An Analysis of Norwegian GDP Growth

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Time Series and Forecasting Methods

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1 Introduction

In this short report we outline the results of our analysis on Norwegian GDP % changes from 2021 Q2 to 2023 Q3. Our analysis will be split into an ordinary ARIMA model with no other parameters, and a multiple regression model taking into account other factors and indicators.

For the sake of brevity we will refer to the following statistical tests with the following acronyms: Shapiro Wilk (S-W) and Lilliefors Kolmogorov-Smirnov (K-S), normality tests, Ljung-Box Test (L-B).

2 Time Series Analysis

We will start by exploring the properties of our time series. The GDP % Growth can be seen in Figure 1. Note an overall slight positive trend which varies around 0, and which remains relatively stable, until the 2nd quarter of 2021. The GDP from that period and on-wards, which corresponds to the outbreak of the COVID pandemic and the subsequent lockdowns imposed in the country, exhibits wild fluctuations.

The GDP change is also not normal (S-W $p = 0.0004$, K-W $p = 0.008$), auto-correlated at lags 1 (ACF), and partially auto-correlated (PACF) at lags 1 and 2.

We discover that using a Moving Average model at Lag 1 (MA(1) model) results in no auto-correlations, showing that our data are relatively stable otherwise. This was to be expected, since the time scale these data were collected (yearly quarters) absorbs most of the shocks and

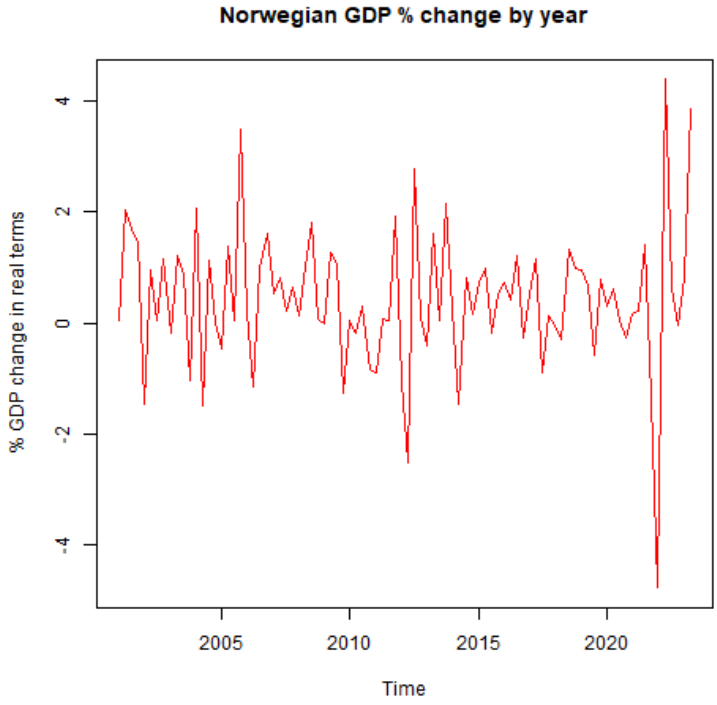

Figure 1: Norwegian real GDP % change.

time-dependent variance which typically plague other financial time series. Our model can thus be written as such:

$$RGDP_t = 0.4166 - 0.3455\varepsilon_{t-1}$$

, where ε_{t-1} are the errors of the previous prediction

Following the Box-Jenkings methodology we confirm that this is the best simple ARIMA model for explaining Norwegian GDP. The resulting residuals are almost normal (S-W $p = 7.85e-05$, K-S $p = 0.08541$, where we prefer the K-S test, since S-W is a very strong test which tends to always dismiss normality on large datasets) and homogeneous. Homogeneity is challenged at lags 6 and 38, but given their position (very long lags) and their lack of pattern, we can safely dismiss them as noise. We can hypothesize that these variations and deviations from normality are caused primarily by the erratic change of GDP during the COVID period.

3 Predicting GDP based on other factors

We fit a model with the parameters outlined in Table 1.

Fitting a model with all the parameters results in normal residuals (S-W $p = 0.1089$, K-S $p = 0.6733$), with no multicollinearity, and no homoscedascity (volatility-through-time) problems (L-B for squared errors $p = 0.9997$).

Table 2 shows the final model used for the Norwegian GDP predictions, selected manually by AIC. The model can be written as:

$$RGDP = 0.303 + 0.722 * RPROD + 0.239 * LEAD$$

where the variables are interpreted according to Table 1.

The model's residuals are normal (K-S $p = 0.1477$, L-B $p = 0.9781$), with no autocorrelations and constant variance through time (L-B with squared errors $p = 1$), with no multicolinearity. The model exhibits an AIC of 207.8 and $R^2_{adj} = 0.573$.

Name	Type	Description
LAG{p}	Numeric	Norwegian RDGP % change for Lags $p \in 1 \cdots 4$
OIL WTI	Numeric	World Oil Index
Diff WUI	Numeric	Quarterly difference of World Uncertainty Index
Diff PI	Numeric	Quarterly difference of Pandemic Index
RPROD NOR	Numeric	% change of Norwegian Production Index
CREG NOR	Numeric	Car Demand Index
DUNEM NOR	Numeric	Difference of Unemployment Index
PPI	Numeric	Producer Index
CONPROD	Numeric	Construction Index
DLONGR NOR	Numeric	Difference of Long Term Interest Rates
DLONGR NOR	Numeric	Difference of Long Term Interest Rates
STEXCHNOR	Numeric	Market Index
LEADNOR	Numeric	Leading Indicator

Table 1: An overview of the data used in our model.

Table 2: Linear regression model predicting real GDP Growth (%).

	Dependent variable:
	'RGDP NOR'
'RPROD NOR'	0.722^{***}
	p = 0.000
LEADNOR	0.239^{***}
	p = 0.00004
Constant	0.303^{***}
	p = 0.002
AIC	207.8
Observations	82
R^2	0.584
Adjusted R^2	0.573
Residual Std. Error	0.834 (df = 79)
F Statistic	55.414^{***} (df = 2; 79)
Note:	*p<0.1; **p<0.05; ***p<0.01