Time-Series Modelling

ECON20222 - Lecture 9

Ralf Becker and Martyn Andrews

March 2019

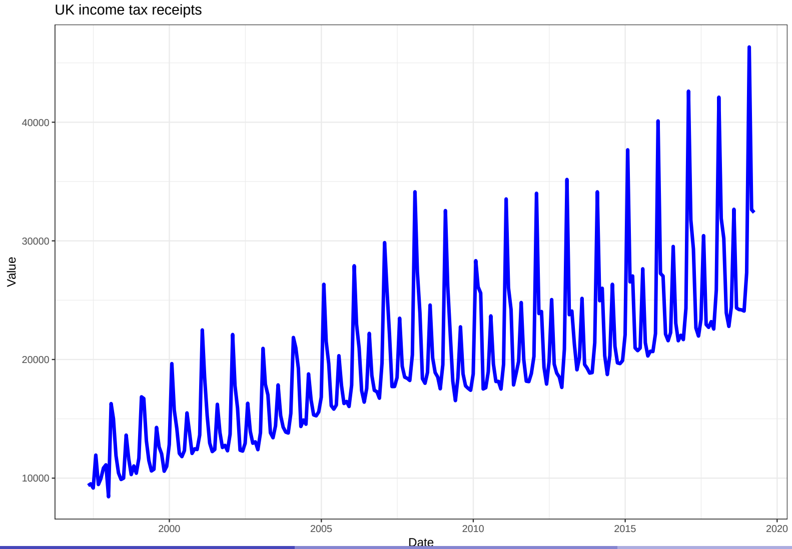
Time-Series Properties

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

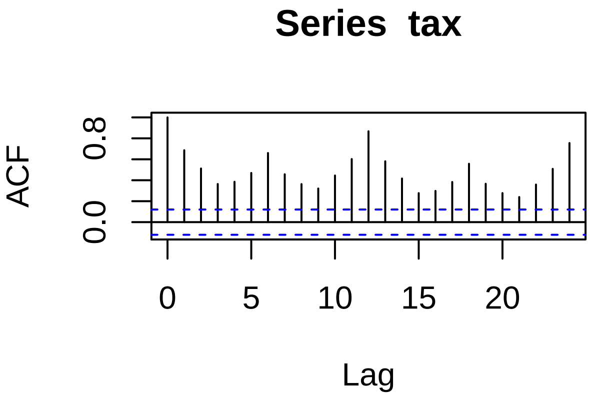
Import some data into R

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, ρ_k.



Stationary and Nonstationary Series

The ACF expresses how persistant a series is.

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

Here: The tax receipt series is nonstationary.

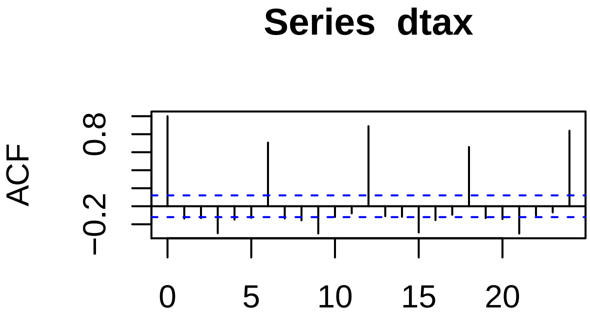
- In general series with a time-trend are nonstationary
- **BUT** there is a huge grey area inbetween.

Formal statistical tests exist (ot 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)

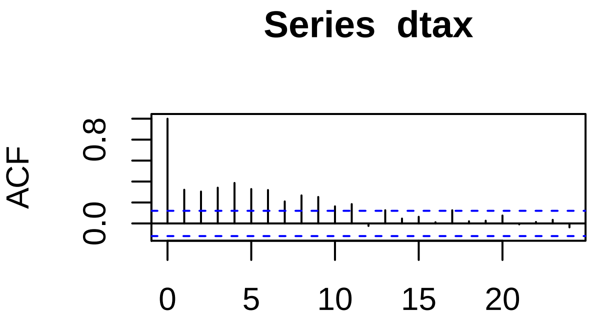
```
# we multiply by 100 to express in percentage points, i.e. 0.5
dtax <- 100*diff(log(tax), lag = 1)
temp_acf <- acf(dtax, na.action = na.pass)
```



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)
```



Spurious Regression

If we run a regression involving nonstationary variables…

Let's get some datasets fron 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

		Exp. Var			
Dep.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:
* Δur: change in unemployment rate
* $\Delta rGDP$: change in real GDP

$$\begin{aligned}\Delta ur_t &= \alpha_0 + \alpha_1 \Delta ur_{t-1} + \alpha_2 \Delta ur_{t-2} + ... + \alpha_p \Delta ur_{t-p} + \\ &\quad \beta_1 \, \Delta rGDP_{t-1} + ... + \beta_k \, \Delta rGDP_{t-k} + u_t\end{aligned}$$

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 which often produces very useful short-term forecasts.

Forecasting Issues

- You may model a differenced series (e.g. Δur) 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).