While you wait for the start of this test, you may fill in the FRONT AND BACK of the BUBBLE FORM and read this cover. BUT, keep these test papers face up and flat on your desk.

Instructor: Prof. Murdock
Duration: 90 minutes. You MUST STAY for at least 60 minutes
Allowed aids: A non-programmable calculator and the aid sheets provided with this test
Format: This test includes these question papers and a BUBBLE FORM. There are 26 multiple choice questions with point values from 1 to 3 points each for a total of 52 points. The point value for each question is shown by [1pt], [2pts], [3pts]. Most questions have choices **(A)** – **(E)**. For questions with fewer choices, the correct answer is ALWAYS one of those offered (e.g. if the choices are **(A)** – **(D)**, then **(E)** is NOT a possible correct answer.)

Once the start of the test is announced, you may detach the aid sheets and statistical tables (Standard Normal, Student t and F) from the end of this test. These question papers and the aid sheets will not be collected.

You must record your answers on the BUBBLE FORM. In ALL cases what is (or is not) indicated on the BUBBLE FORM is your FINAL ANSWER. Marks are based SOLEY on the BUBBLE FORM, which must be completed before the end of the test is announced.

- On the FRONT of the BUBBLE FORM:
  - Print your 9 (or 10) digit student number in the boxes AND darken each number in the corresponding circles.
  - Print your last name and initial in the boxes AND darken each letter in the corresponding circles.
  - Fill in the upper left region of the form.
  - ******Your FORM CODE is A. Darken the circle with the letter A.******
    - Failing to indicate your FORM CODE means that your answers will be out of sync compared to the solution key used to mark your paper. There is NO REMEDY for the resulting failing mark. It is entirely your responsibility to properly indicate your FORM CODE.
- On the BACK of the BUBBLE FORM:
  - Write in your name, sign, and record your answers.
- Use a pencil and make dark solid marks that fill the bubble completely.
- Erase completely any marks you want to change; Crossing out a marked box is incorrect.
- Choose the best answer for each question. If more than one answer is selected that question earns 0 points.
- For questions with numeric answers that require rounding, round your final answer to be consistent with the choices offered. Use standard rounding rules.

▶ **Questions (1) – (4):** Recall the paper discussed in class: "Medicaid Increases Emergency-Department Use: Evidence from Oregon's Health Insurance Experiment" published in *Science* in January 2014. (DOI: 10.1126/science.1246183).

Abstract: In 2008, Oregon initiated a limited expansion of a Medicaid program for uninsured, low-income adults, drawing names from a waiting list by lottery. This lottery created a rare opportunity to study the effects of Medicaid coverage using a randomized controlled design. Using the randomization provided by the lottery and emergency department records from Portland-area hospitals, we study the emergency department use of about 25,000 lottery participants over approximately 18 months after the lottery. We find that Medicaid coverage significantly increases overall emergency use by 0.41 visits per person, or 40 percent relative to an average of 1.02 visits per person in the control group. We find increases in emergency-department visits across a broad range of types of visits, conditions, and subgroups, including increases in visits for conditions that may be most readily treatable in primary care settings.

Recall this excerpt from the paper, which describes the table, and the table below.

Excerpt (p. 265): We report the estimated effect of Medicaid on emergency department use over our study period (March 10, 2008 – September 30, 2009) in the entire sample and in subpopulations based on pre-randomization emergency department use. For each subpopulation, we report the sample size, the control mean of the dependent variable (with standard deviation for continuous outcomes in parentheses), the estimated effect of Medicaid coverage (with standard error in parentheses), and the p-value of the estimated effect. Sample consists of individuals in Portland-area zip codes (N=24,646) or specified subpopulation.

Emergency-department use							
		Percent with any visits[1]			*Number of visits*[2]		
	N	Mean Value in Control Group	Effect of Medicaid Coverage	p-value	Mean Value in Control Group	Effect of Medicaid Coverage	p-value
Panel A: Overall							
All visits	24,646	34.5	7.0 (2.4)	0.003	1.022 (2.632)	0.408 (0.116)	<0.001
Panel B: By emergency department use in the pre-randomization period							
No visits	16,930	22.5	6.7 (2.9)	0.019	0.418 (1.103)	0.261 (0.084)	0.002
One visit	3,881	47.2	9.2 (6.0)	0.127	1.115 (1.898)	0.652 (0.254)	0.010
Two+ visits	3,835	72.2	7.1 (5.6)	0.206	3.484 (5.171)	0.380 (0.648)	0.557

[1] For the percent-with-any-visits measures, the estimated effects of Medicaid coverage are shown in percentage points.
[2] The number-of-visits measures are unconditional, including those with no visits.

(1) [2pts] Using formal notation from our course, what are 0.408 and 0.116 (in parentheses) in Panel A under "*Number of visits*"?

(A) $\bar{d}$ and $s_d/\sqrt{n}$
(B) $(\bar{X}_1 - \bar{X}_2)$ and $\sqrt{s_1^2/n_1 + s_2^2/n_2}$
(C) $(\mu_1 - \mu_2)$ and $\sqrt{\sigma_1^2/n_1 + \sigma_2^2/n_2}$
(D) $(\hat{P}_1 - \hat{P}_2)$ and $\sqrt{\hat{P}_1(1-\hat{P}_1)/n_1 + \hat{P}_2(1-\hat{P}_2)/n_2}$
(E) $(p_1 - p_2)$ and $\sqrt{p_1(1-p_1)/n_1 + p_2(1-p_2)/n_2}$

(2) [3pts] Consider the P-value of 0.557 reported in Panel B for the "Two+ visits" subgroup under "*Number of visits*." This is the classic two-tailed test of statistical significance. If the research hypothesis had been a one-tailed test for a *negative effect of Medicaid coverage* (i.e. that coverage reduces emergency department visits as many had claimed prior to this study), then what would the P-value be?

(A) 0.06
(B) 0.28
(C) 0.58
(D) 0.72
(E) 0.89

(3) [2pts] Focusing on Panel A, overall how strong is the evidence that Medicaid coverage caused at least an extra 0.25 emergency department visits per covered person?

(A) very weak evidence: the P-value is 0.82, which does not meet any conventional significance level
(B) weak evidence: the P-value is 0.18, which does not meet any conventional significance level
(C) some evidence: the P-value is 0.09, which is statistically significant at a 10% level
(D) good evidence: the P-value is 0.04, which is statistically significant at a 5% level
(E) overwhelming evidence: the P-value is less than 0.001, which meets a 0.1% significance level

(4) [2pts] Consider a simple regression where the y variable is number of visits to the emergency department and the x variable is a dummy equal to 1 if the person won lottery and got Medicaid coverage and zero otherwise. The number of observations is 24,646. In this simple regression, which underlying assumption would be of concern?

(A) a violation of homoscedasticity
(B) a violation of the linearity assumption
(C) lurking (unobserved/confounding) variables
(D) serial correlation as people who are sick today are likely to be sick tomorrow
(E) serial correlation as we are comparing the same people before and after Medicaid coverage

(5) [2pts] Suppose regressing salary on sex and years of education and an interaction term gives this result:

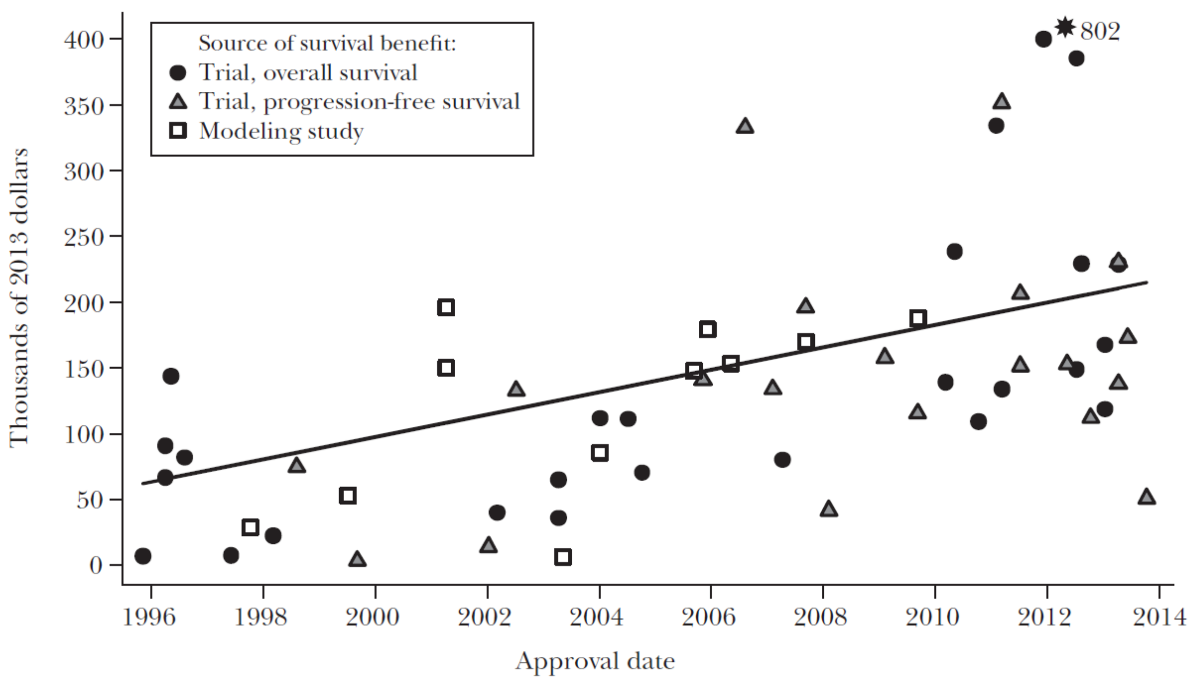
$$\widehat{salary}_i = -55{,}000 - 5{,}000 female_i + 8{,}000 education_i + 1{,}000 female_i * education_i$$

What if a male dummy is used instead?

(A) $\widehat{salary}_i = -50{,}000 + 5{,}000 male_i + 8{,}000 education_i - 1{,}000 male_i * education_i$
(B) $\widehat{salary}_i = -55{,}000 - 5{,}000 male_i + 8{,}000 education_i + 1{,}000 male_i * education_i$
(C) $\widehat{salary}_i = -55{,}000 + 5{,}000 male_i + 8{,}000 education_i + 1{,}000 male_i * education_i$
(D) $\widehat{salary}_i = -60{,}000 + 5{,}000 male_i + 8{,}000 education_i - 1{,}000 male_i * education_i$
(E) $\widehat{salary}_i = -60{,}000 + 5{,}000 male_i + 9{,}000 education_i - 1{,}000 male_i * education_i$

▶ **Questions (6) – (11):** Consider the paper "Pricing in the Market for Anticancer Drugs" published in *The Journal of Economic Perspectives* in 2015 (http://pubs.aeaweb.org/doi/pdfplus/10.1257/jep.29.1.139). Specifically, it studies 58 anticancer drugs meant to extend life that the U.S. FDA approved between 1995 through 2014. This includes the launch price (price when the drug first became available) and how effective the drug is at extending life expectancy. It looks at price per life-year gained. For example, if it cost $200,000 to treat a patient with a drug and this is expected to extend her/his life by 4 years (the "survival benefit") then the price per life year gained is $50,000 (=$200,000/4). The excerpt and figure are taken from the paper.

> ***Excerpt (pp. 148 – 149):*** The price per life-year gained can be thought of as a "benefit-adjusted" price. The sample average is $150,100 per year of life gained (with a standard deviation of $130,500). The figure below plots drugs' price per life-year gained against drugs' approval date. There is an upward trend. A regression of the price per life-year gained on approval year indicates that benefit- and inflation-adjusted launch prices increased by $8,500 (with a 95% confidence interval from $2,900 to $14,100) per year. The intercept (1995 is zero on the x-axis) is $54,100 (95% confidence interval: -$16,700 to $124,900). Put another way, in 1995 patients and their insurers paid $54,100 for a year of life. A decade later, 2005, they paid $139,100 for the same benefit. By 2013, they were paying $207,000.



Notes: The best fit line is: Price per life year gained = $54,100 + $8,500 × Approval Year. Approval Year = 0 for 1995, 1 for 1996, . . . 19 for 2014. For purposes of display, we recoded one value from $802,000 to $400,000.

(6) [2pts] The figure and the notes below it mention an outlier that is included in the analysis. If this outlier were dropped, which of the following should you expect to happen?

> **(A)** The SST would be higher
> **(B)** The OLS slope estimate would be higher
> **(C)** Dropping it would lead to heteroscedasticity
> **(D)** The standard deviation of the residuals would be lower
> **(E)** All of the above

(7) [2pts] Looking at the last sentence in the excerpt, suppose someone wanted to know how precise $207,000 is as an estimate of the mean price per year of life gained in 2013. Which would you suggest?

(A) Compute the prediction interval for Approval Year = 18
(B) Compute the confidence interval for Approval Year = 18
(C) Compute the prediction interval for Approval Year = 21
(D) Compute the confidence interval for Approval Year = 21

(8) [2pts] How should you *interpret* the intercept ($54,100) of the OLS line?

(A) When x is equal to zero, y is equal to 54,100
(B) The average price of prescription drugs in 1995 was around $54,100
(C) Cancer drugs approved in 1995 on average had a price per year of life of $54,100
(D) In the first year a new cancer drug is approved the price per year of life is $54,100 on average
(E) Cannot interpret it because, as the graph shows, an x-value of zero is outside the range of the data

(9) [2pts] The y-axis in the figure shows prices in thousands of dollars but price is measured in dollars in the reported OLS line. What would the OLS line be if price were measured in thousands of dollars?

(A) $\hat{y} = 54.1 + 8.5x$
(B) $\hat{y} = 54{,}100 + 8.5x$
(C) $\hat{y} = 54{,}100 + 8{,}500x$
(D) $\hat{y} = 54{,}100 + 8{,}500{,}000x$
(E) $\hat{y} = 54{,}100{,}000 + 8{,}500{,}000x$

(10) [2pts] Which of these would be smaller if price is measured in thousands of dollars rather than dollars?

(A) The R^2
(B) The SSE
(C) The adjusted-R^2
(D) The t test statistic for the OLS slope
(E) All of the above

(11) [2pts] What is the standard error of the OLS slope estimate ($8,500)?

(A) 2,000
(B) 2,200
(C) 2,400
(D) 2,600
(E) 2,800

▶ **Questions (12) – (14):** Consider data with a sample size of 127. Here are STATA estimates of a multiple regression model that includes six x variables where parts of the STATA output are intentionally erased.

```
      Source |       SS       df       MS
-------------+------------------------------
       Model |  10.5489352     6  1.75815587
    Residual |  142.970595   120  1.19142162
-------------+------------------------------
       Total |   153.51953   126  1.21840897

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   .0797928   .1026455     0.78   0.438    -.1234381    .2830237
          x2 |   .0315515   .0987079     0.32   0.750    -.1638834    .2269864
          x3 |  -.1531886   .0990843    -1.55   0.125    -.3493687    .0429915
          x4 |   .0436357    .094597     0.46   0.645    -.1436597    .2309312
          x5 |    .202175   .0992401     2.04   0.044     .0056865    .3986634
          x6 |   .1949774   .0979026     1.99   0.049      .001137    .3888178
       _cons |   .0210353   .1007573     0.21   0.835    -.1784571    .2205277
------------------------------------------------------------------------------
```

(12) [2pts] What are the R^2 and Adjusted R^2?

(A) 0.0687 and 0.0221
(B) 0.0738 and -0.0500
(C) 0.3891 and 0.3688
(D) 0.3904 and 0.3442
(E) 0.9313 and 0.9279

(13) [2pts] What is the P-value for the overall test of statistical significance?

(A) less than 0.01
(B) between 0.01 and 0.025
(C) between 0.025 and 0.05
(D) between 0.05 and 0.10
(E) more than 0.10

(14) [2pts] Which would change the SST?

(A) dropping x1 – x4 from the analysis
(B) changing the units of measurement of x5
(C) transforming the y variable using a natural logarithm
(D) making the specification more flexible by including a quadratic for each x
(E) All of the above

▶ **<u>Questions (15) – (24):</u>** Consider "Does Beauty Matter in Undergraduate Education?" published in *Economic Inquiry* in April 2015. (doi:10.1111/ecin.12152). Here is the abstract and an excerpt from the paper describing the data.

> ***Abstract:*** Physically attractive individuals achieve greater success in terms of earnings and status than those who are less attractive. However, whether this "beauty premium" arises primarily because of differences in ability or confidence, bias, or sorting remains unknown. We use a rich dataset from a women's college to evaluate each of these three mechanisms at the college level. We find that students judged to be more attractive perform significantly worse on standardized tests but, conditional on test scores, are not evaluated more favorably at the point of admission, suggesting that more attractive people do not possess greater abilities at the beginning of college. Controlling for test scores, more attractive students receive only marginally better grades in some specifications, and the magnitudes of the differences are very small. Finally, there is substantial beauty-based sorting into areas of study and occupations.

> ***Excerpt (p. 942):*** Our dataset consists of 794 alumnae who graduated from an anonymous women's college between the years 2002 and 2011. To measure attractiveness, we use pictures [from student ID cards] taken [by campus officials] when the alumnae were first-year students. The pictures were subsequently rated by current male and female students from a college in another state. Each picture was rated by at least 25 male and 25 female raters. [We combine these to form an attractiveness rating, which we standardize so that a rating of 1 means the person is 1 standard deviation above average.] The attractiveness rating is then matched to the alumna's academic record, which includes her GPA, major, SAT scores [a test most students in the U.S. take in high school], race, non-merit-based financial aid awards, and scores from a quantitative reasoning (QR) test that all first-year students are required to take. Like the SAT, the QR test is scored blindly, without observing the test taker's appearance. Finally, we observe each student's admission rating, as assigned by three or more application reviewers. The college uses a "holistic" approach to assign admission ratings, considering each student's academic record (including high school GPA, SAT and other standardized test scores), extracurricular activities, recommendation letters, two essays, and, in some cases, artwork or music. [There are no photos or interviews for admission so physical attractiveness cannot directly affect the rating.]

Next are three tables (Tables 1 – 3), which are excerpts from that paper. Questions appear in between the tables.

Table 1: Summary Statistics

	Above Median Attractiveness Rating (Attractive)					*Below Median Attractiveness Rating (Unattractive)*					*Entire Sample*	
	Mean	SD	Min	Max	Obs.	Mean	SD	Min	Max	Obs.	Mean	SD
Standardized attractiveness rating	0.70	0.54	-0.03	2.42	397	-0.69	0.47	-2.69	-0.03	397	0	1
Admissions rating	6.34	1.36	0	10	397	6.62	1.29	1.67	10	395	6.48	1.34
cGPA	3.48	0.28	2.5	3.98	396	3.48	0.29	2.3	4	396	3.47	0.31
Math SAT score	678	62	510	800	387	689	57	490	800	378	684	60
Verbal SAT score	696	61	490	800	387	712	59	450	800	378	704	61
QR test score	13.08	2.65	2	18	397	13.42	2.55	4.5	18	397	13.25	2.60

(15) [2pts] The excerpt discusses 794 alumnae. Why is the number of observations as low as 378 in Table 1?

> **(A)** because Table 1 focuses only on the female graduates, which are about half of the original sample
> **(B)** because Table 1 breaks the sample in half by attractiveness rating and there are some missing values
> **(C)** because the data are paired (sample size would be half the original) and there are some missing values
> **(D)** because Table 1 must be focusing on some subset of the data mentioned in the excerpt but insufficient information is given to speculate about the cause of the large discrepancy in the sample size
> **(E)** because there is a very large number of missing values in these data, which is not surprising because most graduates likely would not consent to having their private marks and ratings used for this research project

(16) [2pts] Using the results in Table 1, what is the P-value for the test of whether cGPA differs between unattractive and attractive students?

(A) less than 0.01
(B) between 0.01 and 0.05
(C) between 0.05 and 0.10
(D) between 0.10 and 0.50
(E) more than 0.50

Table 2: Attractiveness and Test Scores

	Dependent variable:					
	Standardized Math SAT		Standardized Verbal SAT		Standardized QR test	
Specification:	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Explanatory variables:						
Standardized attractiveness rating	-0.10 (0.03)		-0.14 (0.03)		-0.20 (0.09)	
Attractiveness quintile = 2		0.04 (0.10)		-0.14 (0.11)		0.00 (0.27)
Attractiveness quintile = 3		-0.12 (0.10)		-0.27 (0.11)		-0.20 (0.29)
Attractiveness quintile = 4		-0.08 (0.10)		-0.30 (0.11)		-0.31 (0.27)
Top attractiveness quintile		-0.29 (0.10)		-0.40 (0.11)		-0.55 (0.27)
Observations	764	764	764	764	793	793
R^2	0.22	0.22	0.11	0.11	0.12	0.12

Notes: Robust standard errors in parentheses. All specifications include year-of-enrollment and race fixed effects, as well as controls for the amount of financial aid received.

(17) [2pts] In the original tables, the authors employed the common practice of marking coefficients that are statistically significant at the 10% level with *, at the 5% level with **, and at the 1% level with ***. The original tables include a note saying "*10%, **5%, ***1%." The stars have been erased in Table 2. How many stars does the standardized attractiveness rating coefficient in Specification (3) get?

(A) *
(B) **
(C) ***
(D) no stars

(18) [2pts] How many stars ("*10%, **5%, ***1%") does the attractiveness coefficient in Specification (5) get?

(A) *
(B) **
(C) ***
(D) no stars

(19) [2pts] The dependent variables in Table 2 have each been standardized. If a student got a score of 610 on the Math SAT then what is the value of the dependent variable for that student in Specifications (1) and (2)?

- **(A)** -1.23
- **(B)** 1.23
- **(C)** 2.18
- **(D)** -37.75
- **(E)** 37.75

(20) [2pts] How should the coefficient -0.20 in Specification (5) be interpreted? After controlling for year of enrolment, race, and the amount of financial aid received, on average a student that is ___ .

- **(A)** one point more attractive has a QR test score that is 0.20 points lower
- **(B)** one percent more attractive has a QR test score that is 20 percent lower
- **(C)** one percent more attractive has a QR test score that is 0.20 percent lower
- **(D)** one percentage point more attractive has a QR test score that is 0.20 percentage points lower
- **(E)** one standard deviation more attractive has a QR test score that is 0.20 standard deviations lower

(21) [2pts] Quintiles divide data up into five pieces. The first quintile is observations below the 20th percentile, the second quintiles is observations between the 20th and 40th percentiles, and so on. Specifications (2), (4) and (6) include indicator variables for the attractiveness quintile of each person. What is the omitted category?

- **(A)** People whose attractiveness rating is below the median
- **(B)** People whose attractiveness rating is above the median
- **(C)** People whose attractiveness rating is in the first quintile
- **(D)** People whose attractiveness rating is in the third quintile
- **(E)** There is no omitted category in these three specifications

(22) [2pts] What is the test statistic to test whether the Math SAT scores differ between the least attractive fifth of students compared to the most attractive fifth of students (after controlling for year of enrolment, race, and the amount of financial aid received)?

- **(A)** -2.9
- **(B)** -0.8
- **(C)** 1.1
- **(D)** 1.645
- **(E)** 1.96

Table 3: Selection Into Subject Areas

	Dependent variable is percentage of all courses that the student took that are in:		
	the sciences	the humanities	economics
Specification:	*(7)*	*(8)*	*(9)*
Explanatory variables:			
Standardized attractiveness rating	-1.92	-0.05	1.59
	(0.62)	(0.63)	(0.45)
Standardized Math SAT score	4.30	-3.72	3.23
	(0.75)	(0.75)	(0.54)
Standardized Verbal SAT score	-1.86	2.26	-1.84
	(0.70)	(0.71)	(0.51)
Admission rating	1.04	-0.25	0.08
	(0.57)	(0.57)	(0.41)
Observations	762	762	762
R^2	0.12	0.15	0.14

Notes: Robust standard errors in parentheses. All specifications include year-of-enrollment and race fixed effects, as well as controls for the amount of financial aid received.

(23) [2pts] How many stars ("*10%, **5%, ***1%") does the attractiveness coefficient in Specification (8) get?

(A) *
(B) **
(C) ***
(D) no stars

(24) [2pts] How should the coefficient 3.23 in Specification (9) be interpreted? After controlling for attractiveness, Verbal SAT scores, admission rating, year of enrolment, race, and the amount of financial aid received, on average a student that has a one standard deviation higher Math SAT score took ___.

(A) about 3 percent more economics courses (e.g. 20.6% economics courses versus 20%)
(B) about 3 more economics courses (e.g. 7 economics courses versus 4 economics courses)
(C) about 3 percentage points more economics courses (e.g. 23% economics courses versus 20%)
(D) some more economics courses but the difference is not statistically significant at a usual 5% level
(E) no more economics course: zero cannot be rejected, which implies that the null hypothesis is true

(25) [2pts] The World Bank provides GDP per capita in $1,000s of current US$ and population (people) in 2012. The natural log of GDP per capita is regressed on the natural log of population for 189 countries without missing data. How should the coefficient of -0.0861 on `ln_pop_2012` be interpreted? In 2012, on average countries with ___.

(A) populations that are 1% larger had GDP per capita that is about 8.6% lower
(B) populations that are 1% larger had GDP per capita that is about 0.86% lower
(C) populations that are 10% larger had GDP per capita that is about 8.6% lower
(D) populations that are 10% larger had GDP per capita that is about 0.86% lower
(E) large populations have lower GDP: the correlation is -0.0861, which is a weak negative correlation

(26) [1pt] Your FORM CODE is A. It must be marked on the front of your bubble form. What is your FORM CODE?

(A) My FORM CODE is A *and* I have properly marked it on the front on my bubble form