ECON3150/4150: Introductory Econometrics – Postponed Exam Spring 2025

Be brief and to the point.

Always motivate your answers.

Use the tables at the end of the exam where necessary.

1. [2 points] True or False? Explain your answer.

   (a) Correlation (between X and Y) does not imply causation (from X to Y).

   (b) Without correlation (between X and Y) there cannot be causation (from X to Y).

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2. [4 points] Table 1 shows summary statistics for a data frame `df` for a categorical variable `x` which takes on the values 1, 2, 3 and a continuous variable `y`. Compute and interpret the point estimates of the following OLS regressions in `R`:

   (a) `feols(y ~ 1, df)`

   (b) `feols(y ~ x1, df)`

   (c) `feols(y ~ x1 + x2, df)`

   (d) `feols(y ~ I(x2 + x3), df)`

   where `x1`, `x2`, and `x3` are dummy variables that take on the value 1 if `x1` (`x2`, `x3`) equals 1 (2, 3) and are zero otherwise.

Table 1: Summary statistics df

Group (x)	Share	Average y
1	0.2	12
2	0.3	22
3	0.5	30
Total	1.0	24

3. [6 points] Consider the following data and regression results which study the relationship between income, education and region:

```
##              mean             SD      min       max     N
## inc   51549.4228 16501.6127682 15365.59 119635.7 10000
## edu      11.4173     2.3512791     1.00     18.0 10000
## iq       98.7539    15.2087233    42.00    160.0 10000
## north     0.1949     0.3961435     0.00      1.0 10000
```

```
##                             m1             m2
## Dependent Var.:       log(inc)       log(inc)
##
## edu              0.093 (0.001)  0.061 (0.001)
## north                          -0.007 (0.025)
## edu x north                    -0.050 (0.003)
## Constant          9.73 (0.013)   10.2 (0.013)
## ---------------- ------------- --------------
## S.E. type                  IID            IID
## R2                       0.406          0.657
## Observations            10,000         10,000
```

(a) State and interpret the point estimate of the coefficient on `edu` in the first regression (`m1`)

(b) Compute the p-value for the coefficient on `edu` in the first regression. Is it economically and statistically significant?

(c) Suppose you add variable `iq` to the first regression `m1`. Predict qualitatively what will likely happen to the estimate of the coefficient on `edu` and explain why (hint: OVB formula).

(d) Consider the second regression `m2`. Test the null hypothesis that the coefficient on `edu x north` is zero against the two-sided alternative. What does this tell you about the return to education in the north?

(e) What is the expected log-income difference between North and non-North adults who each have 12 years of schooling?

(f) Describe how to obtain a standard error for the difference in part (e) by running a single additional regression.

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4. [4 points] Revascularization is a medical procedure designed to restore blood flow to tissues or organs when it has been blocked or severely reduced. The following table shows results from Angrist, et al. (2025, NEJM) who analyze a randomized control trial (RCT), that compared conservative and invasive (revascularization) strategies for management of coronary artery disease. Participants were randomly assigned to revascularization, but many assigned to invasive treatment were not revascularized as planned, and participants not assigned revascularization (but to conservative treatment) crossed over to revascularization.

Outcome measure	Control mean	Reduced-form (ITT)	First-stage (compliance)	Per-protocol (as-treated)
SAQ angina-frequency score	90.36	3.69	0.683	3.95
	(15.94)	(0.421)	(0.011)	(0.424)

The outcome here is an angina (chest pain or pressure) frequency score. The first column reports averages and standard deviation (in parentheses). The other columns report reduced form, first-stage estimates, and the per-protocol (as-treated) treatment effect estimates (standard errors in parentheses), the latter which compares participants by treatment received (revascularization vs. conservative treatment).

(a) Interpret the reduced form, first-stage and per-protocol (as-treated) estimates. What do you need to assume for these to be causal?

(b) Construct and interpret the instrumental variable estimate of the effect of revascularization. What do you need to assume for this to be causal?

Critical Values for the $F_{m,\infty}$ Distribution

```
## Rows denote degrees of freedom (m), and columns significance level (%)

##          10%     5%     1%

##
##  1 :  2.7055 3.8415 6.6349
##  2 :  2.3026 2.9957 4.6052
##  3 :  2.0838 2.6049 3.7816
##  4 :  1.9449 2.3719 3.3192
##  5 :  1.8473 2.2141 3.0173
##  6 :  1.7741 2.0986 2.8020
##  7 :  1.7167 2.0096 2.6393
##  8 :  1.6702 1.9384 2.5113
##  9 :  1.6315 1.8799 2.4073
##  10 :  1.5987 1.8307 2.3209
##  11 :  1.5705 1.7886 2.2477
##  12 :  1.5458 1.7522 2.1847
##  13 :  1.5240 1.7202 2.1299
##  14 :  1.5046 1.6918 2.0815
##  15 :  1.4871 1.6664 2.0385
##  16 :  1.4714 1.6435 2.0000
##  17 :  1.4570 1.6228 1.9652
##  18 :  1.4439 1.6038 1.9336
##  19 :  1.4318 1.5865 1.9048
##  20 :  1.4206 1.5705 1.8783
##  21 :  1.4102 1.5557 1.8539
##  22 :  1.4006 1.5420 1.8313
##  23 :  1.3916 1.5292 1.8104
##  24 :  1.3832 1.5173 1.7908
##  25 :  1.3753 1.5061 1.7726
##  26 :  1.3678 1.4956 1.7554
##  27 :  1.3608 1.4857 1.7394
##  28 :  1.3541 1.4763 1.7242
##  29 :  1.3478 1.4675 1.7099
##  30 :  1.3419 1.4591 1.6964
```

The Cumulative Standard Normal Distribution Function, $\Phi(z) \equiv \Pr(Z \leq z)$

```
## Rows denote 1st decimal value of z, and columns 2nd decimal value of z

## So for example, P(Z <= 1.08) = 0.86
```

	0	1	2	3	4	5	6	7	8	9
0.0 :	0.500	0.504	0.508	0.512	0.516	0.520	0.524	0.528	0.532	0.536
0.1 :	0.540	0.544	0.548	0.552	0.556	0.560	0.564	0.567	0.571	0.575
0.2 :	0.579	0.583	0.587	0.591	0.595	0.599	0.603	0.606	0.610	0.614
0.3 :	0.618	0.622	0.626	0.629	0.633	0.637	0.641	0.644	0.648	0.652
0.4 :	0.655	0.659	0.663	0.666	0.670	0.674	0.677	0.681	0.684	0.688
0.5 :	0.691	0.695	0.698	0.702	0.705	0.709	0.712	0.716	0.719	0.722
0.6 :	0.726	0.729	0.732	0.736	0.739	0.742	0.745	0.749	0.752	0.755
0.7 :	0.758	0.761	0.764	0.767	0.770	0.773	0.776	0.779	0.782	0.785
0.8 :	0.788	0.791	0.794	0.797	0.800	0.802	0.805	0.808	0.811	0.813
0.9 :	0.816	0.819	0.821	0.824	0.826	0.829	0.831	0.834	0.836	0.839
1.0 :	0.841	0.844	0.846	0.848	0.851	0.853	0.855	0.858	0.860	0.862
1.1 :	0.864	0.867	0.869	0.871	0.873	0.875	0.877	0.879	0.881	0.883
1.2 :	0.885	0.887	0.889	0.891	0.893	0.894	0.896	0.898	0.900	0.901
1.3 :	0.903	0.905	0.907	0.908	0.910	0.911	0.913	0.915	0.916	0.918
1.4 :	0.919	0.921	0.922	0.924	0.925	0.926	0.928	0.929	0.931	0.932
1.5 :	0.933	0.934	0.936	0.937	0.938	0.939	0.941	0.942	0.943	0.944
1.6 :	0.945	0.946	0.947	0.948	0.949	0.951	0.952	0.953	0.954	0.954
1.7 :	0.955	0.956	0.957	0.958	0.959	0.960	0.961	0.962	0.962	0.963
1.8 :	0.964	0.965	0.966	0.966	0.967	0.968	0.969	0.969	0.970	0.971
1.9 :	0.971	0.972	0.973	0.973	0.974	0.974	0.975	0.976	0.976	0.977
2.0 :	0.977	0.978	0.978	0.979	0.979	0.980	0.980	0.981	0.981	0.982
2.1 :	0.982	0.983	0.983	0.983	0.984	0.984	0.985	0.985	0.985	0.986
2.2 :	0.986	0.986	0.987	0.987	0.987	0.988	0.988	0.988	0.989	0.989
2.3 :	0.989	0.990	0.990	0.990	0.990	0.991	0.991	0.991	0.991	0.992
2.4 :	0.992	0.992	0.992	0.992	0.993	0.993	0.993	0.993	0.993	0.994
2.5 :	0.994	0.994	0.994	0.994	0.994	0.995	0.995	0.995	0.995	0.995
2.6 :	0.995	0.995	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.996
2.7 :	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.997
2.8 :	0.997	0.998	0.998	0.998	0.998	0.998	0.998	0.998	0.998	0.998
2.9 :	0.998	0.998	0.998	0.998	0.998	0.998	0.998	0.999	0.999	0.999

The Inverse of the Cumulative Standard Normal Distribution Function, $\Phi^{-1}(q)$

```
## Rows denote 1st decimal value of q, and columns 2nd decimal value of q

## So for example for P(Z <= z) = 0.86, z is (approximately) 1.08
```

	0	1	2	3	4	5	6	7	8	9
0.0 :	-Inf	-2.33	-2.05	-1.88	-1.75	-1.64	-1.55	-1.48	-1.41	-1.34
0.1 :	-1.28	-1.23	-1.17	-1.13	-1.08	-1.04	-0.99	-0.95	-0.92	-0.88
0.2 :	-0.84	-0.81	-0.77	-0.74	-0.71	-0.67	-0.64	-0.61	-0.58	-0.55
0.3 :	-0.52	-0.50	-0.47	-0.44	-0.41	-0.39	-0.36	-0.33	-0.31	-0.28
0.4 :	-0.25	-0.23	-0.20	-0.18	-0.15	-0.13	-0.10	-0.08	-0.05	-0.03
0.5 :	0.00	0.03	0.05	0.08	0.10	0.13	0.15	0.18	0.20	0.23
0.6 :	0.25	0.28	0.31	0.33	0.36	0.39	0.41	0.44	0.47	0.50
0.7 :	0.52	0.55	0.58	0.61	0.64	0.67	0.71	0.74	0.77	0.81
0.8 :	0.84	0.88	0.92	0.95	0.99	1.04	1.08	1.13	1.17	1.23
0.9 :	1.28	1.34	1.41	1.48	1.55	1.64	1.75	1.88	2.05	2.33