Continuous Assessment in Applied Econometrics – 2H

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Master 1 – Mock exam 1

Answer the questions in order. All answers must be justified. Calculators are allowed. Throughout, log denotes the natural logarithm. Unless stated otherwise, the assumptions of the classical linear model, including normally distributed errors, are taken to hold. Critical values are read from the tables at the end of the paper. When the number of degrees of freedom is not printed, use the closest lower row, and use the row ∞ above 120. The marking scheme is indicative.

Exercise 1: What ten apiaries say about the yield of a hive ***(5 points)***

A beekeeping cooperative in the Vexin gathers $N = 10$ apiaries. For apiary i, x_i is the number of hives (in tens of hives) and y_i is the honey harvested in the 2026 season (in hundreds of kg). The treasurer only kept the following sums:

$$\sum_i x_i = 40, \qquad \sum_i y_i = 140, \qquad \sum_i x_i^2 = 200, \qquad \sum_i y_i^2 = 2{,}400, \qquad \sum_i x_i y_i = 680.$$

The cooperative first estimates the model $y_i = \beta_0 + \beta_1 x_i + u_i$ by ordinary least squares (OLS).

1. Compute $\bar{x}$, $\bar{y}$, $\sum_i (x_i - \bar{x})^2$, $\sum_i (y_i - \bar{y})^2$ and $\sum_i (x_i - \bar{x})(y_i - \bar{y})$.

2. Compute $\hat{\beta}_0$ and $\hat{\beta}_1$. Interpret $\hat{\beta}_1$ in kilograms of honey per hive.

3. Compute the sum of squared residuals (SSR), the R^2 and the unbiased estimator $\hat{\sigma}^2$ of the error variance. Interpret the R^2 in one sentence.

4. Compute the standard error of $\hat{\beta}_1$. The national average yield is 20 kg per hive. Test, at the 5% level, the hypothesis that the cooperative's hives yield the national average against the alternative that they yield more. State H_0 and H_1 in terms of β_1.

5. (a) Compute the standard error of $\hat{\beta}_0$ and test $H_0 : \beta_0 = 0$ against a two-sided alternative at the 10% level.

(b) A member argues that an apiary without hives produces no honey, and estimates $y_i = \gamma_1 x_i + v_i$ by OLS. Compute $\hat{\gamma}_1$, the SSR of this model and the standard error of $\hat{\gamma}_1$.

6. The SSR of the model without constant (question 5(b)) is larger than the SSR of question 3. In two or three lines, explain why this is always the case, and say which of the two slopes you would report to the cooperative, given your answer to 5(a).

Exercise 2: Selling ski passes ***(4 points)***

A regional tourism observatory studies 150 ski resorts in the French Alps and Pyrenees during the 2025–2026 season. It reports the following OLS estimates (standard errors in parentheses):

$$\widehat{\log(\mathit{passes})} = \underset{(0.42)}{4.10} + \underset{(0.06)}{0.65}\log(\mathit{km}) + \underset{(0.05)}{0.18}\,\mathit{snow} - \underset{(0.0015)}{0.004}\,\mathit{snow}^2 - \underset{(0.004)}{0.012}\,\mathit{price} + \underset{(0.09)}{0.25}\,\mathit{train},$$

$$N = 150, \qquad R^2 = 0.62,$$

where *passes* is the number of day passes sold over the season (in thousands), *km* the length of marked slopes (km), *snow* the average snow depth over the season (in tens of cm, between 2 and 15 in the sample), *price* the price of an adult day pass (euros, between 25 and 60), and *train* a dummy equal to 1 if a railway station is located within 15 km of the resort.

1. Interpret the coefficients on $\log(km)$ and on *price*.

2. Other things equal, compute the predicted percentage change in passes sold when the average snow depth rises from 50 to 60 cm, then from 120 to 130 cm. Give both the approximate and the exact values. Within the sample, is there a snow depth beyond which more snow reduces predicted sales? Justify.

3. Compute the exact percentage effect of *train* on passes sold. Test, at the 5% level, the hypothesis that the presence of a railway station has no effect, against a two-sided alternative.

4. The observatory republishes the equation with passes counted in units (instead of thousands) and the price in tens of euros. Give the new values of the coefficients (and standard errors) that change. Do the R^2 and the t statistics change? Justify.

5. Resorts with better slopes (wider, better groomed) charge higher prices. In two or three lines, say which assumption of the model this threatens and whether the true effect of the price is likely to be more or less negative than -0.012.

Exercise 3: What sells a video game? ***(6 points)***

A market analyst studies 600 games released on a digital distribution platform in 2025. The dependent variable is the log of the number of copies sold during the first year. The regressors are *score*, the critics' average score (from 0 to 100), the log of the launch price in euros, *multi*, a dummy equal to 1 if the game has an online multiplayer mode, and *sale*, a dummy equal to 1 if the game was discounted during its launch week.

Table 1 – First-year sales of video games, OLS estimates

	(1)	(2)	(3)
Dependent variable	$\log(sales)$	$\log(sales)$	$\log(sales)$
score	0.019	0.043	0.043
	(0.0042)	(0.005)	(0.005)
$\log(price)$		-0.877	-0.872
		(0.102)	(0.102)
multi			0.103
			(0.074)
sale			0.133
			(0.080)
Constant	5.769	6.565	6.430
	(0.300)	(0.298)	(0.304)
N	600	600	600
R^2	0.033	0.139	0.146

Notes: standard errors in parentheses.

1. Write the estimated equation of column (2). Interpret the coefficient on *score* (approximate and exact effect of one more point) and the coefficient on $\log(price)$.

2. In column (3), test at the 5% level the hypothesis that multiplayer games sell more, other things equal. State H_0 and H_1. Would your conclusion change at the 10% level?

3. Using only the R^2 of column (2), test at the 5% level the joint significance of the regressors of this column.

4. Test at the 5% level whether *multi* and *sale* can be jointly excluded from column (3). Same question at the 10% level.

5. The coefficient on *score* more than doubles between columns (1) and (2).

(a) State the two conditions under which omitting $\log(price)$ biases the coefficient on *score* in column (1).

(b) Deduce from the table the sign of the sample correlation between *score* and $\log(price)$, then the slope $\tilde{\delta}_1$ of the regression of $\log(price)$ on a constant and *score*.

(c) Is the effect of the critics' score underestimated or overestimated in column (1)? Give the economic reason in one sentence.

6. Other things equal, the sales of multiplayer games are much more dispersed than those of other games. Which assumption of the model fails? In two or three lines, say which of your answers to questions 2 to 4 are affected and why.

Exercise 4: Croissants on weekdays and at the weekend ***(5 points)***

A bakery near a train station records its croissant sales y_i over $N = 28$ consecutive days: 20 weekdays and 8 weekend days. The total sales are 3,000 croissants on weekdays and 1,680 at the weekend. Let $we_i = 1$ if day i is a Saturday or a Sunday and 0 otherwise, and $wd_i = 1 - we_i$.

1. For the model $y_i = \beta_0 + \beta_1 we_i + u_i$, write the row of the matrix X corresponding to a Monday and to a Saturday, then compute $X'X$ and $X'y$.

2. Compute $(X'X)^{-1}$ and $\hat{\beta} = (X'X)^{-1}X'y$. Interpret $\hat{\beta}_0$ and $\hat{\beta}_1$ in terms of average sales.

3. The apprentice adds wd_i to the regression, which now contains a constant, we_i and wd_i. The software answers that $X'X$ is singular. Find a non-zero vector c such that $Xc = 0$, show that $c'X'Xc = 0$, and explain why $X'X$ cannot be inverted. Which assumption of the linear model fails?

4. The apprentice now drops the constant and estimates $y_i = \gamma_1 wd_i + \gamma_2 we_i + u_i$. Compute $X'X$, $(X'X)^{-1}$ and $\hat{\gamma}$. How are $\hat{\gamma}_1$ and $\hat{\gamma}_2$ related to $\hat{\beta}_0$ and $\hat{\beta}_1$?

5. The owner wants to add sat_i, equal to 1 on Saturdays, to the model of question 1. Would $X'X$ be invertible? Answer in two or three lines.

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.

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TABLE G.3a 10% Critical Values of the *F* Distribution

		Numerator Degrees of Freedom									
		1	2	3	4	5	6	7	8	9	10
Denominator Degrees of Freedom	10	3.29	2.92	2.73	2.61	2.52	2.46	2.41	2.38	2.35	2.32
	11	3.23	2.86	2.66	2.54	2.45	2.39	2.34	2.30	2.27	2.25
	12	3.18	2.81	2.61	2.48	2.39	2.33	2.28	2.24	2.21	2.19
	13	3.14	2.76	2.56	2.43	2.35	2.28	2.23	2.20	2.16	2.14
	14	3.10	2.73	2.52	2.39	2.31	2.24	2.19	2.15	2.12	2.10
	15	3.07	2.70	2.49	2.36	2.27	2.21	2.16	2.12	2.09	2.06
	16	3.05	2.67	2.46	2.33	2.24	2.18	2.13	2.09	2.06	2.03
	17	3.03	2.64	2.44	2.31	2.22	2.15	2.10	2.06	2.03	2.00
	18	3.01	2.62	2.42	2.29	2.20	2.13	2.08	2.04	2.00	1.98
	19	2.99	2.61	2.40	2.27	2.18	2.11	2.06	2.02	1.98	1.96
	20	2.97	2.59	2.38	2.25	2.16	2.09	2.04	2.00	1.96	1.94
	21	2.96	2.57	2.36	2.23	2.14	2.08	2.02	1.98	1.95	1.92
	22	2.95	2.56	2.35	2.22	2.13	2.06	2.01	1.97	1.93	1.90
	23	2.94	2.55	2.34	2.21	2.11	2.05	1.99	1.95	1.92	1.89
	24	2.93	2.54	2.33	2.19	2.10	2.04	1.98	1.94	1.91	1.88
	25	2.92	2.53	2.32	2.18	2.09	2.02	1.97	1.93	1.89	1.87
	26	2.91	2.52	2.31	2.17	2.08	2.01	1.96	1.92	1.88	1.86
	27	2.90	2.51	2.30	2.17	2.07	2.00	1.95	1.91	1.87	1.85
	28	2.89	2.50	2.29	2.16	2.06	2.00	1.94	1.90	1.87	1.84
	29	2.89	2.50	2.28	2.15	2.06	1.99	1.93	1.89	1.86	1.83
	30	2.88	2.49	2.28	2.14	2.05	1.98	1.93	1.88	1.85	1.82
	40	2.84	2.44	2.23	2.09	2.00	1.93	1.87	1.83	1.79	1.76
	60	2.79	2.39	2.18	2.04	1.95	1.87	1.82	1.77	1.74	1.71
	90	2.76	2.36	2.15	2.01	1.91	1.84	1.78	1.74	1.70	1.67
	120	2.75	2.35	2.13	1.99	1.90	1.82	1.77	1.72	1.68	1.65
	∞	2.71	2.30	2.08	1.94	1.85	1.77	1.72	1.67	1.63	1.60

Example: The 10% critical value for numerator $df = 2$ and denominator $df = 40$ is 2.44.
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TABLE G.3b 5% Critical Values of the *F* Distribution

		Numerator Degrees of Freedom									
		1	2	3	4	5	6	7	8	9	10
Denominator Degrees of Freedom	10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98
	11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85
	12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75
	13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67
	14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60
	15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54
	16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49
	17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45
	18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41
	19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38
	20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35
	21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32
	22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30
	23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27
	24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25
	25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24
	26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22
	27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25	2.20
	28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24	2.19
	29	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22	2.18
	30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16
	40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08
	60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99
	90	3.95	3.10	2.71	2.47	2.32	2.20	2.11	2.04	1.99	1.94
	120	3.92	3.07	2.68	2.45	2.29	2.17	2.09	2.02	1.96	1.91
	∞	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83

Example: The 5% critical value for numerator $df = 4$ and large denominator $df(\infty)$ is 2.37.

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TABLE G.3c 1% Critical Values of the *F* Distribution

Denominator Degrees of Freedom	Numerator Degrees of Freedom: 1	2	3	4	5	6	7	8	9	10
10	10.04	7.56	6.55	5.99	5.64	5.39	5.20	5.06	4.94	4.85
11	9.65	7.21	6.22	5.67	5.32	5.07	4.89	4.74	4.63	4.54
12	9.33	6.93	5.95	5.41	5.06	4.82	4.64	4.50	4.39	4.30
13	9.07	6.70	5.74	5.21	4.86	4.62	4.44	4.30	4.19	4.10
14	8.86	6.51	5.56	5.04	4.69	4.46	4.28	4.14	4.03	3.94
15	8.68	6.36	5.42	4.89	4.56	4.32	4.14	4.00	3.89	3.80
16	8.53	6.23	5.29	4.77	4.44	4.20	4.03	3.89	3.78	3.69
17	8.40	6.11	5.18	4.67	4.34	4.10	3.93	3.79	3.68	3.59
18	8.29	6.01	5.09	4.58	4.25	4.01	3.84	3.71	3.60	3.51
19	8.18	5.93	5.01	4.50	4.17	3.94	3.77	3.63	3.52	3.43
20	8.10	5.85	4.94	4.43	4.10	3.87	3.70	3.56	3.46	3.37
21	8.02	5.78	4.87	4.37	4.04	3.81	3.64	3.51	3.40	3.31
22	7.95	5.72	4.82	4.31	3.99	3.76	3.59	3.45	3.35	3.26
23	7.88	5.66	4.76	4.26	3.94	3.71	3.54	3.41	3.30	3.21
24	7.82	5.61	4.72	4.22	3.90	3.67	3.50	3.36	3.26	3.17
25	7.77	5.57	4.68	4.18	3.85	3.63	3.46	3.32	3.22	3.13
26	7.72	5.53	4.64	4.14	3.82	3.59	3.42	3.29	3.18	3.09
27	7.68	5.49	4.60	4.11	3.78	3.56	3.39	3.26	3.15	3.06
28	7.64	5.45	4.57	4.07	3.75	3.53	3.36	3.23	3.12	3.03
29	7.60	5.42	4.54	4.04	3.73	3.50	3.33	3.20	3.09	3.00
30	7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.07	2.98
40	7.31	5.18	4.31	3.83	3.51	3.29	3.12	2.99	2.89	2.80
60	7.08	4.98	4.13	3.65	3.34	3.12	2.95	2.82	2.72	2.63
90	6.93	4.85	4.01	3.54	3.23	3.01	2.84	2.72	2.61	2.52
120	6.85	4.79	3.95	3.48	3.17	2.96	2.79	2.66	2.56	2.47
∞	6.63	4.61	3.78	3.32	3.02	2.80	2.64	2.51	2.41	2.32

Example: The 1% critical value for numerator $df = 3$ and denominator $df = 60$ is 4.13.

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