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Fiscal Policy and Forecasting Real GDP

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Abstract

The macroeconomic effect of changes in tax revenue and government spending influences gross domestic product in an economy. The economic growth depends on real business cycle where fiscal policy takes the central role which is managed by the government. When there is a shock in the economy, government changes policy to stabilize the economy to control interest rate otherwise there will be budget deficit which declines economic growth. The purpose of this study is to examine the effect of tax revenue and government spending on the economic growth and forecasting of gross domestic product in the United State. I carefully assess the fiscal interaction on the economic growth using Box- Jenkins methodology from the period 1947q2-2020q4, I select the best autoregressive integrated moving average (1,0,1) model to solve the research problem. The data considered for this study is large enough and the fitted model indicates reliable forecasting for the next quarters.

Keywords: Fiscal policy, Government spending, Taxes, Forecasting and Real gross domestic product.

JEL Classification: G2, G38, H30.

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Introduction

We learn from the theory and empirical evidence that fiscal policy has effects on demand for goods and services. When a government changes expenditure and taxes it ultimately affects the demand for goods and services in the short run. What happens if government increases or decreases taxes and spending in an economy of a country. We observe two types of fiscal policy where tight fiscal policy is contractionary meaning that revenue is greater than government spending that gives budget surplus. On the other hand, when the fiscal policy is loose or expansionary which means government spending is higher than the revenue that gives deficit which is met by issuing government bonds.

The moment a state has budget deficit meaning that it is a fiscal expansion which increases interest rates, and it also declines economic growth. So, fiscal policy is a tool managed by the government which affects GDP of an economy. Once fiscal policy increases the demand for goods and services which leads increasing prices and output. Here, we can learn from the RBC theory that real shock depends on business cycle. The purpose of this study is to learn what's going on in the US economy if there is change in the government spending and taxes.

This directed research contributes an understanding of the macroeconomic effects of changes in taxes and government spending. In chapter 2, I focus on literature review which is previous studies. The empirical effects of changes in fiscal policy are focused in chapter 3. In short, chapter 3 provides the empirical effects of tax and government spending changes in the US fiscal policy. I use VAR model to know the dynamic behavior of fiscal variables as data are multivariate time series. Also, I apply IRF to learn interactions among the variables. Finally, I use ARIMA model to forecast the USGDP in chapter 4.

Objectives of the Study

The broad objective of this study is to learn about fiscal policy and how it affects the US economy when it changes.

Specific Objectives

1. to examine the impact of government spending on the real GDP with the interaction of tax revenue;

2. to assess the effect of tax revenue on the real GDP with the interaction of government spending;
3. to forecast real GDP.

1. Literature Review

Fiscal policy affects the economic growth both in the short-run and long-run. In the short run, fiscal policy moves the economic growth from its potential level by affecting the aggregate demand. In the long run, fiscal policy affects the economic growth by affecting the quantity and quality of labor force (Barro 1991). Recently, there are two types of literatures that focus on time series data in the short run and cross section data in the long run relationship (Kneller and Misch, 2011). This chapter focuses the previous studies related to fiscal policy and tries to summarize the results and findings. As the impact of fiscal policy on output fluctuations focuses on both the short and long run economic growth rates, I will start the discussion on short run first followed by the long run next.

1.1. Fiscal policy and short run growth

A study (Perotti, 2007) found that there is no evidence of stylized facts regarding the impact of fiscal policy shocks. IS-LM theory predicts that a positive shock to government spending increases the consumption (Fragetta and Melina, 2010). In contrast, neoclassical real business cycle theory suggests that a positive shock to government spending increases investment and decreases consumption and wages (Baxster and King, 1993).There are many studies in literature that tried to examine the impact of fiscal policy on economic growth in the short run using econometric approaches. Caldara and Campus (2008) divided these approaches into four different categories out of which the most common approach is the structural VAR approach (Blanchard and Perotti, 2002; Perotti, 2007; Fragetta and Melina, 2010).

Blanchard and Perotti (2002) examined the dynamic effects of government spending and taxes on economic growth in the US using quarterly data for the period 1957- 1997. By applying Structural vector autoregressive model (SVAR), the study found that there is a positive and significant effect of both positive spending shock and negative tax shock on GDP and consumption. However, the study found that private investment responds negatively to a government spending shock and positively to a tax shock. Perotti (2004) applied the same methodology using 5 baseline VAR models for 5 OECD countries including the United States, Canada, Australia, the United Kingdom and Germany. Using quarterly data for the period 1960-2001, the study found that fiscal policy has a small effect on output. Fatah and Mihov (2001) used five variables SVAR model and quarterly data for the period 1960-1996 to examine the short-term impact of government spending on output in 20 OECD countries. The study found that a positive shock from government spending has a positive and persistent effect on output, consumption, and employment.

Gali et al. (2006) used a four variables VAR model for the US economy and quarterly data over the period 1954-2003. The study reported a positive impact of government spending on output, consumption and labor supply. However, it reported a negative impact on private investment. Caldara and Campus (2008) found that there is a strong dispute in the literature regarding both quantitative and qualitative effects of fiscal policy shocks. By applying VAR model and using quarterly data for the US over the period 1955- 2006, the study showed that real GDP, real consumption, real wage responds positively to a shock from government spending. In contrast, they showed complex results regarding the effect of tax revenue.

1.2. Fiscal Policy and long run growth rate

There is no clear answer whether fiscal policy follows long- term economic growth. But there is a debate to answer this question between theoretical and empirical studies. The endogenous growth theory (Barro 1990) supports that fiscal policy has an impact on economic growth in the long run but the empirical studies showed mixed results. Some studies focused mainly on government spending as a proxy of fiscal policy (Barro, 1991;Bajo-Rubbio, 2000). The others focused on taxation as a proxy of fiscal policy (Easterly and Rebelo 1993), while recent studies used a composition of government spending and taxation (Folster and Henrekson, 2001).

1.2.1 Government spending and economic growth

Barro (1991) reported a positive relationship between public investment and economic growth. By contrast, he reported a positive relationship between government consumption expenditure and economic growth, using cross-section data of 98 countries for the period 1960-1985.I will present some previous studies that focused mainly on government spending as a measure of fiscal policy. Some studies reported a positive relationship

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between government spending and Economic growth (Colombier, 2009). Another study reported a negative relationship (Alfonso and Furceri, 2010) while other reported inconclusive results (Levine and Renelt, 1992).Alfonso and Fulcari (2010) examined the negative effects of government spending and revenue on economic growth. The study reported that both government consumption expenditure and investment expenditure have a negative and statistically significant effects on growth.

1.2.2 Tax revenue and economic growth: The literature has focused on the US data. The tax changes are likely to affect GDP that can be found from the past studies. A study initiated by Blanchard and Perotti (2002) who seek to identify the shocks to revenues that are contemporaneously uncorrelated with other fluctuation, and this was found from a structural vector autoregression (SVAR). For the U.S., the positive effect of a tax shock on GDP is typically around 1 percent. The narrative approaches have been used to construct a direct measure of policy shocks to identify government spending shock by Ramey (2011) and tax shocks in the US by Romer and Romer (2010). Romer and Romer found a large positive effect of tax changes on GDP.

H0: The government spending has a negative effect on real GDP with the interaction of tax revenue.

H0: The tax revenue has a negative effect on real GDP with the interaction of government spending.

2. Empirical Analysis

2.1 The Dataset

The objective is to construct a quarterly time series from 1947Q2 to 2019Q4.The data that I gathered for this research was quarterly (quarter to quarter) seasonally adjusted data from 1947Q2 to 2019Q4. I want to understand how the government reacts to different economic conditions. The data is percentage change and taken from St. Louis Fred Website. The variables for the study are *Federal Government Current Expenditure*, *Total Federal Government Tax Revenue*, and *Real Gross Domestic Product*. I think this data source is the most credible and allows to access government spending, tax revenue and GDP data easily. The reason that I want to take percentage change is to make sure that my data is stationary. The results below are from Augmented Dicky-Fuller test. All data are statistically significant since p-values are less than 0.05 meaning that I can reject the null and conclude that my data is stationary.

2.2 The Macroeconomic Effects of Policy Shocks: Baseline Specification

The VAR model is constructed only if the variables are integrated of one order. When the variables are co-integrated, both the short-run VAR and long-run VEC models are constructed. Also, when the variables are not co-integrated then only short-run VAR model is constructed. In this study, the variables are not co-integrated as the trends are removed. All the variables in a VAR system are endogenous and there are no exogenous variables. The VARis specified in levels.

The following equations in (3.2.1) describe a system in which each variable is a function of its own lag and the lag of the other variables in the system. In this case, the system contains three variables R_t, G_t and Y_t. In the first equation R_t (tax revenue) is a function of its own lag R_{t-k} and the lag of the other variables in the system G_{t-k} and Y_{t-k}. In the second equation G_t (government spending) is a function of its own lag G_{t-k} and the lag of the other variables in the system R_{t-k} and Y_{t-k}. In the third equation Y_t (real GDP) is a function of its own lag Y_{t-k} and the lag of the other variables in the system R_{t-k} and G_{t-k}. Together the equations constitute a system known as a vector autoregression (VAR) model with three time series (variables R_t, G_t and Y_t).

$$R_t=\alpha^1_0+\beta_{1,k}R_{t-k}+\beta_{2,k}G_{t-k}+\beta_{3,k}Y_{t-k}+u^R_t \quad (1)$$

$$G_t=\alpha^2_0+ \beta_{1,k}R_{t-k}+ \beta_{2,k}G_{t-k}+ \beta_{3,k}Y_{t-n}+u^G_t \quad (2)$$

$$Y_t= \alpha^3_0+ \beta_{1,k}R_{t-k}+ \beta_{2,k}G_{t-k}+ \beta_{3,k}Y_{t-k}+u^Y_t \quad (3)$$

Here, u^R_t, u^G_t and u^Y_t are the impulse/innovations/shocks in the language of VAR, dependent variable is a function of its lag-length and the lag-length of other variables in the model. VAR is estimated by OLS and I must decide maximum lag-lengths but too many lags loose degrees of freedom, statistically insignificant coefficients, and multicollinearity. Also, too few lags have specification errors. So, I must choose optimal lag using AIC or SC.

2.3 Stationarity Check

As the model is specified, I put raw data in a line graph for the purpose of stationarity check. If I look at the nature of the graph that shows trending upward and that is an indication the series are non-stationary. But after applying percentage change,it shows the data are stationary. Also, I perform the ADF test for stationarity check. The test is performed with only constant for all three variables. The test statistics, ADF is lower than the critical value at 5% level of significant which is -11.67<-2.87. So, I reject the null hypothesis and conclude that the variable has no unit root meaning that the series is stationary.

3.4 VAR Estimation

Maximum lag lengths are selected using SC which is lag length 1. The following table shows the results where a percentage increase in real GDP is associated with a 32.81 percent average increase in real GDP itself and an average increase of 132 percent in tax revenue. In terms of government spending, a 0.5 percent increase with itself and an average decrease of 3.9 percent in tax revenue. Also, a percentage decrease in government spending is associated with an average decrease of 0.7 percent in real GDP. So, there is a positive association of government spending with tax revenue and real GDP. Therefore, the null hypothesis have been rejected at 5 percent level of significant and conclude that If real GDP and tax revenue decrease, then government spending also decreases or vice versa.

Table 1.VAR output

Vector Autoregression Estimates

Date: 03/13/20 Time: 19:57

Sample (adjusted): 1947Q3 2019Q4

Included observations: 290 after adjustments

Stadart errors in ( ) & t-statistics in [ ]

	GDP_PCH	GEXPND_	TAX_PCH
GDP_PCH (-1)	0.328181	-0.290573	1.530294
	(0.06255)	(0.18418)	(0.29746)
	[5.24689]	[-1.57766]	[5.14446]
GEXPND_ PCH (-1)	-0.007566	0.004974	-0.039236
	(0.01994)	(0.05873)	(0.09485)
	[-0.37935]	[0.08471]	[-0.41367]
TAX_PCH (-1)	0.014313	-0.006275	-0.105491
	(0.01353)	(0.03984)	(0.6434)
	[1.05793]	[-0.15750]	[-1.63953]
C	0.518412	1.927180	0.518335
	(0.07470)	(0.21995)	(0.35524)
	[6.94025]	[8.76176]	[1.45910]

Source: The combined results of vector autoregressive estimated models (1,2 and 3).

2.5 Impulse Response Function (IRF)

Perotti and Blanchard conducted two different models to test the effects on a tax shock on GDP and government spending and then they tested separately the effects of government spending shocks on GDP and tax revenue. Using percentage change data, I show the results below. I run Schwarz Criterion (SC) test to determine the number of lags for the VAR analysis. I conclude that having the one lag is the most appropriate for this model.

2.5.1 Tax Shocks

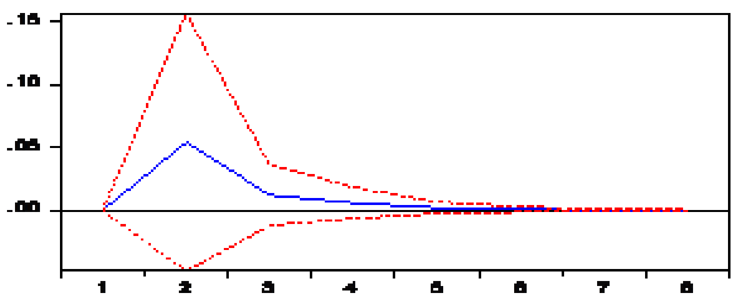

Figure 1. Response of GDP_PCH to TAX_PCH

Source: The combined graph of the impulse responses of the estimated VAR(2) model.

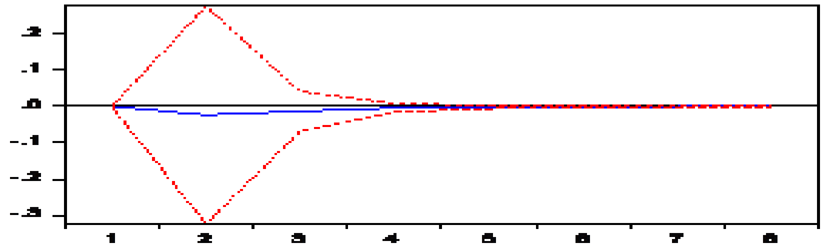

Figure 2. Response of GEXPND_PCH to TAX_PCH

Source: The combined graph of the impulse responses of the estimated VAR(1) model.

On top the figure 1 and 2 represents a onetime tax shock on GDP. This impulse response shows a negative relationship with taxes and GDP, which makes economic sense. If the government is going to increasing the amount of taxes that a household is going to be receiving than that one should see less money to spend which decreases GDP. The impulse response for Perotti and Blanchard they show similar results with taxes taking away the growth of GDP. One the below of figure 1 represents again a tax shock on government spending which looks to be decreasing after the first quarter. One of the reasons government spending could be decreasing as tax revenue is increasing is because they are paying off their debt. This debt could include investors that purchase treasury bonds, which was not included in our data for government expenditure. Perotti and Blanchard also show the same results for their impulse response function. However, they do not give a reason for why government spending is decreasing but make note that the effects are rather small.

2.5.2 Government Spending Shocks

The following figures 3 and 4 show the response of a positive shock of government spending on GDP. This impulse response does not match our economic intuition since as government spending increases GDP is negative but becomes stable from the period 4. One of the reasons why this might be the case is because of government spending is making up about 1/4th of the US GDP, which is a good amount, but it does not have that much of an impact of government spending. Also, my data does not include one of the biggest projects that the US has implemented. In 1956 the US enacted the National Interstate and Defense Highway Act which estimated cost of the US 500 billion dollars. My data that I collected does not take this massive spending into account.

Perotti and Blanchard do not have same conclusion I show in my results. They see a sharp increase in GDP and then see a sharp decrease in GDP. One of the reasons why Blanchard and Perotti might have a very sharp increase than decrease is because of how Government spending affects GDP. Valerie Ramey wrote a paper called, "Identifying Government Spending Shocks: It's all about the timing". In her paper she shows the effects of government spending and how it interacts with output. She concluded that government spending has a direct effect on output, but the results are only temporary and short live. So, seeing that decrease in the Remay paper might explain their impulse response function.

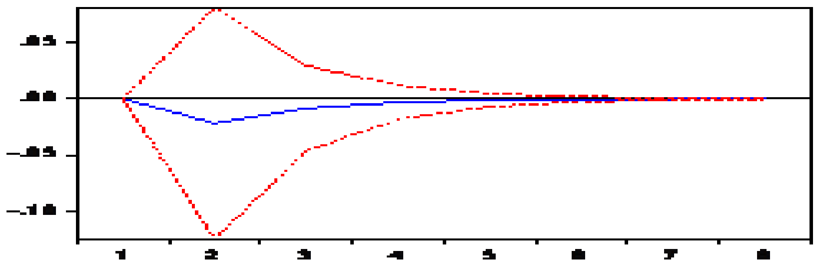

Figure 3. Response of GDP_PCH to GEXPND_PCH

Source: The combined graph of the impulse responses of the estimated VAR(1) model.

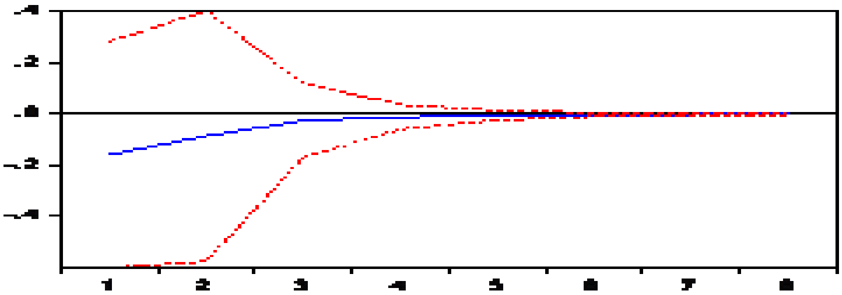

Figure 4. Response of TAX_PCH to GEXPND_PCH

Source: The graph generated from STATA using Box-Jenkins ARMA model.

One of the reasons why tax revenue is decreasing is because of how the government is gaining funding. There are couples of ways that it can gain through issuing treasury bonds. So, the tax part of this shock could be the fact that government spending is being funded through different means. Another way to address this issue is to think about the rate at which the government is spending its money. The rate that the government is spending is always greater than the revenue that they have taken in, thus the reason why the US is trillions of dollars into debt. Therefore, the relationship between government spending is going up is negative. Perotti and Blanchard continue their paper by trying to understand the anticipated fiscal policy shocks on the economy. In order to understand the results of a tax shock I try to predict GDP of one period ahead.

3. Forecasting Real GDP in the United States

Auto Regressive Integrated Moving Average (ARIMA) Model: Box and Jenkins (1976) methodology has been used extensively by many researchers to highlight the future rates of GDP. Wei et. al. (2010) applied ARIMA (1,2,1) model using data from Shaanxi GDP for 1952-2007 to forecast country's GDP for 6 years. They found that GDP of Shaanxi presents an increasing trend. Maity and Chatterjee (2012) applied ARIMA (1,2,2)model for forecasting GDP growth rate in India fora period of 60 years. They showed that predicted values follow an increasing trend for the following years. Shahini and Haderi (2013) test GDP for forecasting applying ARIMA model for Albania using quarterly data. Zhang Haonan (2013) examines GDP for five regions of Sweden for the years 1993–2009 using ARIMA model. His study showed ARIMA model can be used for forecasting in the short run.

The Model: The Box-Jenkins ARMA model is a combination of the AR (Autoregressive) and MA (Moving Average) models as follows:

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + \beta_p Y_{t-p} + u_t \quad (4)$$

The first step in identifying the perfect model is to find out the trend and stationery of data. This has assessed from the line graph and statistically by Augmented Dickey-Fuller (ADF) Test. The line graph of the US GDP (percentage change series) as depicted in Fig. 1 indicates that the series has mean reverting around 0which is stationary.

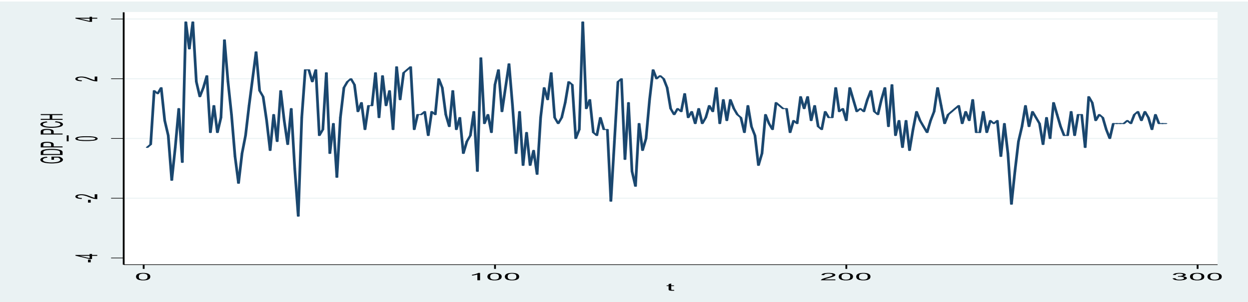

Figure 5. Line graph of the US GDP (percentage change series)

Source: The combined graph of partial autocorrelation functions estimated ARMA (4) model.

Further, the results of Augmented Dickey-Fuller Unit Root Tests confirm that the p-value is significant, which indicates that the series is stationary. Now, the order of Autoregressive (AR) for the value p and the Moving Average (MA) for the value of q, correlograms of partial autocorrelation functions (PACF) and autocorrelation functions (ACF) are respectively examined.

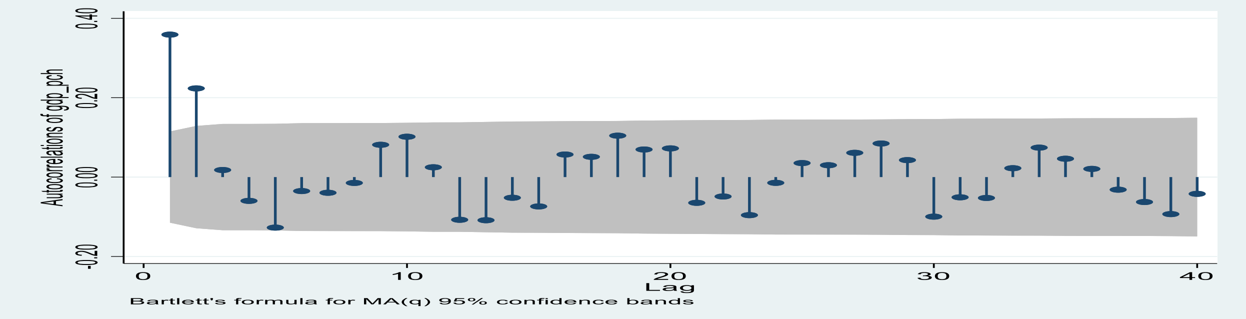

Figure 6. Correlogram of ACF

Source: The combined graph of autocorrelation functions estimated ARMA (4) model.

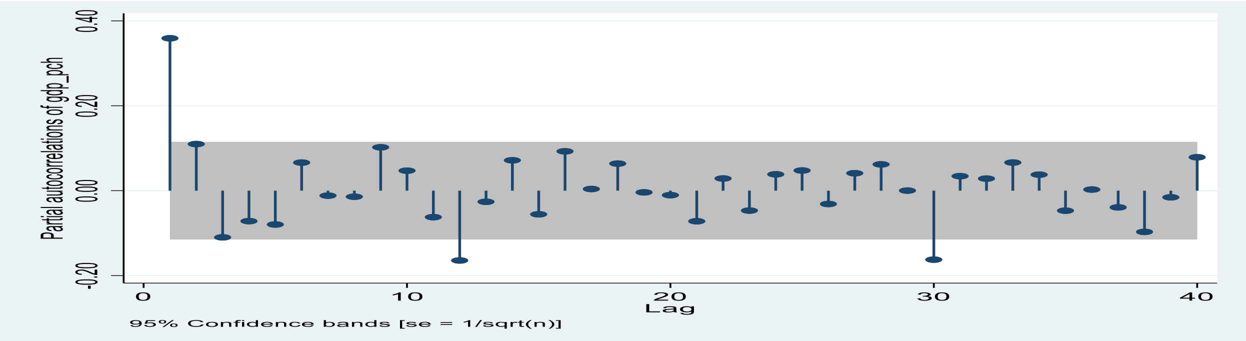

Figure 7. Correlogram of PACF

Source: The combined graph of autocorrelation functions estimated ARMA (4) model.

The correlogram of autocorrelation function (ACF) of GDP (Fig. 2) indicates that the autocorrelation function. To determine the autocorrelation, all the lines which are out of the shaded region will be selected as different lags for MA value of ARIMA model. The shaded region indicates the acceptance region and the lines indicate GDP has autocorrelation with its past legs. The lags 1 and 2 are coming out of the shaded regions which are autocorrelated with GDP. Therefore, the MA value of ARIMA model which is 'q' has been decided to be '1 and 2'. Again, the correlogram of partial autocorrelation function (PACF) of GDP (Fig. 3) indicates that the autocorrelation functions. Here, the lines 1 and 12 are coming out of the shaded region. Therefore, the AR value of ARIMA model which is 'p' has been decided to be '1 and 12'. ARIMA modeling for the time series GDP.

Table 2. ARIMA Modeling

PAC	I	AC	ARIMA
1	0	1	(1,0,1)
12	0	2	(12,0,2)

Source: The combined results of autocorrelation functions (ACF) for ARIMA modeling estimated ARIMA (4) model.

The possible ARIMA models, following ACF and PACF graphs through correlogram are: [ARIMA (1,0,1); ARIMA (12,0,2)]. These are all tentative models to be estimated to select the best model. The use of other diagnostics such as minimum value of AIC & BIC, significance of AR and MA parameters also confirms the selection of the ARIMA (1,0,1) model (Table 2) and the results are presented in the following table from the appendix 4.

Table 3. AIC, BIC and log-likelihood for different ARIMA models

Constant	ARIMA (1,0,1)	ARIMA (12,0,2)
Coefficient	0.51	0.396, 0.01, etc.
P-value	0.00	<0.5
Log-likelihood	372	360
AIC	752.96	753.13
BIC	767.66	811.90

Source: The combined results of autocorrelation functions (ACF) and partial autocorrelation functions (PACF)ßor different ARIMA modeling estimated ARIMA (4) model.

From the above table, ARIMA (1,0,1) is an ideal model because it has highest number of significant coefficients, highest log-likelihood, lowest AIC and BIC. The goodness of fit for the identified model is checked by plotting the residuals for systematic pattern. The time series plots of ACF and PACF of the residuals of fitted ARIMA (1,0,1) model are significant patterns. So, the ARIMA (1,0,1,)model is considered as valid for forecasting.

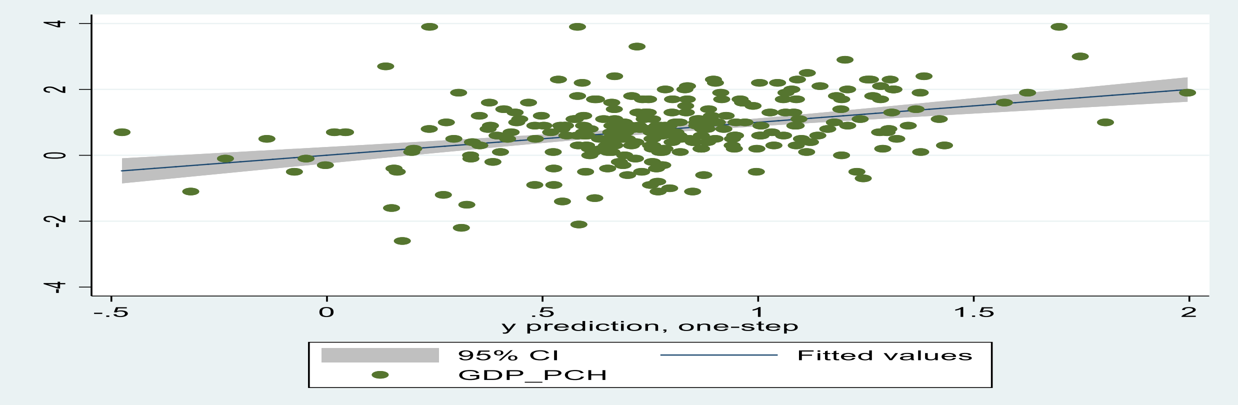

Figure 8. Prediction of the US GDP

Source: The combined graph using AIC, BIC and log-likelihood for forecasting.

The green dots (fig. 8) as the actual US GDP values, shaded region as confidence interval at 95% and straight line as fitted values. That means the mean of both series are not same, predicted values of US GDP differ from the actual values. After I use the command for prediction, STATA generates the forecasting values of the US GDP for 2019q1 to 2019q4 as:

Table 4. Forecasting of the US GDP

Time Periods	US GDP Forecasts	Actual Values
2019q1	0.61	0.76
2019q2	0.75	0.49
2019q3	0.67	0.52
2019q4	0.66	0.51

Source: The combined results of ARIMA (1,0,1) model using estimated ARIMA (4) model.

Conclusion

The Autoregressive integrated moving average (ARIMA) model is one of the best models. The study attempts at modeling and forecasting of gross domestic product in the USA using ARIMA model. Autocorrelation function (ACF) and partial autocorrelation function (PACF) functions are estimated, which led to the identification and construction of ARIMA model (1,0,1). The fitted model indicated an increase in GDP in the next quarters holding other things being constant.

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