

Macroeconometrics - UK variables report

Souleymane Faye & Gereon Staratschek

2025-05-24

Preliminaries

In this project, we aim to analyze the development of the Gross Domestic Product (GDP), exchange rates, and trade balance of the United Kingdom (UK). We collect our data from the OECD open data portal. We use data on a quarterly basis, starting latest in 1997. This period covers important financial events such as the Global Financial Crisis (GFC) in 2007, the Brexit referendum in 2016 and UK's final EU leave in 2020 as well as the COVID-19 pandemic from 2020-2022.

Exercise 1 - Univariate Analysis

Part 1: Analyzing the time series in levels

Looking at the plain time series data and analyzing the plots, we get the following results:

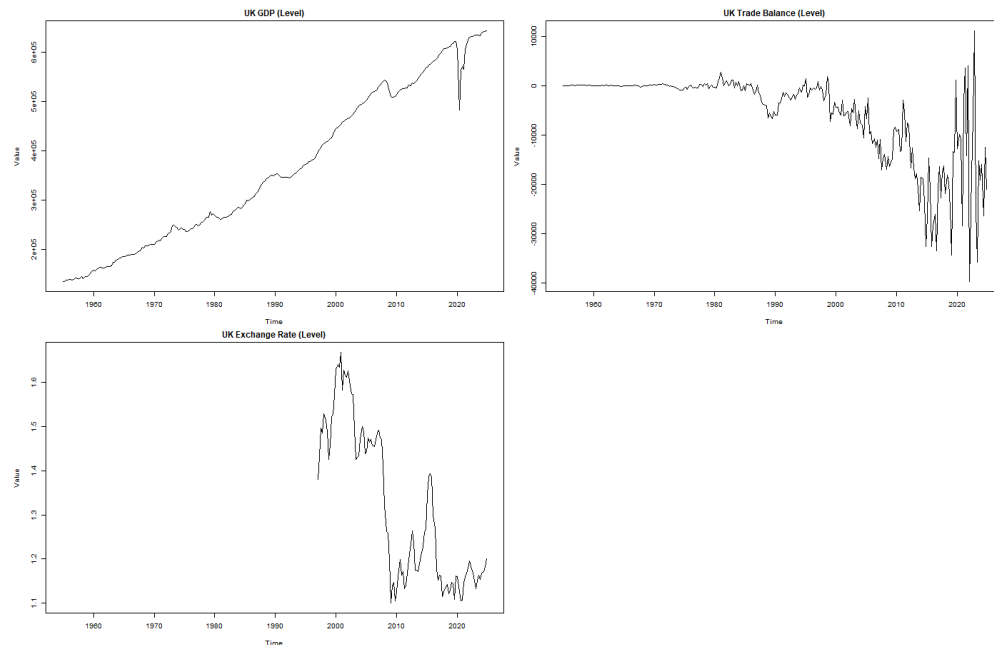


Figure 1: Residual diagnostics from ARIMA(1,0,4).

GDP: Data on UK's GDP is available on a quarterly basis starting in 1955. GDP exhibits a clear, upwards trend with only a few shocks (such as the 2020 COVID-19 pandemic or the 2007 financial crisis) interrupting

the general trend. Hence, the GDP of the UK is clearly not stationary. However, the trend seems to be linear, suggesting that the first-differences time series of the GDP might be stationary. \

Trade Balance: As GDP, data on the trade balance is available on a quarterly basis starting in 1955. We see that the trade balance fluctuates around 0 until the 1990s where a negative trend seems to set in continuing until the 2010s, when trade balance starts fluctuating around a low, negative value. However, since the observed spikes are getting much bigger over time, we also see an increase in fluctuation around the respective stationary mean. Hence, the data seems to be stationary in the beginning and in the end with a negative trend being observed between the 1990s and the 2010s. \

Exchange Rate: Data on the exchange rate is available since 1997 on a quarterly basis. It exhibits stationarity between 1997 and 2007, as well as from 2007 onwards. In 2007, a shock seems to have shifted the mean of the stationary process downwards.

Part 2: Conducting unit roots and stationarity tests

In this section, we aim to formally conduct stationarity tests for the series. As explained in the last section, we have reason to doubt that our series are entirely stationary. However, for our analysis, we are relying on stationarity properties of the series. Hence, after identifying the non-stationary series formally, we will conduct the first-difference transformation to obtain stationary series for our analysis.\

Starting with the non-transformed series, we run a series of tests for each time series separately (Explain the type of tests here!) \

GDP:

test	ADF		KPSS		
	statistic	p.value	crit_10pct	crit_5pct	crit_1pct
ADF	-2.530635	0.3525184	NA	NA	NA
KPSS	4.731673	0.0100000	NA	NA	NA
ERS DF-GLS	3.073724	NA	-1.62	-1.94	-2.57
PP	-21.532938	0.0483211	NA	NA	NA

Table 1: Unit-root and stationarity tests for UK GDP

Trade Balance:

test	ADF		KPSS		
	statistic	p.value	crit_10pct	crit_5pct	crit_1pct
ADF	-2.2250155	0.4812789	NA	NA	NA
KPSS	3.3948515	0.0100000	NA	NA	NA
ERS DF-GLS	-0.6723293	NA	-1.62	-1.94	-2.57
PP	-157.4146465	0.0100000	NA	NA	NA

Table 2: Unit-root and stationarity tests for UK GDP

Exchange Rate:

test	ADF		KPSS		
	statistic	p.value	crit_10pct	crit_5pct	crit_1pct
ADF	-2.382354	0.4179499	NA	NA	NA
KPSS	1.754143	0.0100000	NA	NA	NA
ERS DF-GLS	-1.414941	NA	-1.62	-1.94	-2.58
PP	-13.157562	0.3539359	NA	NA	NA

Table 3: Unit-root and stationarity tests for UK GDP

\ Interpret these results! \

Now, let us turn to the first-difference transformations of the time series. \

GDP:

test	ADF		KPSS		
	statistic	p.value	crit_10pct	crit_5pct	crit_1pct
ADF	-8.0195142	0.01	NA	NA	NA
KPSS	0.0864308	0.10	NA	NA	NA
ERS DF-GLS	-7.9411516	NA	-1.62	-1.94	-2.57
PP	-321.6127812	0.01	NA	NA	NA

Table 4: Unit-root and stationarity tests for UK GDP

Trade Balance:

test	ADF		KPSS		
	statistic	p.value	crit_10pct	crit_5pct	crit_1pct
ADF	-8.1714448	0.01	NA	NA	NA
KPSS	0.0349289	0.10	NA	NA	NA
ERS DF-GLS	-12.9115650	NA	-1.62	-1.94	-2.57
PP	-300.0884288	0.01	NA	NA	NA

Table 5: Unit-root and stationarity tests for UK Trade Balance

Exchange Rate:

test	ADF		KPSS		
	statistic	p.value	crit_10pct	crit_5pct	crit_1pct
ADF	-5.0408902	0.01	NA	NA	NA
KPSS	0.0837118	0.10	NA	NA	NA
ERS DF-GLS	-2.1882524	NA	-1.62	-1.94	-2.58
PP	-82.8852407	0.01	NA	NA	NA

Table 6: Unit-root and stationarity tests for UK Exchange Rate

Part 3: Model Estimation

GDP: For the GDP, we use the stationary first-differenced data. Our tests suggest an ARIMA(1,0,4) process:

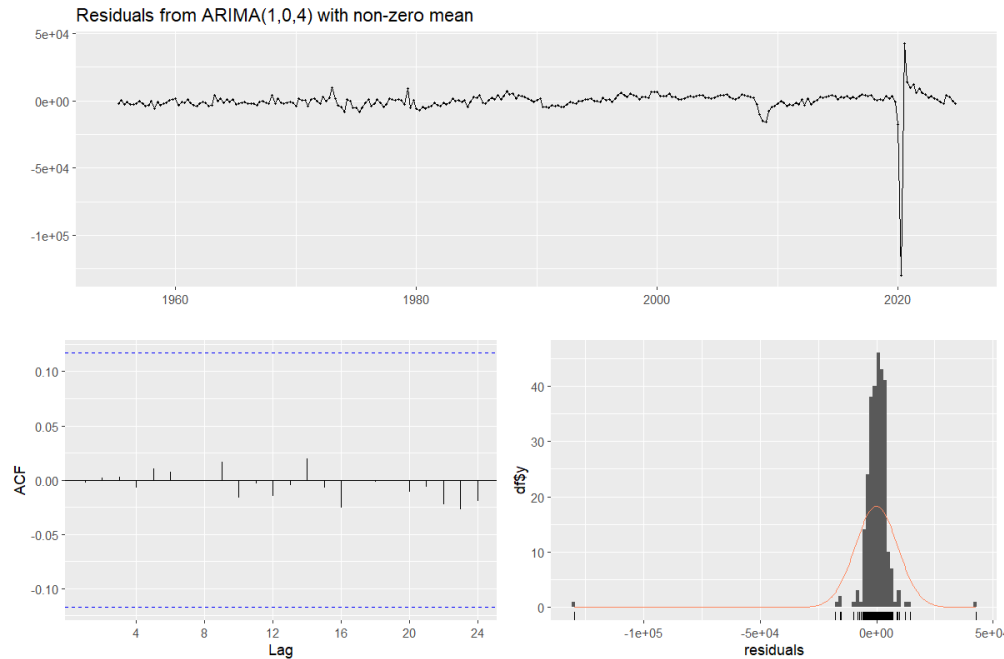


Figure 2: Model estimation - GDP

The coefficients of the model are as follows:

term	estimate	std.error
ar1	0.4886750	0.2015697
ma1	-0.7703784	0.1988893
ma2	0.0925464	0.0930497
ma3	0.1352912	0.0747171
ma4	-0.2405810	0.0610664
intercept	1832.9872955	232.7539989

Table 7: Model coefficients GDP

Trade Balance: For the Trade Balance, we use the stationary level data. Our tests suggests an ARIMA(0,0,4) process:

The coefficients of the model are as follows:

term	estimate	std.error
ma1	-0.7749122	0.0571450
ma2	-0.1000937	0.0735727
ma3	-0.0300321	0.0804010
ma4	0.2784463	0.0640672

Table 8: Model coefficients Trade Balance

Exchange rate: For the Exchange Rate, we use te stationary level data. Our tests suggests an ARIMA(1,0,0) process:

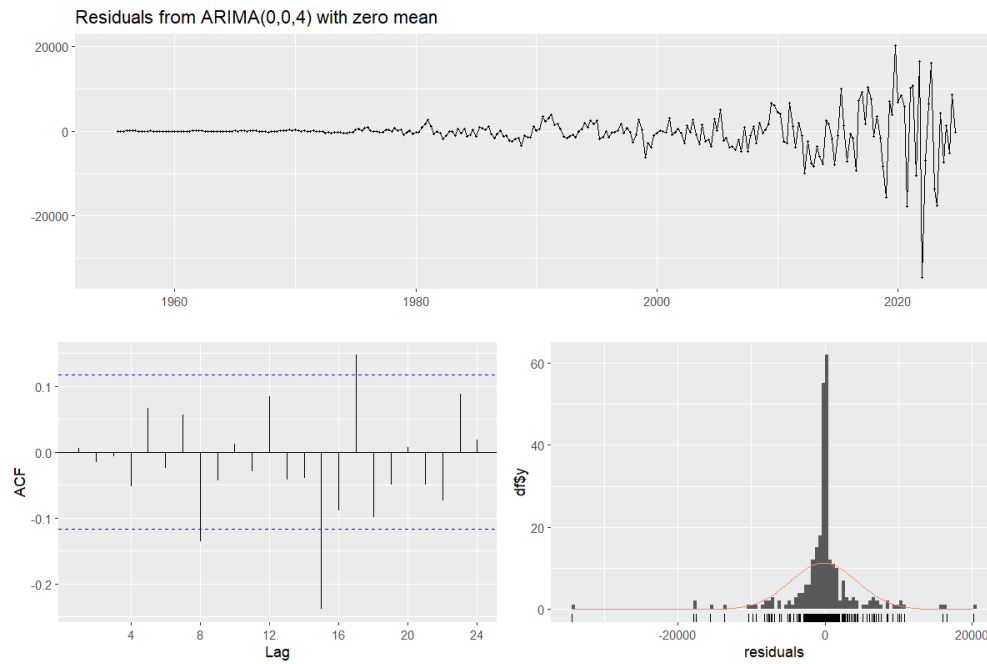


Figure 3: Model estimation - Trade Balance

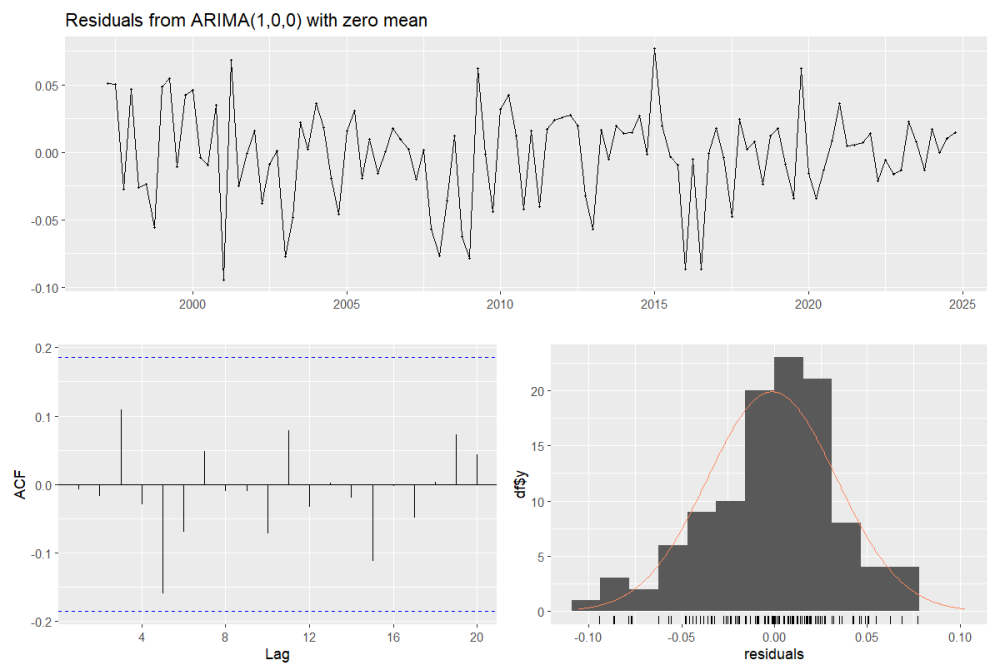


Figure 4: Model estimation - Exchange Rate

The coefficients of the model are as follows:

term	estimate	std.error
ar1	0.2592112	0.0921888

Table 9: Model coefficients Exchange Rate

Part 4 - Forecasting

We should probably focus on one series in the final report, I'll just include all so you can decide

GDP

The fit of the in-sample GDP prediction is shown in the following figure:

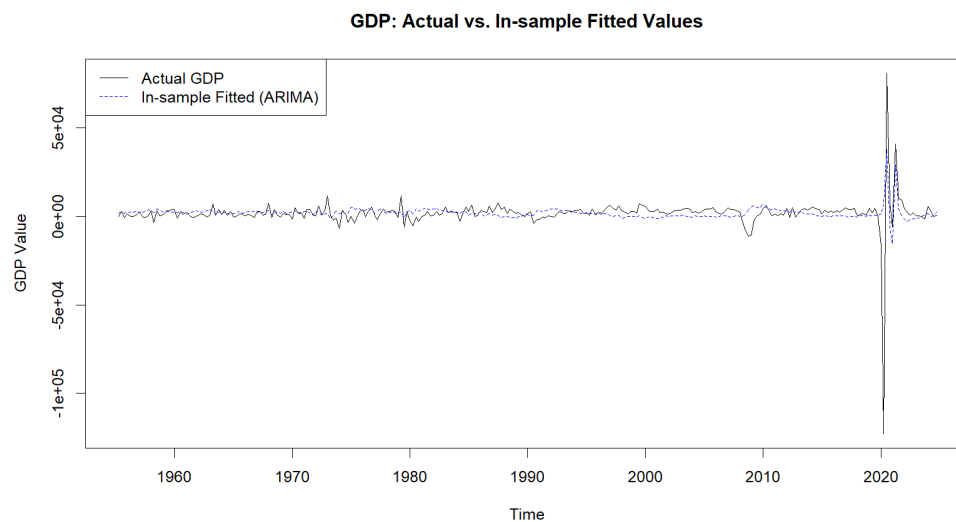


Figure 5: GDP - in-sample prediction

The formal measures of the fit are estimated as:

set	ME	RMSE	MAE	MPE	MAPE	MASE	ACF1
Training set	-30.63153	9021.217	3505.39	-106.5096	452.5585	0.7699877	-0.0027098

Table 10: GDP - accuracy metrics

The forecast of the GDP series is:

Trade Balance:

The in-sample fit of the Trade Balance is described by the following metrics:

set	ME	RMSE	MAE	MPE	MAPE	MASE	ACF1
Training set	-196.0811	4513.033	2255.195	Inf	Inf	0.6855749	0.0055908

Table 11: Trade Balance - accuracy metrics

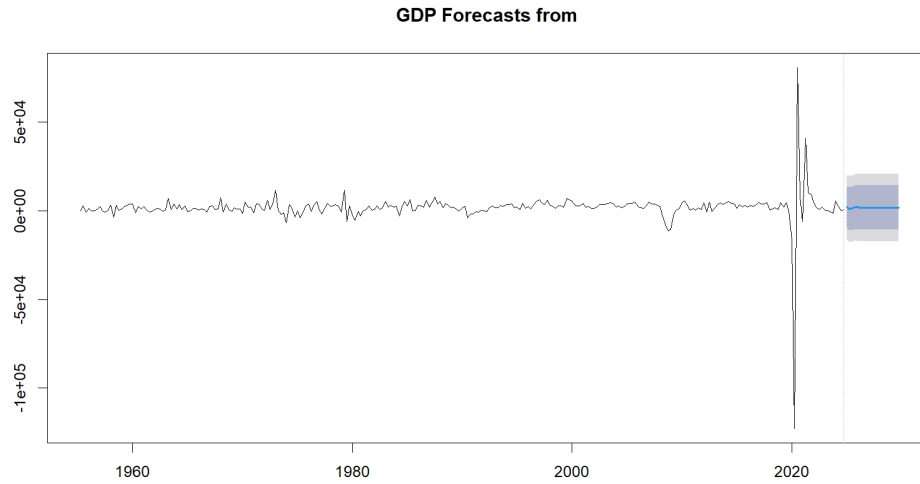


Figure 6: GDP - Forecast

The forecast of the GDP series is:

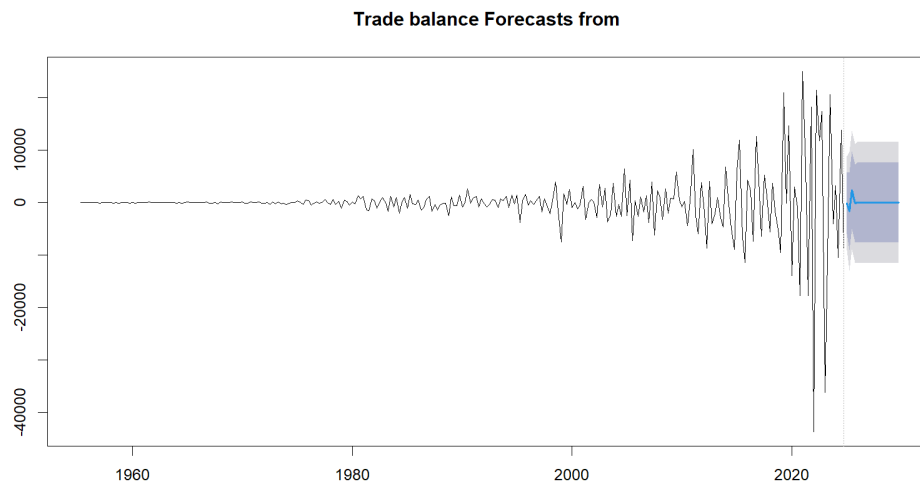


Figure 7: GDP - Forecast

Exchange Rate:

The in-sample fit of the Trade Balance is described by the following metrics:

set	ME	RMSE	MAE	MPE	MAPE	MASE	ACF1
Training set	-0.0011617	0.034616	0.0265389	137.7543	152.9467	0.6818584	-0.0075285

Table 12: Exchange Rate - accuracy metrics

The forecast of the GDP series is:

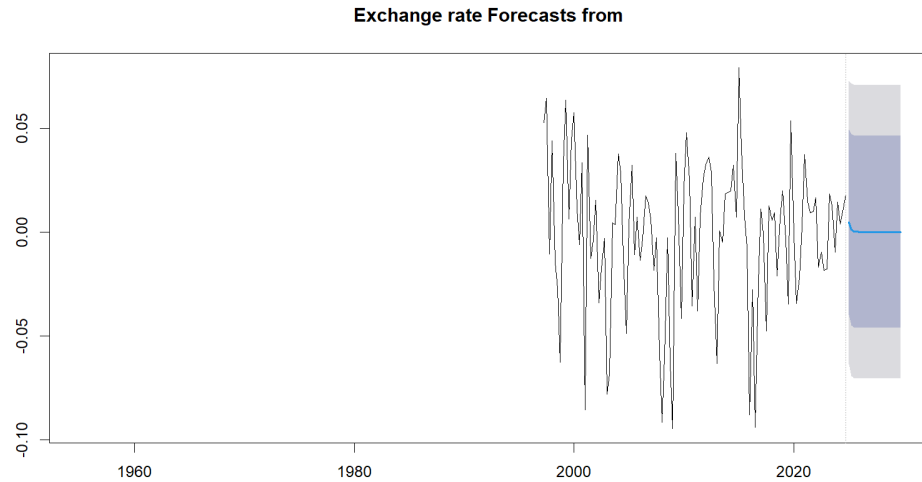


Figure 8: Exchange Rate - Forecast

Exercise 2 - Multivariate Analysis

Part 1 - Lag selection

c.f. R script. Different tests suggest different lags as can be seen in the following table:

AIC(n)	HQ(n)	SC(n)	FPE(n)
7	1	1	7

Table 13: Lag selection

We decide to use a lag of 7, ensuring better forecasting fits at the expense of a loss of power.

Part 2 - Residual testing

The test statistics for the behavior of our residuals are summarized in the following table:

Test	ChiSq	df	p.value
Serial Correlation	70.6377	45	0.0086591
ARCH	290.9468	288	0.4403334
Normality	7261.2574	6	0.0000000

Table 14: Residuals tests

Part 3 - VAR forecasts

We should probably also add an in-sample forecast as Idann and Kenan did?

The VAR forecast of the first-differenced GDP is visualized by:

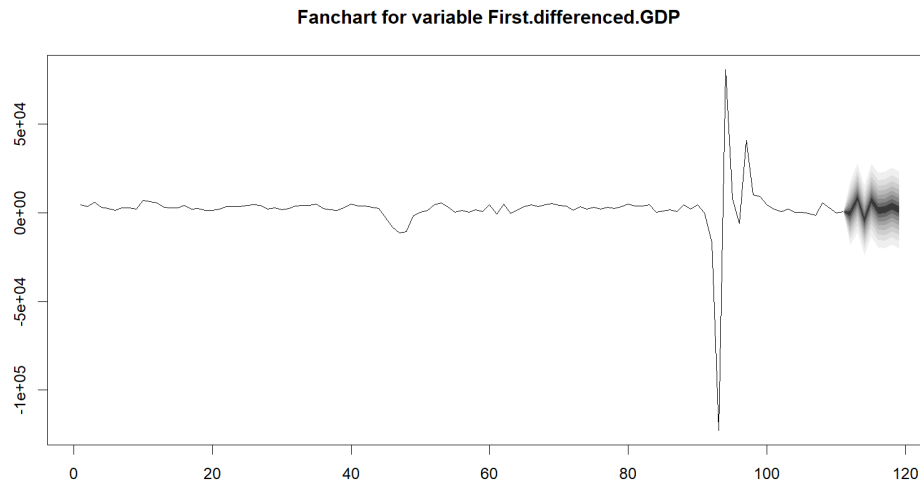


Figure 9: GDP - VAR Forecast

Part 4 - Cholesky decomposition

Part 5 - Impulse response functions

The impulse response functions for GDP are depicted as:

The impulse response functions for Trade Balance are depicted as:

The impulse response functions for Exchange Rate are depicted as:

Part 6: Modify the ordering of the variables

After modifying the ordering, the IRFs look as follows:

The impulse response functions for GDP are depicted as:

The impulse response functions for Trade Balance are depicted as:

The impulse response functions for Exchange Rate are depicted as:

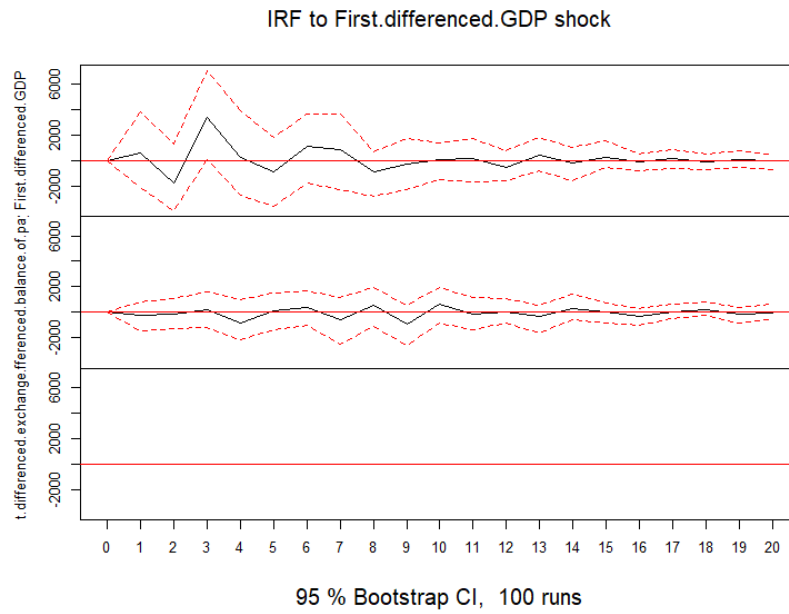


Figure 10: GDP - Shock reactions

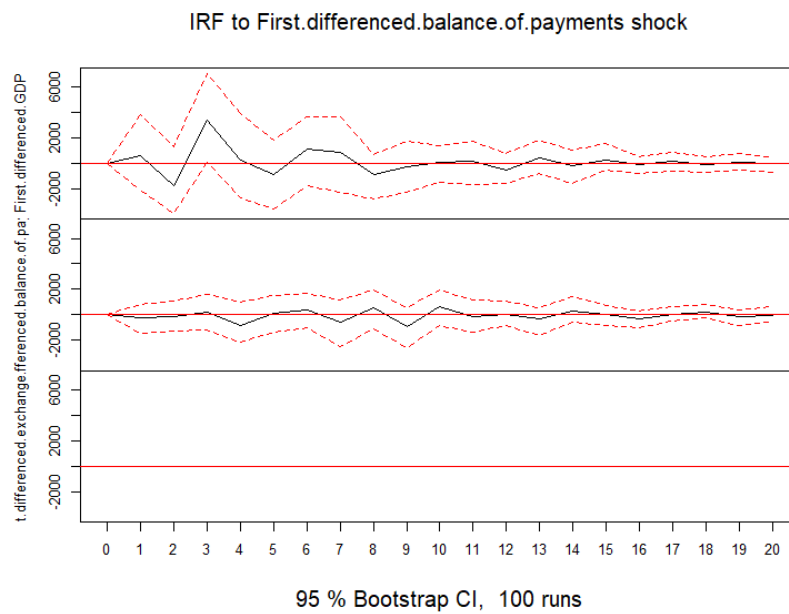


Figure 11: Trade Balance - Shock reactions

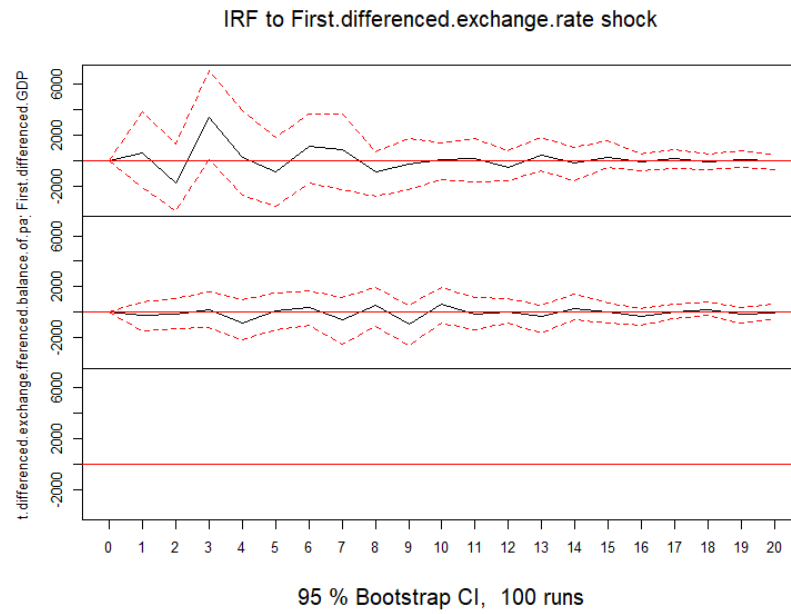


Figure 12: Exchange Rate - Shock reactions

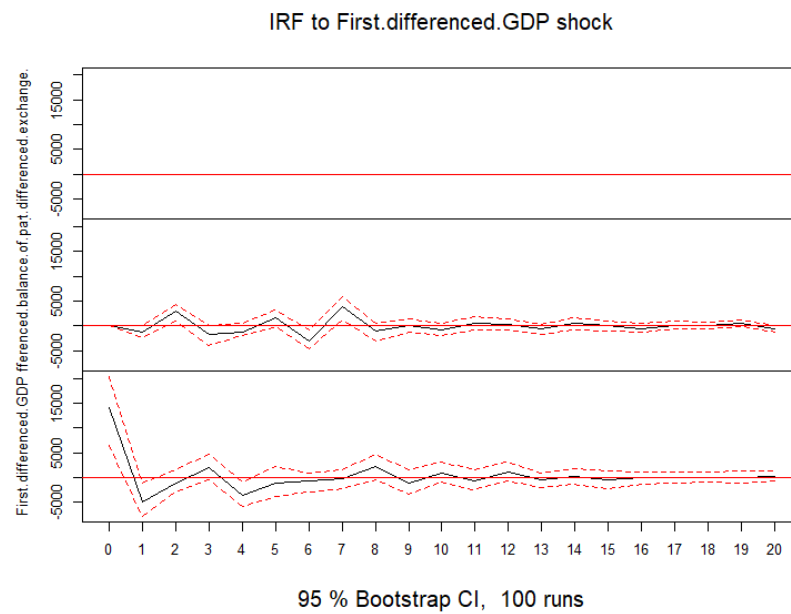


Figure 13: GDP - Shock reactions

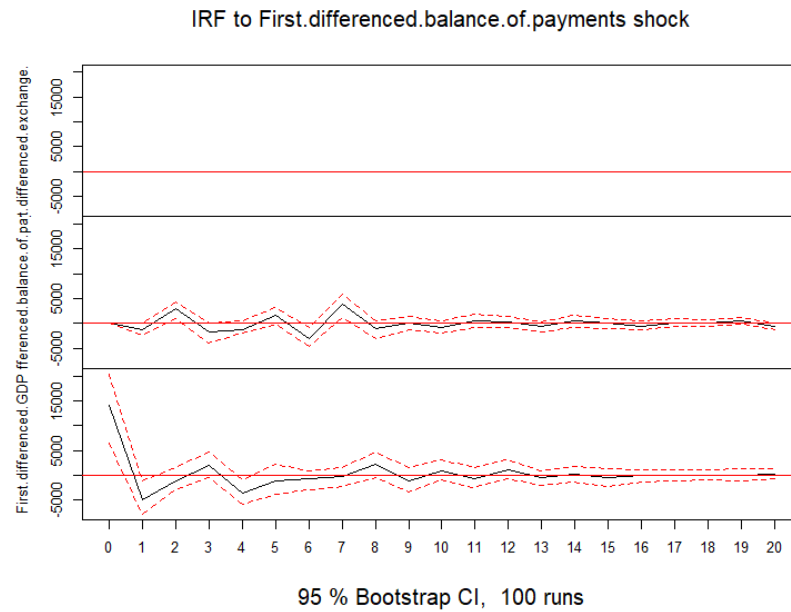


Figure 14: Trade Balance - Shock reactions

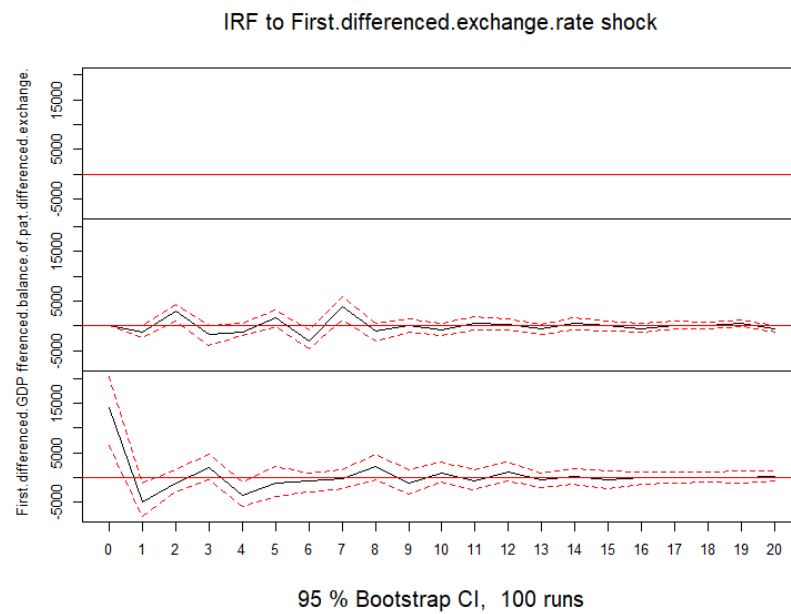


Figure 15: Exchange Rate - Shock reactions