# Exam SØK3001 Advanced Econometrics, Fall 2023

## Question 1

Briefly explain the following concepts:

- Measurement error
- Dummy variable
- Heteroscedasticity
- Instrumental variable

## Question 2

A researcher studies how the interest rate and income affect housing prices. Using 80 quarterly observations, the researcher reports the following estimated housing price equations:

(1) $ph_t = \underset{(0.030)}{-0.060} - \underset{(0.040)}{0.005}\, r_t - \underset{(0.002)}{0.015}\, r_{t-1} + \underset{(0.035)}{0.350}\, y_t + \underset{(0.235)}{0.950}\, y_{t-1}$

(2) $ph_t = \underset{(0.030)}{-0.020} + \underset{(0.020)}{0.80}\, ph_{t-1} - \underset{(0.0025)}{0.008}\, r_t + \underset{(0.035)}{0.330}\, y_t$

(3) $ph_t = \underset{(0.030)}{-0.020} + \underset{(0.025)}{0.70}\, ph_{t-1} - \underset{(0.045)}{0.002}\, r_t - \underset{(0.003)}{0.012}\, r_{t-1} + \underset{(0.040)}{0.120}\, y_t + \underset{(0.080)}{0.440}\, y_{t-1}$

where ph is the log of housing prices, r is the interest rate in per cent and y is the log of real disposable income. Standard errors are reported in parentheses below the estimated parameters. The estimation method is OLS.

a) Give an interpretation of the results reported in equation (1) – (3). Find the short- and long-run effects of the interest rate and income on housing prices and discuss how fast housing prices adjust to changes in the explanatory variables.

The researcher also estimates a fourth specification and reports the results given by:

(4) $\Delta ph_t = \underset{(0.030)}{-0.020} - \underset{(0.015)}{0.30}\, ph_{t-1} - \underset{(0.045)}{0.002}\, \Delta r_t - \underset{(0.003)}{0.014}\, r_{t-1} + \underset{(0.040)}{0.120}\, \Delta y_t + \underset{(0.090)}{0.560}\, y_{t-1}$

b) Use the results in equation (4) to find the short- and long-run effects of the interest rate and income. Compare the effects with those derived from equation (3).

c) Discuss how the estimated parameter in front of $ph_{t-1}$ can be interpreted.

d) Housing prices can be expected to show systematic seasonal variations. Explain how this property can be taken into account in a revised housing price equation.

The empirical study may be problematic since the included variables are non-stationary.

e) Explain what is meant by a non-stationary variable and further explain how you can test statistically whether a variable is non-stationary.

f) Explain how you can test statistically whether ph cointegrates with r and y.

g) Assume that ph cointegrates with r and y. Explain how we can interpret such a relationship between the variables.

**Question 3**

Higher wages might be a motivation for higher education. The average effect of years of education on the wage is therefore of interest. For the age group 28-38 years, we have access to a random sample of workers. The data include the monthly wage (Wage), years of education (Education), years of job experience (Experience), whether the worker lives in a city (Urban), and the result of an IQ test (IQ). We are interested in variations of the following model:

$$\log(wage)_i = \beta_0 + \beta_1 Education_i + \beta_2 Experience_{ii} + \beta_3 Urban_i + \beta_4 IQ + u_i$$

Where the lower letter *i* denotes the individual and *u* is the residual.

a) What are the necessary assumptions for unbiased estimates of the coefficients and the standard errors when using the least square method (BLUE)?
b) Describe the consequences of an omitted variable in the model.

Results for different variants of the model are presented in Table 1. The table presents estimated coefficients, with standard errors in parentheses.

c) What is the economic interpretation of the estimated coefficient of Education in column (1)?
d) Do a hypothesis test for whether the coefficient is equal to zero.
e) The estimated effect of Education changes from column (1) to column (2), and from column (2) to column (3). Explain why.
f) The variable IQ has a mean value of 100 and a standard deviation of 15. Based on the estimated model, how much higher expected wage has an individual with two standard deviations higher IQ than the average, all else equal?
g) A commentator claims that the choice of higher education to a large extent depends on parental background and their influence during childhood. Discuss different econometric approaches that can be used if this claim is correct.
h) Another commentator makes you aware that the data used in the analysis are from the USA. Do you think the results are valid also for Norway? Explain.

Table 1. Estimation results

| | (1) | (2) | (3) |
|---|---|---|---|
| Education | 0.060<br>(0.006) | 0.076<br>(0.006) | 0.055<br>(0.007) |
| Experience | - | 0.020<br>(0.003) | 0.020<br>(0.003) |
| Urban | - | 0.173<br>(0.028) | 0.173<br>(0.028) |
| IQ | - | - | 0.006<br>(0.001) |
| Konstant | 5.973<br>(0.081) | 5.405<br>(0.111) | 5.101<br>(0.120) |
| R-kvadrert | 0.10 | 0.17 | 0.20 |
| Observasjoner | 935 | 935 | 935 |

## TABLE G.2 Critical Values of the *t* Distribution

| | | Significance Level | | | | |
|---|---|---|---|---|---|---|
| 1-Tailed: | | .10 | .05 | .025 | .01 | .005 |
| 2-Tailed: | | .20 | .10 | .05 | .02 | .01 |
| Degrees of Freedom | 1 | 3.078 | 6.314 | 12.706 | 31.821 | 63.657 |
| | 2 | 1.886 | 2.920 | 4.303 | 6.965 | 9.925 |
| | 3 | 1.638 | 2.353 | 3.182 | 4.541 | 5.841 |
| | 4 | 1.533 | 2.132 | 2.776 | 3.747 | 4.604 |
| | 5 | 1.476 | 2.015 | 2.571 | 3.365 | 4.032 |
| | 6 | 1.440 | 1.943 | 2.447 | 3.143 | 3.707 |
| | 7 | 1.415 | 1.895 | 2.365 | 2.998 | 3.499 |
| | 8 | 1.397 | 1.860 | 2.306 | 2.896 | 3.355 |
| | 9 | 1.383 | 1.833 | 2.262 | 2.821 | 3.250 |
| | 10 | 1.372 | 1.812 | 2.228 | 2.764 | 3.169 |
| | 11 | 1.363 | 1.796 | 2.201 | 2.718 | 3.106 |
| | 12 | 1.356 | 1.782 | 2.179 | 2.681 | 3.055 |
| | 13 | 1.350 | 1.771 | 2.160 | 2.650 | 3.012 |
| | 14 | 1.345 | 1.761 | 2.145 | 2.624 | 2.977 |
| | 15 | 1.341 | 1.753 | 2.131 | 2.602 | 2.947 |
| | 16 | 1.337 | 1.746 | 2.120 | 2.583 | 2.921 |
| | 17 | 1.333 | 1.740 | 2.110 | 2.567 | 2.898 |
| | 18 | 1.330 | 1.734 | 2.101 | 2.552 | 2.878 |
| | 19 | 1.328 | 1.729 | 2.093 | 2.539 | 2.861 |
| | 20 | 1.325 | 1.725 | 2.086 | 2.528 | 2.845 |
| | 21 | 1.323 | 1.721 | 2.080 | 2.518 | 2.831 |
| | 22 | 1.321 | 1.717 | 2.074 | 2.508 | 2.819 |
| | 23 | 1.319 | 1.714 | 2.069 | 2.500 | 2.807 |
| | 24 | 1.318 | 1.711 | 2.064 | 2.492 | 2.797 |
| | 25 | 1.316 | 1.708 | 2.060 | 2.485 | 2.787 |
| | 26 | 1.315 | 1.706 | 2.056 | 2.479 | 2.779 |
| | 27 | 1.314 | 1.703 | 2.052 | 2.473 | 2.771 |
| | 28 | 1.313 | 1.701 | 2.048 | 2.467 | 2.763 |
| | 29 | 1.311 | 1.699 | 2.045 | 2.462 | 2.756 |
| | 30 | 1.310 | 1.697 | 2.042 | 2.457 | 2.750 |
| | 40 | 1.303 | 1.684 | 2.021 | 2.423 | 2.704 |
| | 60 | 1.296 | 1.671 | 2.000 | 2.390 | 2.660 |
| | 90 | 1.291 | 1.662 | 1.987 | 2.368 | 2.632 |
| | 120 | 1.289 | 1.658 | 1.980 | 2.358 | 2.617 |
| | ∞ | 1.282 | 1.645 | 1.960 | 2.326 | 2.576 |

Examples: The 1% critical value for a one-tailed test with 25 *df* is 2.485. The 5% critical value for a two-tailed test with large ($> 120$) *df* is 1.96.

*Source*: This table was generated using the Stata® function invttail.