DETERMINATION OF ADEQUATE FUNDING FOR UNEMPLOYMENT INSURANCE IN TURKEY

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF APPLIED MATHEMATICS
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

HACI BURAK YILDIRIM

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
FINANCIAL MATHEMATICS

DECEMBER 2019

Approval of the thesis:

DETERMINATION OF ADEQUATE FUNDING FOR UNEMPLOYMENT INSURANCE IN TURKEY

submitted by **HACI BURAK YILDIRIM** in partial fulfillment of the requirements for the degree of **Master of Science in Financial Mathematics Department, Middle East Technical University** by,

Prof. Dr. Ömür Uğur
Director, Graduate School of **Applied Mathematics** ______________

Prof. Dr. A. Sevtap Kestel
Head of Department, **Financial Mathematics** ______________

Prof. Dr. A. Sevtap Kestel
Supervisor, **Actuarial Science, METU** ______________

Assoc. Prof. Dr. Özlem Türker Bayrak
Co-supervisor, **Department of Inter-Curricular Courses, Çankaya University** ______________

Examining Committee Members:

Assoc. Prof. Dr. Ceylan Yozgatlıgil
Statistics Department, METU ______________

Assoc. Prof. Dr. Ebru Yüksel Haliloğlu
Business Administration Department, TOBB ETU ______________

Prof. Dr. A. Sevtap Kestel
Actuarial Science Department, METU ______________

Date: ______________

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last Name: HACI BURAK YILDIRIM

Signature :

ABSTRACT

DETERMINATION OF ADEQUATE FUNDING FOR UNEMPLOYMENT INSURANCE IN TURKEY

Yıldırım, Hacı Burak
M.S., Department of Financial Mathematics
Supervisor : Prof. Dr. A. Sevtap Kestel
Co-Supervisor : Assoc. Prof. Dr. Özlem Türker Bayrak

December 2019, 47 pages

This thesis analyzes future affordability of unemployment insurance fund (UIF) by determining future income of UIF with occurrence of additional expense which is support and incentive payment to firms, in Turkey. Main goal in this thesis work is to study how monthly income of fund can afford support expenses which is being implemented for last one and a half year by fund managers in Turkey. ARIMA model is built for unemployment rate and autoregression model is constructed for predicting future of UIF. Analysis result can give helpful advises for future affordability of UIF to fund managers.

Keywords: Unemployment insurance , ARIMA, Time series, Augmented Dickey-Fuller test

ÖZ

TÜRKİYE'DE İŞSİZLİK SİGORTASI İÇİN YETERLİ FONUN BELİRLENMESİ

Yıldırım, Hacı Burak
Yüksek Lisans, Finansal Matematik Bölümü
Tez Yöneticisi : Prof. Dr. A. Sevtap Kestel
Ortak Tez Yöneticisi : Doç. Dr. Özlem Türker Bayrak

Aralık 2019, 47 sayfa

Bu tez, Türkiye'deki firmalara destek ve teşvik ödemesi olan, ek gider oluşumu ile işsizlik sigortası fonunun (İSF) gelecekteki ekonomik varlığını, fonun gelecekteki gelirini tahmin ederek analiz etmektedir. Bu tez çalışmasında asıl amaç, fonun aylık gelirinin, Türkiye'de fon yöneticileri tarafından son bir buçuk yıldır uygulanmakta olan destek harcamalarını nasıl karşılayabileceğini incelemektir. İşsizlik oranı için ARIMA modeli, İSF'nin geleceğini tahmin etmek için otoregresyon modeli oluşturulmuştur. Analiz sonucu, İSF'nin fon yöneticilerine gelecekteki satın alınabilirliği konusunda yardımcı tavsiyelerde bulunabilir.

Anahtar Kelimeler: İşsizlik Sigorta Fonu, ARIMA, Zaman serileri, Augmented Dickey-Fuller testi

ACKNOWLEDGMENTS

I would like to express my very great appreciation to my thesis supervisor Prof. Dr. Sevtap Kestel and co-supervisor Assoc. Prof. Dr. Özlem Türker Bayrak for their patient guidance, enthusiastic encouragement and valuable advices during the development and preparation of this thesis. Their willingness to give their precious time and to share their experiences has brightened my path. I will always be grateful you and remember your contribution to my knowledge.

I would also like to thank my entire family for supporting me. You always standed behind me and pushed me to go always forward.

Special thanks for my brother in law Alaattin Işılak. You always trusted and supported me in this path.

TABLE OF CONTENTS

LIST OF TABLES

TABLES

LIST OF FIGURES

FIGURES

LIST OF ABBREVIATIONS

UIF	Unemployment Insurance Fund
SGK	Social Security Institution
ISKUR	Turkey Employment Agency
UR	Unemployment Rate
S	Support and Incentive Expense
ARIMA	AutoRegressive Integrated Moving Average
ADF	Augmented Dickey-Fuller
OLS	Ordinary Least Squares
I	Investment Income
LM	Lagrange Multiplier
JB	Jarque-Bera
ACF	Autocorrelation Function
PACF	Partial Autocorrelation Function
TUIK	Turkish Statistical Institute
DF	Dickey-Fuller
F_{new}	Fund Balance Per Beneficiary
S_{new}	Support Expense Per Beneficiary
I_{rate}	Monthly Investment Income Rate

CHAPTER 1

INTRODUCTION

Unemployment is regarded as the most painful problem for all countries. Hence, governments always seek a solution to diminish its devastating effect on economy. Unemployment compensation system (UCS) is one of the adopted solutions in recent years. The system is simply collecting premiums from workers' salary. When they are faced with unemployment, system makes a payment from unemplyment insurance fund (UIF) as benefit unemployment payment. This creates insurance for both employee and economy in some way.

A new unemployment benefit system similar to those applied in developed countries is implemented in Turkey in 1999 with enacted law number 4447. First collection of premiums started to gather in early 2000 and the first beneficiaries took advantages from UIF of Turkey in March 2002. Main income of fund includes salary deduction from workers. Additionally, for every single employee, employer is liable to pay premium and government also contributes with some percentage of payment depending on gross salary amount[1]. The system covers the ones who are registered with Social Security Institution (SGK) and does not include civil servants or the self-employed. It is mandatory for covering all occupations and industries. Further about the system, benefit amount is decided according to worker's previous salary[2]. Funds are collected by SGK and transferred to Turkish Employment Agency (ISKUR), which implements the program. Collected fund is invested to only fixed-income securities

[1] Insured is compulsory to pay premium 1%, employer 2% and government 1% from gross salary according to Turkey Employment Agency (ISKUR)

[2] Insurance benefit is 40% of worker's salary and cannot be more than 80% of gross minimum wage in Turkey. Payments to beneficiary is made by monthly bases.

in recent years[3]. There are eligibility requirement for employment period[4]. In addition, benefit duration varies by employment duration period[5]. Also, Beneficiaries lose their entitlement if they find a formal job, refuse training offered by ISKUR or fail to provide required documentation to ISKUR. It means actively seeking job is not necessary unlike other countries which implement similar unemployment insurance program.

In Turkey, UIF is established for simply giving financial support for unemployed people like any other countries which implement unemployment insurance program. Since the establishment, fund always shows growing trend. Income items are simply gathered premiums and interest income. 90% of accumulated fund is partially invested in currency baskets, coupon bonds or non-coupon bonds. For bond investment, interest rate offers are accepted from the top ten commercial banks which are listed by Turkey Banks Association and then volume of investments are decided by fund managers. Investment instruments are only bonds and treasury bills for the last 8 years. Besides, for the first ten years, expense item is only benefit payment. After this period, expense items diversify such as active labor force programs which mainly include job certificate courses. However, total income was always higher than the total expenes. After July 2018, fund manager decide to support firms and banks from income of fund for forestall bankruptcy to prevent more unemployment owing to rising request from government. With the addition of this support and incentives expense item, fund balance encountered a serious problem of giving deficit.

[3] Approximately 90% of fund is secured to coupon bonds, around 1% non-coupon bond and rest remains deposit according to monthly media report by ISKUR

[4] To qualify, the unemployed worker must have separated involuntarily; register at the local employment office; and have worked in covered employment (in which insurance premiums have been paid) continuously for 120 days preceding the termination of employment, and for 600 days in the preceding three-year period.

[5] The maximum potential duration of unemployment benefit payments is 180 days for those with 600–899 days of covered employment in the previous three years; 240 days for those with 900–1079 days; and 300 days for those with 1,080 days or more of covered employment

1.1 Literature Review

There is an enormous literature which examines the role of unemployment insurance system on both labor workers and dynamics of economy. In microeconomic aspect of view, many researchers study on the attitude of unemployed who takes advantages of UI benefit. Besides, some studies focus on macroeconomic effects of UI system on system dynamics.

Plenty of approaches are examined in microeconomic view, such as, Meyer [16], Hopenhayn and Nicolini [13], Gruber [12] , Bijwaart [3], Setty [19]. Firstly, Meyer focuses benefit duration of beneficiary. In his pivotal study, Meyer reveals that increase about 9% of UI benefit breeds approximately one week more duration in post-unemployment period. His article is crucial, because it strongly shows mutual affinity between UI benefit and unemployment relationship. Hence, many researchers take his work worth noting to analyze benefit-cost relation of UI systems.

In another milestone study, Hopenhayn and Nicolini examine for design of an optimal UI system by the help of Moral Hazard problem. Their model is based on beneficiary's job effort and and tries to find the optimal UI quantity by equating marginal cost and benefit. However, possible job effort is considered for model as identical and permanent. Both works of Hopenhayn and Nicolini and Meyer do not mention about UI system's details.

Gruber [12], unlike, takes into account a different aspect of view by working on consumption behavior of beneficiary. By using method of linear regression, Gruber showed that how consumption behavior is affected by individual's character and ratio of benefit. Additionally, his precious study pointed out that beneficiaries who obtain more benefit, tends to consume more. Yet, his work does not contain affordability of UI and how higher consumption affects economy dynamics. UI benefit is regarded as in infinite upper and lower bound. Some other approaches which are parallel to previous mentioned works are from Bijwaard and Setty. From the cost-benefit view, Bijwaard uses Proportional Hazard Model to construct time duration model and predicts reasonable upper bound of unemployment duration to be guided for more applicable

UI system. Setty constructs two period log utility model to maximize UI cost-benefit account as regarded main actor job-effort of UI beneficiary. His final suggestion is that benefits should regularly decrease during benefit period and salary taxes should regularly increase after re-employment.

Our aim of study on UI topic is highly different from significant studies mentioned above. Studies in microeconomic perspectives clearly shows us that unemployment duration and benefit amount are main characters for fund's income and expense. In this thesis, determination of adequate funding is mainly studied. Differently, this thesis considers unemployment-UIF relation. While determining future of fund, firstly, how unemployment affects volume of UIF in Turkey is investigated.

Macroeconomic aspect of view is more related to the main purpose of this thesis. Acemoglu and Shimer [2], Ricetti, Russo and Gallegati [18], Lehmann [14] and Goerke, Pannenberg and Ursprung [11] study effects on UI system on the economic system dynamics. Acemoglu and Shimer, contrary to conventional studies, approach from dissimilar side, suggest that UI expands labor efficiency (profitability) by encouraging workers to look for higher standard jobs. This forces firms to create more risky business which can bring high profit. They exercise quantitative model to examine standard moral hazard effects of UI to find out unemployed is whether comparable or not in magnitude. To conclude their work, they found that amount of benefit is a significant factor. If the level of benefit is low, consumption reduces and companies take risks and if it is high, there is an improvement of risk sharing. Hence, more innovator enterprises yield market growth. Yet, UI system details are not considered, additionally UI benefit is regarded as infinity in studied experiment. Also, all beneficiaries are considered to be identically emotional to the issue.

Ricetti et. al claim that government intervention such as unemployment benefit can cause increase in both inflation and nominal GDP. They also point out that considerably high unemployment benefit diminishes unemployment cost of opportunity by the consequence of beneficiary's high salary demand. Their work consequently illustrates us that UI is not harmful to the economy provided that benefit amount and conditions are in a reasonable range. Otherwise, labor demand falls and it causes large unemployment rate. Consequently, economy incline to recessionary phase.

We can drive out that UI system is highly sensitive to the market dynamics, accordingly unemployment, which is observed from the studies of Riccetti et al. [18] and Acemoglu and Shimer [2]. Hence, these significant works strengthen our approaches to UI system.

Another supporting approach which is parallel to the previous studies is done by Lehmann [14]. By the help of standard labor-matching model derived by Mortensen and Pissarides [17], he highlights that money growth without affecting production causes inflation and rising unemployment. This leads to weak worker's bargaining power, and consequently low payroll tax rate which is also crucial for funding UI. Benefit to unemployed naturally means monetary expansion without no return. Therefore, this ongoing consumption causes high inflation, high level interest rate and low wage power of workers. In conclusion, number of unemployed beneficiary, unemployment and also average rate of employed are in crucial parameters for UI fund.

In contrast, Goerke et. al [11] focus on postive effects of the UI system to the economy. They examine wage bargaining model to show that high unemployment benefit can cause reduction in wages and increase in employment if trade unions satisfy the workers' overall bargaining power. Their article focuses on political aspect of view to UI. If wages go down, trade union utility will be disappointed. Hence, government position is damaged. In conclusion, the policy is better to find an equilibrium for UI system by arranging benefit amount, duration etc.

Castaneda [7], apart from many researchers, constructs a portfolio choice model by the use of Black-Scholes approach. His work aspires to give advice to fund managers in a monthly basis.

Edlund and Karlson [10] try to find the best forecasting method for the Swedish unemployment rate. They considered vector auto regression (VAR), autoregressive integrated moving average (ARIMA) and transfer function. Real GDP, consumer index, OECD consumer index, Swedish industrial production index and Swedish labor cost are considered while examining VAR model. However, contrary to expectation, ARIMA model is found more appropriate for. Samely, Dobre and Alexandru [9] consider Box-Jenkins ARIMA model is the most suitable technique for predicting unemployment rate. In their study, only ARIMA model is studied instead of trying and comparing different model for forecasting Romanian unemployment rate.

Proietti [20] makes very comprehensive study to forecast U.S unemployment rate. Mainly, many linear and non-linear forecasting methods are examined in his precious study. Seven linear models for unemployment rate such as cyclical trend model (CTM), autoregressive trend model (ARTM) are constructed in the base of ARIMA structure. Also, Proietti considers 4 non-linear models which are derived from ARTM and CTM. In conclusion, study reveals that linear structural models are more suitable for forecasting unemployment rate than non-linear ones.

Chakravarty [1] similarly find out that constructing ARIMA structure for forecasting U.S unemployment rate is the best way. Instead of Proietti's [20] work, Chakravarty's study focuses only ARIMA models without comparing other modelling options. The only model selection steps for ARIMA and diagnostics of final model are covered by his study.

Floros [6] considers comparing different time series model to forecast unemployment rate in UK. Additionally, forecasting period analysis takes a place in his study. Considered models are ARMA (p, q), AR, MA, ARCH, GARCH (p,q), EGARCH(1,1), TGARCH(1,1). Comparisons are made by root mean squared errors (RMSE), mean absolute error (MAE) and mean absolute percentage error (MAPE). Forecasting periods are divided into 5 parts and the best accurate model is selected based on the smallest error. Among all forecasting periods, the best performance is obtained from AR(4) in period 3.

Mahipan et al [15] study unemployment rate prediction in Thailand. They construct two approaches for analysis which are time series and Artificial Neural Network (ANN). According to mean absolute percentage error (MAPE) criteria, they conclude that SARIMA (0,1,1) performs better than ANN prediction method for the case of unemployment prediction.

1.2 The Aim of the Study

Our approach to UI system differs from the literature in the sense that it analyzes adequate future of UIF in Turkey. In this thesis, the first time in literature, time series regression model is constructed to forecast net income of fund with the help of firstly predicting future of unemployment rate in the certain fund management actions in Turkey. In this point of view, studies on unemployment forecast models are also searched to complete this thesis work.

Studies in the literature discussed so far strongly show that ARIMA model is the most suitable forecast instrument for unemployment rate. Hence, unemployment rate future prediction is examined by using ARIMA modelling in this thesis. Finally, net income of fund and unemployment rate is modelled by least squares time series method. Time interval for data is taken between January of 2008 to July of 2019 in monthly basis.

The subject of this thesis is to analyze UI fund's future stability by taking into consideration unemployment rate forecasting. Instead of portfolio management and benefit duration approximation studies, this study focuses on prediction of directly UIF itself to search on what levels of unemployment rate affect income of UI fund. After predicting future net income of fund, main goal is analyzing how much this income can tolerate additional expenses specifically support and incentive expenses that began to be implemeted after July of 2018. If the future balance of the fund can be predicted, the amount of support expenses can be regulated so that there will be no deficit in the fund. Thus, this study will contribute to the fund management in this sense and can be a guide for the policy makes.

Recently, expert economist and big finance companies begin to state that whole world can face crucial global recession in upcoming years. Crisis, especially golabal one, creates high unemployment rates for all country.Thus, our unemployment based study is more meaningful in this period of time for Turkey and similar developing countries.

CHAPTER 2

PRELIMINERIES

In this chapter, we present the methodology used in this study. *Time series regression* and some methods, which make regression model more acceptable and accurate, are introduced. Simply, time series is a collection of data points arranged by time intervals such as monthly, quarterly, annually etc. There are two main questions have to be answered while making time series regression analysis: (i) what is the true nature of phenomenon represented by time series variables?, (ii) How much the prediction (forecasting) is accurate?

In regression model, there is a dependent variable, which is called endogenous variable, in a data set which is desired to be predicted by other variables. Independent variables, are called exogenous variables, are descriptor of the endogenous variable. If there is more than one dependent variable, the model is called multivariate regression.

2.1 Stationarity and Unit Root

Constructing the best regression model for forecasting is not simple. Data points of explanatory variables often have means, variances and covariances that have change over time. We call them non-stationary series. Non-stationary time series are unpredictable and can not be forecasted. Even final milestone observations seem well, the result can be spurious which indicates dependency between independent time series data points. Hence, in order to get consistent outcome, non-stationary data have to be converted to stationary data having the following properties:

- Constant μ (mean) for all t,
- Constant σ^2 (variance) for all t,
- The autocovariance function between random variable X_{t_1} and X_{t_2} only depend on the time interval t_1 and t_2.

2.1.1 Augmented Dickey-Fuller Test (*ADF*)

Unit root test is used to analyze the stationarity of a time series by investigating the existence of a unit root. Variable can be stationary at level, called I(0). If not, it can be made stationary by taking difference operation which is, let say random variable Y_t, $Y_t - Y_{t-1}$, denoted as ΔY_t. The most frequently used unit root test is constructed by Dickey and Fuller [8]. The Dickey-Fuller test is only valid for AR(1) model given as:

$$Y_t = \phi Y_{t-1} + \epsilon_t. \tag{2.1}$$

where ϵ_t is the white noise which has zero mean and constant covariance and ϵ_k and ϵ_s is uncorrelated to each other, for some *k* and *s* in process time interval. Since the autoregression lag polynomial has only one root equal to one, one say that it has a unit root. Hence, testing if $\phi = 1$ becomes the stationarity analysis here:

$$Y_t = Y_{t-1} + \epsilon_t, \tag{2.2}$$

$$\Delta Y_t = \epsilon_t \overset{iid.}{\sim} WN(0, \sigma^2). \tag{2.3}$$

However Augmented DF test need to be applied when higher order correlation exists. Consider the AR(p) process:

$$Y_t = \sum_{i=1}^{p} \phi_i Y_{t-i} + \epsilon_t, \tag{2.4}$$

$$(1 - \phi_1 B - \phi_2 B^2 - ... - \phi_p B^p) Y_T = \epsilon_t. \tag{2.5}$$

where B is the backshift operator. Hence, existence of unit root obviously means that $B = 1$ is a solution of the AR polynomial $(1 - \phi_1 B - \phi_2 B^2 - ... - \phi_p B^p) = 0$. It gives $\phi_1 + \phi_2 + \phi_3 + ... + \phi_p = 1$. If we rewrite Equation (2.4) as follows:

$$Y_t = (\phi_1+\phi_2+\phi_3+...+\phi_p)Y_{t-1}-(\phi_2+\phi_3+...+\phi_p)(Y_{t-1}-Y_{t-2})-...-\phi_p(Y_{t-p+1}-Y_{t-p})+\epsilon_t. \tag{2.6}$$

we obtain $\phi_1 + \phi_2 + \phi_3 + ... + \phi_p = \theta_1$, $\phi_2 + \phi_3 + ... + \phi_p = \theta_2$ and so on $\phi_p = \theta_p$.

$$Y_t = \theta_1 Y_{t-1} - \theta_2(Y_{t-1} - Y_{t-2}) - ... - \theta_p(Y_{t-p+1} - Y_{t-p}) + \epsilon_t, \tag{2.7}$$

$$\Delta Y_t = (\theta_1 - 1)Y_{t-1} - \sum_{i=1}^{p} \theta_i \Delta Y_{t-i} + \epsilon_t. \tag{2.8}$$

So, having a unit root means $\theta_1 = 1$. The stationarity of a time series is tested by Dickey and Fuller [8] unit root test. Thus, they simulate and tabulate the critical values for the test statistic. Here, H_0: $\theta = 1$ against H_1: $\theta < 1$ by t test statistics in regression analysis. However, distribution is not t anymore.

2.2 ARIMA Processes

ARIMA process is a mathematical tool for future prediction of numerical time series data. Acronym of ARIMA is simply AutoRegressive, Integrated, Moving Average. Each of 3 parts represents different mathematical model.

ARIMA gains popularity after studied extensively by George Box and Gwilym Jenkins [4] in 1971. ARIMA model sometimes is called Box-Jenkins model. The aim of the model is to construct adequate representaion of mathematical model for time series data in a simplest way to forecast its future.

Autorregressive (AR) process is simply modelling variable by using its historical values as exogenous variables. Representation of p order AR(p) process is:

$$X_t = \alpha + \alpha_1 X_{t-1} + \alpha_2 X_{t-2} + ... + \alpha_p X_{t-p} + \epsilon_t. \tag{2.9}$$

Here $\alpha, \alpha_1, .., \alpha_p$ are constants and ϵ_t refers the random error. Moving average (MA) model appears when past errors appear at the right hand side of the equation. *p* order

MA(q) model is:

$$X_t = \theta + \epsilon_t + \theta_1\epsilon_{t-1} + \theta_2\epsilon_{t-1} + .. + \theta_q\epsilon_{t-q}. \tag{2.10}$$

Here θ's are constants. If both AR and MA terms are included in the equation, model is called ARMA(p,q). p is the order of AR terms and q is the order of MA terms. Additionally, if the difference of the variable is modelled, model is called *integrated* and the model is called ARIMA(*p,d,q*), where *d* is the integration degree.

2.3 Diagnostics Checking

2.3.1 Lagrange Multiplier (LM) Test

Serial correlation or autocorrelation is carrying error terms one period to another. In other words, if error term at one period let say k is corrrelated to error at period s, we say there is autocorrelation. This is an critical problem for time series estimation, since, it leads misestimation. For instance, if a firm underestimate or overestimate his profit one period, it can result wrong profit calculation for the next period.

Brauch and Pagan [5] examine lagrange multiplier method for serial correlation detection test. Let, ϵ_t be the residuals of OLS estimation and $(X_1)_t$, $(X_2)_t$, ... ,$(X_k)_t$, ϵ_{t-1} be independent variables in the model. The test statistics is:

$$LM = (n-1)R^2. \tag{2.11}$$

Observe that there are *n*-1 data points in the regression model. When the null hypothesis is true, LM statistics has the chi-distribution with one degree of freedom. Null hyphotesis, H_0, is that there is no serial correlation.

2.3.2 Jargue-Bera (Normality) Test

Jarque-Bera (JB) apply *skewness* and *kurtosis* to detect whether residuals are distributed normally or not. The measurement of asymmetry is called skewness of the data. Kurtosis, simply, tells us about the peakedness or flaterness of the distribution.

The Jarque-Bera coefficient is found by:

$$JB = n[(skewness)^2/6 + (Kurtosis - 3)^2/24]. \tag{2.12}$$

where *n* is the sample size. For normal distribution, skewness is 0 and kurtosis is 3. JB has Chi-squared distribution with two degrees of freedom. Null hypothesis is that the residuals or error terms are normally distributed.

CHAPTER 3

EMPIRICAL ANALYSIS

In this chapter, future of unemployment rate (UR), income balance of UIF and investment income of UIF are modelled. Unemployment rate is the main affecting factor for both incomes and expenses of UIF. Thus, income balance of UIF is modelled with UR. Hereby, future of UR is needed to be forecasted.

Used variables are unemployment rate, income and expenses of UIF, consumer price index (CPI), investment income to UIF, support and incentives expenses and number of beneficiary. Data collected monthly from January, 2008 to July, 2019. Support and incentives expenses begin at July, 2018. Resources for UIF are collected from monthly reports for UIF of Turkish Employment Agency. Seasonally adjusted unemployment rate is taken from database of Statistical Insitute of Turkey. UIF variables are taken as currency of Turkish lira. All data except unemployment rate is inflation adjusted by CPI of Turkey. For this data set, time series models which are ARIMA and least squares estimation analysis are presented with their findings.

In this study, we mainly focus on the income balance of UIF, *F*, as:

$$F_t = Income_t - Expense_t \tag{3.1}$$

where *t* represents time and t$\in\mathbb{R}^+$, $Income_t > 0$, $Expense_t > 0$ $\forall$t$\in\mathbb{R}^+$. Hence, the range of F is $\mathbb{R}$. $Income_t$ includes only collected premiums at the first stage. Another important income of the fund is the investment income. Since, this amount depends on the money in fund, we investigate it seperately at the second stage of the study. Besides, there some other incomes. They do not ecxeed 1% of the total income. Thus, we neglect them in our analysis. $Expense_t$ is defined as for the beneficiaries at the first stage as:

$$Expense_t = (BenefitPayments)_t + (ActiveLaborForcePrograms)_t \quad (3.2)$$

Actually, $Expense_t$ includes other expense items which depend on political desicions. The most important one is the support and incentives payments to firms. The effect of this expense and its affordability by the fund is the main focus in this thesis. Thus, it is examined in the second stage. The abbreviations of data are given in Table 3.1.

Table 3.1: Abbreviations of Variables

UR	Seasonally adjusted unemployment rate
F	Inflation adjusted income balance
S	Inflation adjusted support and incentives
I	Inflation adjusted investment incomes
Expense	Expenses only for beneficiary
Income	Income only collected premiums

Descriptive statistics and the *p*-value for the JB test are given in Table 3.2. *F, S*, Expense and Income are inflation adjusted. It must be noted that all variables are non-normal according to JB test results at 0.05 significance level.

Table 3.2: Descriptive Statistics

Variable	Mean	St. deviation	Max.	Min.	JB p-value
UR (%)	10.51	1.52	14.30	8.00	0.0079
Income (TL)	0.45×10^9	0.127×10^9	0.667×10^9	0.259×10^9	0.0170
Expense (TL)	0.235×10^9	0.168×10^9	0.933×10^9	15,798,405	0.0000
Benef. nb.	299,288	137,756	682,362	106,945	0.0000
F (TL)	0.216×10^9	97,438,237	0.438×10^9	-0.3×10^9	0.0000
S (TL)	1.24×10^9	0.741×10^9	3.59×10^9	0.124×10^9	0.0000

Time series plots are given in Figure 3.1. It can be seen that UR is decreasing between 2009 to 2012 but then has an increasing trend. The same pattern is observed for both beneficiary amount and expense as expected. It is clearly observed from graphs of both UR and the number of beneficiary that sharp increment exists after middle of 2017. Hence, expenses gets its share for this period after slightly increasing trend and shows severe increasing. Income also has ascending trend due to rising population and employment volume, but again after middle of 2017, it loses ascending motion and remains stable around 600m TL. *F*, which is income - expense, also illustrates overal outcome effect on unemployment. After sharp upward movement at UR after middle of 2017, government and fund managers decide to support firms and banks by using fund income. Therefore, huge expense item is generated for UIF as support and incentives expense (*S*). As can be seen in Table 3.2, the inflation adjusted average expense per month is 1.24 billion TL. In conclusion, *UR* is affecting *F*.

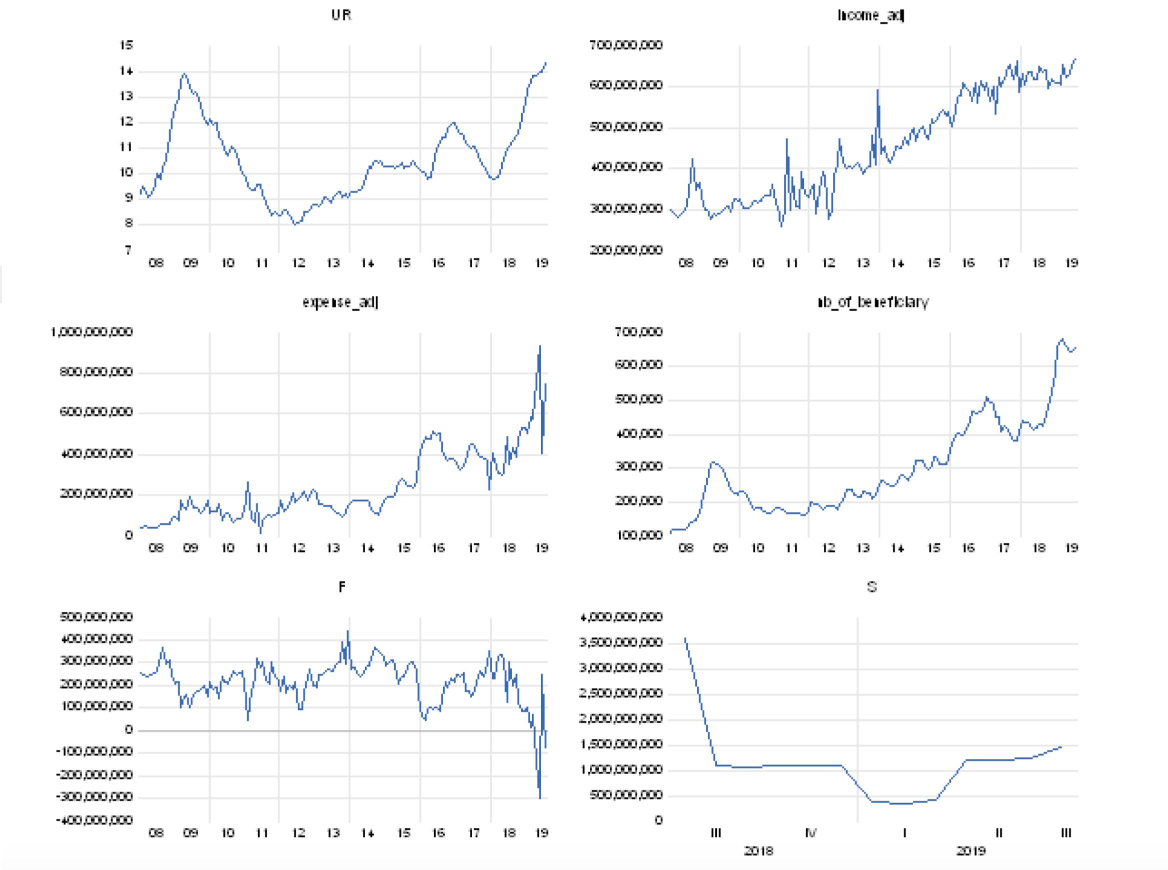


Figure 3.1: Graphs of Original Data

3.1 UIF Modelling

We model F per beneficiary, F_{new}, since modelling unemployment rate is more accurate than modelling the number of unemployed. Graph of F_{new} is given in Figure 3.2.

Figure 3.2: Graph of F_{new}

Firstly, stationarity of variables F_{new} and UR are checked by ADF unit root test. ADF test results are given in Table 3.3. It is seen that UR is integrated of order 1, i.e. I(1) and F_{new} is stationary at level, i.e I(0).

Table 3.3: ADF Unit Root Test Results

Variable	Series Level	Test Statistics	P-values
UR	Level 0	-1.5531	0.5038
UR	Level 1	-6.6571	0.0000*
F_{new}	Level 0	-3.2224	0.0207*

* significant at 1%

Secondly, by analyzing crosscorrelogram illustrated in Figure 3.3, it is observed that the 6th lag is the most significant one.

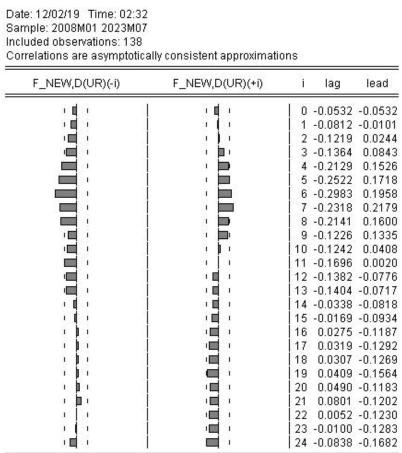


Figure 3.3: Crosscorrelogram of F_{new} and d(UR)

Thus, the model in Equation 3.3 is constructed in the first case.

$$(F_{new})_t = c + \theta d(UR)_{t-6} + \epsilon_t \tag{3.3}$$

where c and θ are constants, ϵ_t are error terms. The regression output of the model 3.3 is given in Figure 3.4:

Dependent Variable: F_NEW
Method: Least Squares
Date: 12/20/19 Time: 15:16
Sample (adjusted): 2008M08 2019M07
Included observations: 132 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	888.2817	43.28476	20.52181	0.0000
D(UR(-6))	-649.0167	158.9390	-4.083431	0.0001

R-squared	0.113683	Mean dependent var	868.1229
Adjusted R-squared	0.106865	S.D. dependent var	522.7816
S.E. of regression	494.0589	Akaike info criterion	15.25822
Sum squared resid	31732249	Schwarz criterion	15.30190
Log likelihood	-1005.043	Hannan-Quinn criter.	15.27597
F-statistic	16.67441	Durbin-Watson stat	0.366172
Prob(F-statistic)	0.000077		

Figure 3.4: Model 1 for the Fund Balance

Durbin-Watson statistic value indicates autocorrelation in residuals. Thus, we examine the residuals correlogram given in Figure 3.5 and saw that the 1st lag of the dependent variable F_{new} must be included in the model.

Sample: 2008M01 2019M07
Included observations: 132

Lag	AC	PAC	Q-Stat	Prob
1	0.767	0.767	79.332	0.000
2	0.624	0.090	132.40	0.000
3	0.501	-0.008	166.84	0.000
4	0.427	0.058	192.08	0.000
5	0.339	-0.046	208.08	0.000
6	0.300	0.065	220.75	0.000
7	0.278	0.052	231.66	0.000
8	0.262	0.024	241.41	0.000
9	0.254	0.045	250.67	0.000
10	0.287	0.122	262.62	0.000
11	0.328	0.103	278.31	0.000
12	0.304	-0.070	291.96	0.000
13	0.275	-0.018	303.17	0.000
14	0.187	-0.153	308.41	0.000
15	0.140	0.000	311.36	0.000
16	0.107	0.031	313.12	0.000
17	0.120	0.076	315.34	0.000
18	0.107	-0.017	317.12	0.000
19	0.094	-0.031	318.50	0.000
20	0.117	0.084	320.68	0.000
21	0.171	0.096	325.34	0.000
22	0.205	0.030	332.12	0.000
23	0.240	0.048	341.50	0.000
24	0.253	0.008	351.96	0.000

Figure 3.5: Residuals correlogram of Model Step 1 for the Fund Model

The new model fitted to the data is:

$$(F_{new})_t = c + \theta(F_{new})_{t-1} + \theta_1 d(UR)_{t-6} + \epsilon_t \tag{3.4}$$

where the output is given in Figure 3.6.

Dependent Variable: F_NEW
Method: Least Squares
Date: 12/20/19 Time: 15:17
Sample (adjusted): 2008M08 2019M07
Included observations: 132 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	152.4724	47.47426	3.211686	0.0017
F_NEW(-1)	0.816124	0.045835	17.80550	0.0000
D(UR(-6))	-224.7551	89.05286	-2.523839	0.0128

R-squared	0.743664	Mean dependent var	868.1229
Adjusted R-squared	0.739690	S.D. dependent var	522.7816
S.E. of regression	266.7261	Akaike info criterion	14.03279
Sum squared resid	9177423.	Schwarz criterion	14.09830
Log likelihood	-923.1639	Hannan-Quinn criter.	14.05941
F-statistic	187.1233	Durbin-Watson stat	2.135303
Prob(F-statistic)	0.000000		

Figure 3.6: The Second Model for the Fund Balance

Though Durbin-Watson statistic is now close to 2.00, it is misleading since the model includes the 1st lag of the dependent variable. Thus, the residuals correlogram is given Figure 3.7 and seen that the 11th lag can be added to the model.

Sample: 2008M01 2019M07
Included observations: 132
Q-statistic probabilities adjusted for 1 dynamic regressor

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.093	-0.093	1.1694	0.280
		2	0.051	0.042	1.5190	0.468
		3	-0.120	-0.113	3.4910	0.322
		4	0.032	0.010	3.6307	0.458
		5	-0.030	-0.017	3.7549	0.585
		6	0.081	0.064	4.6745	0.586
		7	0.097	0.118	6.0093	0.539
		8	-0.036	-0.029	6.1961	0.625
		9	-0.109	-0.110	7.9135	0.543
		10	0.019	0.024	7.9645	0.632
		11	0.208	0.224	14.307	0.216
		12	0.063	0.086	14.901	0.247
		13	0.124	0.116	17.171	0.192
		14	0.004	0.056	17.173	0.247
		15	-0.118	-0.104	19.267	0.202
		16	0.001	0.030	19.267	0.255
		17	-0.037	-0.065	19.480	0.302
		18	0.168	0.087	23.853	0.160
		19	-0.090	-0.071	25.125	0.156
		20	-0.034	-0.068	25.304	0.190
		21	-0.092	-0.062	26.644	0.183
		22	0.068	0.032	27.378	0.197
		23	0.093	0.095	28.784	0.188
		24	0.196	0.130	35.059	0.068

Figure 3.7: Residuals Correlogram for the Second Model of Fund Balance

By adding the 11th lag of F_{new}, we finally fit the model:

$$(F_{new})_t = c + \theta(F_{new})_{t-1} + \theta_1(F_{new})_{t-11} + \theta_2 d(UR_{t-6}) + \epsilon_t \tag{3.5}$$

where c, θ_1, θ_2 are constants and ϵ_t is the error. Obtained output is given in Figure 3.8.

Dependent Variable: F_NEW
Method: Least Squares
Date: 11/26/19 Time: 00:01
Sample (adjusted): 2008M12 2019M07
Included observations: 128 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	117.3952	56.82003	2.066088	0.0409
F_NEW(-1)	0.730005	0.054547	13.38301	0.0000
F_NEW(-11)	0.104064	0.046724	2.227195	0.0277
D(UR(-6))	-328.0443	93.03079	-3.526191	0.0006

R-squared	0.706325	Mean dependent var	825.3077
Adjusted R-squared	0.699220	S.D. dependent var	467.1061
S.E. of regression	256.1769	Akaike info criterion	13.96036
Sum squared resid	8137697.	Schwarz criterion	14.04949
Log likelihood	-889.4633	Hannan-Quinn criter.	13.99658
F-statistic	99.41189	Durbin-Watson stat	2.042276
Prob(F-statistic)	0.000000		

Figure 3.8: Estimated Final Model for UIF

3.1.1 Diagnostic Analysis for UIF Model

Firstly, the serial correlation of the residuals are tested by Breusch-Godfrey serial correlation LM test. It is concluded that the p-value is insignificant. There is no serial correlation as seen in Figure 3.9

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	1.018285	Prob. F(2,122)	0.3643
Obs*R-squared	2.101646	Prob. Chi-Square(2)	0.3496

Figure 3.9: LM Test Result for Model UIF

Besides, the autocorrelation and partial correlation functions of the residuals are examined and seen that all lags are in the confidence interval, see Figure 3.10. Hence, we conclude that there is no serial correlation problem among the residuals.

Date: 11/11/19 Time: 13:06
Sample: 2008M01 2019M07
Included observations: 128
Q-statistic probabilities adjusted for 2 dynamic regressors

	AC	PAC	Q-Stat	Prob*
1	-0.038	-0.038	0.1858	0.666
2	0.107	0.106	1.7102	0.425
3	-0.037	-0.030	1.8941	0.595
4	0.119	0.107	3.8069	0.433
5	-0.009	0.004	3.8185	0.576
6	0.136	0.115	6.3365	0.387
7	0.124	0.144	8.4403	0.295
8	-0.007	-0.035	8.4476	0.391
9	-0.095	-0.118	9.7097	0.374
10	0.035	0.013	9.8817	0.451
11	0.107	0.107	11.511	0.402
12	-0.010	-0.025	11.525	0.485
13	0.068	0.036	12.187	0.512
14	-0.036	-0.044	12.374	0.576
15	-0.102	-0.115	13.901	0.533
16	-0.024	0.007	13.986	0.600
17	-0.064	-0.102	14.601	0.624
18	0.082	0.051	15.624	0.619
19	-0.095	-0.056	16.991	0.591
20	-0.064	-0.080	17.627	0.612
21	-0.122	-0.071	19.946	0.525
22	0.029	0.051	20.074	0.578
23	0.055	0.114	20.549	0.609
24	0.128	0.124	23.166	0.510

*Probabilities may not be valid for this equation specification.

Figure 3.10: Correlogram for Model Residuals of UIF

As next step, normality of the residulas are tested by JB normality test. The test result is given in Figure 3.11. JB p-value is observed as 10%. Thus, residuals of the model can be approximated by normal distribution.

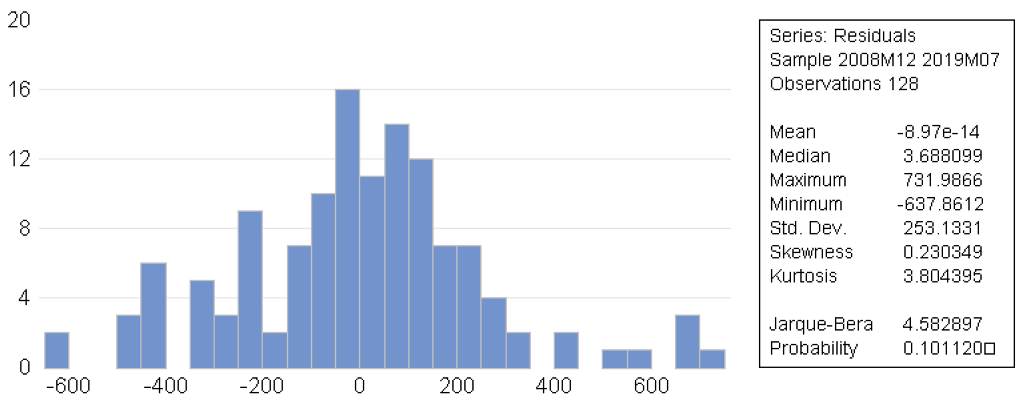


Figure 3.11: JB Normality Test for Model UIF

Finally, Breusch-Pagan-Godfrey heteroscedasticity test is applied to the residuals of model. Test result is given in Figure 3.12 According to the test result, p-value again much more higher than 10%. Hence, there is no heteroscedasticity problem.

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	0.504586	Prob. F(3,124)	0.6798
Obs*R-squared	1.543743	Prob. Chi-Square(3)	0.6722
Scaled explained SS	2.031456	Prob. Chi-Square(3)	0.5659

Figure 3.12: B-P-G Heteroscedasticity Test Result for the Residuals

Since the assumptions seem to be valid, the estimated model in Figure 3.8 can be interpreted. All p-values of exogenous variables are significant at 5% significance level. The coefficient of 6th lag of d(UR) is -328.04 which means that 1 unit increase for the first difference of the unemployment rate causes around 328 TL decline in F_{new} after 6 months. Additionally, R-squared explains to what extent the variance of one variable explains the variance of the second variable. R-squared value is around 0.70 which means that the model explains approximately 70% of F_{new} around its mean.

3.2 UR Modelling

To analyze the future balance of UIF, we have to predict unemployment rate in future. Thus in this section, we model the seasonally adjusted UR by appropriate ARIMA model.

The time series plot of d(UR) can be seen in Figure 3.13. It is seen that all values approximetaly sit around zero. ADF unit root test is applied to the series and found stationary in UIF modelling section.

The the correlogram of the difference of UR given in Figure 3.14 is examined. To check which one of the plausible models can be fitted, we employ ARIMA(1,1,0), ARIMA(0,1,1), ARIMA(1,1,1), ARIMA(2,1,0), ARIMA(1,1,2), ARIMA(2,1,1), ARIMA(4,1,1), AR-IMA(4,1,0) ARIMA(1,1,4), ARIMA(2,1,4), ARIMA(4,1,2), ARIMA(4,1,4), ARIMA (6,1,0), ARIMA(6,1,1), ARIMA(6,1,2) ARIMA(6,1,4). The output of these models are given in Appendix.

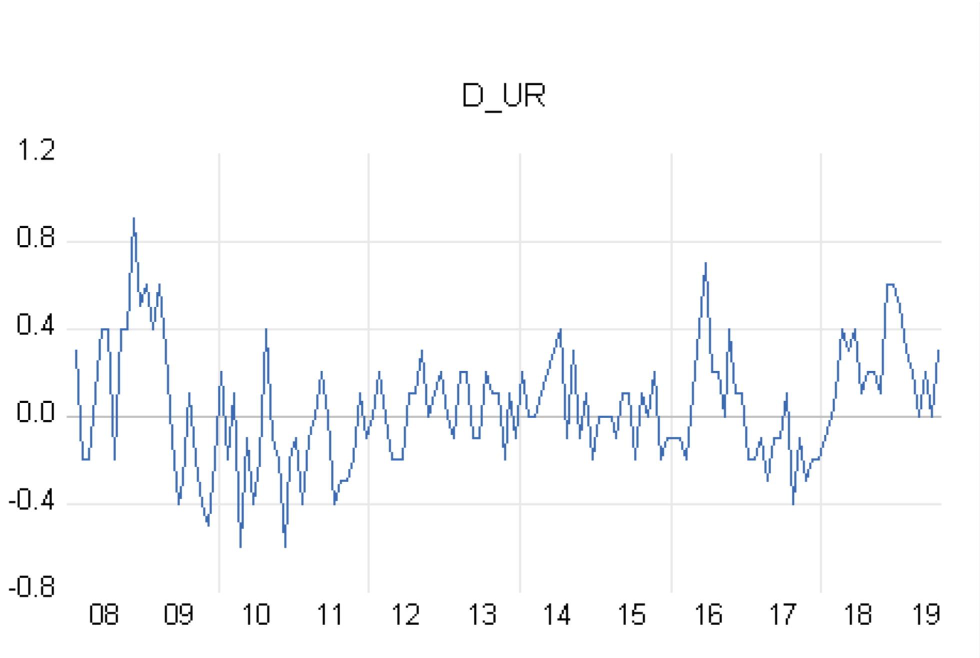
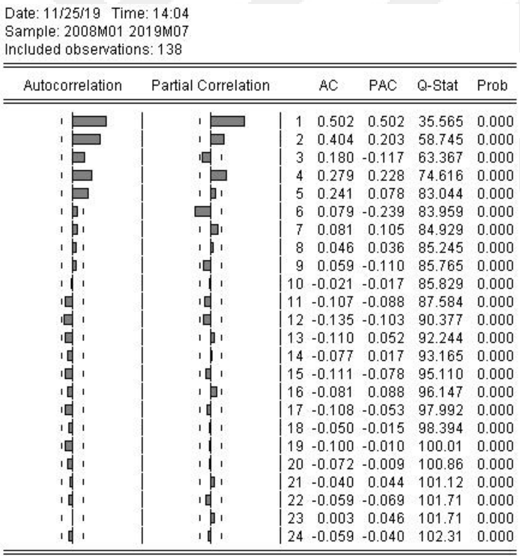


Figure 3.13: Graph of the First Difference of UR, d(UR)



Date: 11/25/19 Time: 14:04
Sample: 2008M01 2019M07
Included observations: 138

Lag	AC	PAC	Q-Stat	Prob
1	0.502	0.502	35.565	0.000
2	0.404	0.203	58.745	0.000
3	0.180	-0.117	63.367	0.000
4	0.279	0.228	74.616	0.000
5	0.241	0.078	83.044	0.000
6	0.079	-0.239	83.959	0.000
7	0.081	0.105	84.929	0.000
8	0.046	0.036	85.245	0.000
9	0.059	-0.110	85.765	0.000
10	-0.021	-0.017	85.829	0.000
11	-0.107	-0.088	87.584	0.000
12	-0.135	-0.103	90.377	0.000
13	-0.110	0.052	92.244	0.000
14	-0.077	0.017	93.165	0.000
15	-0.111	-0.078	95.110	0.000
16	-0.081	0.088	96.147	0.000
17	-0.108	-0.053	97.992	0.000
18	-0.050	-0.015	98.394	0.000
19	-0.100	-0.010	100.01	0.000
20	-0.072	-0.009	100.86	0.000
21	-0.040	0.044	101.12	0.000
22	-0.059	-0.069	101.71	0.000
23	0.003	0.046	101.71	0.000
24	-0.059	-0.040	102.31	0.000

Figure 3.14: Correlogram of d(UR)

Hence, we compare these models by their information criteria and R-square values given in Table 3.4. It can be seen that the lowest AIC and SIC values as well as the highest R-square value is obtained in ARIMA(2, 1, 4).

Table 3.4: Tentative ARIMA Models for UR

Model	AIC	SIC	R-squared
ARIMA(1,1,0)	-0.066727	-0.02410	0.255743
ARIMA(1,1,1)	-0.080105	-0.016163	0.276275
ARIMA(2,1,0)	-0.103502	-0.039252	0.294388
ARIMA(1,1,2)	-0.184559	-0.099304	0.357506
ARIMA(2,1,1)	-0.105632	-0.019965	0.306168
ARIMA(4,1,0)	-0.147650	-0.039522	0.350760
ARIMA(4,1,1)	-0.139176	-0.009422	0.354934
ARIMA(1,1,4)	-0.203961	-0.076079	0.387984
ARIMA(2,1,4)	**-0.264427**	**-0.11451**	**0.433591**
ARIMA(4,1,2)	-0.204917	-0.053537	0.404926
ARIMA(4,1,4)	-0.211374	-0.016743	0.426144
ARIMA(6,1,0)	-0.187913	-0.035037	0.387872
ARIMA(6,1,1)	-0.192634	-0.017919	0.399916
ARIMA(6,1,2)	-0.210934	-0.014379	0.419658
ARIMA(6,1,4)	-0.204483	0.035751	0.433336

Therefore the model is decided to be as follows, model:

$$d(UR_t) = c + \alpha_1 d(UR_{t-1}) + \alpha_2 d(UR_{t-2}) + \alpha_3\epsilon_{t-1} + \alpha_4\epsilon_{t-2} + \alpha_5\epsilon_{t-3} + \alpha_6\epsilon_{t-4} + \epsilon_t \quad (3.6)$$

where c and α_i are constants and ϵ_t are error terms. Obtained output is given in Figure 3.15.

3.2.1 Diagnostic Analysis for UR Model

This section analyzes residuals or error terms of model. Serial correlation, heteroscedasticity, residual normality and correlogram are viewed to conclude on the model selection. Thereafter, future prediction step comes.

Firstly, the serial correlation of the residuals are tested by Breusch-Godfrey serial correlation Lagrange Multipliar (LM) test. It is concluded that there is no serial correlation as seen in Figure 3.16. *p*-value of Chi-Squared(2) is 15% which is higher than significance level of 10%.

Dependent Variable: D(UR)
Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)
Date: 12/22/19 Time: 01:58
Sample (adjusted): 2008M04 2019M07
Included observations: 136 after adjustments
Convergence achieved after 22 iterations
MA Backcast: 2007M12 2008M03

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.037318	0.038285	0.974754	0.3315
AR(1)	0.610225	0.029743	20.51637	0.0000
AR(2)	-0.897667	0.027701	-32.40573	0.0000
MA(1)	-0.102422	0.075403	-1.358322	0.1767
MA(2)	1.145427	0.071429	16.03592	0.0000
MA(3)	0.173713	0.070335	2.469785	0.0148
MA(4)	0.566310	0.072115	7.852911	0.0000

R-squared	0.433591	Mean dependent var	0.036765
Adjusted R-squared	0.407246	S.D. dependent var	0.268551
S.E. of regression	0.206759	Akaike info criterion	-0.264427
Sum squared resid	5.514658	Schwarz criterion	-0.114511
Log likelihood	24.98104	Hannan-Quinn criter.	-0.203505
F-statistic	16.45844	Durbin-Watson stat	2.066984
Prob(F-statistic)	0.000000		

Inverted AR Roots	.31+.90i	.31-.90i		
Inverted MA Roots	.35+.92i	.35-.92i	-.30+.70i	-.30-.70i

Figure 3.15: Estimated Model for UR

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	1.809910	Prob. F(2,127)	0.1679
Obs*R-squared	3.768919	Prob. Chi-Square(2)	0.1519

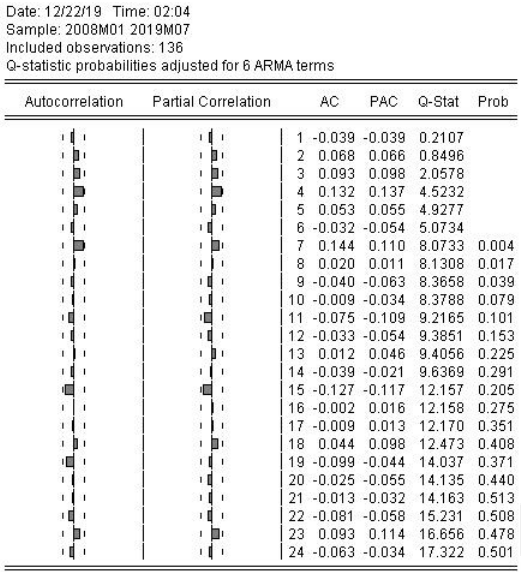
Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 12/22/19 Time: 02:03
Sample: 2008M04 2019M07
Included observations: 136
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000127	0.038053	-0.003329	0.9973
AR(1)	0.010679	0.030579	0.349232	0.7275
AR(2)	-0.012514	0.029089	-0.430183	0.6678
MA(1)	0.189143	0.141784	1.334020	0.1846
MA(2)	-0.220106	0.136531	-1.612131	0.1094
MA(3)	0.245187	0.148700	1.648870	0.1016
MA(4)	-0.088831	0.104741	-0.848099	0.3980
RESID(-1)	-0.231157	0.170733	-1.353907	0.1782
RESID(-2)	0.277157	0.161249	1.718818	0.0881

R-squared	0.027708	Mean dependent var	-0.000418
Adjusted R-squared	-0.033538	S.D. dependent var	0.202112
S.E. of regression	0.205473	Akaike info criterion	-0.263119
Sum squared resid	5.361832	Schwarz criterion	-0.070370
Log likelihood	26.89210	Hannan-Quinn criter.	-0.184791
F-statistic	0.452407	Durbin-Watson stat	2.041061
Prob(F-statistic)	0.887061		

Figure 3.16: B-G-P LM Test Result for UR model

Besides, correlogram of the residulas given in Figure 3.17 are examined and seen that they are uncorrelated.


Date: 12/22/19 Time: 02:04
Sample: 2008M01 2019M07
Included observations: 136
Q-statistic probabilities adjusted for 6 ARMA terms

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.039	-0.039	0.2107	
		2	0.068	0.066	0.8496	
		3	0.093	0.098	2.0578	
		4	0.132	0.137	4.5232	
		5	0.053	0.055	4.9277	
		6	-0.032	-0.054	5.0734	
		7	0.144	0.110	8.0733	0.004
		8	0.020	0.011	8.1308	0.017
		9	-0.040	-0.063	8.3658	0.039
		10	-0.009	-0.034	8.3788	0.079
		11	-0.075	-0.109	9.2165	0.101
		12	-0.033	-0.054	9.3851	0.153
		13	0.012	0.046	9.4056	0.225
		14	-0.039	-0.021	9.6369	0.291
		15	-0.127	-0.117	12.157	0.205
		16	-0.002	0.016	12.158	0.275
		17	-0.009	0.013	12.170	0.351
		18	0.044	0.098	12.473	0.408
		19	-0.099	-0.044	14.037	0.371
		20	-0.025	-0.055	14.135	0.440
		21	-0.013	-0.032	14.163	0.513
		22	-0.081	-0.058	15.231	0.508
		23	0.093	0.114	16.656	0.478
		24	-0.063	-0.034	17.322	0.501

Figure 3.17: Residuals Correlogram for UR model

Then normality of residuals is investigated by JB test whose output is given in Figure 3.18. It can be seen that normality assumption is valid.

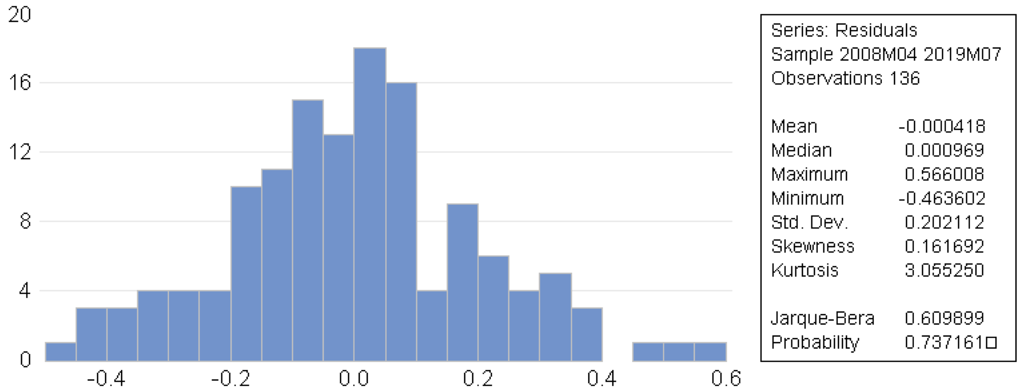


Figure 3.18: JB Test Result

3.3 Investment Model

Investment income (I) is one of the crucial income item of UIF. By forecasting future investment income, determining the future of the fund can be analyzed more truely. Firstly, inflation adjusted investment incomes per beneficary is calculated by the help of CPI. This income obtained from total cumulated UIF, not monthly income. Hence, to observe monthly investment income which comes from F, monthly investment rate, I_{rate}, is obtained by dividing investment income to the previous inflation adjusted cumulative fund:

$$(I_{rate})_t = I_t \div Totalfund_{t-1}. \tag{3.7}$$

In the final part, I_{rate} will be multiplied by predicted F_{new} to observe predicted investment income per beneficiary.

The graph of the new varibale I_{rate} is illustrated in Figure 3.19. Low values seem to be followed by low values and high values seem to be followed by high values. Based on this pattern, it seems that AR process with high correlation value would be appropriate, if it is stationary.

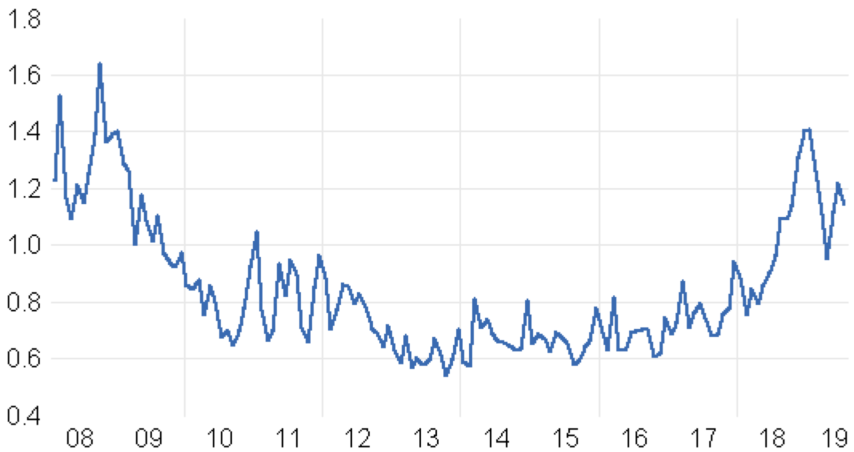


Figure 3.19: Graph of I_{rate}

It is observed from ADF unit root test that I_{rate} is stationary at level, i.e. I(0). The test result is given in Figure 3.20.

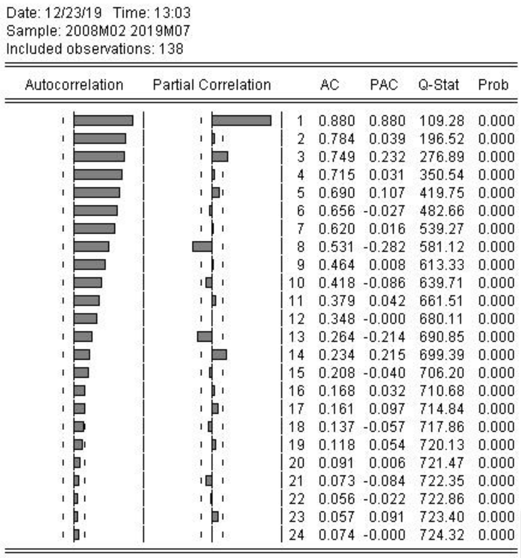
Null Hypothesis: I_RATE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.581231	0.0002
Test critical values:	1% level	-3.478189	
	5% level	-2.882433	
	10% level	-2.577990	

*MacKinnon (1996) one-sided p-values.

Figure 3.20: ADF Test result of I_{rate}

When the correlogram of I_{new} given in Figure 3.21, is examined, AR(14) model seems to be appropriate.


Date: 12/23/19 Time: 13:03
Sample: 2008M02 2019M07
Included observations: 138

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.880	0.880	109.28	0.000
		2	0.784	0.039	196.52	0.000
		3	0.749	0.232	276.89	0.000
		4	0.715	0.031	350.54	0.000
		5	0.690	0.107	419.75	0.000
		6	0.656	-0.027	482.66	0.000
		7	0.620	0.016	539.27	0.000
		8	0.531	-0.282	581.12	0.000
		9	0.464	0.008	613.33	0.000
		10	0.418	-0.086	639.71	0.000
		11	0.379	0.042	661.51	0.000
		12	0.348	-0.000	680.11	0.000
		13	0.264	-0.214	690.85	0.000
		14	0.234	0.215	699.39	0.000
		15	0.208	-0.040	706.20	0.000
		16	0.168	0.032	710.68	0.000
		17	0.161	0.097	714.84	0.000
		18	0.137	-0.057	717.86	0.000
		19	0.118	0.054	720.13	0.000
		20	0.091	0.006	721.47	0.000
		21	0.073	-0.084	722.35	0.000
		22	0.056	-0.022	722.86	0.000
		23	0.057	0.091	723.40	0.000
		24	0.074	-0.000	724.32	0.000

Figure 3.21: Correlogram of I_{rate}

The fitted model:

$$(I_{rate})_t = c + \alpha_1 (I_{rate})_{t-1} + .. + \alpha_{14} (I_{new})_{t-14} + \epsilon_t \quad (3.8)$$

where c, α_j are constants. ϵ_t is the error term.

Figure 3.22 illustrates the output of the AR(14) model. It is seen that there are insignificant lags. After removing insignificant variables from the model, we reach the final:

$$(I_{rate})_t = c + \alpha_1 (I_{rate})_{t-1} + \alpha_2 (I_{new})_{t-3} + \alpha_3 (I_{new})_{t-12} + \alpha_4 (I_{new})_{t-13} + \epsilon_t \quad (3.9)$$

where c and α's are constant and ϵ_t is error term. The output can be found in Figure 3.23.

3.3.1 Diagnostic Analysis for Investment Model

First of all, residuals correlogram is given in Figure 3.24. All lags are in the confidence interval except the 24th lag which is at the boundry which can be neglected.

Secondly, when we apply Breuch-Godfrey LM test, we concluded that there is no serial correlation. The result is given in Figure 3.25.

Dependent Variable: I_RATE
Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)
Date: 12/25/19 Time: 00:11
Sample (adjusted): 2009M03 2019M07
Included observations: 125 after adjustments
Convergence achieved after 3 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.789253	0.067324	11.72313	0.0000
AR(1)	0.820229	0.090220	9.091432	0.0000
AR(2)	-0.162535	0.112077	-1.450210	0.1498
AR(3)	0.217316	0.111571	1.947780	0.0540
AR(4)	-0.109743	0.114520	-0.958284	0.3400
AR(5)	0.195943	0.112103	1.747878	0.0833
AR(6)	0.004109	0.109879	0.037397	0.9702
AR(7)	0.139007	0.108776	1.277926	0.2040
AR(8)	-0.207454	0.107625	-1.927552	0.0565
AR(9)	0.033022	0.108526	0.304276	0.7615
AR(10)	-0.063900	0.107028	-0.597035	0.5517
AR(11)	0.030860	0.106464	0.289865	0.7725
AR(12)	0.274170	0.103234	2.655822	0.0091
AR(13)	-0.418157	0.094123	-4.442649	0.0000
AR(14)	0.132268	0.061008	2.168046	0.0323

R-squared	0.815685	Mean dependent var	0.798936
Adjusted R-squared	0.792227	S.D. dependent var	0.188106
S.E. of regression	0.085743	Akaike info criterion	-1.962763
Sum squared resid	0.808701	Schwarz criterion	-1.623366
Log likelihood	137.6727	Hannan-Quinn criter.	-1.824884
F-statistic	34.77185	Durbin-Watson stat	1.982461
Prob(F-statistic)	0.000000		

Inverted AR Roots	.91-.08i	.91+.08i	.64-.50i	.64+.50i
	.45	.44+.83i	.44-.83i	-.06+.92i
	-.06-.92i	-.48+.81i	-.48-.81i	-.83-.47i
	-.83+.47i	-.88		

Figure 3.22: AR(14) Model of I_{rate}

Dependent Variable: I_RATE
Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)
Date: 12/25/19 Time: 00:18
Sample (adjusted): 2009M02 2019M07
Included observations: 126 after adjustments
Convergence achieved after 3 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.780160	0.054148	14.40798	0.0000
AR(1)	0.704788	0.068154	10.34110	0.0000
AR(3)	0.149874	0.069189	2.166153	0.0323
AR(12)	0.150743	0.064264	2.345678	0.0206
AR(13)	-0.157117	0.054965	-2.858497	0.0050

R-squared	0.783748	Mean dependent var	0.802806
Adjusted R-squared	0.776600	S.D. dependent var	0.192321
S.E. of regression	0.090901	Akaike info criterion	-1.919213
Sum squared resid	0.999826	Schwarz criterion	-1.806662
Log likelihood	125.9104	Hannan-Quinn criter.	-1.873487
F-statistic	109.6333	Durbin-Watson stat	1.782964
Prob(F-statistic)	0.000000		

Inverted AR Roots	.88+.08i	.88-.08i	.71-.45i	.71+.45i
	.40-.76i	.40+.76i	-.02+.88i	-.02-.88i
	-.44+.76i	-.44-.76i	-.75-.44i	-.75+.44i
	-.86			

Figure 3.23: The Final Model of I_{rate}

Date: 12/25/19 Time: 00:20
Sample: 2008M02 2019M07
Included observations: 126
Q-statistic probabilities adjusted for 4 ARMA terms

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.086	0.086	0.9604	
		2	-0.049	-0.056	1.2679	
		3	-0.056	-0.048	1.6840	
		4	-0.036	-0.030	1.8570	
		5	0.088	0.090	2.8996	0.089
		6	0.148	0.129	5.8440	0.054
		7	0.185	0.173	10.458	0.015
		8	-0.020	-0.027	10.515	0.033
		9	-0.005	0.036	10.518	0.062
		10	-0.005	0.006	10.522	0.104
		11	0.021	0.010	10.585	0.158
		12	0.184	0.144	15.392	0.052
		13	-0.034	-0.102	15.558	0.077
		14	0.022	0.025	15.631	0.111
		15	0.005	0.012	15.634	0.155
		16	-0.118	-0.136	17.686	0.126
		17	0.083	0.084	18.707	0.132
		18	0.002	-0.067	18.708	0.176
		19	0.082	0.050	19.731	0.182
		20	0.031	0.052	19.880	0.226
		21	-0.028	-0.043	20.004	0.274
		22	-0.103	-0.075	21.663	0.247
		23	-0.084	-0.052	22.780	0.247
		24	0.237	0.203	31.639	0.047

Figure 3.24: Residuals Correlogram of the Final Model of I_{rate}

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	1.378102	Prob. F(2,119)	0.2560
Obs*R-squared	2.852270	Prob. Chi-Square(2)	0.2402

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 12/25/19 Time: 00:19
Sample: 2009M02 2019M07
Included observations: 126
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003008	0.054053	0.055656	0.9557
AR(1)	-0.232363	0.192613	-1.206372	0.2301
AR(3)	0.169932	0.148707	1.142735	0.2554
AR(12)	0.029478	0.067704	0.435399	0.6641
AR(13)	-0.012413	0.055404	-0.224039	0.8231
RESID(-1)	0.320821	0.210897	1.521217	0.1309
RESID(-2)	0.103685	0.162355	0.638631	0.5243

R-squared	0.022637	Mean dependent var	-6.82E-14
Adjusted R-squared	-0.026642	S.D. dependent var	0.089435
S.E. of regression	0.090618	Akaike info criterion	-1.910364
Sum squared resid	0.977193	Schwarz criterion	-1.752793
Log likelihood	127.3530	Hannan-Quinn criter.	-1.846348
F-statistic	0.459367	Durbin-Watson stat	1.937344
Prob(F-statistic)	0.837084		

Figure 3.25: B-G LM Test Result for the I_{rate} Model

Finally, normality of the residuals is tested with Jarque-Bera test given in Figure 3.26. Since, the p-value is greater than 10% it can be concluded that normal approximation is valid.

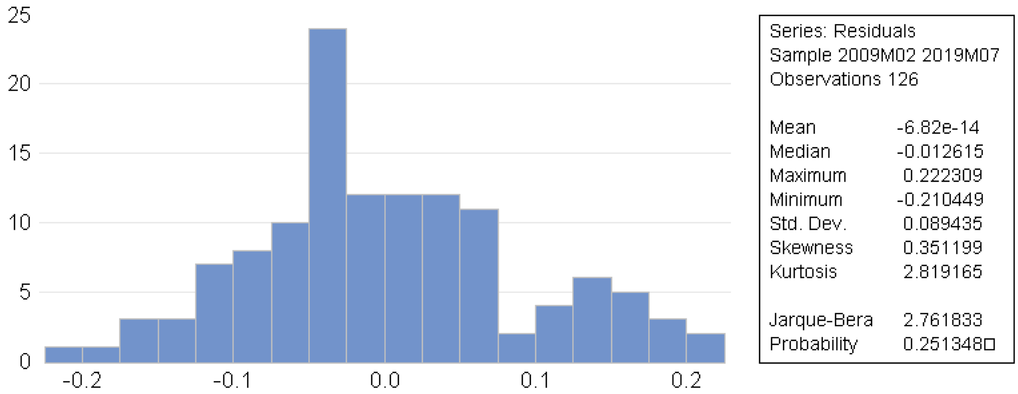


Figure 3.26: Normality Test of the Residuals

CHAPTER 4

ROBUSTNESS ANALYSIS

To investigate sustainability of the system,we search the break point in the estimated models. It requires, firstly, UR to be forecasted. After finding predicted values of unemployment rates, these values are used to predict F_{new} by the help of the UIF model. Additionally, future values of I_{rate} is predicted to find future investment income rate for the fund.

Forecast interval begins at **August of 2019** and ends at **May of 2021**. Figure 4.1 is the forecast graph from the model given in Equation 3.6 of UR.

Thereafter, Fund forecast is constructed for the same period by using the unemployment rate model in Equation 3.6. Figure 4.2 represents forecast graph of F_{new}.

Additionally investment income rate, I_{rate}, is forecasted for the given time interval by using model given in 3.9. The Forecast graph is given in Figure 4.3.

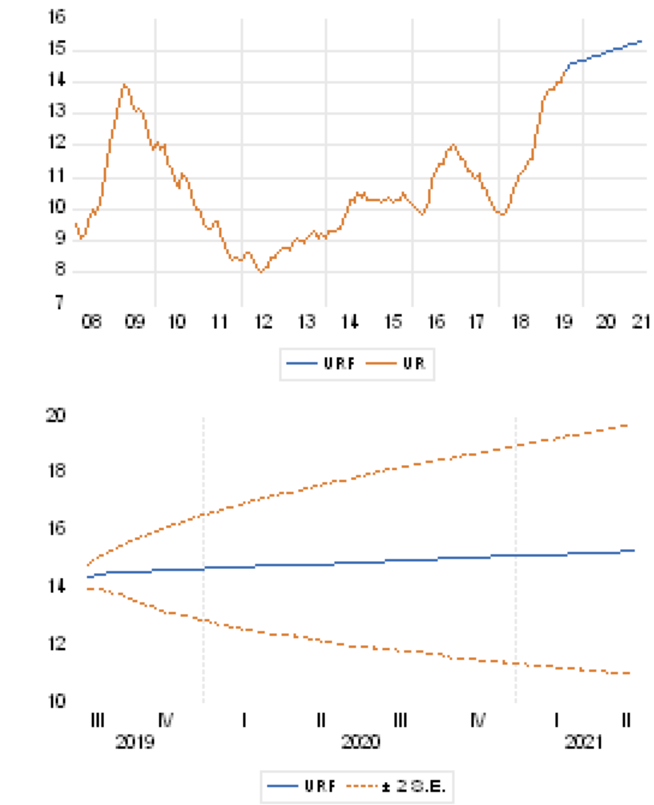


Figure 4.1: UR Forecast Graph

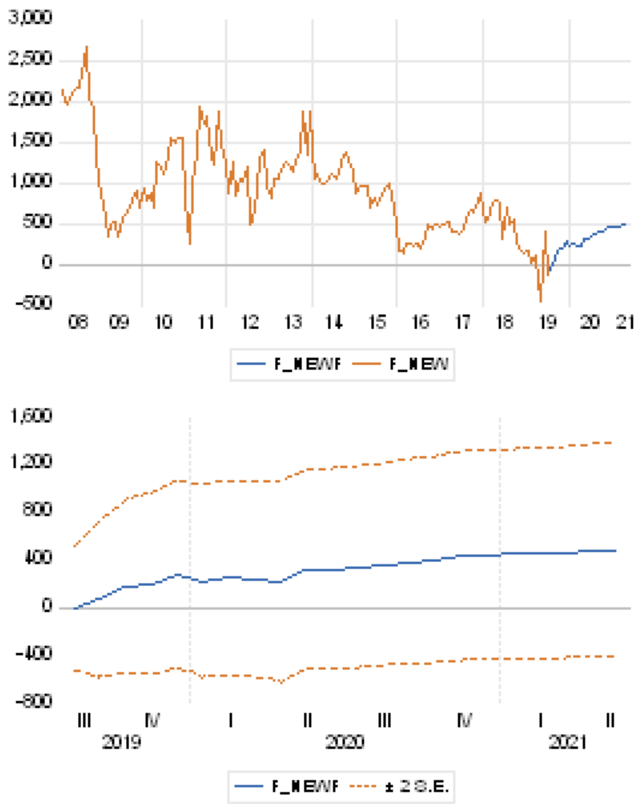


Figure 4.2: F_{new} Forecast Graph

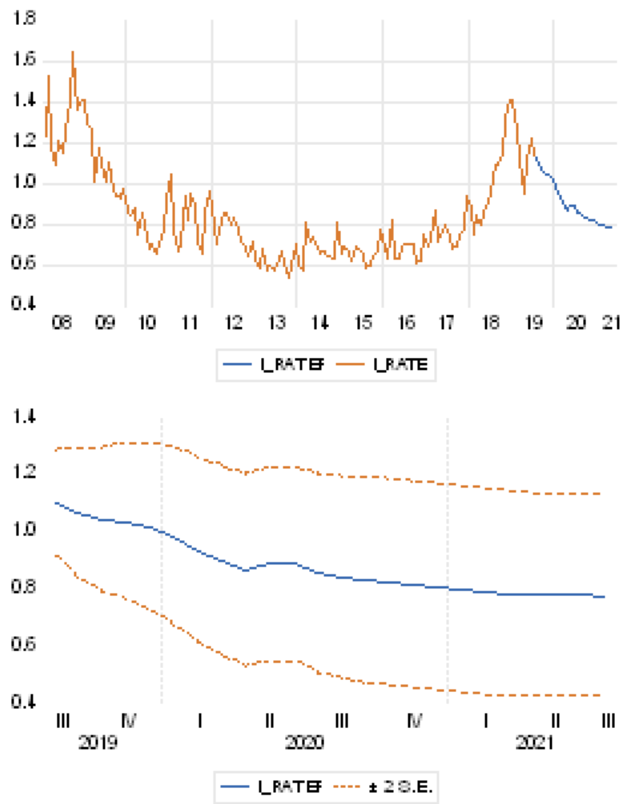


Figure 4.3: Forecast Graph of Investment Income Rate

4.1 Deterministic Analysis Part 1

F_{new} is monthly income balance per beneficary. An important expense of the fund is the support expenses which are determined by the government. Support expenses **S** is also taken per beneficary and denoted as S_{new}. S started at July of 2018, there is not enough data to model it. Therefore, we examine its effect in terms of scenarios. The graph of S_{new} and its descriptive statistics are given in Figure 4.5 and Table 4.1:

Table 4.1: Descriptive Statistics of S_{new}

Variable	Mean	Maximum	Minimum	Std. Dev.	JB p-value
S_{new}	2228.58	8340.64	508.40	1967.44	0.0000

As seen from Table 4.1, the maximum value S_{max} = **8340.64** TL, the minimum value S_{min} = **508.40** and the average value S_{avr} = **2228.58** TL per beneficiary monthly. Descriptive statistics test result of S_{new} is given in Figure 4.4

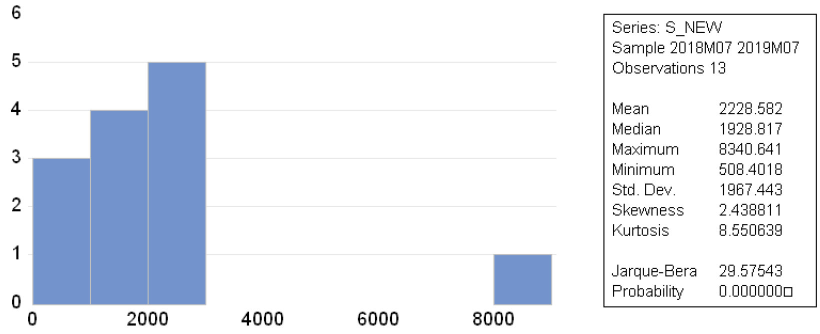


Figure 4.4: Descriptive Statistics of S_{new}

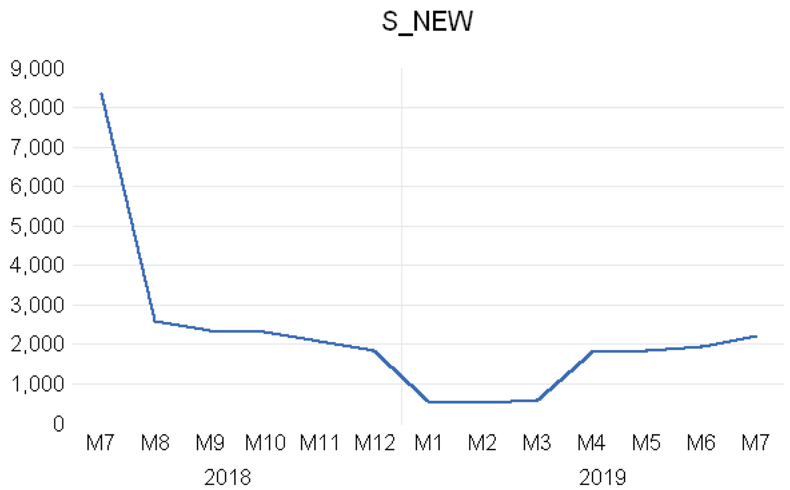


Figure 4.5: Graph of S_{new}

As deterministic approach, three scenarios are constructed for the ratio $\frac{F_{new}}{S_{new}}$ and observed whether these ratios are less than 1 or not. If the monthly rate $\frac{F_{new}}{S_{new}}$ is less than 1, it means that income of the fund can not afford support expenses at that considered month. Three scenarios are:

$$Expense_{max} = \frac{F_{new}}{S_{max}} < 1 \tag{4.1}$$

$$Expense_{min} = \frac{F_{new}}{S_{min}} < 1 \tag{4.2}$$

$$Expense_{avr} = \frac{F_{new}}{S_{avr}} < 1 \tag{4.3}$$

Table 4.2 gives average values of determined three cases:

Table 4.2: Average Values of 3 Cases for Expense

	$Expense_{min}$	$Expense_{max}$	$Expense_{avr}$
Average Value	0.6276	0.0382	0.1431

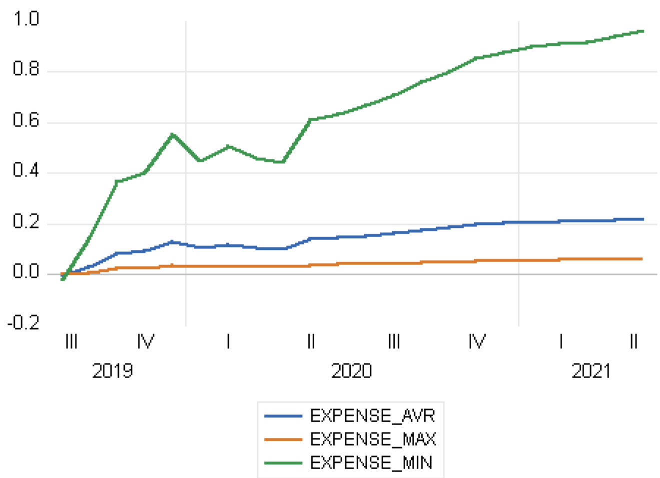


Figure 4.6: Affordability of the Fund under the Scenarios

The forecasted values of these three scenarios are given in Figure 4.6. If the highest support expense is maintained, affordability of fund is very few, on the average $\frac{F_{new}}{S_{max}}$ = 3.82%. If the minimum expense is applied for all period of time, it seems that the fund can afford only 63% of additional support expense on the average. In case of average support payment, the fund can only afford approximately 14% of it. In conclusion, it is observed that the monthly income per beneficiary will not be sufficient to afford support expenses.

Secondly, monthly balance **B** is calculated with the same deterministic approach. Following equations represents the monthly balances for the three scenarios:

$$B_{max} = F_{new} - S_{max} \tag{4.4}$$

$$B_{min} = F_{new} - S_{min} \tag{4.5}$$

$$B_{avr} = F_{new} - S_{avr} \tag{4.6}$$

If B is < 0, it means there is deficit. Figure 4.7 illustrates the monthly difference cases. Average values are for the three cases of the monthly balance are given in Table 4.3 and seen that all monthly balances are negative on the average. In other words, collected premiums income will not be able to afford support expenses. It must be remembered that we do not take the investment income into account in these analyses. Therefore, we rerun the analysis by adding its effect in the following section.

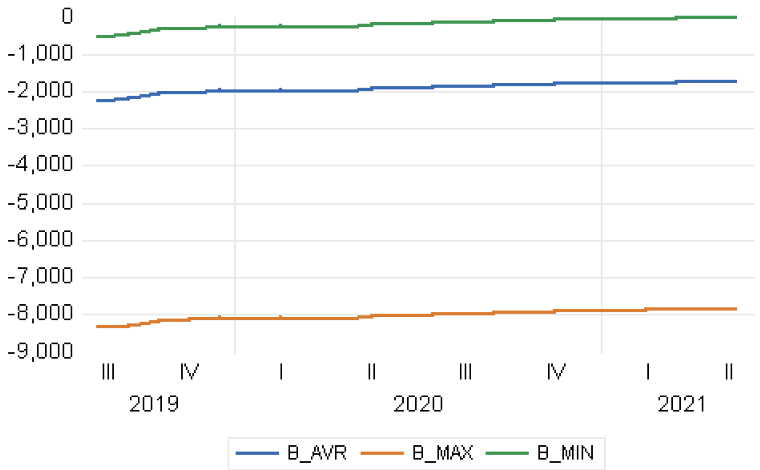


Figure 4.7: Three Cases for Monthly Balance of the Fund

Table 4.3: Average Values of 3 Cases for Expense

	B_{min}	B_{max}	B_{avr}
Average Value	-189.3070	-8021.547	-1909.487

4.2 Deterministic Analysis Part 2

The predicted investment income rate is given in Figure 4.8. The predicted investment income of monthly balance of the fund is calculated by multiplying F_{new} with these rates, I_{rate}, to find the investment income for the next month:

$$(I_{new})_t = (F_{new})_{t-1} \times (I_{rate})_{t-1}. \tag{4.7}$$

Thus, the predicted investment income per beneficiary, I_{new}, is given for the forecast period August of 2019 to May of 2021 in Figure 4.9. If the F_{new} value is negative, naturally there will not be investment income. I_{new} is taken **0%** in this case.

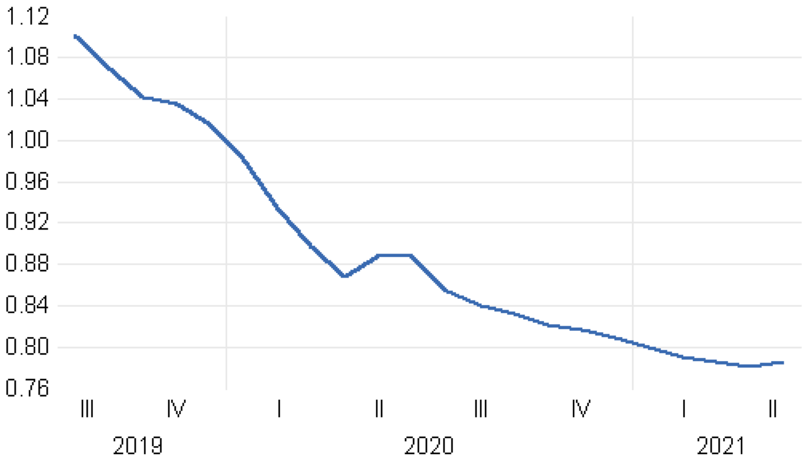


Figure 4.8: Predicted Investment Income Rate (%)

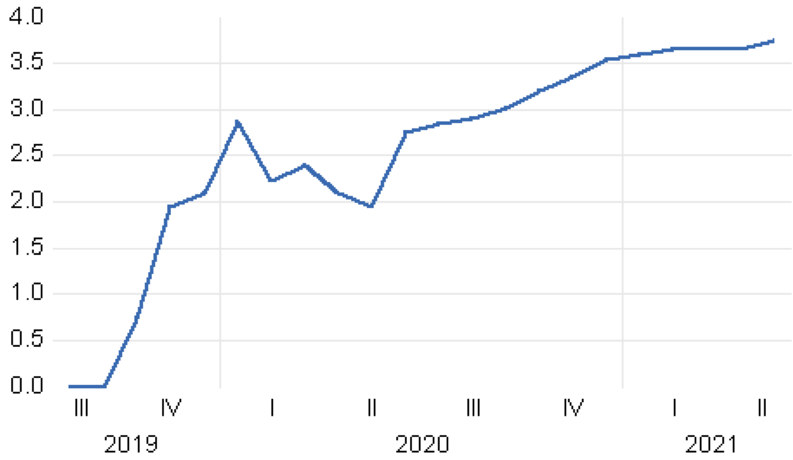


Figure 4.9: Predicted Investment Income

Consequently, total income per beneficiary, **TI**, is ready to be obtained by adding I_{new} to F_{new} as:

$$TI = I_{new} + F_{new}. \tag{4.8}$$

The graph of TI is given in Figure 4.10.

The same deterministic approach in Section 4.1 is applied for TI:

$$T.Expense_{max} = \frac{TI}{S_{max}} < 1, \tag{4.9}$$

$$T.Expense_{min} = \frac{TI}{S_{min}} < 1, \tag{4.10}$$

$$T.Expense_{avr} = \frac{TI}{S_{avr}} < 1. \tag{4.11}$$

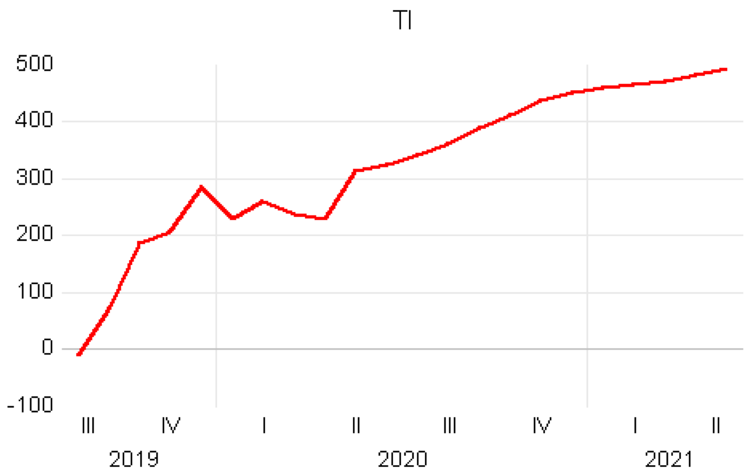


Figure 4.10: Predicted Total Income

The Figure 4.11 represents the affordability of the fund under these scenarios:

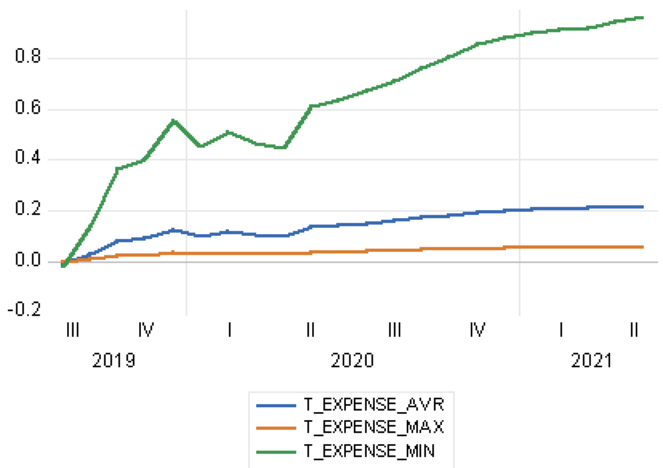


Figure 4.11: Affordability of the Total Fund under the Scenarios

Table 4.4: Average Values of 3 Cases for T.Expense

	$T.Expense_{min}$	$T.Expense_{max}$	$T.Expense_{avr}$
Average Value	0.632667	0.038564	0.144329

Average values for each scenarios are given in Table 4.4. It is seen that similar to part 1, all average values of the three cases are smaller than 1. Hence, total balance of the fund is not able to afford the support expenses. Finally, total balance, **TB**, is observed whether they are < 0 or not for the predicted interval:

$$TB_{max} = TI - S_{new} < 0 \tag{4.12}$$

$$TB_{min} = TI - S_{min} < 0 \tag{4.13}$$

$$TB_{avr} = TI - S_{avr} < 0 \tag{4.14}$$

The graph of and average values of TB under each scenario are given in Figure 4.12 and Table 4.5, respectively.

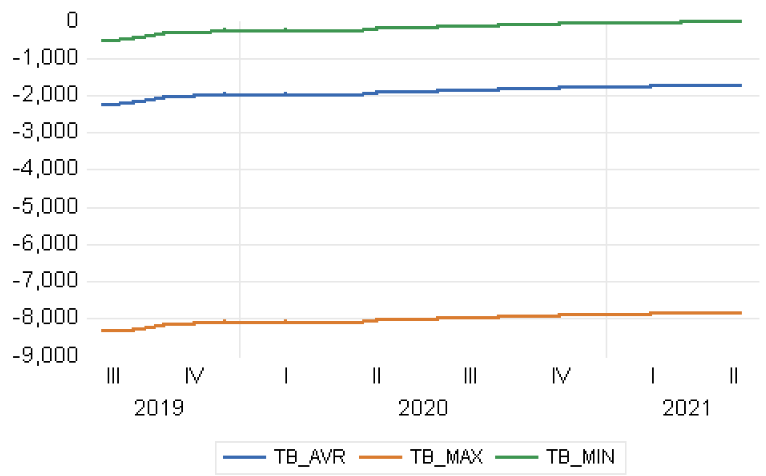


Figure 4.12: Three Cases for Monthly Total Blance of the Fund

Table 4.5: Average Values of 3 Cases for TB

	TB_{min}	TB_{max}	TB_{avr}
Average Value	-186.7520	-8018.992	-1906.932

To conclude, if the support payments continue at the minimum level, monthly total balance per beneficiary will be -186.8 TL. For the other cases, negative balances are much more higher than this value. They are respectively -8018.9 TL for the maximum payment case and -1906.9 TL for the average support payment case. Again it should be noted that we do not consider the total fund asset in these analyses. We conclude that these support payments can not be afforded by the premiums and their investment incomes meaning that the total fund asset will start to decrease and it is another interesting question to figure out the point where the whole system gets stuck which is a future work.

CHAPTER 5

CONCLUSION

This thesis introduces a modelling approach Turkish Unemployment Fund in terms of its components, factors and its sustainability in the future. The influence of unscheduled, unexpected and out of unemployment insurance support payments to the fund growth is investigated.

The main affecting factor to UIF is naturally unemployment rate. Thus, first of all, unemployment rate is predicted by ARIMA model. Then, by the help of this information, monthly fund revenue per beneficiary is predicted by appropriate regression model. Additionally, investment income rate for UIF is modelled and predicted by ARIMA model separately due to the fact that it depends on investment strategies decided by the fund managers and the government.

In deterministic analysis part, predicted fund revenue and investment income added total fund revenue is tested for three cases of ongoing support expenses which are the average, maximum and minimum values. It is observed that the fund will not be able to afford support expenses under all scenarios in the forecast period of August of 2019 to May of 2021. Therefore, the study asserts us that if the ongoing expenses continue, the UIF will be in deficit in terms of premiums and expenses and the support will start to decrease the total fund asset. However, the time when the total fund asset will be spent all is not examined in this thesis and a remained as a future study.

This thesis study can be a reference for those desire to analyze this topic more detailed. The fund managers and authorities can rearrange future support payment programs by considering this thesis study.

REFERENCES

[1] C. A., The us unemployment rate: Stationarity's effect and forecasting, Computational Statistics and Data Analysis, 2013.

[2] D. Acemoglu and R. Shimer, Productivity gains from unemployment insurance, European Economic Review, 44, p. 1195–1224, 2000.

[3] G. E. Bijwaart, Modelling the time on unemployment insurance benefits, Econometric Institute Report, 2008.

[4] J. G. M. Box, G.E.P., Time series analysis forecasting and control, Operational Research Quarterly, 22-2, 1971.

[5] T. S. Breuch and A. R. Pagan, The lagrange multiplier test and its applications to model specification in econometrics, The Review of Economic Studies, 47, pp. 239–253, 1980.

[6] F. C.., Forecasting the uk unemployment rate: Model comparisons, International Journal of Applied econometrics and Quantitative Studies, 2, 2005.

[7] P. Castaneda, Portfolio choice and benchmarking: The case of the unemployment insurance fund in chile, 2005.

[8] D. A. Dickey and W. A. Fuller, Distribution of the estimators for autoregressive time series with a unit root, Journal of the American Statistical Association, 74, pp. 427–431, 1979.

[9] A. A. A. Dobre I., Modelling unemployment rate using box-jenkins procedure, Journal of Applied Quantitative Methods, 3, pp. 156–166, 2008.

[10] K. S. Edlund P., The swedish unemployment rate: Var vs transfer function modelling, International Journal of Forecasting, 9, pp. 61–76, 1993.

[11] L. Goerke, M. Pannenberg, and H. W. Ursprung, A positive theory of the earnings relationship of unemployment benefits, 2007.

[12] J. Gruber, The consumption smoothing benefits of unemployment insurance, The American Economic Review, 87, pp. 192–205, 1997.

[13] H. A. Hopenhayn and J. P. Nicolini, Optimal unemployment insurance and employment history, 105, pp. 412–438, 1997.

[14] E. Lehmann, A search model of unemployment and inflation, IZA Discussion Paper No. 2194, 2006.

[15] K. B. Mahipan K., Chutiman P., A forecasting model for thailand's unemployment rate, Modern Applied Science, 7, 2013.

[16] B. O. Meyer, A quasi-experimental approach to the effects of unemployment insurance, National Bureau of Economic Research Working Paper No. 3159, 1989.

[17] D. T. Mortensen and C. A. Pissarides, A new developments in models of search in the labor market, Chapter 39 in Orley Ashenfelter and David Card (eds.) Handbook of Labor Economics, 3B, 1999.

[18] L. Riccetti, A. Russo, and M. Gallegati, Unemployment benefits and financial leverage in an agent based macroeconomic model, Economics: The Open-Access, Open-Assessment E-Journal, 7, 2013.

[19] O. Setty, Optimal unemployment insurance with monitoring, Working paper, Tel Aviv University, 2015.

[20] P. T., Forecasting the u.s unemployment rate, Computational Statistics and Data Analysis, 42, pp. 451–476, 2003.

APPENDIX A

APPENDIX

A.1 Plausible Tentative Models

Dependent Variable: D(UR)
Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)
Date: 01/03/20 Time: 01:03
Sample (adjusted): 2008M03 2019M07
Included observations: 137 after adjustments
Convergence achieved after 2 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.035036	0.040159	0.872450	0.3845
AR(1)	0.505710	0.074250	6.810939	0.0000

R-squared	0.255743	Mean dependent var	0.035036
Adjusted R-squared	0.250230	S.D. dependent var	0.268326
S.E. of regression	0.232341	Akaike info criterion	-0.066727
Sum squared resid	7.287637	Schwarz criterion	-0.024100
Log likelihood	6.570829	Hannan-Quinn criter.	-0.049405
F-statistic	46.38889	Durbin-Watson stat	2.148182
Prob(F-statistic)	0.000000		
Inverted AR Roots	.51		

Figure A.1: ARIMA(1,1,0) for UR

Dependent Variable: D(UR)
Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)
Date: 01/03/20 Time: 01:05
Sample (adjusted): 2008M04 2019M07
Included observations: 136 after adjustments
Convergence achieved after 3 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.041446	0.050245	0.824887	0.4109
AR(1)	0.415698	0.084658	4.910296	0.0000
AR(2)	0.196227	0.084357	2.326139	0.0215

R-squared	0.294388	Mean dependent var	0.036765
Adjusted R-squared	0.283778	S.D. dependent var	0.268551
S.E. of regression	0.227275	Akaike info criterion	-0.103502
Sum squared resid	6.869959	Schwarz criterion	-0.039252
Log likelihood	10.03814	Hannan-Quinn criter.	-0.077393
F-statistic	27.74449	Durbin-Watson stat	1.957373
Prob(F-statistic)	0.000000		

Inverted AR Roots	.70	-.28

Figure A.2: ARIMA(2,1,0) for UR

Dependent Variable: D(UR)
Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)
Date: 01/03/20 Time: 01:07
Sample (adjusted): 2008M06 2019M07
Included observations: 134 after adjustments
Convergence achieved after 3 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.040370	0.057813	0.698291	0.4863
AR(1)	0.465397	0.085418	5.448441	0.0000
AR(2)	0.210478	0.092347	2.279203	0.0243
AR(3)	-0.240759	0.092377	-2.606267	0.0102
AR(4)	0.234973	0.084327	2.786456	0.0061

R-squared	0.350760	Mean dependent var	0.038060
Adjusted R-squared	0.330628	S.D. dependent var	0.269724
S.E. of regression	0.220675	Akaike info criterion	-0.147650
Sum squared resid	6.281982	Schwarz criterion	-0.039522
Log likelihood	14.89257	Hannan-Quinn criter.	-0.103710
F-statistic	17.42344	Durbin-Watson stat	2.044786
Prob(F-statistic)	0.000000		

Inverted AR Roots	.81	.21+.58i	.21-.58i	-.76

Figure A.3: ARIMA(4,1,0) for UR

Dependent Variable: D(UR)
Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)
Date: 01/03/20 Time: 01:09
Sample (adjusted): 2008M08 2019M07
Included observations: 132 after adjustments
Convergence achieved after 3 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.030020	0.048726	0.616093	0.5390
AR(1)	0.447332	0.086709	5.158971	0.0000
AR(2)	0.288739	0.094053	3.069953	0.0026
AR(3)	-0.294343	0.094869	-3.102611	0.0024
AR(4)	0.232482	0.094214	2.467593	0.0150
AR(5)	0.185863	0.093520	1.987407	0.0491
AR(6)	-0.243658	0.085159	-2.861217	0.0049

R-squared	0.387872	Mean dependent var	0.032576
Adjusted R-squared	0.358490	S.D. dependent var	0.268014
S.E. of regression	0.214664	Akaike info criterion	-0.187913
Sum squared resid	5.760078	Schwarz criterion	-0.035037
Log likelihood	19.40228	Hannan-Quinn criter.	-0.125792
F-statistic	13.20095	Durbin-Watson stat	1.902166
Prob(F-statistic)	0.000000		

Inverted AR Roots	.75+.19i	.75-.19i	.20+.78i	.20-.78i
	-.73-.30i	-.73+.30i		

Figure A.4: ARIMA(6,1,0) for UR

Dependent Variable: D(UR)
Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)
Date: 01/03/20 Time: 01:04
Sample (adjusted): 2008M03 2019M07
Included observations: 137 after adjustments
Convergence achieved after 8 iterations
MA Backcast: 2008M02

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.037400	0.051766	0.722474	0.4713
AR(1)	0.743330	0.105130	7.070565	0.0000
MA(1)	-0.326458	0.148003	-2.205754	0.0291

R-squared	0.276275	Mean dependent var	0.035036
Adjusted R-squared	0.265473	S.D. dependent var	0.268326
S.E. of regression	0.229967	Akaike info criterion	-0.080105
Sum squared resid	7.086586	Schwarz criterion	-0.016163
Log likelihood	8.487163	Hannan-Quinn criter.	-0.054120
F-statistic	25.57664	Durbin-Watson stat	1.956359
Prob(F-statistic)	0.000000		

Inverted AR Roots	.74
Inverted MA Roots	.33

Figure A.5: ARIMA(1,1,1) for UR

Dependent Variable: D(UR)
Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)
Date: 01/03/20 Time: 01:05
Sample (adjusted): 2008M03 2019M07
Included observations: 137 after adjustments
Convergence achieved after 9 iterations
MA Backcast: 2008M01 2008M02

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.036067	0.035893	1.004842	0.3168
AR(1)	-0.267451	0.136100	-1.965103	0.0515
MA(1)	0.797035	0.104182	7.650399	0.0000
MA(2)	0.654607	0.068143	9.606432	0.0000

R-squared	0.357506	Mean dependent var	0.035036
Adjusted R-squared	0.343013	S.D. dependent var	0.268326
S.E. of regression	0.217491	Akaike info criterion	-0.184559
Sum squared resid	6.291193	Schwarz criterion	-0.099304
Log likelihood	16.64229	Hannan-Quinn criter.	-0.149913
F-statistic	24.66856	Durbin-Watson stat	1.994311
Prob(F-statistic)	0.000000		

Inverted AR Roots	-.27	
Inverted MA Roots	-.40-.70i	-.40+.70i

Figure A.6: ARIMA(1,1,2) for UR

Dependent Variable: D(UR)
Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)
Date: 01/03/20 Time: 01:07
Sample (adjusted): 2008M03 2019M07
Included observations: 137 after adjustments
Convergence achieved after 10 iterations
MA Backcast: 2007M11 2008M02

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.036766	0.055163	0.666486	0.5063
AR(1)	0.738848	0.170406	4.335803	0.0000
MA(1)	-0.270276	0.171215	-1.578571	0.1168
MA(2)	0.171879	0.119022	1.444101	0.1511
MA(3)	-0.435273	0.115115	-3.781188	0.0002
MA(4)	0.322091	0.084036	3.832787	0.0002

R-squared	0.387984	Mean dependent var	0.035036
Adjusted R-squared	0.364624	S.D. dependent var	0.268326
S.E. of regression	0.213884	Akaike info criterion	-0.203961
Sum squared resid	5.992757	Schwarz criterion	-0.076079
Log likelihood	19.97134	Hannan-Quinn criter.	-0.151993
F-statistic	16.60932	Durbin-Watson stat	1.931334
Prob(F-statistic)	0.000000		

Inverted AR Roots	.74			
Inverted MA Roots	.57-.35i	.57+.35i	-.44+.73i	-.44-.73i

Figure A.7: ARIMA(1,1,4) for UR

Dependent Variable: D(UR)
Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)
Date: 01/03/20 Time: 01:06
Sample (adjusted): 2008M04 2019M07
Included observations: 136 after adjustments
Convergence achieved after 20 iterations
MA Backcast: 2008M03

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.038216	0.047713	0.800945	0.4246
AR(1)	-0.060193	0.238955	-0.251903	0.8015
AR(2)	0.455338	0.119639	3.805949	0.0002
MA(1)	0.489730	0.257211	1.904004	0.0591

R-squared	0.306168	Mean dependent var	0.036765
Adjusted R-squared	0.290399	S.D. dependent var	0.268551
S.E. of regression	0.226222	Akaike info criterion	-0.105632
Sum squared resid	6.755267	Schwarz criterion	-0.019965
Log likelihood	11.18296	Hannan-Quinn criter.	-0.070819
F-statistic	19.41596	Durbin-Watson stat	1.956848
Prob(F-statistic)	0.000000		

Inverted AR Roots	.65	-.71
Inverted MA Roots	-.49	

Figure A.8: ARIMA(2,1,1) for UR

Dependent Variable: D(UR)
Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)
Date: 01/03/20 Time: 01:07
Sample (adjusted): 2008M06 2019M07
Included observations: 134 after adjustments
Convergence achieved after 67 iterations
MA Backcast: 2008M05

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.037658	0.061479	0.612537	0.5413
AR(1)	0.657762	0.297016	2.214569	0.0286
AR(2)	0.130896	0.156554	0.836108	0.4047
AR(3)	-0.291040	0.119208	-2.441445	0.0160
AR(4)	0.255385	0.086321	2.958561	0.0037
MA(1)	-0.206456	0.309053	-0.668030	0.5053

R-squared	0.354934	Mean dependent var	0.038060
Adjusted R-squared	0.329737	S.D. dependent var	0.269724
S.E. of regression	0.220822	Akaike info criterion	-0.139176
Sum squared resid	6.241587	Schwarz criterion	-0.009422
Log likelihood	15.32480	Hannan-Quinn criter.	-0.086448
F-statistic	14.08589	Durbin-Watson stat	2.002408
Prob(F-statistic)	0.000000		

Inverted AR Roots	.84	.28-.59i	.28+.59i	-.73
Inverted MA Roots	.21			

Figure A.9: ARIMA(4,1,1) for UR

Dependent Variable: D(UR)
Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)
Date: 01/03/20 Time: 01:08
Sample (adjusted): 2008M06 2019M07
Included observations: 134 after adjustments
Convergence achieved after 23 iterations
MA Backcast: 2008M04 2008M05

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.036926	0.048647	0.759058	0.4492
AR(1)	-0.239450	0.163279	-1.466506	0.1450
AR(2)	-0.071010	0.132739	-0.534964	0.5936
AR(3)	0.188980	0.126645	1.492205	0.1381
AR(4)	0.173994	0.106352	1.636020	0.1043
MA(1)	0.755721	0.141534	5.339517	0.0000
MA(2)	0.753133	0.113749	6.621003	0.0000

R-squared	0.404926	Mean dependent var	0.038060
Adjusted R-squared	0.376812	S.D. dependent var	0.269724
S.E. of regression	0.212926	Akaike info criterion	-0.204917
Sum squared resid	5.757874	Schwarz criterion	-0.053537
Log likelihood	20.72942	Hannan-Quinn criter.	-0.143401
F-statistic	14.40314	Durbin-Watson stat	2.057859
Prob(F-statistic)	0.000000		

Inverted AR Roots	.67	-.18-.67i	-.18+.67i	-.55
Inverted MA Roots	-.38-.78i	-.38+.78i		

Figure A.10: ARIMA(4,1,2) for UR

Dependent Variable: D(UR)
Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)
Date: 01/03/20 Time: 01:08
Sample (adjusted): 2008M06 2019M07
Included observations: 134 after adjustments
Convergence achieved after 28 iterations
MA Backcast: 2008M02 2008M05

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.054289	0.058077	0.934763	0.3517
AR(1)	0.451080	0.101696	4.435582	0.0000
AR(2)	-0.036403	0.040421	-0.900598	0.3695
AR(3)	-0.648735	0.039167	-16.56316	0.0000
AR(4)	0.684028	0.085619	7.989173	0.0000
MA(1)	-0.020648	0.146234	-0.141201	0.8879
MA(2)	0.215301	0.046659	4.614334	0.0000
MA(3)	0.871129	0.044209	19.70461	0.0000
MA(4)	-0.318281	0.141134	-2.255175	0.0259

R-squared	0.426144	Mean dependent var	0.038060
Adjusted R-squared	0.389418	S.D. dependent var	0.269724
S.E. of regression	0.210762	Akaike info criterion	-0.211374
Sum squared resid	5.552567	Schwarz criterion	-0.016743
Log likelihood	23.16206	Hannan-Quinn criter.	-0.132282
F-statistic	11.60310	Durbin-Watson stat	1.965099
Prob(F-statistic)	0.000000		

Inverted AR Roots	.78	.32-.90i	.32+.90i	-.97
Inverted MA Roots	.34+.93i	.34-.93i	.33	-.99

Figure A.11: ARIMA(4,1,4) for UR

Dependent Variable: D(UR)
Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)
Date: 01/03/20 Time: 01:09
Sample (adjusted): 2008M08 2019M07
Included observations: 132 after adjustments
Convergence achieved after 12 iterations
MA Backcast: 2008M07

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.030776	0.054019	0.569724	0.5699
AR(1)	0.016382	0.229232	0.071464	0.9431
AR(2)	0.466719	0.122867	3.798567	0.0002
AR(3)	-0.175424	0.108067	-1.623296	0.1071
AR(4)	0.124693	0.109692	1.136747	0.2578
AR(5)	0.238120	0.087718	2.714625	0.0076
AR(6)	-0.173824	0.097212	-1.788087	0.0762
MA(1)	0.464692	0.231509	2.007230	0.0469

R-squared	0.399916	Mean dependent var	0.032576
Adjusted R-squared	0.366041	S.D. dependent var	0.268014
S.E. of regression	0.213397	Akaike info criterion	-0.192634
Sum squared resid	5.646743	Schwarz criterion	-0.017919
Log likelihood	20.71383	Hannan-Quinn criter.	-0.121638
F-statistic	11.80540	Durbin-Watson stat	1.976585
Prob(F-statistic)	0.000000		

Inverted AR Roots	.66-.05i	.66+.05i	.15-.73i	.15+.73i
	-.80-.30i	-.80+.30i		
Inverted MA Roots	-.46			

Figure A.12: ARIMA(6,1,1) for UR

Dependent Variable: D(UR)
Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)
Date: 01/03/20 Time: 01:09
Sample (adjusted): 2008M08 2019M07
Included observations: 132 after adjustments
Convergence achieved after 12 iterations
MA Backcast: 2008M06 2008M07

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.033034	0.057791	0.571618	0.5686
AR(1)	-0.335938	0.223924	-1.500236	0.1361
AR(2)	0.106709	0.161467	0.660871	0.5099
AR(3)	0.141228	0.147399	0.958130	0.3399
AR(4)	0.132163	0.106457	1.241468	0.2168
AR(5)	0.202929	0.101764	1.994121	0.0484
AR(6)	-0.016029	0.124064	-0.129200	0.8974
MA(1)	0.832341	0.212946	3.908696	0.0002
MA(2)	0.594242	0.188524	3.152076	0.0020

R-squared	0.419658	Mean dependent var	0.032576
Adjusted R-squared	0.381912	S.D. dependent var	0.268014
S.E. of regression	0.210709	Akaike info criterion	-0.210934
Sum squared resid	5.460976	Schwarz criterion	-0.014379
Log likelihood	22.92163	Hannan-Quinn criter.	-0.131063
F-statistic	11.11799	Durbin-Watson stat	1.986486
Prob(F-statistic)	0.000000		

Inverted AR Roots	.78	.08	.07-.67i	.07+.67i
	-.67+.38i	-.67-.38i		
Inverted MA Roots	-.42+.65i	-.42-.65i		

Figure A.13: ARIMA(6,1,2) for UR

Dependent Variable: D(UR)
Method: ARMA Conditional Least Squares (Marquardt - EViews legacy)
Date: 01/03/20 Time: 01:10
Sample (adjusted): 2008M08 2019M07
Included observations: 132 after adjustments
Convergence achieved after 24 iterations
MA Backcast: 2008M04 2008M07

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.011178	0.048491	0.230510	0.8181
AR(1)	-0.125647	0.231415	-0.542952	0.5882
AR(2)	0.622582	0.201349	3.092057	0.0025
AR(3)	0.208955	0.223763	0.933824	0.3523
AR(4)	0.192920	0.169948	1.135174	0.2585
AR(5)	-0.014454	0.131729	-0.109722	0.9128
AR(6)	-0.171366	0.110682	-1.548268	0.1242
MA(1)	0.635238	0.238288	2.665836	0.0087
MA(2)	-0.049135	0.253065	-0.194161	0.8464
MA(3)	-0.453447	0.233752	-1.939859	0.0547
MA(4)	-0.429674	0.183107	-2.346569	0.0206

R-squared	0.433336	Mean dependent var	0.032576
Adjusted R-squared	0.386505	S.D. dependent var	0.268014
S.E. of regression	0.209924	Akaike info criterion	-0.204483
Sum squared resid	5.332262	Schwarz criterion	0.035751
Log likelihood	24.49585	Hannan-Quinn criter.	-0.106863
F-statistic	9.253054	Durbin-Watson stat	2.039883
Prob(F-statistic)	0.000000		

Inverted AR Roots	.80	.72	-.06+.69i	-.06-.69i
	-.76-.21i	-.76+.21i		
Inverted MA Roots	.83	-.33-.73i	-.33+.73i	-.81

Figure A.14: ARIMA(6,1,4) for UR