UNIVERSITETET I OSLO
ØKONOMISK INSTITUTT

Eksamen i: **ECON3150/4150 – Elementær økonometri**
Exam: ECON3150/4150 – Introductory econometrics

Eksamensdag: Fredag 28. november 2008 **Sensur kunngjøres: 15. desember 2008**
Date of exam: Friday, November 28, 2008 ***Grades will be given: December 15, 2008***

Tid for eksamen: kl. 09:00 – 12:00
Time for exam: 09:00 a.m. – 12:00 noon

Oppgavesettet er på 11 sider
The problem set covers 11 pages ***English version on page 7***

Tillatte hjelpemidler:
- Alle trykte og skrevne hjelpemidler, samt kalkulator er tillatt

Resources allowed:
- *All written and printed resources, as well as calculator, is allowed*

Eksamen blir vurdert etter ECTS-skalaen. A-F, der A er beste karakter og E er dårligste ståkarakter. F er ikke bestått.

The grades given: A-F, with A as the best and E as the weakest passing grade. F is fail.

Vi er interessert i å studere sammenhengen mellom verdien på bedrifter uttrykt ved bedriftenes aksjekapital og størrelsen på utbytte (dividende) bedriftene deler ut til sine aksjeeiere. Vårt datasett, som du finner vedlagt, er aggregerte tall i faste priser og dekker årene 1923- 1996. P_t betegner den samlede verdi på bedriftenes aksjekapital i år t, D_t betegner den samlede verdi på utbytte, og endelig betegner C_t det samlede konsum. Variabelen C_t er inkludert for å vise utviklingen av realinntekten i periode.

Utskrift 1 viser resultatet av regresjonen

(1) $$P_t = \beta_0 + \beta_1 D_t + \beta_2 C_t + \varepsilon_t \qquad t = 1, 2, 3, \ldots\ldots\ldots, 74$$

der ε_t betegner stokastiske restledd.

Spørsmål 1

(i) Diskuter regresjonsresultatene i utskrift 1, og gjør rede for om du synes resultatene er rimelige.

(ii) Gjør rede for hvordan tallene i kolonnene betegnet t-value og t-prob er fremkommet.

Utskrift 2 viser resultatene når variabelen C_t ekskluderes fra regresjon (1), og utskrift 3 viser resultatene når konstantleddet β_0 ekskluderes i regresjonen.

Spørsmål 2

Ved å sammenligne utskriftene 1 og 2 ser vi at estimatet på β_0 har forskjellige egenskaper alt etter som C_t er inkludert i eller ekskludert fra regresjonen. Likeså ser vi ved å sammenligne utskriftene 1 og 3 at estimatet på β_2 har forskjellige egenskaper alt etter som et konstantledd er inkludert i eller ekskludert fra regresjonen. Hvordan vil du forklare disse forskjellene?

I det følgende skal vi basere oss på regresjonen (utskrift 2)

(2) $\quad P_t = \beta_0 + \beta_1 D_t + u_t$

der u_t betegner stokastiske restledd.

Ved bruk av tidsrekkedata i regresjonsberegninger vil autokorrelerte restledd ofte være et problem man møter. Siden vi benytter årsdata i vår undersøkelse, er det rimelig å gå ut fra at restleddene er autokorrelerte av orden 1. Vi skal derfor anta at restleddene u_t i regresjon (2) tilfredsstiller ligningen

(3) $\quad u_t = \rho u_{t-1} + e_t \qquad |\rho| < 1$

der e_t er stokastisk uavhengige med forventning 0 *og* var*ians* σ^2.

For å undersøke om autokorrelasjon er til stede vil de fleste programmene beregne den så kalte Durbin-Watson observatoren, betegnet DW i utskriftene nedenfor.

Spørsmål 3

- (i) I spesifikasjonen (3) forutsetter vi at $-1 < \rho < 1$. Forklar hvorfor dette er en viktig forutsetning.
- (ii) Gi en kort begrunnelse for Durbin-Watson testen.
- (iii) Ta utgangspunkt i utskrift 2 og test null hypotesen $H_0: \quad \rho = 0$ mot den alternative hypotesen $H_1: \quad \rho > 0$. Velg signifikansnivå $\alpha = 0.05$

Spørsmål 4

Noen benytter den såkalte 'Lagrange multiplier test' for å teste om restleddene i regresjonen er autokorrelerte.

- (i) Forklar innholdet i denne testen.
- (ii) Utskrift 4 gir resultatene av regresjonen $P_t = \beta_0 + \beta_1 D_t + \rho \hat{u}_{t-1} + e_t$, der $\hat{u}_{t-1}$ betegner estimerte restledd i periode t-1. Synes du resultatet av 'Lagrange multiplier testen' tyder på at restleddene i regresjon (2) er autokorrelerte?

I modeller for å forklare aksjeverdien P_t oppfattes P_t ofte som nåverdien av fremtidige aksjeutbytter. Lar vi $D_{t+1}^t, D_{t+2}^t, D_{t+3}^t, \ldots\ldots, D_{t+k}^t, \ldots\ldots,$ betegne prognosene vi stiller opp på tidspunkt t for de fremtidige utbytter, vil bakgrunnsmodellen være gitt ved

(4) $$P_t = \beta_0 + \sum_{i=1}^{\infty} \gamma^i D_{t+i}^t$$

der diskonteringsfaktoren tilfredsstiller $0 < \gamma < 1$. Det kan vises ved å ta utgangspunkt i og å utvikle summen av prediksjonsfeilene $\sum_{i=1}^{\infty} \gamma^i (D_{t+i}^t - D_{t+i-1}^t)/(1-\gamma)$ at vi kan avlede regresjonen

(5) $$P_t = \beta_0 + \frac{\gamma}{1-\gamma} D_t + v_t$$

der v_t betegner de stokastiske restledd.

Spørsmål 5

(i) Bruk beregningsresultatene for regresjon 2 til å utlede et estimat for diskonteringsfaktoren γ.

Utskrift 1

EQ(1) Modelling P by OLS-CS (using anders2.data.xls)
The estimation sample is: 1923 to 1996

	Coefficient	Std.Error	t-value	t-prob
Constant	0.794263	38.26	0.0208	0.983
D	10.6511	1.498	7.11	0.000
C	39.0183	37.37	1.04	0.300

sigma 16.8032 RSS 20046.6157
R^2 0.423268 F(2,71) = 26.05 [0.000]**
DW 0.571
no. of observations 74 no. of parameters 3
mean(P) 72.3683 var(P) 469.716

Utskrift 2

EQ(2) Modelling P by OLS-CS (using anders2.data.xls)
The estimation sample is: 1923 to 1996

	Coefficient	Std.Error	t-value	t-prob
Constant	40.4074	4.885	8.27	0.000
D	10.6926	1.498	7.14	0.000

sigma 16.8137 RSS 20354.3759
R^2 0.414414 F(1,72) = 50.95 [0.000]**
DW 0.567
no. of observations 74 no. of parameters 2
mean(P) 72.3683 var(P) 469.716

Utskrift 3

EQ(3) Modelling P by OLS-CS (using anders2.data.xls)
The estimation sample is: 1923 to 1996

	Coefficient	Std.Error	t-value	t-prob
D	10.6539	1.481	7.19	0.000
C	39.7879	4.737	8.40	0.000

sigma 16.6861 RSS 20046.7374
DW 0.572
no. of observations 74 no. of parameters 2
mean(P) 72.3683 var(P) 469.716

Utskrift 4

EQ(4) Modelling P by OLS-CS (using anders2.data.xls)
The estimation sample is: 1923 to 1996

	Coefficient	Std.Error	t-value	t-prob
Constant	45.1276	3.526	12.8	0.000
D	9.29604	1.080	8.61	0.000
$\hat{u}$	0.769830	0.09149	8.41	0.000

sigma 11.9806 RSS 10190.9267
R^2 0.7068 F(2,71) = 85.58 [0.000]**
DW 2
no. of observations 74 no. of parameters 3
mean(P) 72.3683 var(P) 469.716

År	P	D	C
1923	103,6993	5,589781	1,141157
1924	93,17604	4,832872	0,963807
1925	88,10332	4,828003	0,944243
1926	94,89188	4,023264	1,014396
1927	111,4123	4,558058	1,042601
1928	96,14725	4,832613	1,040178
1929	95,45085	5,001909	1,036813
1930	93,84067	5,759148	1,05559
1931	76,38751	5,682266	1,017391
1932	88,48215	3,821318	0,982119
1933	105,9413	4,781308	1,035726
1934	109,0258	4,892575	1,000733
1935	114,6861	4,853379	0,976657
1936	123,4317	5,132861	1,043843
1937	109,45	5,425435	1,012885
1938	104,1041	5,726927	1,016876
1939	94,39961	5,475441	1,014449
1940	71,85662	3,403939	0,794373
1941	74,1038	2,024033	0,969756
1942	71,47864	1,83632	1,093775
1943	84,91922	1,818256	0,993319
1944	80,23401	1,949298	1,050588
1945	78,18262	2,440167	1,155075
1946	80,6134	3,129035	1,184328
1947	64,95877	2,890143	0,859066
1948	55,73625	2,715931	0,978522
1949	57,34626	2,662837	1,043831
1950	54,68429	2,670131	1,069195
1951	50,75287	2,589379	0,998844
1952	50,32	2,780489	0,980413

1953	51,49171	3,031236	1,016653
1954	55,95186	3,051253	1,041233
1955	62,06836	3,089615	0,995625
1956	72,45417	3,014475	1,006291
1957	75,51395	3,36794	1,014277
1958	71,6754	3,031023	1,016733
1959	81,19708	3,127122	1,027755
1960	79,5349	3,187356	1,056084
1961	79,61206	3,35199	1,051675
1962	71,04093	3,291848	1,019078
1963	79,34734	3,209369	1,019753
1964	79,11305	3,10792	1,044847
1965	76,67075	3,169518	1,015596
1966	68,48697	2,920493	1,021352
1967	57,98781	3,067194	1,037256
1968	66,06509	2,984002	1,032687
1969	59,91717	3,093627	1,048971
1970	51,97577	2,931572	1,016856
1971	49,44823	2,932855	0,976994
1972	98,24397	2,959608	1,009483
1973	70,92534	2,760884	1,05056
1974	52,90305	2,818501	0,961154
1975	60,18103	2,51081	1,018615
1976	51,6001	2,454505	1,07903
1977	41,25889	2,274953	1,022533
1978	32,97178	2,019308	1,010987
1979	25,66773	2,116455	1,030503
1980	31,94699	1,761845	0,933806
1981	37,09898	1,727272	1,015602
1982	40,2983	1,386674	1,008959
1983	64,99195	1,33253	1,025052
1984	44,56823	1,218432	1,040507
1985	49,30337	1,327973	1,051108
1986	44,6696	1,406106	1,058479
1987	44,99809	1,457907	0,974401
1988	66,90096	1,431387	0,983056
1989	74,54881	1,465983	0,993516
1990	70,80184	1,733938	0,996484
1991	72,73641	1,444753	1,003156
1992	62,33585	1,394767	1,011212
1993	86,4855	1,133446	1,011305
1994	72,87233	1,176492	1,066491
1995	80,42155	1,267112	1,017427
1996	109,1567	1,522543	1,01974

ENGLISH VERSION

We are interested in studying the relationship between the aggregate value of firms expressed by their stock value and the aggregate value of dividend payments by the firms. Our data set, which you find attached, is in fixed prices and covers the period 1923-1996. P_t denotes the firms' aggregate stock value in year t, D_t denotes the firms' aggregate dividend payments, and finally C_t which denotes the aggregate consumption in year t. The variable C_t is used as a proxy variable for real income, and is included to represent the time path of real income during the period.

Output 1 shows the results of the regression

(1) $P_t = \beta_0 + \beta_1 D_t + \beta_2 C_t + \varepsilon_t \qquad t = 1, 2, 3, ..., 74$

where ε_t denotes the random disturbances.

Question 1

(iii) Discuss the regression results as they appear in output 1. Do you think these results are reasonable?

(iv) Explain how one calculates the numbers appearing in the columns denoted t-value and t-prob.

Output 2 shows the results when the variable C_t is excluded from regression (1), and output 3 shows the results when the intercept term β_0 is excluded from the regression.

Question 2

Comparing the outputs 1 and 2 we observe that the properties of the estimate $\hat{\beta}_0$ change depending on whether the variable C_t is included or excluded from the regression. Similarly, by comparing the outputs 1 and 3 we observe that the properties of the estimate $\hat{\beta}_2$ also change depending on whether the intercept term is included or excluded from the regression. How would you explain these changes?

In the folIowing we shall use the regression (output 2)

(2) $P_t = \beta_0 + \beta_1 D_t + u_t$

where u_t denote the random disturbances.

When we apply regression analysis to time-series data we almost always run the risk that the random disturbances are auto-correlated. In the present application with annual data it is intuitively reasonable that the disturbances are auto-correlated of order 1, i.e. that the disturbances u_t in regression (2) satisfy the equation

(3) $u_t = \rho u_{t-1} + e_t \qquad |\rho| < 1$

where e_t are independently, identically distributed with mean 0 and $\text{var}iance\ \sigma^2$.

In order to examine whether auto-correlation is present, most regression programs calculate the so-called Durbin-Watson statistic, denoted DW in the present outputs.

Question 3

(iv) In specification (3) we suppose that $-1 < \rho < 1$. Explain why this is an important requirement on the disturbance process.

(v) Give a brief explanation of the Durbin-Watson test.

(vi) Use information supplied by output 2 to test the null hypothesis $H_0: \quad \rho = 0$ against the alternative hypothesis $H_1: \quad \rho > 0$. Choose level of significance $\alpha = 0.05$.

Question 4

Some authors use the so-called 'Lagrange multiplier test' to find out if the random disturbances are auto-correlated.

(iii) Give a brief explanation of this test.

(iv) Output 4 shows the results of the regression $P_t = \beta_0 + \beta_1 D_t + \rho \hat{u}_{t-1} + e_t$, where $\hat{u}_{t-1}$ denotes the estimated residual in year t-1. Do you think the results of the 'Lagrange multiplier test' indicate that the disturbances in regression (2) are auto-correlated?

Models for explaining the stock value P_t will often consider P_t as the present value of the future dividend payments. If $D_{t+1}^t, D_{t+2}^t, D_{t+3}^t, \ldots\ldots, D_{t+k}^t, \ldots\ldots$, denote predictions formed at time t of the future dividend payments, the basic background model is

(4) $$P_t = \beta_0 + \sum_{i=1}^{\infty} \gamma^i D_{t+i}^t$$

where the discounting factor γ is assumed to satisfy $0 < \gamma < 1$. It can be shown by manipulating on the sum of prediction errors $\sum_{i=1}^{\infty} \gamma^i (D_{t+i}^t - D_{t+i-1}^t)/(1-\gamma)$ that we can derive the regression

(5) $$P_t = \beta_0 + \frac{\gamma}{1-\gamma} D_t + v_t$$

where v_t denote the random disturbances.

Question 5

(ii) Use the results from regression 2 to derive an estimate of the discounting factor γ.

Output 1

EQ(1) Modelling P by OLS-CS (using anders2.data.xls)
The estimation sample is: 1923 to 1996

	Coefficient	Std.Error	t-value	t-prob
Constant	0.794263	38.26	0.0208	0.983
D	10.6511	1.498	7.11	0.000
C	39.0183	37.37	1.04	0.300

sigma 16.8032 RSS 20046.6157
R^2 0.423268 F(2,71) = 26.05 [0.000]**
DW 0.571
no. of observations 74 no. of parameters 3
mean(P) 72.3683 var(P) 469.716

Output 2

EQ(2) Modelling P by OLS-CS (using anders2.data.xls)
The estimation sample is: 1923 to 1996

	Coefficient	Std.Error	t-value	t-prob
Constant	40.4074	4.885	8.27	0.000
D	10.6926	1.498	7.14	0.000

sigma 16.8137 RSS 20354.3759
R^2 0.414414 F(1,72) = 50.95 [0.000]**
DW 0.567
no. of observations 74 no. of parameters 2
mean(P) 72.3683 var(P) 469.716

Output 3

EQ(3) Modelling P by OLS-CS (using anders2.data.xls)
The estimation sample is: 1923 to 1996

	Coefficient	Std.Error	t-value	t-prob
D	10.6539	1.481	7.19	0.000
C	39.7879	4.737	8.40	0.000

sigma 16.6861 RSS 20046.7374
DW 0.572
no. of observations 74 no. of parameters 2
mean(P) 72.3683 var(P) 469.716

Output 4

EQ(4) Modelling P by OLS-CS (using anders2.data.xls)
The estimation sample is: 1923 to 1996

	Coefficient	Std.Error	t-value	t-prob
Constant	45.1276	3.526	12.8	0.000
D	9.29604	1.080	8.61	0.000
$\hat{u}$	0.769830	0.09149	8.41	0.000

sigma	11.9806	RSS	10190.9267
R^2	0.7068	F(2,71) =	85.58 [0.000]**
		DW	2
no. of observations	74	no. of parameters	3
mean(P)	72.3683	var(P)	469.716

The data set

År	P	D	C
1923	103,6993	5,589781	1,141157
1924	93,17604	4,832872	0,963807
1925	88,10332	4,828003	0,944243
1926	94,89188	4,023264	1,014396
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1933	105,9413	4,781308	1,035726
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1954	55,95186	3,051253	1,041233
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1956	72,45417	3,014475	1,006291
1957	75,51395	3,36794	1,014277
1958	71,6754	3,031023	1,016733
1959	81,19708	3,127122	1,027755
1960	79,5349	3,187356	1,056084
1961	79,61206	3,35199	1,051675
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1964	79,11305	3,10792	1,044847
1965	76,67075	3,169518	1,015596
1966	68,48697	2,920493	1,021352
1967	57,98781	3,067194	1,037256
1968	66,06509	2,984002	1,032687
1969	59,91717	3,093627	1,048971
1970	51,97577	2,931572	1,016856
1971	49,44823	2,932855	0,976994
1972	98,24397	2,959608	1,009483
1973	70,92534	2,760884	1,05056
1974	52,90305	2,818501	0,961154
1975	60,18103	2,51081	1,018615
1976	51,6001	2,454505	1,07903
1977	41,25889	2,274953	1,022533
1978	32,97178	2,019308	1,010987
1979	25,66773	2,116455	1,030503
1980	31,94699	1,761845	0,933806
1981	37,09898	1,727272	1,015602
1982	40,2983	1,386674	1,008959
1983	64,99195	1,33253	1,025052
1984	44,56823	1,218432	1,040507
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1986	44,6696	1,406106	1,058479
1987	44,99809	1,457907	0,974401
1988	66,90096	1,431387	0,983056
1989	74,54881	1,465983	0,993516
1990	70,80184	1,733938	0,996484
1991	72,73641	1,444753	1,003156
1992	62,33585	1,394767	1,011212
1993	86,4855	1,133446	1,011305
1994	72,87233	1,176492	1,066491
1995	80,42155	1,267112	1,017427
1996	109,1567	1,522543	1,01974