the GDP per Capita and Population of age group (15-64) has a positive effect on international air travel demand holding other things the same. As the GDP per Capita goes up by one unit, on the average demand for air travel goes up by 46950 passengers. Likewise, if the Population of age group (15-64) goes up by one unit point, on the average demand for air travel goes up by 2848744 passengers, other things keeping the same.

Furthermore, for India, it is found that the Gross Domestic Product and Exchange Rate Fluctuation has a positive effect on international air travel demand holding other things the same. As the Gross Domestic Product goes up by one unit, on the average demand for air travel goes up by 4.257e-05 passengers. Likewise, if the total exchange rate fluctuation goes up by one unit point, on the average demand for air travel goes up by 1.058e+05 passengers, other things keeping the same.

- **<u>Brazil</u>**

The two-tailed t-test can be used to test whether such a null hypothesis stands up against the (two-sided) alternative hypothesis that true population coefficient is different from zero. The degrees of freedom are 41, which are obtained by subtracting the number of parameters estimated, which are 3 in the selected Model from n (=45). If α is set at 0.05, the two-tailed critical t value is about $\pm$2.018 for 42 d.f. If α is fixed at 0.01 or 1% level, the critical t value for 42 d.f. is $\pm$2.698 (two-tailed). Looking at the t-values presented in Table 26, it is found that each partial regression coefficient is statistically significantly different from zero at the 5% level of significance.

What about the overall significance of the estimated regression line? That is, the null hypothesis that all partial slopes are simultaneously equal to zero or, equivalently, R= ‘0’, be accepted? This hypothesis was tested with the help of F-test. The F value has an F distribution with 3 and 41 d.f. If α is set at 0.05, the F table shows the critical F value of 2.84. The corresponding value at α ‘0.01’ is 4.31 .The computed F of 376.3 far exceeds either of this critical F value. Therefore, the null hypothesis, i.e., all partial slopes are simultaneously equal to zero or, alternatively, R^2 =0, is rejected. Gross Domestic Product, Exchange

Rate Fluctuation and Oil Prices, collectively and individually, influence international air travel demand. The previous analysis shows that all the developed models for international air travel demand are well fitting.

- **<u>China</u>**

The two-tailed t-test can be used to test whether such a null hypothesis stands up against the (two-sided) alternative hypothesis that true population coefficient is different from zero. The degrees of freedom are 42, which are obtained by subtracting the number of parameters estimated, which are 2 in the selected Model from n (=45). If α is set at 0.05, the two-tailed critical t value is about $\pm$2.018 for 42 d.f. If α is fixed at 0.01 or 1% level, the critical t value for 42 d.f. is $\pm$2.698 (two-tailed). Looking at the t-values presented in Table 28, it is found that each partial regression coefficient is statistically significantly different from zero at the 1% level of significance.

What about the overall significance of the estimated regression line? That is, the null hypothesis that all partial slopes are simultaneously equal to zero or, equivalently, R= '0', be accepted? This hypothesis was tested with the help of F-test. The F value has an F distribution with 2 and 42 d.f. If α is set at 0.05, the F table shows the critical F value of 3.23. The corresponding value at α '0.01' is 5.18. The computed F of 2034 far exceeds either of this critical F value. Therefore, the null hypothesis, i.e., all partial slopes are simultaneously equal to zero or, alternatively, R^2 =0, is rejected. Gross Domestic Product, Exchange Rate Fluctuation and Oil Prices, collectively and individually, influence international air travel demand. Since the computed d value in the model is closer to 2, the evidence is in favor of no autocorrelation. The previous analysis shows that all the developed models for international air travel demand are well fitting.

- **India**

The two-tailed t-test can be used to test whether such a null hypothesis stands up against the (two-sided) alternative hypothesis that true population coefficient is different from zero. The degrees of freedom are 42, which are obtained by subtracting the number of parameters estimated, which are 2 in the present instance from n (=45). If α is set at 0.05, the two-tailed critical t value is about $\pm$2.018 for 42 d.f. If α is fixed at 0.01 or 1% level, the critical t value for 42 d.f. is $\pm$2.698 (two-tailed). Looking at the t-values presented in Table 30, it is found that each partial regression coefficient is statistically significantly different from zero at the 1% level of significance.

What about the overall significance of the estimated regression line? That is, the null hypothesis that all partial slopes are simultaneously equal to zero or, equivalently, R= '0', be accepted? This hypothesis was tested with the help of F-test. The F value has an F distribution with 2 and 42 d.f. If α is set at 0.05, the F table shows the critical F value of 2.23. The corresponding value at α '0.01' is 5.18. The computed F of 4427 far exceeds either of this critical F value. Therefore, the null hypothesis, i.e., all partial slopes are simultaneously equal to zero or, alternatively, R^2 =0, is rejected. Gross Domestic Product, Exchange Rate Fluctuation and Oil Prices, collectively and individually, influence international air travel demand. Since the computed d value in the model is closer to 2, the evidence is in favor of no autocorrelation. The previous analysis shows that all the developed models for international air travel demand are well fitting.

6.2. LIMITATIONS AND CHALLENGES

The thesis devotes a detailed description of the steps followed for the development of the econometric models of international air travel demand in Brazil, China and India. Econometric models were attempted to analyze and forecast the air traffic through establishing statistical relationship between selected demand-influencing factors and the corresponding level of traffic. From the statistical measures for evaluating the models, it is found that (i) Gross Domestic Product, Exchange rate fluctuation and Oil Prices, (ii) GDP per Capita and Population of ages 15-64 (% of total),(iii) Gross Domestic Product and Exchange rate fluctuation are the main determinants of international air travel in Brazil, China and India respectively. This model is very good in terms of Goodness of Fit measure. Based on the air traffic analysis through the proposed model, the airlines and civil aviation authorities can develop their corporate plan.

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Appendix A: R code

1. Brazil

Autocorrelation Matrix

```
                           Gross.Domestic.Product GDP.per.Capita  GDP.
Growth
Gross.Domestic.Product                 1.00000000     0.99779224 -0.229
35562
GDP.per.Capita                         0.99779224     1.00000000 -0.252
93994
GDP.Growth                            -0.22935562    -0.25293994  1.000
00000
Inflation.GDP.Deflator                -0.16540154    -0.14714373 -0.217
22449
Exchange.Rate.Fluctuation              0.64134023     0.62343439 -0.221
06556
Population                             0.82865145     0.83220912 -0.427
55518
Population.ages.15.64                  0.83211230     0.83449859 -0.410
99145
Oil.Prices                             0.92310017     0.91415229 -0.223
81076
Accidents.Deaths                       -0.04648559    -0.03723149  0.07
660289
No.of.Accidents                       -0.25406605    -0.24382781  0.107
45496
No.of.passengers                       0.97382767     0.96201043 -0.259
99025

Inflation.GDP.Deflator      Exchange.Rate.Fluctuation  Population
Gross.Domestic.Product                -0.16540154                0.6413
4023  0.82865145
GDP.per.Capita                        -0.14714373                0.6234
3439  0.83220912
GDP.Growth                            -0.21722449               -0.2210
6556 -0.42755518
Inflation.GDP.Deflator                 1.00000000               -0.3046
2604 -0.03457744
Exchange.Rate.Fluctuation             -0.30462604                1.0000
0000  0.84752728
Population                            -0.03457744                0.8475
2728  1.00000000
Population.ages.15.64                 -0.08130970                0.8742
0894  0.99707149
Oil.Prices                            -0.21183355                0.6002
4831  0.75480605
Accidents.Deaths                       -0.03556841               -0.041
78082 -0.03207420
No.of.Accidents                        0.11067823               -0.0531
1509 -0.14254913
No.of.passengers                      -0.19301529                0.7078
4653  0.83993717
```

```
                       Population.ages.15.64  Oil.Prices Accidents.Dea
ths
Gross.Domestic.Product             0.8321123  0.92310017     -0.046
48559
GDP.per.Capita                     0.8344986  0.91415229     -0.037
23149
GDP.Growth                        -0.4109915 -0.22381076      0.076
60289
Inflation.GDP.Deflator            -0.0813097 -0.21183355     -0.035
56841
Exchange.Rate.Fluctuation          0.8742089  0.60024831     -0.041
78082
Population                         0.9970715  0.75480605     -0.032
07420
Population.ages.15.64              1.0000000  0.76001611     -0.033
04940
Oil.Prices                         0.7600161  1.00000000      0.041
64056
Accidents.Deaths                  -0.0330494  0.04164056      1.00
000000
No.of.Accidents                   -0.1321082 -0.37289756      0.076
12069
No.of.passengers                   0.8450881  0.92682425     -0.108
74893
```

```
                       No.of.Accidents No.of.passengers
Gross.Domestic.Product       -0.25406605        0.9738277
GDP.per.Capita               -0.24382781        0.9620104
GDP.Growth                    0.10745496       -0.2599902
Inflation.GDP.Deflator        0.11067823       -0.1930153
Exchange.Rate.Fluctuation    -0.05311509        0.7078465
Population                   -0.14254913        0.8399372
Population.ages.15.64        -0.13210821        0.8450881
Oil.Prices                   -0.37289756        0.9268243
Accidents.Deaths              0.07612069       -0.1087489
No.of.Accidents               1.00000000       -0.2685733
No.of.passengers             -0.26857329        1.0000000
```

Step Wise Regression

Group 1

(Gross.Domestic.Product,Exchange.Rate.Fluctuation,Population, Oil.Prices)

```
> leaps( x=Group.1[,2:5], y=Group.1[,1], names=names(Group.1)[2:5], me
thod="adjr2")
$which
  Gross.Domestic.Product Exchange.Rate.Fluctuation Population Oil.Pric
es
1                   TRUE                     FALSE      FALSE      FAL
SE
1                  FALSE                     FALSE      FALSE       TR
UE
```

```
1                    FALSE                          FALSE        TRUE        FAL
SE
1                    FALSE                           TRUE       FALSE        FAL
SE
2                     TRUE                           TRUE       FALSE        FAL
SE
2                     TRUE                          FALSE       FALSE         TR
UE
2                     TRUE                          FALSE        TRUE        FAL
SE
2                    FALSE                          FALSE        TRUE         TR
UE
2                    FALSE                           TRUE       FALSE         TR
UE
2                    FALSE                           TRUE        TRUE        FAL
SE
3                     TRUE                           TRUE       FALSE         TR
UE
3                     TRUE                           TRUE        TRUE        FAL
SE
3                     TRUE                          FALSE        TRUE         TR
UE
3                    FALSE                           TRUE        TRUE         TR
UE
4                     TRUE                           TRUE        TRUE         TR
UE

$label
[1] "(Intercept)"               "Gross.Domestic.Product"    "Exchange.
Rate.Fluctuation"
[4] "Population"                "Oil.Prices"

$size
 [1] 2 2 2 2 3 3 3 3 3 3 4 4 4 4 5

$adjr2
 [1] 0.9471390 0.8557242 0.6986455 0.4894431 0.9582263 0.9513882 0.949
5155 0.9002602
 [9] 0.8898881 0.6915306 0.9623924 0.9582387 0.9543791 0.8998407 0.962
0955
```

Result 1 (Gross.Domestic.Product Exchange.Rate.Fluctuation, Oil.Prices)

Group 2

```
>   View(Group.2)
> leaps( x=Group.2[,2:5], y=Group.2[,1], names=names(Group.2)[2:5], me
thod="adjr2")
$which
  GDP.per.Capita Exchange.Rate.Fluctuation Population.ages.15.64 Oil.P
rices
1            TRUE                         FALSE                   FALSE
FALSE
1           FALSE                         FALSE                   FALSE
TRUE
```

```
1          FALSE                          FALSE                   TRUE
FALSE
1          FALSE                           TRUE                  FALSE
FALSE
2           TRUE                           TRUE                  FALSE
FALSE
2           TRUE                          FALSE                  FALSE
TRUE
2           TRUE                          FALSE                   TRUE
FALSE
2          FALSE                          FALSE                   TRUE
TRUE
2          FALSE                           TRUE                  FALSE
TRUE
2          FALSE                           TRUE                   TRUE
FALSE
3           TRUE                           TRUE                  FALSE
TRUE
3           TRUE                           TRUE                   TRUE
FALSE
3           TRUE                          FALSE                   TRUE
TRUE
3          FALSE                           TRUE                   TRUE
TRUE
4           TRUE                           TRUE                   TRUE
TRUE

$label
[1] "(Intercept)"              "GDP.per.Capita"            "Exchange.
Rate.Fluctuation"
[4] "Population.ages.15.64"    "Oil.Prices"

$size
 [1] 2 2 2 2 3 3 3 3 3 3 4 4 4 4 5

$adjr2
 [1] 0.9237307 0.8557242 0.7075267 0.4894431 0.9419386 0.9362386 0.928
0863 0.9013811
 [9] 0.8898881 0.7048160 0.9521694 0.9450020 0.9412541 0.8996928 0.953
5577
```

Results 2 (GDP.per.Capita , Exchange.Rate.Fluctuation, Population.ages.15.64, Oil.Prices)

Group 3

```
> leaps( x=Group.3[,2:4], y=Group.3[,1], names=names(Group.3)[2:4], me
thod="adjr2")
$which
  Gross.Domestic.Product Population Oil.Prices
1                   TRUE      FALSE
1                  FALSE      FALSE       TRUE
1                  FALSE       TRUE      FALSE
2                   TRUE      FALSE       TRUE
2                   TRUE       TRUE      FALSE
2                  FALSE       TRUE       TRUE
3                   TRUE       TRUE       TRUE
```

```
$label
[1] "(Intercept)"            "Gross.Domestic.Product" "Population"
[4] "Oil.Prices"

$size
[1] 2 2 2 3 3 3 4

$adjr2
[1] 0.9471390 0.8557242 0.6986455 0.9513882 0.9495155 0.9002602 0.9543
791
```

Result 3 (Gross.Domestic.Product, Population, Oil.Prices)

Group 4

```
>   View(Group.4)
> leaps( x=Group.4[,2:4], y=Group.4[,1], names=names(Group.4)[2:4], me
thod="adjr2")
$which
  GDP.per.Capita Population.ages.15.64 Oil.Prices
1           TRUE                 FALSE      FALSE
1          FALSE                 FALSE       TRUE
1          FALSE                  TRUE      FALSE
2           TRUE                 FALSE       TRUE
2           TRUE                  TRUE      FALSE
2          FALSE                  TRUE       TRUE
3           TRUE                  TRUE       TRUE

$label
[1] "(Intercept)"           "GDP.per.Capita"        "Population.ages.1
5.64"
[4] "Oil.Prices"

$size
[1] 2 2 2 3 3 3 4

$adjr2
[1] 0.9237307 0.8557242 0.7075267 0.9362386 0.9280863 0.9013811 0.9412
541
```

Result 4 (GDP.per.Capita Population.ages.15.64 Oil.Prices)

Group 5

```
> leaps( x=Group.5[,2:3], y=Group.5[,1], names=names(Group.5)[2:3], me
thod="adjr2")
$which
  Gross.Domestic.Product Exchange.Rate.Fluctuation
1                   TRUE                     FALSE
1                  FALSE                      TRUE
2                   TRUE                      TRUE

$label
[1] "(Intercept)"               "Gross.Domestic.Product"    "Exchange.
Rate.Fluctuation"

$size
```

```
[1] 2 2 3

$adjr2
[1] 0.9471390 0.4894431 0.9582263
```

Result 5 (Gross.Domestic.Product Exchange.Rate.Fluctuation)

Group 6

```
> Group.6 <- read.csv("C:/University of Oklahoma/University of Oklahom
a/Thesis/Project/Brazil/Group 6.csv")
>   View(Group.6)
> leaps( x=Group.6[,2:3], y=Group.6[,1], names=names(Group.6)[2:3], me
thod="adjr2")
$which
  GDP.per.Capita Exchange.Rate.Fluctuation
1           TRUE                     FALSE
1          FALSE                      TRUE
2           TRUE                      TRUE

$label
[1] "(Intercept)"               "GDP.per.Capita"            "Exchange.
Rate.Fluctuation"

$size
[1] 2 2 3

$adjr2
[1] 0.9237307 0.4894431 0.9419386
```

Result 6 (GDP.per.Capita Exchange.Rate.Fluctuation)

Group 7

```
> leaps( x=Group.7[,2:3], y=Group.7[,1], names=names(Group.7)[2:3], me
thod="adjr2")
$which
  Gross.Domestic.Product Population
1                   TRUE      FALSE
1                  FALSE       TRUE
2                   TRUE       TRUE

$label
[1] "(Intercept)"            "Gross.Domestic.Product" "Population"

$size
[1] 2 2 3

$adjr2
[1] 0.9471390 0.6986455 0.9495155
```

Result 7 (Gross.Domestic.Product Population)

Group 8

```
> leaps( x=Group.8[,2:3], y=Group.8[,1], names=names(Group.8)[2:3], me
thod="adjr2")
$which
  GDP.per.Capita Population.ages.15.64
1           TRUE                 FALSE
1          FALSE                  TRUE
2           TRUE                  TRUE

$label
[1] "(Intercept)"           "GDP.per.Capita"        "Population.ages.1
5.64"

$size
[1] 2 2 3

$adjr2
[1] 0.9237307 0.7075267 0.9280863
```

Result 8 (GDP.per.Capita Population.ages.15.64)

Multiple Regression

Model 1

```
> myModel<-lm( No.of.passengers~ Gross.Domestic.Product+Exchange.Rate.
Fluctuation+Oil.Prices , Group.1)
> summary(myModel)

Call:
lm(formula = No.of.passengers ~ Gross.Domestic.Product + Exchange.Rate
.Fluctuation +
    Oil.Prices, data = Group.1)

Residuals:
      Min        1Q    Median        3Q       Max
-11152603  -1748823    620954   1364721  13797840

Coefficients:
                           Estimate Std. Error t value Pr(>|t|)
(Intercept)               2.077e+06  1.161e+06   1.789 0.081084 .
Gross.Domestic.Product    2.610e-05  2.882e-06   9.054 2.49e-11 ***
Exchange.Rate.Fluctuation 3.422e+06  9.386e+05   3.645 0.000744 ***
Oil.Prices                1.585e+05  6.666e+04   2.378 0.022175 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 5067000 on 41 degrees of freedom
Multiple R-squared:  0.965,    Adjusted R-squared:  0.9624
F-statistic: 376.3 on 3 and 41 DF,  p-value: < 2.2e-16
```

Model 2

```
> myModel<-lm( No.of.passengers~ GDP.per.Capita+Exchange.Rate.Fluctuat
ion+Population.ages.15.64+Oil.Prices, Group.2)
> summary(myModel)
```

```
Call:
lm(formula = No.of.passengers ~ GDP.per.Capita + Exchange.Rate.Fluctua
tion + 
    Population.ages.15.64 + Oil.Prices, data = Group.2)

Residuals:
      Min        1Q    Median        3Q       Max 
-11255423  -2722398   -171477   3351572  14783955 

Coefficients:
                            Estimate Std. Error t value Pr(>|t|)    
(Intercept)               48934385.6 33815817.6   1.447  0.15567    
GDP.per.Capita              5507.1      790.3   6.968 2.08e-08 ***
Exchange.Rate.Fluctuation  6291031.2  1826607.7   3.444  0.00136 ** 
Population.ages.15.64      -884525.1   592906.2  -1.492  0.14358    
Oil.Prices                  209107.7    71500.1   2.925  0.00566 ** 
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 5631000 on 40 degrees of freedom
Multiple R-squared:  0.9578,	Adjusted R-squared:  0.9536 
F-statistic: 226.9 on 4 and 40 DF,  p-value: < 2.2e-16
```

Model 3

```
> myModel<-lm( No.of.passengers~ Gross.Domestic.Product+Population+Oil
.Prices, Group.3)
> summary(myModel)

Call:
lm(formula = No.of.passengers ~ Gross.Domestic.Product + Population + 
    Oil.Prices, data = Group.3)

Residuals:
      Min        1Q    Median        3Q       Max 
-10958541  -2787933    990277   2575073  14506714 

Coefficients:
                         Estimate Std. Error t value Pr(>|t|)    
(Intercept)            -8.098e+06  5.751e+06  -1.408   0.1666    
Gross.Domestic.Product  2.546e-05  3.571e-06   7.129 1.08e-08 ***
Population              8.597e-02  4.438e-02   1.937   0.0596 .  
Oil.Prices              1.719e+05  7.347e+04   2.340   0.0242 *  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 5581000 on 41 degrees of freedom
Multiple R-squared:  0.9575,	Adjusted R-squared:  0.9544 
F-statistic: 307.8 on 3 and 41 DF,  p-value: < 2.2e-16
```

Model 4

```
> myModel<-lm( No.of.passengers~ GDP.per.Capita+Population.ages.15.64+
Oil.Prices, Group.4)
> summary(myModel)
```

```
Call:
lm(formula = No.of.passengers ~ GDP.per.Capita + Population.ages.15.64 
+ 
    Oil.Prices, data = Group.4)

Residuals:
      Min        1Q    Median        3Q       Max 
-11934123  -4061733    867610   4547234  16938916 

Coefficients:
                        Estimate Std. Error t value Pr(>|t|)    
(Intercept)           -4.707e+07  2.153e+07  -2.187  0.03454 *  
GDP.per.Capita         4.448e+03  8.188e+02   5.432 2.77e-06 ***
Population.ages.15.64  8.035e+05  3.752e+05   2.141  0.03823 *  
Oil.Prices             2.550e+05  7.901e+04   3.227  0.00246 ** 
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 6333000 on 41 degrees of freedom
Multiple R-squared:  0.9453,	Adjusted R-squared:  0.9413 
F-statistic:   236 on 3 and 41 DF,  p-value: < 2.2e-16
```

Model 5

```
> myModel<-lm( No.of.passengers~ Gross.Domestic.Product+Exchange.Rate.
Fluctuation, Group.5)
> summary(myModel)

Call:
lm(formula = No.of.passengers ~ Gross.Domestic.Product + Exchange.Rate
.Fluctuation, 
    data = Group.5)

Residuals:
      Min        1Q    Median        3Q       Max 
-11930037  -2498401    763002   3040573  13845147 

Coefficients:
                           Estimate Std. Error t value Pr(>|t|)    
(Intercept)               3.038e+06  1.148e+06   2.647  0.01137 *  
Gross.Domestic.Product    3.210e-05  1.460e-06  21.990  < 2e-16 ***
Exchange.Rate.Fluctuation 3.484e+06  9.888e+05   3.523  0.00104 ** 
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 5340000 on 42 degrees of freedom
Multiple R-squared:  0.9601,	Adjusted R-squared:  0.9582 
F-statistic: 505.6 on 2 and 42 DF,  p-value: < 2.2e-16
```

Model 6

```
> myModel<-lm( No.of.passengers~ GDP.per.Capita+Exchange.Rate.Fluctuat
ion, Group.6)
> summary(myModel)

Call:
```

```
lm(formula = No.of.passengers ~ GDP.per.Capita + Exchange.Rate.Fluctua
tion,
    data = Group.6)

Residuals:
      Min        1Q    Median        3Q       Max 
-14976148  -2727393    725799   3337538  16735584 

Coefficients:
                            Estimate Std. Error t value Pr(>|t|)    
(Intercept)               -1258295.4  1471187.7  -0.855 0.397242    
GDP.per.Capita                6559.8      357.8  18.333  < 2e-16 ***
Exchange.Rate.Fluctuation  4353807.2  1143968.4   3.806 0.000453 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 6296000 on 42 degrees of freedom
Multiple R-squared:  0.9446,	Adjusted R-squared:  0.9419 
F-statistic: 357.9 on 2 and 42 DF,  p-value: < 2.2e-16
```

Model 7

```
> myModel<-lm( No.of.passengers~ Gross.Domestic.Product+Population, Gr
oup.7)
> summary(myModel)

Call:
lm(formula = No.of.passengers ~ Gross.Domestic.Product + Population, 
    data = Group.7)

Residuals:
      Min        1Q    Median        3Q       Max 
-12478634  -3801309   1035563   1949131  14495785 

Coefficients:
                         Estimate Std. Error t value Pr(>|t|)    
(Intercept)            -6.426e+06  6.003e+06  -1.071   0.2905    
Gross.Domestic.Product  3.223e-05  2.200e-06  14.652   <2e-16 ***
Population              8.109e-02  4.663e-02   1.739   0.0894 .  
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 5871000 on 42 degrees of freedom
Multiple R-squared:  0.9518,	Adjusted R-squared:  0.9495 
F-statistic: 414.8 on 2 and 42 DF,  p-value: < 2.2e-16
```

Model 8

```
> myModel<-lm( No.of.passengers~ GDP.per.Capita+Population.ages.15.64,
Group.8)
> summary(myModel)

Call:
lm(formula = No.of.passengers ~ GDP.per.Capita + Population.ages.15.64
,
```

```
    data = Group.8)

Residuals:
      Min        1Q    Median        3Q       Max 
-15711436  -3689183    750539   3636846  17861135 

Coefficients:
                       Estimate Std. Error t value Pr(>|t|)    
(Intercept)           -45910449   23816591  -1.928   0.0607 .  
GDP.per.Capita             6514        565  11.527 1.36e-14 ***
Population.ages.15.64    788127     415126   1.899   0.0645 .  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 7007000 on 42 degrees of freedom
Multiple R-squared:  0.9314,	Adjusted R-squared:  0.9281 
F-statistic: 284.9 on 2 and 42 DF,  p-value: < 2.2e-16
```

2. China

Correlation Matrix

```
                                Years Gross.Domestic.Product  GDP.Grow
th GDP.per.Capita
Years                     1.000000000             0.76840462  0.160173
46      0.77220549
Gross.Domestic.Product    0.768404619             1.00000000 -0.014550
28      0.99994715
GDP.Growth                0.160173455            -0.01455028  1.000000
00     -0.01257345
GDP.per.Capita            0.772205486             0.99994715 -0.012573
45      1.00000000
Inflation.GDP.Deflator    0.231274198            -0.02760619  0.360747
69     -0.02574070
Exchange.Rate.Fluctuation 0.832314262             0.39356338  0.217299
89      0.39837404
Population                0.990775100             0.68186307  0.169349
27      0.68598752
Population.ages.15.64     0.985117710             0.71657259  0.230057
49      0.72085326
Oil.Prices                0.778649105             0.92089877  0.053801
12      0.92294784
Accidents.Deaths           0.005895971            -0.21647157  0.14325
006    -0.21694571
No.of.Accidents           0.239973443            -0.08552680  0.062644
04     -0.08434894
No.of.passengers          0.839162099             0.98688231  0.038274
89     0.98791864
                        Inflation.GDP.Deflator Exchange.Rate.Fluctuati
on Population
Years                                0.23127420                  0.832
3143  0.9907751
Gross.Domestic.Product              -0.02760619                  0.393
5634  0.6818631
GDP.Growth                           0.36074769                  0.217
2999  0.1693493
```

```
GDP.per.Capita                       -0.02574070                 0.398
3740  0.6859875
Inflation.GDP.Deflator                1.00000000                 0.288
2708  0.2832665
Exchange.Rate.Fluctuation             0.28827076                 1.000
0000  0.8745436
Population                            0.28326650                 0.874
5436  1.0000000
Population.ages.15.64                 0.29616442                 0.810
1807  0.9803413
Oil.Prices                            0.06956476                 0.361
0734  0.7011247
Accidents.Deaths                       0.37433380                 0.10
40993  0.0624218
No.of.Accidents                       0.12718379                 0.389
2901  0.3004969
No.of.passengers                      0.01104102                 0.501
7921  0.7611885
                    Population.ages.15.64     Oil.Prices      Accident
s.Dead     No.of.Accidents
Years                                0.98511771  0.77864911     0.0058
95971       0.23997344
Gross.Domestic.Product               0.71657259  0.92089877    -0.2164
71569      -0.08552680
GDP.Growth                           0.23005749  0.05380112     0.1432
50055       0.06264404
GDP.per.Capita                       0.72085326  0.92294784    -0.2169
45707      -0.08434894
Inflation.GDP.Deflator               0.29616442  0.06956476     0.3743
33796       0.12718379
Exchange.Rate.Fluctuation            0.81018066  0.36107335     0.1040
99328       0.38929006
Population                           0.98034126  0.70112472     0.0624
21805       0.30049692
Population.ages.15.64                1.00000000  0.75996119     0.0370
67625       0.25068652
Oil.Prices                           0.75996119  1.00000000    -0.1878
54870      -0.09608376
Accidents.Deaths                      0.03706763 -0.18785487     1.000
000000       0.52212151
No.of.Accidents                      0.25068652 -0.09608376     0.5221
21514       1.00000000
No.of.passengers                     0.79355757  0.92678745    -0.1938
69887      -0.05142400

                       No.of.passengers
Years                       0.83916210
Gross.Domestic.Product      0.98688231
GDP.Growth                  0.03827489
GDP.per.Capita              0.98791864
Inflation.GDP.Deflator      0.01104102
Exchange.Rate.Fluctuation   0.50179205
Population                  0.76118855
Population.ages.15.64       0.79355757
Oil.Prices                  0.92678745
Accidents.Deaths            -0.19386989
No.of.Accidents            -0.05142400
```

```
No.of.passengers                1.00000000
```

Stepwise Regression

Group 1

```
> leaps( x=Group.1[,2:4], y=Group.1[,1], names=names(Group.1)[2:4], me
thod="adjr2")
$which
  Gross.Domestic.Product Population Oil.Prices
1                   TRUE      FALSE      FALSE
1                  FALSE      FALSE       TRUE
1                  FALSE       TRUE      FALSE
2                   TRUE       TRUE      FALSE
2                   TRUE      FALSE       TRUE
2                  FALSE       TRUE       TRUE
3                   TRUE       TRUE       TRUE

$label
[1] "(Intercept)"            "Gross.Domestic.Product" "Population"
[4] "Oil.Prices"

$size
[1] 2 2 2 3 3 3 4

$adjr2
[1] 0.9733306 0.8556544 0.5696268 0.9879510 0.9749217 0.8777863 0.9879
197
```

Result 1 (Gross.Domestic.Product Population)

Group 2

```
  > leaps( x=Group.2[,2:4], y=Group.2[,1], names=names(Group.2)[2:4],
method="adjr2")
$which
  GDP.per.Capita Population.ages.15.64 Oil.Prices
1           TRUE                 FALSE      FALSE
1          FALSE                 FALSE       TRUE
1          FALSE                  TRUE      FALSE
2           TRUE                  TRUE      FALSE
2           TRUE                 FALSE       TRUE
2          FALSE                  TRUE       TRUE
3           TRUE                  TRUE       TRUE

$label
[1] "(Intercept)"           "GDP.per.Capita"        "Population.ages.1
5.64"
[4] "Oil.Prices"

$size
[1] 2 2 2 3 3 3 4

$adjr2
[1] 0.9754247 0.8556544 0.6211228 0.9892945 0.9764283 0.8719641 0.9890
426
```

Result 2 (GDP.per.Capita Population.ages.15.64)

Group 3

```
> leaps( x=Group.3[,2:3], y=Group.3[,1], names=names(Group.3)[2:3], me
thod="adjr2")
$which
  Gross.Domestic.Product Population
1                   TRUE      FALSE
1                  FALSE       TRUE
2                   TRUE       TRUE

$label
[1] "(Intercept)"            "Gross.Domestic.Product" "Population"

$size
[1] 2 2 3

$adjr2
[1] 0.9733306 0.5696268 0.9879510
```

Result 3 (Gross.Domestic.Product Population)

Group 4

```
> leaps( x=Group.4[,2:3], y=Group.4[,1], names=names(Group.4)[2:3], me
thod="adjr2")
$which
  GDP.per.Capita Population.ages.15.64
1           TRUE                 FALSE
1          FALSE                  TRUE
2           TRUE                  TRUE

$label
[1] "(Intercept)"           "GDP.per.Capita"        "Population.ages.1
5.64"

$size
[1] 2 2 3

$adjr2
[1] 0.9754247 0.6211228 0.9892945
```

Result 4 (GDP.per.Capita Population.ages.15.64)

Group 5

```
> leaps( x=Group.5[,2:6], y=Group.5[,1], names=names(Group.5)[2:6], method="adjr2")
$which
  Gross.Domestic.Product GDP.per.Capita Population Population.ages.15.64 Oil.Prices
1                  FALSE           TRUE      FALSE                 FALSE      FALSE
1                   TRUE          FALSE      FALSE                 FALSE      FALSE
1                  FALSE          FALSE      FALSE                 FALSE       TRUE
1                  FALSE          FALSE      FALSE                  TRUE      FALSE
1                  FALSE          FALSE       TRUE                 FALSE      FALSE
2                  FALSE           TRUE      FALSE                  TRUE      FALSE
2                   TRUE          FALSE      FALSE                  TRUE      FALSE
2                  FALSE           TRUE       TRUE                 FALSE      FALSE
2                   TRUE          FALSE       TRUE                 FALSE      FALSE
2                   TRUE           TRUE      FALSE                 FALSE      FALSE
2                  FALSE           TRUE      FALSE                 FALSE       TRUE
2                   TRUE          FALSE      FALSE                 FALSE       TRUE
```

```
2                     FALSE           FALSE       TRUE                  FALSE       TRUE
2                     FALSE           FALSE      FALSE                   TRUE       TRUE
2                     FALSE           FALSE       TRUE                   TRUE      FALSE
3                      TRUE            TRUE      FALSE                   TRUE      FALSE
3                      TRUE            TRUE       TRUE                  FALSE      FALSE
3                     FALSE            TRUE       TRUE                   TRUE      FALSE
3                     FALSE            TRUE      FALSE                   TRUE       TRUE
3                      TRUE           FALSE       TRUE                   TRUE      FALSE
3                     FALSE            TRUE       TRUE                  FALSE       TRUE
3                      TRUE           FALSE      FALSE                   TRUE       TRUE
3                      TRUE           FALSE       TRUE                  FALSE       TRUE
3                      TRUE            TRUE      FALSE                  FALSE       TRUE
3                     FALSE           FALSE       TRUE                   TRUE       TRUE
4                      TRUE            TRUE      FALSE                   TRUE       TRUE
4                      TRUE            TRUE       TRUE                   TRUE      FALSE
4                      TRUE            TRUE       TRUE                  FALSE       TRUE
4                     FALSE            TRUE       TRUE                   TRUE       TRUE
4                      TRUE           FALSE       TRUE                   TRUE       TRUE
5                      TRUE            TRUE       TRUE                   TRUE       TRUE

$label
[1] "(Intercept)"            "Gross.Domestic.Product" "GDP.per.Capita"
[4] "Population"             "Population.ages.15.64"  "Oil.Prices"

$size
 [1] 2 2 2 2 2 3 3 3 3 3 3 3 3 3 3 4 4 4 4 4 4 4 4 4 4 5 5 5 5 5 6

$adjr2
 [1] 0.9754247 0.9733306 0.8556544 0.6211228 0.5696268 0.9892945 0.9887640 0.9886325
 [9] 0.9879510 0.9844396 0.9764283 0.9749217 0.8777863 0.8719641 0.6196686 0.9901389
[17] 0.9900233 0.9890706 0.9890426 0.9885159 0.9884955 0.9884903 0.9879197 0.9841887
[25] 0.8777251 0.9902043 0.9900024 0.9898358 0.9887978 0.9882370 0.9899704
```

Result 5 (Gross.Domestic.Product GDP.per.Capita, Population.ages.15.64 Oil.Prices)

Group 6

```
> leaps( x=Group.6[,2:5], y=Group.6[,1], names=names(Group.6)[2:5], me
thod="adjr2")
$which
  Gross.Domestic.Product GDP.per.Capita Population.ages.15.64 Oil.Pric
es
1                  FALSE           TRUE                 FALSE      FAL
SE
1                   TRUE          FALSE                 FALSE      FAL
SE
1                  FALSE          FALSE                 FALSE       TR
UE
1                  FALSE          FALSE                  TRUE      FAL
SE
2                  FALSE           TRUE                  TRUE      FAL
SE
2                   TRUE          FALSE                  TRUE      FAL
SE
2                   TRUE           TRUE                 FALSE      FAL
SE
```

```
2                   FALSE           TRUE                   FALSE        TR
UE
2                    TRUE          FALSE                   FALSE        TR
UE
2                   FALSE          FALSE                    TRUE        TR
UE
3                    TRUE           TRUE                    TRUE       FAL
SE
3                   FALSE           TRUE                    TRUE        TR
UE
3                    TRUE          FALSE                    TRUE        TR
UE
3                    TRUE           TRUE                   FALSE        TR
UE
4                    TRUE           TRUE                    TRUE        TR
UE

$label
[1] "(Intercept)"            "Gross.Domestic.Product" "GDP.per.Capita"
[4] "Population.ages.15.64"  "Oil.Prices"

$size
 [1] 2 2 2 2 3 3 3 3 3 3 4 4 4 4 5

$adjr2
 [1] 0.9754247 0.9733306 0.8556544 0.6211228 0.9892945 0.9887640 0.984
4396 0.9764283
 [9] 0.9749217 0.8719641 0.9901389 0.9890426 0.9884903 0.9841887 0.990
2043
```

Result 6 (Gross.Domestic.Product GDP.per.Capita Population.ages.15.64 Oil.Prices)

Group 7

```
> leaps( x=Group.7[,2:4], y=Group.7[,1], names=names(Group.7)[2:4], me
thod="adjr2")
$which
  Gross.Domestic.Product GDP.per.Capita Population.ages.15.64
1                  FALSE           TRUE                 FALSE
1                   TRUE          FALSE                 FALSE
1                  FALSE          FALSE                  TRUE
2                  FALSE           TRUE                  TRUE
2                   TRUE          FALSE                  TRUE
2                   TRUE           TRUE                 FALSE
3                   TRUE           TRUE                  TRUE

$label
[1] "(Intercept)"            "Gross.Domestic.Product" "GDP.per.Capita"
[4] "Population.ages.15.64"

$size
[1] 2 2 2 3 3 3 4

$adjr2
[1] 0.9754247 0.9733306 0.6211228 0.9892945 0.9887640 0.9844396 0.9901
389
```

```
Result 7 (Gross.Domestic.Product GDP.per.Capita Population.ages.15.64)
```

Multiple Regression

Group 1

```
> myModel<-lm( No.of.passengers~ Gross.Domestic.Product+Population, Gr
oup.1)
> summary(myModel)

Call:
lm(formula = No.of.passengers ~ Gross.Domestic.Product + Population,
    data = Group.1)

Residuals:
      Min        1Q    Median        3Q       Max
-15374453  -8449892  -3138766   3166955  29452172

Coefficients:
                         Estimate Std. Error t value Pr(>|t|)
(Intercept)            -1.042e+08  1.549e+07  -6.726 3.58e-08 ***
Gross.Domestic.Product  3.472e-05  8.984e-07  38.651  < 2e-16 ***
Population              1.052e-01  1.443e-02   7.292 5.57e-09 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 11670000 on 42 degrees of freedom
Multiple R-squared:  0.9885,   Adjusted R-squared:  0.988
F-statistic:  1805 on 2 and 42 DF,  p-value: < 2.2e-16
```

Group 2

```
> myModel<-lm( No.of.passengers~ GDP.per.Capita+Population.ages.15.64,
Group.2)
> summary(myModel)

Call:
lm(formula = No.of.passengers ~ GDP.per.Capita + Population.ages.15.64
,
    data = Group.2)

Residuals:
      Min        1Q    Median        3Q       Max
-16981368  -8096214  -1910078   6861950  25656477

Coefficients:
                        Estimate Std. Error t value Pr(>|t|)
(Intercept)           -173262563   23666561  -7.321 5.07e-09 ***
GDP.per.Capita             46950       1220  38.468  < 2e-16 ***
Population.ages.15.64    2848744     378289   7.531 2.56e-09 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.1e+07 on 42 degrees of freedom
Multiple R-squared:  0.9898,   Adjusted R-squared:  0.9893
F-statistic:  2034 on 2 and 42 DF,  p-value: < 2.2e-16
```

3. India

Autocorrelation Matrix

```
> mcor <- cor(Data_India)
> mcor
                               Years Gross.Domestic.Product  GDP.Growth GDP.per.Capita
Years                      1.0000000              0.8555272  0.48622536      0.8626372
Gross.Domestic.Product     0.8555272              1.0000000  0.39985824      0.9988883
GDP.Growth                 0.4862254              0.3998582  1.00000000      0.4131179
GDP.per.Capita             0.8626372              0.9988883  0.41311789      1.0000000
Consumer.Price.Index       0.9285394              0.9684232  0.41456910      0.9641625
Inflation.GDP.Deflator    -0.2696387             -0.2169125 -0.49162407     -0.2064550
Exchange.Rate.Fluctuation  0.9575281              0.8069248  0.42887853      0.8020961
Population                 0.9994299              0.8616144  0.48489003      0.8676328
Population.ages.15.64      0.9748795              0.9304873  0.46279145      0.9317694
Oil.Prices                 0.7786491              0.9435743  0.31368984      0.9489493
Accidents.Deaths           -0.1941443             -0.1811858 -0.01835877      -0.1803513
No.of.Accidents           -0.3708947             -0.3143033 -0.07627371     -0.3186793
No.of.passengers           0.8317491              0.9964147  0.38214801      0.9957605


                          Consumer.Price.Index Inflation.GDP.Deflator  Exchange.Rate.Fl
uctuation
Years                                0.9285394            -0.26963869                0.
9575281
Gross.Domestic.Product               0.9684232            -0.21691246                0.
8069248
GDP.Growth                           0.4145691            -0.49162407                0.
4288785
GDP.per.Capita                       0.9641625            -0.20645503                0.
8020961
Consumer.Price.Index                 1.0000000            -0.28755920                0.
9223702
Inflation.GDP.Deflator              -0.2875592             1.00000000               -0.
3488877
Exchange.Rate.Fluctuation            0.9223702            -0.34888771                1.
0000000
Population                           0.9344850            -0.27755420                0.
9631569
Population.ages.15.64                0.9776943            -0.29954124                0.
9532756
Oil.Prices                           0.8822029            -0.12590779                0.
6873823
Accidents.Deaths                     -0.2013909             0.04464670               -0
.1923672
No.of.Accidents                     -0.3520952             0.05227746               -0.
3662042
No.of.passengers                     0.9537465            -0.20518113                0.
7748783
```

```
                           Population Population.ages.15.64 Oil.Prices Accidents.Dea
ths
Years                       0.9994299             0.9748795  0.7786491     -0.19414430
Gross.Domestic.Product      0.8616144             0.9304873  0.9435743     -0.18118578
GDP.Growth                  0.4848900             0.4627915  0.3136898     -0.01835877
GDP.per.Capita              0.8676328             0.9317694  0.9489493     -0.18035127
Consumer.Price.Index        0.9344850             0.9776943  0.8822029     -0.20139088
Inflation.GDP.Deflator     -0.2775542            -0.2995412 -0.1259078      0.04464670
Exchange.Rate.Fluctuation   0.9631569             0.9532756  0.6873823     -0.19236722
Population                  1.0000000             0.9796638  0.7812636     -0.19616473
Population.ages.15.64       0.9796638             1.0000000  0.8583959     -0.21278618
Oil.Prices                  0.7812636             0.8583959  1.0000000     -0.22821234
Accidents.Deaths            -0.1961647            -0.2127862 -0.2282123      1.00000000
No.of.Accidents            -0.3711260            -0.3900560 -0.3596949      0.40754259
No.of.passengers            0.8374054             0.9097140  0.9492494     -0.18969535

                          No.of.Accidents No.of.passengers
Years                         -0.37089475        0.8317491
Gross.Domestic.Product        -0.31430329        0.9964147
GDP.Growth                    -0.07627371        0.3821480
GDP.per.Capita                -0.31867925        0.9957605
Consumer.Price.Index          -0.35209523        0.9537465
Inflation.GDP.Deflator         0.05227746       -0.2051811
Exchange.Rate.Fluctuation     -0.36620420        0.7748783
Population                    -0.37112598        0.8374054
Population.ages.15.64         -0.39005599        0.9097140
Oil.Prices                    -0.35969495        0.9492494
Accidents.Deaths               0.40754259       -0.1896954
No.of.Accidents                1.00000000       -0.3006744
No.of.passengers              -0.30067442        1.0000000
```

Group 1
(Gross.Domestic.Product,Consumer.Price.Index,Exchange.Rate.Fluctuation ,Population, Oil.Prices)

```
> Group.1 <- read.csv("C:/University of Oklahoma/University of Oklahoma/Thesis/Project/I
ndia/Group 1.csv")
>   View(Group.1)
> leaps( x=Group.1[,2:6], y=Group.1[,1], names=names(Group.1)[2:6], method="adjr2")
$which
  Gross.Domestic.Product Consumer.Price.Index Exchange.Rate.Fluctuation Population Oil.P
rices
1                   TRUE                FALSE                     FALSE      FALSE
FALSE
1                  FALSE                 TRUE                     FALSE      FALSE
FALSE
1                  FALSE                FALSE                     FALSE      FALSE
TRUE
1                  FALSE                FALSE                     FALSE       TRUE
FALSE
1                  FALSE                FALSE                      TRUE      FALSE
FALSE
2                   TRUE                FALSE                      TRUE      FALSE
FALSE
```

```
2                    TRUE                 TRUE                      FALSE      FALSE
FALSE
2                    TRUE                FALSE                      FALSE       TRUE
FALSE
2                    TRUE                FALSE                      FALSE      FALSE
TRUE
2                   FALSE                 TRUE                       TRUE      FALSE
FALSE
2                   FALSE                 TRUE                      FALSE      FALSE
TRUE
2                   FALSE                 TRUE                      FALSE       TRUE
FALSE
2                   FALSE                FALSE                       TRUE      FALSE
TRUE
2                   FALSE                FALSE                      FALSE       TRUE
TRUE
2                   FALSE                FALSE                       TRUE       TRUE
FALSE
3                    TRUE                FALSE                       TRUE      FALSE
TRUE
3                    TRUE                 TRUE                       TRUE      FALSE
FALSE
3                    TRUE                FALSE                       TRUE       TRUE
FALSE
3                    TRUE                 TRUE                      FALSE      FALSE
TRUE
3                    TRUE                FALSE                      FALSE       TRUE
TRUE
3                    TRUE                 TRUE                      FALSE       TRUE
FALSE
3                   FALSE                 TRUE                       TRUE       TRUE
FALSE
3                   FALSE                 TRUE                       TRUE      FALSE
TRUE
3                   FALSE                 TRUE                      FALSE       TRUE
TRUE
3                   FALSE                FALSE                       TRUE       TRUE
TRUE
4                    TRUE                 TRUE                       TRUE       TRUE
FALSE
4                    TRUE                 TRUE                       TRUE      FALSE
TRUE
4                    TRUE                FALSE                       TRUE       TRUE
TRUE
4                    TRUE                 TRUE                      FALSE       TRUE
TRUE
4                   FALSE                 TRUE                       TRUE       TRUE
TRUE
5                    TRUE                 TRUE                       TRUE       TRUE
TRUE

$label
[1] "(Intercept)"                "Gross.Domestic.Product"    "Consumer.Price.Index"
[4] "Exchange.Rate.Fluctuation" "Population"                "Oil.Prices"

$size
 [1] 2 2 2 2 2 3 3 3 3 3 3 3 3 3 3 4 4 4 4 4 4 4 4 4 4 5 5 5 5 5 6
```

```
$adjr2
 [1] 0.9926758 0.9075308 0.8987738 0.6943001 0.5911443 0.9950536 0.9946174 0.9943153 0.9
932852
[10] 0.9824729 0.9602901 0.9293049 0.9261080 0.9210358 0.7015531 0.9950273 0.9950000 0.9
949662
[19] 0.9946160 0.9945996 0.9945916 0.9875381 0.9854593 0.9691197 0.9245287 0.9950055 0.9
949851
[28] 0.9949090 0.9946499 0.9877788 0.9949238
```

Result 1 :(Gross.Domestic.Product Exchange.Rate.Fluctuation)

Group 2(GDP.per.Capita,Consumer.Price.Index,Exchange.Rate.Fluctuation, Population.ages.15.64, Oil.Prices)

```
> Group.2 <- read.csv("C:/University of Oklahoma/University of Oklahoma/Thesis/Project/I
ndia/Group 2.csv")
>   View(Group.2)
> leaps( x=Group.2[,2:6], y=Group.2[,1], names=names(Group.2)[2:6], method="adjr2")
$which
  GDP.per.Capita Consumer.Price.Index Exchange.Rate.Fluctuation Population.ages.15.64 Oi
l.Prices
1           TRUE                FALSE                     FALSE                 FALSE
FALSE
1          FALSE                 TRUE                     FALSE                 FALSE
FALSE
1          FALSE                FALSE                     FALSE                 FALSE
TRUE
1          FALSE                FALSE                     FALSE                  TRUE
FALSE
1          FALSE                FALSE                      TRUE                 FALSE
FALSE
2           TRUE                FALSE                     FALSE                  TRUE
FALSE
2           TRUE                FALSE                      TRUE                 FALSE
FALSE
2           TRUE                 TRUE                     FALSE                 FALSE
FALSE
2           TRUE                FALSE                     FALSE                 FALSE
TRUE
2          FALSE                 TRUE                      TRUE                 FALSE
FALSE
2          FALSE                 TRUE                     FALSE                 FALSE
TRUE
2          FALSE                FALSE                     FALSE                  TRUE
TRUE
2          FALSE                FALSE                      TRUE                 FALSE
TRUE
2          FALSE                 TRUE                     FALSE                  TRUE
FALSE
2          FALSE                FALSE                      TRUE                  TRUE
FALSE
3           TRUE                 TRUE                     FALSE                  TRUE
FALSE
```

```
3            TRUE                   TRUE                          TRUE                   FALSE
FALSE
3            TRUE                  FALSE                          TRUE                    TRUE
FALSE
3            TRUE                  FALSE                         FALSE                    TRUE
TRUE
3            TRUE                  FALSE                          TRUE                   FALSE
TRUE
3            TRUE                   TRUE                         FALSE                   FALSE
TRUE
3           FALSE                   TRUE                          TRUE                    TRUE
FALSE
3           FALSE                   TRUE                          TRUE                   FALSE
TRUE
3           FALSE                   TRUE                         FALSE                    TRUE
TRUE
3           FALSE                  FALSE                          TRUE                    TRUE
TRUE
4            TRUE                   TRUE                         FALSE                    TRUE
TRUE
4            TRUE                  FALSE                          TRUE                    TRUE
TRUE
4            TRUE                   TRUE                          TRUE                    TRUE
FALSE
4            TRUE                   TRUE                          TRUE                   FALSE
TRUE
4           FALSE                   TRUE                          TRUE                    TRUE
TRUE
5            TRUE                   TRUE                          TRUE                    TRUE
TRUE

$label
[1] "(Intercept)"                "GDP.per.Capita"             "Consumer.Price.Index"
[4] "Exchange.Rate.Fluctuation" "Population.ages.15.64"     "Oil.Prices"

$size
 [1] 2 2 2 2 2 3 3 3 3 3 3 3 3 3 3 4 4 4 4 4 4 4 4 4 4 5 5 5 5 5 6

$adjr2
 [1] 0.9913423 0.9075308 0.8987738 0.8235699 0.5911443 0.9937415 0.9928024 0.9917322 0.9
913329
[10] 0.9824729 0.9602901 0.9322029 0.9261080 0.9176293 0.9172237 0.9945766 0.9943610 0.9
942011
[19] 0.9935958 0.9926315 0.9915548 0.9893607 0.9854593 0.9698143 0.9335729 0.9946848 0.9
945055
[28] 0.9944953 0.9942209 0.9891128 0.9945545
```

Result 2; (GDP.per.Capita, Consumer.Price.Index, Population.ages.15.64, Oil.Prices)

Group 3(Gross.Domestic.Product, Population, Oil.Prices)

```
> Group.3 <- read.csv("C:/University of Oklahoma/University of Oklahoma/Thesis/Project/I
ndia/Group 3.csv")
>   View(Group.3)
```

```
> Group.4 <- read.csv("C:/University of Oklahoma/University of Oklahoma/Thesis/Project/I
ndia/Group 4.csv")
>   View(Group.4)
> leaps( x=Group.3[,2:4], y=Group.3[,1], names=names(Group.3)[2:4], method="adjr2")
$which
  Gross.Domestic.Product Population Oil.Prices
1                   TRUE      FALSE      FALSE
1                  FALSE      FALSE       TRUE
1                  FALSE       TRUE      FALSE
2                   TRUE       TRUE      FALSE
2                   TRUE      FALSE       TRUE
2                  FALSE       TRUE       TRUE
3                   TRUE       TRUE       TRUE

$label
[1] "(Intercept)"            "Gross.Domestic.Product" "Population"
[4] "Oil.Prices"

$size
[1] 2 2 2 3 3 3 4

$adjr2
[1] 0.9926758 0.8987738 0.6943001 0.9943153 0.9932852 0.9210358 0.9945996
```

Result 3 (Gross.Domestic.Product Population Oil.Prices)

Group 4 (GDP.per.Capita , Population.ages.15.64 , Oil.Prices)

```
> leaps( x=Group.4[,2:4], y=Group.4[,1], names=names(Group.4)[2:4], method="adjr2")
$which
  GDP.per.Capita Population.ages.15.64 Oil.Prices
1           TRUE                 FALSE      FALSE
1          FALSE                 FALSE       TRUE
1          FALSE                  TRUE      FALSE
2           TRUE                  TRUE      FALSE
2           TRUE                 FALSE       TRUE
2          FALSE                  TRUE       TRUE
3           TRUE                  TRUE       TRUE

$label
[1] "(Intercept)"           "GDP.per.Capita"        "Population.ages.15.64" "Oil.Prices"

$size
[1] 2 2 2 3 3 3 4

$adjr2
[1] 0.9913423 0.8987738 0.8235699 0.9937415 0.9913329 0.9322029 0.9935958
```

Result 4: (GDP.per.Capita , Population.ages.15.64)

Group 5 (Gross.Domestic.Product ,Consumer.Price.Index , Exchange.Rate.Fluctuation)

```
> Group.5 <- read.csv("C:/University of Oklahoma/University of Oklahoma/Thesis/Project/I
ndia/Group 5.csv")
>   View(Group.5)
```

```
> leaps( x=Group.5[,2:4], y=Group.5[,1], names=names(Group.5)[2:4], method="adjr2")
$which
  Gross.Domestic.Product Consumer.Price.Index Exchange.Rate.Fluctuation
1                   TRUE                FALSE                     FALSE
1                  FALSE                 TRUE                     FALSE
1                  FALSE                FALSE                      TRUE
2                   TRUE                FALSE                      TRUE
2                   TRUE                 TRUE                     FALSE
2                  FALSE                 TRUE                      TRUE
3                   TRUE                 TRUE                      TRUE

$label
[1] "(Intercept)"               "Gross.Domestic.Product"    "Consumer.Price.Index"
[4] "Exchange.Rate.Fluctuation"

$size
[1] 2 2 2 3 3 3 4

$adjr2
[1] 0.9926758 0.9075308 0.5911443 0.9950536 0.9946174 0.9824729 0.9950000
```

Result 5: (Gross.Domestic.Product, Exchange.Rate.Fluctuation)

Group 6 (GDP.per.Capita , Consumer.Price.Index , Exchange.Rate.Fluctuation)

```
> Group.6 <- read.csv("C:/University of Oklahoma/University of Oklahoma/Thesis/Project/I
ndia/Group 6.csv")
>   View(Group.6)
> leaps( x=Group.6[,2:4], y=Group.6[,1], names=names(Group.6)[2:4], method="adjr2")
$which
  GDP.per.Capita Consumer.Price.Index Exchange.Rate.Fluctuation
1           TRUE                FALSE                     FALSE
1          FALSE                 TRUE                     FALSE
1          FALSE                FALSE                      TRUE
2           TRUE                FALSE                      TRUE
2           TRUE                 TRUE                     FALSE
2          FALSE                 TRUE                      TRUE
3           TRUE                 TRUE                      TRUE

$label
[1] "(Intercept)"               "GDP.per.Capita"            "Consumer.Price.Index"
[4] "Exchange.Rate.Fluctuation"

$size
[1] 2 2 2 3 3 3 4

$adjr2
[1] 0.9913423 0.9075308 0.5911443 0.9928024 0.9917322 0.9824729 0.9943610
```

Result 6:(GDP.per.Capita Consumer.Price.Index Exchange.Rate.Fluctuation)

Group 7 (Gross.Domestic.Product, Population)

```
> Group.7 <- read.csv("C:/University of Oklahoma/University of Oklahoma/Thesis/Project/I
ndia/Group 7.csv")
>   View(Group.7)
> leaps( x=Group.7[,2:3], y=Group.7[,1], names=names(Group.7)[2:3], method="adjr2")
```

```
$which
  Gross.Domestic.Product Population
1                   TRUE      FALSE
1                  FALSE       TRUE
2                   TRUE       TRUE

$label
[1] "(Intercept)"            "Gross.Domestic.Product" "Population"

$size
[1] 2 2 3

$adjr2
[1] 0.9926758 0.6943001 0.9943153
```

Result 7 :(Gross.Domestic.Product Population)

Group 8 (GDP.per.Capita, Population.ages.15.64)

```
> Group.8 <- read.csv("C:/University of Oklahoma/University of Oklahoma/Thesis/Project/I
ndia/Group 8.csv")
>   View(Group.8)
> leaps( x=Group.8[,2:3], y=Group.8[,1], names=names(Group.8)[2:3], method="adjr2")
$which
  GDP.per.Capita Population.ages.15.64
1           TRUE                 FALSE
1          FALSE                  TRUE
2           TRUE                  TRUE

$label
[1] "(Intercept)"           "GDP.per.Capita"        "Population.ages.15.64"

$size
[1] 2 2 3

$adjr2
[1] 0.9913423 0.8235699 0.9937415
```

Result 8 :(GDP.per.Capita Population.ages.15.64)

Multiple Regression

Group 1

```
> myModel<-lm( No.of.passengers~ Gross.Domestic.Product+Exchange.Rate.
Fluctuation , Group.1)
> summary(myModel)

Call:
lm(formula = No.of.passengers ~ Gross.Domestic.Product + Exchange.Rate
.Fluctuation,
    data = Group.1)

Residuals:
     Min       1Q   Median       3Q      Max
-4446712  -394352   -69041  1011352  3819604

Coefficients:
```

```
                            Estimate Std. Error t value Pr(>|t|)    
(Intercept)                8.621e+05  4.499e+05   1.916   0.0622 .  
Gross.Domestic.Product     4.257e-05  7.183e-07  59.264  < 2e-16 ***
Exchange.Rate.Fluctuation -1.058e+05  2.272e+04  -4.655 3.23e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1581000 on 42 degrees of freedom
Multiple R-squared:  0.9953,   Adjusted R-squared:  0.9951 
F-statistic:  4427 on 2 and 42 DF,  p-value: < 2.2e-16
```

Group 2

```
> myModel<-lm( No.of.passengers~ GDP.per.Capita+Consumer.Price.Index+P
opulation.ages.15.64+Oil.Prices, Group.2)
> summary(myModel)

Call:
lm(formula = No.of.passengers ~ GDP.per.Capita + Consumer.Price.Index 
+ 
    Population.ages.15.64 + Oil.Prices, data = Group.2)

Residuals:
     Min       1Q   Median       3Q      Max 
-3655124 -1101414   367721   709066  4549753 

Coefficients:
                       Estimate Std. Error t value Pr(>|t|)    
(Intercept)           113141704   23866758   4.741 2.70e-05 ***
GDP.per.Capita            52481       3779  13.887  < 2e-16 ***
Consumer.Price.Index     147328      48053   3.066  0.00388 ** 
Population.ages.15.64  -2122019     423190  -5.014 1.13e-05 ***
Oil.Prices                39355      29056   1.354  0.18319    
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1639000 on 40 degrees of freedom
Multiple R-squared:  0.9952,   Adjusted R-squared:  0.9947 
F-statistic:  2060 on 4 and 40 DF,  p-value: < 2.2e-16
```

Group 3

```
> myModel<-lm( No.of.passengers~ Gross.Domestic.Product+Population+Oil
.Prices, Group.3)
> summary(myModel)

Call:
lm(formula = No.of.passengers ~ Gross.Domestic.Product + Population + 
    Oil.Prices, data = Group.3)

Residuals:
     Min       1Q   Median       3Q      Max 
-4116182  -681924   -58398  1071445  3305213 

Coefficients:
                         Estimate Std. Error t value Pr(>|t|)    
(Intercept)             4.454e+06  1.648e+06   2.702  0.00997 ** 
Gross.Domestic.Product  4.013e-05  1.676e-06  23.940  < 2e-16 ***
Population             -7.329e-03  2.188e-03  -3.350  0.00174 ** 
```

```
Oil.Prices              4.604e+04  2.569e+04   1.792  0.08050 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1652000 on 41 degrees of freedom
Multiple R-squared:  0.995,	Adjusted R-squared:  0.9946 
F-statistic:  2702 on 3 and 41 DF,  p-value: < 2.2e-16
```

Group 4

```
> myModel<-lm( No.of.passengers~ GDP.per.Capita+Population.ages.15.64, Group.4)
> summary(myModel)

Call:
lm(formula = No.of.passengers ~ GDP.per.Capita + Population.ages.15.64
,
    data = Group.4)

Residuals:
     Min       1Q   Median       3Q      Max 
-5406547  -716161   406364   812123  3962701 

Coefficients:
                      Estimate Std. Error t value Pr(>|t|)    
(Intercept)           53679999   14376421   3.734 0.000561 ***
GDP.per.Capita           60963       1782  34.208  < 2e-16 ***
Population.ages.15.64 -1070566     256027  -4.181 0.000144 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1779000 on 42 degrees of freedom
Multiple R-squared:  0.994,	Adjusted R-squared:  0.9937 
F-statistic:  3494 on 2 and 42 DF,  p-value: < 2.2e-16
```

Group 5

```
> myModel<-lm( No.of.passengers~ GDP.per.Capita+Consumer.Price.Index+Exchange.Rate.Fluctuation, Group.6)
> summary(myModel)

Call:
lm(formula = No.of.passengers ~ GDP.per.Capita + Consumer.Price.Index 
+
    Exchange.Rate.Fluctuation, data = Group.6)

Residuals:
     Min       1Q   Median       3Q      Max 
-3741871  -861213   308105   683578  4292952 

Coefficients:
                          Estimate Std. Error t value Pr(>|t|)    
(Intercept)               -2587985     964592  -2.683 0.010473 *  
GDP.per.Capita               41707       4407   9.463 7.23e-12 ***
Consumer.Price.Index        272446      76726   3.551 0.000981 ***
Exchange.Rate.Fluctuation  -320400      70626  -4.537 4.91e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
Residual standard error: 1688000 on 41 degrees of freedom
Multiple R-squared:  0.9947,	Adjusted R-squared:  0.9944
F-statistic:  2587 on 3 and 41 DF,  p-value: < 2.2e-16
```

Group 6

```
> myModel<-lm( No.of.passengers~ Gross.Domestic.Product+Population, Gr
oup.7)
> summary(myModel)

Call:
lm(formula = No.of.passengers ~ Gross.Domestic.Product + Population,
    data = Group.7)

Residuals:
     Min       1Q   Median       3Q      Max
-3966335  -842313   125085  1084839  3885971

Coefficients:
                         Estimate Std. Error t value Pr(>|t|)
(Intercept)             5.258e+06  1.627e+06   3.232 0.002391 **
Gross.Domestic.Product  4.270e-05  8.961e-07  47.648  < 2e-16 ***
Population             -8.069e-03  2.204e-03  -3.661 0.000697 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1695000 on 42 degrees of freedom
Multiple R-squared:  0.9946,	Adjusted R-squared:  0.9943
F-statistic:  3849 on 2 and 42 DF,  p-value: < 2.2e-16
```