Statistics for Lawyers
Fall 2011 Exam

Instructions: You have 24 hours to complete this exam. The exam is open book/open notes. Show all of your work if you hope to receive partial credit in the event of an incorrect answer. Each of the questions 1-7 is worth 10 points. Each of the subparts of question 8 (8a-8f) is worth 5 points.

1. Referring to Helland and Klick, "The Effect of Judicial Expedience on Attorney Fees in Class Actions," Journal of Legal Studies, 36(1): 171-187 (2007) available at http://www.law.upenn.edu/fac/jklick/36JLS171.pdf, provide a discussion of the hypothesis tested, the research design/identification strategy, potential sources of an omitted variables bias, and the authors' attempt(s) to address these potential biases.

The general hypothesis is that judges try to reduce their workload when they are busy. The specific hypothesis is that judges sign off on higher attorney fees in class actions as court congestion grows. Finally, the tested hypothesis is that there is a positive correlation between attorneys' fees in class actions as court congestion grows.

The basic design is to regress the log of fees on a court congestion metric and a number of case characteristics.

There are a number of ways an omitted variable bias could arise. There could be reverse causation in that higher fees attract more cases. There could be a selection effect whereby busy courts just happen to have more complicated cases which justify larger fees. Other possibilities as well.

To address reverse causality, the authors use criminal case volume for their congestion measure on the assumption that higher fees do not attract more criminal cases. For the selection effect, they look at a fixed effects regression where they identify changes in fees within a given court as its congestion varies.

2. The principle of financial diversification suggests that a portfolio containing equal shares of two uncorrelated stocks, each of which has the same variance and the same expected return, will have a lower variance than a portfolio consisting of only one of the stocks without a corresponding reduction in the portfolio's rate of return. More generally, a portfolio with n uncorrelated stocks, each comprising 1/n of the total portfolio, each with an equal return and variance, will have a lower variance than a portfolio composed of n-1 stocks, while having the same return. Assume that the available stocks are all uncorrelated and they all have the following probabilistic outcomes: 1/3 of the time the return is -5%, 1/3 of the time the return is 0%, and 1/3 of the time the return is 5%. Show that an equally weighted portfolio of 3 of these stocks has a lower variance than an equally weighted portfolio of 2 of these stocks which in turn has a lower variance than a portfolio that consists of a single stock (note: assume the three comparison portfolios are all of equal size).

One could have done this by actually calculating the relevant variances. It's easy to show in general though if you noted that the variance of two independent random variables is the sum of the variables and a constant times a random variable has a variance equal to the constant squared times

the random variable's variance. So, if the variance of the single stock is V, then the variance of a portfolio containing just that stock is also V. The variance of an equal size portfolio containing equal proportions of 2 stocks is then 1/4V + 1/4V = 1/2V. The variance of an equal size portfolio containing equal proportions of three stocks is 1/9V + 1/9V + 1/9V = 1/3V. V>1/2V>1/3V.

3. The "Moneyball" approach to baseball involves using statistical analyses to value a player's contribution to team success. For example, Billy Beane of the Oakland A's relied on regression analysis suggesting that a team's number of walks had a large statistically significant positive effect on a team's winning percentage. Because other teams ignored walks in favor of other higher profile statistics (e.g., batting average, stolen bases, etc) , Beane was able to get "undervalued" players who had high walk totals believing that these players would provide large contributions to the team's success at a low cost in terms of salary. During Beane's tenure, the A's have done very well during the long 162 game regular season. In fact, the A's have been competitive for years with teams that spent much more money on players than they did. However, critics have pointed out that Beane's teams have not been successful in the playoffs, suggesting that Moneyball doesn't work. Beane's response is that his method works over a long season, but is not well suited to winning short playoff series (series in the playoffs are best 3 out of 5 or best 4 out of 7 game series). Provide a statistical rationale for this claim.

The statistical analysis works in the regular season due to the law of large numbers (n = 162), whereas there is no corresponding law of small numbers for the short playoff series (n ≤ 7).

4. Some advocates have suggested that individuals who suffer from fetal alcohol syndrome (i.e., a condition in which the individual's mother drank alcohol while pregnant leading to a host of physical and mental problems) should receive leniency when sentenced for a crime. To support this position, the advocates suggest that fetal alcohol syndrome predisposes an individual to engage in criminal activities due to impulse control problems and other cognitive deficiencies. To investigate this issue, you find the following statistics: 1) among a sample of criminals, 1% are diagnosed with fetal alcohol syndrome; 2) about 6% of the total population engages in criminal activity over the course of their life; and 3) the rate of fetal alcohol exposure is 2 out of 1000 births. Do these numbers give you a reasonable basis to draw a conclusion about the advocates' claim? Explain your conclusion including any reservations you may have about this analysis.

$$P(\text{criminal}|\text{FAS}) = \frac{P(FAS \mid \text{criminal}) * P(\text{criminal})}{P(FAS)}$$

From Bayes Rule:

$$P(\text{criminal}|\text{FAS}) = \frac{.01*.06}{.002} = 30\%$$

This could go two ways. First, it suggests that FAS sufferers are more than 5X more likely to become criminals than people without FAS. On the other hand, even a person with FAS is more likely than not to NOT be a criminal. This latter point may be used to suggest that even folks with FAS are not predisposed to be criminals.

5. You are asked to perform an event study to analyze a securities fraud case. The potentially fraudulent statement was made on January 4, 2010. The relevant company had merged with another company on December 10, 2009. Between the merger and the current date December 9, 2011, the fraudulent statement is the only out of the ordinary thing to occur at this company. Does the fact of this merger complicate your event study? Why? Can you offer any solutions to mitigate this problem?

An event study requires estimating a model that provides a counterfactual prediction of the stock's return on the event day if the event had not occurred. For the counterfactual to be a good one, you need data that captures the firm's relationship with the market. Before the merger, this was a different firm with a relationship to the market that was likely different than the current firm has, so you can't really use pre-merger data. This restricts you to using only post-merger data which leaves you with < 25 data points. This is too few data points, most likely, to provide a reliable model. At a minimum, it will not be very precise so there would be power problems (i.e., standard errors will be very large making it hard to find statistical significance even if the event effect is quite large). To mitigate this problem, you might consider using post-event data which should provide you with a good idea of how this post-merger firm relates to the market.

6. You are retained as the plaintiff's expert in a discrimination case. The plaintiff alleges that his employer systematically discriminates against black employees in various ways, including paying them less than other employees with similar attributes. As evidence, you provide a wage regression showing that the coefficient on a dummy variable indicating that the worker is black is negative and statistically significant. In the regression, you control for age, seniority on the job, and education. The defense expert re-runs the regression including a control for the subjective score received by each employee during his most recent evaluation by management. In this new regression, the magnitude of the black dummy coefficient gets smaller and is no longer statistically significant. The defense claims that this shows the firm does not discriminate against blacks. Instead, the lower wage is justified by worse performance on the job. What is your response to this claim and the associated evidence?

The evaluation may itself be affected by bias/discrimination. If so, the evaluation variable will "absorb" some/much of the race effect. In this case, it is inappropriate to control for this (intermediate) outcome.

7. Choose one question, 1-6, to count double.

8. Download the dataset at http://www.law.upenn.edu/fac/jklick/examfall2011.csv which contains share price data for Apple and for an exchange traded fund that mirrors the S&P 500. After a long battle with cancer, Steve Jobs stepped down as the CEO of Apple on August 24, 2011 after stocks had finished trading for the day.

    a. Use an event study to estimate the effect of Jobs' resignation on the return to Apple's stock. Use the 100 days before the event to estimate your model.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.762741422
R Square	0.581774476
Adjusted R Square	0.573239261
Standard Error	0.011238662
Observations	101

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	0.017219	0.008609	68.16167	2.81E-19
Residual	98	0.012378	0.000126		
Total	100	0.029597			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*
Intercept	0.001924184	0.001127	1.7081	0.090784	-0.00031	0.00416	-0.00031
SPr	0.86719745	0.074396	11.65653	3.24E-20	0.719561	1.014834	0.719561
event	0.00475069	0.011344	0.418783	0.676291	-0.01776	0.027263	-0.01776

Jobs' resignation appears to have led to a positive return of 0.475%

b. At what type 1 error level would this effect be statistically significant?

According to the associated p value, this would be statistically significant at a type 1 error of 67.63%

c. Why might this approach underestimate the market's evaluation of the value of Jobs as Apple's CEO?

Two main issues: 1) The market presumably knew of Jobs' pending resignation given his health problems (or at least thought there was a high likelihood he would resign) and so the effect was likely capitalized into the price well before the actual resignation took place; 2) Apple is part of the S&P500 and also likely has some market-wide effects, so some of the effect may be included in the downward turn of the overall market.

d. Given your answer in 8.c, conceptually, how might you try to estimate the market's evaluation of the value Jobs provided as CEO more accurately?

Use a broader event window or focus on specific days when the market was given some indication that Jobs would step down. Also, net Apple out of the market index.

e. Interpret the R-squared produced in your event study.

The R2 suggests that the model (ie the market index and the event indicator) explains about 58% of the variation in Apple's returns over the 101 days studied.

f. In what way(s) is the R-squared a useful diagnostic statistic?

An R2 is somewhat useful for comparing the explanatory quality of various models examining the same data. All other things equal, in that case, a model with a higher R2 is generally better than one with a lower R2. No such comparison can be made using R2's to compare models looking at different datasets.