

## Midterm Examination #2

**Instructions:** You have 2 hours to complete the examination and there are 4 questions worth a total of 120 possible points. You may use a calculator, but you may not use pre-programmed formulas.\* The standard normal “Z” table from the second page of your book has been provided to you. Partial credit is possible on all questions so be sure to write clearly and show all of your work. If you have questions regarding the wording of a particular question feel free to ask for clarifications. Good luck!

1. **Only Four Years to 2012 (30 pts.)** Now that the 2008 election has ended, we can all begin obsessing over polls for the 2012 election. The first poll for the 2012 Republican Primary was done by Newsweek last week. The following results come from 257 registered Republican voters in their sample.

### Newsweek 2012 Republican Presidential Nomination

Mitt Romney	35%
Mike Huckabee	26%
Sarah Palin	20%

- a. (5 pts) Describe the distribution of the sample proportion of Americans who would vote for Mitt Romney. A complete answer describes the distribution, mean and variance in terms of population parameters.
- b. (5 pts) Using the results of the CNN/Opinion Research Corporation poll, construct a 95% confidence interval around the proportion of Republicans who support Mitt Romney.
- c. (5 pts) Suppose that Rachel Maddow claims that more than 40% of Republicans support Mitt Romney. Write down a null and alternative hypothesis in terms of population parameters that will allow you to assess whether there is strong evidence against Rachel Maddow’s claim.
- d. (5 pts) What is the p-value associated with this hypothesis test? Can we reject Maddow’s claim?
- e. (5 pts) Recalculate your p-value from part (d), but instead assume that  $n=500$ .
- f. (5 pts) Why did your p-value shift from part (d) to part (e)?

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\* In the interest of fairness I expect those of you with fancy graphing calculators that can compute probabilities associated with the normal distribution not to use this feature.

2. **Government Spending and Growth (30 pts.)** The Penn World Table from the University of Pennsylvania's economics department contains an array of data relating growth, trade, population, and government expenditure. The following data come from the 82 countries in 2004 that had available data.

You are interested here in the relation between gross domestic product per capita ( $gdp$ ) and government expenditure as a share of gross domestic product ( $gov$ ). You separate  $gdp$  based on whether government expenditure is high ( $gdp^{HI}$ ) and whether government expenditure is low ( $gdp^{LO}$ ).

Assume that you know that the true distribution of  $gdp$  comes from a normal distribution with mean  $\mu=15,800$ . You observe a sample standard error of  $s=3000$ . Assume  $\alpha=.05$ .

- a. (5 pts) What is the assumed distribution of the sample mean of  $gdp$ ? A complete answer describes the distribution, mean and variance in terms of population parameters.
- b. (5 pts) You observe a value of  $gdp^{LO}=16,850$ , with  $n=41$ . State the relevant null and alternative hypotheses.
- c. (5 pts) Give a general definition of a p-value. (5 pts)
- d. (5 pts) What is the p-value for this particular hypothesis test? (Give a specific number.) Do we reject the null?
- e. (5 pts) What does the p-value for this particular hypothesis tell us in simple language?
- f. (5 pts) Explain in simple language how the size of the p-value helps us to determine whether or not to reject the null hypothesis.

3. **Is Our Children Learning? (40 pts.)** One area of policy research involves whether students using vouchers to attend private schools perform better on standardized tests than those attending public schools. Research by Prof. John Witte has explored this question at length.

A pilot program in Milwaukee from 1990-1995 was called the Public Choice Program. Parent had the opportunity to use a voucher and apply for their child's acceptance to a private school, and the private school then selected applications at random. The following question concerns 1991 scores of students who were accepted to private schools in Milwaukee, the set of all Milwaukee Public School low-income students, and a "control" group of students who applied but were not accepted. The data is below:

	Enrolled Choice		Milwaukee Public School Low-Income		Milwaukee Public School Control	
	Reading	Math	Reading	Math	Reading	Math
1991 Mean Test Scores	39.8	39.0	38.0	41.5	40.0	43.4
Standard Deviation	17.0	18.6	15.1	17.3	16.6	18.4
<i>N</i>	192	198	911	895	1173	1148

- (5 pts) Comparisons of tests scores between charter schools and public school students ignore a crucial selection bias. Explain.
- (5 pts) Consider students enrolled in the choice program. Construct a 95% confidence interval for the sample mean of observed math scores.
- (5 pts) Would you expect wider or shorter confidence intervals for the control group? Why?

The Milwaukee City Council will only institute the choice program if there is strong evidence to suggest that students enrolling in the program will have a mean test score above 42. *This is now your alternative hypothesis.*

- (5 pts) Clearly state the relevant null and alternative hypotheses. Define Type II error and power. What does Type II error mean in this situation, i.e. what effect will a Type II error committed by the legislature have on Milwaukee students?
- (5 pts) If we take  $\alpha = 0.05$  and do a one-tailed test, what is the cut-off value between accepting and rejecting the null?
- (5 pts) What is the probability of a Type II error, with  $\alpha = 0.05$  and your alternative hypothesis from part (d)?
- (5 pts) If the scientists used  $\alpha = 0.01$  instead, how would that change the previous two answers? How are  $\alpha$  and power related?

4. **Super Batteries, Inc. (20 points)** The current state of the art cell phone battery last an average of 5 hours in continuous talk mode before it needs to be recharged. Super Batteries Inc. believes it has developed a new cell phone battery that last longer than an average of 5 hours in continuous talk mode. Super Batteries Inc. decides to test a sample of batteries in continuous talk mode and record how long each batter last. Suppose you know that  $\sigma = 2$ , and you decide to fix the probability of a Type I error at 5%.
- a. (5 points) State the relevant null and alternative hypotheses if Super Batteries, Inc would like to claim that there is strong evidence that their new battery last longer than the current state of the art battery.
  - b. (15 points) Super Batteries commissions you to conduct a study to evaluate the hypothesis test in part (a). Determine the sample size that will allow you to correctly conclude that Super Batteries Inc's new battery lasts longer than the current state of the art battery with probability 0.95 if the true average life for their new battery is 5.5 hours.