

# Time-Series Modelling/Forecasting

## ECON20222 - TS Revision

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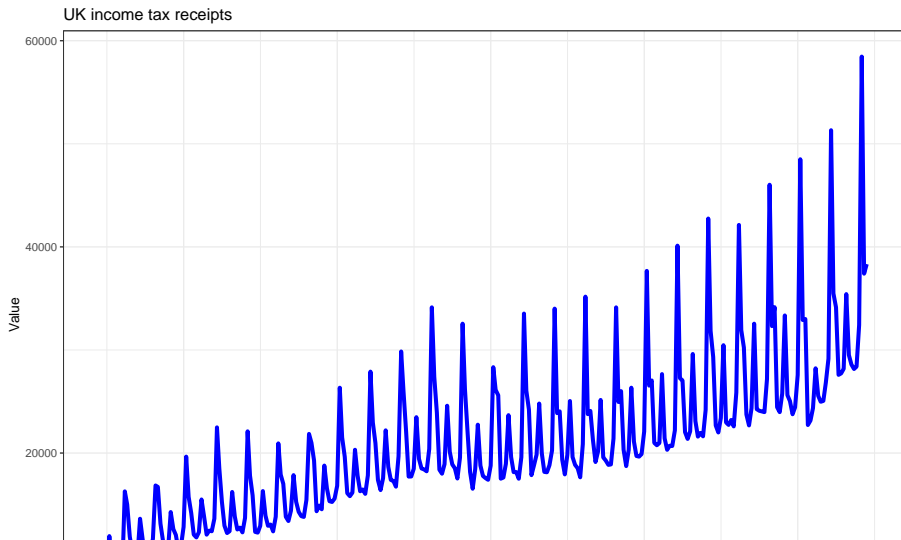
# Time-Series Properties

We model economic time-series in order to:

- understand the dynamics in **one** or between **several** time-series
- Forecast the **one or several** time-series
- understand causal relationships between **several** time-series

# Import some data into R

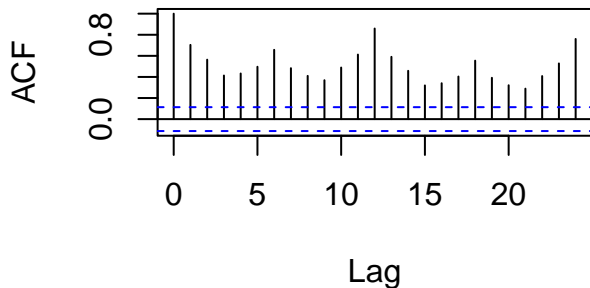
Income tax and compulsory social contributions (NICs): £m CPNSA, monthly observations



## The autocorrelation function (ACF)

The ACF expresses how observations are correlated to observations 1, 2, 3 or  $k$  observations prior,  $\rho_k$ .

### Series tax



# Stationary and Nonstationary Series

The ACF expresses how persistent a series is.

- A series that is extremely persistent is called a **nonstationary** series.
- A series that is not very persistent is called a **stationary** series.

Here: The tax receipt series is nonstationary.

- In general series with a time-trend are nonstationary
- **BUT** there is a huge grey area inbetween.

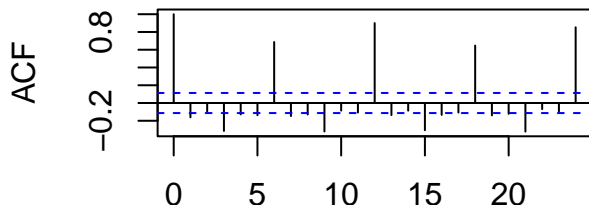
Formal statistical tests exist (not covered here). Here we eye-ball the series and look at how slowly the ACF converges to 0.

# Transformations

An important time-series transformation we consider is that of **differencing** a series (or log differencing)

```
# we multiply by 100 to express in percentage points, i.e. 0.5  
dtax <- 100*diff(log(tax), lag = 1)  
temp_acf <- acf(dtax, na.action = na.pass)
```

## Series dtax

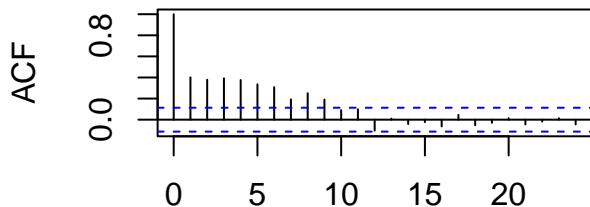


## Transformations

Let's difference with `lag = 12`, e.g. the difference between January and January receipts.

```
# we multiply by 100 to express in percentage points, i.e. 0.5  
dtax <- 100*diff(log(tax), lag = 12)  
temp_acf <- acf(dtax, na.action = na.pass)
```

### Series dtax



# Spurious Regression

If we run a regression involving nonstationary variables...

Let's get some datasets from EUROSTAT (using `pdfetch_EUROSTAT`).

- % of agricultural area Total fully converted and under conversion to organic farming in Germany [`Org`]
- Thousands of passengers travelling to and from Norway by boat [`Pass`]
- % of population with tertiary education in Italy [`Tert`]
- Hospital Discharges, Alcoholic liver disease (in Thousands) in France [`Alc`]



# Spurious Regression

All possible combinations of simple regressions between the four variables.

Table 1: Regression statistics

Dep. Var	Exp. Var			
	Org	Pass	Tert	Alc
Org	$\hat{\gamma}_1$	0.001	0.567***	-0.125***
	$se_{\hat{\gamma}_1}$	(0.0005)	(0.031)	(0.009)
	$R^2$	0.127	0.954	0.928
Pass	$\hat{\gamma}_1$	196.720	196.720	-17.717
	$se_{\hat{\gamma}_1}$	(137.969)	(137.969)	(18.298)
	$R^2$	0.127	0.188	0.067
Tert	$\hat{\gamma}_1$	1.681***	0.001*	-0.215***
	$se_{\hat{\gamma}_1}$	(0.093)	(0.001)	(0.013)
	$R^2$	0.954	0.188	0.951
Alc	$\hat{\gamma}_1$	-7.421***	-0.004	-4.420***
	$se_{\hat{\gamma}_1}$	(0.532)	(0.004)	(0.259)
	$R^2$	0.928	0.067	0.951

Note: \* $p < 0.1$ ; \*\* $p < 0.05$ ; \*\*\* $p < 0.01$ ,  
Newey-West standard errors in parenthesis

# Adding dynamic effects and Forecasting models

Note:

\*  $\Delta ur$ : change in unemployment rate

\*  $\Delta rGDP$ : change in real GDP

$$\Delta ur_t = \alpha_0 + \alpha_1 \Delta ur_{t-1} + \alpha_2 \Delta ur_{t-2} + \dots + \alpha_p \Delta ur_{t-p} + \beta_1 \Delta rGDP_{t-1} + \dots + \beta_k \Delta rGDP_{t-k} + u_t$$

**No** contemporaneous terms on the right hand side! We can produce forecasts for period  $t$  only having information at time (say)  $t - 1$ .

These models can also be used to perform granger causality testing (Demo Class 5 and some Group Projects).

By taking out all the  $\Delta rGDP$  we reduce the model to an **autoregressive model (AR)** which often produces very useful short-term forecasts.

# Forecasting Issues

- You may model a differenced series (e.g.  $\Delta ur$ ) but still be interested in forecasting the level ( $ur$ )
- Often we forecast from AR models
- Order selection by information criterion
- If you have several forecasting models then they can be compared by comparing the RMSE (or other measures which we did not cover).