[web:reg] ARMA Excel Add-In

[web:reg] Kurt Annen

www.web-reg.de
annen@web-reg.de

Körner Str. 30
41464 Neuss
- Germany -

[web:reg] arma Excel Add-In

[web:reg] ARMA Excel Add-In is a XLL for estimating and forecast AR(I)MA models with Excel. You do not have to know anything about numerical methods to use [web:reg] ARMA Excel Add-In – just install it and use it with Excel.

Requirements

Operating System: Windows® 95, 98, ME, 2000, XP
Microsoft Excel® 97, 2000 or XP

Setup and Installation

To install the [web:reg] ARMA Add-In you must download and execute the setup program from my web page and follow than the installation instructions.

Functions

[web:reg] time series functions

The following time series functions are available. The output will be a range of the series size. Note that #N/A will be returned for observations for which lagged values are not available.

`diff(time series as range, d as integer)`	d'th order difference
`difflog(time series, d as integer)`	d'th order difference of the logarithm
`diffs(time series as range, d as integer, s as integer)`	d'th order difference with a seasonal difference s
`diffslog(time series as range, d as integer, s as integer)`	d'th order difference with a seasonal difference s of the logarithm

If the values are not numbers or the values are not positive using `difflog` or `diffslog` #N/A will be returned.

All time series functions are array-function. First select an empty range which is of the same dimension as the time series that should be differenced. Then write the function you want to use. At this point, do not press Enter. Rather, hold down the Shift and the Ctrl Keys and then press Enter.

Example

`diff(A2:A102,1)` will output the difference of the time series Range A2:A102.

[web:reg] arma function

This function estimates the parameters of an ARMA(p,q) model. arma needs as parameters a time series as a range, the order of autoregressive terms q as integer, the order of moving average terms q as integer, and if you want an constant term into the model an boolean as true.

```
arma(time series as range, p as Integer, q as Integer, c as bool)
```

After estimating this functions returns the residual, the parameters, useful statistics, impulse response function and forecast evolution in a range of the size $(T-p)\times\max(p+q+c,3)$. The first parameter will be outputted in column 2 and row 1. The order of parameter are constant, autoregressive parameters and moving average parameters.

Output

	constant ->	AR-coeffients ->			MA- coeffients
Residual p	coefficient 1	...	...	...	coefficient (p+q+c)
Residual p+1	std. error 1	...	...	...	std. error (p+q+c)
...	t-stat. 1	...	...	...	t-stat (p+q+c)
...	P-Value 1	...	...	...	P-Value (p+q+c)
...	inverted roots (if c = false. else #N/A)	inverted roots[1]	inverted roots	...	inverted roots
...	R-squared	Mean dependent var	#N/A	...	#N/A
...	Adjusted R-squared	S.D. dependent var	#N/A	...	#N/A
...	S.E. of regression	Akaike info criterion	#N/A	...	#N/A
...	Sum squared resid	Schwarz criterion	#N/A	...	#N/A
...	Log likelihood	Durbin-Watson stat	#N/A	...	#N/A
...	Impulse Response (T=1)	Forecast (T=1)	#N/A	...	#N/A
...	...	...	#N/A	...	#N/A
Residual T	Impulse Response (T=observations-10-p)	Forecast (T=observations-10-p)	#N/A	...	#N/A

The estimation employs an efficient non linear technique (Levenberq Marquardt algorithm). The derivates will be computed by finite differencing methods. The maximum of iterations is 500 and the convergence is 0.0001. Moving average terms will be backcasted

Example

```arma(A2:A102,2,0,false)``` will estimates an AR(2) model without constant.

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[1] Excel does not know complex numbers. On this account the inverted AR/MA roots are Strings.

[web:reg] ARMA form

The output of the function is difficult for many persons to recognize. For this reason I integrated a VBA form. The input is simplified and the outputs is formatted and diagrams will be created.
When installed, [web:reg] ARMA Excel Add-In adds a new menu item to Excel's main menu.
Start the Add in by clicking on [web:reg] -> univariate time series -> ARMA-Estimation in Excel.

The following dialog appears:

In here, you tell the program about the data that we would like to estimate. If there is the name of the time series in the first row, you are going to tell this, by clicking on the "Label" checkbox.

Either you could specify the model manual or the Add-In fits the best model by using information criteria.

You could also specify the time horizon of the impulse response function and forecast.

The estimation result will be displayed in a new worksheet.

ARMA Estimation of y

timeseries: y
Method: Nonlinear Least Squares (Levenberg-Marquardt)
date: 07-25-05 time: 0:27
Included observations: 21
p = 1 - q = 1 - no constant - manual selection

	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	0,866953776	0,126002521	6,880447856	1,45684E-06
MA(1)	0,256265558	0,241830848	1,059689284	0,302572171

R-squared	0,742837	Mean dependent var	0,014930
Adjusted R-squared	0,729303	S.D. dependent var	0,020930
S.E. of regression	0,010889	Akaike info criterion	-5,811570
Sum squared resid	0,002253	Schwarz criterion	-5,712091
Log likelihood	63,021481	Durbin-Watson stat	1,831213

Inverted AR-roots	0,87
Inverted MA-roots	-0,26

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Actual & Fitted

Residualplot

Diagrammfläche

Table

Period	Actual	Fitted	Residual
2	0,013421586	0,005531206	0,00789038
3	0,020032684	0,020792483	-0,0007598
4	0,018629644	0,025748573	-0,007118929
5	0,008837401	0,02071062	-0,01187322
6	-0,00603594	0,017223708	-0,023259647
7	-0,03153522	-0,03746268	0,00592746
8	-0,02737277	-0,03020548	0,002832709
9	-0,01937921	-0,02818426	0,008805044
10	-0,00726991	-0,03245366	0,025183752
11	0,021137505	0,022196207	-0,001058702
12	0,023720266	0,008511749	0,015208517
13	0,035501582	0,042752363	-0,007250781
14	0,027424869	0,020498863	0,006926006
15	0,028843975	0,027591358	0,001252617
16	0,028033906	0,019523487	0,00851042
17	0,033135523	0,024293293	0,00884223
18	0,039750124	0,047888742	-0,008138618
19	0,028588862	0,018335993	0,010252869
20	0,032952443	0,039642285	-0,006689842
21	0,02450586	0,025243175	-0,000737315

Tabelle2 Tabelle3 Diagramm1 Tabelle4 Tabelle1

Further notes

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This Add-In was written in C/C++/Assembler and compiled with MinGW[2]. The Levenberg-Marquardt algorithm was taken from the MINPACK[3] package translated by f2c.

Each 30 estimation appears my visited card. Do not ask please whether I can remove this.

I would like thank Roland Grube[4] for designing the new [web:reg] logo.

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[2] Before you ask, why the XLL-file is so large.

From MinGW - Frequently Asked Questions "C++ programs using the Standard Template Library (ie/ #include <iostream>) cause a large part of the library to be statically linked into the binary. The need to statically link the stdc++ into the binary is two fold. First MSVCRT.dll does not contain C++ stdlib constructs. Second the legal implications of generating a libstdc++.dll are restricted by the licensing associated with the library."

[3] MINPACK is a numerical library written in Fortran

[4] Roland is one of my best friends - www.rgtect.com

Brief introduction in AR(I)MA models

Time series arise in many fields, including economics and finance. A time series is defined as a vector x_t of observations made at regulary time points $t = 1,2,\ldots,T$.

Ideally, one would like to describe these time series with mathematically models to do, e.g. predictions for future. A widely popular class of generating process, or models, are the AR(I)MA models. The acronym AR(I)MA stands for „Auto-Regressive Integrated Moving Average". Lags of the differenced time series appearing in the model are called „autoregressive" terms, lags of the errors are called „moving average", and a time series which needs to be differenced to made be stationary is said to be an „integrated" time series.

Is the time series stationary it is possible to represent it by an ARMA model. Note please that the theory of AR(I)MA model is based on stationary.

Using the backshift operator L

$$\Delta^d = (1-L)^d\, x$$

specifies the d-th order of difference of the time series X.

An ARMA(p,q) model can be expressed as:

$$x_t - \phi_1 x_{t-1} - \ldots - \phi_p x_{t-p} = \varepsilon_t + \theta_1 \varepsilon_{t-1} + \ldots + \theta_q \varepsilon_{t-q} \quad^5$$

or expressed by the backshift operator

$$\Phi(L)x_t = \Theta(L)\varepsilon_t$$

where

$$\Phi(L) = 1 - \sum_{j=1}^{p} \phi_j L^j$$

and

$$\Theta(L) = \sum_{j=0}^{q} \theta_j L^j \qquad b_0 = 1$$

If $q = 0$ one has an autoregressive, $AR(p)$, model if $p = 0$ the model is a moving average, denoted $MA(q)$. The error terms are, of course not directly observable, but a model is said to be invertible if the original errors an be re-constructed from the observed x. Mathematically a ARMA model is be invertible if the roots of the equation[6] $\Theta(z) = 0$ all lie outside the unit circle or the absolute value of each root is greater than one.

If the roots of the equation $\Phi(z) = 0$ all lie outside the unit circle the model is stationary. If only one of the roots is in absolute value greater one the difference system is explosive.

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[5] often a constant μ will be included

$$x_t - \phi_1 x_{t-1} - \ldots - \phi_p x_{t-p} = \mu + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \ldots + \theta_q \varepsilon_{t-q}$$

[6] z might be a complex number

A stationary $ARMA(p,q)$ process has an $MA(\infty)$ representation. The coefficients of the $MA(\infty)$ representation could be calculated recursively and are called „impulse response" function. The impulse response function gives the answer of the question: what is the effect on x_t given a unit shock at time s. Note please if there is only a pure $MA(q)$ process the effect holds only until $s+q$. The effect of an $AR(p)$ or an $ARMA(p,q)$ process converges to zero if the time series is stationary.

Forecast

Normally ARMA models are used to forecast a time series. A very simple method for forecasting ARMA models is:

$$x_{T+h} = \phi_1 x_{T+h-1} + \ldots + \phi_p x_{t+h-p} + \varepsilon_T - \theta_1 \varepsilon_{T+h-1} - \ldots - \theta_q \varepsilon_{T+h-q}$$

As you can see x_{T+h} can easily be updated. The optimal forecast for ε_{T-h} is, of course, zero for $h>q$.

Estimating

Estimating an $AR(p)$ model is really simple, because the model is linear and OLS is applicable. Unfortunately, an $MA(q)$ or an $ARMA(p,q)$ $(q>0)$ is non linear in nature, and requires an iterative procedure to resolve the parameters. A very good algorithm in estimating non-linear model is the Levenberg-Marquardt algorithm.

Identifying the order of p and q

The Box Jenkins procedure for identifying the orders of p and q is very difficult and will not be described. A simple and popular procedure is to minimize Akaike or Schwarz Information criteria. These criterions forms a trade-off between the fit of the model (which lowers the sum of squared residuals) and the model's complexity, which is measured by the numbers of parameters.