**YANGON UNIVERSITY OF ECONOMICS**

**DEPARTMENT OF STATISTICS**

**MASTER OF APPLIED STATISTICS PROGRAMME**

# MODELLING AND FORECASTING OF THE UNDER-FIVE MORTALITY RATES IN MYANMAR AND SOME NEIGHBOURING COUNTRIES

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**MARCH, 2020**

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MAS – 30 (1st BATCH)

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# MODELLING AND FORECASTING OF THE UNDER-FIVE MORTALITY RATES IN MYANMAR AND SOME NEIGHBOURING COUNTRIES

This thesis is submitted to the Board of Examination as partial fulfillment of the requirements for the Degree of Master of Applied Statistics

**Approved by the Board of Examiners**


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**YANGON UNIVERSITY OF ECONOMICS**
**DEPARTMENT OF STATISTICS**
**MASTER OF APPLIED STATISTICS PROGRAMME**

This is to certify that this thesis entitled "**MODELLING AND FORECASTING OF THE UNDER-FIVE MORTALTIY RATES IN MYANMAR AND SOME NEIGHBOURING COUNTRIES**" submitted as a partial fulfillment towards the requirements of Master of Applied Statistics has been accepted by the Board of Examiners.

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# ABSTRACT

The under-five mortality rate is a key indicator of the state of public health of a society. Under-five mortality statistics is not only important indicators of demographic situation but also social and health conditions of Myanmar and some neighbouring countries. The secondary data used in this study was extracted from ADB and the World Bank Database. In this study, the under-five mortality rates over the years (2003-2017) are modeled using time series analysis. This study designs to predict the future of Myanmar and some neighbouring countries by selecting the appropriate model among four commons models as Linear, Quadratic, Cubic, and Exponential. In Myanmar, the values of coefficient in the Exponential model are statistically significant and the value MSE (63.2685) for Exponential model is the smallest on comparing with other models. Thus, the Exponential model was chosen as the most appropriate and predictable future model in Myanmar. It found that the forecast value of U5MR in Myanmar was decreased little by little from 40.66 in 2018 to 32.91 in 2021. In Thailand, the values of coefficient in four common models are statistically significant and the value of MSE (6.9064) for the Cubic model is the smallest on comparing with other models. Thus, the Cubic model was chosen as the most appropriate and predictable future model in Thailand. It found that the forecast value of U5MR in Thailand was decreased little by little from 5.66 in 2018 to -14.51 in 2021. In China, the values of coefficient in four common models are statistically significant and the value of MSE (0.4459) for the Cubic model is the smallest on comparing with other models. Thus, the Cubic model was chosen as the most appropriate and predictable future model in China. It found that the forecast value of U5MR in China was decreased little by little from 7.47 in 2018 to 0.117 in 2021. In India, the values of coefficient in the Linear model are statistically significant and the value of MSE (3.4277) for the Linear model is the smallest on comparing with other models. Thus, the Linear model was chosen as the most appropriate and predictable future model in India. It found that the forecast value of U5MR in India was decreased little by little from 36.13 in 2018 to 26.22 in 2021. In Bangladesh, the values of coefficient in Quadratic model are statistically significant and the value MSE (9.6080) for the Quadratic model is the smallest on comparing with other models. Thus, the Quadratic model was chosen as the most appropriate and predictable future model in Bangladesh. It found that the forecast value of U5MR in Bangladesh was decreased little by little from 30.4 in 2018 to 26.43 in 2021. Thus, the forecast values of under-five mortality rates (2018 to 2021) were decreasing in Myanmar and neighbouring countries. Forecasting is very important in future decisions making. The forecast based on the appropriate models were also validated in this thesis to support future decision making for planning purpose.

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# LIST OF ABBREVIATIONS

| | |
|---|---|
| ADB | Asian Development Bank |
| ANOVA | Analysis of Variance |
| ARIMA | Auto Regressive Integrated Moving Average |
| ASEAN | Association of Southeast Asian Nations |
| CAPMAS | Central Agency Public Mobilization and Statistics |
| CMR | Crude Mortality Rate |
| GDP | Gross Domestic product |
| MAPE | Mean Absolute Percent Error |
| MDG | Millennium Development Goal |
| MMR | Maternal Mortality Rate |
| MSE | Mean Squared Error |
| NGOs | Non-Governmental Organization |
| NMR | Neonatal Mortality Rate |
| PNMR | Perinatal Mortality Rate |
| SDG | Sustainable Development Goal |
| U5MR | Under-Five Mortality Rate |

# CHAPTER I
# INTRODUCTION

## 1.1 Rationale of the Study

Under-five mortality rate is an important role of a nation's health and social condition. Development economics focuses primarily on the economic, social, and institutional mechanisms needed to bring about rapid and large scale improvement in standards of living for the masses of poor people in developing countries. Economic development is no longer confined to a process of persistent increase in per capita income. Other dimensions are now considered central aspects of this process; the most notable of them are improvements in health and education. Undoubtedly, the health of children and young people are among the most important health issues. In this regard, such as Infant Mortality Rate, Under-five Mortality Rate, nutrition and baby weight at birth are widely used as credible measure of child health.

The difference between developing and developed nations in terms of rates of population growth can be explained simply by the fact that birth rates in developing countries are generally much higher than in developed countries. Death rates are also higher in developing countries than in developed countries. Under-five mortality rate is not only important measures of the living and socio-economic conditions of the nation but also powerful indicators of social economic development and can be used to measure the overall health status of a nation.

Developing countries suffer from a lack of access to affordable and professional health care resources and skilled personnel during deliveries. Countries with histories of extreme poverty also have a pattern of epidemics, endemic infectious diseases and low levels of access to maternal and childcare. High rates of under-five mortality occur in developing countries where financial and material resources are scare and there is a high tolerance to high number of under five deaths.

At the world, and for both less developed countries (LDCs) and more developed countries (MDCs), U5MR declined significantly between 1990 and 2013.

According to the State of the World's Mothers report by Save the Children, the world under-five mortality rate declined from 90 in 1990 to 46 in 2013.

According to the "Myanmar Demographic and Health Surveys", carried out by the Ministry of Health and Sport in 2015-2016, childhood mortality is substantially higher in rural areas than urban areas. There are 80 under five deaths for every 1,000 live births in rural areas compared with 42 deaths in urban areas. Under-five mortality was 50 deaths per 1,000 live births. This means that 1 in 20 children do not survive until his or her fifth birthday. Under-five mortality is lowest in Mon State (44 deaths per 1,000 live births) and Kayah State (50 deaths) and is highest in Chin State (104 deaths per 1,000 live births).

The speed and magnitude of declines in death rates have varied from one country to another country. Trend data provides a dynamic rather than a fixed view of the health status of Myanmar and some countries' population and of the services and systems that can have an impact on that health status. In Myanmar and some neighbouring countries, maternal and child health and birth spacing programmers have played an important role in influencing mortality, population growth, improving quality of life and human resources development.

This study attempts to find the suitable trend of under-five mortality rates in Myanmar and some countries during 2003 and 2017. The under-five mortality rates are obtained using the most appropriate model for each country.

## 1.2 Objectives of the Study

The main objectives of the study are-

i. To describe the under-five mortality situations in Myanmar and some neighbouring countries.

ii. To build the most appropriate model for under-five mortality and to forecast future under-five mortality in Myanmar and some neighbouring countries.

## 1.3 Method of Study

The data were assessed from ADB and World Bank Database. These data were analyzed by descriptive statistics such as graphs and charts to compare the under-five mortality patterns in Myanmar and some neighbouring countries. Time series models namely Linear, Quadratic, Cubic, and Exponential were applied to make forecasting for the future under-five mortality rates.

## 1.4 Scope and Limitations of the Study

In this study, the yearly time series data on under-five mortality rate of Myanmar, Thailand, China, India and Bangladesh for the period of 2003 to 2017 are used from ADB and World Bank Database.

## 1.5 Organization of the Study

There are five chapters in this thesis. Chapter (1) is introduction which comprise of five sub-headings: rationale of the study, objectives of the study, method of study, scope and limitations of the study and organization of the study. The related literature review of Under-Five Mortality and Geographic and Demographic Background in Myanmar and some neighbouring countries will be presented in Chapter (2). Chapter (3) describes research methodology. Analysis of the data using curve estimation of trend models portrays in Chapter (4). Chapter (5) summarizes the conclusion which presents findings and suggestions.

# CHAPTER II
# LITERATURE REVIEW AND GEOGRAPHIC AND DEMOGRAPHIC BACKGOROUND OF MYANMAR AND SOME NEIGHBOURING COUNTRIES

## 2.1 Review of Literature on Under-Five Mortality

This chapter provides a review of several research works have been carried out at different levels and different places across the developing world in an attempt to find out how the socio-economic and demographic factors in a population affect under-five mortality.

Han Cao and et al., (2017) evaluated to analyse trends in mortality and causes of death among children aged under 5 years in Beijing, China between 1992 and 2015 and to forecast under-five mortality rates for the period 2016–2020. Methods An entire population-based epidemiological study was conducted. Data collection was based on the Child Death Reporting Card of the Beijing Under-Five Mortality Rate Surveillance Network. An autoregressive integrated moving average (ARIMA) model was fitted to forecast U5MRs between 2016 and 2020. Mortality in neonates, infants and children aged under-five years decreased by 84.06%, 80.04% and 80.17% from 1992 to 2015, respectively. However, the U5MR increased by 7.20% from 2013 to 2015. Birth asphyxia, congenital heart disease, preterm/low birth weight and other congenital abnormalities comprised the top five causes of death. The greatest, most rapid reduction was that of pneumonia by 92.26%, with an annual average rate of reduction of 10.53%. The distribution of causes of death differed among children of different ages. Accidental asphyxia and sepsis were among the top five causes of death in children aged 28 days to 1 year and accident was among the top five causes in children aged 1–4 years. The under-five mortality rates in Beijing are projected to be 2.88‰, 2.87‰, 2.90‰, 2.97‰ and 3.09‰ for the period 2016–2020, based on the predictive model. Beijing has made considerable progress in reducing under-five mortality rates from 1992 to 2015. However, under-five mortality rates could show a slight upward trend from 2016 to 2020. Future considerations for child healthcare include the management of birth asphyxia, congenital heart disease, preterm/low birth weight and other congenital abnormalities. Specific preventative measures should be implemented for children of various age groups.

Sultana Rajial et al., (2019) evaluated the trends in maternal and child health indicators of Bangladesh. The secondary data used in this study was extracted from the World Bank Dataset. The selected indicators were maternal mortality ratio (MMR), under-five children mortality and neonatal mortality rate, and prevalence of stunting and wasting of under-five children. Trend analysis technique and ARIMA forecasting models were used in this study to find currents trend and predict the future of selected indicators. This study revealed clear evidence that neonatal, under-five child and maternal mortality in Bangladesh had been gradually decreasing during the last two and half decades. The decreasing rate of these indicators suggests that it should be possible to achieve the national target of sustainable development goals (SDGs) of Bangladesh by 2021. While, it was observed that the prevalence of underweight, stunting and wasting among under-five children was still high, these indicators have been slowly decreasing over time. The decreasing rate of these indicators displayed that without guided measures, the Bangladesh government would not be able to achieve the target goal of child malnutrition by 2021 under SDG-2.2.It is recommended that the government, as well as non-government health organizations (NGOs), and other policy makers should provide programs that are effective so that the national target goals can be achieved by the year 2030. Consequently, our findings should assist in the achievement of the national goals in Bangladesh regarding these health issues.

Mona Hassan Ahmed Hassan et al., (2004) stated that time-Series analysis of Under-Five Mortality. The aim of this study is to analyze levels, trend and seasonal patterns of under-five mortality. Data collection was based on recorded data about under -5 deaths and live births from 1996 to 2001 from Health Information Center and CAPMAS in Alexandria. Several trend equations were tried to select the best fit trend equation. Seasonality is tested using the moving average method. The predicted value for under-5 mortality rates for the year 2002 is calculated using the best-fit trend equation and the seasonal index and compared to the actual levels to test the validity of the prediction models. The study revealed a significant downward trend of under-five mortality rate, PNMR and CMR while the NMR does not show significant decrease over the study period. Maximum index of under-five mortality rate due to ARI is in winter while rates related to congenital malformations are in autumn while deaths due to perinatal conditions are mainly in summer.

In Prince Edward Opare (2014), a time series data comprising of annual estimates of Under-five Mortality rates for Ghana from the year 1961 to 2012, obtained from the Worldbank website was used for the analysis. Three time series models; the Box-Jenkins (ARIMA), the Bayesian Dynamic Linear Model, and the Random walk with drift models are built for the decline of Ghana"s under-five Mortality. Each model is built with data values from 1961 to year 2000, and an in-sample forecasting is made with each model from year 2001 to 2012. The Mean Squared Error (MSE) and the Mean Absolute Percentage Error (MAPE) as a measure of accuracy are used to determine the best fit model. The Random Walk with drift model produced the least values for both the MSE and the MAPE and is selected the best fit Model, and used for an out-of-sample forecasting for the years (2013 – 2016), producing respectively; 69.3, 66.6, 64.0 and 61.3 deaths per 1,000 live births. The forecast value of 64.0 deaths per 1000 live births for year 2015 show that Ghana may not be able to realize her Millennium Development Goal four (MDG 4) target of reducing her under-five mortality rate to about 42.7 deaths per 1,000 live births by the year 2015.

Myint Myint Thein (2014) studied that a study on under- five mortality rates in selected ASEAN Countries (1999-2013). The secondary data were obtained from World Bank Indicators (2014). This paper examines the statistical analysis on under-five mortality rates in Myanmar, Lao PDR, Philippines and Indonesia.

These rates depend on time have significant or not by using trend analysis. Measures of accuracy were used as the model selection criteria that could best describe the trend of Under- Five Mortality Rates of selected ASEAN countries during 1999 to 2013. Under- Five Mortality Rates are described to estimate for 2014 to 2016 individual year.

## 2.2 Geographic and Demographic Background of Myanmar and Some Neighbouring Countries

Land area of 676,578 square kilometer, Myanmar is the largest country in the Southeast Asia region, bounded by mountain complex in the North, East and West, and enclosed by the Andamen Sea and the Bay of Bengal in the South, Southwest, and West. Myanmar shares borders with Bangladesh, India, China and Thailand.

### 2.2.1 Myanmar

Myanmar is situated in Southeast Asia and is bordered on the north and north-east by China, on the east and south-east by Laos and Thailand, on the south by the Andaman Sea and the Bay of Bengal and on the west by Bangladesh and India. It is located between latitudes 09 32'N and 28 31'N and longitudes 92 10'E and 101 11'E. Myanmar has an area of 676575 square kilometer. Myanmar is the largest country in the Southeast Asia region.

It has a 2,832 kilometer long coastline on the Indian Ocean. Myanmar’s Highest Mountains, situated in the far north, include Hkakabo Razi, the highest peak, which rises 5,881 kilometer above sea level. The two mountain systems: a group of low mountains called the Rakhine Yoma stands in the West forming a border with the Indian Subcontinent, and the hilly Shan Plateau separates Myanmar from China, Lao PDR and Thailand.

The central lowland region of Myanmar consists of the Ayeyarwaddy and Sittaung river valleys. Ayeyarwaddy is the longest river in the country, running for 2,010 kilometer from the northern region to the Bay of Bengal, and serves as the principle transportation route and as the main source of water supply for the central dry zone.

The country’s 2014 census counted the population to be 51.5 million people. Myanmar is a union of 135 ethnic groups with their own languages, dialects and culture. The overall population density is about 76 persons per square kilometer.
The population density of Myanmar is lower than most other Asian countries. The population is more than 70 percent rural areas and 30 percent live in urban areas.

The official language is Myanmar, which is spoken by virtually all of Myanmar people, including large national races and non-Myanmar ethnic minorities though they have their own languages and dialects spoken only in their communities or in particular regions. English, being the second language, is widely spoken and understood among the educated urban population.

Agriculture remains the main sector of the economy and measures are being taken to increase productively, promote crop diversification, increase agriculture exports and develop agriculture based industries.

Under the new economic policy, Myanmar’s rich natural and human resources are being utilized and developed not only by the state sector but also by local and foreign investors. Myanmar is also rich in tourist attractions and there is enormous potential for the tourism industry. Table (2.1) illustrates the summary measures of demographic statistics of Myanmar.

**Table (2.1)**

**Summary Measures of Demographic Statistics of Myanmar**

| **Summary Measures** | **2000** | **2005** | **2010** | **2017** |
|---|---|---|---|---|
| Population (Million) | 46.1 | 48.5 | 50.2 | 53.4 |
| Annual growth rate (%) | 1.2 | 0.9 | 0.7 | 0.9 |
| Broad age group (%) | | | | |
| 0-14 years | 32.1 | 30.9 | 30 | 26.8 |
| 15-64 years | 63 | 64.3 | 65.1 | 67.4 |
| 65+ years | 4.8 | 4.8 | 4.9 | 5.7 |
| Dependency ratio | 58.6 | 55.6 | 53.6 | 48.3 |

Source: Key Indicators for Asia and the Pacific 2018

According to the 'Myanmar Population and Housing census, 2014', Myanmar's total population was 51.5 million. The population of Myanmar increased at a rate of 0.89 percent per annum between 2003 and 2014. The population density is 76 persons per square kilometer. The distribution of the Myanmar population among age groups in 2014 describes those under 15 years is 28.6 percent, the population between 15 and 64 years is 65.6 percent, and the population 65 years and over is 5.8 percent of the population. The dependency ratio is 53 percent of the population.

Table (2.1) shows the summary measures of the demographic statistics of Myanmar. In Myanmar, the population was increased from 46.1(million) in 2000 to 53.49(million) in 2017, and the annual growth rate of the population was declined from 1.2% in 2000 to 0.9% in 2017. The population in the age group 15-64 years was increased from 63% in 2000 to 67.4 % in 2017. And then, the population in the age group 0 -14 years was decreased from 32.1% in 2000 to 26.8% in 2017, while the population in the age group 65 years and above was increased from 4.8% in 2000 to 5.7% in 2017. The dependency ratio was decreased from 58.6% in 2000 to 48.3% in 2017.

### 2.2.2 Thailand

Thailand locates between 29° 40' and 5° 40' North latitude and between 97° 30' and 105° 45' East latitudes. It is situated in Indochinese and Malayan peninsulas in Southeast Asia. In the North West the country is bordered by Myanmar, in the north Lao PDR and Cambodia in the East, and Malaysia in the south.

The Capital is Bangkok and area of the country is 515,115 square kilometer. The estimated population in 2017 is 67.7 million. The using language is Thai. Buddhism and Islam are the major religions. The currency is Bath.

Major industries are electronics, gems and jewelry, footwear, textiles. Major exports are textiles, computer and components, integrated circuit and jewelry, footwear. Major imports are industry machinery, iron and steel electrical machine chassis and body. Table (2.2) illustrates the summary measures of demographic statistics of Thailand.

**Table (2.2)**

**Summary Measures of Demographic Statistics of Thailand**

| Summary Measures | 2000 | 2005 | 2010 | 2017 |
|---|---|---|---|---|
| Population (Million) | 62.2 | 64.1 | 65.9 | 67.7 |
| Annual growth rate (%) | 1.1 | 0.6 | 0.6 | 0.4 |
| Broad age group (%) | | | | |
| 0-14 years | 24 | 21.3 | 19.2 | 17.3 |
| 15-64 years | 69.5 | 70.9 | 71.9 | 71.3 |
| 65+ years | 6.5 | 7.8 | 8.9 | 11.4 |
| Dependency ratio | 43.9 | 41 | 39.1 | 40.2 |

Source: Key indicators for Asia and Pacific 2018

Table (2.2) shows the summary measures of the demographic statistics of Thailand. In Thailand, the population was increased from 62.2(million) in 2000 to 67.7(million) in 2017, and the annual growth rate of the population was declined from 1.1% in 2000 to 0.4% in 2017. The population in the age group 15-64 years was increased from 69.5% in 2000 to 71.3% in 2017. And then, the population in the age group 0 -14 years was decreased from 24% in 2000 to 17.3% in 2017, while the population in the age group 65 years and above was increased from 6.5% in 2000 to 11.4% in 2017. The dependency ratio was decreased from 43.9% in 2000 to 40.2% in 2017.

### 2.2.3 China

China is situated between latitudes $18^{\circ}$ and 54′ North and longitudes $73^{\circ}$ and 135′ East, which is in Eastern Asia. Fourteen countries share boundaries with China. With a population of over 1390 million residents, the People’s Republic of China is the most densely populated nation in the world. The total area of China is 9641,821 square kilometers. In terms of land area, the People’s Republic of China is the second largest country in the world and in terms of total area, the fourth largest country in the world.

The using language is Mandarian. Religions are Buddhism, Muslims and Christians. Primary exports commodities are electrical and other machinery, including data processing equipment, apparel, ratio telephone handsets, textiles, integrated circuits. Primary imports commodities are electrical and other machinery, oil and mineral fuels, optical and medical equipment, metal ores, motor vehicles. Major industries are iron, steel, coal, machine building, textiles and apparel, oil, cement, chemical fertilizers. Table (2.3) illustrates the summary measures of demographic statistics of China.

**Table (2.3)**

**Summary Measures of Demographic Statistics of China**

| Summary Measures | 2000 | 2005 | 2010 | 2017 |
|---|---|---|---|---|
| Population (Million) | 1267.4 | 1307.6 | 1340.9 | 1390.1 |
| Annual growth rate (%) | 0.8 | 0.6 | 0.5 | 0.5 |
| Broad age group (%) | | | | |
| 0-14 years | 24.6 | 19.9 | 17.8 | 17.7 |
| 15-64 years | 68.5 | 72.4 | 73.8 | 71.7 |
| 65+ years | 6.9 | 7.7 | 8.4 | 10.6 |
| Dependency ratio | 46.1 | 38.1 | 35.6 | 39.5 |

Source: Key indicators for Asia and Pacific 2018

Table (2.3) shows the summary measures of the demographic statistics of China. In China, the population was increased from 1267.4(million) in 2000 to 1390.1(million) in 2017, and the annual growth rate of the population was declined from 0.8% in 2000 to 0.5% in 2017. The population in the age group 15-64 years was increased from 68.5% in 2000 to 71.7 % in 2017. And then, the population in the age group 0 -14 years was decreased from 24.6% in 2000 to 17.7% in 2017, while the population in the age group 65 years and above was increased from 6.9% in 2000 to 10.6% in 2017. The dependency ratio was decreased from 46.1% in 2000 to 39.5% in 2017.

### 2.2.4 India

India is located in Southeast Asia, bordering the Arabian Sean and the Bay of Bengal between latitudes $8^{\circ} 4'$ and $37^{\circ} 6'$ north and longitudes $68^{\circ} 7'$ and $97^{\circ} 25'$ east. The estimated population in 2017 is 1316 million. India is the second most population country in the world. New Delhi is the capital city of India.

The official language is Hindu and English. Religions are Hindu, Muslim, Christian and Sikh. It is situated in Pakistan on West, China, Nepal, Bhutan on North; Myanmar, Bangladesh on East. Major industries are textiles, Chemicals, food product, steel, transportation, equipment, oil, cement, mining, machinery, software. Table (2.4) illustrates the summary measures of demographic statistics of India.

**Table (2.4)**

**Summary Measures of Demographic Statistics of India**

| Summary Measures | 2000 | 2005 | 2010 | 2017 |
|---|---|---|---|---|
| Population (Million) | 1019 | 1106 | 1186 | 1316 |
| Annual growth rate (%) | 1.8 | 1.5 | 1.4 | 1.3 |
| Broad age group (%) | | | | |
| 0-14 years | 34.7 | 32.8 | 30.9 | 27.8 |
| 15-64 years | 60.9 | 62.4 | 64 | 66.2 |
| 65+ YEARS | 4.4 | 4.8 | 5.1 | 6 |
| Dependency ratio | 64.3 | 60.1 | 56.3 | 51 |

Source: Key Indicators for Asia and the Pacific 2018

Table (2.4) shows the summary measures of the demographic statistics of India. In China, the population was increased from 1019(million) in 2000 to 13161(million) in 2017, and the annual growth rate of the population was declined from 1.8% in 2000 to 1.3% in 2017. The population in the age group 15-64 years was increased from 60.9% in 2000 to 66.2 % in 2017. And then, the population in the age group 0 -14 years was decreased from 34.7% in 2000 to 27.8% in 2017, while the population in the age group 65 years and above was increased from 4.4% in 2000 to 6% in 2017. The dependency ratio was decreased from 64.3% in 2000 to 51% in 2017.

### 2.2.5 Bangladesh

Bangladesh lies in the north eastern part of South Asia between $20^{\circ} 34'$ and $26^{\circ} 38'$ north latitude and $88^{\circ} 01'$ and $92^{\circ} 41'$ east longitude. The country is bounded by India on the west, north and north-west while Myanmar on the south-east and the Bay of Bengal on the south. The area of the country is 56,977 square miles or 14,570 square kilometer.

Dhaka is the capital and the largest metropolitan city of the country. The estimated population of Bangladesh is 162.7 million in 2017. It is one of the ten most populous countries in the world. Bangladesh is predominantly an agriculture country a large number of large scale industries based on both indigenous and imported raw materials have been set up. Table (2.6) illustrates the summary measures of demographic statistics of Bangladesh.

**Table (2.5)**

**Summary Measures of Demographic Statistics of Bangladesh**

| Summary Measures | 2000 | 2005 | 2010 | 2017 |
|---|---|---|---|---|
| Population (Million) | 129.3 | 138.6 | 148.6 | 162.7 |
| Annual growth rate (%) | 1.4 | 1.4 | 1.3 | 1.2 |
| Broad age group (%) | | | | |
| 0-14 years | 37.1 | 34.4 | 32.1 | 28.4 |
| 15-64 years | 59.1 | 61.3 | 63.2 | 66.5 |
| 65+ YEARS | 3.8 | 4.3 | 4.7 | 5.1 |
| Dependency ratio | 69.2 | 63.1 | 58.2 | 50.3 |

Source: Key indicators for Asia and Pacific 2018

Table (2.5) shows the summary measures of the demographic statistics of Bangladesh. In Bangladesh, the population was increased from 129.3(million) in 2000 to 162.7(million) in 2017, and the annual growth rate of the population was declined from 1.4% in 2000 to 1.2% in 2017. The population in the age group 15-64 years was increased from 59.1% in 2000 to 66.5 % in 2017. And then, the population in the age group 0 -14 years was decreased from 37.1% in 2000 to 28.4% in 2017, while the population in the age group 65 years and above was increased from 3.8% in 2000 to 5.1% in 2017. The dependency ratio was decreased from 69.2% in 2000 to 50.3% in 2017.

# CHAPTER III
# RESEARCH METHODOLOGY

## 3.1 Sources of Data

The under-five mortality rate was obtained from ADB Basic Statistics and World Bank Database in 2003 to 2017. However, ADB Basic Statistics do not mentioned 2014 data on under-five mortality rate, so it is replaced by the World Bank Database.

## 3.2 Different Types of Models

The four common models such as Linear, Quadratic, Cubic and Exponential were used to choose the suitable trend model for under five mortality rate of Myanmar and neighbouring countries. The types of models, models equation, meaning and assumptions are expressed in Table (3.1).

**Table (3.1)**

**Types of Models**

| **Sr.** | **Name of the model** | **Models Equation** | **Meanings** |
|---|---|---|---|
| 1 | Linear | $Y_t = a_0 + a_1 t + e_t$ | $Y_t$ is the values of time series in period t.<br>t represents time taking integer values starting from 1. (t = 1, 2, 3, …, n )<br>n is the number of time periods.<br>$a_0, a_1, a_2$ and $a_3$ are the coefficients of the models.<br>$e_t$ is the error term.<br>E($e_t$) = 0, zero mean<br>E($e_t{}^2$) = $\sigma^2$, constant variance<br>E ($e_t$, $X_t$) = 0, no correlation with X<br>$e_t$~ Normally distributed |
| 2 | Quadratic | $Y_t = a_0 + a_1 t + a_2 t^2 + e_t$ | |
| 3 | Cubic | $Y_t = a_0 + a_1 t + a_2 t^2 + a_3 t^3 + e_t$ | |
| 4 | Exponential | $Y_t = a_0 e^{a_1 t + e_t}$ | |

### 3.3 F- test for the Significance of the Model

The ANOVA procedure measures the amount of variation in the model. There are three sources of variation in the model: variation explained by model (MSS), variation unexplained due to error (ESS) and the total variation (TSS). These can be summarized in ANOVA table; the general form of table is shown in Table (3.2).

Step (1) State the null and alternative hypotheses:

$H_0$: $a_1 = a_2 = \cdots = a_k = 0$

$H_1$: At least one $a_i$ is not equal to zero

Step (2) Compute the test statistics.

$$F = \frac{MSM}{MSE}$$

Step (3) Find the critical value.

Step (4) Decision Rule.

If test value is greater than critical value, reject the null hypothesis. Otherwise accept the null hypothesis.

OR

If p-value is less than the level of significance, reject the null hypothesis. Otherwise, accept the null hypothesis.

Step (5) Make the decision by comparing test value and critical value.

Step (6) Summarize the result and interpretation.

**Table (3.2)**

**Analysis of Variance (ANOVA) Table**

| **Source of variation** | **Sum of square** | **Degree of freedom** | **Mean square** | **F-value** |
|---|---|---|---|---|
| Model | MSS | K | MSM | F |
| Error | ESS | n-k-1 | MSE | |
| Total | TSS | n-1 | | |

Where:

TSS = Total sum of square

TSS = $\sum(Y_t - \bar{Y})^2$

MSS = Model sum of squares

ESS = $\sum\left(Y_t - \hat{Y}\right)^2$

n = Number of sample size

k = Number of parameters

MSM = Mean squares of Model = $\frac{MSS}{k}$

MSE = Mean square error = $\frac{ESS}{n-k-1}$

## 3.4 Testing the Coefficients of the Significance of the Model

Testing each coefficient determine which one is significant. There are six steps to test the coefficients of the model.

Step (1) State the null and alternative hypotheses.

$H_0$: $a_i = 0$

$H_1$: $a_i \neq 0$

Step (2) Compute the test statistics.

$$t = \frac{\hat{a}_i - a_i}{s_{a_i}}$$

Step (3) Find the critical value.

Step (4) Decision Rule.

If test value is greater than critical value, reject the null hypothesis.

Otherwise, accept the null hypothesis.

OR

If p-value is less than the level of significance, reject the null hypothesis.

Step (5) Make the decision

Step (6) Conclusion and Interpretation the result.

### 3.5 Coefficient of Determination ($R^2$)

The coefficient of determination, proposed by Theil (1961), is the ratio of the model sum of square to the total sum of square.

$$R^2 = \frac{Model\ sum\ of\ squares}{Total\ sum\ of\ squares} = \frac{MSS}{TSS} = 1 - \frac{ESS}{TSS}$$

In interpreting $R^2$, it is generally considered that the more the value of $R^2$, the better is the fit. But there are some limitations in interpreting it in this way. One of the more objections is that $R^2$ can overstate the value of a model fit since the error sum of squares (ESS) can be reduced simply by adding further explanatory variables even, if they are not relevant to explaining the dependent variable.

### 3.6 Adjusted Coefficient of Determination ($\bar{R}^2$)

An alternative $R^2$, denoted by $\bar{R}^2$, which is adjusted for the degree of freedom associated with model and total sum of squares, is defined as

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

where n is the number of observation and k is the number of parameters to be estimated. It is to be noted that in some cases particularly for bad fit $\bar{R}^2$ can be negative and it does not exist when the number of observations is less than or equal to the number of parameter to be estimated. Granger and Newbold (1986), Johnston and some other econometricians recommended this alternative. The grater the value of this criterion, the more is the accuracy of the model.

### 3.7 Errors in Forecasting

All forecasting situations involve some degree of uncertainty. This means that inclusion of irregular component in the description of a time series. The presence of this irregular component, which represents unexplained or unpredictable fluctuations in the data, means that some error in forecasting must be expected. If the effect of the irregular component is substantial, the forecast accurately will be limited. If, however, the effect of the irregular component is small, determination of the appropriate trend should allow forecasting with more accuracy.

The irregular component is not the only source of errors in forecasting. The accuracy with the other components of a time series also influences the magnitude of error in the forecasts. Since these components cannot be perfectly predicted in a practical situation, the errors in forecasting represent the combined effects of the irregular component and the accuracy with the forecasting technique can predict trend. Hence, large forecasting errors may indicate that the irregular component is so large that no forecasting technique will produce accurate forecasts, or these may indicate that forecasting technique is not capable of accurately predicting the trend, and therefore, that the technique is inappropriate.

#### 3.7.1 Measuring Forecast Error

The actual value of the variable of interest in time period t as $y_t$, and the predicted value as $\widehat{y_t}$ are denoted. Then the predicted value of $y_t$ can be subtracted from the actual value $y_t$ to obtain the forecast error $e_t$ . That is, the forecast error for a particular forecast $\widehat{y_t}$ is

$$e_t = y_t - \widehat{y_t} \qquad (3.1)$$

An examination of forecast errors over time can often indicate whether the forecasting technique does not or does not match this pattern. If a forecasting technique is accurately forecasting the trend that is present in a time series, the forecast errors should reflect only the irregular component. In such a case, the forecast errors should appear purely random.

If the forecasting errors overtime indicate that the forecasting methodology is appropriate, it is important to measure the magnitude of the errors so that determination of accurate forecasting is possible. In order to do this, one might consider the sum of all forecast errors over time. That is, one might calculate

$$\sum_{t}^{n}( y_t - \hat{y_t} ) \quad (3.2)$$

However, this quality is not used because if the errors display a random pattern, some errors will be positive while other errors will be negative, and the sum of the forecast errors will be near regardless of the size of the errors. That is, the positive and negative errors, no matter how large or small, will cancel each other out. One way to solve this problem is to consider the absolute values of the forecasting errors. These absolute values are called the absolute deviations.

$$\text{Absolute deviation} = |e_t| = |y_t - \hat{y_t}| \quad (3.3)$$

Another way to prevent positive and negative forecast errors from cancelling each other is square the forecast errors. These squares are called the squared errors:

$$\text{Square error} = ( e_t ) = ( y_t - \hat{y_t} )^2 \quad (3.4)$$

Given the squared errors, the Mean Squared error (MSE) can be defined.

$$MSE = \frac{\sum(e_t{}^2)}{n}$$

where, $e_t$ is the error, which is the difference between the actual value and the estimated value, $n$ is the sample size. The MSE is always non-negative and its values closer to zero are better.

# CHAPTER IV
# ANALYSIS OF UNDER-FIVE MORTALITY RATES IN MYANMAR AND SOME NEIGHBOURING COUNTRIES

## 4.1 A Comparison of Under-Five Mortality Rates for Myanmar and Some Neighbouring Countries

Under five Mortality is a key indicator not only of child health and nutrition but also of the implementation of child survival inventions and, more broadly, of social and economic development. The most common used definition of child mortality is ‘ the number of children dying between one and four completed years of age, per 1,000 live births.

The under-five mortality is the best indicator of childhood mortality because it reflects mortality risk during the most vulnerable years of childhood and it is the end result of a variety of inputs. The nutrition and knowledge of caregivers, the availability of appropriate maternal and child health services, the availability of clean water and sanitation, family income and the safety of the environment are needed for determining the level of development. Child mortality in urban area is smaller than rural areas. This variation is occurred due to unequal distribution of socio-economic factors and health facilities, for example in rural area the distribution of health resource is more likely limited than urban areas because of the lack of modernization and limited health facilities, rural areas are expected to have higher risk of child mortality.

Moreover, developing countries have more deaths in children under-five than in developed countries. There are several characteristics that are commonly held throughout developing countries. This includes health risks such as having low access to safe water, as well as sanitation and hygiene problems. There may also be high levels of pollution and a high percentage of people with infectious diseases. Other common characteristics include widespread poverty, low education and literacy levels and government corruption. There are also challenges in energy and higher rates of violence against women.

A developed country is defined as a sovereign state that has a developed economy and technologically advanced infrastructure when compared to other nations. Several factors that determine whether or not a country is developed, such as the Human Development Index, political stability, gross domestic product (GDP), industrialization and freedom. A developing country is also known as an LMIC, or a low and middle income country. It is less developed than countries classified as "developed countries" but these nations are ranked higher than "less economically developed countries." These countries are characterized by being less developed industrially and a lower Human Development Index when compared to other countries. This paper comprised five countries: China, India, Bangladesh, Myanmar and Thailand. As of World Population Review 2019, the developed country is China and the rest countries are developing countries.Table (4.1) illustrates the under-five mortality of Myanmar and some countries for the year 2003 to 2017.

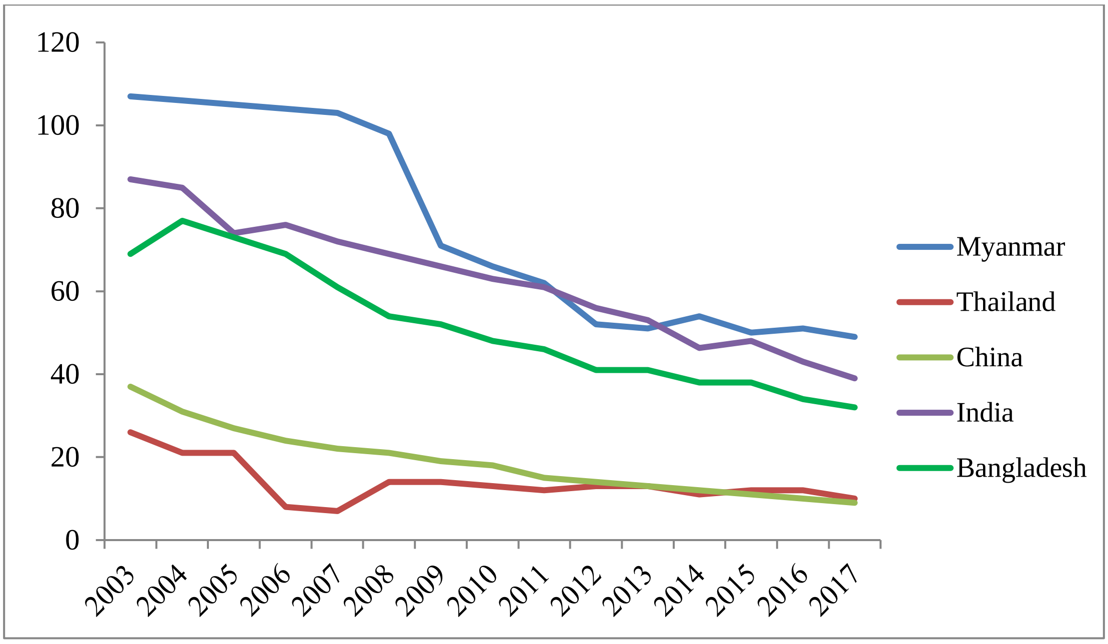
**Table (4.1)**
**Under-Five Mortality Rates (U5MR) for Myanmar and Some Neighbouring Countries (2003-2017)**

| Year | U5MR per 1000 live-births | | | | |
|---|---|---|---|---|---|
| | Myanmar | Thailand | China | India | Bangladesh |
| 2003 | 107 | 26 | 37 | 87 | 69 |
| 2004 | 106 | 21 | 31 | 85 | 77 |
| 2005 | 105 | 21 | 27 | 74 | 73 |
| 2006 | 104 | 8 | 24 | 76 | 69 |
| 2007 | 103 | 7 | 22 | 72 | 61 |
| 2008 | 98 | 14 | 21 | 69 | 54 |
| 2009 | 71 | 14 | 19 | 66 | 52 |
| 2010 | 66 | 13 | 18 | 63 | 48 |
| 2011 | 62 | 12 | 15 | 61 | 46 |
| 2012 | 52 | 13 | 14 | 56 | 41 |
| 2013 | 51 | 13 | 13 | 53 | 41 |
| 2014 | 54 | 11 | 12 | 46 | 38 |
| 2015 | 50 | 12 | 11 | 48 | 38 |
| 2016 | 51 | 12 | 10 | 43 | 34 |
| 2017 | 49 | 10 | 9 | 39 | 32 |

Source: ADB Basic Statistics, World Bank Database

**Figure (4.1)**

**Under-Five Mortality Rates (U5MR) for Myanmar and Some Neighbouring Countries (2003-2017)**




Source: ADB Basic Statistics, World Bank Database

Table (4.1) and Figure (4.1) show the under five mortality rate of China from 2003 to 2017. In 2003, the under five mortality of China was 37 deaths per 1000 live births. But in 2017, the under five mortality of China was 9 deaths per 1000 live births. The under five mortality rate dramtically declined from 37 per 1,000 live births in 2003, to 9 per 1,000 live births in 2017. The Chinese Government has worked continuously to provide health care services for children and improve children's health, and has made obvious progress.China has made considerable progress towards successfully accomplishing the Millennium Development Goals .

Further, Table (4.1) and Figure (4.1) also show the under five mortality rate of Myanmar, Thailand, India and Bangladesh from 2003 to 2017. In 2003, the highest under five mortality rate can be seen in Myanmar and the lowest under five mortality rate can be seen in Thailand. But in 2017, the highest under five mortality rate can be seen in Myanmar and the lowest under five mortality rate can be seen in Thailand.The under-five mortality rates in Myanmar were high in 2003, which decreased gradually overtime to about 49 per 1,000 live births in 2017. Generally, the under five mortality rates have declined year by year when compared to annual data in Myanmar and some neighbouring countries.

## 4.2 Fitting the Appropriate Model for Under-Five Mortality Rates of Myanmar

The four common models considered for this study are estimated for the under-five mortality rates in Myanmar during 2003 to 2017 and shown in Table (4.2).

**Table (4.2)**

**Results from Trend Analysis of Under-Five Mortality Rates of Myanmar**

| Model | Coefficient | | | | Std. Error | F | $R^2$ | $\bar{R}^2$ |
|---|---|---|---|---|---|---|---|---|
| | Constant | $a_1$ | $a_2$ | $a_3$ | | | | |
| Linear | 117.229 (0.000) | -5.249 (0.000) | | | 8.905 | 97.277 (0.000) | 0.882 | 0.873 |
| Quadratic | 125.409 (0.000) | -8.136 (0.003) | 0.180 (0.205) | | 8.643 | 52.523 (0.000) | 0.897 | 0.880 |
| Cubic | 102.208 (0.000) | 6.896 (0.128) | -2.094 (0.005) | 0.095 (0.003) | 5.892 | 80.279 (0.000) | 0.956 | 0.944 |
| Exponential | 125.542 (0.000) | -0.070 (0.000) | | | 0.110 | 114.162 (0.000) | 0.898 | 0.890 |

Note: The figures in the parentheses are p values.

Source: Based on calculation

According to the result of Table (4.2), all the models considered for this study are estimated for under-five mortality in Myanmar during the period of 2003 to 2017. The value of F statistics for Linear model was 97.277 and the model was significant at 1% level with p-value was 0.000. And, the coefficient of determination $R^2$ value was 0.882 and this model can explain 88.2% for under-five mortality rate. The standard error of this model was 8.905. Moreover, all of the coefficients of the Linear model were significant at 1% level, the value of F statistics for the Quadratic model was 52.5230 and the model was significant at 1% level with p-value was 0.000. And, the coefficient of determination $R^2$ value was 0.897 and this model can explain 89.7% for under-five mortality rate. The standard error of this model was 8.643. Although the coefficient $(a_2)$ of the Quadratic model was insignificant, other coefficients were significant at 1% level, the value of F statistics for the Cubic model was 80.279 and the model was significant at 1% level with p-value was 0.000. And, the coefficient of determination $R^2$ value was 0.956 and this model can explain 95.6% for under-five mortality rate. The standard error of this model was 5.892. Although, the coefficient $(a_1)$ of the Cubic model was insignificant, other coefficients were significant at 1% level, the value of F statistics for the Exponential model was 114.162 and the model was significant at 1% level with p-value was 0.000. And, the coefficient of determination $R^2$ value was 0.898 and this model can explain 89.8% .The standard error of this model was 0.110. All of the coefficients of the Exponential model were significant at 1% level. The analysis shows that the Linear and Exponential model are appropriate models and Quadratic and Cubic models are not suitable models for under-five mortality of Myanmar. Moreover, measuring the errors appeared that the value of MSE for the Linear model was 68.7197 and the value of MSE for the Exponential model was 63.2685. Thus, the Exponential model which has a minimum MSE was the most appropriate to forecast the under-five mortality for Myanmar.

The estimated exponential model is

$$\widehat{Y_t} = a_0 e^{a_1 t}$$
$$= 125.542\ e^{-0.070t}$$

### 4.2.1 Estimated Values and 95% Confidence Interval for the Under-five Mortality of Myanmar

The observed values, estimated values and 95% confidence intervals for Under-five mortality rates from 2003 to 2017 were shown in Table (4.3) and Figure (4.2).

**Table (4.3)**

**The Observed Value and Estimated Value by the Exponential Model (2003-2017)**

| Year | Observed value | Estimated Value | 95% Confidence Interval |
|---|---|---|---|
| 2003 | 107 | 117 | 90, 153 |
| 2004 | 106 | 109 | 84, 142 |
| 2005 | 105 | 102 | 79, 131 |
| 2006 | 104 | 95 | 74, 122 |
| 2007 | 103 | 88 | 69, 113 |
| 2008 | 98 | 82 | 64, 105 |
| 2009 | 71 | 77 | 60, 98 |
| 2010 | 66 | 71 | 56, 91 |
| 2011 | 62 | 67 | 52, 85 |
| 2012 | 52 | 62 | 48, 80 |
| 2013 | 51 | 58 | 45, 74 |
| 2014 | 54 | 54 | 42, 69 |
| 2015 | 50 | 50 | 39, 65 |
| 2016 | 51 | 47 | 36, 61 |
| 2017 | 49 | 44 | 33, 57 |

Source: Based on calculation

In Table (4.3), the estimated values of the under-five mortality rates for years 2005, 2006, 2007, 2008, 2012, 2016, and 2017 under-estimated and for years 2003, 2004, 2009, 2010, 2011, and 2013 over-estimated by the review back on the observed values of Myanmar. And the actual and the estimated values for years 2014 and 2015 were the same. But, all the estimated values of the under-five mortality rate lie between 95% lower confidence limit and upper confidence limit.

**Figure (4.2)**

**Actual and Fitted Value for Under-Five Mortality in Myanmar of Exponential Trend Model**

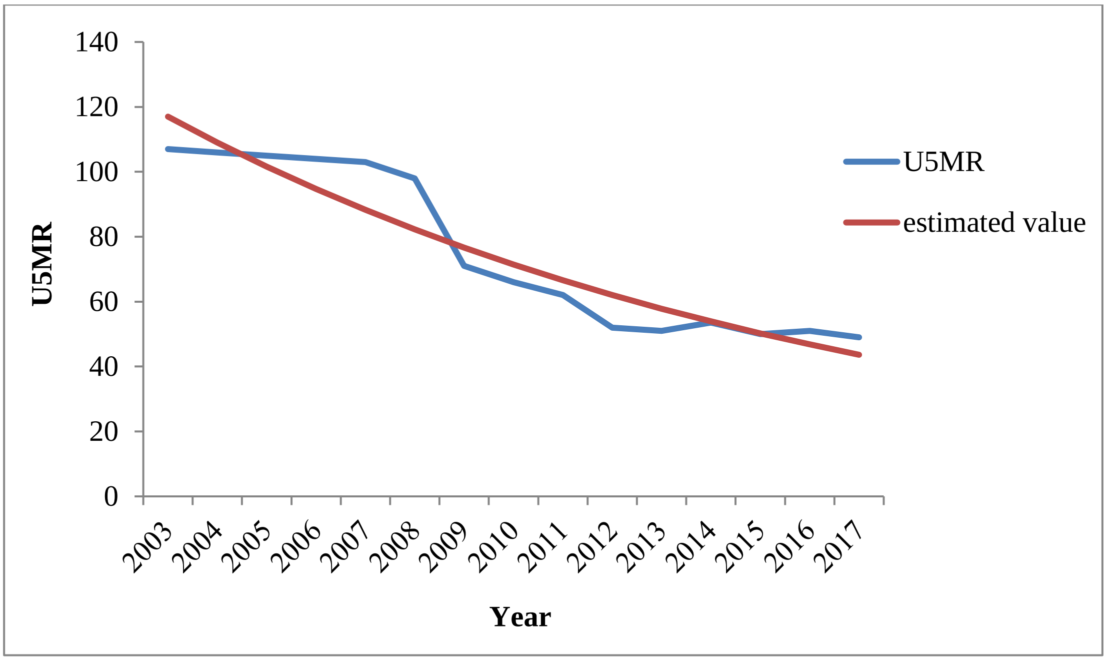



Figure (4.2) shows the plot of the observed time-series data from 2003 to 2017, which was fitted by the Exponential trend model. The figure shows that the under-five mortality rate in Myanmar occurred a downward trend. The under-five mortality rates are a slightly decreasing trend during the period 2003-2008 and but were highly decreased during the period 2009-2013. After that, the under-five mortality rates are increased in 2014 and are slightly decreased during the period 2015-2017. So, the series is fluctuated and decreasing over 15 years. Based on these results, it can be assumed that the under-five mortality rate in Myanmar will be decreased in the future.

### 4.2.2 Forecast with Exponential Trend Model for Under-Five Mortality Rates in Myanmar

The forecast values of under-five mortality rates from 2018 to 2021 using the exponential trend model were shown in Table (4.4).

**Table (4.4)**

**Forecast Values with 95% Confidence Intervals for Under-Five Mortality Rates (2018-2021)**

| Year | Forecast Values | Lower Limit | Upper Limit |
|---|---|---|---|
| 2018 | 40.66 | 30.99 | 53.33 |
| 2019 | 37.89 | 28.71 | 50.02 |
| 2020 | 35.32 | 26.57 | 46.94 |
| 2021 | 32.91 | 24.58 | 44.07 |

Source: Based on calculation

In Table (4.4) ,the four’s year forecast values lie between 95% lower confidence limit and upper confidence limit. It found that the under-five mortality rate of Myanmar was decreased little by little from 40.66 in 2018 to 32.91 in 2021.Therefore, the estimated values of under-five mortality rate in Myanmar will decrease in the future.

### 4.3 Fitting the Appropriate Model for Under-Five Mortality Rates of Thailand

The four common models considered for this study are estimated for under-five mortality rates in Thailand during 2003 to 2017 and shown in Table (4.5).

**Table (4.5)**

**Results from Trend Analysis of Under-Five Mortality Rates of Thailand**

| Model | Coefficient | | | | Std Error | F | $R^2$ | $\bar{R}^2$ |
|---|---|---|---|---|---|---|---|---|
| | Constant | $a_1$ | $a_2$ | $a_3$ | | | | |
| Linear | 19.086 (0.000) | -0.661 (0.024) | | | 4.334 | 6.508 (0.024) | 0.334 | 0.578 |
| Quadratic | 24.921 (0.000) | -2.720 (0.017) | 0.129 (0.052) | | 3.828 | 6.504 (0.012) | 0.520 | 0.440 |
| Cubic | 33.613 (0.000) | -8.352 (0.003) | 0.981 (0.009) | -0.036 (0.018) | 3.069 | 9.302 (0.002) | 0.717 | 0.640 |
| Exponential | 17.338 (0.000) | -0.036 (0.084) | | | 0.320 | 3.507 (0.084) | 0.212 | 0.152 |

Note: The figures in the parentheses are p values.

Source: Based on calculation

According to the result of Table (4.5), all the models considered for this study are estimated for under-five mortality in Thailand during the period of 2003 to 2017. The value of F statistics for Linear model was 6.508 and the model was significant at 5% level with p-value was 0.024. And, the coefficient of determination $R^2$ value was 0.334 and this model can explain 33.4% for under-five mortality rate. The standard error of this model was 4.334. Moreover, the coefficients $(a_1)$ of the Linear model was significant at 5% level and other coefficient was significant at 1% level, the value of F statistics for the Quadratic model was 6.504 and the model was significant at 5% level with p-value was 0.012. And, the coefficient of determination $R^2$ value was 0.520 and this model can explain 52% for under-five mortality rate. The standard error of this model was 3.828. Moreover, the coefficients of the Quadratic model $(a_1)$ was significant at 5% level and $(a_2)$ was significant at 10% level, other coefficient was significant at 1% level, the value of F statistics for the Cubic model was 9.302 and the model was significant at 1% level with p-value was 0.002. And, the coefficient of determination $R^2$ value was 0.717 and this model can explain 71.7% for under-five mortality rate. The standard error of this model was 3.069. And then, the coefficient ($a_3$) of the Cubic model was significant at 5% level, other coefficients were significant at 1% level, the value of F statistics for the Exponential model was 3.507 and the model was significant at 10% level with p-value was 0.084. And, the coefficient of determination $R^2$ value was 0.212 and this model can explain 21.2% for the under-five mortality rate .The standard error of this model was 0.320. And, the coefficients of the Exponential model ($a_1$) was significant at 10% level and other coefficient was significant at 1% level. The analysis shows that the Linear, Quadratic, Cubic and Exponential models are appropriate models for under-five mortality of Thailand. Moreover, measuring the errors appeared that the value of MSE for the Linear model was 16.278, the Quadratic model was 11.721, the Cubic model was 6.9064, the Exponential model was 16.748. Thus, the Cubic model which has a minimum MSE was the most appropriate to forecast the under-five mortality for Thailand.

The estimated cubic model is

$$\widehat{Y}_t = a_0 + a_1 t + a_2 t^2 + a_3 t^3$$

$$= 33.613 - 8.352\,t + 0.981t^2 - 0.036t^3$$

### 4.3.1 Estimated Values and 95% Confidence Interval for the Under-five Mortality of Thailand

The observed values, estimated values and 95% confidence intervals for Under-five mortality rates from 2003 to 2017 were shown in Table (4.6) and Figure (4.3).

**Table (4.6)**

**The Observed Value and Estimated Value by the Cubic Model (2003-2017)**

| Year | Observed Value | Estimated Value | 95% Confidence Interval |
|---|---|---|---|
| 2003 | 26 | 26.21 | 17.47, 34.94 |
| 2004 | 21 | 20.55 | 12.93, 28.17 |
| 2005 | 21 | 16.43 | 9.04, 23.82 |
| 2006 | 8 | 13.63 | 6.20, 21.06 |
| 2007 | 7 | 11.94 | 4.49, 19.38 |
| 2008 | 14 | 11.15 | 3.77, 18.52 |
| 2009 | 14 | 11.04 | 3.75, 18.32 |
| 2010 | 13 | 11.40 | 4.15, 18.64 |
| 2011 | 12 | 12.02 | 4.73, 19.30 |
| 2012 | 13 | 12.68 | 5.30, 20.06 |
| 2013 | 13 | 13.17 | 5.73, 20.62 |
| 2014 | 11 | 13.29 | 5.85, 20.72 |
| 2015 | 12 | 12.80 | 5.41, 20.19 |
| 2016 | 12 | 11.51 | 3.89, 19.13 |
| 2017 | 10 | 9.20 | 0.47, 17.94 |

Source: Based on calculation

In Table (4.6), the estimated values of the under-five mortality rates for years 2004, 2005, 2008, 2009, 2010, 2012, 2016 and 2017 underestimated and for years 2003, 2006, 2007, 2011, 2013, 2014 and 2015 overestimated by the review back on the observed values of Thailand. But, all the estimated values of the under-five mortality rate lie between 95% lower confidence limit and upper confidence limit.

**Figure (4.3)**

**Actual and Fitted Value for Under-Five Mortality Rates in Thailand of Cubic Trend Model**

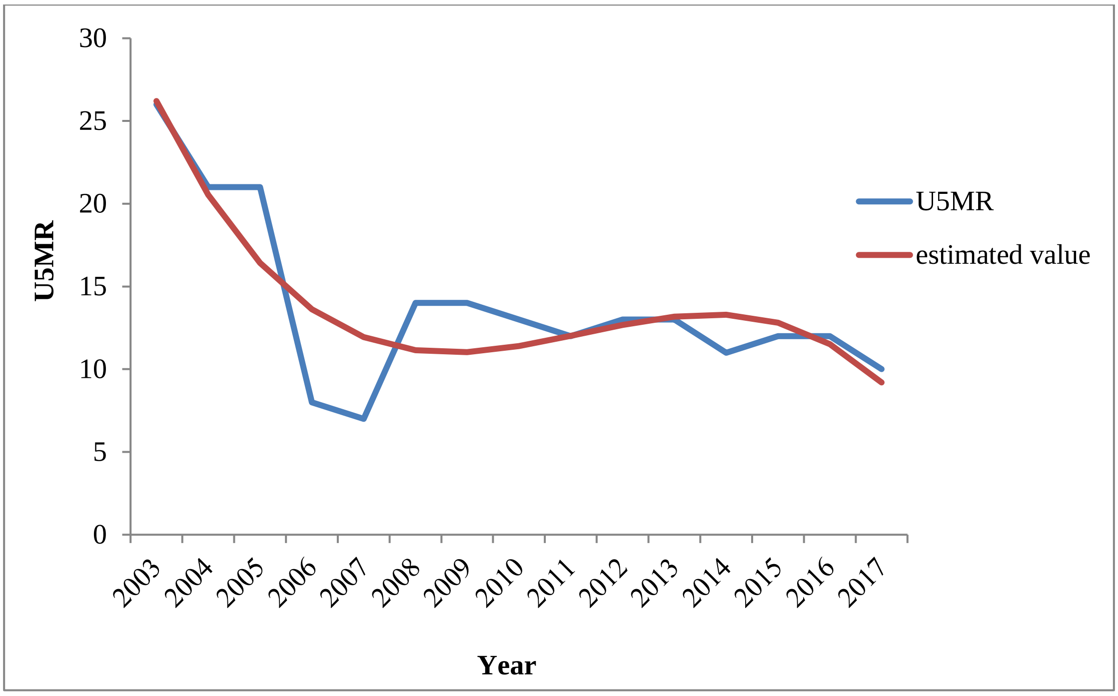



Figure (4.3) shows the plot of the observed time series data from 2003 to 2017, which was fitted by the Cubic trend model. The figure shows that the under-five mortality rate in Thailand occurs a downward trend. The under-five mortality rates are a slightly decreased during the period 2003-2005. Obviously, the under-five mortality rates showed an exceedingly decreasing trend from the period 2006 to 2007 and are highly increased in 2008. The under-five mortality rates are slightly decreased after the period 2008. Based on these results, it can be assumed that the under-five mortality rate in Thailand will be decreased in the future.

### 4.3.2 Forecast with Cubic Trend Model for Under-Five Mortality Rates in Thailand

The forecast values of under-five mortality rates from 2018 to 2021 using the cubic trend model were shown in Table (4.7).

**Table (4.7)**

**Forecast Values with 95% Confidence Intervals for Under-Five Mortality Rates (2018-2021)**

| Year | Forecast Values | Lower Limit | Upper Limit |
|---|---|---|---|
| 2018 | 5.66 | -5.72 | 17.03 |
| 2019 | 0.67 | -15.18 | 16.51 |
| 2020 | -5.99 | -28.15 | 16.18 |
| 2021 | -14.51 | -44.90 | 15.88 |

Source: Based on calculation

In Table (4.7), the four's year forecast values lie between 95% lower confidence limit and upper confidence limit. It found that the under-five mortality rate of Thailand was decreased little by little from 5.66 in 2018 to -14.51 in 2021. Therefore, the estimated values of under-five mortality rate in Thailand will decrease in the future.

## 4.4 Fitting the Appropriate Model for Under-Five Mortality of China

The four common models considered for this study are estimated for under-five mortality in China during 2003 to 2017 and shown in Table (4.8).

**Table (4.8)**

**Results from Trend Analysis of Under-Five Mortality Rates of China**

| Model | coefficient | | | | Std Error | F | $R^2$ | $\bar{R}^2$ |
|---|---|---|---|---|---|---|---|---|
| | Constant | $a_1$ | $a_2$ | $a_3$ | | | | |
| Linear | 32.839 (0.000) | -1.729 (0.024) | | | 2.350 | 151.680 (0.000) | 0.921 | 0.915 |
| Quadratic | 38.141 (0.000) | -3.601 (0.000) | 0.117 (0.000) | | 1.130 | 349.812 (0.000) | 0.983 | 0.980 |
| Cubic | 41.147 (0.000) | -5.548 (0.000) | 0.412 (0.000) | -0.012 (0.003) | 0.780 | 494.595 (0.000) | 0.993 | 0.991 |
| Exponential | 36.421 (0.000) | -0.091 (0.000) | | | 0.047 | 1049.166 (0.000) | 0.988 | 0.987 |

Note: The figures in the parentheses are p values.

Source: Based on calculation

According to the result of Table (4.8), all the models considered for this study are estimated for under-five mortality in China during the period of 2003 to 2017. The value of F statistics for Linear model was 151.680 and the model was significant at 1% level with p-value was 0.000. And, the coefficient of determination $R^2$ value was 0.921 and this model can explain 92.1% for under-five mortality rate. The standard error of this model was 2.350. Moreover, all of the coefficients of the Linear model were significant at 1% level, the value of F statistics for the Quadratic model was 349.812 and the model was significant at 1% level with p-value was 0.000. And, the coefficient of determination $R^2$ value was 0.983 and this model can explain 98.3% for under-five mortality rate. The standard error of this model was 1.130. Moreover, all of the coefficients of the Quadratic model were significant at 1% level, the value of F statistics for the Cubic model was 494.595 and the model was significant at 1% level with p-value was 0.000. And, the coefficient of determination $R^2$ value was 0.993 and this model can explain 99.3% for under-five mortality rate. The standard error of this model was 0.780. Moreover, all of the coefficients of the Cubic model were significant at 1% level, the value of F statistics for the Exponential model was 1049.166 and the model was significant at 1% level with p-value was 0.000. And, the coefficient of determination $R^2$ value was 0.988 and this model can explain 98.8% for the under-five mortality rate .The standard error of this model was 0.047. And, all of the coefficients of the Exponential model were significant at 1% level. The analysis shows that the Linear, Quadratic, Cubic and Exponential models are appropriate models for under-five mortality of China. Moreover, measuring the errors appeared that the value of MSE for the Linear model was 4.784, the Quadratic model was 1.022, the Cubic model was 0.446, the Exponential model was 1.344. Thus, the Cubic model which has a minimum MSE was the most appropriate to forecast the under-five mortality for China.

The estimated cubic model is

$$\widehat{Y_t} = a_0 + a_1 t + a_2 t^2 + a_3 t^3$$

$$= 41.147 - 5.548t + 0.412\, t^2 - 0.012\, t^3$$

### 4.4.1 Estimated Values and 95% Confidence Interval for the Under-five Mortality of China

The observed values, estimated values and 95% confidence intervals for Under-five mortality rates from 2003 to 2017 were shown in Table (4.9) and Figure (4.4).

**Table (4.9)**

**The Observed Value and Estimated Value by the Cubic Model (2003-2017)**

| Year | Observed value | Estimated Value | Confidences Interval |
|---|---|---|---|
| 2003 | 37 | 36.0 | 33.8, 38.2 |
| 2004 | 31 | 31.6 | 29.7, 33.5 |
| 2005 | 27 | 27.9 | 26.0, 29.8 |
| 2006 | 24 | 24.8 | 22.9, 26.6 |
| 2007 | 22 | 22.2 | 20.3, 24.1 |
| 2008 | 21 | 20.0 | 18.2, 21.9 |
| 2009 | 19 | 18.3 | 16.4, 20.1 |
| 2010 | 18 | 16.8 | 15.0, 18.7 |
| 2011 | 15 | 15.6 | 13.8, 17.5 |
| 2012 | 14 | 14.6 | 12.7, 16.4 |
| 2013 | 13 | 13.6 | 11.7, 15.5 |
| 2014 | 12 | 12.6 | 10.7, 14.5 |
| 2015 | 11 | 11.6 | 9.7, 13.5 |
| 2016 | 10 | 10.5 | 8.5, 12.4 |
| 2017 | 9 | 9.1 | 6.9, 11.3 |

Source: Based on calculation

In Table (4.9), the estimated values of the under-five mortality rates for years 2003, 2008, 2009, and 2010 underestimated and for years 2004, 2005, 2006, 2007, 2011, 2012, 2013, 2014, 2015, 2016 and 2017 overestimated by the review back on the observed values in China. But, all the estimated values of the under-five mortality rate lie between 95% lower confidence limit and upper confidence limit.

**Figure (4.4)**

**Actual and Fitted Value for Under-Five Mortality in China of Cubic Trend Model**

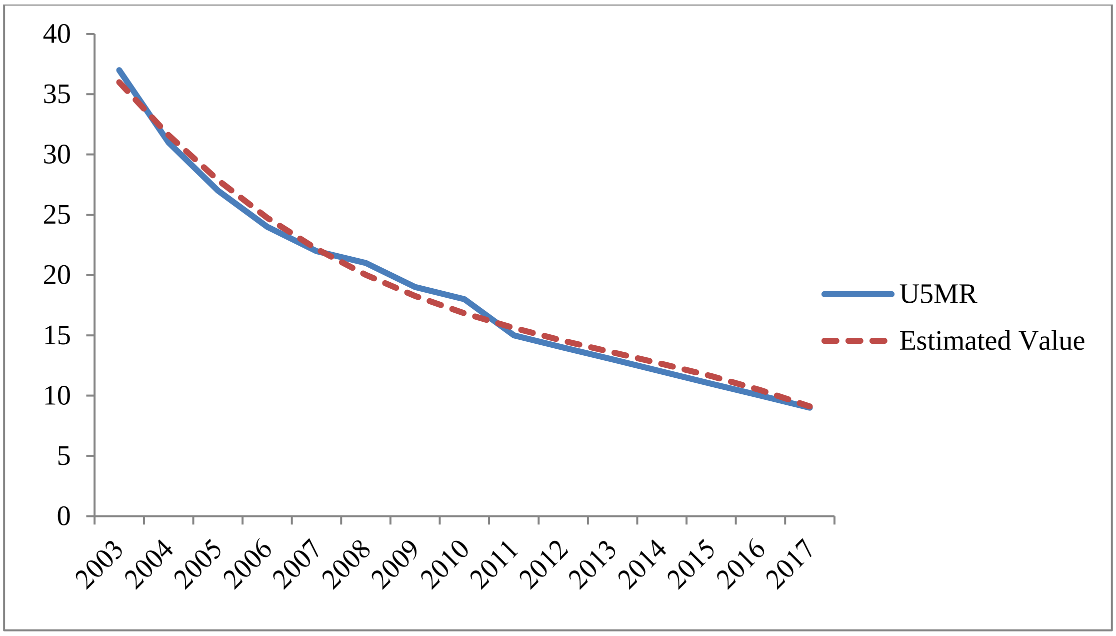



Figure (4.4) shows the plot of the observed time series data from 2003 to 2017, which was used for the modelling. The figure shows that the under-five mortality rate in China occur a downward trend. The under-five mortality rates show the actual and estimated values are very close during the period 2003-2017. Based on these results, it can be assumed that the under-five mortality rate in China will be decreased in the future.

### 4.4.2 Forecast with Cubic Trend Model for Under-Five Mortality Rates in China

The forecast values of under-five mortality rates from 2018 to 2021 using the cubic trend model were shown in Table (4.10).

**Table (4.10)**

**Forecast Values with 95% Confidence Intervals for Under-Five Mortality Rates (2018-2021)**

| Year | Forecast Values | Lower Limit | Upper Limit |
|---|---|---|---|
| 2018 | 7.47 | 4.57 | 10.36 |
| 2019 | 5.47 | 1.44 | 9.49 |
| 2020 | 3.05 | -2.59 | 8.68 |
| 2021 | 0.12 | -7.61 | 7.84 |

Source: Based on calculation

In Table (4.10) ,the four's year forecast values lie between 95% lower confidence limit and upper confidence limit. It is found that the under-five mortality rate of China is expected to be decreasing little by little from 7.47 in 2018 to 0.117 in 2021.Therefore, the estimated values of under-five mortality rate in China will decrease in the future.

### 4.5 Fitting the Appropriate Model for Under-Five Mortality of India

The four common models considered for this study are estimated for under-five mortality in India during 2003 to 2017 and shown in Table (4.11).

**Table (4.11)**

**Results from Trend Analysis of Under-Five Mortality Rates of India**

| Model | Coefficient | | | | Std Error | F | $R^2$ | $\bar{R}^2$ |
|---|---|---|---|---|---|---|---|---|
| | Constant | $a_1$ | $a_2$ | $a_3$ | | | | |
| Linear | 88.976 (0.000) | -3.303 (0.000) | | | 1.989 | 772.308 (0.000) | 0.983 | 0.982 |
| Quadratic | 89.260 (0.000) | -3.403 (0.000) | 0.006 (0.849) | | 2.067 | 357.597 (0.000) | 0.983 | 0.981 |
| Cubic | 91.057 (0.000) | -4.567 (0.011) | 0.182 (0.409) | -0.007 (0.419) | 2.093 | 232.770 (0.000) | 0.984 | 0.980 |
| Exponential | 94.114 (0.000) | -0.055 (0.000) | | | 0.041 | 490.613 (0.000) | 0.974 | 0.972 |

Note: The figures in the parentheses are p values.

Source: Based on calculation

According to the result of Table (4.11), all the models considered for this study are estimated for the time series of under-five mortality in India during the period of 2003 to 2017. The value of F statistics for Linear model was 772.308 and the model was significant at 1% level with p-value was 0.000. And, the coefficient of determination $R^2$ value was 0.983 and this model can explain 98.3% for under-five mortality rate. The standard error of this model was 1.989. Moreover, all of the coefficients of the Linear model were significant at 1% level, the value of F statistics for the Quadratic model was 357.597 and the model was significant at 1% level with p-value was 0.000. And, the coefficient of determination $R^2$ value was 0.983 and this model can explain 98.3% for under-five mortality rate. The standard error of this model was 2.067. Although the coefficient ($a_2$) of the Quadratic model was insignificant, other coefficients were significant at 1% level, the value of F statistics for the Cubic model was 232.770 and the model was significant at 1% level with p-value was 0.000. And, the coefficient of determination $R^2$ value was 0.984 and this model can explain 98.4% for under-five mortality rate. The standard error of this model was 2.093. Although, the coefficients $(a_2)$ and $(a_3)$ of the Cubic model were insignificant, other coefficients were significant, the value of F statistics for the Exponential model was 490.613 and the model was significant at 1% level with p-value was 0.000. And, the coefficient of determination $R^2$ value was 0.974 and this model can explain 97.4% .The standard error of this model was 0.041. All of the coefficients of the Exponential model were significant at 1% level. The analysis shows that the Linear and Exponential model are appropriate models and Quadratic and Cubic models are not suitable models for under-five mortality of India. Moreover, measuring the errors appeared that the value of MSE for the Linear model was 3.428 and the value of MSE for the Exponential model was 5.418. Thus, the Linear model which has a minimum MSE was the most appropriate to forecast the under-five mortality for India..

The estimated linear model is

$$\widehat{Y_t} = a_0 + a_1 t$$

$$= 88.976 - 3.303t$$

### 4.5.1 Estimated Values and 95% Confidence Interval for the Under-five Mortality of India

The observed values, estimated values and 95% confidence intervals for Under-five mortality rates from 2003 to 2017 were shown in Table (4.12) and Figure (4.5).

**Table (4.12)**

**The Observed Value and Estimated Value by the Linear Model (2003-2017)**

| Year | Observed Value | Estimated Value | Confidence Interval |
|---|---|---|---|
| 2003 | 87 | 85.67 | 80.89, 90.46 |
| 2004 | 85 | 82.37 | 77.67, 87.07 |
| 2005 | 74 | 79.07 | 74.45, 83.69 |
| 2006 | 76 | 75.76 | 71.21, 80.32 |
| 2007 | 72 | 72.46 | 67.96, 76.97 |
| 2008 | 69 | 69.16 | 64.69, 73.63 |
| 2009 | 66 | 65.86 | 61.41, 70.30 |
| 2010 | 63 | 62.55 | 58.12, 66.99 |
| 2011 | 61 | 59.25 | 54.81, 63.70 |
| 2012 | 56 | 55.95 | 51.48, 60.41 |
| 2013 | 53 | 52.64 | 48.14, 57.15 |
| 2014 | 46 | 49.34 | 44.79, 53.90 |
| 2015 | 48 | 46.04 | 41.42, 50.66 |
| 2016 | 43 | 42.74 | 38.04, 47.43 |
| 2017 | 39 | 39.43 | 34.65, 44.22 |

Source: Based on calculation

In Table (4.12), the estimated values of the under-five mortality rates for years 2003, 2004, 2006, 2009, 2010, 2011, 2012, 2013, 2015, and 2016 under-estimated and for years 2005, 2007, 2008, 2014, and 2017 over-estimated by the review back on the observed values of India. But, all the estimated values of the under-five mortality rate lie between 95% lower confidence limit and upper confidence limit.

**Figure (4.5)**

**Actual and Fitted Value for Under-Five Mortality in India of Linear Trend Model**

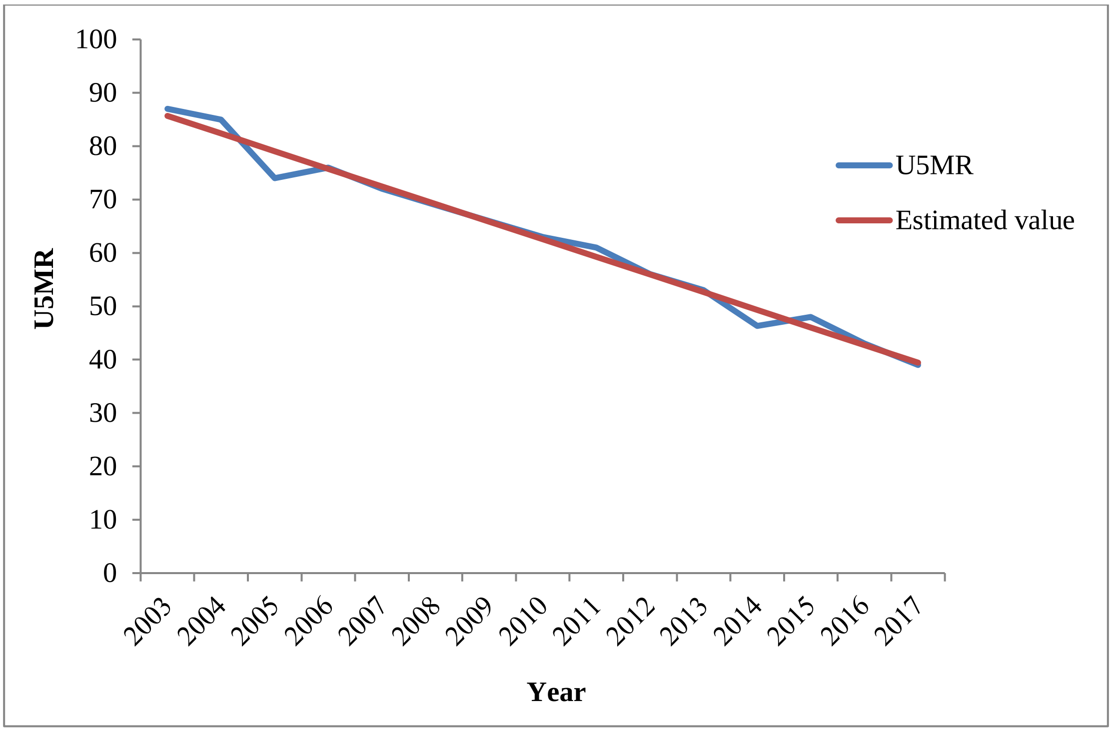



Figure (4.5) shows the plot of the observed time series data from 2003 to 2017, which was fitted by the Linear trend model. The figure shows that the under-five mortality rate in India occur a downward trend. The under-five mortality rates show a slightly decreasing trend during the period 2003-2005. But the under-five mortality rates are increased in 2006 and are highly decreased after that. Based on these results, it can be assumed that the under-five mortality rate in India will be decreased in the future.

### 4.5.2 Forecast with Linear Trend Model for Under-Five Mortality Rates in India

The forecast values of under-five mortality rates from 2018 to 2021 using the Linear trend model were shown in Table (4.13).

**Table (4.13)**

**Forecast Values with 95% Confidence Intervals for Under-Five Mortality Rates (2018-2021)**

| Year | Forecast Values | Lower Limit | Upper Limit |
|---|---|---|---|
| 2018 | 36.13 | 31.24 | 41.02 |
| 2019 | 32.83 | 27.82 | 37.83 |
| 2020 | 29.52 | 24.39 | 34.65 |
| 2021 | 26.22 | 20.96 | 31.48 |

Source: Based on calculation

In Table (4.13), the four's year forecast values lie between 95% lower confidence limit and upper confidence limit. It is found that the under-five mortality rate of India is expected to be decreasing little by little from 36.13 in 2018 to 26.22 in 2021. Therefore, the estimated values of under-five mortality rate in India will decrease in the future.

## 4.6 Fitting the Appropriate Model for Under-Five Mortality of Bangladesh

The four common models considered for this study are estimated for the time series of under-five mortality in Bangladesh during 2003 to 2017 and shown in Table (4.14).

**Table (4.14)**

**Results from Trend Analysis of Under-Five Mortality Rates of Bangladesh**

| Model | Coefficient | | | | Std Error | F | $R^2$ | $\bar{R}^2$ |
|---|---|---|---|---|---|---|---|---|
| | Constant | $a_1$ | $a_2$ | $a_3$ | | | | |
| Linear | 77.533 (0.000) | -3.229 (0.000) | | | 3.778 | 204.618 (0.000) | 0.940 | 0.936 |
| Quadratic | 82.074 (0.000) | -4.832 (0.000) | 0.100 (0.088) | | 3.466 | 123.292 (0.000) | 0.954 | 0.946 |
| Cubic | 76.071 (0.000) | -0.943 (0.682) | -0.488 (0.156) | 0.025 (0.090) | 3.157 | 100.169 (0.000) | 0.965 | 0.955 |
| Exponential | 82.365 (0.000) | -0.063 (0.000) | | | 0.053 | 396.593 (0.000) | 0.968 | 0.966 |

Note: The figures in the parentheses are p values.

Source: Based on calculation

According to the result of Table (4.14), all the models considered for this study are estimated for the time series of under-five mortality in Bangladesh during the period of 2003 to 2017. The value of F statistics for Linear model was 204.618 and the model was significant at 1% level with p-value was 0.000. And, the coefficient of determination $R^2$ value was 0.940 and this model can explain 94.0% for under-five mortality rate. The standard error of this model was 3.778. Moreover, all of the coefficients of the Linear model were significant at 1% level, the value of F statistics for the Quadratic model was 123.292 and the model was significant at 1% level with p-value was 0.000. And, the coefficient of determination $R^2$ value was 0.954 and this model can explain 95.4% for under-five mortality rate. The standard error of this model was 3.466. And, the coefficient ($a_2$) of the Quadratic model was significant at 10% level and other coefficient were significant at 1% level, the value of F statistics for the Cubic model was 100.169 and the model was significant at 1% level with p-value was 0.000. And, the coefficient of determination $R^2$ value was

0.965 and this model can explain 96.5% for under-five mortality rate. The standard error of this model was 3.157. Although, the coefficients $(a_1)$ and $(a_2)$ of the Cubic model were insignificant, other coefficients were significant, the value of F statistics for the Exponential model was 396.593 and the model was significant at 1% level with p-value was 0.000. And, the coefficient of determination $R^2$ value was 0.968 and this model can explain 96.8% for the under-five mortality rate .The standard error of this model was 0.053. Moreover, all of the coefficients of the Exponential model were significant at 1% level. The analysis shows that the Linear, Quadratic and Exponential models are appropriate models and Cubic model is not suitable model. Moreover, measuring the errors appeared that the value of MSE for the Linear model was 12.368, the Quadratic model was 9.608, and the Exponential model was 10.071. Thus, the Quadratic model which has a minimum MSE was the most appropriate to forecast the under-five mortality for Bangladesh.

The estimated quadratic model is

$$\hat{Y}_t = a_0 + a_1 t + a_2 t^2$$

$$= 82.074 - 4.832t - 0.100t^2$$

### 4.6.1 Estimated Values and 95% Confidence Interval for the Under-five Mortality of Bangladesh

The observed values, estimated values and 95% confidence intervals for Under-five mortality rates from 2003 to 2017 were shown in Table (4.15) and Figure (4.6)

**Table (4.15)**

**The Observed Value and Estimated Value by the Quadratic Model (2003-2017)**

| Year | Observed Value | Estimated Value | Confidence Interval |
|---|---|---|---|
| 2003 | 69 | 77.34 | 68.20, 86.48 |
| 2004 | 77 | 72.81 | 64.31, 81.31 |
| 2005 | 73 | 68.48 | 60.33, 76.63 |
| 2006 | 69 | 64.35 | 56.34, 72.36 |
| 2007 | 61 | 60.42 | 52.42, 68.41 |
| 2008 | 54 | 56.69 | 48.65, 64.72 |
| 2009 | 52 | 53.16 | 45.07, 61.24 |
| 2010 | 48 | 49.83 | 41.73, 57.93 |
| 2011 | 46 | 46.70 | 38.62, 54.78 |
| 2012 | 41 | 43.77 | 35.73, 51.81 |
| 2013 | 41 | 41.04 | 33.04, 49.04 |
| 2014 | 38 | 38.51 | 30.50, 46.52 |
| 2015 | 38 | 36.19 | 28.03, 44.34 |
| 2016 | 34 | 34.06 | 25.56, 42.56 |
| 2017 | 32 | 32.13 | 22.99,41.27 |

Source: Based on calculation

In Table (4.15), the estimated values of the under-five mortality rates for years 2004, 2005, 2006, 2007, and 2015 under-estimated and for years 2003, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2016 and 2017 over-estimated by the review back on the observed values in Bangladesh. But, all the estimated values of the under-five mortality rate lie between 95% lower confidence limit and upper confidence limit.

**Figure (4.6)**

**Actual and Fitted Value for Under-Five Mortality in Bangladesh of Quadratic Trend Model**

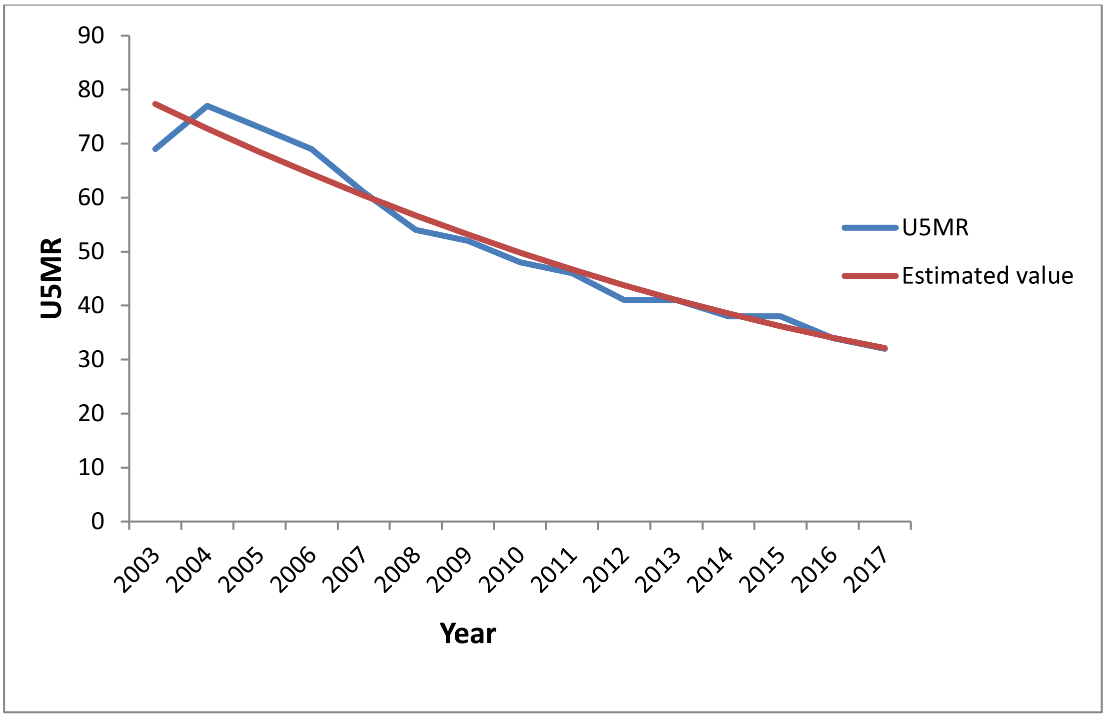



Figure (4.6) shows the plot of the observed time series data from 2003 to 2017, which was fitted by the Quadratic trend model. The figure shows that the under-five mortality rate in Bangladesh occur a downward trend. The under-five mortality rates are increased during the period 2003-2004 and are decreased during the period 2004-2005. The under-five mortality rates in Bangladesh are slightly decreased after the period 2005. Based on these results, it can be assumed that the under-five mortality rate in Bangladesh will be decreased in the future.

### 4.6.2 Forecast with Quadratic Trend Model for Under-Five Mortality Rates in Bangladesh

The forecast values of under-five mortality rates from 2018 to 2021 using the Quadratic trend model were shown in Table (4.16).

**Table (4.16)**

**Forecast Values with 95% Confidence Intervals for Under-Five Mortality Rates (2018-2021)**

| Year | Forecast Values | Lower Limit | Upper Limit |
|---|---|---|---|
| 2018 | 30.4 | 20.29 | 40.51 |
| 2019 | 28.88 | 17.43 | 40.32 |
| 2020 | 27.55 | 14.41 | 40.69 |
| 2021 | 26.43 | 11.25 | 41.59 |

Source: Based on calculation

In Table (4.16), the four’s year forecast values lie between 95% lower confidence limit and upper confidence limit. It is found that the under-five mortality rate of Bangladesh is expected to be decreasing little by little from 30.4 in 2018 to 26.43 in 2021. Therefore, the estimated values of under-five mortality rate in Bangladesh will decrease in the future.

# CHAPTER V
# CONCLUSION

Under-five child mortality rate is widely accepted as an indicator of a country's development level, because it can illustrates a reflection of a country's health care system and health monitoring systems, economic status, social welfare and inequalities in a society and quality of life.

There are several types of forecasting model in general employ. In this study, the curve estimation models are employed to predict the future rates of under-five mortality in Myanmar and neighbouring countries. Comparing the model selection criteria MSE of all methods, it is found that the linear trend model, quadratic trend model, cubic trend model and exponential trend model are the best for trend analysis and forecasting future of the under-five mortality rates in Myanmar and some neighbouring countries.

According to the data, under-five mortality rates are decreased year by year in each country. Reducing child mortality was one of the Millennium Development Goals (MDGs). By the ADB and World Bank database, the under-five mortality birth rates from 2003 to 2017 are the value for mortality rate, under-five (per 1,000 live births) in China was 9 as of 2017. Over the past 14 years this indicator reached a maximum value of 37 in 2003 and a minimum value of 9 in 2017. As a developed country, China is one of the few countries that has already achieved child health goals for MDG4 (reduce under-five mortality by two thirds between 1990 and 2015). Similarly, as a developing country, Thailand‘s progress in reducing the under-five mortality rate puts the country on track to achieve the fourth Millennium Development Goal. The value for mortality rate, under-five( per 1,000 live births ) in Thailand was 10 as of 2017. Over the past 14 years this indicator reached a maximum value of 26 in 2003 and a minimum value of 10 in 2017. And the other developing countries, the under-five mortality of India, Bangladesh and Myanmar were 39, 32, and 49 in 2017. Over the past 14 years this indicator reached a maximum value of 87, 69 and 107 in 2003 and a minimum value of 39, 32 and 49 in 2017.

According to the results, the future predicted values are decreased year by year in each country. By the estimated of the exponential trend model, in Myanmar, the maximum and minimum values of the under-five mortality rates are 40.66 and 32.91 in 2018 and 2021. In Thailand, by the estimated of the cubic trend model the maximum and minimum values of the under-five mortality rates are 5.66 and -14.51 in 2018 and 2021, respectively. In China, by the estimated of the cubic trend model, the maximum and minimum values of the under-five mortality rates are 7.47 and 0.12 in 2018 and 2021. In India, by the estimated of the linear trend model, the maximum and minimum values of the under-five mortality rates are 36.13 and 26.22 in 2018 and 2021. In Bangladesh, by the estimated of the quadratic trend model, the maximum and minimum values of the under-five mortality rates are 30.40 and 26.43 in 2018 and 2021. According to the predicted values, under-five mortality rate for forecasting period 2018 to 2021 is expected to be looking forward to decrease year after year.

Among these countries, China and Thailand achieved improvement in under-five mortality rates. Other countries, Myanmar, India and Bangladesh are decreasing under-five mortality rate in 2003 to 2017. But these countries should needs to decrease and needs to support more health service for public. Generally, the changes of under-five mortality is also influenced by socio-economic factors, such as parents education, family income, urban or rural residence, housing conditions, cultural and environment factors, mother’s age and nutritional conditions, especially breast-feeding. Furthermore, under-five mortality depends on the characteristics of family’s living condition, other sanitation facilities and employment attainment. The policy makers must decide suitable health programmes and other related health services for the public due to the impact of under-five mortality.

# REFERENCES


Asian Development Bank 2018: *Key Indicators for Asia and the Pacific 2018,* Asian Development Bank.

Asian Development Bank: *Basic Statistics (2003-2017),* Economic Research and Regional Cooperation Department, Asian Development Bank.

Gideon Kwartaeng Acheampong (2017) : Determinants of under-five mortality in Ghana; A logistic Regression Analysis using Evidence from the Demographic and Health Survey (1988-2014), *American Journal of Public Health Research. 2017, 5(3), 70-78.*

Gordon, R. M. (2009). Socio-economic Determinants of Infant and Child Mortality in Haiti. *Journal Of Eastern Caribbean Studies*, *34*(1), 1-18.

Granger, C.W.J.; and M Morris (1976), "Time Series modeling an interpretation." *Journal of the Royal Statistical Society* A 139.

Grossman, M., & Jacobowitz, S. (1981). Variations in infant mortality rates among counties of the United States: the role of public policies and programs. *Demography, 18 (4), 695-713.*

H. Booth And L.Tickle (2008): Mortality Modelling and Forecasting; A view of methods. *Annals of Actuarial Science, 3(1/2), 3-43.*

Henri Theil (1961). *Economic Forecast and Policy, North-Holland Pub. Co.*

Hill Kenneth, R. Pande, M. Mahy, G. Jones, (1999): *Trends in Child Mortality in the Developing World: 1960-1990*. UNICEF. New York.

http://dx-doi.org/10.4178/epih/e2015003: *Modelling and forecasting of the under-five mortality rate in Kermanshah province in Iran: a time series analysis.*

https://bmjopen.bmj.com: *Trends in mortality and causes of death among children aged under 5 years in Beijing, China between 1992 and 2015 and to forecast under-five mortality rates for the period 2016–2020.*

https://doi.org/10.1371/journal .pone .0211875: *Trends and future of maternal and child health in Bangladesh.*

Joshua Kembo and Jeroen K.VanGimeken (2009): Determinants of infant and child mortality in Zinbabwe Results of multivariate hazard analysis. *Demographic Research Vol.21, 2009, pp 367-384.*

Lal Hrin Mawi (2018), *Factors Associated with Infant and Under-five Mortalities in Myanmar*. Faculty of Economics, Chulalongkorn University.

Montgomery, D. C., Cheryl, L. J., and Murat, K. (2008), "*Introduction to Time Series Analysis and Forecasting",* John Wiley & Sons, Inc.

Myint Myint Thein (2014): *A study on under-five mortality rates in selected ASEAN countries (1999-2013).* Department of Statistics, University of Economics.

Naha Saleh Mohamed, Mona Hassan Ahmed Hassan, Saleh Mesbah (2004): Time-Series analysis of under-five mortality in Alexandria. *The journal of the Egyptian Public Health Association.*

Prince Edward Opare (2014): *Time series models for the decrease in under-five mortality rate in GHANA, case study 1961-2012.* Department of Mathematics, Kwame Nkrumah University of Science and Technology.

The Ministry of Health and Sports of the Republic of the Union of Myanmar (2017): *Myanmar Demographic and Health Survey (2015-16 MDHS).* The DHS Program ICF Rockville, Maryland, USA

The World Bank (2017): *World Development Indicators 2017.*The World Bank.

Ueda, Kozo (1983): *Recent Trends of Mortality in Asia Countries; South East Medical Information Center*, International Medical Foundation of Japan.

UNICEF: *Levels and Trends in Child Mortality report, 2019*

Usman, Abubakar & Sulaiman, Muhammad & Abubakar, Idris. (2019). Trend of neonatal mortality in Nigeria from 1990 to 2017 using time series analysis. *Journal of Applied Sciences and Environmental Management. 23. 865. 10.4314/jasem.v23i5.15.*