

I got my data from <https://fred.stlouisfed.org/> and it is from 1947 to 2023. It contains import good and services, GDP, real income GDP columns and values. I drew the graphs above to check whether it is stationary or nonsationary. If we comment from these graphs and interpret the following tests, our data will be nonstationary.

Augmented Dickey-Fuller:

The Augmented Dickey-Fuller test (ADF) is a statistical test that is used to determine whether a time series is stationary or not. It is a type of unit root test that helps to determine the presence of a unit root in the time series, which is a source of non-stationarity.

KPSS TEST:

The KPSS test is used to determine if a time series is stationary or not. The test statistic compares the difference between the data and a trend, and the P-value is used to determine the significance of the test statistic.

Real GDP Income

KPSS Stationarity Test Results

Test Statistic	0.676
P-value	0.000
Lags	10

KPSS Stationarity Test Results

Test Statistic	0.035
P-value	0.801
Lags	5

Real GDP income KPSS test results, the test statistic is 0.676 and the P-value is 0.000, which means that the time series is likely not stationary. In the second test results, the test statistic is 0.035 and the P-value is 0.801 which means that the time series is likely stationary. It's worth

noting that a low p-value (typically less than 0.05) indicates that the time series is not stationary, while a high p-value (greater than 0.05) indicates that the time series is stationary.

GDP

KPSS Stationarity Test Results	
Test Statistic	0.679
P-value	0.000
Lags	10

KPSS Stationarity Test Results	
Test Statistic	0.036
P-value	0.788
Lags	5

GDP KPSS test results, the test statistic is 0.679 and the P-value is 0.000, which means that the time series is likely not stationary. In the second test results, the test statistic is 0.036 and the P-value is 0.788 which means that the time series is likely stationary. It's worth noting that a low p-value (typically less than 0.05) indicates that the time series is not stationary, while a high p-value (greater than 0.05) indicates that the time series is stationary.

Import Good And Services

KPSS Stationarity Test Results	
Test Statistic	0.704
P-value	0.000
Lags	10

KPSS Stationarity Test Results	
Test Statistic	0.028
P-value	0.900
Lags	1

Import Good And Services KPSS test results, the test statistic is 0.704 and the P-value is 0.000, which means that the time series is likely not stationary.

In the second test results, the test statistic is 0.028 and the P-value is 0.900 which means that the time series is likely stationary.

It's worth noting that a low p-value (typically less than 0.05) indicates that the time series is not stationary, while a high p-value (greater than 0.05) indicates that the time series is stationary.

Real GDP Income

Augmented Dickey-Fuller Results

Test Statistic	-1.286
P-value	0.891
Lags	2

OLS Regression Results

Dep. Variable:	y	R-squared:	0.061
Model:	OLS	Adj. R-squared:	0.049
Method:	Least Squares	F-statistic:	4.824
Date:	Mon, 16 Jan 2023	Prob (F-statistic):	0.000878
Time:	23:11:28	Log-Likelihood:	-1904.9
No. Observations:	300	AIC:	3820.
Df Residuals:	295	BIC:	3838.
Df Model:	4		
Covariance Type:	nonrobust		

	coef	std err	t	P> t	[0.025	0.975]
Level.L1	-0.0100	0.008	-1.286	0.199	-0.025	0.005
Diff.L1	-0.0351	0.057	-0.612	0.541	-0.148	0.078
Diff.L2	-0.1707	0.057	-2.976	0.003	-0.284	-0.058
const	22.7659	16.322	1.395	0.164	-9.356	54.887
trend	0.9366	0.487	1.923	0.055	-0.022	1.895

Omnibus:	418.804	Durbin-Watson:	1.981
Prob(Omnibus):	0.000	Jarque-Bera (JB):	100033.958
Skew:	-6.324	Prob(JB):	0.00
Kurtosis:	91.559	Cond. No.	2.14e+04

Augmented Dickey-Fuller Results

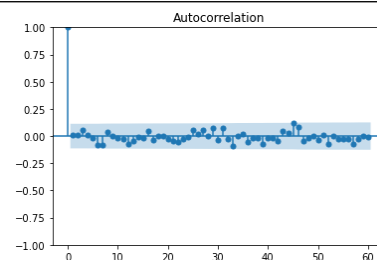
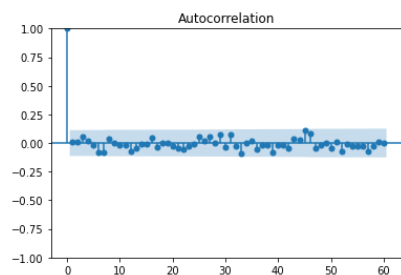
Test Statistic	-14.729
P-value	0.000
Lags	1

OLS Regression Results

Dep. Variable:	y	R-squared:	0.531
Model:	OLS	Adj. R-squared:	0.526
Method:	Least Squares	F-statistic:	111.8
Date:	Mon, 16 Jan 2023	Prob (F-statistic):	2.08e-48
Time:	23:11:28	Log-Likelihood:	-1905.7
No. Observations:	300	AIC:	3819.
Df Residuals:	296	BIC:	3834.
Df Model:	3		
Covariance Type:	nonrobust		

	coef	std err	t	P> t	[0.025	0.975]
Level.L1	-1.2139	0.082	-14.729	0.000	-1.376	-1.052
Diff.L1	0.1748	0.057	3.048	0.003	0.062	0.288
const	24.8508	16.259	1.528	0.127	-7.147	56.848
trend	0.3225	0.096	3.364	0.001	0.134	0.511

Omnibus:	424.760	Durbin-Watson:	1.981
Prob(Omnibus):	0.000	Jarque-Bera (JB):	104672.429
Skew:	-6.490	Prob(JB):	0.00
Kurtosis:	93.583	Cond. No.	478.



In the first set of results, the test statistic is -1.286 and the P-value is 0.891, which means that the time series is not stationary. The ADF test suggests that there is a unit root, which is a source of non-stationarity. In the second set of results, the test statistic is -14.729 and the P-value is 0.000 which means that the time series is stationary. The ADF test suggests that there is no unit root, which means the time series is stationary. The second set of results also includes the OLS Regression results, which are used to check the relationship between the dependent variable

e (y) and the independent variables. The R-squared value of 0.531, indicates that 53.1% of the variation in the dependent variable can be explained by the independent variables. The F-statistic and P-value, suggest that the model is a good fit.

IMPORT GOOD AND SERVICES:

Augmented Dickey-Fuller Results

Test Statistic	-0.198
P-value	0.992
Lags	12

OLS Regression Results

Dep. Variable:	y	R-squared:	0.239
Model:	OLS	Adj. R-squared:	0.201
Method:	Least Squares	F-statistic:	6.184
Date:	Mon, 16 Jan 2023	Prob (F-statistic):	1.07e-10
Time:	23:11:37	Log-Likelihood:	-1601.8
No. Observations:	290	AIC:	3234.
Df Residuals:	275	BIC:	3289.
Df Model:	14		
Covariance Type:	nonrobust		

	coef	std err	t	P> t	[0.025	0.975]
Level.L1	-0.0017	0.009	-0.198	0.843	-0.019	0.015
Diff.L1	0.2443	0.059	4.120	0.000	0.128	0.361
Diff.L2	-0.0493	0.062	-0.800	0.425	-0.171	0.072
Diff.L3	-0.1300	0.062	-2.111	0.036	-0.251	-0.009
Diff.L4	-0.1577	0.062	-2.563	0.011	-0.279	-0.037
Diff.L5	0.0358	0.063	0.570	0.569	-0.088	0.160
Diff.L6	-0.1282	0.063	-2.039	0.042	-0.252	-0.004
Diff.L7	-0.1831	0.062	-2.934	0.004	-0.306	-0.060
Diff.L8	-0.1747	0.064	-2.745	0.006	-0.300	-0.049
Diff.L9	0.0751	0.087	0.863	0.389	-0.096	0.246
Diff.L10	-0.5095	0.138	-3.680	0.000	-0.782	-0.237
Diff.L11	0.4748	0.146	3.254	0.001	0.188	0.762
Diff.L12	-0.4401	0.116	-3.803	0.000	-0.668	-0.212
const	-11.2089	9.812	-1.142	0.254	-30.526	8.108
trend	0.2479	0.110	2.248	0.025	0.031	0.465

Omnibus:	168.703	Durbin-Watson:	1.991
Prob(Omnibus):	0.000	Jarque-Bera (JB):	21619.351
Skew:	-1.294	Prob(JB):	0.00
Kurtosis:	45.220	Cond. No.	3.95e+03

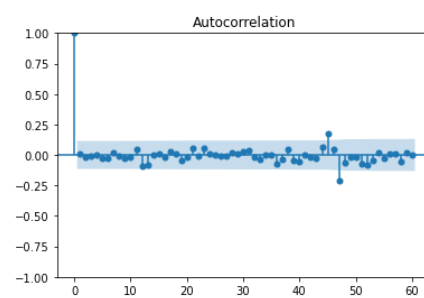
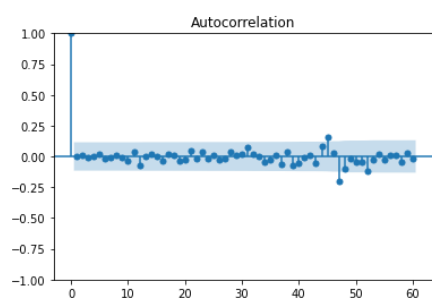
Augmented Dickey-Fuller Results

Test Statistic	-7.593
P-value	0.000
Lags	9

OLS Regression Results

Dep. Variable:	y	R-squared:	0.431
Model:	OLS	Adj. R-squared:	0.409
Method:	Least Squares	F-statistic:	19.28
Date:	Mon, 16 Jan 2023	Prob (F-statistic):	1.18e-28
Time:	23:11:37	Log-Likelihood:	-1620.0
No. Observations:	292	AIC:	3264.
Df Residuals:	280	BIC:	3308.
Df Model:	11		
Covariance Type:	nonrobust		

	coef	std err	t	P> t	[0.025	0.975]
Level.L1	-1.7000	0.224	-7.593	0.000	-2.141	-1.259
Diff.L1	0.9247	0.208	4.450	0.000	0.516	1.334
Diff.L2	0.8793	0.195	4.501	0.000	0.495	1.264
Diff.L3	0.7766	0.180	4.306	0.000	0.422	1.132
Diff.L4	0.6075	0.165	3.680	0.000	0.283	0.932
Diff.L5	0.6472	0.149	4.338	0.000	0.354	0.941
Diff.L6	0.5593	0.130	4.295	0.000	0.303	0.816
Diff.L7	0.3512	0.112	3.126	0.002	0.130	0.572
Diff.L8	0.1895	0.095	1.995	0.047	0.002	0.376
Diff.L9	0.2237	0.102	2.184	0.030	0.022	0.425
const	-8.9335	7.505	-1.190	0.235	-23.708	5.841
trend	0.2004	0.050	4.033	0.000	0.103	0.298
Omnibus:	193.054		Durbin-Watson:	1.985		
Prob(Omnibus):	0.000		Jarque-Bera (JB):	30867.574		
Skew:	-1.599		Prob(JB):	0.00		
Kurtosis:	53.268		Cond. No.	344.		



In the first set of results, the test statistic is -0.198 and the P-value is 0.992, which means that the time series is not stationary. The P-value is too high, indicating that we fail to reject the null hypothesis, which states that there is a unit root (i.e. the time series is non-stationary).

In the second set of results, the test statistic is -7.593 and the P-value is 0.000 which means that the time series is stationary. The P-value is too low, indicating that we reject the null hypothesis, which states that there is a unit root (i.e. the time series is non-stationary). The second set of results also includes the OLS Regression results, which are used to check the relationship between the dependent variable (y) and the independent variables. The R-squared value of 0.431, indicates that 43.1% of the variation in the dependent variable can be explained by the independent variables. The F-statistic and P-value, that the model is a good fit.

GDP:

Augmented Dickey-Fuller Results

Test Statistic	-1.432
P-value	0.851
Lags	1

OLS Regression Results

Dep. Variable:	y	R-squared:	0.060			
Model:	OLS	Adj. R-squared:	0.051			
Method:	Least Squares	F-statistic:	6.343			
Date:	Mon, 16 Jan 2023	Prob (F-statistic):	0.000351			
Time:	23:11:41	Log-Likelihood:	-1912.3			
No. Observations:	301	AIC:	3833.			
Df Residuals:	297	BIC:	3847.			
Df Model:	3					
Covariance Type:	nonrobust					
	coef	std err	t	P> t	[0.025	0.975]
Level.L1	-0.0117	0.008	-1.432	0.153	-0.028	0.004
Diff.L1	-0.1690	0.057	-2.962	0.003	-0.281	-0.057
const	22.4857	16.268	1.382	0.168	-9.530	54.502
trend	1.0179	0.508	2.003	0.046	0.018	2.018
Omnibus:	394.744	Durbin-Watson:	2.007			
Prob(Omnibus):	0.000	Jarque-Bera (JB):	100413.035			
Skew:	-5.562	Prob(JB):	0.00			
Kurtosis:	91.784	Cond. No.	2.13e+04			

Augmented Dickey-Fuller Results

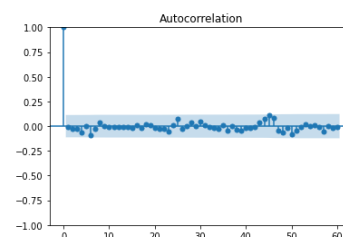
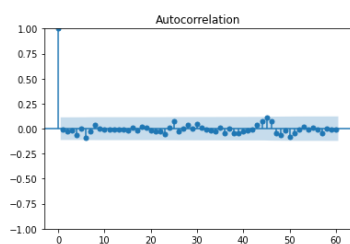
Test Statistic	-20.554
P-value	0.000
Lags	0

OLS Regression Results

Dep. Variable:	y	R-squared:	0.586
Model:	OLS	Adj. R-squared:	0.584
Method:	Least Squares	F-statistic:	211.2
Date:	Mon, 16 Jan 2023	Prob (F-statistic):	7.46e-58
Time:	23:11:41	Log-Likelihood:	-1913.4
No. Observations:	301	AIC:	3833.
Df Residuals:	298	BIC:	3844.
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P> t	[0.025	0.975]
Level.L1	-1.1730	0.057	-20.554	0.000	-1.285	-1.061
const	24.4386	16.240	1.505	0.133	-7.521	56.398
trend	0.3027	0.094	3.217	0.001	0.118	0.488

Omnibus:	401.033	Durbin-Watson:	2.009
Prob(Omnibus):	0.000	Jarque-Bera (JB):	104711.786
Skew:	-5.726	Prob(JB):	0.00
Kurtosis:	93.653	Cond. No.	395.



In the first set of results, the test statistic is -1.432 and the P-value is 0.851, which means that the time series is not stationary. The P-value is too high, indicating that we fail to reject the null hypothesis, which states that there is a unit root (i.e. the time series is non-stationary).

In the second set of results, the test statistic is -20.554 and the P-value is 0.000 which means that the time series is stationary. The P-value is too low, indicating that we reject the null hypothesis, which states that there is a unit root (i.e. the time series is non-stationary).

	trace test stat	0.1	0.05	0.01
0	35.910230	27.0669	29.7961	35.4628
1	9.873294	13.4294	15.4943	19.9349
2	0.033910	2.7055	3.8415	6.6349

The trace test statistic is 35.910230, 9.873294, and 0.033910 for lag lengths 0, 1, and 2 respectively at 0.1 significance level. At this significance level, the critical value for lag length 0, 1 and 2 is 27.0669, 13.4294 and 2.7055 respectively. Since the test statistic is greater than the critical value for all the lag lengths, it suggests that the null hypothesis of unit root is not rejected and the series may be non-stationary.

	meigen test stat	0.1	0.05	0.01
0	26.036936	18.8928	21.1314	25.8650
1	9.839384	12.2971	14.2639	18.5200
2	0.033910	2.7055	3.8415	6.6349

The Meigen test statistic is 26.036936, 9.839384 and 0.033910 for lag lengths 0, 1, and 2 respectively at 0.1 significance level. At this significance level, the critical value for lag length 0, 1 and 2 is 18.8928, 12.2971 and 2.7055 respectively. Since the test statistic is greater than the critical value for all the lag lengths, it suggests that the null hypothesis of unit root is not rejected and the series may be non-stationary.

INTERVAL RESULT:

lower bounds of confidence intervals:

```
[ [ 2771.503 17783.084 17816.922]
  [ 2717.608 17781.2    17794.055]
  [ 2668.844 17777.21   17768.922]
  [ 2640.257 17783.181 17754.238]
  [ 2629.916 17797.819 17750.204]]
```

point forecasts:

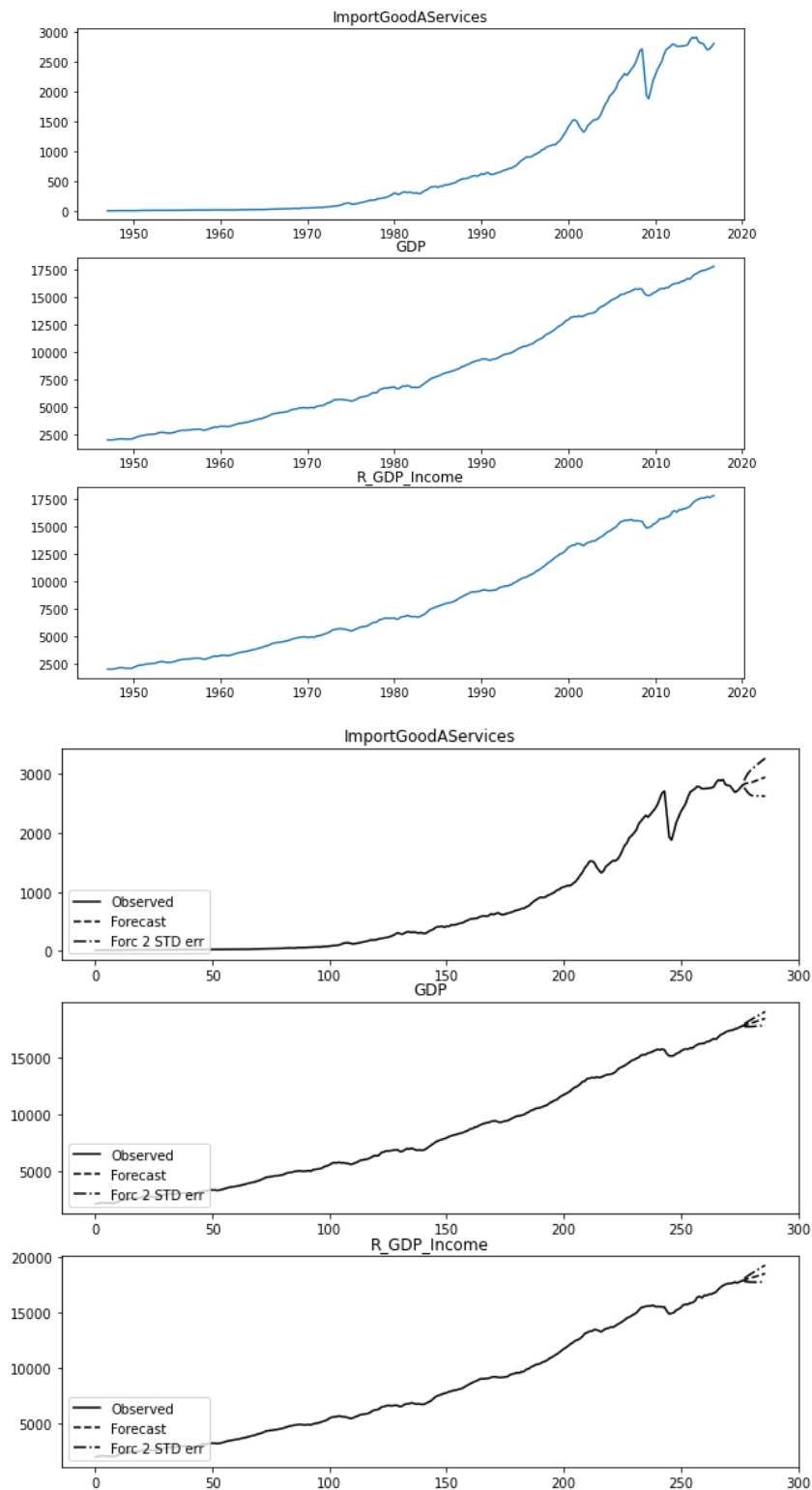
```
[ [ 2830.6 17891.1 17942.3]
  [ 2844.   17960.6 18008.6]
  [ 2849.6 18024.9 18070.1]
  [ 2856.9 18090.3 18131.6]
  [ 2869.6 18158.2 18196.5]]
```

upper bounds of confidence intervals:

```
[ [ 2889.737 17999.073 18067.698]
  [ 2970.31  18140.082 18223.23 ]
  [ 3030.313 18272.621 18371.338]
  [ 3073.593 18397.506 18508.997]
  [ 3109.301 18518.507 18642.774]]
```

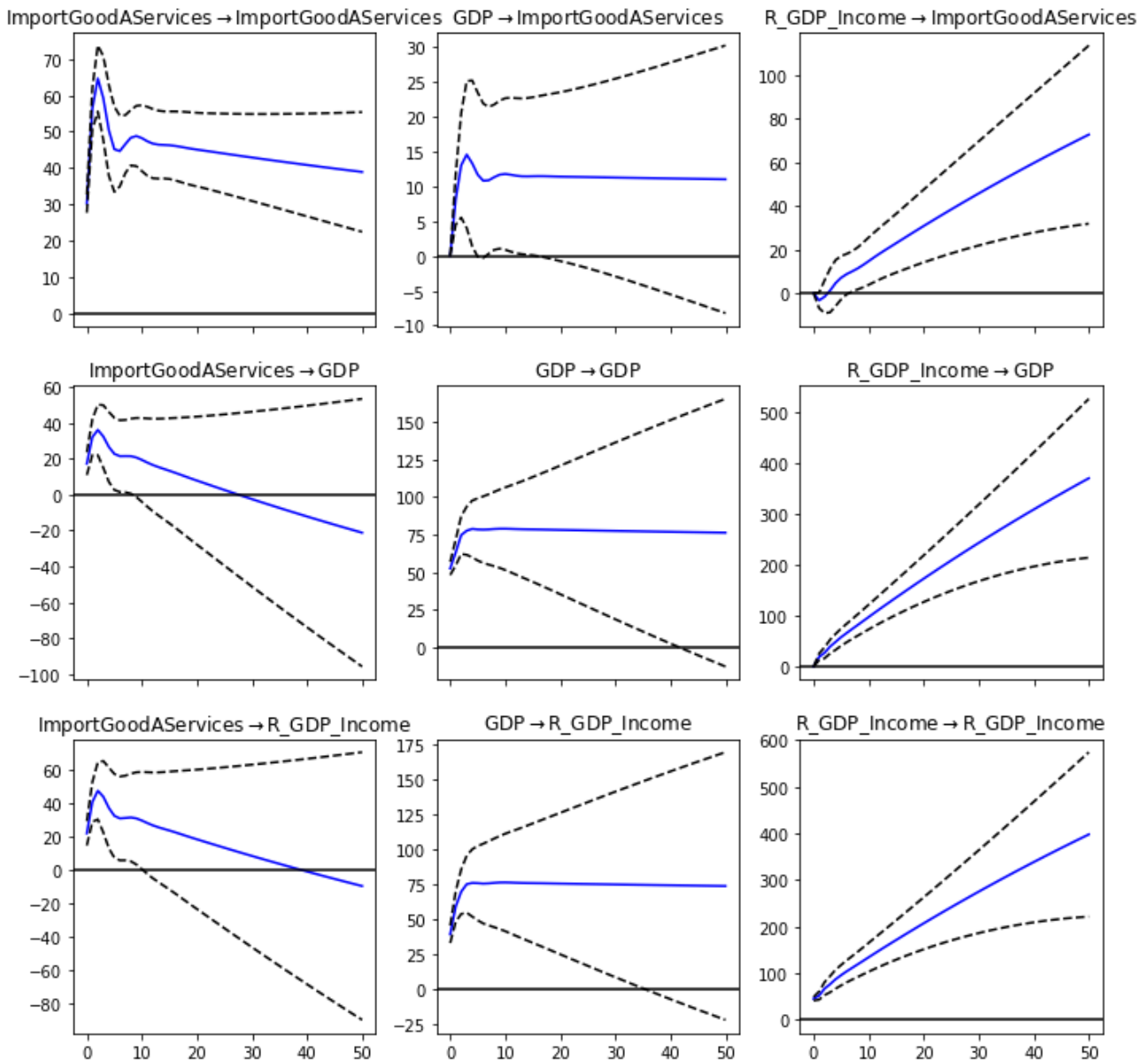
The first period, the point forecast for the variable is 2830.6, and the lower bound and upper bound of the confidence interval are 2771.503 and 2889.737 respectively. This means that there is a high level of confidence that the true value of the variable will fall between 2771.503 and 2889.737 at that time period.

FORECAST PLOTS:



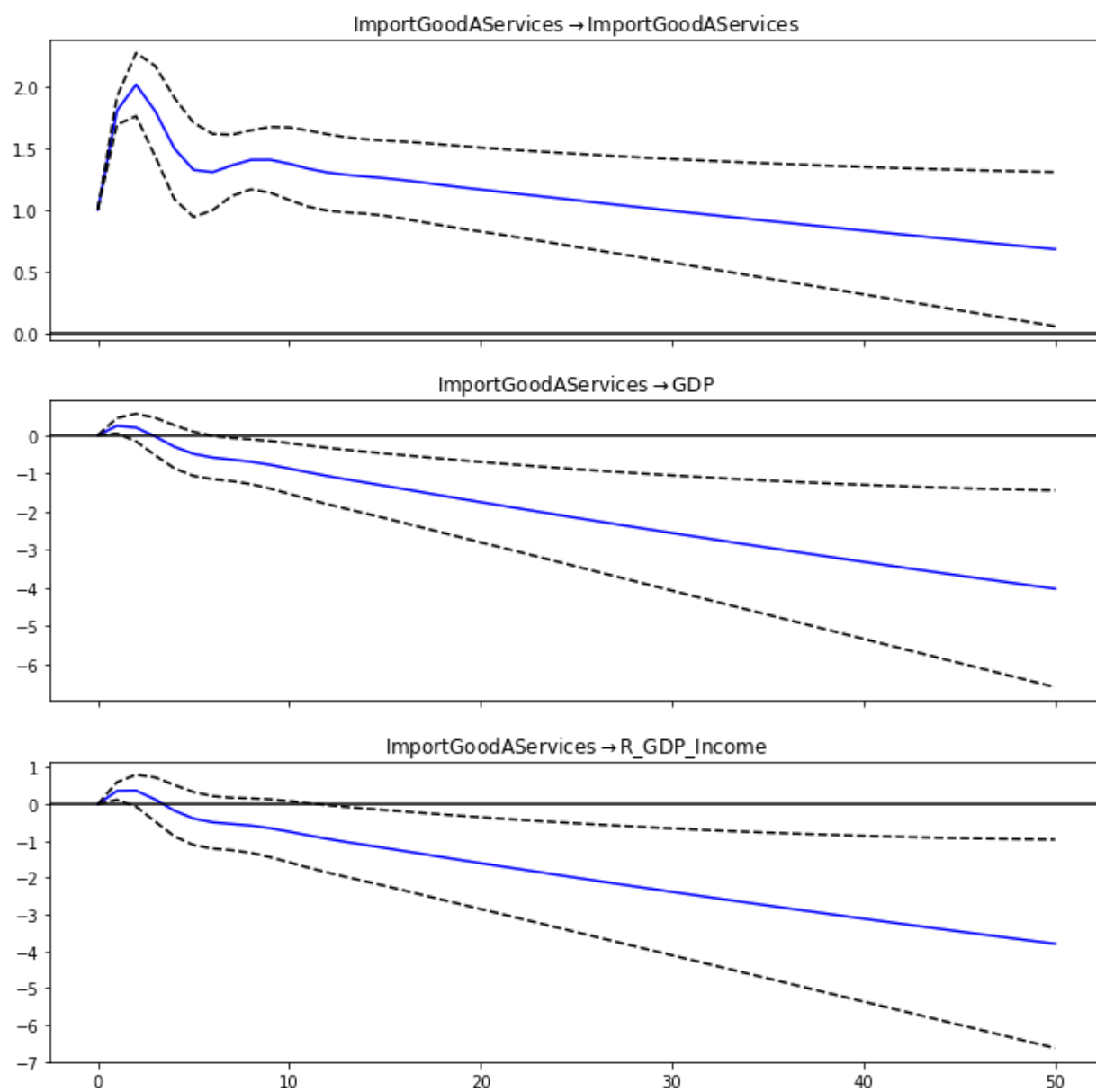
Looking at the graphs, Import goods and services Forc2 STD error errors are more than others, but it can be said that this model is good, mostly without deviations.

Impulse responses (orthogonalized)



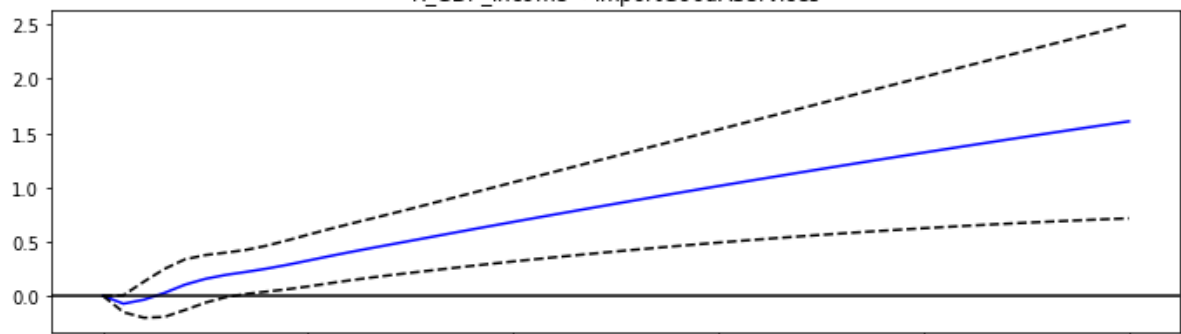
GDP Import good and services response increased and decreased in the first period and remained stable. Real GDP income, import good and services response has increased continuously. Import good and services decreased as the GDP response increased and decreased sequentially. Real GDP Income, GDP response has increased. Import good and services , Real GDP income response increased and decreased sequentially. GDP, real GDP income first increased, then remained stable. Below we can see more detailed graphics.

Impulse responses

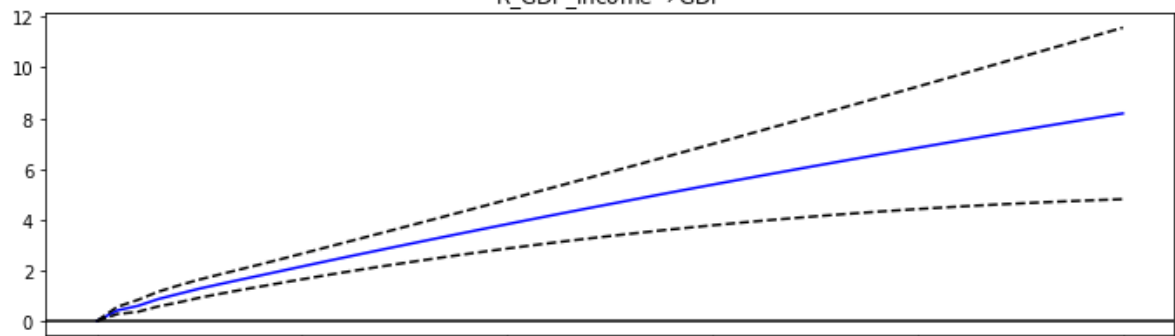


Impulse responses

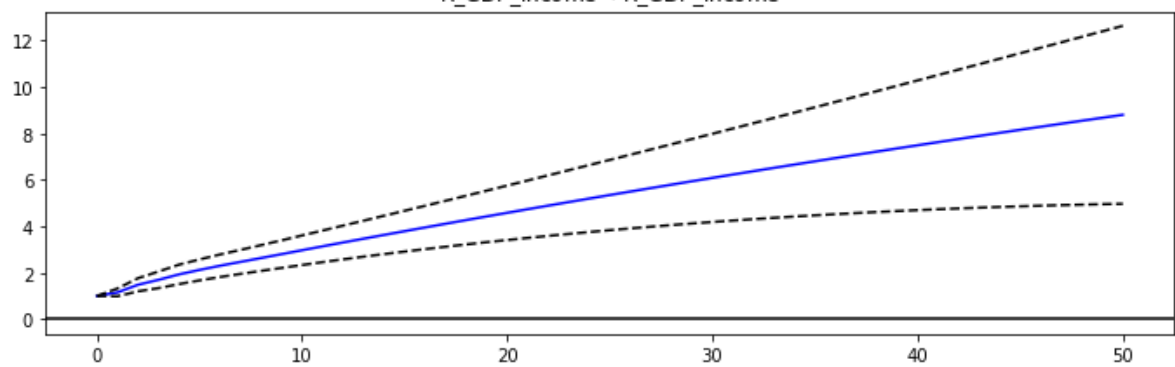
R_GDP_Income → ImportGoodAServices

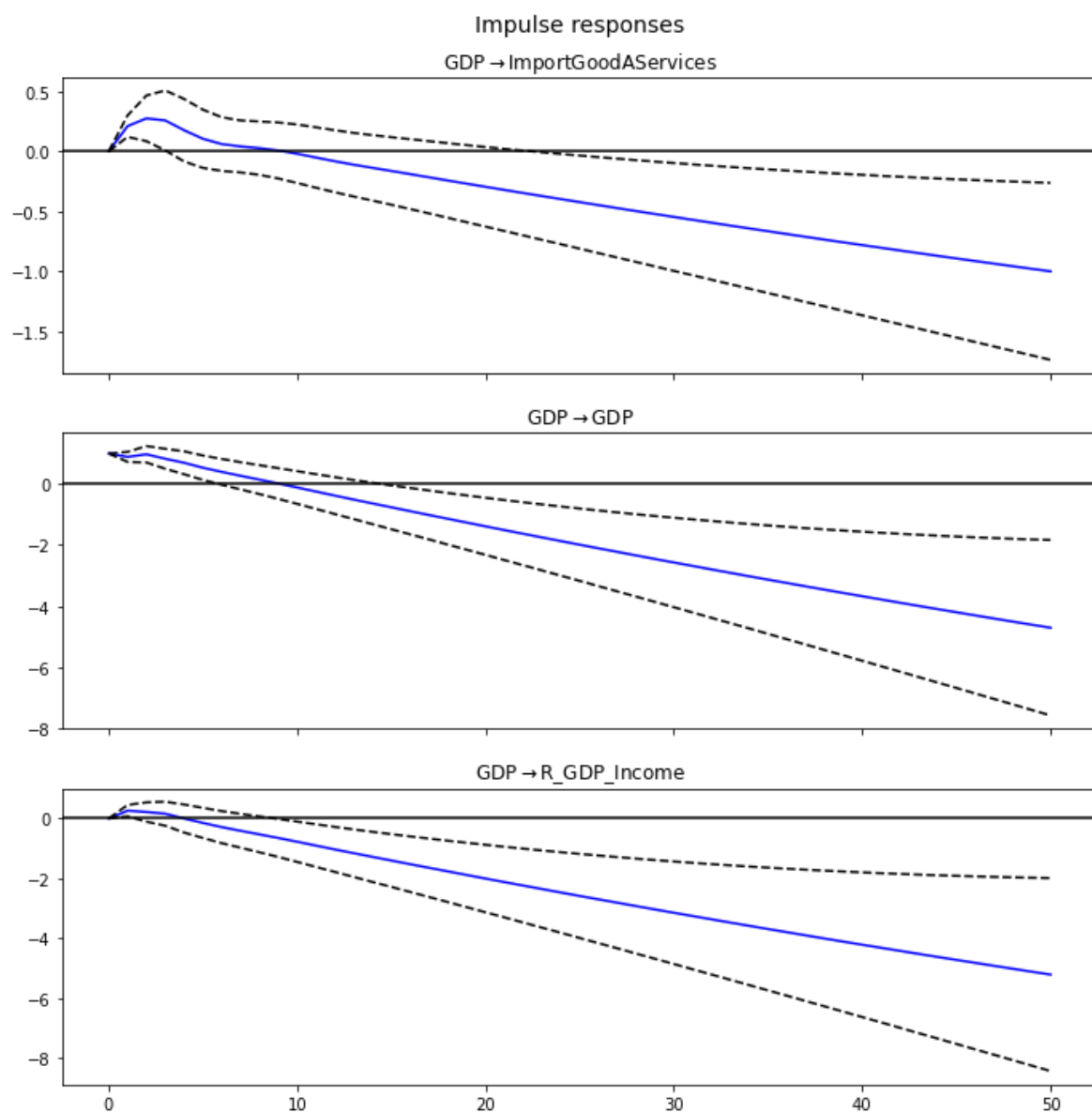


R_GDP_Income → GDP



R_GDP_Income → R_GDP_Income





MODEL RESULT:

	ImportGoodAServices	R_GDP_Income	GDP
mape	0.24920249177168788	0.10138814761353639	0.0924307043003064
mae	959.5284413301197	2034.1416363459932	1840.7216266381197
rmse	984.4087552748346	2036.2407725367884	1843.067434926893

I used the VECM model and the metrics of this model are given in the table above. Comparing these metrics, it seems that the model is performing better on "GDP" variable with lower MAPE, MAE and RMSE values.