# Lab 2, Decision theory

2018

TMS150, MSG400

# General task and terms

- Task: Choose between different *actions*
- Unknown: future *state/event*
- Assume: possible to do a description of our gain/loss depending on action and state, called *utility function*
- Assume: a probability distribution for future states/conditions

# Example 1, actions and states

- Actions to choose between:

  $a_1$ = go to beach

  $a_2$ = go shopping

- Set of possible states:

  $\theta_1$ = sunny tomorrow

  $\theta_2$ = rainy tomorrow

  $\pi(\theta_1) = 0.8$, $\pi(\theta_2) = 0.2$ (assumption)

# Ex 1, utility function u(a,θ)

| | | States of nature | |
|---|---|---|---|
| | | $\theta_1$ = "sunny" | $\theta_2$ = "rainy" |
| Actions | $a_1$ = "beach" | 10 | -5 |
| | $a_2$ = "shopping" | 2 | 6 |

# Expected utility

- How much we expect to gain by choosing each of the actions, given a probability distribution $\pi(\theta)$ for the possible states
- $U(a) = E_{\Theta}[u(a,\theta)] = \ldots$
- $U(a_1) = u(a_1,\theta_1)*\pi(\theta_1) + u(a_1,\theta_2)*\pi(\theta_2) =$

  $= 10*0.8 + (-5)*0.2 = 7$

  $U(a_2) = u(a_2,\theta_1)*\pi(\theta_1) + u(a_2,\theta_2)*\pi(\theta_2) =$

  $= 2*0.8 + 6*0.2 = 2.8$

# How to make decisions

- Choose the action with highest expected utility! / Maximize the expected utility.

- A set of actions
- A set of possible states/events, assume a probability distribution for the states/events
- Determine a utility function $u(a,\theta)$
- Calculate, and maximize, the expected utility $U(a)$

# Example 2, actions and states

- Actions to choose between:

  $a_1$ = store the money away

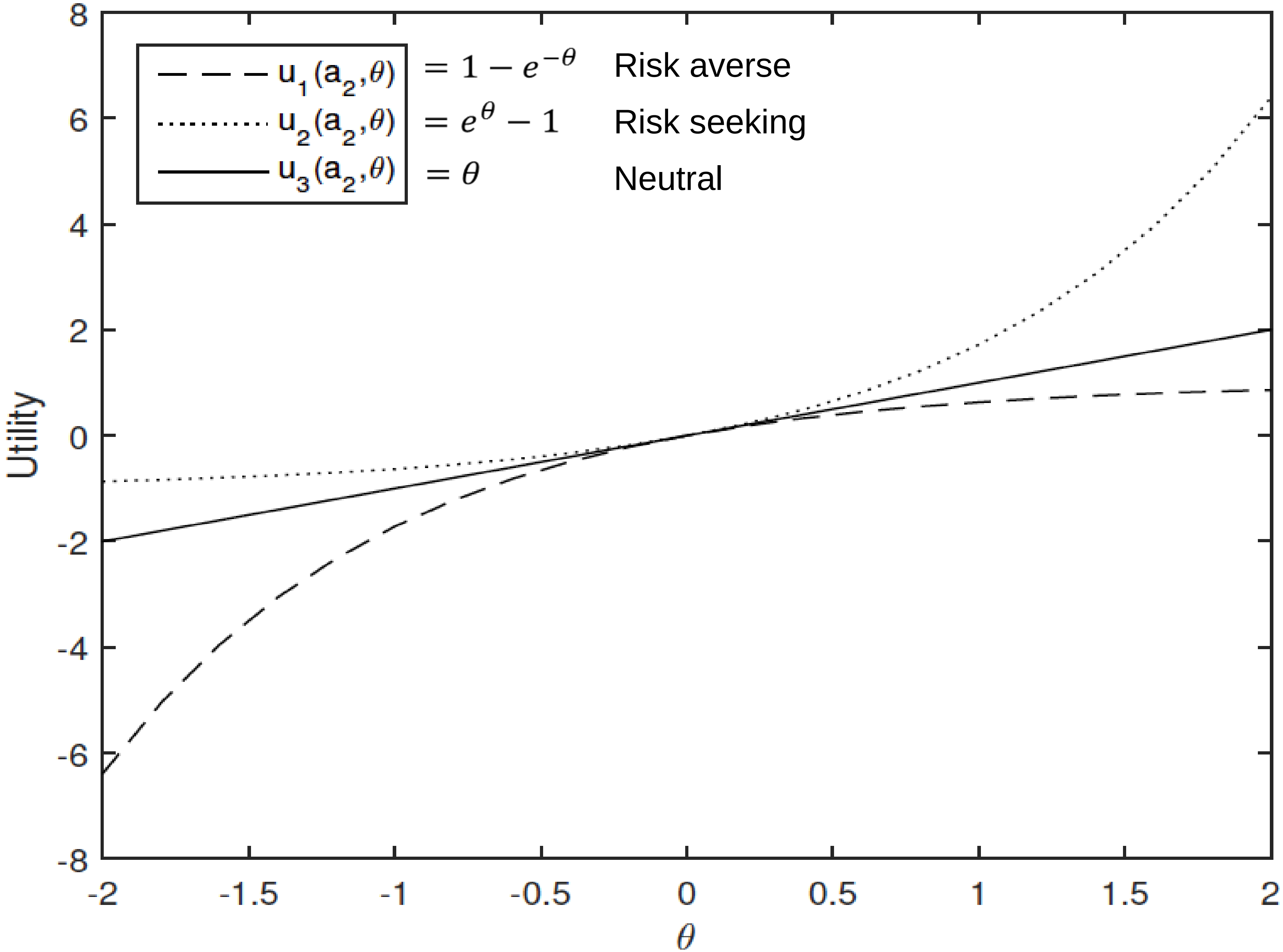
  $a_2$ = invest the money in stocks

- Set of possible states:

  all possible differences, $\theta$, in the prices of the stock between today and tomorrow, $\Theta$ cont.

  $\theta \sim N(0,1)$ (assumption)

# Utility functions $u(a_2,\theta)$, 3 examples



# Expected utility, risk averse

- Risk averse, action $a_2$:

  $E_\Theta[u(a_2,\theta)] = \int_{-\infty}^{\infty}(1 - e^{-\theta})f(\theta)d\theta = -0.65$

- Expected utility, U(a), for case "risk averse":

  $U(a_1) = 0$

  $U(a_2) = -0.65$

- Choose $a_1$!

# Expected utility

- Risk averse:

$$E_\Theta[u_1(a_2,\theta)] = \int_{-\infty}^{\infty}\left(1 - e^{-\theta}\right)f(\theta)d\theta = -0.65$$

- Risk seeking:

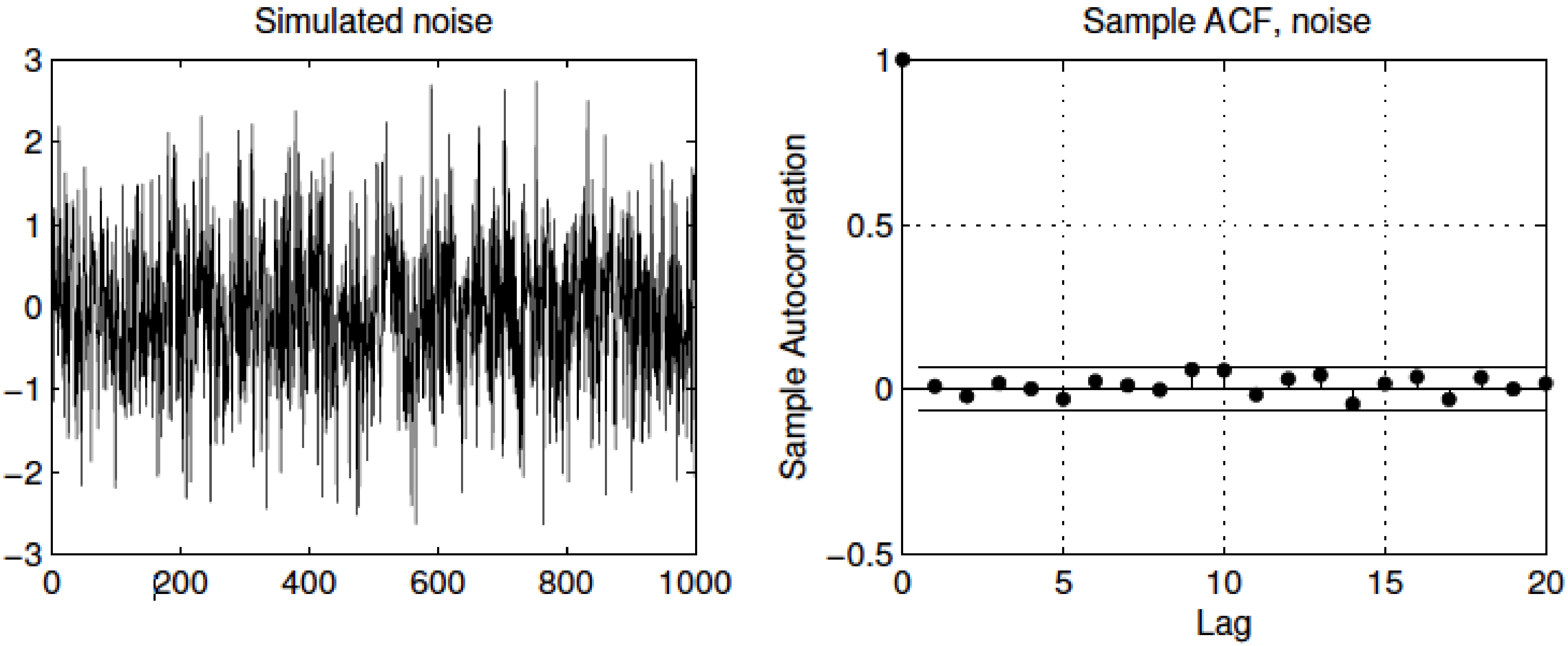
$$E_\Theta[u_2(a_2,\theta)] = \int_{-\infty}^{\infty}\left(e^{\theta} - 1\right)f(\theta)d\theta = 0.65$$

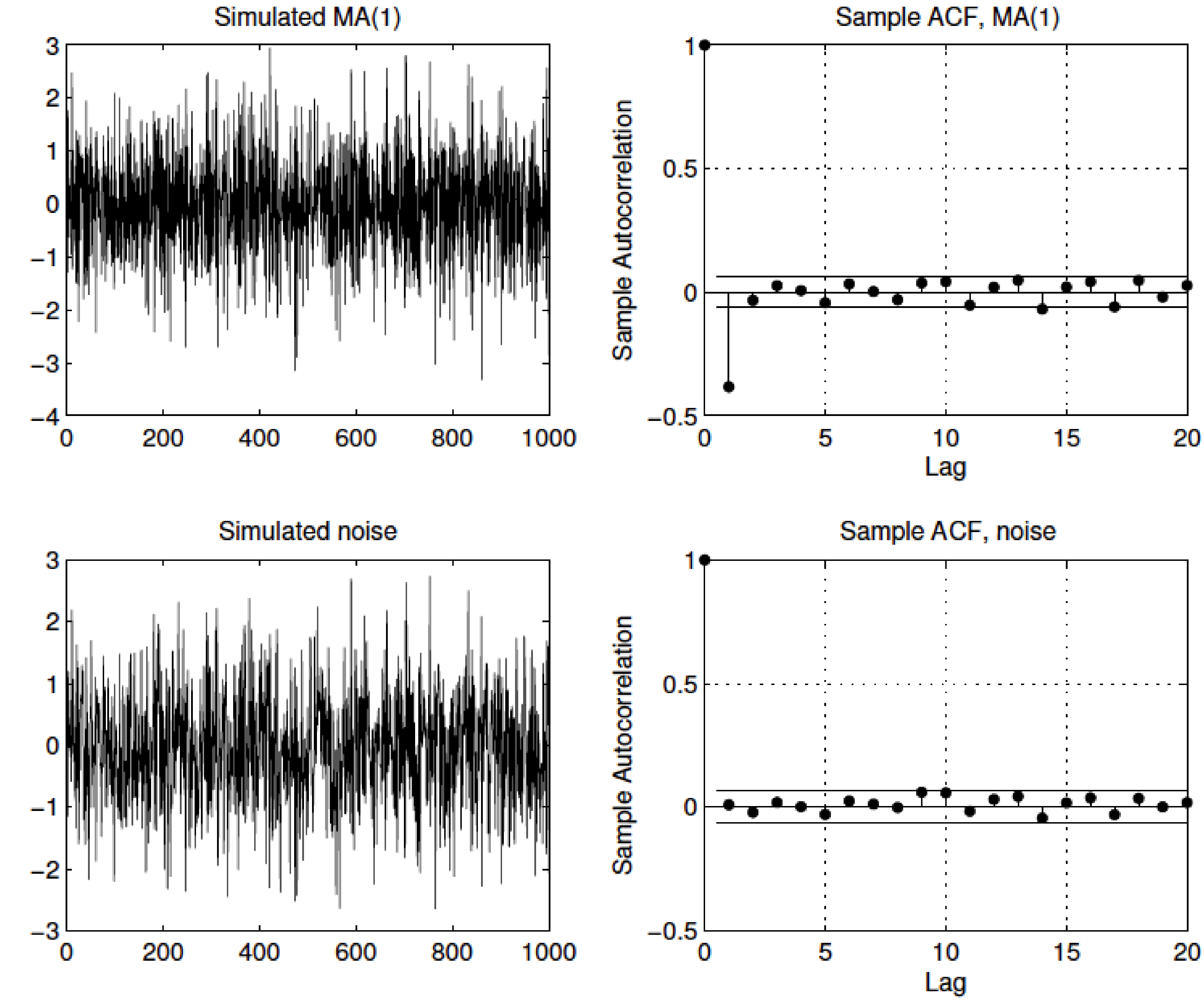
- Risk neutral:

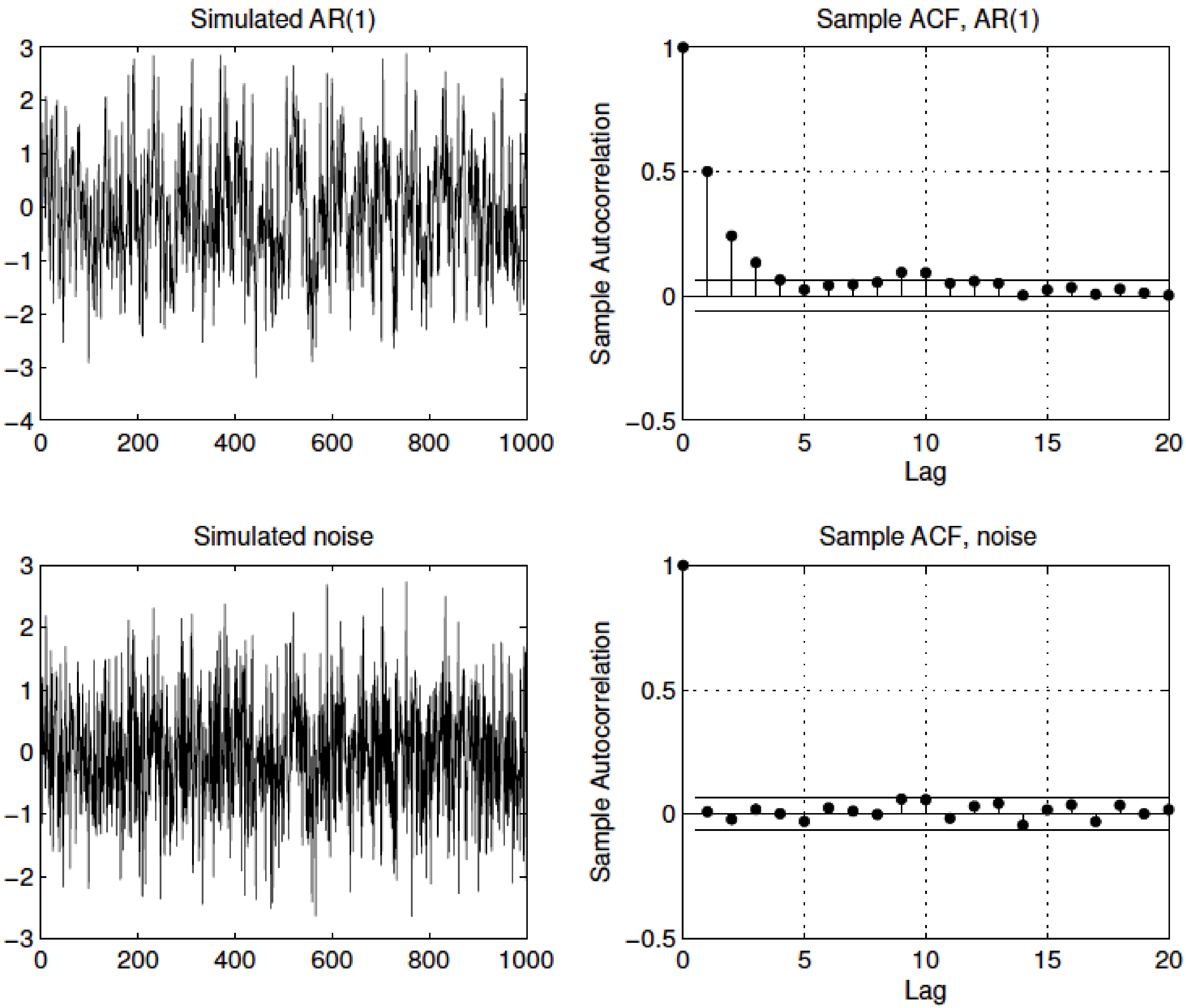
$$E_\Theta[u_2(a_2,\theta)] = \int_{-\infty}^{\infty}\theta f(\theta)d\theta = 0$$

In all cases the expected utility for $a_1$ equals 0

# The autocorrelation function




Simulated MA(1)
Sample ACF, MA(1)
Sample Autocorrelation
Lag
Simulated noise
Sample ACF, noise
Sample Autocorrelation
Lag
3
2
1
0
−1
−2
−3
−4
0
200
400
600
800
1000
1
0.5
0
−0.5
0
5
10
15
20



Simulated AR(1)
Sample ACF, AR(1)
Sample Autocorrelation
Lag
Simulated noise
Sample ACF, noise
Sample Autocorrelation
Lag

# Report writing

- One of the learning goals of the course
- Write individually (see rules on course web page)
- Clear report structure and writing gives **0.5 points** extra
  - See templates on course page
  - Figure size: labels etc. should be easily readable when printed
  - Use a sensible number of digits when printing values!
- Code
  - Include in appendix
  - Tidy and well commented code gives **0.5 points** extra
  - Code and comments can be identical to your lab partner’s
- See details on course web page!

# Report writing

- Report should “stand by itself”
  - Give brief background
  - What have you done and how did you do it?
  - Results: numerical values and figures and your interpretation
  - What was the big picture question(s) and what did you find out?
- It should be clear you understand:
  - The functions you have used
  - Why your results make sense