ECO220Y1Y, Test #1, Prof. Murdock

October 27, 2023, 9:10 am – 11:00 am

- Keep ALL pages closed and face up on your desk until we announce the start, and only then you may detach the *Supplement*, which has the aid sheets and readings, figures, tables, and other materials for some test questions.
- There are 8 test pages with 7 questions, with varying numbers of parts, worth a total of 95 points.
- You have 110 minutes. You must stay for a minimum of 60 minutes.

Instructions:

- For each question referencing the *Supplement*, carefully review *all* materials. The ***Supplement is NOT collected:*** write your answers on the test papers. At the end, hand in your test papers (you keep the *Supplement*).
- Write your answers clearly, completely, and concisely in the designated space provided immediately after each question. An answer guide ends each question to let you know what is expected. For example, a quantitative analysis, a fully labelled graph, and/or sentences. Any answer guide asking for a quantitative analysis *always* automatically means that you must show your work and make your reasoning clear.
    - Anything requested by the question and/or the answer guide is required. Focus on those expectations.
    - Marking TAs are instructed to accept all reasonable rounding.
- ***Your entire answer must fit in the designated space provided immediately after each question.*** No extra space/pages are possible. You *cannot* use blank space for other questions, nor can you write answers on the *Supplement*. ***Write in PENCIL and use an ERASER as needed*** so that you can fit your final answer (including work and reasoning) in the appropriate space. We give more blank space than is needed for each answer (with typical handwriting) worth full marks. ***Follow the answer guides and avoid excessively long answers.***

(1) See ***Supplement for Question (1)***: *Ontario Salary Disclosure Data.*

(a) [9 pts] Draw a box plot of the salary variable. Answer with a fully labelled graph.

(b) [5 pts] Of the _____ [#] employees of the Ontario Court of Justice with their 2022 salary disclosed, _____% [#] have a salary above $385,000. The single most common salary is _____ [# with units] and at least _____% [#] of the employees have this salary exactly. Further, _____ [about 68.3% / about 75% / about 89% / about 95.4% / about 99.7% / exactly 100%] of these employees have a salary within two standard deviations of the mean. Answer by filling in the blanks.

(2) See ***Supplement for Question (2)***: *Survey of ECO220Y Students, Competitiveness.*

(a) [4 pts] Compute the sample mean. Answer with a quantitative analysis.

(b) [5 pts] Two formulae suggesting the number of bins for a histogram are: $\sqrt{n}$ and $\frac{10\ln(n)}{\ln(10)}$. All things considered, for the competitiveness variable, what is the best number of bins? Justify your proposed number. Answer with 2 sentences.

(3) See ***Supplement for Question (3)***: *Four Facts About ESG Beliefs and Investor Portfolios.*

(a) [2 pts] In **Panel (a)** of Figure A.1, the best estimate of the 95th percentile is _____ [9 / 12 / 18 / 21 / 25] and the best estimate of the standard deviation is _____ [1.0 / 5.6 / 12.4 / 15.0 / 22.1]. Answer by filling in the blanks.

(b) [10 pts] For this question, focus on **Panel (b)** of Figure A.1 (and *not* Panel (a)). The median is -1. *Interpret* that median. Next, *interpret* the tallest bar. Finally, what is the overall message of this panel? Answer with 4 sentences.

(4) See ***Supplement for Question (4)***: *PWT 10.0.*

(a) [3 pts] For the data in asiap_rates_pwt_100.xlsx, what is the *unit of observation*? Answer with 1 sentence.

(b) [6 pts] *Interpret* 0.3913. Answer with 2 – 3 sentences.

(5) See ***Supplement for Question (5)***: *2023 World Happiness Report Data.*

(a) [5 pts] The whr_2023.xlsx data are _____ [experimental / observational] and are _____ [cross sectional / panel / time series]. The subset of those data used to estimate Regression #1 are _____ [cross sectional / panel / time series], the subset of those data used to estimate Regression #2 are _____ [cross sectional / panel / time series] and the subset of those data used to estimate Regression #3 are _____ [cross sectional / panel / time series]. Answer by filling in the blanks.

(b) [8 pts] *Interpret* the intercept and slope for **Regression #1**. Answer with 2 – 3 sentences.

(c) [6 pts] *Interpret* the slope for **Regression #2**. Answer with 2 – 3 sentences.

(d) [4 pts] *Interpret* the R-squared for **Regression #3**. Answer with 1 sentence.

(6) See ***Supplement for Question (6)***: *Qualities to Encourage Children to Learn.*

(a) [6 pts] Is the figure a histogram? *Explain.* Answer with 2 – 3 sentences.

(b) [8 pts] *Interpret* the difference between the first two bars. Answer with 2 – 3 sentences.

(7) See ***Supplement for Question (7)***: *Bitcoin and Carbon Dioxide Emissions: Evidence from Daily Production Decisions.*

(a) [8 pts] *Interpret* 0.010. Answer with 1 sentence.

(b) [6 pts] If we apply a natural log transformation to both the dependent and explanatory variable in Column (1), then instead of 0.010 the value 0.21 would appear. *Interpret* 0.21. (Presume your reader sees what you wrote for (a), so do not be repetitive). Answer with 1 sentence.

Sample mean: $\bar{X} = \frac{\sum_{i=1}^{n} x_i}{n}$ **Sample variance:** $s^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{X})^2}{n-1} = \frac{\sum_{i=1}^{n} x_i^2}{n-1} - \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n(n-1)}$ **Sample s.d.:** $s = \sqrt{s^2}$

Sample coefficient of variation: $CV = \frac{s}{\bar{X}}$ **Sample covariance:** $s_{xy} = \frac{\sum_{i=1}^{n}(x_i - \bar{X})(y_i - \bar{Y})}{n-1} = \frac{\sum_{i=1}^{n} x_i y_i}{n-1} - \frac{\left(\sum_{i=1}^{n} x_i\right)\left(\sum_{i=1}^{n} y_i\right)}{n(n-1)}$

Sample interquartile range: $IQR = Q3 - Q1$ **Sample coefficient of correlation:** $r = \frac{s_{xy}}{s_x s_y} = \frac{\sum_{i=1}^{n} z_{x_i} z_{y_i}}{n-1}$

<u>SIMPLE REGRESSION</u>: OLS line: $\hat{y}_i = b_0 + b_1 x_i \quad b_1 = \frac{s_{xy}}{s_x^2} = r\frac{s_y}{s_x} \quad b_0 = \bar{Y} - b_1 \bar{X}$

Residuals: $e_i = y_i - \hat{y}_i$ **Standard deviation of residuals:** $s_e = Root\ MSE = \sqrt{\frac{SSE}{n-2}} = \sqrt{\frac{\sum_{i=1}^{n}(e_i - 0)^2}{n-2}}$

$SST = \sum_{i=1}^{n}(y_i - \bar{Y})^2 = SSR + SSE \quad SSR = \sum_{i=1}^{n}(\hat{y}_i - \bar{Y})^2 \quad SSE = \sum_{i=1}^{n} e_i^{\,2} = \sum_{i=1}^{n}(y_i - \hat{y}_i)^2$

$s_y^2 = \frac{SST}{n-1}$ **Coefficient of determination:** $R^2 = (r)^2 = \frac{SSR}{SST} = 1 - \frac{SSE}{SST}$

Supplement for Question (1): Recall the 2023 Ontario public disclosure of salary data for all public sector employees earning $100,000 CAN or more in the 2022 calendar year. The variable named salary is in $1,000s of Canadian dollars. The Stata summary below is for the subset who are employees of the Ontario Court of Justice.

```
                          salary
-------------------------------------------------------------
      Percentiles      Smallest
 1%     111.526        100.043
 5%      138.25        101.712
10%     165.501        103.914       Obs                 619
25%     166.926        104.088       Sum of Wgt.         619

50%     183.908                      Mean           248.7966
                       Largest       Std. Dev.      91.51561
75%     347.139        380.022
90%     347.139        389.087       Variance       8375.107
95%     347.139        397.702       Skewness       .1044681
99%     367.565        398.284       Kurtosis        1.15113
```

Supplement for Question (2): For the students in ECO220Y in September 2023 who answered the self-assessed competitiveness level survey question, see the tabulation below.

comp	Freq.	Percent	Cum.
0	10	1.92	1.92
1	3	0.58	2.50
2	6	1.15	3.65
3	16	3.08	6.73
4	24	4.62	11.35
5	66	12.69	24.04
6	67	12.88	36.92
7	135	25.96	62.88
8	113	21.73	84.62
9	52	10.00	94.62
10	28	5.38	100.00
Total	520	100.00	

Supplement for Question (3): Consider a 2023 *NBER Working Paper* "Four Facts About ESG Beliefs and Investor Portfolios." The first sentence of the paper explains what "ESG" stands for: "The last decade has seen a dramatic growth in investment approaches that consider assets' environmental, social, and governance (ESG) characteristics, and by the end of 2022, sustainability-focused funds had more than $2.5 trillion in global assets under management (Bioy et al., 2023)." The first part of the abstract is reproduced below.

> **Abstract:** We analyze survey data on ESG beliefs and preferences in a large panel of retail investors linked to administrative data on their investment portfolios. The survey elicits investors' expectations of long-term ESG equity returns … We document four facts. First, investors generally expected ESG investments to underperform the market.

The GMSU-Vanguard survey asks many questions of a random sample of Vanguard's U.S.- based investors. (Vanguard is an asset management firm.) Two questions that are relevant for Figure A.1 are reproduced below.

- What do you expect the average annual return on the US stock market to be over the next 10 years? (Please answer only with a positive or negative numeric value with at most 1 decimal.)

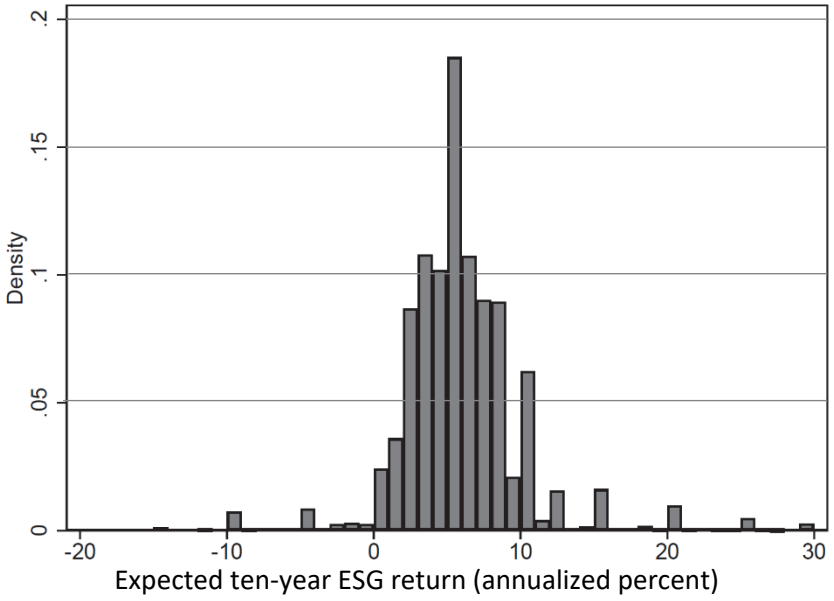
  _____% per year, over the next 10 years

- What do you expect the average annual return of a diversified US ESG equity portfolio to be over the next 10 years? (Please answer only with a positive or negative numeric value with at most 1 decimal.)

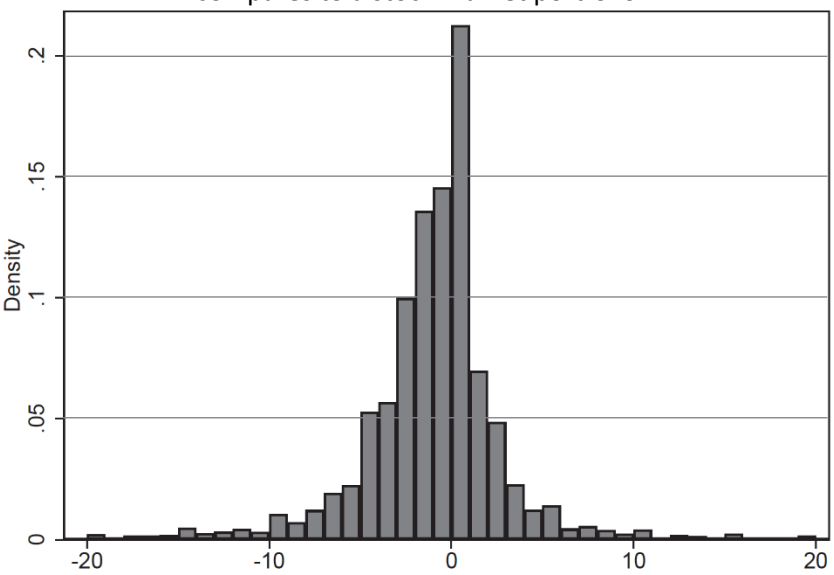
  _____% per year, over the next 10 years

Figure A.1: Histograms of Answers to ESG Expected 10-Year Returns

(a) Expected return for an environmental, social, and governance (ESG) portfolio



(b) How the expected return for an ESG portfolio compares to a stock market portfolio



Note: Figure reports the histograms of the answers from the GMSU-Vanguard survey about the 10-year (average annualized) expected returns of a US ESG portfolio (panel (a), top) and the difference in returns compared to the US stock market (panel (b), bottom).

The researchers have about 18,000 completed surveys from the period starting June 2021 through December 2022. The average annual expected return for the US stock market (the first of the two survey questions above) is 6.98% and the average annual expected return for the US ESG equity portfolio is 5.60% (the second of the two survey questions above).

Supplement for Question (4): Recall the Penn World Tables, 10.0. For the DACM dataset asiap_rates_pwt_100.xlsx, in the readme tab, r_2000_10 is "Estimated annual growth rate of GDP per capita from 2000 to 2010," r_1990_00 is "Estimated annual growth rate of GDP per capita from 1990 to 2000," and so on. For observations with non-missing values for all the variables below, see the correlation matrix. One value is in boldface for easy reference.

(obs=66)

	r_1950_60	r_1960_70	r_1970_80	r_1980_90	r_1990_00	r_2000_10
r_1950_60	1.0000					
r_1960_70	0.3717	1.0000				
r_1970_80	0.0600	0.3414	1.0000			
r_1980_90	-0.0593	0.4429	**0.3913**	1.0000		
r_1990_00	-0.0933	0.3295	0.3885	0.4456	1.0000	
r_2000_10	-0.2867	-0.2227	0.0582	-0.0887	0.2549	1.0000

Supplement for Question (5): The readme worksheet for the DACM dataset whr_2023.xlsx is reproduced below.

obs: 2,199
vars: 11

variable name	variable label
country	Name of country
year	Year
lifeladder	Average Cantril life ladder (0 worst to 10 best) survey answer
ln_gdp_pc	Natural log of GDP per capita (PPP constant 2017 international dollar prices)
soc_support	Proportion of survey respondents with relatives/friends can count on for help
healthy_le	Healthy life expectancy (in years) at birth
freedom	Proportion of survey respondents satisfied with freedom to make life choices
corruption	Average 2 survey questions (0 or 1) if corruption widespread, gov't and business
pos_affect	Positive affect: mean 3 survey questions (0 or 1) on happiness, laughing, enjoy
neg_affect	Negative affect: mean 3 survey questions (0 or 1) on worry, sadness, anger
oecd	Dummy variable = 1 if member of OECD and = 0 otherwise

Sorted by: country year

Consider Regression #1 below that uses the data for all countries with non-missing values for happiness for 2022 and 2007. The variable dum_2022 is a dummy equal to one for 2022 and zero otherwise.

Regression #1: cantril-hat = 5.512316 + 0.1774885*dum_2022, R-squared = 0.0065, n = 158

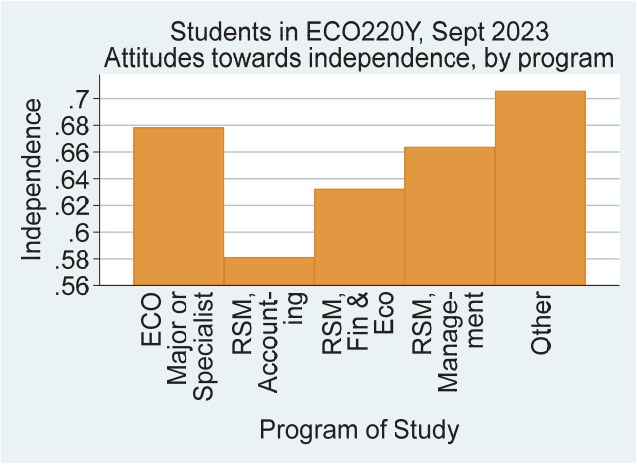
Consider Regression #2 below that uses the data for India with non-missing values for both happiness and economic output for 2005 through 2022.

Regression #2: cantril-hat = 23.388650 - 2.229301*ln_gdp_pc, R-squared = 0.8502, n = 17

Consider Regression #3 below that uses the data for all countries with non-missing values for both happiness and economic output for 2022.

Regression #3: cantril-hat = -2.163906 + 0.8162397*ln_gdp_pc, R-squared = 0.6327, n = 108

Supplement for Question (6): Recall the survey of students in ECO220Y in September 2023. One question asked "Here is a list of qualities that children can be encouraged to learn at home. Which, if any, do you consider to be especially important? Please choose up to five!" It offered 11 qualities including, for example, independence, hardwork, and obedience. Another question asked about the student's primary program of study with a multiple-choice format. See the figure to the right.



Supplement for Question (7): Consider a 2023 *NBER Working Paper* "Bitcoin and Carbon Dioxide Emissions: Evidence from Daily Production Decisions." Over the study period, the mean daily Bitcoin price is $21,140 USD and on average the Scrubgrass Power Plant emits 1,059 metric tons of CO2 per day. One value in Table A5 is in boldface for easy reference.

> **Abstract, excerpt:** Environmental externalities from cryptomining may be large, but have not been linked causally to mining incentives. We exploit daily variation in Bitcoin price as a natural experiment for an 86 megawatt coal-fired power plant with on-site cryptomining. We find that carbon emissions respond swiftly to mining incentives … Our study highlights both the revitalization of US fossil assets and the potential value of financial industry accounting standards that incorporate cryptomining externalities.
>
> **Excerpt, pp. 2-3:** [We focus] on an integrated electricity generator-cryptominer. We argue cryptomining at the Scrubgrass power plant in Pennsylvania presents a unique opportunity to study the marginal carbon emissions from Bitcoin mining due to the planned retirement of the plant in the absence of the cryptocurrency mining agreement. Coupled with the fact that Bitcoin mining is conducted on-site with power generated at the facility, this means that the plant's carbon emissions are marginal emissions of the on-site cryptomining activity. We account for the changing computing power requirements of mining each new Bitcoin block in multiple ways. In our main regression framework, the dependent variable is daily carbon dioxide emissions at the Scrubgrass plant and the independent variable of interest is daily Bitcoin price.

Table A5: Daily Bitcoin Price and CO2 Emissions at Scrubgrass Power Plant

Explanatory variables:	*Dependent variable:* Carbon Dioxide (CO2) Emissions (Metric Tons)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bitcoin Price ($)	**0.010***** (0.001)	0.005*** (0.001)	0.020*** (0.001)	0.005*** (0.001)	0.019*** (0.001)	0.016*** (0.003)	0.020*** (0.003)
Year fixed effects						✓	✓
Month of the year fixed effects						✓	✓
Days of the week fixed effects				✓	✓	✓	✓
Coal price		✓	✓	✓	✓	✓	✓
Local electricity price		✓		✓		✓	
Electricity needed to mine Bitcoin			✓		✓		✓
Outdoor temperature						✓	✓
Observations	1,796	1,796	1,796	1,796	1,796	1,796	1,796

Notes: Each column shows results for a separate regression of carbon dioxide emissions on daily Bitcoin price for May 2018 – March 2023, where any included control variables are indicated. Standard errors are in parenthesis. * p<0.005, ** p<0.01, *** p<0.001. *Note from Prof. Murdock:* You have not yet studied standard errors, statistical tests, and OLS estimates in Columns (2) through (7). Those are in grey font, and you should *not* discuss those items in your answers.