YANGON UNIVERSITY OF ECONOMICS

DEPARTMENT OF STATISTICS

FORECASTING GOLD PRICE AND EXCHANGE RATE IN MYANMAR (January 2009 – December 2018)

BY

KYI KYI SWE

M.Econ (Statistics)

Roll No.12

NOVEMBER, 2019

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This is certify that the thesis entitled "**FORECASTING GOLD PRICE AND EXCHANGE RATE 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

In this thesis, an attempt has been made using " Ordinary Least Squares Method" to find out the relationship between average prices of gold and kyats per US dollar in Myanmar by using monthly time series data for the period January 2009 to December 2018. The data used in this study is collected from "Selected Monthly Economic Indicators". Suitable stochastic models for monthly average gold price series (Thousand Kyats) in Myanmar from year 2009 to 2018 and monthly average kyats per US dollar price series in Myanmar for year 2009 to 2018 are found by following the four stages of model building, namely, identification, estimation, diagnostic checking and forecasting. Forecasting is very important in future decisions making. The forecasts based on the fitted model were also validated in this thesis in order to support future decision making for planning purpose. Whenever needed, computer programs for the that ARIMA (1, 0, 0) $\times (1, 1, 0)_{12}$ model was suitable for average gold prices and ARIMA (0, 1, 0)$\times (1, 1, 0)_{12}$ model was suitable for kyats per US dollar during the study period.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
SSM	Sum of Square for Months
SSY	Sum of Square for Years
SSE	Error Sum of Square
SST	Total Sum of Square
SSR	Regression Sum of Squares
MSE	Mean Square of Error
MSR	Mean Square Regression
GP_t	prices of average gold in month t
PUS_t	prices of average kyats per US dollar in month t
AR	Autoregressive
MA	Moving Average
ARMA	Autoregressive Moving Average
ARIMA	Autoregressive Integrated Moving Average
SAR	Seasonal Autoregressive
SARMA	Seasonal Autoregressive Moving Average
SARIMA	Seasonal Autoregressive Integrated Moving Average
ACF	Autocorrelation Function
PACF	Partial Autocorrelation Function
SACF	Simple Autocorrelation Function
SPACF	Simple Partial Autocorrelation Function

CHAPTER I

INTRODUCTION

1.1 Rationale of the Study

Gold is used as a standard of value for currencies all over the world. The price of gold gets stated as a currency value, often in US dollars and the price of gold can fluctuate with market conditions. Gold which is a unit of value saving accepted by all the world since long time is a precious metal. It is started to be frequently used in industrial field with developed technology in recent years because of being easily shapeable, resistant to chemical substances, noncorrosive, resistant to oxidation, high heat and electric conductivity, and having reflective feature (Aslan, 1999).

Gold, is considered one of the most precious metals in all around the world is shiny and glamorous. Throughout history, it has been treasured for its natural beauty and radiance. For this reason, many cultures have imagined gold to represent the sun. Yellow gold jewelry is still the most popular color, but today gold is available in a diverse palette.

Since gold is superior to all other metals, both the developing and developed nations are frequently watching its price movements and its relationship with other financial instruments. That is why: many of such countries are formulating their economic policies by considering the fluctuations in gold price. The domestic gold price and US dollar exchange rate are directly related to the global market, according to market experts. As US dollar is considered as world's reserve currency, the gold price is also denominated in dollar. Therefore, the fluctuations of dollar rate have a great impact on gold price. The historical data reveals that there exists an inverse relationship between gold price and US dollar i.e. the value of gold rises as the price of US dollar collapsed and vice versa (Ranjusha).

The gold price fluctuates in the world market all the time. Gold is one of the most widely discussed metals due to its prominent role in both the investment and consumer world. Even though it is no longer used as a primary form of currency in developed nations, it has a significant influence on the value of those currencies. Moreover, there is a close correlation between the value of gold and the currencies, which are trading in foreign exchange.

Gold still plays an important role in the global economy including Myanmar. Myanmar will start selling gold with 99.99 percent purity in the international unit of gram and instead of Myanmar weight kyat-thar. However, in the same time, the gold price is varying from measurement unit. The weight of gold is measured in troy ounces and 'karat' which is a purity measure for gold. The troy ounce is standard unit of measurement used for precious metals.

In Myanmar, the Central Bank is responsible for setting the daily exchange rate. It also sells a designated amount of foreign currency to local banks and authorized money changers, which limits the amount of foreign exchange available for trade in the market. Currently, only State-owned banks like the Myanmar Foreign Trade Bank (MFTB) and local private banks are allowed to open foreign currency accounts as well as transfer, deposit and withdraw cash in foreign currency. World major currencies, such dollar, euro, pounds may appreciate and depreciate and thus effect the gold price. In 1785, the dollar was officially adopted as the money unit of the United States. Approximately $1.2 trillion traded in foreign exchange market in every day. The US dollar is one of the most widely utilized currencies around the world. The US dollar is the most commonly converted currency in the world. Companies use foreign exchange to settle transactions involving the imports and exports of goods and services, for foreign investment. Additionally, the US dollar is used as the standard currency in the commodity market and therefore it has a direct impact on commodity price. Myanmar is the 77th largest foreign-exchange reserve holder in the world (8,463 million US$). The top 10 countries by foreign-exchange reserves are: China, Japan, Switzerland, Saudi Arabia, Russia, Taiwan, Hong Kong, South Korea, India and Brazil.

Gold is as an investment product, its price is extremely important for the investors. Since the gold is one of the many investment channels interested, the investors look to gold as a safe heaven on the stock market direction. Investing and trading gold is a risky area because the gold prices have fluctuated continuously in recent year. Also, for this reason, the investors are more interested in the role of forecasting gold price in the future. This is a support channel for investors if they know how to use and perform correctly. Hence, the estimate of gold price Myanmar is necessary for investment decision making in the present period. For this reason, Seasonal (ARIMA) modes are used for predicting the gold price and market exchange rate.

1.2 Objectives of the Study

The main objectives of the study are as follows:

- To analyze the situations of Myanmar's gold prices and exchange rate.
- To investigate the relationship between gold prices and exchange rate.
- To develop the seasonal ARIMA models and forecast the gold prices and exchange rate.

1.3 Scope and Limitations of the Study

The secondary data are used for this study. The monthly average gold price and exchange rate data are collected from the "Selected Monthly Economic Indicators" for January 2009 to December 2018 published by the Central Statistical Organization (CSO) of Myanmar.

1.4 Method of Study

The descriptive method are used to analyze the trends and fluctuations of gold price and exchange rate in Myanmar. The simple regression model are used to find the relationship between gold prices and exchange rate. The price of gold and exchange rate in Myanmar are estimated by using Seasonal (ARIMA) models for over a period of January 2019 to December 2019.

1.5 Organization of the Study

This study is organized into five chapters. Chapter I is introduction section containing rationale of the study, objectives of the study, scope and limitations of the study, method of study and organization of the study. Chapter II presents the overview of gold price and exchange rate in Myanmar. Chapter III provides theoretical background. Chapter IV concerns with the analysis of gold prices and exchange rate. Chapter V is the conclusion.

CHAPTER II

OVERVIEW OF GOLD PRICE AND EXCHANGE RATE IN MYANMAR

2.1 The World Gold Markets

World gold market is conducted along with world stock share trading in major cities in Asia, Europe and America. Prevailing prices round the time can be seen in media like Bloomberg, Internet online and transactions can be made online. International exchange system in periods that gold is used as means of exchange in monetary system, thus strict controls on gold trade prevent development of gold market in many countries. Many gold exchanges are structured different from good exchanges by reason of the fact that gold is strategically important and international means of reserve. Gold is used as a standard of value for currencies all over the world. The price of gold gets stated as a currency value, offer in US dollars and the price of gold on fluctuated with market conditions (Ahmet Kutalmis, 2010). Internal gold trading is available 24 hours in the world going through time zone, starting from East Asia and finally to New York city in U.S market. The market time period is Monday to Friday and the market closed at evening on Friday in New York. The weekends are closed for trading. World gold trading uses British standard troy ounces. One troy ounce equals to 1.9047 Myanmar Kyat Thar (tical) in Myanmar. One troy ounce of gold is the same around the world and for larger transaction are usually priced in US dollar as that is the most active market; however, the value of an ounce of gold can be higher or lower based on the value of a nation’s currency. Among international gold markets, the most important ones are Landon, Zurich, New York and Tokyo. The daily fixed price occurred in London Gold Market is considered as most important indicator at the market about occurrence of world gold prices.

Some gold exchange are London Gold Exchange, Zurich Gold Exchange, New York Gold Exchange (COMEX), Hong Kong Gold Exchange and Tokyo Gold Exchange. There are differences in development of exchanges and also between markets developed in national or regional conditions. The other difference among world gold markets is regulatory authorities. In some countries gold authorities operate under supervision of central banks, whilst in some of them this task is carried out by governmental agencies responsible for operation of futures markets.

The certain standards are applied in transactions realized in international gold markets and there are some differences. According to said international standards, ounce is used as weight in London, Singapore, Hong Kong and USA markets and US Dollar is used as the major gold related currency. The transactions are made in Swiss Franc in Zurich Gold Market, in Tokyo Gold Market; 100 g is used as weight instead of 1 ounce.

2.2 Myanmar Gold Market

Gold has traditionally been a popular investment in many Asian countries and as a tool of wealth management. The supply chain in Myanmar comprises wholesalers, providers, jewelers, retailers, miners and refiners – major refiners and 25 small refiners. Wholesale markets are in Yangon and Mandalay. Three associations support the supply chain: Myanmar Gold Development Public Company, Myanmar Gold Entrepreneurs Association, Yangon Gems and Jewellery Entrepreneurs Association. However, the infrastructure for gold trading is still not developed.

Myanmar has an independent gold market, so gold price are not necessarily determined by international prices. However, trading prices are close to international market prices, and it appears that traders refer to international spot prices at the time of opening as a benchmark, converting it to local units and currency. The wholesale market in Yangon, located at 42 Shwe Bhone Thar Street, managed by the Myanmar Gold Entrepreneurs Association. All market players are members of the Myanmar Gold Entrepreneurs Association. Most of the countries gold trading takes place in Yangon Region. Mandalay Region, produces gold and trade mostly in Yangon Region or sometimes in Taunggyi and Shan State. From Yangon, the gold is distributed throughout the country. The carrying change per tical (kyat thar) from Mandalay to Yangon is K 200 – K 500 (Aung Thamidi Gold Smith, 2010).

The Government of Myanmar offers opportunities to expatriate companies to conduct prospecting and exploration of minerals within the country. Myanmar has numerous natural resources, many of which are largely untapped. The nation reportedly has numerous gold deposits, and the government reportedly earned a significant sum from exports of gold and other base metals during the 1990s. The majority of Myanmar gold is consumed by Asia, and this makes sense given the fact that two of the nation's neighbors, India and China, are two of the largest consumer of gold in the world.

Myanmar has been referred to as the “Golden Land” as the yellow metal is used for domestic as well as religious purposes. Myanmar’s gold reserves as well as its reserves of tungsten, copper, jade and oil have attracted foreign investment in recent years.

Myanmar’s local gold traders are planning to start up gold export and import businesses following the government’s announcement of relaxing rules for trading gold products abroad. The export and import of gold and jewellery were permitted by the Ministry of Commerce aiming at eradicating illegal trading as well as earning more revenue for the government and maintaining the market’s stability. The traders will start the export and import of pure gold in accordance with the international gold weight measurement standard of fine gold and gold bar with slightly lower standard regulated by the Central bank of Myanmar. The Myanmar Gold Entrepreneur’s Association set a nationwide standardized weight and density for gold measurement. The gold market will also be an important part of the stock exchange, as the nature of the stock market is that it welcomes a variety of commodities.

The gold standard is a monetary system of a country or paper money has a value directly linked to gold. With the gold standard, countries agreed to convert paper money into a fixed amount of gold. A country that uses the gold standard sets a fixed price for gold and buys and sells gold at that price. That fixed price is used to determine the value of the currency.

There are certain important things to be noted while purchasing golden jewelry. The primary thing is the quality of the gold metal measured by it purity in Carats. The higher the carat value, the purer of the gold. Pure gold is mixed with other metals like silver, copper to give strength and other character to the jewelry made out of it. Chinese people like to buy jewelry made from 24 carat gold and some folk from the Arabic counties prefer 22 carat gold, but the rest of the world likes 9 carat which is the most used in Australia and a good deal in England, 14 carat and 18 carat which is used in the USA and Europe. There are factor which determine to the price of jewelry. If golden jewelry is made from 24 carat yellow gold, then it only has 99.9 percent gold in it. If it is 23 carat, then it only has 94.1 percent real gold in it and if only has 22 carat then it only has 91.6 percent.

Businessmen from Thailand, Hong Kong, Vietnam and Japan are interested in opening gold shops in Myanmar. In Myanmar, gold is produced commercially in Pegu, Saging, Mandalay, Magway and Taninthayi Region, as well as Kachin, Karen and Mon states.

Domestic gold prices and US dollar exchange rates are directly related to the global market. Although domestic gold prices fluctuate, depending on global gold prices, it is not traded higher than global prices according to chair of the Mandalay Gold Entrepreneurs Association. The gap between the global gold price and the domestic price is Ks 5,000 – 10, 000. Myanmar gold market been expanding steadily and Myanmar gold prices are mostly to heighted depending upon the world gold price and us dollar exchange rate increase.

In 2010, as long as the government gives opportunities to gold entrepreneurs and control monetary policy well, the gold business will continue to be positive. Business people have always bought gold as a commodities for trade and investment. Gold sales usually drop after Thingyan and remain low end of the rainy season. October to December is the best time for gold sales. On the world gold market, the price of gold has remained relatively stable this year, experts say similar to Myanmar.

2.3 Gold Spot Market

Spot markets are markets that gold is physically purchased and sold, and delivery is made two days after payment. The spot gold price refers to the price of gold for immediate delivery. Transactions for bullion coins are almost always priced using the spot price as a basis. The spot gold market is trading very close to 24 hours a day as there is almost always a location somewhere in the world that is actively taking orders for gold transactions. If customer wants this transaction to occur in another place, it can be realized at its cast and risk. The investors who want to hold gold, the jewelers who need gold and mining companies and banks that want to receive their money when gold sold, are some participants of spot gold markets. The leading spot gold market of the world are Landon Gold Market and Zurich Gold Market. London, the biggest center of gold trade, played an important role in development of spot markets. London has organizational structure in purchase-sale of gold (Ahmet Kutalmis Turkes, 2010).

2.4 Gold Demand in Jewellery Sector

Gold is mainly used in jewellery sector. The demand to the gold jewellery varies from country to country and the area of use. The economical, political and cultural differences in countries directly affects the processed jewelry of people live in that country. While gold jewelry is used only for ornament, they are bought in developing countries as safety factor for reason of saving, value protection and wealth accumulation. Gold jewelry trend is directly in relation with economic growth, income level and welfare level. There is an increase in the amount of money allotted to gold jewelries by people whose financial saturation become well and income level increase (Ahmet Kutalmis Turkes, 2010).

2.5 Foreign Exchange Market

Foreign exchange is the marketplace for trading all the world's currencies and is the largest financial market in the world. The foreign exchange market is the largest and liquid financial market in the world with worldwide average daily turnover around $5.3 trillion, which makes foreign exchange highly global trading asset. Foreign exchange forms the basis of dealings for trade and other monetary transactions between economics of the world. Foreign exchange market operates with heterogeneous participants comprises of central banks, commercial banks, companies, brokers, fund managers, speculators and individuals. Central banks regulate the market for smooth and orderly operations with a broader objective of economic and financial development.

Foreign exchange market is one of the enormous financial markets having trading centers across the globe on which the sun never sets and operate in a virtual platform. It operates like other financial markets where the price of the currency is measured as the value of a foreign currency relative to domestic currency. The Foreign Exchange Rate (FER) is defined as the price of a unit of foreign currency, measured in units of domestic currency. The determination of (FER) is closely associated with the existing international monetary system. The Bretton Woods system which set the exchange rates based on the gold banking (also known as gold standard) collapsed in 1973. The foreign exchange rate movements is not only crucial for exporters and importers but also other active market participants such as commercial banks, brokers, central banks, traders, speculators, tourists and investors. Fundamental analysis involves the study of economic fundamentals of a country such as Gross Domestic Product (GDP), Balance of Payment (BOP) position, Political Stability, Inflation, Interest rates by major Global Credit Rating Agencies etc.

Foreign exchange market is a network for the trading of foreign currencies, including interactions of the traders and regulations of how, where and when they close deals. The foreign exchange market typically traded takes the form of bank deposits or bank transfers of deposits denominated in foreign currency. The currency market is open 24 hours a day, five days a week, with all major currencies traded in all major financial centers. The most popular foreign exchange market is the euro to us dollar exchange rate (EUR to USD), which trades the value of Euros in US dollars.

2.6 Structure of Myanmar's Foreign Exchange Market

Myanmar foreign exchange regulatory framework has evolved substantially since 2011. There are two type of market in Myanmar foreign exchange. They are Formal Market and Informal Market.

2.6.1 Formal Market

Since the abolition of the official peg of the Myanmar kyat in April 2012, the Central Bank of Myanmar (CBM) has operated daily two-way foreign exchange auctions. Participants are 14 local banks to whom the CBM granted authorized dealer licenses. In its daily auctions, the CBM calls for sealed bids and offers of US dollars from the banks. The banks then submit their price and quantity bids (offers) to the Central Bank of Myanmar (CBM). The bids and offers must be fully covered by a bank's current account deposits held at the CBM. The CBM sets the cutoff price of US dollars in terms of the Myanmar kyat and accepts the bids (offers) above (below) the cutoff rate.

There are two notable points in Myanmar's foreign exchange auctions in comparison with those held in other developing countries. First, the daily auctions are two-way: the CBM accepts both bids and offers from participating banks. Second, no systematic arrangement exists to transfer the government's foreign exchange receipts, such as export revenues from state enterprises, to the CBM due to the state sector's obsolete foreign exchange administration. Thus, the CBM's supply of foreign exchange is rather limited at present.

The introduction of the auctions was a consequence of the country's shallow and underdeveloped official market for foreign exchange. Until October 2011, banks had not been permitted to engage in foreign exchange trading. Although state banks had been offering international banking services such as current international payments and transfers, they did not sell or buy foreign exchange with customers; buyers and sellers of foreign exchange had to find counterparties outside the banking system.

During the reform process, the private banks who had been newly granted foreign exchange dealer licenses moved ahead of the state banks with respect to money-changing services in October 2011 and customer dealing of foreign exchange in August 2012. Later, in August 2013, the CBM instituted an interbank market for foreign exchange. This series of reforms are still paving the way for the establishment of a two-tier official foreign exchange market: (1) the wholesale segment including the official auctions and the interbank market, and (2) the retail segment including banks' customer dealings and transactions at authorized money changers.

2.6.2 Informal Market

Despite Myanmar's foreign exchange policy reforms, the informal market remains pervasive, a legacy of the country's previous peculiar exchange rate regime. Prior to the April 2012 Introduction of a Managed Float (IMF), the Myanmar kyat had been officially pegged to the Special Drawing Right (SDR) of the IMF at 8.50847 kyat per SDR; the official rate had not been adjusted for over three decades. However, this official rate had been applied only to transactions in the public sector for fiscal accounting.

Under the previous fixed exchange rate regime, private exporters and importers were relegate to the informal market where they traded foreign exchange regulations restricted private exporters to only being able to deposit them in the state banks in foreign currency deposit accounts. By regulation, the banks could not accept conversion of Foreign Currency Deposit (FCD) into the Myanmar kyat whereas they tolerated domestic account transfers of Foreign Currency Deposit (FCD). Domestic account transfers of FCD thus fostered private exporter's ability to sell FCD to importers by transferring FCD to importers' accounts in exchange for side payments in Myanmar kyat. In this way, buyers and sellers traded FCD at bilaterally negotiated prices. Sometimes brokers acted as middlemen and their quoted prices of FCD were widely circulated in the private sector.

The practice of informal foreign exchange trading in the private sector remains largely the same even after the ongoing reforms were first enacted. Since August 2012, private exporters have had two choices for disposal of export revenues: banks (the official market) and the informal market. When banks deal with customers, banks buy foreign exchange from exporters and sell it to importers.

2.7 Monthly Average Gold Prices per Tical (Kyat Thar) (Jan 2009 - Dec 2018)

Monthly average gold prices in Myanmar from January 2009 to December 2018 is presented in Table (2.1) and Figure (2.1).

Table (2.1)
Monthly Average Gold Prices (Thousand Kyats) in Myanmar

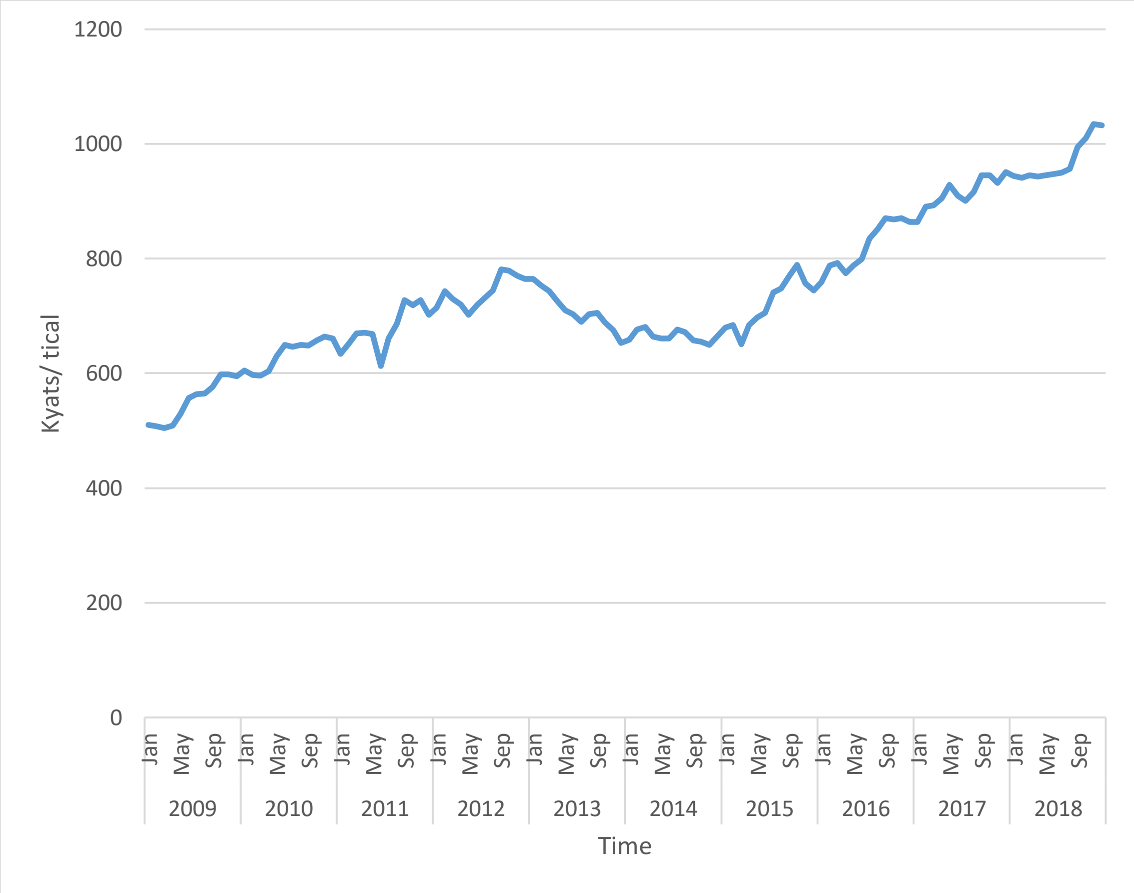
Year / Month	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
January	510.304	604.748	634.367	713.812	764.731	658.135	680.033	758.740	864.180	944.136
February	507.717	596.483	652.022	742.860	752.783	676.352	684.050	787.708	890.563	940.922
March	504.557	596.2	669.923	729.438	743.705	680.552	650.778	792.300	892.528	945.042
April	508.356	603.344	670.353	719.667	726.472	664.271	683.944	774.382	905.452	942.633
May	529.467	629.127	668.36	702.108	709.284	661.084	697.500	787.608	928.050	945.026
June	557.377	649.404	612.127	718.154	702.908	660.820	705.260	798.846	910.050	947.050
July	562.992	646.208	661.083	731.720	690.172	676.780	741.250	834.860	901.064	950.133
August	564.700	649.615	686.315	744.346	702.641	671.665	747.320	851.848	916.041	955.892
Septembe r	575.319	648.462	727.058	780.988	705.580	657.115	769.548	870.980	945.442	994.244
October	598.435	657.58	718.125	778.935	688.135	655.080	789.308	868.135	945.442	1009.813
November	598.250	663.813	727.813	770.271	675.592	649.458	756.309	870.438	931.648	1034.817
December	595.000	660.700	702.241	764.392	652.560	664.038	744.638	863.704	950.400	1031.979

Sources: Selected Monthly Economic Indicators: Central Statistical Organization (C.S.O)

Figure (2.1)

Average Gold Prices per Tical (Kyat Thar) (Jan 2009 to Dec 2018)

(Thousand Kyats)



Source: Selected Monthly Economic Indicators: Central Statistical Organization (CSO)

At the earliest year of study period, monthly average gold prices never come below 600,000 kyats per tical. It is ranging from 504557 kyats per tical in March to 598435 kyats per tical in October. In 2010 and 2011, although prices are below 700,000 kyats per tical between in 2010 January to 2011 August, it crosses over 700, 000 kyats per tical lines in the next 24 months. After September 2013, monthly average gold prices are decrease in following months of October 2013. The monthly average gold prices from 2014 January to 2015 May can be seen stable prices. It is ranging from 649458 kyats to 697500 kyats. Again, price goes over 700, 000 kyats in June 2015. Since gold prices never come below 700, 000 kyat per tical. The average gold prices in 2018 can be seen from a low of 940922 kyats per tical in February to that dizzying 1034817 kyats per tical in November.

2.8 Monthly Average Kyats per US Dollar (Jan 2009 - Dec 2018)

US Dollar prices against Myanmar Kyat from January 2009 to December 2018 is presented in the following Table (2.2) and Figure (2.2).

Table (2.2)

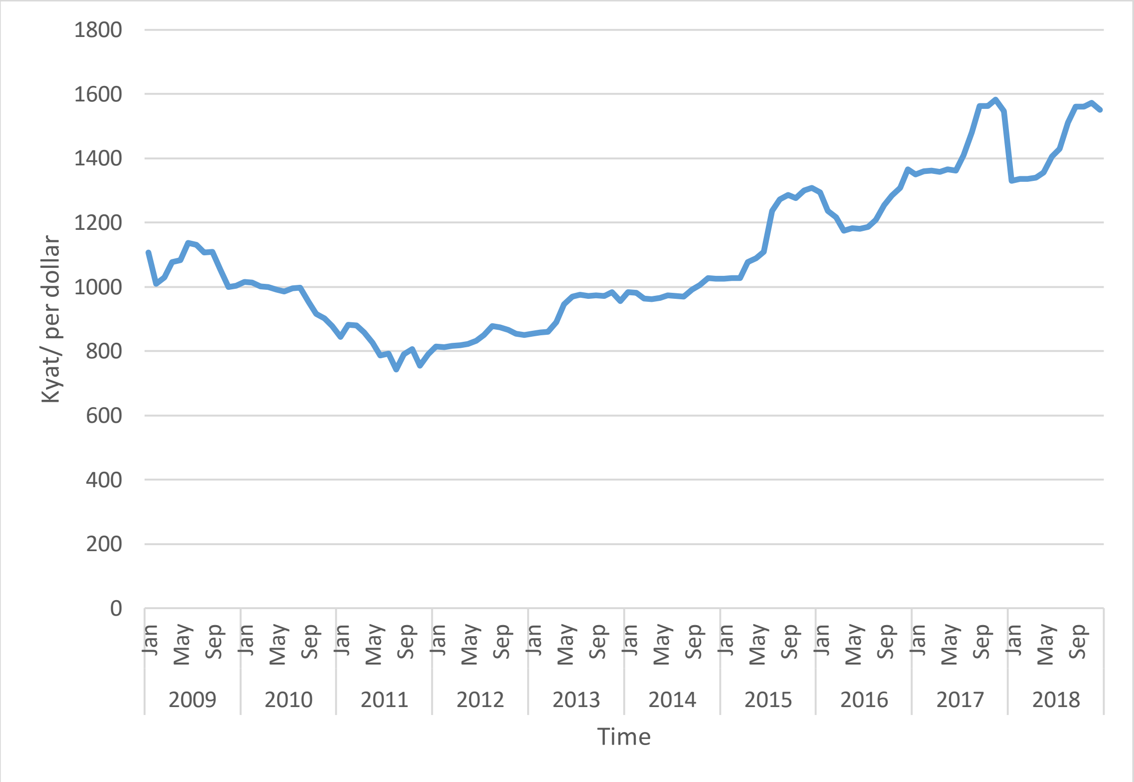
Kyats per US Dollar in Myanmar

Month \ Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
January	1107	1015	845	815	854	983	1025	1294	1350	1330
February	1010	1013	883	813	858	982	1027	1237	1360	1336
March	1030	1001	881	816	860	964	1027	1216	1362	1335
April	1077	1000	859	819	890	962	1078	1175	1358	1340
May	1083	991	826	822	945	966	1090	1182	1365	1355
June	1137	985	787	832	969	973	1110	1181	1362	1405
July	1130	995	792	850	975	972	1236	1187	1410	1429
August	1107	998	742	878	972	970	1273	1208	1482	1512
September	1110	954	790	874	973	992	1287	1255	1562	1560
October	1055	915	806	866	972	1006	1277	1285	1563	1560
November	1000	902	755	854	983	1028	1300	1308	1583	1573
December	1003	878	791	851	955	1026	1309	1365	1547	1550

Source: Selected Monthly Economic Indicators: Central Statistical Organization (CSO)

Figure (2.2)

Monthly Average Kyats per US Dollar (Jan 2009 - Dec 2018)



Source: Selected Monthly Economic Indicators: Central Statistical Organization (CSO)

Accordingly, kyats per US dollar is 1137 kyats in June and decreases in following months of 2009. In the end of December kyats per US dollar is closed at 1003 kyat. Dollar prices goes down below 1000 kyats in May and it does not rise more than 1000 kyats during next 52 months. The lowest price can be seen in August 2011. Price goes down to 742 kyats in this month. In October 2014, it rises over 1000 kyats again. This time, price does not goes down below 1000 kyats. US dollar against Myanmar kyat rises steadily from 1025 kyats in January to 1309 kyats in end of 2015. Prices do not go up to 1400 kyats in 2016. According to Figure (2.2), it can be seen that 2017 is high US dollar exchange rate years. The highest exchange rate is found in November 2017. It rises up to 1583 kyats. The price of US dollar in 2018 see from a low of 1330 kyats on in January to that dizzying 1573 kyats in November.

2.9 Average Gold Prices of Myanmar

The monthly data of average gold prices of Myanmar are collected for 10 years, from January 2009 to December 2018. Basic statistical characteristic of this series are investigated from two aspect. Firstly, the basic statistics for each month over a number of years (10 years) are computed. This enable us to see the pattern clearly from January to December throughout the year of the means and variances. Secondly, the basic statistic for each year over a number of months (12 months) are computed. The patterns over the years of the means and variances can be seen clearly from these. Some basic statistics of monthly average gold prices in Myanmar are computed for each month and presented in Table (2.3).

Table (2.3)

Monthly Average Gold Prices of Myanmar

Month	Mean (Thousand Kyats)	Variance $(Thousand\ kyats)^2$	C.V	Maximum (Thousand kyats)	Minimum (Thousand Kyats)
January	713.32	14413.14	16.83	944.14	510.30
February	723.15	15212.01	17.06	940.92	507.72
March	720.50	15688.32	17.38	945.04	504.56
April	719.89	15222.96	17.14	942.63	508.36
May	725.76	14980.01	16.86	945.03	529.47
June	726.20	14058.47	16.33	947.05	557.38
July	739.63	13200.09	15.53	950.13	562.99
August	749.04	13721.23	15.64	955.89	546.70
September	767.47	16272.85	16.62	994.24	575.32
October	770.90	16303.75	16.56	1009.81	598.44
November	767.84	17248.35	17.10	1034.82	598.25
December	762.97	18232.03	17.70	1031.98	595.00

From Table (2.1), it can be seen that the monthly mean values vary from month to month for this series. For instance, January to July have the means which are less than the overall mean 740.55 (Thousand Kyats). The monthly mean is highest in October with 770.90 (Thousand Kyats) and the lowest in January with 713.32

(Thousand Kyats). The variance for each of the month vary from 13200.09 $(Thousand\ Kyats)^2$to 18232.03 (Thousand kyats)^2 and the coefficient of variations vary from 15.53 percent to 17.70 percent. The coefficient of variations for December is found to be largest (17.70%). The maximum value for each month is the lowest in February and the highest in November. The minimum value for each month is the lowest in March and the highest in October. When the mean value for the month is large, the maximum value and the minimum value of the series are also large. For the hold observed records, the minimum value of the gold price per tical (kyat thar) is 504.56 (Thousand Kyats), which occurs in March, 2009. Similarly, the maximum value is 1034.82 (Thousand Kyats) which occurs in November, 2018.

The yearly mean value, the variance, the coefficient of variations, maximum and minimum over the twelve months for each year from 2009 to 2018 of yearly average gold prices of Myanmar are presented in Table (2.4).

Table (2.4)

Yearly Average Gold Prices of Myanmar

Year	Mean (Thousand Kyats)	Variance $(Thousand\ Kyats)^2$	C.V	Maximum (Thousand Kyats)	Minimum (Thousand Kyats)
2009	551.04	1279.24	6.49	598.44	504.56
2010	633.81	637.68	3.98	663.81	596.2
2011	677.48	1214.36	5.14	727.81	612.13
2012	741.39	658.63	3.46	780.99	702.11
2013	709.55	975.81	4.40	764.73	652.56
2014	664.61	86.30	1.40	680.55	649.46
2015	720.83	1673.22	5.67	789.31	650.78
2016	821.63	1642.82	4.93	870.98	758.74
2017	915.07	629.15	2.74	950.4	864.18
2018	970.14	1237.14	3.63	1034.82	940.92

From Table (2.4), it can be seen that the yearly means vary from 551.04 (Thousand Kyats) in 2009 to 970.14 (Thousand Kyats) in 2018. The variance of each year varies from 86.30 in 2014 to 1673.22 in 2015 and coefficient of variation for each year lies between 1.40 percent and 6.49 percent.

2.10 Average Kyats per US Dollar

The monthly data of kyats per US dollar prices are collected for 10 years, from January 2009 to December 2018. Basic statistical characteristics of this series are computed in the same way as in kyat per US dollar prices. For each month these statistical characteristic are computed and presented in Table (2.5).

Table (2.5)

Monthly Average Kyats per US Dollar

Month	Mean	Variance	C.V	Maximum	Minimum
January	1062.30	37135.21	2.86	1350	815
February	1051.30	34237.21	3.07	1360	813
March	1049.00	33645.80	3.12	1362	816
April	1055.10	32227.69	3.27	1358	819
May	1062.60	33438.04	3.18	1365	822
June	1074.00	37947.80	2.83	1405	787
July	1098.80	42931.36	2.56	1429	792
August	1113.40	57834.64	1.93	1512	742
September	1134.30	67294.21	1.69	1562	790
October	1128.30	69480.01	1.62	1563	806
November	1127.10	76922.29	1.47	1583	755
December	1127.50	78329.85	1.44	1573	791

From Table (2.5), it can be seen that the monthly mean value vary from month to month for this series. For instance, January to June have the means which are less than overall mean 1090.31. The monthly mean is highest in September with 1134.4 and the lowest in March with 1049. The variance for each of the months vary from 33645.8 to 78329.85 and the coefficient of variations vary from 1.44 percent to 3.27 percent. The coefficient of variations for April is found to be largest (3.27%). The maximum value for each month is the lowest in January and the highest in November. The minimum value for each month is the lowest in August and the highest in May. When the mean value for the month is large, the maximum value and the minimum value of the series are also large. For the hold observed records, the minimum value of the US dollar against Myanmar Kyat is 742, which occurs in August, 2011. Similarly, the maximum value is 1583 which occurs in November, 2017.

The yearly mean value, the variance, the coefficient of variations, maximum and minimum over the twelve months for each year from 2009 to 2018 of the US dollar series are presented in Table (2.6).

Table (2.6)

Yearly Average Kyats per US Dollar

Year	Mean	Variance	C.V	Maximum	Minimum
2009	1070.75	2287.69	46.80	1137	1000
2010	965.00	2695.17	35.80	1020	855
2011	813.08	1951.41	41.67	883	742
2012	840.83	536.97	156.59	878	813
2013	933.83	2488.81	37.52	983	854
2014	985.33	491.72	200.38	1028	962
2015	1169.92	13059.24	8.96	1309	1025
2016	1241.08	3407.41	36.42	1365	1175
2017	1442.00	8628.67	16.71	1583	1350
2018	1441.25	9880.52	14.59	1573	1330

From Table (2.6), it can be seen that the yearly means vary from 813.08 in 2010 to 1442 in 2017. The variance of each year varies from 491.72 to 9880.52 and coefficient of variation for each year lies between 14.59 percent and 200.38 percent.

CHAPTER III

THEORETICAL BACKROUND

3.1 Simple Linear Regression Model

Simple linear regression is a statistical method for obtaining a formula to predict values of one variable from another whether there is a causal relationship between the two variables. Simple regression analysis indicates that there is only one independent variable.

The simple regression model is

$$Y_i = \beta_0 + \beta_1 X_i + \varepsilon \tag{3.1}$$

where

$Y_i =$ Value of the dependent variable.

β_0= intercept

$\beta_1 =$ Slope

$X_i =$ Value of the independent variable.

$\varepsilon =$ Random error term

Firstly, the simple linear regression requires that the relationship between the independent and dependent variable to be linear. The linearity assumption can be tested with scatter diagram.

Secondly, it requires that the errors between observed and predicted variable (i.e. the residuals of the regression) should be normally distributed. This assumption may be checked by looking at a histogram or Normal P-P plot.

The last assumption of simple linear regression is homoscedasticity. A scatter plot of residuals versus predicted values is good way to check for homoscedasticity. If there should be no clear pattern in the distribution, the data is homoscedasticity. If there is a cone-shaped pattern, the data is heteroscedastic.

3.2 Testing the Overall Significance of a Simple Regression Model

In simple regression analysis, one is often concerned with the nature and significance of the relation between the dependent variable and independent variable. One needs to find out the relative importance of the effect of a given independent variable on the dependent variable.

The F test is used to determine whether there exists a significant relationship between the dependent variable and independent variable in the model. The overall F-test is used to test the significance of overall simple regression model. The ANOVA procedure test the null hypothesis that the β value is zero against the alternative that at least one β is not zero.

Table (3.1)

ANOVA Table for General Linear Regression Model

Sources of variation	Sum of Square	Degree of Freedom	Mean Square	F
Regression	SSR = $\sum(\hat{Y}_i - \bar{Y})^2$	k	MSR = $\frac{SSR}{k}$	$MSR/_{MSE}$
Residual	SSE = $\sum(Y_i - \hat{Y}_i)^2$	n-k-1	MSE = $\frac{SSE}{n-k-1}$	
Total	SST = $\sum(Y_i - \hat{Y})^2$	n-1		

SSR = Regression Sum of Squares
SSE = Error Sum of Squares
SST = Total Sum of Squares
k = the number of independent variables in the regression model
n-k-1 = the degrees of freedom for residual
MSE = the mean square of error
MSR = Mean Square Error

If F ≥ $F_{\alpha,k,n-k-1}$, reject H_0, otherwise you do not reject it, where $F_{\alpha,k,n-k-1}$ is the critical F value at the α level of significance and k numerator df and (n – k - 1) denominator df.

If the null hypothesis is rejected, it can be concluded that one or more of the parameters in the model is not equal to zero. Thus, the overall relationship between the dependent variable y and the independent variable x is significant. However if the null hypothesis is not rejected, it can be concluded that there is an overall significant relationship and estimated regression equation cannot explain the variation of the dependent variable.

3.3 The Durbin-Waston Statistic

The Durbin-Waston Statistic is used to detect autocorrelation. This statistic measures the correlation between each residual and the residual for the time period immediately preceding it. Equation (3.2) defines the Durbin-Waston statistic,

$$d = \frac{\sum_{t=2}^{n}(\hat{u}_t - \hat{u}_{t-1})^2}{\sum_{t=1}^{t=n}\hat{u}_t^{\,2}} \qquad (3.2)$$

u_t= residual at time period t.

To better understand the Durbin-Waston statistic d, examine the composition of the statistic presented in equation (3.2). The numerator d = $\sum_{t=2}^{n}(\hat{u}_t - \hat{u}_{t-1})^2$ represents the squared difference between two successive residuals, summed from the second value of the n^{th} value. The denominator $\sum_{t=1}^{t=n}\hat{u}_t^{\,2}$ represents the sum of the squared residuals. When successive residuals are positively autocorrelated, the value of d will approach 0. If the residuals are not correlated, the value of d will be closed to 2. If there is negative autocorrelation d will be greater than 2 and could even approach its maximum value of 4.

d_L and d_U are lower and upper limits from the Durbin-Watson's table

Reject H_0 evidence of positive autocorrelation	Zone of indecision	Do not reject H_0 or H_1 or both	Zone of indecision	Reject H_0
0 — d_L	d_L — d_U	d_U — 2 — 4-d_U	4-d_U — 4-d_L	4-d_L — 4

1. H_0: $\rho = 0$ versus H_1: $\rho > 0$. Reject H_0 at α level if d $< d_U$. That is there is statistically significant positive autocorrelation.
2. H_0: $\rho = 0$ versus H_1: $\rho < 0$. Reject H_0 at α level if the estimated (4-d) $< d_U$, that is, there is statistically significant evidence of negative autocorrelation.
3. H_0: $\rho = 0$ versus H_1: $\rho \neq 0$. Reject H_0 at 2α level if d $< d_U$ or (4-d) $< d_U$,that is, there is statistically significant evidence of autocorrelation, positive or negative.

3.4 Remedy of Autocorrelation between Disturbances

Knowing the consequences of autocorrelation, especially the lack of efficiency of OLS estimators, we may need to remedy the problem. The remedy depends on the knowledge one has about the nature of interdependence among the disturbances, that is, knowledge about the structure of autocorrelation.

As a starter, consider the two-variable regression model:

$$Y_t = \beta_1 + \beta_2 X_t + u_t \tag{3.3}$$

And assume that the error term follows the AR (1) scheme, namely,

$$u_t = \rho u_{t-1} + \varepsilon_t \qquad -1 < \rho < 1 \tag{3.4}$$

If the coefficient of first-order autocorrelation is known, the problem of autocorrelation can be easily solved. If Eq (3.3) holds true at time t, it also holds true at time (t-1). Hence,

$$Y_{t-1} = \beta_1 + \beta_2 X_{t-1} + u_{t-1} \tag{3.5}$$

Multiplying Eq (3.5) by ρ on both sides, we obtain

$$\rho Y_{t-1} = \rho\beta_1 + \rho\, \beta_2 X_{t-1} + \rho\, u_{t-1} \tag{3.6}$$

Subtracting Eq (3.6) from Eq (3.3) gives

$$(Y_t - \rho Y_{t-1}) = \beta_1(1-\rho) + \beta_2(X_t - \rho X_{t-1}) + \rho u_{t-1} + \varepsilon_t \tag{3.7}$$

Where $\varepsilon_t = (u_t - \rho u_{t-1})$

We can express Equation (3.7) as

$$Y_t^* = \beta_1^* + \beta_2^* X_t^* + \varepsilon_t \tag{3.8}$$

Where $\beta_1^* = \beta_1(1-\rho)$, $Y_t^* = (Y_t - \rho Y_{t-1})$, $X_t^* = (X_t - \rho X_{t-1})$ and $\beta_2^* = \beta_2$

Regression (3.8) is known as the generalized, or quasi, difference equation. In this differencing procedure we lose one observation because the first observation on Y and X is transformed as follows. $Y_1\sqrt{1-\rho^2}$ and $X_1\sqrt{1-\rho^2}$. This transformation is known as the Prais-Winsten transformation.

ρ Based on Durbin-Watson d Statistic

If the first-difference transformation cannot use because ρ is not sufficiently close to unity, it has an easy method of estimating from the relationship between d and ρ established in the following equation;

$$\hat{\rho} \approx 1-\frac{d}{2} \tag{3.9}$$

Thus, in reasonably large samples one can obtain ρ from (3.9) and use it to transform the data as shown in the generalized difference equation (3.8).

3.5 Test of Seasonality

In the study of seasonality, seasonal variation for each month of the year is usually considered. The following model for the randomized complete block design (Daniel, W.W and Terre, T.C., 1992) will be used in testing seasonality in monthly average gold price and kyats per US dollar price time series.

$$y_{ij} = \mu + \beta_i + \gamma_j + e_{ij} \quad ; \quad 1 \leq i \leq n, 1 \leq j \leq k$$

Where, y_{ij} is a typical value from the overall population,

μ is an known constant,

β_i represents a yearly effect, reflecting the fact that the experimental unit fell in the i^{th} year,

γ_j represents a monthly effect, reflecting the fact that the experimental unit received the j^{th} month and

e_{ij} is a residual component representing all sources of variation other than months and years.

One make three assumptions when use the randomized completed block design. (a) Each observed y_{ij} constitutes an independent random variable of size 1 from one of the kn population represented. (b) Each of these kn populations is normally distributed with mean μ_{ij} and the same variance σ^2. The e_{ij} are independently and normally distributed with mean 0 and variance σ^2. (c) The block and treatment effects are additive. To state this assumption another way, one say that there is no interactions between months and years.

In general, one test

H_0: There is no seasonality.

H_1 : There is a seasonality.

In other words, one test the null hypothesis that the monthly means are all equal which mean that there are no differences in monthly effect.

To analyze the data, the needed quantities are the total sum of squares SST, the sum of square for months SSM, the sum of square for years SSY and the error sum of square SSE. When these sum of squares are divided by the appropriate degree of freedom, one have the mean squares necessary for computing the F statistics. For monthly average gold prices and kyats per US dollar in Myanmar during (2009-2018) data k=12 and n=10 years. The degree of freedom are computed as follows:

Total = Months + Years + Error

(kn - 1) = (k - 1) + (n - 1) + (n - 1) (k - 1)

Where

k = months, n = years

The degrees of freedom for error can be found the following:

$$
\begin{aligned}
(kn-1) - (k-1) - (n-1) &= kn -1- k + 1- n + 1 \\
&= kn - k - n +1 \\
&= k (n-1) - (n-1) \\
&= (k-1) (n -1)
\end{aligned}
$$

Short-cut formulas for computing the required sum of squares are follows:

$$\text{SSM} = \sum_{j=1}^{k} \frac{y_{.j}^2}{n} - \text{C} \qquad ; \; y_{.j} = \sum_{i=1}^{n} y_{ij}$$

$$\text{SSY} = \frac{\sum_{i=1}^{n} y_{i.}^2}{k} - \text{C} \qquad ; \; y_{i.} = \sum_{j=1}^{k} y_{ij}$$

$$\text{SSY} = \sum_{i=1}^{n} \sum_{j=1}^{k} y_{ij}^2 - \text{C}$$

$$\text{SSE} = \text{SST- (SSM + SSY)}$$

Where

$$\text{C} = \frac{y_{..}^2}{nk} \; ; \qquad y_{..} = \sum_{i=1}^{n} \sum_{j=1}^{k} y_{ij}$$

The results of the calculations for the randomized complete block design are presented in the following analysis of variance (ANOVA) Table.

Table (3.2)

ANOVA Table for General Linear Regression Model

Source	S.S	D.F	M.S	F-Ratio
Between Months	SSM	k-1	MSM = SSM/ k-1	F_1=MSM/MSE
Between Years	SSY	n-1	MSY = SSY / n-1	$F_2=MSY/MSE$
Error	SSE	(n-1) (k-1)	MSE = SSE/(n-1)(k-1)	
Total	SST	kn-1		

The computed ratios F_1 with critical value $K_1 = F_{\alpha,(k-1),(n-1)(k-1)}$ is then compared. If this ratios are equal to or exceed the critical values, reject the null hypothesis.

3.6 The Box-Jenkins Methodology

The Box-Jenkins Methodology has been expressed steps for model identification, methods of parameters estimation in the ARIMA models, diagnostic checking and forecasting.

3.6.1 Steps of Model Identification

Consider the general ARIMA (p,d,q) model

$$(1 - \emptyset_1 B - \cdots - \emptyset_p B^p)(1 - B)^d \dot{Z}_t = \theta_0 + (1 - \theta_1 B - \cdots - \theta_q B^q) a_t$$

Model identification refers to the methodology in identifying the required transformations such as variance stabilizing transformation and differencing transformations, the decision to include the deterministic parameter θ_0 when d $\geq$1 and the proper order of p and q for the model.

The following useful steps are used to identify a tentative model.

Step 1. `Plot the time series data and choose proper transformations. In any time series analysis, the first step is to plot the data. One usually gets a good idea about whether the series contains a trend, seasonality, outliers, non-constant variance and other non-normal and non-stationary phenomena. This understanding of ten provide a basis for postulating a possible data transformation.

Step2. Compute and examine the sample ACF and the sample PACF of the original series to further confirm a necessary degree of differencing. Some general rules are:

1. If the sample ACF decays very slowly and the sample PACF cuts off after lag 1 it indicates that differencing is needed. Try taking the first differencing (1-B)z_t.
2. More generally, to remove non-stationarity that one may need to consider a higher order differencing $(1-B)^d\dot{z}_t$ for d>1. In most cases, d is either 0, 1 or 2.

Step3. Compute and examine the sample ACF and PACF of the properly transformed and differenced series to identify the order of p and q, where p is the highest order in AR polynomial (1 - $\emptyset_1 B - \cdots - \emptyset_p B^p$) and q is the highest order in MA polynomial (1 - $\theta_1 B - \cdots - \theta_q B^q$). Usually the needed orders of these p and q less than or equal to 3.

It is useful and interesting to note that a strong duality exists between the AR and MA model in terms of their ACFs and PACFs. To build a reasonable ARIMA model, we need a minimum of n=50 observations and the number of sample ACF and PACF to be calculated should be about $\frac{n}{4}$, although occasionally for data of good quality one may be able to identify an adequate model with a smaller sample size. We identify the order p and q by matching patterns in the sample ACF and PACF with the theoretical patterns of known models.

Table (3.3)

Characteristics Behavior of ACF, PACF for AR, MA and ARMA process

Processes	**Autocorrelation**	**Partial Autocorrelation**
AR(P)	Infinite (damped exponentials and / or damped sine waves). Tail off according to $\rho_j = \emptyset_1\rho_{j-1} + \emptyset_2\rho_{j-2} + - \cdots - \emptyset_p\rho_{j-p}$	Finite Spike at lag 1 through p, then cut off
MA(q)	Finite Spike at lag 1 through q, then cuts off	Infinite (dominated by damped exponentials and/ or damped sine waves) Tail off.
ARMA(p,q)	Infinite (damped exponentials and/ or damped sine waves after first q-p lags). Irregular pattern at lag 1 through q, then tails off according to $\rho_j = \emptyset_1\rho_{j-1} + \emptyset_2\rho_{j-2} + - \cdots - \emptyset_q\rho_{j-p}$	Infinite (damped exponentials and/ or damped sine waves after first p-q lags). Tail off

Source: Univariate and Multivariate Methods (William W.S. Wei)

Step 4. Test the deterministic trend term θ_0 when d > 0 for a nonstationary model, $\emptyset_p\,(B)(1-B)^d\dot{z_t} = \theta_0 + \theta_q(B)a_t$, Where the parameter θ_0 is usually omitted so that it is capable of representing series with random changes in the level, slope or trend. However, the differenced series contains a deterministic trend mean, we can test for its inclusion by comparing the sample mean $\overline{w}$ of the differenced series $W_t = (1-B)^d\dot{z}_t$ with its approximates standard error $S_{\overline{w}}$.

To derive $S_{\overline{w}}$

$\lim_{n\to\infty} n \operatorname{Var}(\overline{w}) = \sum_{j=-\infty}^{\infty}\gamma_j$, and hence

$$\sigma_{\overline{w}}^{\,2} = \frac{\gamma_0}{n}\sum_{j=-\infty}^{\infty}\rho_j = \frac{1}{n}\sum_{j=-\infty}^{\infty}\gamma_j = \frac{1}{n}\gamma(1) \qquad (3.10)$$

Where

γ (B) $=\sum_{-\infty}^{\infty}\gamma_k B^k = \sigma_a^{\,2}\,\psi(B)\psi(B)^{-1}$ is the autocovariance generating function and γ (1) is it value at B=1. Thus, the variance and hence the standard error for $\overline{w}$ is model dependent. For the ARIMA (1, d, 0) model, $W_t = a_t$

$$(1-\emptyset \mathrm{B})(1-B)^d \dot{z_t} = a_t$$

$$(1\text{-}\emptyset \mathrm{B})W_t = a_t \quad ; \qquad W_t = \frac{1}{(1-\emptyset \mathrm{B})} a_t$$

MA representation, $Z_t = \psi(B)a_t$

$$\psi(B) = \frac{1}{(1-\emptyset \mathrm{B})}$$

Autocovariance generating function is

$$\gamma(B) = \sigma_a{}^2 \psi(B)\psi(B)^{-1} = \frac{\sigma_a{}^2}{(1-\emptyset \mathrm{B})(1-\emptyset B^{-1})}$$

Where, B = 1, $\gamma(1) = \frac{\sigma_a{}^2}{(1-\emptyset)^2}$

$$\sigma_{\overline{w}}{}^2 = \frac{\sigma_a{}^2}{n(1-\emptyset)^2}$$

$$= \frac{\sigma_w{}^2(1-\emptyset^2)}{n(1-\emptyset)^2} \qquad (\because \sigma_w{}^2 = \frac{\sigma_a{}^2}{(1-\phi)^2})$$

$$= \frac{\sigma_w{}^2}{n}\left[\frac{1+\emptyset}{1-\emptyset}\right]$$

$$= \frac{\sigma_w{}^2}{n}\left[\frac{1+\rho_1}{1-\rho_1}\right] \qquad (\because \ \emptyset = \rho_1) \tag{3.11}$$

The required standard error is

$$S_{\overline{w}} = \sqrt{\frac{\hat{\gamma}_0}{n}\left[\frac{1+\hat{\rho}_1}{1-\hat{\rho}_1}\right]} \tag{3.12}$$

Expression of $S_{\overline{w}}$ for other models can be derived similarly. However, at the model identification phase, since the underlying model is unknown, most available software use the approximation.

$$S_{\overline{w}} = \left[\frac{\hat{\gamma}_0}{n}(1 + 2\hat{\rho}_1 + 2\hat{\rho}_2 + \cdots + 2\hat{\rho}_K\right]^{1/2} \tag{3.13}$$

Where, $\hat{\gamma}_0$ is the sample variance and $\hat{\rho}_1, \hat{\rho}_2, \ldots, \hat{\rho}_K$ are the first K significance sample autocorrelation functions of (W_t).

Under null hypothesis $\rho_K = 0$; for k ≥ 1

$$S_{\overline{w}} = \sqrt{\frac{\hat{\gamma}_0}{n}} \tag{3.14}$$

Alternatively, one can include θ_0 initially and discard it at the final model estimation if the preliminary estimation result is not significant.

3.6.2 Methods of the Estimation of the parameters in the ARIMA Models

After a model is identified for a given time series it is important to obtain efficient estimate of the parameter. To obtain the estimate of the parameter $\emptyset_1, \emptyset_1, \dots,$ $\emptyset_p$, $\theta_1, \theta_2, \dots, \theta_q$ we may use the least squares method since t_i can be proved that the least squares estimate are approximately maximum likelihood estimates in ARIMA model. If the least squares method is used, to choose those value of $\emptyset'_s$ and θ'_s of the parameter set which minimize the sum of squared error $\sum_{t=1}^{n} a_t{}^2$ obtained from the observed time series.

There arise two difficulties in estimation stage:

(i) The equation involve unknown starting value, $(W_0, W_{-1}, \dots, W_{1-p}, a_0, a_{-1}, \dots, a_{1-q})$

(ii) The sum of squared errors function is in general nonlinear in the coefficients to be estimated.

There are two approaches to (i)

(a) The unknown starting values are simply replaced by some appropriately assumed value and estimation is conditional on these assumed starting value.

(b) The estimation is based on estimated starting value from the sample data. This unconditional approach is more efficient than the conditional approach.

3.6.3 Diagnostic Checking

The series model building is an iterative procedure. It starts with model identification and parameter estimation. After parameter estimation, we have to assess model adequacy by checking whether the model assumptions are satisfied. The basic assumption is that the $\{a_t\}$ are white noise. The $a_t{}'$ are uncorrelated random shocks with zero mean and constant variance. For any estimated model, the residuals are estimates of these unobserved white noise. Hence, model diagnostic checking is accomplished through a careful analysis of the residual series $(\hat{a}_t)$. Because this residual series is the product of parameter estimation, the model diagnostic checking is usually contained in the estimation phase of a time series package.

(1) To check whether the errors are normally distributed, one can construct a histogram of the standardized residuals $\frac{\hat{a}_t}{\widehat{\sigma_a}^2}$ and compare it with the standard normal distribution using the chi-square goodness of fit test.

(2) To check whether the variance is constant, one can examine the plot of residuals or evaluate the effect of different h value via Box-Cox method.

(3) To check whether the variance residuals are approximately white noise, one can compute the sample ACF and sample PACF (or IACF) of the residuals to see whether they do not form any pattern and are all statistically insignificant.

Another useful test is the portmanteau Lack of fit test. This test uses the entire sample ACF's to check null hypothesis.

Hypothesis H_0: $\rho_1 = \rho_2 = \cdots = \rho_k = 0$

The residual are not autocorrelated.

H_1: At least one autocorrelation are not equal.

Test statistic : Q = n (n + 2)$\sum_{K=1}^{K}(n-k)^{-1}\,\hat{\rho}^2{}_k$

Critical value : K = $\chi^2{}_{(\alpha,K-m)}$

Decision Rule : Q $> K$; Reject H_0

Otherwise ; Accept H_0

Where, m = the number of parameter estimated in the model. Based on the residual results, if the model is inadequate, a new model can be easily derived.

3.7 Seasonal Time Series Models

In this section, seasonal time series are discussed. These models were developed by Box and Jenkins (1974) and have been successfully applied to many time series with seasonal variation.

3.7.1 The Seasonal Autoregressive Process of Order P, SAR (P)

The seasonal autoregressive process of order P (1) if s is the number of observation per seasonal period then the order of the AR process is an integer multiple of s and (2) the non-zero coefficients are those with subscripts that are an integer multiple of s.

The SAR (P) model is

$$\dot{z}_t = \phi_s\,\dot{z}_{t-s} + \phi_2\dot{z}_{t-2s} + \cdots + \phi_p\,\dot{z}_{t-ps} + a_t \qquad (3.15)$$

Where, P is the largest multiple of s presented in the model. To provide special notation for seasonal model, and so if we let

$$\emptyset_{js} = \Phi_{js} \tag{3.16}$$

So that Equation (3.15) becomes,

$$\dot{Z}_t = \phi_1 \dot{Z}_{t-1} + \phi_2 \dot{Z}_{t-2s} + \cdots + \phi_p \dot{Z}_{t-ps} + a_t \tag{3.17}$$

Referred to as seasonal AR process of order P, the seasonal autoregressive model in equation (3.17) expresses the current value of the process Z_t as finite weighted sum of P previous values $Z_{t-s}, Z_{t-2s}, \dots, Z_{t-Ps}$ of the process plus random shock a_t.

Here, E$[a_t]$ = 0 for all t

V$[a_t] = E[a_t{}^2]$ = $[\sigma_t{}^2]$ for all t, and

Cov $[a_t , a_t{}']$ =0 for all t $\neq t'$

The Autoregressive Function of SAR (P) Process is

$$\gamma_k = \phi_1 \gamma_{k-s} + \phi_1 \gamma_{k-2s} + \cdots + \phi_p \gamma_{k-Ps} \quad ; \text{k=1, 2,…, Ps} \tag{3.18}$$

The autocorrelation function (ACF) satisfies the difference equation.

$$\rho_k = \phi_1 \rho_s + \phi_2 \rho_{k2s} + \cdots + \phi_p \rho_{Ps} \quad ; \text{k=1, 2, …, Ps} \tag{3.19}$$

The autocorrelation function (ACF) will be non-zero at only lags that are integer multiples of s. The autocorrelation at seasonal lags persists indefinitely, although with declining intensity.

The First Order Seasonal Autoregressive SAR (1) Process

Consider the SAR (1) model (P=1)

$$\dot{z}_t = \phi_1 \dot{z}_{t-s} + a_t$$

Where, $a_t{}'s$ are random shocks satisfying with usual assumptions.

The autocovariance function of the SAR (1) process is obtained by substituting P=1 in Equation (3.15).

The Autocovariance function is

$$\gamma_k = \phi_1 \gamma_{k-s} \quad ; \text{k=1,2,…,Ps}$$

The autocovariance function of the SAR(1) process is

$$\gamma_k = \begin{cases} \dfrac{\sigma_a{}^2}{1-\Phi_1{}^2} & ; k = 0 \\ \Phi_1{}^k \gamma_0 & ; k = s, 2s, 3s, \dots \\ 0 & ; k = 0, s, 2s, 3s, \dots \end{cases}$$

The autocorrelation function of the SAR(1) process is,

$$\rho_k = \begin{cases} 1 & ; k = 0 \\ {\Phi_1}^k & ; k = s, 2s, 3s, \dots \\ 0 & ; k \neq 0, s, 2s, 3s, \dots \end{cases}$$

Therefore, the autocovariance and the autocorrelatons are non-zero at lags that are integer multiples of s.

The Second Order Seasonal Autoregressive SAR (2) Process

Consider SAR (2) model (P=2)

$$\dot{z}_t = \phi_1 \dot{z}_{t-s} + \phi_2 \dot{z}_{t-2s} + a_t$$

Where, a_t's are random shocks satisfying with usual assumptions. The autocovariance function of the SAR (2) model is obtained by substituting P=2 in Equation (3.15).

The Autocovariance Function is

$$\gamma_k = \phi_1 \gamma_{k-s} + \phi_2 \gamma_{k-2s} \quad ; \text{k=1,2,…,Ps}$$

Therefore, The autocovariance function of the SAR (2) process is

$$\gamma_k = \begin{cases} \left[\frac{1-\Phi_2}{1+\Phi_2}\right] \left[\frac{{\sigma_a}^2}{(1-\Phi_2)^{2-}\,{\Phi_1}^2}\right] & ; k = 0 \\ \left[\frac{\Phi_1}{1-\Phi_1}\right] \gamma_0 & ; k = s \\ \left[\frac{{\Phi_1}^2}{1-\Phi_2} + \Phi_2\right] \gamma_0 & ; k = 2s \\ \Phi_1 \gamma_{k-s} + \Phi_2 \gamma_{k-2s} & ; k = 3s, 4s, \dots \\ 0 & ; k = 0, s, 2s, 3s, \dots. \end{cases}$$

The autocorrelation function of the SAR (2) process is

$$\rho_k = \begin{cases} 1 & ; k = 0 \\ \frac{\emptyset_1}{1-\emptyset_1} & ; k = s \\ \frac{{\emptyset_1}^2}{1-\emptyset_2} + \emptyset_2 & ; k = 2s \\ \Phi_1 \gamma_{k-s} + \Phi_2 \gamma_{k-2s} & ; k = 3s, 4s, \dots \\ 0 & ; k = 0, s, 2s, 3s, \dots. \end{cases}$$

Therefore, the autocovariance and the autocorrelation function are non-zero at lags that are integer multiple of s.

3.7.2 The General Multiplicative Seasonal ARIMA Model

Box and Jenkins (1976) proposed that the correlation between observations within seasonal periods may be introduced by supposing that the noise input to the seasonal ARIMA is serially correlated rather than independent. In particular, they suggest that Z_t be generated by the seasonal model of the form,

$$\Phi(B^s)\nabla_s{}^D X_t = \Theta\,(B^s)\alpha_t \tag{3.20}$$

Where $\nabla_s = 1 - B^s$ and $\phi(B^s)$, $\Phi(B^s)$ are polynominals in B^s of degrees P and Q, respectively, and satisfying stationary and invertibility conditions. Similarly, a model

$$\Phi(B^s)\nabla_s{}^D X_{t-1} = \Theta\,(B^s)\alpha_{t-1} \tag{3.21}$$

might be used to link the current behavior of a month (e.g. April) with previous April observations, and so on, for each of the twelve months. Moreover, it would usually be reasonable to assume that the parameter Φ and Θ contained in these monthly models would be approximately the same for each month. Therefore, such a model relationship,

$$\emptyset(B)\nabla^d \alpha_1 = \theta(B)a_t \tag{3.22}$$

Where a_t is a white noise process, and $\emptyset(B)$, $\theta(B)$ are polynomials in B of degrees p and q respectively, and satisfying stationary and invertible condition and $\nabla = \nabla_1$=1-B.

Combining Equation (3.20) and (3.22), the following Box-Jenkins general multiplicative SARIMA model is finally obtained as,

$$\emptyset(B)\Phi_p(B^s)\nabla^d\nabla^D{}_s X_t = \theta_q(B)\Theta_Q(B^s)a_t \tag{3.23}$$

In Equation (3.25), the subscripts p,P,q,Q have been added to remind the orders of the various operators. $\emptyset(B)$ and $\theta_q(B)$ are the regular autoregressive and moving average factors and $\Theta_Q(B^s)$ are the seasonal autoregressive and moving average factors (polynomials). The stationary series (1 - $B^S)^D$ (1 - $B)^d$ $\dot{Z}_t$ may have non-zero mean. The degree of seasonal differencing D and consecutive differencing d will usually be either 0 or 1. This model is often denoted as (p,d,q) $\times(P,D,Q)_s$ and s refer to the seasonal period.

The seasonal model is multiplicative in the sense that the observed data result from the successive filtering of the random noise series a_t through the non-seasonal filter (3.22) and seasonal filter (3.23).

CHAPTER IV

ANALYSIS OF GOLD PRICE AND EXCHANGE RATE IN MYANMAR

In this chapter, the application of simple regression model and seasonal ARIMA models were demonstrated on the basic of secondary data which can be obtained several issues of selected monthly economic indicators.

4.1 Simple Regression Model for Average Gold Prices of Myanmar

The simple regression model is constructed by using the ordinary least square method. In fitting simple linear regression model, kyats per us dollar was used as explanatory variable and the prices of gold was used as dependent variable.

The following simple linear regression model for average gold prices is

$GP_t = \beta_0 + \beta_1 PUS_t + \varepsilon$

GP_t = the prices of average gold in month t

PUS_t = the price of average kyats per US dollar in month t

ε = error term

β_0, β_1 = the unknown parameters

4.1.1 Correlation between Average Prices of Gold and Kyats per US Dollar

Correlation determines the strength of the relationship. That is, while regression decreases the basic nature of the relationship between the average price of gold and average price of US dollar in Myanmar, correlation measures how strong that relationship is.

Test for Correlation Coefficient

(i) Hypotheses:

Null Hypothesis $H_0: \rho = 0$

There is no relationship between kyats per US dollar and average prices of gold.

Alternative Hypothesis $H_a: \rho \neq 0$

There is relationship between kyats per US dollar and average prices of gold.

(ii) Test Statistic

r^2 = 0.531, r = 0.728, n = 120

$$S_r = \sqrt{\frac{1-r^2}{n-2}} = \sqrt{\frac{1-0.531}{120-2}} = 0.0630$$

$$t = \frac{r}{s_r} = \frac{0.728}{0.0630} = 11.5556$$

(iii) Critical value

k = $t_{\alpha/2},(n - 2) = t_{0.05/2},(120 - 2) = t_{0.025},(118) = 1.962$

(iv) Decision Rule: If t ≥ k ; reject H_0

Otherwise ; accept H_0

(v) Decision : t = 11.5556 > k = 1.962 (reject H_0)

(vi) Conclusion;

Since H_0 is rejected, there is a relationship between kyats per US dollar and average prices of gold in Myanmar.

Table (4.1)

Pearson Correlation Coefficient between average prices of gold and kyats per US dollar

		Goldprice	USDollar
Pearson Correlation	Goldprice	1.000	.728
	USDollar	.728	1.000
Sig. (1-tailed)	Goldprice	.	.000
	USDollar	.000	.
N	Goldprice	120	120
	USDollar	120	120

Source: SPSS Output

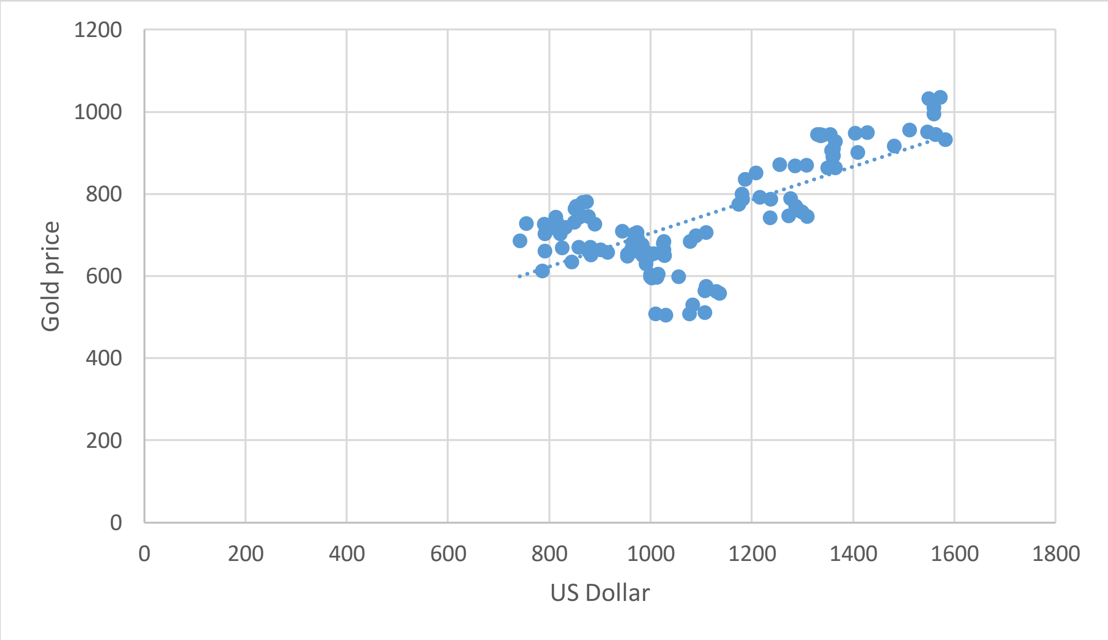
Table (4.1) displays Pearson correlation coefficients, there is strongly positive correlation between average prices gold and kyats per US dollar.

4.1.2 Checking for Linearity between Prices of Average Gold and Kyats per US Dollar

The first assumption is that there is a linear relationship between the independent and dependent variable. The linearity assumption can be tested using a scatter plot.

Figure (4.1)

Scattered Graph of Average Gold Prices and Average Kyats per US Dollar



The scatterplot above suggests that there is an upwards trend in the data, indicating a linear relationship. It rises from left to right, meaning that the dependent variable (average gold prices) increases as the independent variable (average kyats per US dollar) increases. So there is positive correlation can be assumed.

4.1.3 Testing for the Overall Simple Linear Regression Model

Table (4.2) shows the analysis of variance (ANOVA) table for testing the relationship between average gold prices and average exchange rate.

Table (4.2)

ANOVA Table

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	1007351.130	1	1007351.130	133.436	.000***
Residual	890821.114	118	7549.331		
Total	1898172.244	119			

Source: SPSS Output

*** denote statistically significance at 1% level

According to above table, the value of F is 133.436 and the probability value (0.000) is smaller than 0.01. It can be said that the test is significant at 1 percent level.

4.1.4 Fitted Regression Model

The result of the fitting regression model for average gold prices during January 2009 to December 2018 is presented in the following table (4.3).

Table (4.3)

Results for Simple Linear Regression Analysis between GP_t and PUS_t

Variable	Coefficient	t-statistic	p-value	Std.Error
Constant	297.667	7.603	0.00***	39.152
PUS_t	0.406	11.551	0.00***	0.035
F-statistic	133.436		0.00***	
Adjusted R Square	0.527			
R Square	0.531			
N	120			
Durbin- Watson stat	0.057			

Sources: SPSS Output

***denote statistically significant at 1% levels

The estimated simple linear regression model for average gold prices can be expressed as follows:

$$GP_t = 297.667 + 0.406PUS_t \quad (4.1)$$

Se = (39.152) (0.035)

P-value = (0.000) (0.000)

R^2 = 0.531, Adjusted R^2 = 0.527, F = 133.436

From the above equation, it is found that kyats per US dollar has positive effects on average gold prices. If the intercept β_0 = 297.667, this means that average gold prices is β_0 = 297.667 when kyats per US dollar is equal to zero. If the slope β_1= 0.406, this means that when one kyat increases in kyats per US dollar 0.406 increase in average gold prices. The coefficients of kyats per US dollar is statistically significance at 1% level (p = 0.000). It can be said that, there exists linear relationship between average gold prices and kyats per US dollar.

According to the result, the R^2 value and adjusted R^2 value are 0.531 and 0.527 respectively. The R^2 value of 0.531 means that about 53% of the variation in the average gold prices is explained by the kyats per US dollar.

The computed value of Durbin-Watson d statistic is 0.057 is lower than the tabulated value of d_L = 1.611 at 1 percent significance level. This statistic indicates that the error terms are correlated so error correlation can be deleted by using Generalized Least Squares (GLS).

4.1.5 Detect Autocorrelation of between Disturbances

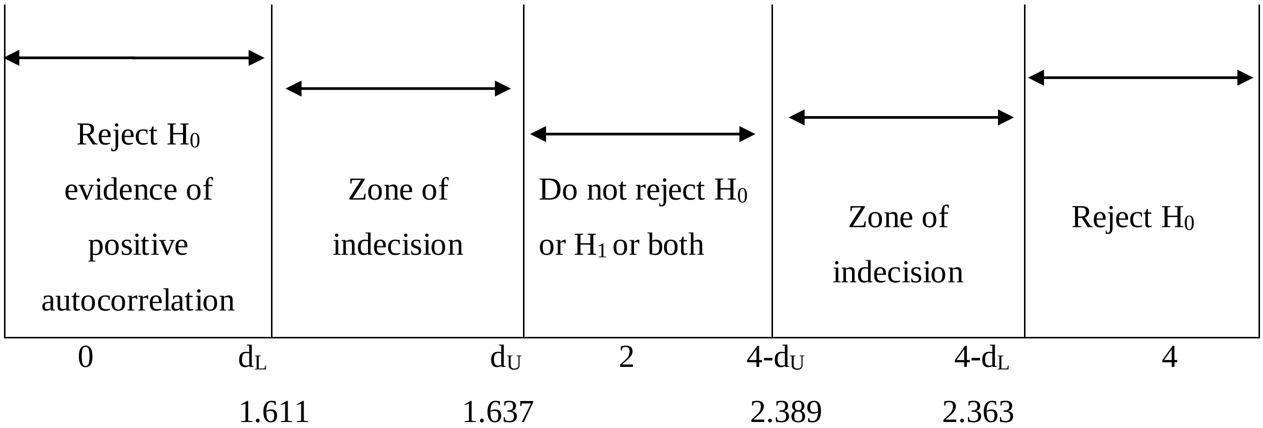
This problem can be deleted by using Generalized Least Square (GLS) Transformation. The value of estimated autocorrelation parameter $\hat{\rho}$ = 0.9715. On fitting the transform equation to the variables Y_t^*= (Y_t – 0.9715Y_{t-1}) and X_t^*= (X_t – 0.9715X_{t-1}).

Durbin–Watson Test

Durbin–Watson test is used to determine whether the residuals were autocorrelated or not. The Durbin-Watson statistics is used to test the hypothesis of no autocorrelation.

Figure (4.2)

Durbin-Watson Statistic of average gold price and kyats per US dollar



The Durbin-Watson d statistic for this regression is 1.641. The critical values of Durbin-Watson d test are d_L = 1.611 and d_U = 1.637 at 1 percent significance level. d_U < d < 4-d_U, accept H_0: there is no serial correlation. The statistic 1.641 is within 1.637 and 2.389, thus there is no positive and negative correlation between disturbances.

4.1.6 Testing for Normality of Disturbances

The second assumption is those disturbance are normally distributed with mean zero and constant variance. To check the normal assumption, tests of normality, Histogram and normal probability plot of the disturbances are used in this analysis. The tests of normality of disturbances for average gold prices can be constructed in the following Table (4.4).

Table (4.4)

Test for Normality of Disturbances

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Standardized Residual	.043	120	.200	.990	120	.496

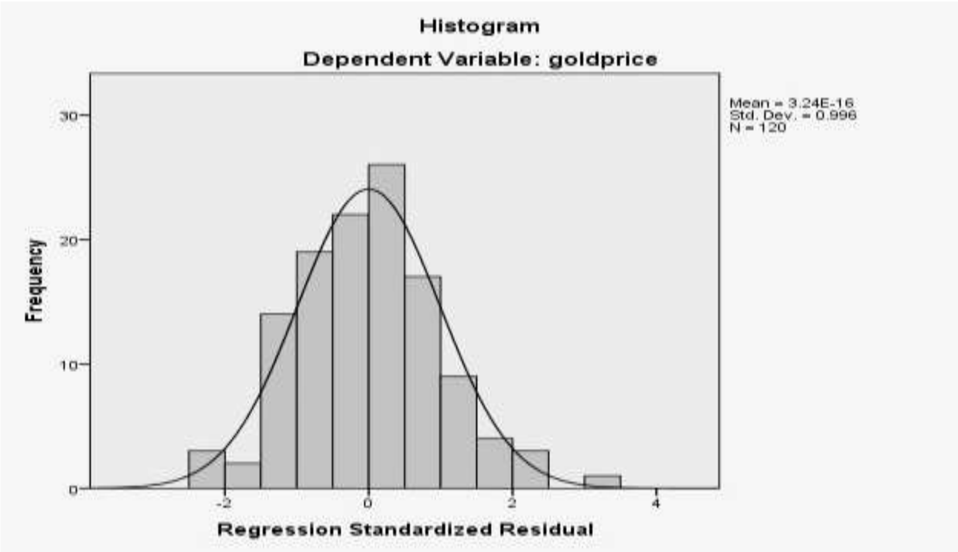
Source: SPSS Output

For both the Kolmogorov- Smirnov test and Shapiro-Wilk test, the computed significance level (0.2 and 0.496) are greater than 0.05. Therefore, normality can be assumed.

The Histogram of disturbances and the Normal plot of disturbances for the value of average prices of gold are shown in Figure (4.3) and Figure (4.4).

Figure (4.3)

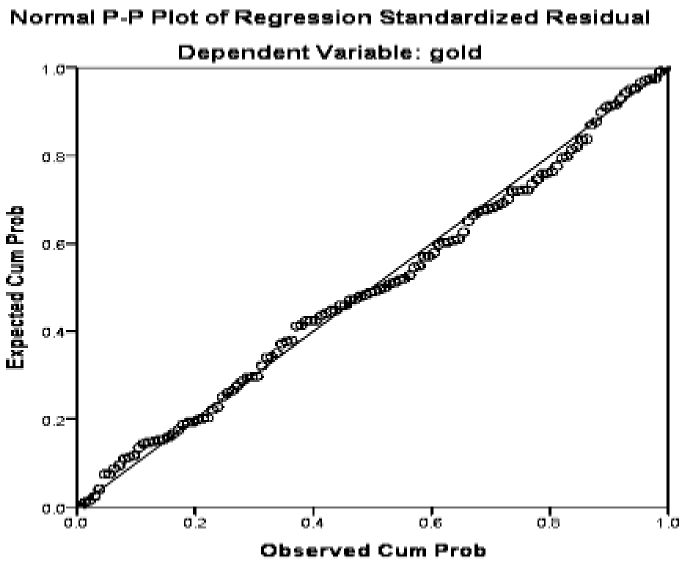
Histogram of Disturbances



According to Figure (4.3), it can be concluded that the normality assumption appears to be generally reasonable.

Figure (4.4)

Normal Plot for Disturbances



Another diagnostic test for normality is the normal P-P plot. The normal distribution form 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 normality assumption is met.

4.1.7 Harvey Test of Heteroskedasticity

The following table (4.5) is the pre – test for homoscedasticity to test the hypothesis of kyat per US dollar in Myanmar.

Table (4.5)

Result of Pre – test (Heteroskedasticity Test)

	F- statistic	p-value
Harvey test	1.3093	0.2548

Source: Eview output

The assumption of homogeneity of variance is tested by the Harvey test, which test the hypothesis test the population variances are equal. The pre-test of F-value is 1.3093 and the corresponding level of significance is ($p = 0.2548 > \alpha = 0.05$). Thus the assumption of homogeneity of variance has not been violated.

4.2 Stochastic Model for Gold Price Series in Myanmar

Stochastic model for average gold price series in Myanmar cover 10 years from January 2009 to December 2018. The series consists of 120 observations.

4.2.1 Test of Seasonality

The result of calculation for testing the seasonality in the gold price series in Myanmar (2009-2018) are shown in Table (4.6).

Table (4.6)

ANOVA Table for Average Gold Price Series in Myanmar

Sources	Sum of Square	df	Mean Square Error	F-ratio
Between month	SSM = 52644.51	11	MSM = 4785.4655	6.9915
Between year	SSY = 1777764.335	9	MSY =197528.877	
Error (Residual)	SSE = 67767.815	99	MSE = 684.5234	
Total	SST	119		

At 5% level of significance, the critical value K = $F_{(0.05,11,99)}$ is 1.8866. Since the computed F-value = 6.9915 is greater than K = 1.8866, it can be concluded that the monthly data of average gold price series in Myanmar exists seasonality.

4.2.2 Identification

The sample autocorrelation function (ACF) and sample partial autocorrelation function (PACF) were found for the original series z_t were shown in Table (4.7) and Figure (4.5) along with the confidence limits calculated as $\gamma_k \pm 2\,\widehat{S.E}\,(\gamma_k)$
where

$$\hat{\rho}_k = \gamma_k = \frac{\sum_{i=1}^{k}(z_t-\bar{z})\,(z_{t+k}-\bar{z})}{\sum_{i=1}^{k}(z_t-\bar{z})^2} \quad , \qquad \bar{z} = \frac{\sum_{t=1}^{n} z_t}{n}$$

and

$$\widehat{S.E(\gamma_k)} \approx \frac{1}{n}(1 + 2\textstyle\sum_1^q \gamma_j{}^2)^{1/2} \ , \quad j > q$$

Table (4.7)

Estimated Autocorrelation and Partial Autocorrelation Function for Original Series of Average Gold Prices in Myanmar

(a) $\hat{\rho}_k$ For $\{Z_t\}$ $\bar{Z}$ = 740.5549 S_z = 126.2974 n = 120

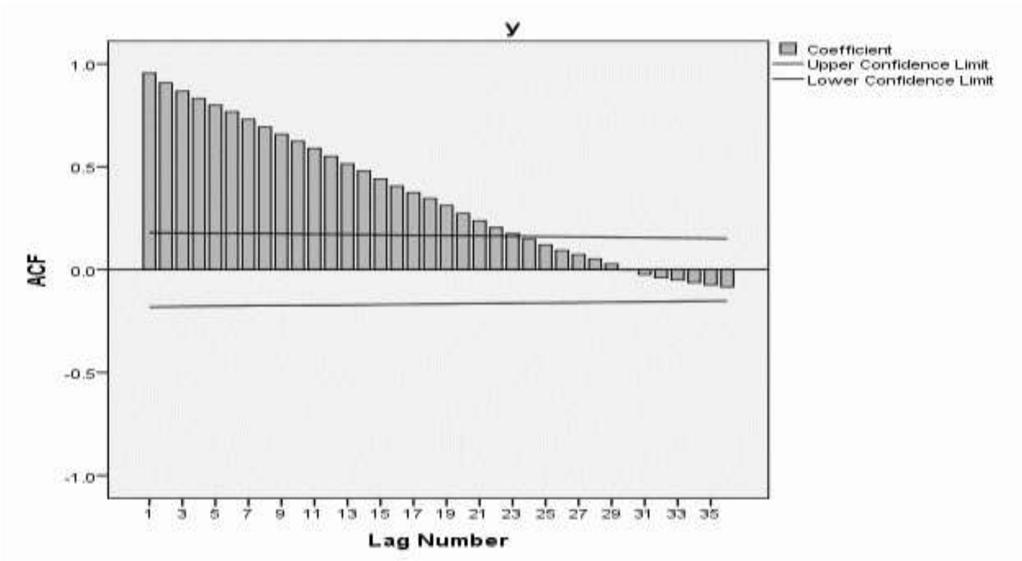
Lag k	1	2	3	4	5	6	7	8	9	10	11	12
1-12	.954	.905	.859	.819	.785	.752	.718	.682	.651	.622	.591	.556
S.E	.090	.090	.089	.089	.089	.088	.088	.087	.087	.087	.086	.086
13-24	.519	.481	.439	.399	.365	.336	.304	.267	.235	.207	.180	.157
S.E	.085	.085	.085	.084	.084	.083	.083	.083	.082	.082	.081	.081
25-36	.129	.100	.075	.048	.022	-.009	-.029	-.042	-.049	-.058	-.067	-.074
S.E	.081	.080	.080	.079	.079	.078	.078	.078	.077	.077	.076	.076

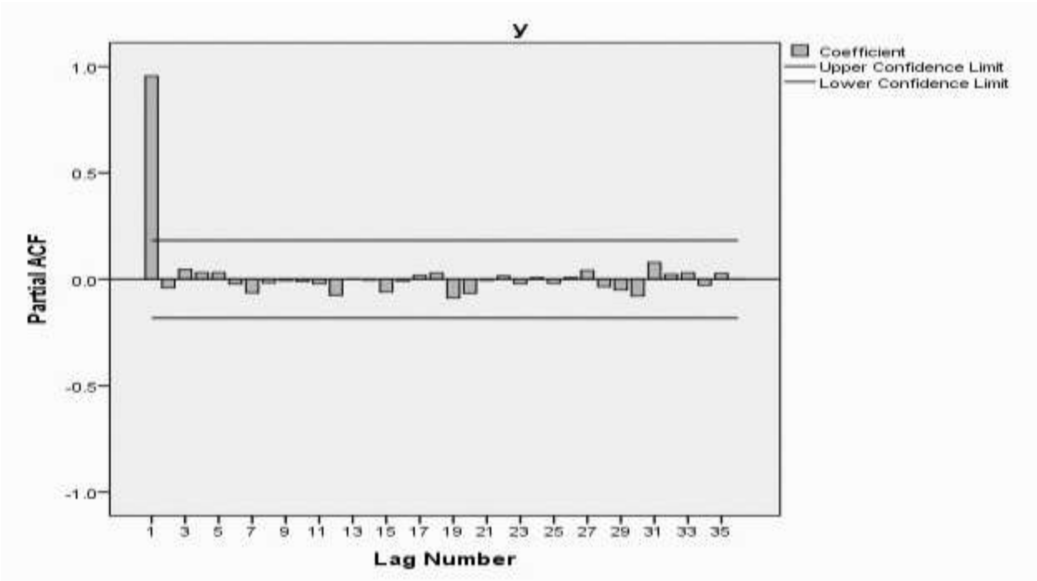
(b) $\widehat{\emptyset}_{kk}$ For $\{Z_t\}$ $\bar{Z}$ = 740.5549 S_z= 126.2974 n =120

Lag k	1	2	3	4	5	6	7	8	9	10	11	12
1-12	.945	-.062	.019	.027	.059	-.021	-.028	-.017	.030	-.009	-.025	-.069
S.E	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091
13-24	-.034	-.023	-.089	-.019	.043	.021	-.060	-.070	.035	.028	-.028	.010
S.E	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091
25-36	-.050	-.007	.009	-.050	-.028	-.079	.112	.022	.057	-.036	.022	-.010
S.E	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091

Figure (4.5)

Sample Correlogram for Original Series of Average Gold Prices Series in Myanmar





The sample ACF slowly decays and the sample PACF has a single large spike at lag 1. These values indicated that the series is nonstationary and that differencing is called for. To remove nonstationary, the sample ACF of the first difference series ∇Z_t were shown in Table (4.8) and they were displayed in Figure (4.6).

Table (4.8)

Estimated Autocorrelation and Partial Autocorrelation Function for Frist Difference Series of Average Gold Prices in Myanmar

(a) $\hat{\rho}_k$ for $\{W_t = (1-B)Z_t\}$ $\overline{W}$= 4.3838 S_w= 16.9877 n =119

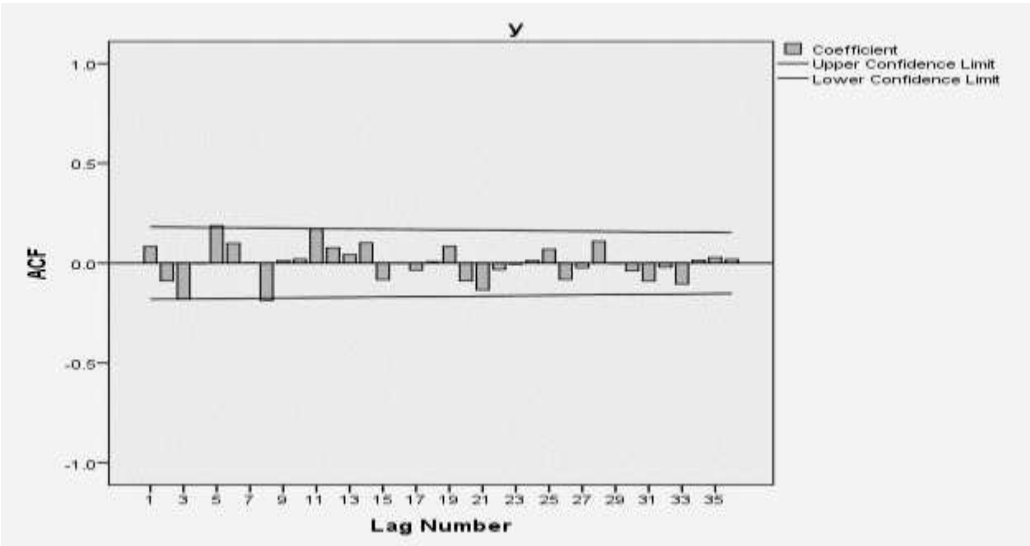
Lag k	1	2	3	4	5	6	7	8	9	10	11	12
1-12	.084	-.090	-.180	-.002	.187	.100	-.188	.012	.019	.172	.077	.043
S-E	.091	.090	.090	.089	.089	.089	.088	.088	.087	.087	.087	.086
13-24	.101	-.082	-.002	-.035	.006	.085	.085	-.089	-.134	-.032	-.005	.012
S-E	.086	.085	.085	.085	.084	.084	.083	.083	.082	.082	.082	.081
25-36	.069	-.081	-.023	.110	-.003	-.038	-.090	-.020	-.104	.015	.028	.019
S-E	.081	.080	.080	.079	.079	.079	.078	.078	.077	.077	.076	.076

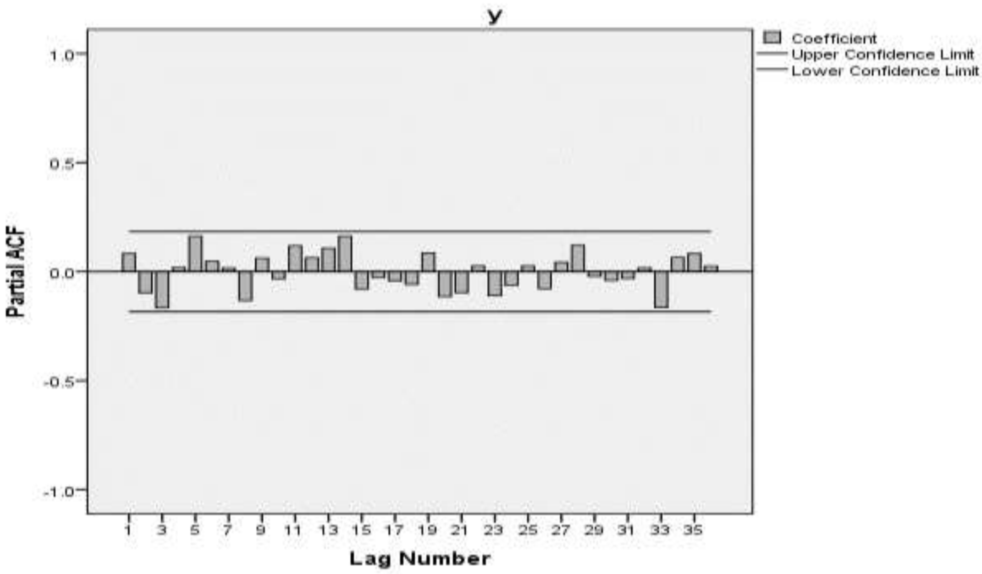
(b) $\widehat{\emptyset}_{kk}$ For $\{W_t = (1-B)Z_t\}$ $\overline{W}$= 4.3838 S_w= 16.9877 n=119

Lag k	1	2	3	4	5	6	7	8	9	10	11	12
1-12	.084	-.097	-.166	.019	.163	.048	.017	-.133	.061	-.033	.118	.063
S-E	.092	.092	.092	.092	.092	.092	.092	.092	.092	.092	.092	.092
13-24	.107	.162	-.080	-.026	-.042	-.059	.087	-.114	-.097	.026	-.111	-.062
S-E	.092	.092	.092	.092	.092	.092	.092	.092	.092	.092	.092	.092
25-36	.026	-.078	.043	.122	-.021	-.040	-.031	.017	-.165	.064	.083	.024
S-E	.092	.092	.092	.092	.092	.092	.092	.092	.092	.092	.092	.092

Figure (4.6)

Sample Correlogram for First Difference Series of Average Gold Price in Myanmar





The value ACF and PACF of the first difference series lie within the confidence band (± 2SE). This indicate that the series are white noise series. Therefore, the ACF and PACF of the $\nabla\nabla_{12}Z_t$ series were obtained and the results are shown in Table (4.9) and Figure (4.7).

Table (4.9)

Estimated Autocorrelation and Partial Autocorrelation Function for Nonseasonal First Difference and Seasonal First Difference Series of Average Gold Price Series in Myanmar

(a) $\hat{\rho}_k$ for $\{W_t = (1-B)(1-B^{12})Z_t\}$ $\bar{W}$ = -0.1202 S_w= 23.6814 n = 107

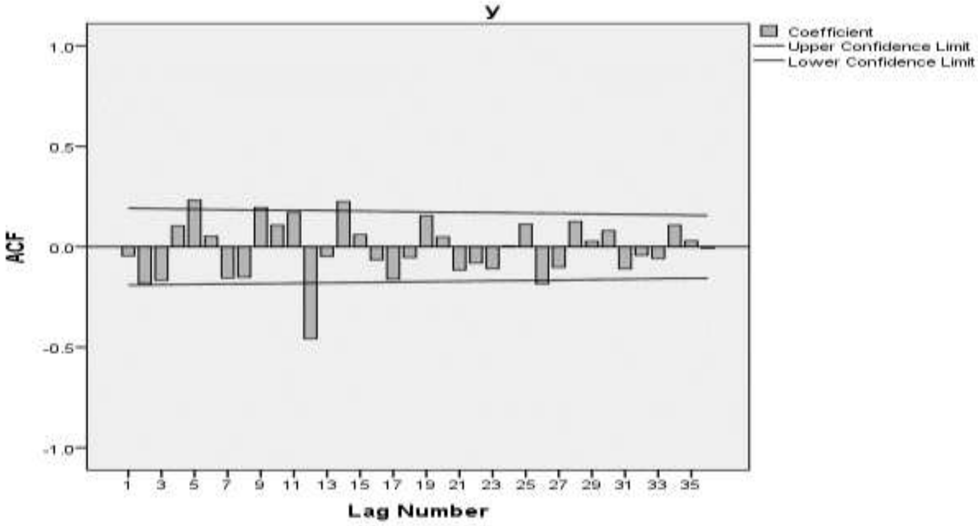
Lag k	1	2	3	4	5	6	7	8	9	10	11	12
1-12	-.040	-.181	-.169	.101	.232	.055	-.156	-.151	.193	.107	.166	-.450
St-E	.095	.095	.094	.094	.094	.093	.093	.092	.092	.091	.091	.090
13-24	-.046	.225	.056	-.065	-.158	-.050	.158	.042	-.115	-.080	-.108	-.003
St-E	.090	.089	.089	.088	.088	.087	.087	.086	.086	.085	.085	.084
25-36	.105	-.179	-.095	.133	.026	.072	-.115	-.040	-.051	.106	.026	-.010
St-E	.084	.083	.083	.082	.082	.081	.081	.080	.080	.079	.079	.078

(b) $\hat{\rho}_k$ for $\{W_t = (1-B)(1-B^{12})Z_t\}$ $\bar{W}$ = -0.1202 S_w= 23.6814 n =107

Lag k	1	2	3	4	5	6	7	8	9	10	11	12
1-12	-.040	-.183	-.192	.048	.191	.093	-.051	-.100	.142	.020	.204	-.375
St-E	.097	.097	.097	.097	.097	.097	.097	.097	.097	.097	.097	.097
13-24	.008	.125	-.126	-.037	.010	-.032	.088	-.165	.068	-.022	-.058	-.288
St-E	.097	.097	.097	.097	.097	.097	.097	.097	.097	.097	.097	.097
25-36	.031	-.056	-.110	.115	.014	.078	.071	-.085	-.096	.106	-.005	-.160
St-E	.097	.097	.097	.097	.097	.097	.097	.097	.097	.097	.097	.097

Figure (4.7)

Correlogram for Nonseasonal First Difference and Seasonal First Difference Series of Average Gold Price Series in Myanmar



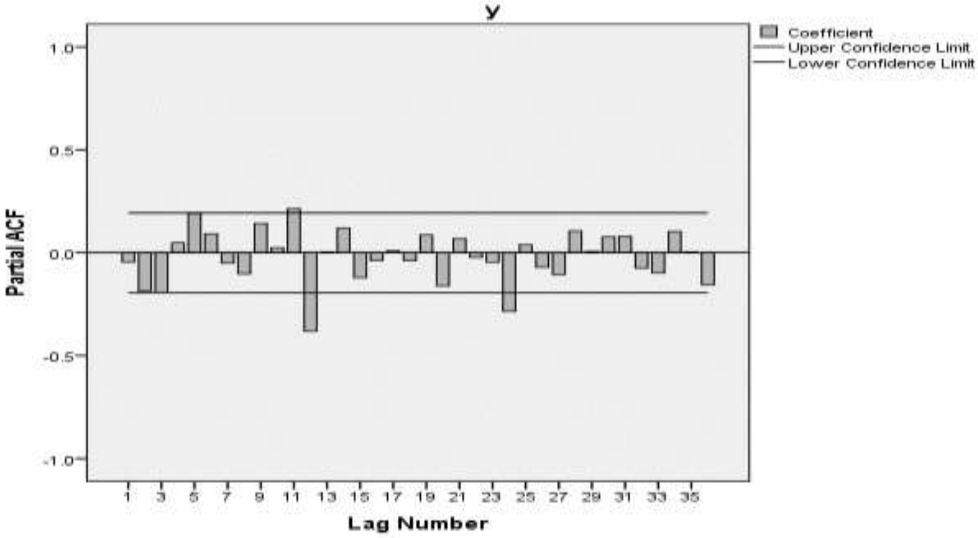


Figure (4.7) shows that the values of ACF and PACF for $\nabla\nabla_{12}Z_t$ series have spikes at 12. Therefore, the ARIMA (0, 1, 0) $\times$ $(1, 1, 1)_{12}$ model was considered as possible model to fit $\nabla\nabla_{12}Z_t$ series.

Since, $\bar{W}$ = - 0.1202 $S_w = 23.6814,$ n = 107

The t value of t $= \frac{\bar{W}}{S_w/\sqrt{n}} = \frac{-0.1202}{23.6814/\sqrt{107}} =$ - 0.0525

Which is not significant and thus deterministic trend term θ_0 is not needed in the model. Hence, the tentative model for the series is following ARIMA (0, 1, 0) $\times$ $(1,1,1)_{12}$ process:

$$(1\text{-}\Phi B^{12})(1-B)\,(1-B^{12})Z_t = (1-\Theta B^{12})\,a_t$$

4.2.3 Parameter Estimation for ARIMA (0, 1, 0) × $(1, 1, 1)_{12}$ Model

Using multiplicative seasonal ARIMA (0, 1, 0) × $(1, 1, 1)_{12}$ model, the estimated parameter with their statistics were shown in Table (4.10).

Table (4.10)

Estimated Parameter and Model Statistics for ARIMA (0, 1, 0) × $(1, 1, 1)_{12}$ Model

	Estimate	S.E	t	Sig
Constant	0.228	0.533	0.427	0.676
Φ	-0.013	0.140	-0.090	0.979
Θ	0.976	1.529	0.638	0.523

Source: SPSS Output

The following estimated model was obtained

$$(1\text{-}\Phi B^{12})(1-B)\ (1-B^{12})Z_t = (1-\Theta B^{12})\ a_t$$

$$(1\text{+}0.013)(1-B)\ (1-B^{12})Z_t = (1\text{+}\ 0.976B^{12})\ a_t$$

(0.140) (1.529)

According to this Table (4.10), the estimated parameter of Φ is -0.013 and Θ is 0.976 with the estimated standard errors are 0.140 and 1.529 respectively. The test statistic t for Φ and Θ are not statistically significant at 5% level.

4.2.4 Parameter Estimation for ARIMA (0, 1, 0)× $(1, 1, 0)_{12}$ Model

The estimated parameter of the ARIMA (0, 1, 0) × $(1, 1, 0)_{12}$ model are not statistically significant at the 5% level. Therefore, another possible ARIMA (0, 1, 0) × $(1, 1, 0)_{12}$ model is considered for fitting $\nabla\nabla_{12}Z_t$ series because the ACF of $\nabla\nabla_{12}Z_t$ series can be obtained tails off and its PACF has a spikes at lag 12. Therefore, using multiplicative seasonal ARIMA (0, 1, 0) × $(1, 1, 0)_{12}$ model, the estimated parameter with their statistics was shown in Table (4.11).

Table (4.11)

Estimated Parameter and Model Statistics for ARIMA (0, 1, 0)× $(\mathbf{1,1,0})_{\mathbf{12}}$

Model of Average Gold Prices

	Estimate	**S.E**	**t**	**Sig**
Constant	.089	1.448	.061	0.951
Φ	-.450	.089	-5.048	0.000

Source: SPSS Output

***denote statistically significant at 1% levels

The following estimated model is

$$(1\text{-}\Phi B^{12})(1-\text{B})\ \ (1-B^{12})Z_t = \ a_t$$

$$(1\text{+}0.450)\ (1\text{-B})\ (1-B^{12})Z_t = \ a_t$$

$$(0.089)$$

According to this Table (4.11), the estimated parameter of Φ is -0.450 with the estimated standard errors is 0.089. The test statistic t for Φ is statistically significant at 5% level.

4.2.5 Diagnostic Checking for ARIMA (0, 1, 0)× $(\mathbf{1,1,0})_{\mathbf{12}}$ Model

The residual ACF of the modified model as shown in Table (4.12) and Figure (4.8).

Table (4.12)

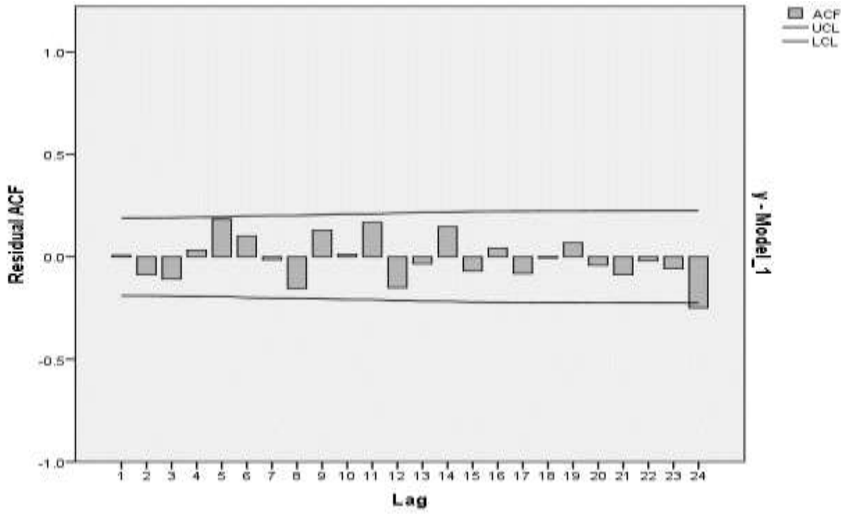
Estimated Autocorrelation Function of Residual for ARIMA (0, 1, 0)× $(\mathbf{1,1,0})_{\mathbf{12}}$

Model for Average Gold Price Series

Lag k	1	2	3	4	5	6	7	8	9	10	11	12
1-12	.006	-.087	-.109	.032	.184	.101	-.015	-.156	.130	.012	.168	-.151
S-E	.097	.097	.097	.099	.099	.102	.103	.103	.105	.106	.106	.109
13-24	-.033	.146	-.070	.042	-.081	-.006	.068	-.041	-.087	-.019	-.058	-.249
S-E	.111	.111	.113	.113	.113	.114	.114	.114	.114	.115	.115	.115

Figure (4.8)

Sample Autocorrelation Function of Residual values for Seasonal ARIMA $(0, 1, 0) \times (1, 1, 0)_{12}$ Model of Average Gold Price Series in Myanmar



To check model adequacy, Table (4.12) gives the ACF. All the sample autocorrelation of $\hat{a}_t$ is lie inside the confidence limits except for lag 24 and hence the sample ACF of residual for the ARIMA $(0, 1, 0) \times (1, 1, 0)_{12}$ model cannot be assumed white noise process.

4.2.6 Parameter Estimation for ARIMA $(1, 0, 0)\times (1, 1, 0)_{12}$ Model

Although the estimated parameter of the ARIMA $(0, 1, 0)\times (1, 1, 0)_{12}$ model is statistically significant at the 5% level, the sample autocorrelation of $\hat{a}_t$ is lie inside the confidence limits except for lag 24. Since the sample ACF of residual for the ARIMA $(0, 1, 0) \times (1, 1, 0)_{12}$ model are not white noise process, another possible model is further considered. Therefore, another possible ARIMA $(1, 0, 0)\times (1, 1, 0)_{12}$ model is considered for fitting original series because the ACF of original series can be assumed tails off and its PACF has a spike at lag1. Therefore, using multiplicative seasonal ARIMA $(1, 0, 0) \times (1, 1, 0)_{12}$ model, the estimated parameter with their statistics were shown in Table (4.13).

Table (4.13)

Estimated Parameter and Model Statistics for ARIMA (1, 0, 0)× $(1, 1, 0)_{12}$

Model of Average Gold Prices

	Estimate	S.E	t	Sig
Constant	56.299	25.107	2.167	0.032**
ϕ	0.951	0.029	32.49	0.000***
Φ	-0.442	0.092	-4.782	0.000***

Source: SPSS Output

***denote statistically significant at 1% levels

**denote statistically significant at 5% levels

The following estimated model is

$$(1\text{-}\emptyset B)\,(1\text{-}\Phi B^{12})\,(1-B^{12})Z_t = a_t$$

$$(1\text{-}0.951\text{B})\,(1\text{+}\,0.442B^{12})\,(1-B^{12})Z_t = a_t$$

(0.029) (0.092)

The estimation of the (1, 0, 0)× $(1, 1, 0)_{12}$ model gives ∅ = 0.951 with the estimated standard error 0.029, Φ = -0.442 with the estimated standard errors is 0.092. The test statistic t for ∅ and Φ are statistically significant at 5% level.

4.2.7 Diagnostic Checking

The residual ACF of the modified model as shown in Table (4.14) and Figure (4.9) along with the confidence interval calculated as

$$\gamma_k(\hat{a}_t) \pm 2\widehat{S.E}[\gamma_k(\hat{a}_t)]$$

Where $\widehat{S.E}[\gamma_k(\hat{a}_t)]=\frac{1}{\sqrt{n}}$

Table (4.14)

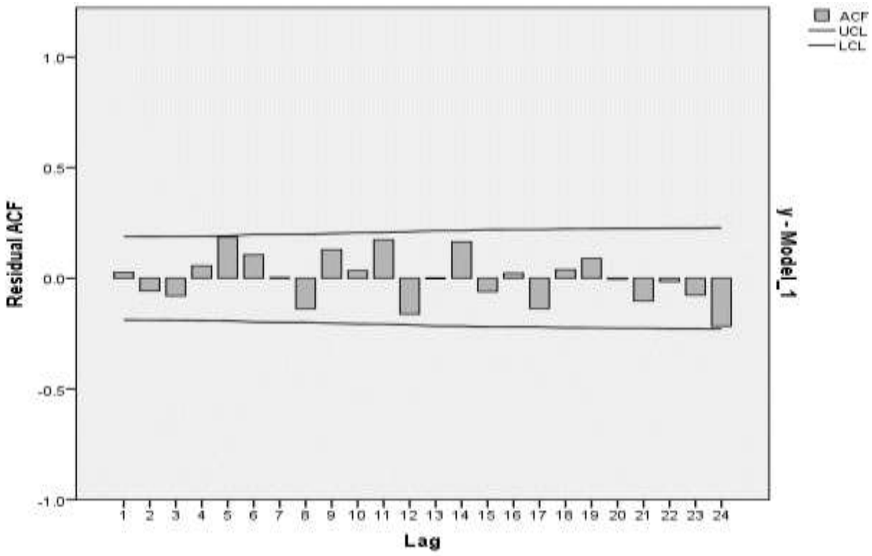
Estimated Autocorrelation Function of Residual values for Seasonal ARIMA

(1, 0, 0) × $(1, 1, 0)_{12}$ Model of Average Gold Price Series in Myanmar

Lag k	1	2	3	4	5	6	7	8	9	10	11	12
1-12	.027	-.057	-.079	.056	.187	.106	.004	-.137	.129	.034	.173	-.162
S-E	.096	.096	.097	.097	.097	.101	.102	.102	.103	.105	.105	.108
13-24	.000	.165	-.060	.023	-.136	.039	.090	-.005	-.101	-.015	-.076	-.215
S-E	.110	.110	.112	.112	.113	.114	.114	.115	.115	.116	.116	.116

Figure (4.9)

Sample Autocorrelation Function of Residual values for Seasonal ARIMA $(1, 0, 0) \times (1, 1, 0)_{12}$ Model of Average Gold Price Series in Myanmar



To check model adequacy, Table (4.14) gives the ACF. All the sample autocorrelation of $\hat{a}_t$ is lie inside the confidence limits and hence the sample ACFS of residual for the ARIMA $(1, 0, 0) \times (1, 1, 0)_{12}$ model are white noise process. Moreover, the residual ACF are all small and exhibit no pattern. This suggested that this model is adequate. Hence the autocorrelations of $\hat{a}_t$ can be taken as significant different from zero. The model statistics was shown in Table (4.15) by using ARIMA $(1, 0, 0) \times (1, 1, 0)_{12}$ model.

Table (4.15)

Model Statistics

Model	**Ljung-Box Q (18)**		
	Statistics	**df**	**Sig**
ARIMA $(1, 0, 0) \times (1, 1, 0)_{12}$	24.716	16	0.075

Source: SPSS Output

As the result of p value, the observed value of Q statistics is 24.716 and it is not significant at 5 % significant level p-value is 0.075.Thus, the fitted seasonal ARIMA $(1, 0, 0) \times (1, 1, 0)_{12}$ model is judged adequate for the series.

4.2.8 Forecasting

Since the model ARIMA (1, 0, 0) × $(1, 1, 0)_{12}$ model is adequate, this models can be used to forecast the future value for gold price series in Myanmar. The forecasting of average gold prices series for January to December, 2019 was shown in Table (4.16).

Table (4.16)

The Forecasts for January 2019 to December 2019 of Gold Prices in Myanmar

Jan	1026681	Apr	1038612	Jul	1036147	Oct	1085007
Feb	1034633	May	1048286	Aug	1044560	Nov	1091640
Mar	1035978	Jun	1039891	Sep	1077604	Dec	1097180

Source: SPSS Output

According to Table (4.16), the highest forecasting of average gold prices in Myanmar is expected 1097180 kyats (per tical) in December. The lowest forecasting of average gold prices in Myanmar is expected 1026681 kyats (per tical) in January. The comparison between actual values and forecast values is shown in Table (4.17).

Table (4.17)

Comparison between Actual Values and Forecast Values

Month	Actual Values	Forecast Values
January	1050948	1026681
February	1070978	1034633
March	1059125	1035978
April	1042705	1038612

According to Table (4.17), it can be seen that the forecast values of the average gold prices are 1026681 kyats (per tical) in 2019 January, 1034633 kyats (per tical) in February, 1035978 kyats (per tical) in March and 1038612 kyats (per tical) in April. Although these forecast values are less than the actual values that are published by the Central Statistical Organization (CSO) of Myanmar, they are not very different. Therefore, the fitting model of ARIMA (1, 0, 0) × $(1, 1, 0)_{12}$ model is seem to be appropriate for fitting average gold prices data for 2009 – 2018.

4.3 Stochastic Model for Average Kyats per US Dollar Price Series

Stochastic model for average kyats per US dollar price series in Myanmar cover 10 years from January 2009 to December 2018. The series consists of 120 observation.

4.3.1 Test of Seasonality

The result of calculation for testing the seasonality in the average kyats per US dollar price series in Myanmar (January 2009 – December 2018) are shown in Table (4.18).

Table (4.18)

ANOVA Table for Average Kyats per US Dollar Price Series in Myanmar

Sources	Sum of Square	df	Mean Square Error	F-ratio
Between month	SSM = 133511.8	11	MSM = 12137.4364	2.9953
Between year	SSY = 5575721.567	9	MSY = 619524.6185	
Error (Residual)	SSE = 401169.033	99	MSE = 4052.2125	
Total	SST = 6110402.4	119		

At 5% level of significance, the critical value K = $F_{(0.05,11,99)}$ is 1.8866. Since the computed F-value = 2.9953 is greater than K = 1.8866, it can be concluded that the monthly data of average kyats per US dollar Price Series in Myanmar exists seasonality.

4.3.2 Identification

The sample autocorrelation function (ACF) and sample partial autocorrelation function (PACF) were found for the original series z_t were shown in Table (4.19) and Figure (4.10) along with the confidence limits calculated as

$$\gamma_k \pm 2\,\widehat{S.E}\,(\gamma_k)$$

where

$$\hat{\rho}_k = \gamma_k = \frac{\sum_{i=1}^{k}(z_t-\bar{z})\,(z_{t+k}-\bar{z})}{\sum_{i=1}^{k}(z_t-\bar{z})^2} \quad , \bar{z} = \frac{\sum_{t=1}^{n} z_t}{n}$$

and

$$\widehat{S.E(\gamma_k)} \approx \frac{1}{n}\left(1 + 2\sum_{j=1}^{q}{\gamma_j}^2\right)^{1/2} \quad , \text{j} > \text{q}$$

Table (4.19)

Estimated Autocorrelation and Partial Autocorrelation Function for Original Series of Kyats per US Dollar Price Series in Myanmar

(a) $\hat{\rho}_k$ for $\{Z_t\}$ $\bar{Z}$ = 1090.783 S_z= 226.6008 n = 120

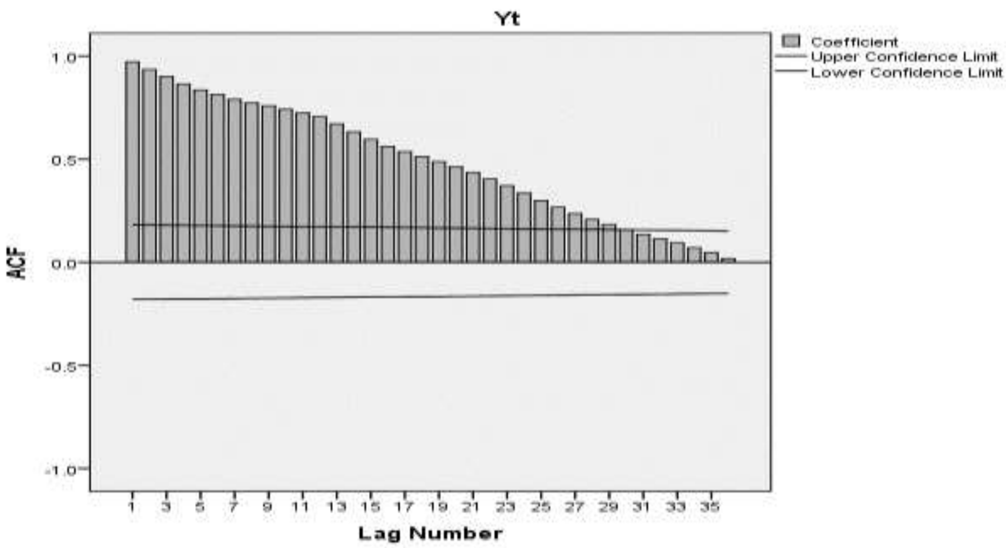
Lag k	1	2	3	4	5	6	7	8	9	10	11	12
1-12	.970	.931	.890	.846	.811	.787	.768	.756	.747	.736	.723	.707
S.E	.090	.090	.089	.089	.089	.088	.088	.087	.087	.087	.086	.086
13-24	.671	.631	.591	.552	.521	.496	.475	.453	.429	.403	.373	.341
S.E	.085	.085	.085	.084	.084	.083	.083	.083	.082	.082	.081	.081
25-36	.306	.272	.238	.205	.174	.148	.127	.109	.093	.074	.054	.028
S.E	.081	.080	.080	.079	.079	.078	.078	.078	.077	.077	.076	.076

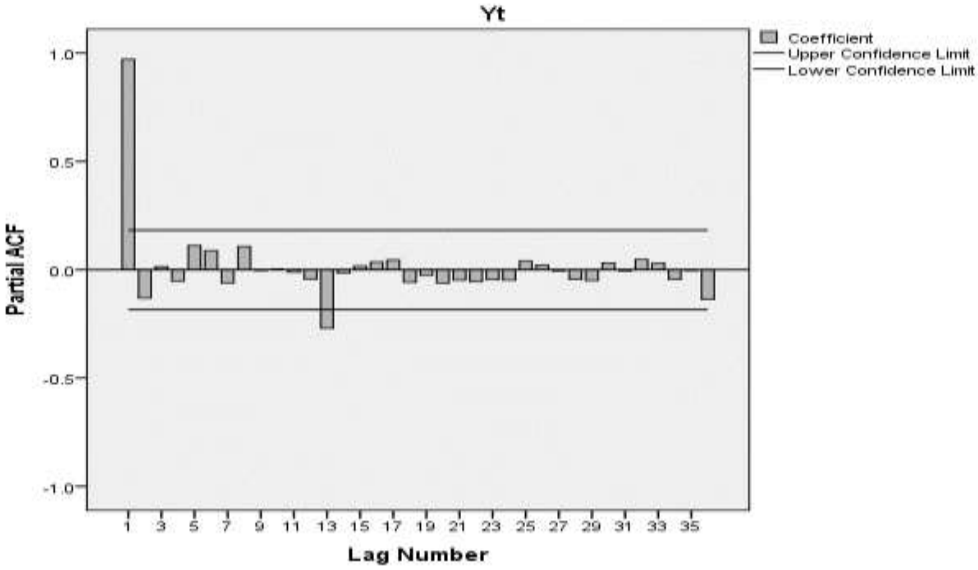
(b) $\widehat{\emptyset}_{kk}$ for $\{Z_t\}$ $\bar{Z}$= 1090.783 S_z= 226.6008 n = 120

Lag k	1	2	3	4	5	6	7	8	9	10	11	12
1-12	.970	-.156	-.029	-.069	.129	.133	.037	.076	.004	-.007	-.018	-.021
S.E	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091
13-24	-.302	.001	-.012	.025	.045	-.044	-.004	-.093	-.034	-.038	-.019	-.037
S.E	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091
25-36	.016	.010	-.044	-.061	-.054	.048	.034	.041	.030	-.040	-.002	-.119
S.E	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091

Figure (4.10)

Sample Correlogram for Original Series of Kyats per US Dollar Price Series in Myanmar





The sample ACF slowly decays and the sample PACF has a single large spike at lag 1. These values indicated that the series is nonstationary and that differencing is called for. To remove nonstationary, the sample ACF and PACF of the first difference series ∇Z_t were computed as shown in Table (4.20) and they were displayed in Figure (4.11).

Table (4.20)

Estimated Autocorrelation and Partial Autocorrelation Function for Frist Difference Series of Kyats per US Dollar Price Series in Myanmar

(a) $\hat{\rho}_k$ for $\{W_t = (1-B)Z_t\}$ $\overline{W}$= 3.7227 S_w= 36.8027 n = 119

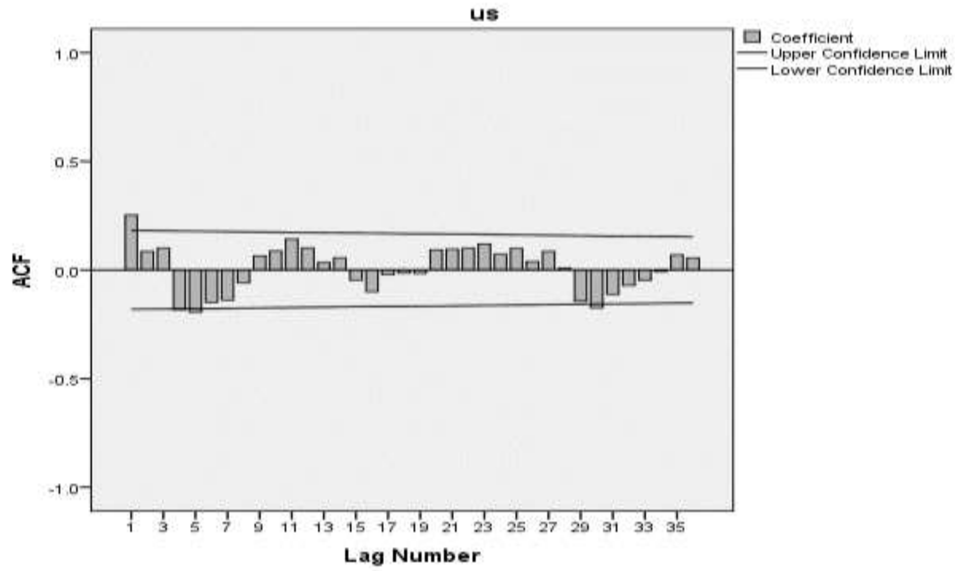
Lag k	1	2	3	4	5	6	7	8	9	10	11	12
1-12	.253	.085	.100	-.184	-.194	-.149	-.138	-.059	.065	.087	.143	.101
S-E	.091	.090	.090	.089	.089	.089	.088	.088	.087	.087	.087	.086
13-24	.034	.056	-.047	-.100	-.021	-.014	-.016	.093	.095	.100	.120	.072
S-E	.086	.085	.085	.085	.084	.084	.083	.083	.082	.082	.082	.081
25-36	.098	.039	.085	.008	-.144	-.174	-.113	-.071	-.048	-.008	.068	.055
S-E	.081	.080	.080	.079	.079	.079	.078	.078	.077	.077	.076	.076

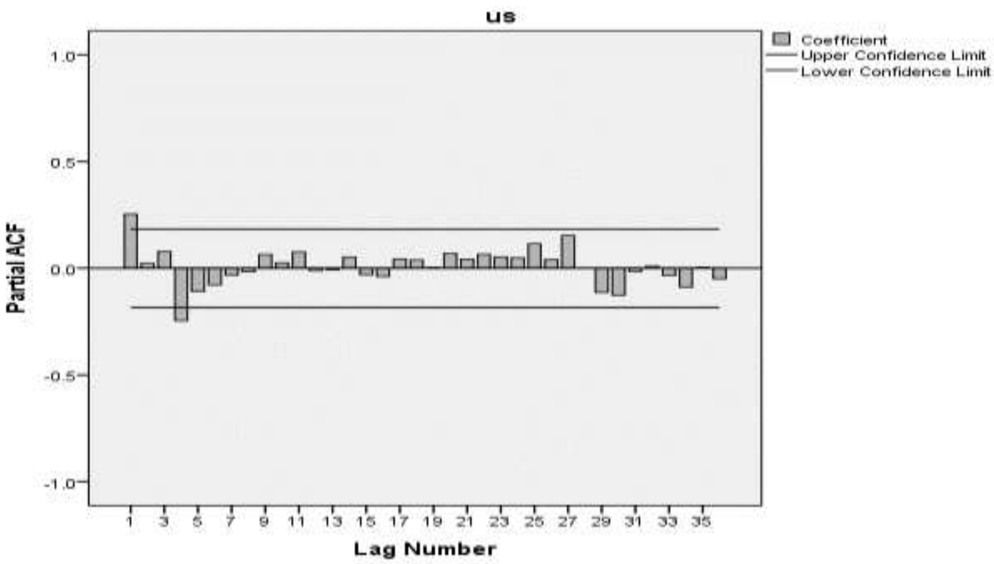
(b) $\hat{\emptyset}_{kk}$ For $\{W_t = (1-B^{12})Z_t\}$ $\overline{W}$ = 3.7227 S_w= 36.8027 n = 119

Lag k	1	2	3	4	5	6	7	8	9	10	11	12
1-12	.253	.022	.078	-.246	-.109	-.078	-.032	-.018	.065	.025	.075	-.010
S-E	.092	.092	.092	.092	.092	.092	.092	.092	.092	.092	.092	.092
13-24	-.007	.051	-.031	-.039	.043	.038	.002	.069	.042	.065	.052	.048
S-E	.092	.092	.092	.092	.092	.092	.092	.092	.092	.092	.092	.092
25-36	.114	.041	.153	-.001	-.113	-.127	-.015	.008	-.034	-.088	.004	-.049
S-E	.092	.092	.092	.092	.092	.092	.092	.092	.092	.092	.092	.092

Figure (4.11)

Sample Correlogram for First Difference Series of Kyats per US Dollar Price Series in Myanmar





The sample ACF is damped sine wage and the sample PACF cuts off after lag 1 because none of the sample PACF values is significant expect that lag 4. The ACF and PACF of the $\nabla\nabla_{12}Z_t$ series were obtained and the results are shown in Table (4.21) and Figure (4.12).

Table (4.21)

Estimated Autocorrelation and Partial Autocorrelation Function for Nonseasonal First Difference and Seasonal First Difference Series of US Dollar Price Series in Myanmar

(a) $\hat{\rho}_k$ for $\{W_t = (1-B)(1-B^{12})Z_t\}$ $\bar{W}$= 0.8879 S_w= 43.9011 n = 107

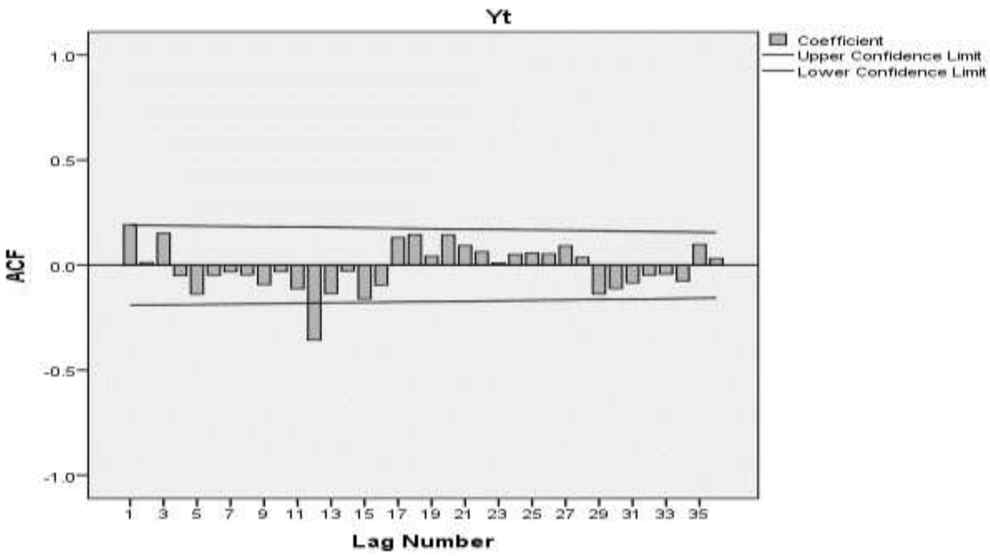
Lag k	1	2	3	4	5	6	7	8	9	10	11	12
1-12	.199	.012	.153	-.048	-.146	-.055	-.032	-.044	-.090	-.025	-.108	-.367
St-E	.095	.095	.094	.094	.094	.093	.093	.092	.092	.091	.091	.090
13-24	-.137	-.026	-.157	-.095	.127	.142	.047	.142	.091	.061	.008	.062
St-E	.090	.089	.089	.088	.088	.087	.087	.086	.086	.085	.085	.084
25-36	.062	.057	.090	.033	-.138	-.118	-.086	-.045	-.039	-.073	.102	.035
St-E	.084	.083	.083	.082	.082	.081	.081	.080	.080	.079	.079	.078

(b) $\hat{\rho}_k$ for $\{W_t = (1-B)(1-B^{12})Z_t\}$ $\bar{W}$ = 0.8879 S_w= 43.9011 n = 107

Lag k	1	2	3	4	5	6	7	8	9	10	11	12
1-12	.199	-.029	.163	-.120	-.111	-.034	.004	-.002	-.095	-.007	-.124	-.332
St-E	.097	.097	.097	.097	.097	.097	.097	.097	.097	.097	.097	.097
13-24	-.038	-.014	-.099	-.143	.044	.089	-.025	.051	-047	-.070	-.089	-.049
St-E	.097	.097	.097	.097	.097	.097	.097	.097	.097	.097	.097	.097
25-36	.023	.075	.011	-.083	-.092	-.008	-.047	.099	.030	-041	.101	-.004
St-E	.097	.097	.097	.097	.097	.097	.097	.097	.097	.097	.097	.097

Figure (4.12)

Correlogram for Nonseasonal First Difference and Seasonal First Difference Series of Kyats per US Dollar Price Series in Myanmar



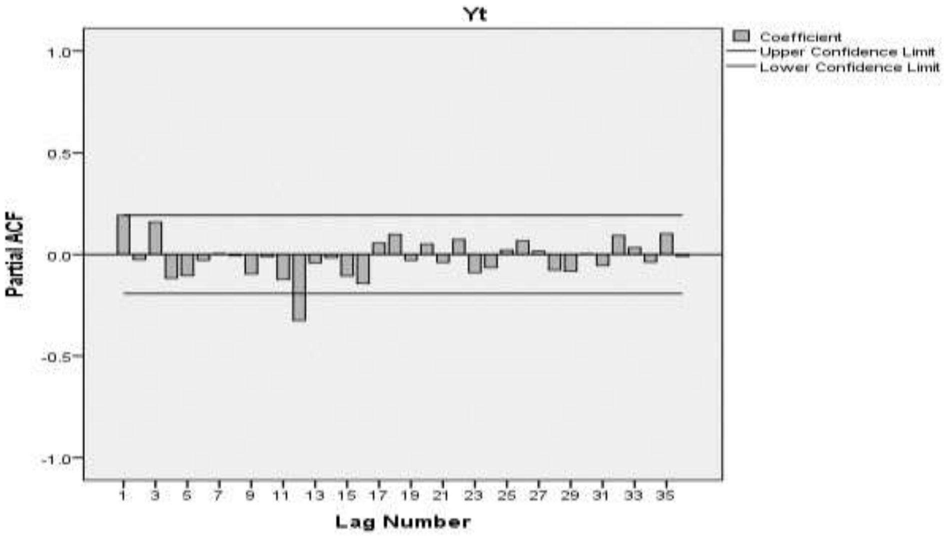


Figure (4.12) shows that the values of ACF and PACF for $\nabla\nabla_{12}Z_t$ series have after lag 12 lies inside the confidence limits. Therefore, the ARIMA (0, 1, 0) × $(1,1,1)_{12}$ model is considered a possible model to be fitted to $\nabla\nabla_{12}Z_t$ series.

Since, $\bar{W}$ = 0.8879 $S_w = 43.9011,$ n =107

The t value of t = $\frac{\bar{W}}{S_w/\sqrt{n}} = \frac{0.8879}{43.9011/\sqrt{107}} = 0.2092$

Which is not significant and thus deterministic trend term θ_0 is not needed in the model. Hence, the tentative model for the series is following ARIMA (0, 1, 0) × $(1,1,1)_{12}$ model process:

$$(1-\Phi_1 B^{12})\ (1-B)(1-B^{12})Z_t = (1-\Theta B^{12})\ a_t$$

4.3.3 Parameter Estimation for ARIMA (0, 1, 0) × $(1,1,1)_{12}$ Model of Kyats per US Dollar

Using multiplicative seasonal ARIMA (0, 1, 0) × $(1,1,1)_{12}$ model, the estimated parameter with their statistics were shown in Table (4.22).

Table (4.22)

Estimated Parameter and Model Statistics for ARIMA (0, 1, 0) × $(1,1,1)_{12}$ Model

	Estimate	S.E	t	Sig
Constant	2.069	1.904	1.086	0.280
Φ	-0.151	0.211	-0.713	0.477
Θ	0.500	0.228	2.190	0.031

Source: SPSS Output

The following estimated model was obtained

$$(1-\Phi B^{12})(1-B)\ (1-B^{12})Z_t = (1-\Theta B^{12})\ a_t$$

$$(1+0.151)(1-B)\ (1-B^{12})Z_t = (1-0.5B^{12})\ a_t$$

(0.211) (0.228)

According to this Table (4.22), the estimated parameter of Φ is -0.151 and Θ is 0.5 with the estimated standard errors are 0.211 and 0.228 respectively. The test statistic t for Φ and Θ are not statistically significant at 5% level.

4.3.4 Parameter Estimation for ARIMA (0, 1, 0)× $(1, 1, 0)_{12}$ Model

The estimated parameter of the ARIMA (0, 1, 0) × $(1, 1, 0)_{12}$ model are not statistically significant at the 5% level. Therefore, another possible ARIMA (0, 1, 0) × $(1, 1, 0)_{12}$ model is considered for fitting $\nabla\nabla_{12}Z_t$ series because the ACF of $\nabla\nabla_{12}Z_t$ series can be obtained tails off and its PACF has a spikes at lag 12. Therefore, using multiplicative seasonal ARIMA (0, 1, 0) × $(1, 1, 0)_{12}$ model, the estimated parameter with their statistics was shown in Table (4.23).

Table (4.23)

Estimated Parameter and Model Statistics for ARIMA (0, 1, 0)× $(1, 1, 0)_{12}$ Model of Kyats per US Dollar Prices

	Estimate	S.E	t	Sig
Constant	1.787	2.697	0.663	0.509
Φ	-0.472	0.098	-4.832	0.000

Source: SPSS Output

***denote statistically significant at 1% levels

The following estimated model was obtained

$$(1-\Phi_1 B^{12})\ (1-B)\ (1-B^{12})\ Z_t = a_t$$

$$(1+0.472B^{12})\ (1-B)\ (1-B^{12})\ Z_t = a_t$$

(0.098)

The estimated of the ARIMA (0, 1, 0) × $(1, 1, 0)_{12}$ model of kyats per US dollar price series gives Φ= -0.472 with the estimated standard error 0.098. The test statistics t for Φ which is statistically significant at 5% level.

4.3.5 Diagnostic Checking for ARIMA (0, 1, 0)× $(1, 1, 0)_{12}$ Model

The residual ACFS of the modified model as shown in in Table (4.24) and Figure (4.13).

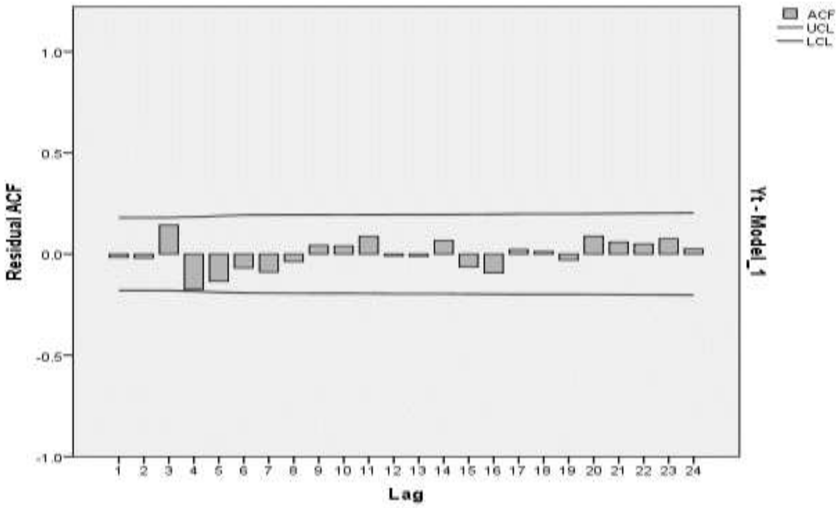
Table (4.24)

Estimated Autocorrelation Function of Residual values for Seasonal ARIMA (0, 1, 0) × $(1, 1, 0)_{12}$ Model of Kyats per US Dollar Price Series in Myanmar

Lag k	1	2	3	4	5	6	7	8	9	10	11	12
1-12	.136	-.021	.080	-.159	-.127	-.039	-.073	-.015	.018	-.001	-.023	-.056
S-E	.097	.098	.098	.099	.101	.103	.103	.104	.104	.104	.104	.104
13-24	-.093	-.012	-.092	-.122	.085	.096	-.003	.137	.039	.032	.037	-.097
S-E	.104	.105	.105	.105	.107	.107	.108	.108	.110	.110	.110	.110

Figure (4.13)

Sample Autocorrelation Function of Residual values for Seasonal ARIMA (0, 1, 0) × (1, 1, 0) Model of Kyats per US Dollar Price Series in Myanmar



To check model adequacy, Table (4.24) gives the ACF. All the sample autocorrelation of $\hat{a}_t$ is lie inside the confidence limits and hence the sample ACFS of residual for the ARIMA (0, 1, 0) × $(1, 1, 0)_{12}$ are white noise process. This suggested that this models are adequate. Therefore, the model statistics was shown in Table (4.25) by using ARIMA (0, 1, 0)×$(1, 1, 0)_{12}$.

Table (4.25)

Model Statistics

Model	Ljung-Box Q (18)		
	Statistics	df	Sig
ARIMA (0, 1, 0) × $(1, 1, 0)_{12}$	15.036	17	0.593

Source: SPSS Output

As the result of p value, the observed value of Q statistics is 15.036 and it is not significant at 5 % significant level p-value is 0.593.Thus, the fitted seasonal ARIMA (0, 1, 0) $\times (1, 1, 0)_{12}$ model is judged adequate for the series.

4.3.6 Forecasting

Since the model ARIMA (0, 1, 0) $\times (1, 1, 0)_{12}$ model is adequate, this models can be used to forecast the future value for kyats per US dollar series in Myanmar. The forecast for January to December, 2019 are as shown in Table (4.26).

Table (4.26)

The Forecasts for January 2019 to December 2019 of Kyats per US Dollar Price Series in Myanmar

Jan	1431	Apr	1448	Jul	1527	Oct	1677
Feb	1441	May	1462	Aug	1606	Nov	1695
Mar	1445	Jun	1489	Sep	1673	Dec	1669

Source: SPSS Output

According to Table (4.26), the highest forecasting of kyats per US dollar is expected 1695 kyats in November. The lowest forecasting of kyats per US dollar is 1431 kyats in January. The comparison between actual values and forecast values is shown in Table (4.27).

Table (4.27)

Comparison between Actual Values and Forecast Values

Months	Actual Values	Forecast Values
January	1518	1431
February	1508	1441
March	1515	1445
April	1522	1448

According to Table (4.27), it can be seen that average exchange rates (kyats per US dollar) are 1431 kyats in January, 1441 kyats in February, 1445 kyats in March and 1448 kyats in April. Although these forecast values are less than the actual values that are published by the Central Statistical Organization (CSO) of Myanmar, they are not very different. Therefore, the fitted model of ARIMA (0, 1, 0) $\times (1, 1, 0)_{12}$ model in seem to be appropriate for fitting the exchange rate data for 2009 – 2018.

CHAPTER V
CONCLUSION

In conclusion, the relationship between the price of Gold and US dollar are determined by applying simple regression model. From the estimated gold price model for the period January 2009 to December 2018, the coefficient of price is significant at 1 % level. The coefficient of determination R^2 is 0.531. According to the p-value of F statistics, the model is significant at 1% level. For $\propto = 0.01$ or 1% level of significance, critical values for the Durbin-Watson statistic are d_L = 1.611 and d_U = 1.637. Since D.W= 1.669, the null hypothesis is not rejected and it can be concluded that there is no evidence of autocorrelation. As a general rule, if d is close to 2, assume that autocorrelation is not a problem. Therefore, DW statistic is also confirmed that there is no positive or negative correlation between disturbances. Due to Kolmogorov-Smirnov statistic and Normal plot, it can be concluded that the normality assumption appears to be generally reasonable.

Many time series data have important seasonal components and it is necessary to measure the seasonal variation. In time series analysis, one study the four components: trend, seasonal, cyclical and random existed in the time series model. One may test the seasonality for these data by using the ANOVA Table.

In addition, the Box-Jenkins method was utilized in modelling and forecasting the price of gold and US Dollar series. The multiplicative seasonal ARIMA (1, 0, 0)× $(1,1,0)_{12}$ model was found to be suitable for Average Gold Price Series in Myanmar. The multiplicative seasonal ARIMA (0, 1, 0)× $(1,1,0)_{12}$ model was found to be suitable for Kyats per US Dollar Price Series in Myanmar. The accepted models for these two series were used to find forecasts for each series for the next one year, January 2019 to December 2019. Moreover, it is expected that the results of this thesis would be useful for future researchers. An analysis of time series can be used to make current decisions and plans based on long-term forecasting.

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