ECO220Y1Y, Term Test #4, Prof. Murdock

March 2, 2018, 9:10 – 11:00 am

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Instructions:

- You have 110 minutes. Keep these test papers and the *Supplement* closed and face up on your desk until the start of the test is announced. You must stay for a minimum of 60 minutes.
- You may use a non-programmable calculator.
- There are 6 questions (some with multiple parts) with varying point values worth a total of 100 points.
- This test includes these 8 pages plus the *Supplement*. The *Supplement* contains formula sheets, the Standard Normal table, the Student t table, and necessary materials for some test questions.
    - The *Supplement* will *not* be graded. We will only collect these test papers, not 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 (which shows your work), a fully-labelled graph, and/or sentences.
    - Anything requested by the question and/or the answer guide is required.
    - Similarly, limit yourself to the answer guide. For example, if the answer guide does not request sentences, provide only what is requested (e.g. quantitative analysis). Leave yourself time to complete all questions rather than overdoing some questions and running out of time.
    - For questions with multiple parts (e.g. (a) – (d)), ***attempt each part***.
- ***Unless otherwise specified, you choose the significance level. Absent any special considerations, you may choose α = 0.05.***
- ***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.*** This way you can make sure to fit your final answer (including work and reasoning) in the appropriate space. Most questions give more blank space than is needed to answer. ***Follow the answer guides and avoid excessively long answers.***

(1) See ***Supplement for Question (1)***: *Differences in Professors' Salaries by Sex at Waterloo.*

(a) [6 pts] What is the full interpretation of 12.748? Answer with 1 precise sentence that would be clear to someone who *has not read* the supplement.

(b) [4 pts] If salary were regressed on a dummy variable for females (i.e. Female equals 1 for a female professor and equals 0 for a male professor), what would the regression results be? Answer with the OLS results in equation form.

(c) [4 pts] What is the interpretation of 0.084? Answer with 1 precise sentence that would make sense to someone who has already read the sentence you wrote for Part (a).

(2) See ***Supplement for Question (2)***: *Gender Gaps among Lawyers.*

(a) [9 pts] Consider Table 1 and the "Law school ranking" row. Given that the test statistic is -1.38 and the degrees of freedom are 826, does the P-value column refer to one- or two-tailed tests? Explain and reference the appropriate table. <u>Answer with formal hypotheses, 1 – 2 sentences & do *not* recompute the given values of -1.38 and 826.</u>

(b) [5 pts] Use the "Marriage" row of results in Table 1. Do marriage rates differ by sex in a *statistically significant* way? If so, at which significance levels? Is the difference *economically significant*? <u>Answer with 2 sentences.</u>

(c) [5 pts] Use the "Tenure (years)" results in Table 1. Do years of tenure differ by sex in a *statistically significant* way? If so, at which significance levels? Is the difference *economically significant*? <u>Answer with 2 sentences.</u>

(d) [10 pts] How large is the difference in the number of children between male and female lawyers? Answer with an appropriate confidence interval and interpret the interval. Answer with a quantitative analysis & 1 sentence that would be clear to someone *who has read* the supplement.

(e) [8 pts] Given the 441 female lawyers, to statistically prove that more than one fifth of all female lawyers in the target population have the highest level of aspirations (10 out of 10), how large of a sample proportion is needed? Answer with a quantitative analysis & 1 sentence.

(3) [12 pts] See ***Supplement for Question (3)***: *Cars making life-and-death decisions: sacrifice passenger or save pedestrians?* Recall that each participant assessed *one* of the five lives-saved scenarios (selected at random) and *not each* of the five, which makes the sample size for each lives-saved scenario about 90 (≈ 451/5), not 451. For what AV's *should* do, compute the 90% confidence interval estimate of the difference in the proportion who agree for the 5 versus 20 lives saved scenarios. *Fully interpret* the interval and discuss its width. Answer with a quantitative analysis & 2 – 3 sentences that would be clear to someone who *has not read* the supplement.

(4) See ***Supplement for Question (4)***: *Paying Down Credit Card Debt in Suboptimal Ways.*

(a) [12 pts] Is the mean percent of the total monthly payment *actually* allocated to the high APR card *statistically significantly* higher than 50%? (Recall that 50% corresponds to being completely unresponsive to relative interest rates on the two cards.) Include the P-value. Next, is the result *economically significant*? Explain what the results for statistical significance and economic significance mean and *why* they came out this way. Answer with formal hypotheses, a quantitative analysis & 2 – 3 sentences that would be clear to someone who *has read* the supplement.

(b) [9 pts] To make an inference about the size of the difference between the mean optimal and mean actual payment in pounds (£), what is wrong with using: $(377.30 - 259.76) \pm 1.960\sqrt{\frac{849.70^2}{394{,}111} + \frac{733.92^2}{394{,}111}}$? After explaining what is wrong, identify the correct set up. However, you are *not* asked to compute and interpret the correct final answer. Answer with 1 – 2 sentences, the correct formula & the values to plug into it.

(5) [6 pts] Vitamin D may protect against the flu. Suppose OHIP wishes to prove that notification letters (in the mail) increase the fraction of individuals taking vitamin D supplements. What would a Type I error be? What would a Type II error be? Answer with 2 sentences. Be context-specific (i.e. *apply* the concepts and go beyond generic definitions).

(6) [10 pts] Recall the NBER Working Paper 20573 "Asiaphoria Meets Regression to the Mean" by Pritchett and Summers (2014) and Table 1 (excerpt below). It uses the Penn World Table (PWT) version 8.0 data. Suppose a new version has annual real GDP per capita for 160 countries from 1996 through 2016, which is 3,360 observations of the real GDP per capita variable. This is *the raw data*. Consider the research question: across countries, how well do GDP per capita growth rates in the decade from 1996 to 2006 predict GDP per capita growth rates in the decade from 2006 to 2016? Answering involves running a regression like the one reported in Table 1 but with 160 observations, instead of 142, and for the periods 1996 – 2006 and 2006 – 2016, instead of 1990 – 2000 and 2000 – 2010.

Table 1: Little persistence in cross-national growth rates across decades						
Period 1	Period 2	Correlation	Rank Correlation	Regression Coefficient	R-squared	N
1990 – 2000	2000 – 2010	0.237	0.289	0.205	0.056	142
Source: Author's calculations with PWT8.0 data (Feenstra, Inklaar and Timmer (2013)).						

Following the approach of Pritchett and Summers (2014), but with the new version of data and the research question above, how many regressions must be run on *the raw data* ($n = 3{,}360$) to build *the data* ($n = 160$) on which to run the regression like in Table 1? Next, for *each* of those regressions run on *the raw data*, what are the y and x variables and what is the sample size? Finally, what do we need to take from the regressions run on *the raw data* so that we can build *the data* ($n = 160$) on which to run the regression like in Table 1? Answer with 3 – 4 sentences.

This *Supplement* contains formula sheets, the Standard Normal table, the Student t table, and necessary materials for some test questions. For each question referencing this *Supplement*, carefully review *all* materials, noticing continuations onto the next page.

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:** $s_{xy} = \frac{\sum_{i=1}^{n}(x_i - \bar{X})(y_i - \bar{Y})}{n-1} = \frac{\sum_{i=1}^{n} x_i y_i}{n-1} - \frac{(\sum_{i=1}^{n} x_i)(\sum_{i=1}^{n} y_i)}{n(n-1)}$

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

Expected value: $E[X] = \mu = \sum_{all\ x} x p(x)$ **Variance:** $V[X] = E[(X-\mu)^2] = \sigma^2 = \sum_{all\ x}(x-\mu)^2 p(x)$

Covariance: $COV[X,Y] = E[(X-\mu_X)(Y-\mu_Y)] = \sigma_{XY} = \sum_{all\ x}\sum_{all\ y}(x-\mu_X)(y-\mu_Y)p(x,y)$

Laws of expected value:

$E[c] = c$

$E[X + c] = E[X] + c$

$E[cX] = cE[X]$

$E[a + bX + cY] = a + bE[X] + cE[Y]$

Laws of variance:

$V[c] = 0$

$V[X + c] = V[X]$

$V[cX] = c^2 V[X]$

$V[a + bX + cY] = b^2 V[X] + c^2 V[Y] + 2bc * COV[X,Y]$

$V[a + bX + cY] = b^2 V[X] + c^2 V[Y] + 2bc * SD(X) * SD(Y) * \rho$

where $\rho = CORRELATION[X,Y]$

Laws of covariance:

$COV[X,c] = 0$

$COV[a + bX, c + dY] = bd * COV[X,Y]$

Sampling distribution of $\bar{X}$:

$\mu_{\bar{X}} = E[\bar{X}] = \mu$

$\sigma_{\bar{X}}^2 = V[\bar{X}] = \frac{\sigma^2}{n}$

$\sigma_{\bar{X}} = SD[\bar{X}] = \frac{\sigma}{\sqrt{n}}$

Sampling distribution of $\hat{P}$:

$\mu_{\hat{P}} = E[\hat{P}] = p$

$\sigma_{\hat{P}}^2 = V[\hat{P}] = \frac{p(1-p)}{n}$

$\sigma_{\hat{P}} = SD[\hat{P}] = \sqrt{\frac{p(1-p)}{n}}$

Sampling distribution of $(\hat{P}_2 - \hat{P}_1)$:

$\mu_{\hat{P}_2 - \hat{P}_1} = E[\hat{P}_2 - \hat{P}_1] = p_2 - p_1$

$\sigma_{\hat{P}_2 - \hat{P}_1}^2 = V[\hat{P}_2 - \hat{P}_1] = \frac{p_2(1-p_2)}{n_2} + \frac{p_1(1-p_1)}{n_1}$

$\sigma_{\hat{P}_2 - \hat{P}_1} = SD[\hat{P}_2 - \hat{P}_1] = \sqrt{\frac{p_2(1-p_2)}{n_2} + \frac{p_1(1-p_1)}{n_1}}$

Sampling distribution of $(\bar{X}_1 - \bar{X}_2)$, independent samples:

$\mu_{\bar{X}_1 - \bar{X}_2} = E[\bar{X}_1 - \bar{X}_2] = \mu_1 - \mu_2$

$\sigma_{\bar{X}_1 - \bar{X}_2}^2 = V[\bar{X}_1 - \bar{X}_2] = \frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}$

$\sigma_{\bar{X}_1 - \bar{X}_2} = SD[\bar{X}_1 - \bar{X}_2] = \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$

Sampling distribution of $(\bar{X}_d)$, paired $(d = X_1 - X_2)$:

$\mu_{\bar{X}_d} = E[\bar{X}_d] = \mu_1 - \mu_2$

$\sigma_{\bar{X}_d}^2 = V[\bar{X}_d] = \frac{\sigma_d^2}{n} = \frac{\sigma_1^2 + \sigma_2^2 - 2*\rho*\sigma_1*\sigma_2}{n}$

$\sigma_{\bar{X}_d} = SD[\bar{X}_d] = \frac{\sigma_d}{\sqrt{n}} = \sqrt{\frac{\sigma_1^2 + \sigma_2^2 - 2*\rho*\sigma_1*\sigma_2}{n}}$

Inference about a population proportion:

***z* test statistic:** $z = \frac{\hat{P} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$ **CI estimator:** $\hat{P} \pm z_{\alpha/2}\sqrt{\frac{\hat{P}(1-\hat{P})}{n}}$

<u>Inference about comparing two population proportions</u>:

***z* test statistic under Null hypothesis of no difference:** $z = \frac{\hat{P}_2 - \hat{P}_1}{\sqrt{\frac{\bar{P}(1-\bar{P})}{n_1} + \frac{\bar{P}(1-\bar{P})}{n_2}}}$ **Pooled proportion:** $\bar{P} = \frac{X_1 + X_2}{n_1 + n_2}$

CI estimator: $(\hat{P}_2 - \hat{P}_1) \pm z_{\alpha/2}\sqrt{\frac{\hat{P}_2(1-\hat{P}_2)}{n_2} + \frac{\hat{P}_1(1-\hat{P}_1)}{n_1}}$

<u>Inference about the population mean</u>:

***t* test statistic:** $t = \frac{\bar{X} - \mu_0}{s/\sqrt{n}}$ **CI estimator:** $\bar{X} \pm t_{\alpha/2}\frac{s}{\sqrt{n}}$ **Degrees of freedom:** $\nu = n - 1$

<u>Inference about a comparing two population means, independent samples, unequal variances</u>:

***t* test statistic:** $t = \frac{(\bar{X}_1 - \bar{X}_2) - \Delta_0}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$ **CI estimator:** $(\bar{X}_1 - \bar{X}_2) \pm t_{\alpha/2}\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$

Degrees of freedom: $\nu = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{1}{n_1 - 1}\left(\frac{s_1^2}{n_1}\right)^2 + \frac{1}{n_2 - 1}\left(\frac{s_2^2}{n_2}\right)^2}$

<u>Inference about a comparing two population means, independent samples, assuming equal variances</u>:

***t* test statistic:** $t = \frac{(\bar{X}_1 - \bar{X}_2) - \Delta_0}{\sqrt{\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}}}$ **CI estimator:** $(\bar{X}_1 - \bar{X}_2) \pm t_{\alpha/2}\sqrt{\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}}$ **Degrees of freedom:** $\nu = n_1 + n_2 - 2$

Pooled variance: $s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$

<u>Inference about a comparing two population means, paired data:</u> (n is number of pairs and $d = X_1 - X_2$)

***t* test statistic:** $t = \frac{\bar{d} - \Delta_0}{s_d/\sqrt{n}}$ **CI estimator:** $\bar{X}_d \pm t_{\alpha/2}\frac{s_d}{\sqrt{n}}$ **Degrees of freedom:** $\nu = n - 1$

<u>SIMPLE REGRESSION</u>:

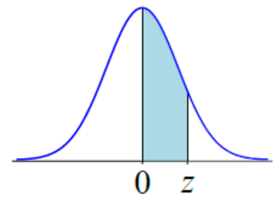
Model: $y_i = \beta_0 + \beta_1 x_i + \varepsilon_i$ **OLS line:** $\hat{y}_i = b_0 + b_1 x_i$ $b_1 = \frac{s_{xy}}{s_x^2} = r\frac{s_y}{s_x}$ $b_0 = \bar{Y} - b_1\bar{X}$

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

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

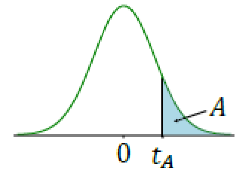
Coefficient of determination: $R^2 = (r)^2$ $R^2 = \frac{SSR}{SST} = 1 - \frac{SSE}{SST}$

$s_y^2 = \frac{SST}{n-1}$ $MSE = \frac{SSE}{n-2}$ $Root\ MSE = \sqrt{\frac{SSE}{n-2}}$



The Standard Normal Distribution:

	Second decimal place in z									
z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990
3.1	0.4990	0.4991	0.4991	0.4991	0.4992	0.4992	0.4992	0.4992	0.4993	0.4993
3.2	0.4993	0.4993	0.4994	0.4994	0.4994	0.4994	0.4994	0.4995	0.4995	0.4995
3.3	0.4995	0.4995	0.4995	0.4996	0.4996	0.4996	0.4996	0.4996	0.4996	0.4997
3.4	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4998
3.5	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998
3.6	0.4998	0.4998	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999

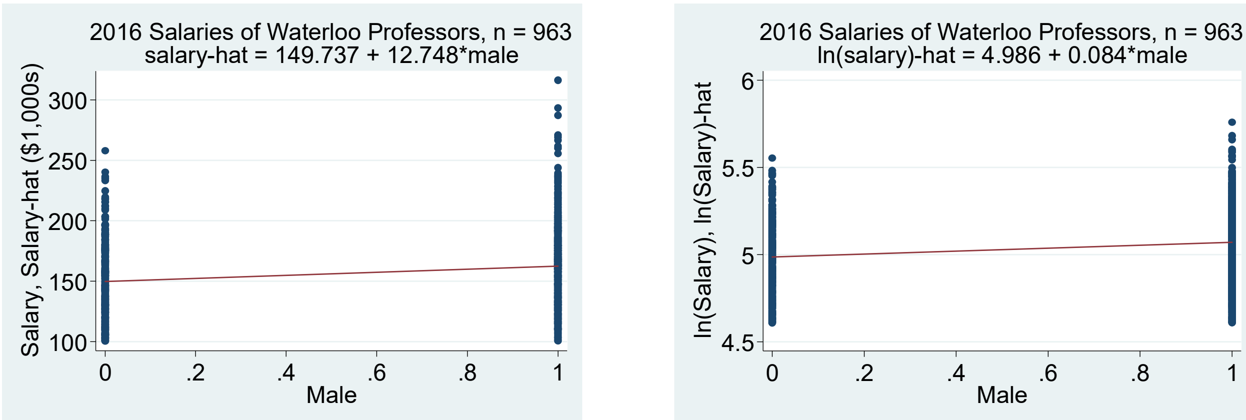


Critical Values of Student t Distribution:

ν	$t_{0.10}$	$t_{0.05}$	$t_{0.025}$	$t_{0.01}$	$t_{0.005}$	$t_{0.001}$	$t_{0.0005}$	ν	$t_{0.10}$	$t_{0.05}$	$t_{0.025}$	$t_{0.01}$	$t_{0.005}$	$t_{0.001}$	$t_{0.0005}$
1	3.078	6.314	12.71	31.82	63.66	318.3	636.6	38	1.304	1.686	2.024	2.429	2.712	3.319	3.566
2	1.886	2.920	4.303	6.965	9.925	22.33	31.60	39	1.304	1.685	2.023	2.426	2.708	3.313	3.558
3	1.638	2.353	3.182	4.541	5.841	10.21	12.92	40	1.303	1.684	2.021	2.423	2.704	3.307	3.551
4	1.533	2.132	2.776	3.747	4.604	7.173	8.610	41	1.303	1.683	2.020	2.421	2.701	3.301	3.544
5	1.476	2.015	2.571	3.365	4.032	5.893	6.869	42	1.302	1.682	2.018	2.418	2.698	3.296	3.538
6	1.440	1.943	2.447	3.143	3.707	5.208	5.959	43	1.302	1.681	2.017	2.416	2.695	3.291	3.532
7	1.415	1.895	2.365	2.998	3.499	4.785	5.408	44	1.301	1.680	2.015	2.414	2.692	3.286	3.526
8	1.397	1.860	2.306	2.896	3.355	4.501	5.041	45	1.301	1.679	2.014	2.412	2.690	3.281	3.520
9	1.383	1.833	2.262	2.821	3.250	4.297	4.781	46	1.300	1.679	2.013	2.410	2.687	3.277	3.515
10	1.372	1.812	2.228	2.764	3.169	4.144	4.587	47	1.300	1.678	2.012	2.408	2.685	3.273	3.510
11	1.363	1.796	2.201	2.718	3.106	4.025	4.437	48	1.299	1.677	2.011	2.407	2.682	3.269	3.505
12	1.356	1.782	2.179	2.681	3.055	3.930	4.318	49	1.299	1.677	2.010	2.405	2.680	3.265	3.500
13	1.350	1.771	2.160	2.650	3.012	3.852	4.221	50	1.299	1.676	2.009	2.403	2.678	3.261	3.496
14	1.345	1.761	2.145	2.624	2.977	3.787	4.140	51	1.298	1.675	2.008	2.402	2.676	3.258	3.492
15	1.341	1.753	2.131	2.602	2.947	3.733	4.073	52	1.298	1.675	2.007	2.400	2.674	3.255	3.488
16	1.337	1.746	2.120	2.583	2.921	3.686	4.015	53	1.298	1.674	2.006	2.399	2.672	3.251	3.484
17	1.333	1.740	2.110	2.567	2.898	3.646	3.965	54	1.297	1.674	2.005	2.397	2.670	3.248	3.480
18	1.330	1.734	2.101	2.552	2.878	3.610	3.922	55	1.297	1.673	2.004	2.396	2.668	3.245	3.476
19	1.328	1.729	2.093	2.539	2.861	3.579	3.883	60	1.296	1.671	2.000	2.390	2.660	3.232	3.460
20	1.325	1.725	2.086	2.528	2.845	3.552	3.850	65	1.295	1.669	1.997	2.385	2.654	3.220	3.447
21	1.323	1.721	2.080	2.518	2.831	3.527	3.819	70	1.294	1.667	1.994	2.381	2.648	3.211	3.435
22	1.321	1.717	2.074	2.508	2.819	3.505	3.792	75	1.293	1.665	1.992	2.377	2.643	3.202	3.425
23	1.319	1.714	2.069	2.500	2.807	3.485	3.768	80	1.292	1.664	1.990	2.374	2.639	3.195	3.416
24	1.318	1.711	2.064	2.492	2.797	3.467	3.745	90	1.291	1.662	1.987	2.368	2.632	3.183	3.402
25	1.316	1.708	2.060	2.485	2.787	3.450	3.725	100	1.290	1.660	1.984	2.364	2.626	3.174	3.390
26	1.315	1.706	2.056	2.479	2.779	3.435	3.707	120	1.289	1.658	1.980	2.358	2.617	3.160	3.373
27	1.314	1.703	2.052	2.473	2.771	3.421	3.690	140	1.288	1.656	1.977	2.353	2.611	3.149	3.361
28	1.313	1.701	2.048	2.467	2.763	3.408	3.674	160	1.287	1.654	1.975	2.350	2.607	3.142	3.352
29	1.311	1.699	2.045	2.462	2.756	3.396	3.659	180	1.286	1.653	1.973	2.347	2.603	3.136	3.345
30	1.310	1.697	2.042	2.457	2.750	3.385	3.646	200	1.286	1.653	1.972	2.345	2.601	3.131	3.340
31	1.309	1.696	2.040	2.453	2.744	3.375	3.633	250	1.285	1.651	1.969	2.341	2.596	3.123	3.330
32	1.309	1.694	2.037	2.449	2.738	3.365	3.622	300	1.284	1.650	1.968	2.339	2.592	3.118	3.323
33	1.308	1.692	2.035	2.445	2.733	3.356	3.611	400	1.284	1.649	1.966	2.336	2.588	3.111	3.315
34	1.307	1.691	2.032	2.441	2.728	3.348	3.601	500	1.283	1.648	1.965	2.334	2.586	3.107	3.310
35	1.306	1.690	2.030	2.438	2.724	3.340	3.591	750	1.283	1.647	1.963	2.331	2.582	3.101	3.304
36	1.306	1.688	2.028	2.434	2.719	3.333	3.582	1000	1.282	1.646	1.962	2.330	2.581	3.098	3.300
37	1.305	1.687	2.026	2.431	2.715	3.326	3.574	∞	1.282	1.645	1.960	2.326	2.576	3.090	3.291

Degrees of freedom: ν

Supplement for Question (1): Recall the 2017 Ontario disclosure of 2016 salaries of public sector employees making at least $100K. Consider those employed at the University of Waterloo with a job title that includes the word Professor (i.e. Assistant, Associate, or Full Professor). The scatter diagrams and OLS regression results below assess salary differences by sex. Male is a dummy variable that equals 1 for a male professor and equals 0 for a female professor.



Supplement for Question (2): Recall the 2017 article in the *Journal of Political Economy* titled "Gender Gaps in Performance: Evidence from Young Lawyers." Below are some excerpts and Figure 3. Table 1 is on the next page. In Table 1, the final column titled p-Value enables testing for differences between male and female lawyers.

EXCERPTS (pp. 1315 – 1318): Our analysis uses data from *After the JD*, a nationally representative, longitudinal survey of lawyers in the United States. Lawyers in the sample are representative of all lawyers first admitted to the bar in 2000. We focus on lawyers who bill hours—the large majority of whom work for private law firms. Table 1 [on next page] reports descriptive statistics for this core sample in 2007. The first measure of performance, hours billed, corresponds to lawyers' total number of hours billed during the year before the survey, 2006. As shown in Table 1, male lawyers bill, on average, 1,826 hours per year, while female lawyers bill 1,677 hours, on average.

EXCERPT (p. 1334): Gender differences in the career aspirations of young lawyers may contribute to differences in performance. When asked to rate, on a scale from 1 to 10, their aspirations to become an equity partner in their firm, 60 percent of male lawyers answered with 8 or more, compared to only 32 percent of female lawyers (see Fig. 3).

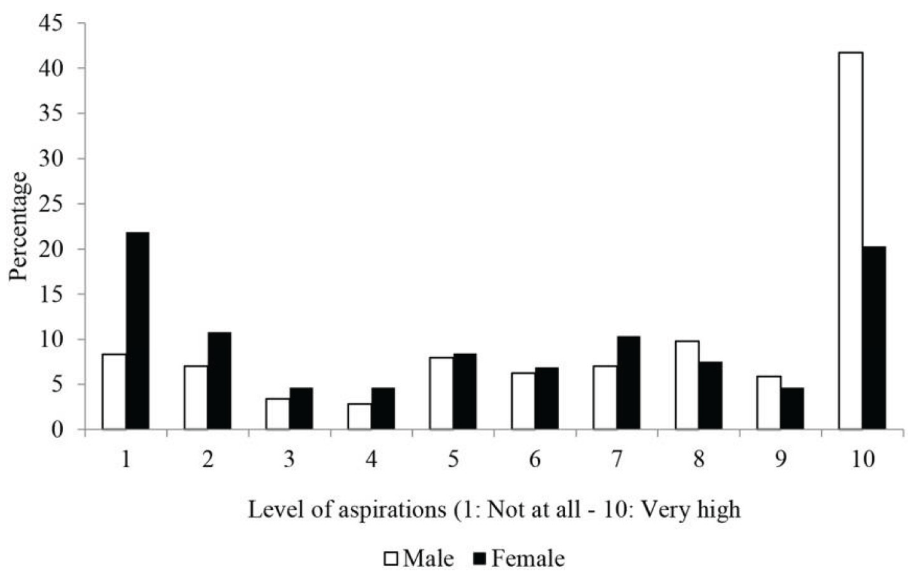


FIG. 3.—Aspirations to become partner. Percentage of responses by gender to the question "How strongly do you aspire to attain an Equity Partner position within your firm?" with possible answers ranging from 1 = not at all to 10 = very high (After the JD study, 2007).

Supplement for Question (2) continues on next page >>>>>

Supplement for Question (2), cont'd:

TABLE 1
DESCRIPTIVE STATISTICS

	Male Lawyers			Female Lawyers			
	Observations	Mean	Standard Deviation	Observations	Mean	Standard Deviation	*p*-Value
Total earnings ($)	684	150,667	74,531	441	132,685	70,282	.00
Hours billed (annual)	684	1,826	535	441	1,677	520	.00
New client revenue ($)	684	53,346	171,965	441	23,349	68,892	.00
Target hours to bill	458	1,827	144	304	1,759	201	.01
Hours worked (per week)	684	54.09	12.80	441	48.83	13.84	.00
Age	684	36.12	4.98	441	35.29	4.92	.01
Marriage	684	.81	.39	441	.75	.43	.02
Children	684	1.22	1.24	441	.82	.91	.00
White	684	.83	.38	441	.75	.43	.00
Tenure (years)	684	5.18	2.49	441	5.26	2.44	.59
Private law firm	684	.92	.27	441	.93	.26	.57
Size of workplace > 100	684	.48	.50	441	.51	.50	.26
Law school ranking	597	4.95	1.08	392	5.05	1.10	.17
Undergraduate university ranking	662	12.89	3.50	435	13.04	3.62	.48
Judicial clerk	684	.02	.15	441	.03	.17	.44
Moot court	684	.32	.47	441	.35	.48	.31
General journal	684	.22	.42	441	.20	.40	.39
Specific journal	684	.20	.40	441	.25	.44	.05

Note.—Total earnings are calculated as a sum of straight salary and bonus (expressed in US dollars). Hours billed (annual) is the number of hours billed last year (2006). New client revenue is the approximate amount of new client revenue (expressed in US dollars) generated last year (2006). Target hours to bill is the total number of hours the lawyer was expected to bill in the previous year (2006) by the law firm for which the lawyer worked, conditional on having a strictly positive number of target hours. Marriage takes the value one if the lawyer is married, remarried after divorce, or in a domestic partnership and zero if single, divorced or separated, widowed, or other. Children refers to the lawyer's number of children. White takes the value one if the lawyer is Caucasian and zero if the lawyer is a member of a minority group (black, Hispanic, Native American, and Asian). Tenure is the number of years that the lawyer has been working for the current employer. Private law firm takes the value one if the lawyer works in a private law firm and zero if the lawyer works for another organization. Size of workplace > 100 takes the value one if the number of individuals employed in the organization is greater than 100 and zero otherwise. Hours worked (per week) is the number of hours spent working last week (at the office or away from the office). Undergraduate university ranking and law school ranking are bracketed rankings based on the U.S. News and World Report of 1996 and 2003 for undergraduate and law school studies, respectively. Both variables are redefined such that the higher the value, the more prestigious the educational institution. Judicial clerk takes the value one if the lawyer has held a position as a judicial clerk in state or federal courts and zero otherwise. Moot court takes the value one if the lawyer participated in simulated mock trials as a student and zero otherwise. General (specific) journal takes the value one if the lawyer participated in law journal editorial activities as a student and zero otherwise.

Supplement for Question (3): Recall a 2016 article "The social dilemma of autonomous vehicles" in the magazine *Science.* "Dilemma" means a difficult problem and "autonomous vehicles" (AVs) are cars that drive themselves. The researchers asked survey participants about both what they think AVs *will* do and what they think AVs *should* do when faced with dilemmas. The excerpted passage focuses on participants' moral assessments regarding what AVs *should* do.

EXCERPT (Abstract): Autonomous vehicles (AVs) will sometimes have to choose between two evils, such as running over pedestrians or sacrificing themselves and their passenger to save the pedestrians. [See Figures 1a and 1b.]

Figure 1a. Car decides between killing one pedestrian or sacrificing (i.e. killing) its own passenger to save 1 life.

Figure 1b. Car decides between killing ten pedestrians or sacrificing (i.e. killing) its own passenger to save 10 lives.

EXCERPT (p. 1574): In Study Two (n = 451 participants), participants were presented with dilemmas that varied the number of pedestrians' lives that could be saved, from 1 to 100. Participants did not think that AVs should sacrifice [kill] their passenger when only one pedestrian could be saved, with an average approval rate of 23% [and 95% CI of 14 to 32], but their moral approval increased with the number of lives that could be saved. [Figure 3 shows that the approval rate jumped to 54% for 2 lives saved, 66% for 5 lives saved, 74% for 20 lives saved, and 86% for 100 lives saved.]

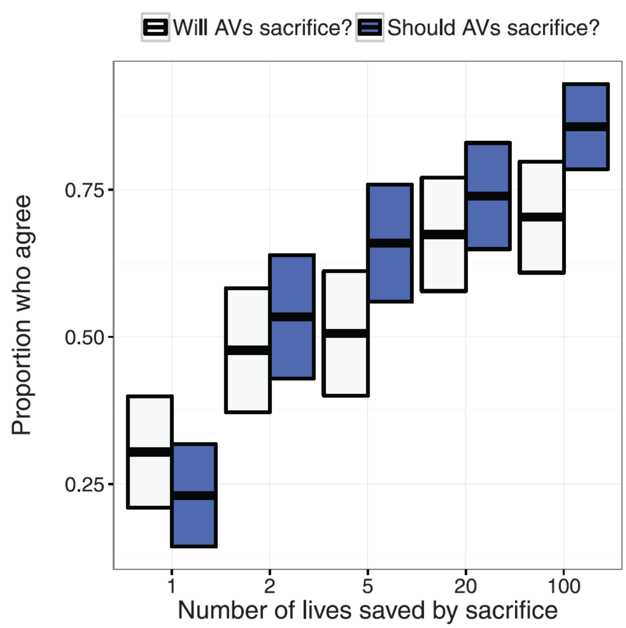


Figure 3. Participants' replies in Study Two. Boxes show the 95% Confidence Intervals. As noted in the legend above, the lighter boxes correspond to proportion agreeing that AVs *will* sacrifice [kill] their passengers and the darker boxes correspond to proportion agreeing that AVs *should* sacrifice [kill] their passengers.

Supplement for Question (4): Consider the 2018 NBER Working Paper 24161 "How Do Individuals Repay Their Debt? The Balance-Matching Heuristic." APR is the annual percentage interest rate. Using monthly data on 1.4 million individuals with credit cards in the U.K. over a two-year period, the researchers focus on individuals in months with two cards, each with money owed, where one card has a higher APR. The unit of observation is an individual x month. Further, the sample includes only *economically meaningful* allocation decisions between two cards: the individual is paying off more than the minimum due on each card and the two cards have different APRs. The sample size is 394,111 observations.

EXCERPT (p. 10): Figure 1 plots the distribution of actual and optimal payments in the two-card sample. The distribution of actual repayments appears close to symmetric, with a mass point at 50%, and smaller mass points at 33% and 67%. In contrast, the distribution of optimal repayments is heavily weighted towards the high APR card. It is not optimal for individuals to place 100% of their payments on the high APR card because (i) they need to pay the minimum on the low interest rate card and (ii) they are sometimes able to pay off more than the full balance on the high interest rate card.

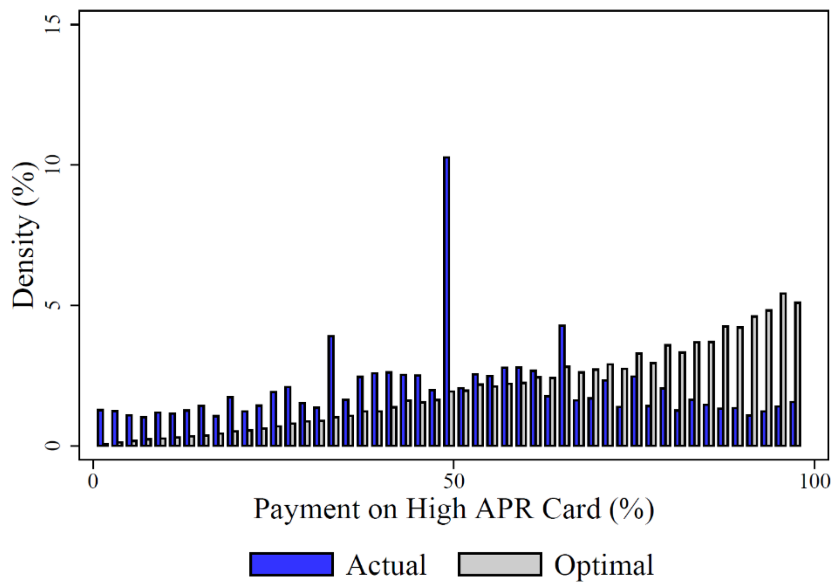


Figure 1: Two Cards. Light bars show the *optimal* distribution of percent of total payment that an individual should allocate to the high APR card. Dark bars show the *actual* distribution.

Table 2 shows summary statistics for actual and optimal repayments for the two-card sample. On average, individuals should allocate 70.7% of repayments to the high APR card. If individuals were completely unresponsive to interest rates, we might expect them to place 50% of payments on the high APR card. On average, individuals allocate 51.2% to the high APR card, which is very close to the completely non-responsive baseline. Individuals, thus, misallocate 19.5% of their total monthly payment on average.

Table 2: Actual and Optimal Payments on the High APR Card

			Percentiles				
	Mean	Std. Dev.	10th	25th	50th	75th	90th
i) As % Total Monthly Payment							
Actual Payment (%)	51.22	24.21	16.86	33.33	50.00	67.99	84.78
Optimal Payment (%)	70.74	22.17	38.10	55.92	75.23	89.48	95.83
Difference (%)	19.52	23.75	0.00	0.72	9.91	32.40	54.55
ii) Payment in £							
Actual Payment (£)	259.76	733.92	25.00	45.49	100.00	200.00	450.00
Optimal Payment (£)	377.30	849.70	32.62	65.00	138.51	307.09	807.21
Difference (£)	117.54	422.14	0.00	1.00	17.80	75.00	237.47

Note: Summary statistics for actual and optimal payments on the high APR card. Top panel shows the percentage of total payment (over both cards) that an individual allocates to the high APR card in a month. Bottom panel shows values in £s (British pounds). The two-card sample is restricted to individual x months with an economically meaningful allocative decision, which includes 394,111 observations.