

Statistics 712, Spring 1999

Take-Home Final Exam

Your solutions to this exam are due back in my office by **10:30 am on Monday, May 3, 1999**. This is the time at which the normally scheduled in-class exam for this class would conclude. Unlike your homework assignments, you are **not** to discuss this exam with your classmates or any others. If you have a question, please come see me or send me an e-mail. We will discuss this exam in class on Thursday, so please read through all of the questions before then so that we can discuss them together. During the exam, I will post comments to the **class web page** so you might want to occasionally check there for any general announcement.

Please type your solutions. Be concise in your answers, particularly for items 1-9. Save discussion comments and tangential issues for question 10. You should show only the minimal computer output to justify your answers. Superfluous output will cost you points, so only add the figures and output that you need. Be sure to discuss any output graphic.

The context for these questions revolves around decisions at a privately held company that sells several established computer software products. Its products are mature and incur very small production and distribution costs, about \$0.10 per dollar in sales, not including promotional expenses. Promotional expenses are the main expenditure of this firm and have been increasing. In a battle to maintain market share, this company has steadily increased its advertising budget and is now considering plans to increase its level of promotion over the next year. Two managers have different opinions about how this planned level of expenditures for new advertising will affect sales. Manager A believes that sales will rise as expenditures increase, and offers a set of projections based on a regression model. Manager B is less optimistic and feels that the response of sales to more advertising will be flatter over this range of expenditures; he too has a model to support his conjecture. Both have submitted projections for the level of sales. Underlying data and these projections are in the file **Final.jmp** that you can get from the class web page. The data are quarterly with 36 quarters prior to the forecast period. The sales and advertising values in the data file are in millions of dollars (\$US).

The ownership of the firm has changed recently; the firm was inherited by one of the nine children of the previous owner (quarter 34 in this data). This new owner has a current net worth of about \$20M, and is considering taking the firm public.

- (1) Recover the regression models used by the two managers to predict sales from gross advertising levels. Describe briefly how the models capture the perspectives of these managers. Check that your models reproduce the offered forecasts given in the data file.
- (2) Can you distinguish which model identified in #1 is “right” from the data? Do the statistical summaries of these two models offer an apparent significant difference that would allow you to decide which set of projections is better?
- (3) A data-mining research firm was hired to consider alternative models using other types of predictors in addition to gross advertising. The additional predictors include the following (all are in the data file):
- *Season* (abbreviations for winter, spring, summer, fall).
 - *TV Share* of gross advertising expenses.
 - *Computer sales* of a particular configuration suited to the software sold by this firm (an index).
 - *Competitor advertising*, as estimated from commercials.
 - *Version update*, coded as 1 for a quarter in which a version update was released and zero otherwise.
 - *Lag version*, *Lag gross advertising* are one period lags of these.

The data-mining group produced the model summarized below, using combinations of predictors to investigate the presence of nonlinear terms. They claim that the small p-values for the estimates indicate extremely important predictors. Do you agree? Do you think that this model will give better prediction intervals than the simple models of Manager A or Manager B?

RSquare	0.908
Root Mean Square Error	0.370
Observations	36

Term	Estimate	Std Error	t Ratio	Prob> t
Intercept	123.733	34.979	3.54	0.0016
Season{W&Sp&Sm-Fall}	-0.810	0.225	-3.60	0.0014
TV Share	-100.436	47.833	-2.10	0.0460
Computer Sales	-1.401	0.325	-4.31	0.0002
Competitor Adv	1.945	0.497	3.91	0.0006
Lag Gross Adv	5.247	1.586	3.31	0.0028
TV Share*TV Share	-47.584	22.292	-2.13	0.0428
Comp sales*TV Share	1.752	0.357	4.90	<.0001
Comp Adv*Season	0.084	0.029	2.88	0.0081
Comp Adv*TV Share	-2.152	0.545	-3.95	0.0006
Lag Gr Adv*Comp Sales	-0.042	0.013	-3.27	0.0032

- (4) To keep our analysis of this company and its sales simple, we will continue using the model chosen by Manager A.
- (a) Find the 95% prediction interval for sales in quarter 40 (row 40) based on the model fit by Manager A.

- (b) Find the associated 95% prediction interval for net profits in quarter 40 (net of production costs and advertising). See the “profits” column in the data file for a formula.
- (5) Find the certainty equivalent value of the future profits to be earned during quarter 40 from the advertising campaign, based upon the assumed truth of the model of Manager A and the assumption that the owner has constant risk aversion. Does your CEV suggest that the new owner should go forward with this promotional campaign?
- (6) As suggested by the analysis performed by the data-mining group, consider the possibility that neither the model of Manager A nor Manager B is “right” for this data. As a result – at a minimum – one has to pool the resulting uncertainty from these two estimated forecasts. Given that one considers the form of the model unknown, treat the nominal 95% prediction intervals *for profits* produced by these two models as 50% subjective intervals and find the pooled subjective interval for profits.
- (7) Use the pooled subjective interval from #6 for these two items.
- (a) Find the expected utility of the profits implied by this interval. For this calculation, use the assumption that the utility of the new owner has the logistic form (where k is as defined in our other type of utility)
- $$U(x) = \frac{1}{1 + e^{-x/k}}$$
- (b) Find the certainty equivalent value based on the pooled subjective interval. At a minimum describe the procedure graphically if you are unable to complete the calculations.
- (8) The new owner is considering taking this firm public, and has found someone to underwrite an IPO expecting the total value of sold shares to be \$100M. (We cannot expect this \$100M value to be a reasonable estimate of the value of the firm farther back in time.) If we use this value to compute returns during recent quarters, we obtain the returns found in the data file. Based on these returns and the associated S&P500 returns found in the last column of the data file, would this company be a good investment?
- (9) Suppose that instead of focusing on quarter 40, you needed an analysis of the next year spanning quarters 37-40 and thus had to pool the intervals for quarters 37-40 into one. (You need not do calculations for this question.)
- (a) What additional information would you need in order to find an interval for the next year found by combining intervals for the four quarters?
- (b) Would this information – were it known – be expected to make the pooled interval longer, shorter or about the same as the one found by simply adding the values for quarters 38, 38, 39, and 40?
- (10) What advice would you offer to those considering purchasing shares of this company? Keep in mind that there are a great many privately held firms in the US, and relatively few of these are taken public each year. Are there other features of your analysis of this company that you think are relevant to point out to prospective purchasers?