YANGON UNIVERSITY OF ECONOMICS

DEPARTMENT OF STATISTICS

AN ANALYSIS OF FOREIGN DIRECT INVESTMENT, EXPORTS AND ECONOMIC GROWTH IN MYANMAR

BY

WAR WAR MAW OO

M.Econ (Statistics)

Roll No.11

NOVEMBER, 2019

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This is to certify that the thesis entitled "**AN ANALYSIS OF FOREIGN DIRECT INVESTMENT, EXPORTS AND ECONOMIC GROWTH IN MYANMAR"** submitted as a partial fulfillment towards the requirements of Master of Economics (Statistics) has been accepted by the Board of Examiners.

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ABSTRACT

This study attempts to investigate the effect of foreign direct investment and exports on real gross domestic product of Myanmar. The required data of annual values of foreign direct investment, exports and gross domestic product from the year (1989/90 to 2017/18) are attained from various of sources of Statistical Year Book. The based period of foreign direct investment, exports and gross domestic product are shifted into (2000/01) constant prices. After that the GDP growth rate is calculated. Augmented Dickey- Fuller test is performed for stationarity of data. Multiple linear regression model is used to find out the impact of foreign direct investment, exports on gross domestic product growth rate of Myanmar. The real value of GDP growth rate is taken as dependent viable while FDI and exports are considered as independent variables. The result shows that the overall model is significant. There is a positive and significant relationship between GDP growth rate and exports while significant negative relationship between GDP growth rate and foreign direct investment. The result also found that the residuals of the regressions have a normal distribution and do not show any auto-correlation.

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ADF	=	Augmented Dickey-Fuller
ASEAN	=	Associated of South East Asian
CSO	=	Central Statistical Organization
DW	=	Durbin-Watson
EXP	=	Exports of good and service
FIL	=	Foreign Investment Law
FDI	=	Foreign Direct Investment
GDP	=	Gross Domestic Product
IMF	=	International Monetary Fund
MSE	=	Mean Square Error
OLS	=	Ordinary Least Square
SST	=	Total Sum of Squares
SSR	=	Sum of Squares due to Regression
SSE	=	Sum of Squares due to error
UNCTAD	=	United Nation Conference Trade and Development
VIF	=	Variance Inflation Factor

CHAPTER I
INTRODUCTION

1.1 Rationale of the Study

Foreign direct investment (FDI) is known as an engine for economic development and also used to measure the potential economy of a country. Moreover, Foreign direct investment can provide the development of living standards and the economic growth of the country. All of these play the important role of Economy's development. In the late 1988, Myanmar started a market-oriented policy from closed-door policy market-After transforming into market-oriented economy, Myanmar made many economic reforms including accepting foreign direct investment into the country. With the country opening up to foreign investors and implementing a new economic policy, new laws, regulations and procedures have been enacted. (Miguel, 2013)

Myanmar first introduced a foreign investment policy in 1998 (the1998 FIL). Myanmar foreign investment policy is an important component of the overall restructuring and development policy of the government. Myanmar Government has enacted the new foreign investment law on November 2nd, 2012, which allow 100% foreign-owned companies and joint venture companies in which at least the amount of foreign equity 35%. According to this law, a foreign investor who has been economic benefited from tax incentives and reliefs. FDI is very important for Myanmar because it needs foreign capital to generate employment for its citizens, acquire technology know-how and accumulate foreign exchange to implement developed projects. Moreover, FDI increase career opportunities, improves labor productivity and provides developing countries access to foreign capital. Some research believe that FDI has positively promoted economic growth in Myanmar. (Naw Eh Khu Mue, 2015)

Exports are the main source of foreign exchange and important stimulants to rapid economic growth in developing nations. Exports play a very important position in the country's economic growth. Countries with the highest per capita GDP also have the highest exports (Marconi,2013). Moreover, exporting is considered as a key engine of economic growth since it also serves as an international marketing strategy to attract more foreign investors with various kinds of investment such as directly invest, joint venture and investment with a legal license which supports the growth of the national economy of a country. (Grigoryan, 2011).

Myanmar is the 75th largest export economy in the world. Myanmar's principal exports are oil and natural gas, precious stones and agricultural products such as leguminous vegetables, wood, fish and natural rubber are also significant export. Myanmar's main exports partners are China, India, Japan, South Korea, Germany, Indonesia and Hong Kong. The biggest foreign income earner for the Myanmar economy is its natural gas exports. Natural gas is Myanmar's top export which brings in the most revenue. The government's annual budget expenditures still have to mainly rely on the revenue of natural resources and raw materials, including natural gas.

In 2017-2018, both government exports (33.0%) and imports (10.1%) increased compared to the previous year. Over this period, private exports (20.3%) and imports (8.5%) also increased compared to the previous year. In 2016-2017, both government exports and imports decreased compared to the previous year, by 32.4% and 62.2% respectively. For the economic growth, the stability of exports sector performance has been critical in developing countries. Therefore, it's highly imperative for least developing economics like Myanmar to focus on structural and policy dimensions to bring about a sustainable and balanced diversification and export growth.

Economic growth is one of the most important determinants of economic welfare. Economic growth refers to a rise in national income or per-capital income and product.so, the productions of goods and services can rise a nation's economic growth. National income or product is commonly expressed in terms of a measure of the aggregate value-added output of the domestic economy called GDP. There are many indicators to measure a country's economic growth, such as gross domestic product (GDP), gross national product (GNP) and economic growth rate and so on. In doing so, GDP is used as the explained variable to measure economic growth of the major countries in the world today to measure their nation' economic growth.

Since 1998, the economy of Myanmar was managed formulating and implementing development plants in accordance with the political economic and social objectives laid down for the establishment of a peaceful, modern and developed nation. Myanmar Economy consists of 14 sub-sectors under three main economic activities such as agriculture, industries and services. Myanmar's economy largely depends on natural resources and agriculture. Agriculture in Myanmar has a usually high share

(59%) of GDP. Trade sector is also one of the 14 sectors of Myanmar's economy. International trade can also be said that it played an important role in economic growth of Myanmar.

The GDP growth rate for Myanmar had steadily grown from 1989-1990 to 2017-2018. Myanmar has large potential for growth, with a young labor force, abundant natural resources and proximity to a fast-growing dynamic economic region. So, it is necessary to study dealt with both foreign direct investment and exports and its interaction are done influencing on the economic growth and causal relationship among them.

1.2 Objectives of the Study

The main objectives of the study are as follows:

1. To identify the integrated order of foreign direct investment, exports and economic growth in Myanmar.
2. To investigate the effect of foreign direct investment, exports and economic growth in Myanmar.

1.3 Method of Study

Annual time-series data on foreign direct investment (FDI), export and gross domestic product (GDP) for the year (1989/90 to 2017/2018) are obtained from various issues of Statistical Year Books published by the Central Statistical Organization (CSO). The based period of foreign direct investment, exports and gross domestic product are shifted into (2000-01) constant price. Augmented Dickey-Fuller (ADF) test is performed for the stationary of the data. After that, the ordinary least squares (OLS) method on multiple regression model is used to test the relationship between foreign direct investment, exports and economic growth.

1.4 Scope and Limitation of the Study

In this study, GDP growth rate is proxy of economic growth rate of Myanmar. The annual real values of foreign direct investment, exports and gross domestic product growth rate are represented by FDI, EXP and GDPG.

1.5 Organization of the Study

This study consists of five chapters. Chapter I presents the introduction that includes rationale, objectives, method, scope and organization of the study. Chapter II describes literature review. Theoretical background of this study is presented in Chapter III. Results and Findings of the study are described in Chapter IV. Finally, conclusion of the study is presented in Chapter V.

CHAPTER II

LITERATURE REVIEW

2.1 Historical Background

2.1.1 Definitions of Foreign Direct Investment

Foreign direct investment is defined as a cross-border investment in which a resident in one economy (the direct investor) acquires a lasting interest in an enterprise in another economy (the direct investment enterprise). Foreign direct investment is a source of for development and a means of acquiring foreign technology foreign direct investment make transfer of ideas and information to receiving countries a mechanism by which a national economy becomes integrated into the international flow of goods and services.

The International Monetary Fund (IMF) defines foreign direct investment as "an investment that is made to acquire a lasting interest in an enterprise operating in an economy other than that of the investor, the investor's purpose being to have an effective voice in the management of the enterprise. "According to UNCTAD definition, foreign direct investment is defined as an investment involving management control of a resident entity in one economy by an enterprise resident in another country.

Ohlin (1933) assumes that if the host countries have lower interest rates for investment and higher rates of profitability in growing markets for investors, then there is a higher motivation.

2.1.2 Foreign Direct Investment in Myanmar

According World Investment Report (1998), UNCTAD (1998), Foreign direct investment is a phenomenon resulting from globalization, which involves the integration of the domestic economic system with global markets. It is accomplished through opening up of the local economic sector as well as domestic capital for foreign investors to establish business, within the economy. Even after nations acquired independence, globalization continued to influence trade between investors and foreign countries, whereby the less developed countries were supported by the developed nations to acquire materials and equipment to extract and utilize the available natural resources for economic development.

Myanmar is the 40th largest country in the world and second largest in South-East Asia. Nowadays, the government of Myanmar has initiated a broad range of reforms to open its economy to foreign trade and invest Myanmar has rich natural resources base, young labor force and strategic geographic location between two economics giants India and China and stands to benefit from greater global and regional economic integration including ASEAN. Sufficient Infrastructure development is an essential prerequisite to carry the industrial and agricultural growth and the highest priority work to attract foreign direct investment in Myanmar. Myanmar government, need to make adequate preparations for attracting foreign direct investment irrespective of the realization of an investment boom in the country.

Since the late 1988, the Government began to seek foreign investment in Myanmar. Myanmar' Foreign Investment Law was first enacted in 1988 soon after the adoption of a market-oriented economic system to accelerate the flow of foreign direct investment into the country. Myanmar had signed and entered many agreements in regard to the ASEAN Investment Area to collaborate with the member countries and to enhance free flows of investments into Myanmar. Myanmar has carried out a series of foreign direct investment development initiatives; (1) adoption of market oriented economy, (2) passing foreign direct investment related laws, (3) encouraging private investments and entrepreneurial activities, (4) taking necessary action for the promotion of foreign investments, (5) opening the economy for foreign trade and investment and (6) establishing special economic zones. As a developing country Myanmar needs more foreign direct investment in order to develop the country's economy.

In late 1998, Myanmar transformed its economy from an economic system of central planning towards a market-oriented one. After the transformation, Myanmar carried out many economic reforms and also accepted foreign direct investment into the country. The government undertook many efforts to create a favorable investment environment aiming to create more employment opportunities for its citizens, develop human resources, and facilitate economic growth in the country.

Foreign direct investment is one of the main factors to improve trade in each and every country to boost its economy. The Union of Myanmar government after 2011 was intended in large part to attract more foreign direct investment and a revised foreign investment law was introduced in 2012. Then the new law was enacted on 2nd November 2012. It includes a lot of business which are " restricted or prohibited " items such as timber, forests, oil and gas, jade, pearls and precious stones, post and telecom, air and railway transport, banks, insurance, mining, power generation, defense related manufacturing.

2.1.3 Foreign Direct Investment and Economic Growth in Myanmar

Closely three decades ago, foreign direct investment has become an important part of in the developing countries, with a huge succeed in attracting substantial and rising amounts of inward. The foreign direct investment according to International Monetary Fund is an investment in a foreign company where the foreign investor owns at least 10% of ordinary shares, undertaken with the objective of establishing a 'lasting interest' in the countries a long term relationship and a significant influence on the management of the firm. The host country's economy such as output, the balance of payments, and the market structure can be impacted by foreign direct investment. In addition to, foreign direct investment can take the gap of technology between the host country and the foreign and it can improve the productivity and growth of the host country.

In recent times, Myanmar has experienced high economic growth rate and change from a backward and under developed nation in 1990s to a developing economy increasingly converging to the regional fast growing economies.

Since 2010, open door policy has connected the country to international economies which brought in a lot of structural transformation together with export, published foreign direct investment law. It has been considered one of the elements to contribute to recent growth in Myanmar. In 1997, Asian economic crisis and its effect on foreign direct investment inflow in Myanmar by the period of 1993-2003 in 2003 Myanmar jointed the WTO.

In 1978, the law on foreign direct investment has been issued with three types of business. (1) Business cooperation contract, (2) 100% foreign owned companies, (3) join venture companies. This law has been amended four times since then the law has been applied since 2006. These change are toward a more convenient and equitable environment for both domestic and foreign enterprises operating in Myanmar. Foreign direct investment flows to Myanmar have increased rapidly both in the number of the projects and the amount of funds since then. Foreign direct investment flows have played an important role as providing investment capital, stimulating export activities, introducing new labor and management skills, transferring technologies and generating job opportunities. However, Myanmar has still some typical weaknesses of physical and human capital.

2.1.4 Exports in Myanmar

Myanmar exports are mostly primary products like gas, rice, agricultural products, gems and many minerals. The agricultural economy is still primary and 36% of gross domestic product came agriculture, livestock and fisheries, and forestry in 2012. In 1988, the exports concerning garment and knitting, oil and gas and mineral increased significantly according to the foreign investment law. The government allowed that foreign enterprises included all sectors such as manufacturing sector and also introduced the cut, make and pack (CMP) system especially for labor intensive Garment sector under the enacting of foreign investment law in late 1988. In 2000, the export share of apparel and clothing accessories (knitted) sector was the importance of Myanmar's garment sector export because it was 42% total export value (Data Source: COMTRADE DATA from WITS Data Base).

In 2000, the economic sanctions affected on Myanmar exports. Especially, the garment products exports were prohibited to United States and European markets. As a result, the booming of Myanmar garment sector was seriously decrease; so there were jobless over 300,000 workers and moved to other sectors. The 39% of total export value is the export share of mineral fuels and oils in 2011. Both exporting products and choosing trading partners were negatively affected the economic sanctions. Myanmar's major export partner countries was become ASEAN member countries and East Asia countries because of the economic sanctions of the United States, Western and European countries. (Yee Mon Oo,2016)

Myanmar's trade sanctions have been less restricted since the beginning of 2012. United States and European Union dismantled the sanctions slowly resulting with increasing Myanmar's exports to United States and European Union markets. According to the Myanmar's export destinations (2010), Thailand, India, China, Japan, Malaysia, Republic of Korea, Germany, Singapore, Taipei (China) and Vietnam are Myanmar's stop 10 trade partner countries. Natural gas, wood, wood products, fish, beans, rice, base metal and ores, clothing, jade and gems are Myanmar's major export items. (Yee Mon Oo, 2016)

2.2 Some Empirical Reviews

Kundan. P. M. and Gu. Q. (2010) analyzed a time series analysis of Foreign Direct Investment and Economic Growth: A case study of Nepal for the period (1980-2006). The results concluded that Nepal's Gross Domestic Product growth rate especially does not depend up on foreign direct investment.

Qaiser Abbas (2011) investigated the impact of foreign direct investment on Growth (GDP) of SAARC countries during 2001 to 2010. This relationship is tested by applying multiple regression models. The change in GDP is taken as dependent variable while FDI and inflation are considered as independent variables. The result also shows that there is positive and significant relationship between GDP and FDI while an insignificance relationship between GDP and FDI while an insignificant relationship between GDP and inflation.

Gaurav Agrawal (2011) investigated the effect of FDI on economic growth of China and India during the period 1993-2009. This study implies OLS (Ordinary Least Square) method. GDP was dependent variable and Human Capital, Labor Force, FDI and Gross Capita formation were independent variables. The results found that 1% increase in FDI would results in 0.07% increase in GDP of China and 0.02% increase in GDP of India. The results also found that china's growth is more affected by FDI, than India's growth.

Amna Muhammad Gudaro (2012) analyzed the link between gross domestic product (GDP), foreign direct investment and inflation in Pakistan for the period 1981 to 2010. The multiple regression models are used to find out the link between these variables. In this model, GDP is used as dependent variable whereas FDI and inflation (CPI) are measured as independent variables. This study recommended that the model is overall significant with the positive and significant association of GDP and FDI while negative and significant relationship found between GDP and inflation.

Javed, Qaiser and Iqbal (2012) examined the effect of international trade on economic growth. In this study, the annual data are used over the period 1973 to 2010.The Ordinary Least Square (OLS) technique and Augmented Dickey-Fuller (ADF) unit root test were used to find out the relationship between the variables. The result suggested that trade openness has a positive effect on the economic growth. This study also recommended that the Pakistan Government should adopt the strategies for the development of the economy and also used the suitable economic policies to decrease the imports of costly products in the country.

Anitta Phommahaxay (2013) investigated the impact of FDI for both aggregate and disaggregate levels and some macroeconomic variables on real economic growth in Laos during the period from 1990-2011. The multiple linear regression is applied to estimate the significance factors influence on economic growth. The findings show that FDI inflows in Manufacturing sectors have played a crucial role to support economic growth.

Eleanya Kalu Nduka (2013) empirically studied the relationship between openness and economic growth in Nigeria over the period 1970-2008 by using Ordinary Least Square (OLS) technique. The author uses gross domestic product proxy for economic growth as dependent variable, whereas investment, degree of openness, government expenditure and lagged GDP as the explanatory variables. All the variables of interest have direct impact on the economic growth of Nigeria during the studied period. Moreover, the research finds that there is a long-run equilibrium between trade openness, investment, government expenditure, and economic growth and impact of openness on economic development is significant in Nigeria.

Miguel D. Ramirez (2013) analyzed the effect of foreign investment policies on FDI flows at a cross-section of ASEAN member countries for the period 1995-2011 using a panel fixed-effects regression. The results show that the trends in the region are promising for economic growth in general and growth of FDI inflows.

Zaw Yadanar Hein (2014) analyzed how both countries strive to attract FDI, and which variables determine the period 1989 to 2012 by using linear regression analyses. The results show that any openness of the trade is statistically significant at the percent level implying that Vietnam's FDI polices have a positive effect in attracting FDI.

Samiul Parvez Ahmed (2014) examined the relationship between foreign direct investments and economic growth of Bangladesh during the period 1972-2011. This study evaluates the association between FDI and economic growth using multiple regression method by considering relationship between real gross domestic product, foreign direct investment, domestic investment and openness of the trade policy regime. The results indicate that domestic investments exert positive influence on economic growth whereas foreign direct investments, openness of trade are less significant.

Lim GuechHeang and Pahlaj Moolio (2014) examined the relationship between foreign direct investment and gross domestic product of Cambodia in long run over the period of 1993-2011 by using simple regression analysis, Augmented Dickey-Fuller test, Durbin-Watson test, Breusch-Godfrey Serial Correlation LM test, Breusch-Pagan-Godfrey test, and Jarque-Bera test. The result from regression found that there is a positive relationship between FDI and GDP in the long run in Cambodia.

Kyaw Kyaw Lynn (2015) analyzed the relationship between foreign trade and economic growth in Myanmar over the period 1990-2014. The results concluded that foreign trade did not have significant impact on the economic growth of Myanmar.

Samina Zaz (2015) analyzed the effect of foreign direct investment (FDI) on economic growth of Pakistan using multiple linear regression model and unit root test. This study utilized time series data for 35 years from 1979-2013. The findings showed that FDI has positive relationship with GDP while inflation has negative relationship with GDP.

Limam Ould (2015) investigated the impact of foreign direct investment (FDI) and Gross Fixed Capital Formation on the economic growth of Mauritania for the period 1976 to 1995 quarterly data. Multiple Regressions model has been applied alongside with various econometrics techniques such as unit root test, Granger-Causality Test and Ordinary Least Square (OLS). GDP is the dependent variable whereas FDI and GFCF are measured as independent variables. The result indicated that all the variables were not stationary at level except FDI, whereas GDP and GFCF are stationary at first defiance. The result revealed that there was no causality between the variables since as p-value obtained are more than 5%.

Muhammad Ali Jibran Qamar (2016), studied the relationship between FDI and employment rate, exports and foreign reserves with GDP in Pakistan for the period of 1963-2014. The results confirmed that an increase in FDI has a positive impact on the economic growth both in the short and long-run.

Tolkyn Azatbek (2016), estimated the communication of foreign direct investment, net exports and economic growth of Kazakhstan by using regression analysis. They found statistically significant relationship between the indicator of FDI, net exports and GDP in Kazakhstan.

Aqsa parveen Tabyya Iqbal, Sidra Muneer, M.Phool (2018) analyzed the impact of foreign direct investment (FDI), export (EXPO) and import (IMP) in the economic growth of Pakistan from 1990 to 2015. The link of foreign direct investment (FDI), export (EXPO) and import(IMP) with economic growth is measured through multiple regression model. Foreign direct investment (FDI), export (EXPO) and import (IMP) treated as regrassors and gross domestic product (GDP) treated as regressand in this model. Eviews software used to analyze the annual time series data from 1990 to 2015. The result fined that there is a negative and insignificant association between foreign direct investment (FDI) and GDP while there is significant and positive relationship found of export (EXPO) and import (IMP) with GDP.

Rashid Ismail Mfinanga (2018) analyzed the determinants of foreign direct investment inflow in Tanzania using the annual time series data between 1990-2015. Ordinary Least Square (OLS) estimation method used to examine the relationship between foreign direct investment inflow and its determinants and Augmented Dickey-Fuller test (ADF) used to see stationary and non-stationary of the variables. The results found that the fluctuated exchange rate policy adopted by the country increase the inflow of foreign direct investment in the country. The results also found that trade openness and inflation rate have insignificant relationship with foreign dirct investment inflow in the country.

CHAPTER III
THEORETICAL BACKGROUND

3.1 The Unit Root Test

A test of stationary (or non-stationary) that has become widely popular over the past several years is the unit root test.

The unit root (stochastic) process is

$$\boldsymbol{Y_t = \rho Y_{t-1} + u_t} \qquad \boldsymbol{-1 \leq \rho \leq 1} \tag{3.1}$$

where u_t is a white noise error term.

If $\rho = 1$, that is, in the case of the unit root, Equation (3.1) becomes a random walk model without drift, which is nonstationary stochastic process. If it is, then Y_t is non-stationary. This is the general idea behind the unit root test of stationary. However, we cannot estimate Equation (3.1) by OLS and test the hypothesis that $\rho = 1$ by the usual t test because that test is several biased in the case of a unit root. Therefore, we manipulate Equation (3.1) as follows : Subtract Y_{t-1} from both sides of Equation (3.1) to obtain:

$$\boldsymbol{Y_t - Y_{t-1} = \rho Y_{t-1} - Y_{t-1} + u_t}$$
$$\boldsymbol{= (\rho - 1) Y_{t-1} + u_t} \tag{3.2}$$

which can be alternatively written as:

$$\boldsymbol{\Delta Y_t = \delta Y_{t-1} + u_t} \tag{3.3}$$

Where $\delta = (\rho - 1)$ and Δ, as usual, is the first-difference operator.

In practice, therefore, instead of estimating Equation(3.4), Equation(3.1) is estimated and test the (null) hypothesis that $\delta = 0$, the alternative hypothesis being that $\delta < 0$. If $\delta = 0$, then $\rho = 0$, i.e., there is a unit root, meaning the time series under consideration is non- stationary.

If $\delta = 0$, Equation (3.3) will become

$$\boldsymbol{\Delta Y_t = (Y_t - Y_{t-1}) = u_t} \tag{3.4}$$

Since u_t is a white noise error term, it is stationary, which means that the first differences of a random walk time series are stationary.

Takes the first differences of Y_t and regress them on Y_{t-1} and see if the estimated slope coefficient in this regression ($\hat{\delta}$) is zero or not. If it is zero, it can be concluded that Y_t is non-stationary. But if it is negative, it can be concluded that Y_t is stationary. Dickey and Fuller have shown that under the null hypothesis that $\delta = 0$, the estimated t value of the coefficient of Y in Equation (3.3) follows the $\tau(tau) statistic$. In the literature, the tau statistic or test is known as the Dickey-Fuller (DF) test.

The actual procedure of implementing the DF test involves several decisions. The Dickey-Fuller test is estimated in three different forms, under three different null hypotheses.

Y_t is a random walk: $$\Delta \boldsymbol{Y_t} = \boldsymbol{\delta Y_{t-1}} + \boldsymbol{u_t} \tag{3.5}$$

Y_t is a random walk with drift: $$\Delta \boldsymbol{Y_t} = \boldsymbol{\beta_1} + \boldsymbol{\delta Y_{t-1}} + \boldsymbol{u_t} \tag{3.6}$$

Y_t is a random walk with drift around a stochastic trend: $$\Delta \boldsymbol{Y_t} = \boldsymbol{\beta_1} + \boldsymbol{\beta_2 t} + \boldsymbol{\delta Y_{t-1}} + \boldsymbol{u_t} \tag{3.7}$$

Where t is the time or trend variable. In each case, the hypotheses are:

Null hypothesis: H_0: $\delta = 0$ (i.e., there is a unit root or the time series is non-stationary).

Alternative hypothesis: H_1: $\delta < 0$ (i.e., the time series is stationary).

If the null hypothesis is rejected, it means that Y_t is stationary with zero mean in the case of Equation (3.5), that Y_t is stationary with nonzero mean $[= \beta_1/(1-\rho)]$ in the case of Equation (3.6), and that Y_t is stationary around a deterministic trend in Equation (3.7).

It is extremely important to note that the critical values of the tau test the hypothesis that $\delta = 0$, are different for each of the preceding three specifications of the Dickey- Fuller test.

3.1.1 Augmented Dickey-Fuller (ADF) Test

In conducting the Dickey-Fuller test as in Equations (3.5, 3.6 and 3.7), it was assumed that the error term u_t was uncorrelated. But in case the u_t are correlated, Dickey and Fuller have developed another test, known as the Augmented Dickey-Fuller (ADF) test. This test is conducted by "augmenting" the preceding three Equations by adding the lagged values of the dependent variable ΔY_t. To be specific, the Augmented Dickey-Fuller test consists of estimating the following regression:

$$\Delta \boldsymbol{Y_t} = \boldsymbol{\beta_1} + \boldsymbol{\beta_2 t} + \boldsymbol{\delta Y_{t-1}} + \sum_{i=1}^{m} \boldsymbol{\alpha_i} \Delta \boldsymbol{Y_{t-i}} + \boldsymbol{\varepsilon_t} \tag{3.8}$$

Where ε_t=a pure white noise error term

$\Delta \boldsymbol{Y_{t-1}} = (\boldsymbol{Y_{t-1}} - \boldsymbol{Y_{t-2}})$; $\Delta \boldsymbol{Y_{t-2}} = (\boldsymbol{Y_{t-2}} - \boldsymbol{Y_{t-3}})$.

The number of lagged difference terms to include is often determined empirically, based on that the error term in Equation (3.8) is serially uncorrelated, so that we can obtain an unbiased estimate of δ, the coefficient of lagged Y_{t-1}. In Augmented Dickey-Fuller it is needed to test where $\delta = 0$ and the Augmented Dickey-Fuller test follows the same asymptotic distribution as the Dickey-Fuller statistic, so the same critical values can be used.

3.2 Linear Models and Regression Analysis

Suppose the outcome of any process is denoted by a random variable Y, called as dependent (or study) variable, depends on k independent (or explanatory) variables denoted by $X_1, X_2, \ldots, X_k$. Suppose the behavior of Y can be explained by a relationship given by

$$Y = f(X_1, X_2, \ldots, X_k, \beta_1, \beta_2, \ldots, \beta_k) + \varepsilon \tag{3.9}$$

Where f is some well-defined function and $\beta_1, \beta_2, \ldots, \beta_k$ are the parameters which characterize the role and contribution of $X_1, X_2, \ldots, X_k$ respectively. The term ε reflects the stochastic nature of the relationship between Y and $X_1, X_2, \ldots, X_k$ indicates that such a relationship is not exact in nature. When $\varepsilon = 0$, then the relationship is called the mathematical model otherwise the statistical model.

A model or relationship is termed as linear if it is linear in parameters and nonlinear, if it is not linear in parameters. In other words, if all the partial derivatives of Y with respect to each of the parameters $\beta_1, \beta_2, \ldots, \beta_k$ are independent of the parameters, then the model is called as a linear model. If any of the partial derivatives of Y with respect to any of $\beta_1, \beta_2, \ldots, \beta_k$ is not independent of the parameters, the model is called as nonlinear. Note that the linearity of non-linearity of the model is not described by the linearity or nonlinearity of explanatory variables in the model.

When the function of f is linear in parameter, then

Y = f $(X_1, X_2, \ldots, X_k, \beta_1, \beta_2, \ldots, \beta_k)$+$\varepsilon$ is called a linear model and when the function f is nonlinear in parameters, then it is called a nonlinear model. In general, the function f is chosen as

$$f(X_1, X_2, \ldots, X_k, \beta_1, \beta_2, \ldots, \beta_k) = \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k$$

to describe a linear model. Since $X_1, X_2, \ldots, X_k$ are pre-determined variables and Y is the outcome, so both are known. Thus the knowledge of the model depends on the knowledge of the parameters $\beta_1, \beta_2, \ldots, \beta_k$.

To statistical linear modeling essentially consists of developing approaches and tools to determine $\beta_1, \beta_2, \ldots, \beta_k$ in the linear model

$$Y = \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k + \varepsilon$$

given the observations on Y and $X_1, X_2, \ldots, X_k$.

The regression analysis is a technique which helps in determining the statistical model by using the data on study and explanatory variables. The classification of linear and nonlinear regression analysis is based on the determination of linear and nonlinear models, respectively.

The theory and fundamentals of linear models lay the foundation for developing the tools for regression analysis that are based on valid statistical theory and concepts.

3.3 Multiple Linear Regression Model

The multiple linear regression models are an extension of a simple linear regression model to incorporate two or more independent variables in a prediction equation for a response variable. The use of two or more independent variables regression analysis is an extension of the basic principles used in two-variable regression analysis. It is necessary to determine the Equation for the average relationship between the variable.

The multiple regression models with k independent variables is

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \ldots + \beta_k X_{ik} + \varepsilon_i \quad \textbf{i=1, 2,, n} \qquad (3.10)$$

Where Y_i = value of the dependent variable in the ith observation

β_0 = intercept

$\beta_1, \beta_2, \ldots, \beta_k$ = regression coefficients associated with each of the X_k independent variables

X_{ij} = value of the jth independent variable in the ith observation

ε_i = random error terms

It is often more convenient to employ matrix notation:

$$Y = X\beta + e \qquad (3.11)$$

Where;

Y is a n × 1 vector:

$$Y = \begin{pmatrix} y_1 \\ \vdots \\ y_n \end{pmatrix}$$

X is a n× (k+1) matrix:

$$X = \begin{pmatrix} 1 & x_{11} & \cdots & x_{1k} \\ \vdots & \vdots & \ddots & \vdots \\ 1 & x_{n1} & \cdots & x_{nk} \end{pmatrix}$$

β is (k+1) × 1 vector:

$$\beta = \begin{pmatrix} \beta_0 \\ \vdots \\ \beta_k \end{pmatrix}$$

e is n × 1 vector:

$$e = \begin{pmatrix} e_1 \\ \vdots \\ e_n \end{pmatrix}$$

3.4 Assumptions of Multiple Regression Model

In the above, described the methods to statistically evaluate the multiple regression equation. The results of the test let know if at least one of the coefficients was not equal to zero and described a procedure of evaluating each regression coefficient.

It is important to know that the validity of the statistical F-test and individual coefficients t-tests rely on several assumptions. That is, if the assumptions are not true, the results might be biased or misleading. However, strict adherence to the following assumptions is not always possible. Fortunately, the statistical techniques discussed in this work well even when one or more of the assumptions are violated. Even if the values in the multiple regression equation will be closer than any that could be made otherwise. Just as with the simple regression model, several assumptions are making about the multiple regression. The following are the assumptions of the multiple regression model:

1. There is a linear relationship. That is, there is a straight-line relationship between the dependent variable and the set of independent variables.

2. The variation in the residuals is the same for both large and small values **of$\hat{y}_i$.** To put it another way, $(y_i - \hat{y}_i)$is unrelated to whether$\hat{y}_i$ is large or small.
3. The residuals follow the normal probability distribution. Recall the residual is the difference between the actual value of $y_i$and the estimated value$\hat{y}_i$. So the term $(y_i - \hat{y}_i)$is computed for every observation in the data set. These residuals should approximately follow a normal probability distribution. In addition, the mean of the residuals should be 0.
4. The independent variables should not be correlated. That is, would like to select a set of independent variables that are not themselves correlated.
5. The residuals are independent. This means that successive observations of the dependent variable are not correlated. This assumption is often violated when time is involved with the sample observations.

3.4.1 Multicollinearity

Multicollinearity is a phenomenon where two or more of the covariates are related to each other in such a way that the quantitative measures of the variables are linearly dependent to a large extent. If some covariates are collinear, the ordinary least square (OLS) estimates of these parameters will have a large variance.

A consequence of having a large variance is that the estimates are not precise and will therefore not work for hypothesis testing. When the OLS is used for prediction, multicollinearity will not be an issue. Another problem arises when trying to interpret a collinear relationship and not knowing what parameters influence one another. This may lead to specification errors.

3.4.2 Detecting Multicollinearity

Multicollinearity problem arises when of the independent variables is linearly related to one of more of the other independent variables. Such a situation violates one of the conditions for multiple regression. Specifically multicollinearity occurs if there is a high correlation between two independent variables, X_i and X_j. In multiple regression analysis, if the correlation between X_i and X_j, r_{ij} is high, multicollinearly exist. Multicollinearly is a problem of degree. Any time two or more independent variables are linearly related, some degree of multicollinearly exists. If its presence becomes too pronounced, the model is adversely affected. The presence of multicollinearly creates many problems in use of regression techniques. The most direct way of testing for multicollinearly is to produce a correlation matrix for all variables in the model. Highest correlation is probably high enough to indicate a significant problem.

$$R(X_1, X_2) = \frac{Cov(X_1, X_2)}{\sqrt{Var(X_1)Var(X_2)}} \quad (3.12)$$

The off-diagonal elements in R represent the correlation coefficients for the data in question. A correlation coefficient above 0.8 indicates a high correlation between the variables.

Another way to detect multicollinearity is to use the variance inflation factor (VIF). The VIF associated with any X variable is found by regression it on all the other X variables. The resulting R^2 is then used to calculate that variable's VIF . The VIF for any X_i represents that variable's influence on multicollinearity. The VIF for any given independent variable X is

$$VIF = \frac{1}{1-R^2} \quad (3.13)$$

Where, R^2 = coefficient of determination

Multicollinearity produces an increase in the variation, or standard error, of the regression coefficient. In general, multicollinearity is not considered a significant problem unless the VIF of a single independent variable measure at least 10 or the sum of the $VIF's$ for all independent variable is at least 10.

3.4.3 Homoscedasticity and Heteroscedasticity

The fourth assumption states that the error terms all have the same variance. This is called homoscedasticity and may in mathematical terms be written as $Var(e_i/x_i) = \delta^2$ where e_i is the error term and x_i is the measure of some covariate.

The opposite of homoscedasticity is the phenomenon of heteroscedasticity, where the error term can be formulated as a function of x_i; the error term increases for larger measurements of x_i.

3.5 Ordinary Least Squares Estimation

The ordinary least squrae (OLS) estimator is considered the optimal estimator of the unknown parameters β when the assumption of the multiple linear regression model are met. The estimates of the OLS is denoted with a hat; e.g, the OLS of β is expressed as $\hat{\beta}$.

The estimated $\hat{\beta}$ achieved by this method minimizes the sum of the squared errors. This is done by putting the derivative of the sum of the errors with respect to $\hat{\beta}$ equal to zero.

The sum of the squared errors:

$$\sum_{i=1}^{n} \hat{e}_i^{\,2} = \sum_{i=1}^{n} (Y_i - \hat{Y}_i)^2$$

$$= (Y - X\hat{\beta})'(Y - X\hat{\beta})$$

$$= Y'Y - Y'X\hat{\beta} - \hat{\beta}'X'Y + \hat{\beta}'X'X\hat{\beta}$$

$$= Y'Y - 2\hat{\beta}'X'Y + \hat{\beta}'X'X\hat{\beta}$$

Because $\hat{\beta}'X'Y$ is a (1×1) matrix, or a scalar, and its transpose $(\hat{\beta}'X'Y)' = Y'X\hat{\beta}$ is the same scalar.

The derivative with respect to $\hat{\beta}$:

$$\frac{\partial (Y'Y - 2\hat{\beta}'X'Y + \hat{\beta}'X'X\hat{\beta})}{\partial \hat{\beta}} = 0$$

$$-2X'Y + 2X'X\hat{\beta} = 0$$

$$X'Y = X'X\hat{\beta}$$

It follows that

$$\hat{\beta} = (\mathrm{X}'\mathrm{X})^{-1} X'Y \tag{3.14}$$

Under the multiple linear regression model's assumptions the OLS method is unbiased and thus $E(\hat{\beta}) = \beta$. The covariance of the OLS is calculated as

$$Cov(\hat{\beta}/X) = (X'X)^{-1}\delta^2 \tag{3.15}$$

3.5.1 Assumptions of Ordinary Least Squares (OLS)

i. The error term is a random variable and is normally distributed.
ii. Any two errors are independent of each other.
iii. All errors have the same variance.
iv. The mean of the Y-values all lie on a straight line.

3.6 Model Validation

When using regression in order to create a predictive model it is important to examine how well the model represents the data it is derived from and to what extent it is possible to use the model for predictive purpose. This type of analysis is referred to as model validation and may be done with different types of statistical tools.

3.6.1 Significance F-test for Entire Model

The F-test is used to determine whether there exists a significant relationship the dependent variable and the entire set of independent variables in the regression model, thus F-test is a test of the overall significance of the regression model.

The hypotheses for F-test are as follows:

Null hypothesis: $\boldsymbol{\beta_0} = \boldsymbol{\beta_1} = \cdots = \boldsymbol{\beta_k} = \mathbf{0}$

Alternative hypothesis: At least one β is not zero.

If the null is not rejected, there is no linear relationship between the dependent variable and any of the independent variables. On the other hand, if the null is rejected, then at least on independent variable is linearly related to the dependent variable.

The characteristics of the F distribution are:

1. There is a family of F distributions. Each time the degrees of freedom in either the numerator or the denominator changes, a new F distribution is created.
2. The F distribution cannot be negative. The smallest possible value is 0.
3. It is a continuous distribution. The distribution can assume an infinite number of values between 0 and positive infinity.
4. It is positively skewed. The long tail of the distribution is to the right-hand side. As the number of degrees of freedom increases in both the numerator and the denominator, the distribution approaches the normal probability distribution. That is, the distribution will move toward a symmetric distribution.
5. It is asymptotic. As the values of X increase, the F curve will approach the horizontal axis, but will never tough it.

The ANOVA process is required to test the hypothesis of F-test which is used to make the determination. The following is ANOVA table for the multiple regression model.

ANOVA Table

Source of variation	**Sum of Squares**	**Degrees of Freedom**	**Mean Squares**	**F-value**
Treatment	*SSR*	k	MSR = SSR / k	F=MSR / MSE
Error	*SSE*	n-k-1	MSE = SSE / (*n* –k-1)	
Total	*SST*	n-1		

Where, n-k-1 is the degrees of freedom and k is the number of independent variables. The decision rule for the F-test is the following form:

If $> F_{\alpha,k,n-k-1}$: reject the null hypothesis.

If $F \leq F_{\alpha,k,n-k-1}$: do not reject the null hypothesis.

Where$F_{\alpha,k,n-k-1}$, is based on the F-distribution with n-k-1 degrees of freedom.

3.6.2 Significance t-test for Regression Coefficients

The t-test of significance works the same as it did for simple regression model. For any parameterβ_i, the hypotheses take the form:

Null hypothesis: $\beta_i = 0$

Alternative hypothesis:$\beta_i \neq 0$

The t-test statistic is

$$\boldsymbol{t = \frac{b_i}{S_{b_i}}} \tag{3.16}$$

Where; b_i = the individual coefficient being tested

S_{b_i} =the standard error of b_i

The decision rule for t-test takes the following form:

If $< \boldsymbol{-t_{\frac{\alpha}{2},n-k-1} \; or \; t > t_{\frac{\alpha}{2},n-k-1}}$: reject the null hypothesis.

If $\boldsymbol{-t_{\frac{\alpha}{2},n-k-1} \leq t \leq t_{\frac{\alpha}{2},n-k-1}}$: do not reject the null hypothesis.

3.6.3 Multiple Coefficient of Determination

In the simple linear regression, the total sum of squares, the total variation in the dependent variable (***SST***), can be broken into two parts: the sum of squares due to regression (***SSR***) and the sum of squares due to error (***SSE***).

$$SST = SSR + SSE \tag{3.17}$$

The quality of the fit for the regression can be calculated by computing the coefficient of determination. The coefficient of determination measures the strength of relationship between the dependent variable y and the independent variables x's. It is defined as the percentage of variation in the dependent variable y, explained by the set of independent variables x's.

The characteristics of the multiple of coefficient determination are:

1. It is symbolized by a capital R squared. In other words, it is written asR^2 because it behaves like the square of a correlation coefficient.
2. It can range from 0 to 1. A value near 0 indicates little association between the set of independent variables and the dependent variable. A value near 1 means a strong association.
3. It cannot assume negative values. Any number that is squared or raised to the second power cannot be negative.
4. It is easily to interpret. BecauseR^2 is a value between 0 and 1, it is easily to interpret, compare, and understand.

It is computed as follows:

$$\boldsymbol{R^2 = \frac{SSR}{SST}} \tag{3.18}$$

From Equation (3.18):

$$\boldsymbol{R^2 = 1 - \frac{SSE}{SST}} \tag{3.19}$$

As with the simple model, it is found that. The higher the R^2, the more explanatory power the model has.

3.6.4 Adjusted Coefficient of Determination

The number of independent variables in a multiple regression equation makes the coefficient of determination larger. Each new independent variable causes the predictions to be more accurate. That, in turn, makes *SSE* smaller and *SSR* larger. Hence, R^2 increases only because of the total number of independent variables and not because the added independent variable is a good predictor of the dependent variable.

In fact, if the number of independent variables, *k*, and the sample size, *n*, are equal, the coefficient of determination is 1.0. In practice, this situation is rare and would also be ethically questionable. To balance the effect that the number of independent variables has on the coefficient of multiple determination, statistical software packages use an adjusted coefficient of multiple determination.

The adjusted coefficient of determination is obtained by dividing *SSE* and *SST* by their respective degrees of freedom as follows:

$$\boldsymbol{R^2_{adj} = 1 - \frac{\frac{SSE}{n-k-1}}{\frac{SST}{n-1}}} \qquad (3.20)$$

3.6.5 Variation in Residuals

This requirement indicates that the variation about the predicted values is constant, regardless of whether the predicted values are large or small. The requirement for constant variation around the regression line is called homoscedasticity. It is defined as the variation around the regression equation is the same for all of the values of the independent variables. To check the homoscedasticity, the residuals are plotted against the fitted values of y.

3.6.6 Serial Autocorrelation

The fifth assumption about regression and correlation analysis is that successive residuals should be independent. This means that there is no pattern to the residuals, the residuals are not highly correlated, and there are not long runs of positive or negative residuals. When successive residuals are correlated, this refers to serial autocorrelation.

The most celebrated test for detecting serial autocorrelation is that developed by statistics Durbin and Watson. It is popularly known as the Durbin-Watson *d* statistic, which is defined as:

$$\boldsymbol{d = \frac{\sum_{t=2}^{n}(\hat{e}_t - \hat{e}_{t-1})^2}{\sum_{t=1}^{n}\hat{e}_t^2}} \qquad (3.21)$$

Which is simply the ratio of the sum of squared differences in successive residuals to the *RSS*. The numerator of the *d* statistic the number of observations is n-1 because one observation is lost in taking successive differences. A great advantage of the *d* statistic is that it is based on the estimated residuals, which are routinely computed in regression analysis. Because this advantage, it is now a common practice to report the Durbin-Watson *d* along with summary statistics such as R^2, adjusted R^2, *t-ratio*, etc.

Although, it is now used routinely, it is important to note the assumptions underlying the *d* statistic:

1. The regression model includes an intercept term. If such term is not present, as in the case of the regression through the origin, it is essential to rerun the regression including the intercept term to obtain the *RSS*.
2. The explanatory variables, the *x's*, are no stochastic, or fixed in repeated sampling.
3. The disturbances are generated by the first-order autoregressive scheme:
4. The regression model does not include lagged value(s) of the dependent variable as one of the explanatory variables. Thus, the test is inapplicable to models of the following types:

   $$\boldsymbol{y_t = \beta_1 + \beta_2 x_{2t} + \cdots + \beta_k x_{kt} + \gamma y_{t-1} + e_t} \quad (3.22)$$

   Where $\boldsymbol{y_{t-1}}$ is the one-period lagged value of *y*. Such models are known as autoregressive models.
5. There are no missing observations in the data.

The exact sampling or probability distribution of the *d* statistic given in Equation (3.21) is difficult to drive because, as Durbin and Watson have shown, it depends in a complicated way on the *x* values present in a given sample. This difficulty should be understandable because *d* is computed from$\boldsymbol{\hat{e}_t}$, which are, of course, dependent on the given *x's*. Therefore, unlike the *t, F*, or χ^2 tests, there is no unique critical value that will lead to the rejection or the acceptance of the null hypothesis that there is no first-order serial autocorrelation in the disturbances e_t. However, Durbin and Watson were successful in deriving a lower bound d_L and an upper boundd_U such that if the computed *d* from Equation(3.22) lies outside these critical values, a decision can be made regarding the presence of positive or negative serial autocorrelation. Moreover, these limits depend only on the number of observations n and the number of explanatory variables *x's* and do not depend on the values taken by these explanatory variables. The actual test procedure can be explained better with aid of Figure (3.2) which shows that the limits of *d*are 0 and 4. These can be established as follows: Expand the Equation (3.21) to obtain

$$\mathbf{d} = \frac{\sum \hat{e}_t^2 + \sum \hat{e}_{t-1}^2 - 2\sum \hat{e}_t \hat{e}_{t-1}}{\sum \hat{e}_t^2} \quad (3.23)$$

Since $\sum \hat{e}_t^2$ and $\sum \hat{e}_{t-1}^2$ differ in only one observation, they are approximately equal. Therefore, setting$\sum \hat{e}_{t-1}^2 = \sum \hat{e}_t^2$.

Equation (3.23) may be written as:

$$\mathbf{d = 2(1-\frac{\sum \hat{e}_t\hat{e}_{t-1}}{\sum \hat{e}_t^2})} \tag{3.24}$$

Now let define:

$$\boldsymbol{\rho}= \frac{\sum \hat{e}_t\hat{e}_{t-1}}{\sum \hat{e}_t^2} \tag{3.25}$$

As the sample first-order coefficient of autocorrelation, an estimate of ρ.

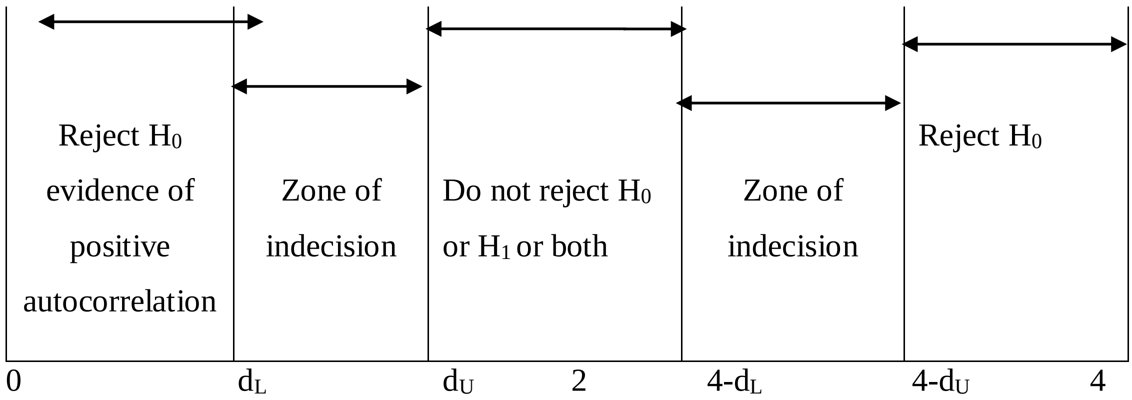


Figure (3.2): Durbin-Watson *d* statistic

H_0: No positive autocorrelation.

H_1: No negative autocorrelation.

$$\mathbf{d = 2(1- \rho)} \tag{3.26}$$

But since $-1 \le \rho \le 1$, Equation (3.26) implies that

$$\mathbf{0 \le d \le 4} \tag{3.27}$$

There are bounds of *d;* any estimated *d* value must lie within these limits. It is apparent from Equation(3.26) that if $\hat{\rho} = 0$, *d*=2; that is, if there is no serial correlation (of the first-order), *d* is expected to be about 2. Therefore, as a rule of thumb, if d is found to be 2 in an application, one may assume that there is no first-order autocorrelation, either positive or negative. If $\hat{\rho} = +1$, indicating perfect positive correlation in the residuals, *d=0*. Therefore, the closer *d* is to 0, the greater the evidence of positive serial correlation. This relationship should be evidence from Equation (3.21) because if there is positive autocorrelation, the$\hat{e}_t{}'s$ will be bunched together and their differences will therefore tend to be small. As a result, the numerator sum of square will be smaller in comparison with the denominator sum of squares, which remains a unique value for any given regression. If $\hat{\rho} = -1$, that is, there is perfect negative correlation among successive residuals, *d=4*. Hence, the closer *d* is 4, the greater evidence of negative serial correlation. Again, at Equation (3.21), this is understandable. For if there is negative autocorrelation, a positive $\hat{e}_t$ will tend to be followed by a negative $\hat{e}_t$ and vice versa so that $|\hat{e}_t - \hat{e}_{t-1}|$ will usually be greater than $|\hat{e}_t|$. Therefore, the numerator of *d* will be comparatively larger than the denominator.

Table (3.1): Decision Rules for Durbin-Watson *d* test

Null hypothesis	**Decision**	**If**
No positive autocorrelation	Reject	$0 < d < d_L$
No positive autocorrelation	No decision	$d_L \leq d \leq d_U$
No negative correlation	Reject	$4\text{-}d_L < d < 4$
No negative correlation	No decision	$4\text{-}d_U \leq d \leq 4\text{-}d_L$
No autocorrelation, positive or negative	Do not reject	$d_U < d < 4\text{-}d_U$

3.6.7 Standard Error of the Estimate

The interpretation of the standard error of the estimate is much the same as the simple regression model. It measures the dispersion of the actual values of y around those predicted by the model, y. The mean square error (***MSE***) is got by dividing the sum of the squared errors (***SSE***) by the degree of freedom.

Since $\boldsymbol{SSE} = \sum_{i=1}^{n}(\boldsymbol{y_i} - \boldsymbol{\hat{y}_i})^2$,

$$\boldsymbol{MSE} = \frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{n-k-1} \quad (3.28)$$

Then, $$\boldsymbol{Se} = \sqrt{\frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{n-k-1}} \quad (3.29)$$

CHAPTER IV
RESULTS AND FINDINGS

4.1 Introduction

The required data on current value and different constant values of gross domestic product, foreign direct investment and exports for the year (1989/89 to 2017/18) are obtained from statistical year book and presented in Appendix Table (A.1), (A.2) and (A.3) respectively. The based period of foreign direct investment, exports and gross domestic product are shifted into (2000/01) constant prices and showed in Appendix Table (A.4), (A.5) and (A.6) respectively. Due to the problem of autocorrelation, foreign direct investment and exports are transformed into logarithmic. Thereafter, annual growth rate of gross domestic product, foreign direct investment and exports are calculated and presented in Appendix Table (A.7) together with log values of foreign direct investment and exports.

4.2 Results of Testing for Unit Root Test

Testing for unit root is a test of the data series are stationary or non-stationary. This test is performed using Augmented Dickey- Fuller test. The results are shown in Table (4.1).

Table (4.1)

Results of Unit Root Test on Variables (ADF)

H_0: The observe series are non- stationary.

Variable	Test Type (c , p)	ADF-statistics	Critical Value		Decision
			1%	5%	
RGDPG	(1, 0)	-2.55	-3.69	-2.97	Do not Rejected H_0
ΔRGDPG	(1, 1)	-7.36	-3.71	-2.98	Rejected H_0
LRFDI	(1, 0)	-1.25	-3.77	-3.01	Do not Rejected H_0
ΔLRFDI	(1, 1)	-6.75	-3.77	-3.01	Rejected H_0
LREXP	(1, 0)	-1.16	-3.69	-2.98	Do not Rejected H_0
ΔLREXP	(1, 1)	-5.01	-3.71	-2.98	Rejected H_0

Note: (i) test type (c, p), where c denotes drift term, p denotes lag length

(ii) Δ denotes the first difference operator

According to Table (4.1), the result of Augmented Dickey- Fuller test states that the real value of GDP growth rate, foreign direct investment and exports are non-stationary at their level values with constant term. However, their first differences of all data series with constant, the null hypothesis of unit root is rejected. Thus, the real value of GDP growth rate, foreign direct investment and exports are first different series of stationary, that is they are integrated of order one I (1) series.

4.3 Results of Testing for Multiple Linear Regression Model

In fitting multiple linear regression model, GDP growth rate is used as the dependent variable and log values of foreign direct investment and exports represents as the independent variables. The following semi-log (lin-log) regression model is constructed to investigate the effect of foreign direct investment and exports on economic growth rate.

$$RGDPG = \beta_0 + \beta_1 LRFDI + \beta_2 LREXP + u_i \quad (4.1)$$

Where,

$RGDPG$= real value of gross domestic product (growth rate)

$LRFDI$= real value of foreign direct investment

$LREXP$= real value of exports

u_i = the disturbance terms

The estimated model of GDP growth rate on log value of foreign direct investment and exports are described in Table (4.2):

Table (4.2)

Results of Estimated values for coefficients

Variables	Coefficients	t-statistic	p-value	Standard Error
constant	-26.866	-3.677	0.001	7.306
$LRFDI$	-0.696	-4.127	0.000	0.169
$LREXP$	4.467	5.525	0.000	0.808
F-ratio	19.262		0.000	
Adjusted R Square	0.566			
R Square	0.597			
n	29			
D.W	1.83			

Source: SPSS output

According to Table (4.2), the estimated coefficient of foreign direct investment is highly significant at 1 percent level because p-value of $LRFDI$ (0.000) is less than 0.01. The estimated coefficient of export is also highly significant at 1 percent level because p-value of $LREXP$(0.000) is less than 0.01. Therefore, if foreign direct investment is increased by 1 percent and export is held constant, the estimated gross domestic product growth rate will be decrease by 0.00696 million (Kyat) on an average. Similarly, by holding the effect of foreign direct investment remain constant, 1 % increase in the value of export cause to increase the estimated gross domestic product by 1 percent and foreign direct investment is remain constant, the estimated growth rate of gross domestic product by 0.04467 million (Kyat) on an average.

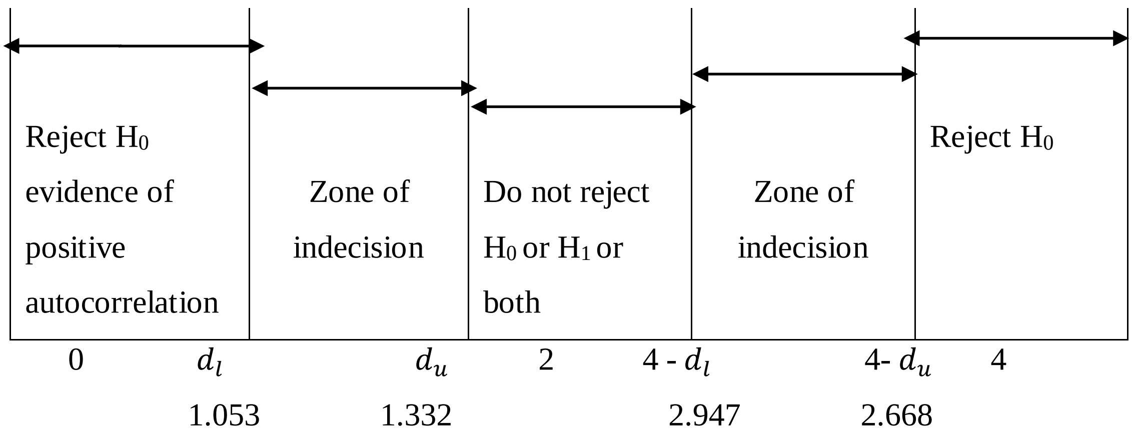
The significant probability of F-statistic 0.000 is less than 99% confidence probability 0.01. Thus, the estimated model is unbiased. In addition, the coefficient of determination adjusted R^2 indicates that 56.6 percent of the total variation in the gross domestic product growth rate is explained by the foreign direct investment and exports.

4.3.1 Result of Testing for Autocorrelation (Durbin –Watson Test)

The Durbin Watson (DW) statistic is used to test whether there exists autocorrelation in the residuals series.

Figure (4.1)

Durbin-Watson Test for Serial Correlation



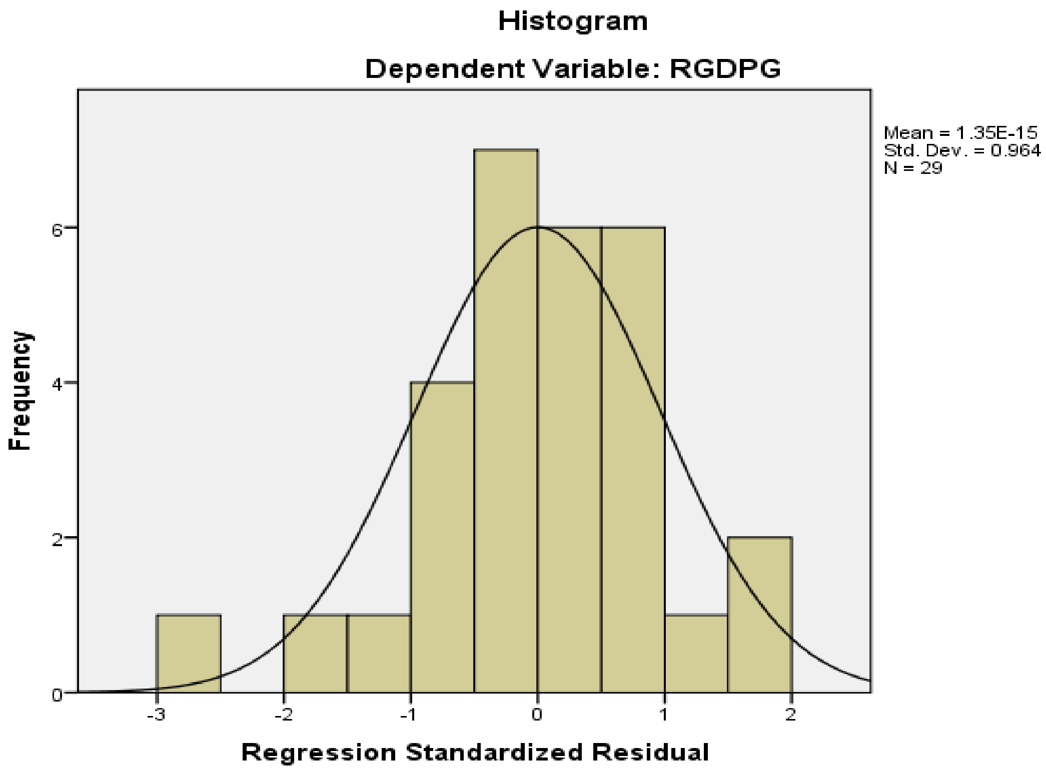
From Table (4.2), the value of Durbin Watson statistic (D.W =1.835) is greater than the table value of upper limit for1% significance level critical value $d_l = 1.270$ and $d_u = 1.332$. Since the statistic 1.835 is within 1.332 and 2.668, thus the null hypothesis of no positive or negative autocorrelation among the residual series cannot be rejected at 1% level of significance. Thus, it can be concluded that there is no evidence of autocorrelation among the residual series.

4.3.2 Result of Testing for Normality of Disturbances

One of the basic assumptions of multiple regression model is that the disturbances are normally distributed with zero mean and constant variance. To check whether the disturbances are normally distributed, histogram of the standardized residual and Normal P-P plot of the regression standardized residual are given in the following Figure (4.2) and Figure (4.3).

Figure (4.2)

Histogram for the Regression Standardized Residual

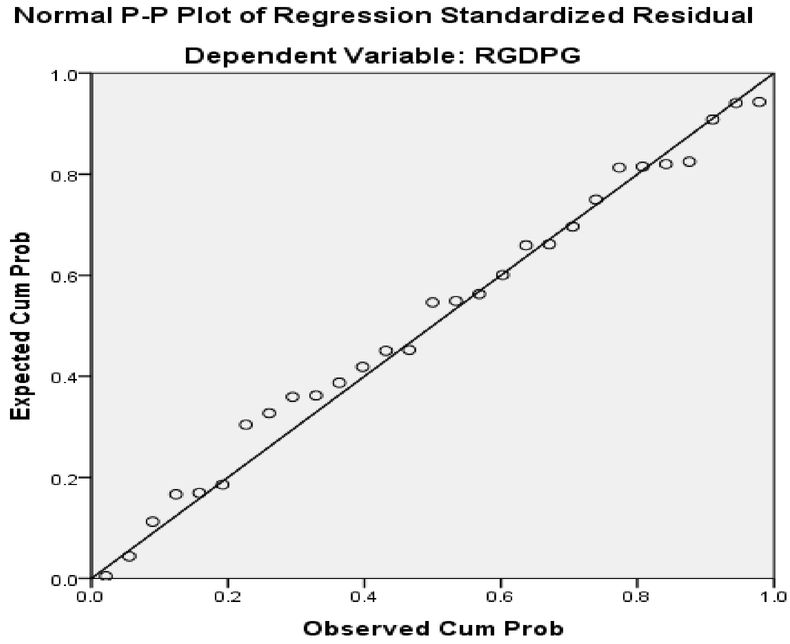


Source: SPSS Output

According to Figure (4.2), the histogram is bell-shaped, so the null hypothesis of the normality test is failed to reject. Therefore, the error terms are normality distributed.

Figure (4.3)

Normal P-P plot for the Regression Standardized Residual



Source: SPSS output

In Figure (4.3), the normal distribution forms a straight diagonal line, and if a variable's distribution is normal, the data distribution will fall more or less on the diagonal. According to the normal P-P plot, it can be concluded that the normal assumption is met.

4.3.3 Result of Testing for Detecting Multicollinearity

Multicollinearity can be detected with the help of tolerance and its reciprocal, called variance inflation factor (VIF). If the value of tolerance is less than 0.2 or 0.1 and, simultaneously, the value of VIF 10 and above, there is multicollinearity problem between independent variables. The values of tolerance and variance inflation factor (VIF) for collinearity statistics are given in the following Table (4.3):

Table (4.3)

Results of Collinearity Statistics

Variables	Tolerance	VIF
LRFDI	.937	1.068
LREXP	.937	1.068

Source: SPSS output

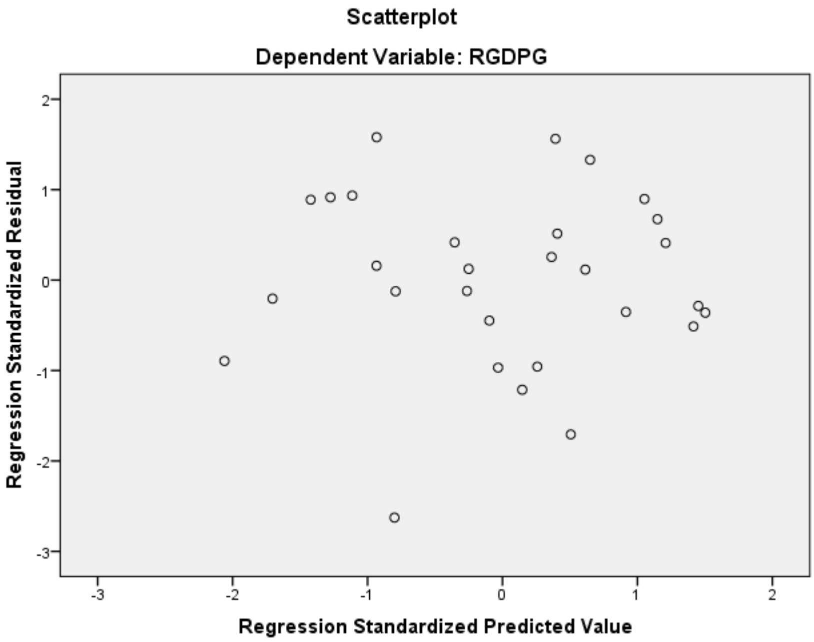
As shown in Table (4.3), there is no evidence of significance problem in multicollinearity because the tolerance value for each independent variable is not less than 0.2 or 0.1 and VIF value is not morethan10. It is concluded that multicollinearity is not problem in the model.

4.3.4 Result of Testing for Same Variance (Homoscedasticity)

Another basic assumption of the multiple regression models is homoscedasticity. In the presence of heteroscedasticity, the regression coefficients less efficient. Heteroscedasticity can often be detected by plotting the estimated Y values against the disturbances in the following Figure (4.4):

Figure (4.4)

Residual Pattern for Heteroscedasticity



Source: SPSS output

According to Figure (4.4), it can be seen that there is no definite pattern. Therefore, it can be concluded that residuals from the estimated semi-log (lin-log) model has an evidence of homoscedasticity.

In summarizing, the results of the estimated model from F-statistic, adjusted coefficient of determination, the value of Durbin-Watson statistics, homoscedasticity and normal probability plot, the semi-log (lin-log) regression model is appropriate for this study.

CHAPTER-V
CONCLUSION

5.1 Discussions

The main objective of this study is to identify the integrate order of foreign direct investment, exports and economic growth and to find out the relationship between real foreign direct investment, exports and economic growth of Myanmar. The required data of annual values on foreign direct investment, exports and gross domestic product for the year (1989/90 to 2017/18) are attained from various sources of Statistical Year Books. The based period of foreign direct investment, exports and gross domestic product are shifted into (2000/01) constant prices. After that GDP growth rate is calculated. The data set employed in this study is secondary data of annual growth rate of Gross Domestic Product (GDP), log value exports and foreign direct investment in Myanmar.

The data series of real foreign direct investment, real exports and real gross domestic product growth rate are tested for the stationary by using Augmented Dicker-Fuller unit root test. Because, it is very important to find out if the relationship between economic variables are true or spurious. To avoid the spurious regression problem, it is needed to test the time series data are stationary or not. Because, it is very important to find out if the relationship between economic variables are true or spurious. To avoid the spurious regression problem, it is needed to test the time series data are stationary or not. The finding is showed that real foreign direct investment, real exports and real GDP growth rate are stationary at the first difference level I (1).

The line-log regression model is constructed to examine dependent variable real value of gross domestic product growth rate based on independent variables (foreign direct investment and exports). In the estimate linear-log model, it is found that the value of real value of gross domestic product growth rate elasticity of real value of foreign direct investment and exports were -0.696 and 4.467 respectively. Over the period of the study of real value of exports remain unchanged, one percent increases in foreign direct investment on the average to about 0.00696 percent decrease in the gross domestic product growth rate. And then, if real value of foreign direct investment remains unchanged, on percent increase in exports on the average to about 0.04467 percent increase in gross domestic product growth rate. The adjusted R-square indicates that 56.6 percent of the variation in the gross domestic product growth rate is explained by the foreign direct investment and exports. Moreover, if Durbin- Watson statistic is close to 2, assume that autocorrelation is not a significant problem. Durbin-Watson (DW) statistic has supported that there is no positive and negative correlation between disturbances terms. Due to the normal P-P plot, it can be concluded that the normal assumption is met. The results of the estimated line-log regression model, the independent variables are all significant and F value shows that the entire model is highly significant at 1 percent. Therefore, all independent variables in the model jointly influence the dependent variable.

5.2 Recommendations

In this study, foreign direct investment shows negative effects on gross domestic product growth rate because most of the Western firms are stopped in investment. Moreover, inflows of foreign direct investment only influenced local consumption and usage for products. Therefore, the government needs to create an investor friendly environment in the country to attract more foreign direct investment and upgrade the existing infrastructure and system more conducive to the utilization of the foreign direct investment for productive and developmental purpose.

The results of exports show positive effects on gross domestic product growth rate. For the exports policy, the product package should be modified as the international markets. And the local firms in Myanmar should produce from primary goods to value-added goods as well as the transportation also should be promoted.

5.3 Further Study

1. The further research can study identifying other elements such as exchange rate, inflation rate, interest rate with large of time series data year.
2. The co-integration analysis can also be used to investigate the short run or long run effect on foreign direct investment, exports and gross domestic product growth rate.
3. And, the Granger- Causality test can also be used to identify the direction of causality between foreign direct investment, exports and gross domestic product growth rate.

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APPENDIX- A

Table (A.1) Current values of Gross Domestic Product, Foreign Direct Investment and Exports (Million Kyats)

Year	GDP (Million Kyats)	FDI (Million Kyats)	EXP (Million Kyats)
1989-1990	1246666.3	3056.178	2834
1990-1991	151941.5	1871.565	2961.9
1991-1992	186802.4	40.026	2926
1992-1993	249394.7	650.549	3590
1993-1994	360320.7	2278.571	4228
1994-1995	472773.7	8113.834	5405.3
1995-1996	604729.1	3933.816	5043.8
1996-1997	791980.0	16887.41	5487.7
1997-1998	1119509.2	6072.254	6446.8
1998-1999	1609775.6	331.411	6728.1
1999-2000	2190319.7	348.899	8947
2000-2001	2552732.5	1306.128	12736
2001-2002	3548472.2	114.012	16955.5
2002-2003	5625254.7	521.688	19955.1
2003-2004	7716616.2	548.32	14119.2
2004-2005	9078928.5	949.698	16697.3
2005-2006	12286765.4	36394.05	20646.6
2006-2007	16852757.8	4318.212	30026.1
2007-2008	23336112.7	1234.32	35296.8
2008-2009	29165117.5	5908.584	37027.8
2009-2010	33894039.1	1977.48	38672.8
2010-2011	39776764.9	119993.8	7791732
2011-2012	46307887.7	27866.76	7140425
2012-2013	51259260.0	1163963	7572517
2013-2014	58011626.0	3918250	9689983
2014-2015	65261890.2	7850322	11519572
2015-2016	72714021.2	10434735	12648219
2016-2017	79760096.5	7979774	13877942
2017-2018	90450949.1	7433512	18058076

Source: Statistical Year Book

Table (A.2) Different constant values of Gross Domestic Product (Million Kyats)

Year	GDP at (1985/86) Prices	GDP at (2000/01) Prices	GDP at (2005/06) Prices	GDP at (2010/11) prices
1989-1990	48883.1			
1990-1991	50259.5			
1991-1992	49933.3			
1992-1993	54756.6			
1993-1994	58063.9			
1994-1995	62406.1			
1995-1996	66741.6			
1996-1997	71042.4			
1997-1998	75123.1			
1998-1999	79460.2			
1999-2000	88157.0			
2000-2001	100274.8	2552732.5		
2001-2002		2842314.4		
2002-2003		3184117.3		
2003-2004		3624926.4		
2004-2005		4116635.4		
2005-2006		4675219.6	12286765.4	
2006-2007			13893395.3	
2007-2008			15559412.8	
2008-2009			17155078.1	
2009-2010			18964940.4	
2010-2011			20891324.3	39776764.9
2011-2012				42000875.7
2012-2013				45080661.5
2013-2014				48879158.5
2014-2015				52785211
2015-2016				56635381.1
2016-2017				59787128.5
2017-2018				63827918.6

Source: Statistical Year Book

Table (A.3) Different constant values of Exports (Million Kyats)

Year	Export at (1985/86) Prices	Export at (2000/01) Prices	Export at (2005/06) Prices	Export at (2010/11) prices
1989-1990	3527.8			
1990-1991	4038.3			
1991-1992	3925.5			
1992-1993	5381.3			
1993-1994	6228.9			
1994-1995	6527.6			
1995-1996	5089.4			
1996-1997	5608.3			
1997-1998	6958.9			
1998-1999	7894			
1999-2000	9172			
2000-2001	13203.2	12736		
2001-2002		14034.6		
2002-2003		17258.5		
2003-2004		12940.4		
2004-2005		14953.9		
2005-2006		15495.1	20646.6	
2006-2007			24804.9	
2007-2008			24024.6	
2008-2009			20298.9	
2009-2010			19883.2	
2010-2011			22060	7791732
2011-2012				6723564
2012-2013				7157388
2013-2014				8081720
2014-2015				9592055
2015-2016				11037171
2016-2017				10989818
2017-2018				13076086

Source: Statistical Year Book

Table (A.4) Calculation Real Gross Domestic Product (Million Kyats)

Year	GDP at Current Prices	GDP at (1985/86) Prices	GDP Deflators (1985/86=100)	GDP at (2000/01) Prices	GDP deflators (2000/01=100)	GDP at (2005/06) Prices	GDP deflators (2005/06=100)	GDP at (2010/11) prices	GDP deflators (2010/11=100)
1989-1990	1246666.3	48883.1	255.0294		10.0179		3.8119		2.0063
1990-1991	151941.5	50259.5	302.3138		11.8753		4.5187		2.3733
1991-1992	186802.4	49933.3	374.1039		14.6953		5.5917		2.9368
1992-1993	249394.7	54756.6	455.4605		17.8911		6.8077		3.5755
1993-1994	360320.7	58063.9	620.5589		24.3764		9.2754		4.8716
1994-1995	472773.7	62406.1	757.5761		29.7586		11.3234		5.9472
1995-1996	604729.1	66741.6	906.0752		35.5919		13.5430		7.1130
1996-1997	791980.0	71042.4	1114.7991		43.7908		16.6628		8.7515
1997-1998	1119509.2	75123.1	1490.2330		58.5384		22.2744		11.6988
1998-1999	1609775.6	79460.2	2025.8892		79.5797		30.2808		15.9039
1999-2000	2190319.7	88157.0	2484.5670		97.5972		37.1366		19.5047
2000-2001	2552732.5	100274.8	2545.7368	2552732.5	100.0000		38.0509		19.9849
2001-2002	3548472.2		3178.2124	2842314.4	124.8445		47.5044		24.9500
2002-2003	5625254.7		4497.4539	3184117.3	176.6661		67.2230		35.3065
2003-2004	7716616.2		5419.2754	3624926.4	212.8765		81.0013		42.5430
2004-2005	9078928.5		5614.4290	4116635.4	220.5424		83.9183		44.0751
2005-2006	12286765.4		6690.3541	4675219.6	262.8062	12286765.4	100.0000		52.5214
2006-2007	16852757.8		8115.4321		318.7852	13893395.3	121.3005		63.7087
2007-2008	23336112.7		10034.2405		394.1586	15559412.8	149.9807		78.7720
2008-2009	29165117.5		11400.7640		447.8375	17155078.1	170.4060		89.4997
2009-2010	33894039.1		11956.9668		469.6859	18964940.4	178.7195		93.8660
2010-2011	39776764.9		12738.3349		500.3791	20891324.3	190.3985	39776764.9	100.0000
2011-2012	46307887.7		14044.5983		551.6909		209.9231	42000875.7	110.2546
2012-2013	51259260.0		14484.2088		568.9594		216.4939	45080661.5	113.7057
2013-2014	58011626.0		15118.3417		593.8690		225.9722	48879158.5	118.6838
2014-2015	65261890.2		15749.3076		618.6542		235.4032	52785211	123.6371
2015-2016	72714021.2		16369.6630		643.0226		244.6756	56635381.1	128.5071
2016-2017	79760096.5		16993.80057		667.54		254.005	59787128.5	133.407
2017-2018	90450949.1		18051.57033		709.09		269.815	63827918.6	141.711

Source: Statistical Year Book

Table (A.5) Calculation Real Exports (Million Kyats)

Year	Export at Current Prices	Export at (1985/86) Prices	Export Deflators (1985/86=100)	Export at (2000/01) Prices	Export deflators (2000/01=100)	Export at (2005/06) Prices	Export deflators (2005/06=100)	Export at (2010/11) prices	Export deflators (2010/11=100)
1989-1990	2834	3527.8	80.33335		83.28025		65.6692		0.176954
1990-1991	2961.9	4038.3	73.34522		76.03577		59.7663		0.161561
1991-1992	2926	3925.5	74.53828		77.27259		60.9277		0.164189
1992-1993	3590	5381.3	66.7125		69.15975		54.5328		0.14695
1993-1994	4228	6228.9	67.87715		70.36712		55.4822		0.149516
1994-1995	5405.3	6527.6	82.80685		85.84449		67.6875		0.182402
1995-1996	5043.8	5089.4	99.10402		102.7395		80.8322		0.218301
1996-1997	5487.7	5608.3	97.84962		101.4391		79.9851		0.215537
1997-1998	6446.8	6958.9	92.64108		96.03947		77.5210		0.204064
1998-1999	6728.1	7894	85.23055		88.3571		69.9586		0.187741
1999-2000	8947	9172	97.54688		101.1252		79.7447		0.214871
2000-2001	12736	13203.2	96.46146	12736	100		78.2474		0.21248
2001-2002	16955.5		94.82199	14034.6	120.8121		91.1582		0.256701
2002-2003	19955.1		108.1999	17258.5	115.6248		87.9503		0.245679
2003-2004	14119.2		109.1095	12940.4	109.1095		83.0207		0.231835
2004-2005	16697.3		111.6585	14953.9	111.6585		83.9593		0.237252
2005-2006	20646.6		128.531	15495.1	133.246	20646.6	100		0.283121
2006-2007	30026.1		126.5943		161.293	24804.9	118.1001		0.342715
2007-2008	35296.8		183.1933		195.7642	24024.6	141.5000		0.415957
2008-2009	37027.8		243.0578		243.0578	20298.9	158.6997		0.516448
2009-2010	38672.8		259.1633		259.1633	19883.2	194.4999		0.550669
2010-2011	7791732		45397.98		47063.33	22060	35320.63	7791732	100
2011-2012	7140425		39228.86		49981.26		37510.51	6723564	106.2
2012-2013	7572517		46595.56		49793		37369.23	7157388	105.8
2013-2014	9689983		56428.93		56428.93		42349.44	8081720	119.9
2014-2015	11519572		56520.67		56520.67		42418.29	9592055	120.0949
2015-2016	12648219		52024.52		53932.96		40477.45	11037171	114.5966
2016-2017	13877942		46646.14		59431.57		44602.9	10989818	126.28
2017-2018	18058076		60820.86		64994.46		48777.8	13076086	138.1

Source: Statistical Year Book

Table (A.6) Calculation Real Foreign Direct Investment (Million Kyats)

Year	FDI (Million Kyats)	GDP deflators (2000/01=100)	Real FDI
1989-1990	3056.178	10.0179	30507.17
1990-1991	1871.565	11.8753	15760.15
1991-1992	40.026	14.6953	272.37
1992-1993	650.549	17.8911	3636.16
1993-1994	2278.571	24.3764	9347.45
1994-1995	8113.834	29.7586	27265.51
1995-1996	3933.816	35.5919	11052.56
1996-1997	16887.41	43.7908	38563.83
1997-1998	6072.254	58.5384	10373.11
1998-1999	331.411	79.5797	416.45
1999-2000	348.899	97.5972	357.49
2000-2001	1306.128	100.0000	1306.13
2001-2002	114.012	124.8445	91.32
2002-2003	521.688	176.6661	295.30
2003-2004	548.32	212.8765	257.58
2004-2005	949.698	220.5424	430.62
2005-2006	36394.05	262.8062	13848.26
2006-2007	4318.212	318.7852	1354.58
2007-2008	1234.32	394.1586	313.15
2008-2009	5908.584	447.8375	1322.44
2009-2010	1977.48	469.6859	4216.90
2010-2011	119993.8	500.3791	23980.58
2011-2012	27866.76	551.6909	5051.15
2012-2013	1163963	568.9594	204577.65
2013-2014	3918250	593.8690	659783.63
2014-2015	7850322	618.6542	1268935.84
2015-2016	10434735	643.0226	1619681.81
2016-2017	7979774	667.54	1195400.19
2017-2018	7433512	709.09	1048317.11

Source: Statistical Year Book

Table (A.7) Annual growth rate of gross domestic product, Log value of FDI and Log value of Exports

Year	GDPG	LFDI	LEXP
1989-1990	3.7	10.325717	8.1324031
1990-1991	2.815697	9.6652398	8.2675525
1991-1992	-0.649032	5.6071717	8.2392224
1992-1993	9.6594858	8.1986834	8.5546587
1993-1994	6.0400025	9.1428585	8.7009284
1994-1995	7.4783127	10.213378	8.747768
1995-1996	6.9472375	9.3104173	8.4988886
1996-1997	6.443957	10.56007	8.5959763
1997-1998	5.7440345	9.2469724	8.8117501
1998-1999	5.7733241	6.0317704	8.9378317
1999-2000	10.94485	5.8791039	9.087884
2000-2001	13.745704	7.1748223	9.4521879
2001-2002	11.343997	4.5144089	9.549281
2002-2003	12.025513	5.6879789	9.7560601
2003-2004	13.843997	5.5513194	9.4681095
2004-2005	13.564662	6.0652261	9.6127274
2005-2006	13.56895	9.5359146	9.6482791
2006-2007	13.076101	7.21125	9.8317697
2007-2008	11.991435	5.7466938	9.7998068
2008-2009	10.255305	7.1872363	9.6312952
2009-2010	10.550009	8.3468548	9.6106036
2010-2011	10.157606	10.085	9.7144945
2011-2012	5.5914824	8.5273719	9.5670497
2012-2013	7.3326704	12.228703	9.6295765
2013-2014	8.426001	13.399667	9.7510361
2014-2015	7.9909156	14.053689	9.9223664
2015-2016	6.9928403	14.29774	10.0627
2016-2017	5.8624729	13.993992	10.058401
2017-2018	6.7586288	13.862697	10.232216

Source: Statistical Year Book