M.S. Comprehensive Exam, August 2021

Department of Agricultural and Resource Economics, UC Davis

You have THREE hours for this exam after a 15 minute reading period. You do not need to use the whole time period. This exam consists of three questions. You must answer all three questions, which will be weighted equally.

Watch the time carefully. The logic used to answer each question is important, so be sure to clearly specify your reasoning using full sentences. Support your answers as rigorously as possible – e.g., using diagrams or equations. If you use graphs, make sure they are clearly labeled and large enough to read easily. This is not the time to economize on paper, but keep your responses clear and concise. Make sure your writing is legible; if we can't read it, it will be assumed to be wrong.

Students are expected to understand and comply with the "MS Comprehensive Exam Instructions – Summer 2021" details that were circulated. A few of these details are worth reiterating here:

- This exam will be "open book" in the sense that students can consult any books or notes – online or otherwise – during the exam. Student responses must be given entirely in their own words and cannot include direct quotes from anyone else.
- Students are not allowed to communicate in any form with any human during the exam other than the proctors and Christy Hansen (see below). Such unauthorized communication will result in the student(s) involved failing the exam.
- Student responses must be handwritten either on paper or electronically via touchscreen, or typed. Students can use a combination of handwritten and typed responses as they see fit.
- Students will keep their video on and their mic muted for the duration of the exam unless instructed otherwise.
- Students will be allowed short bathroom breaks by request via Chat to Christy Hansen.
- For technical or connection problems, students should contact Rich Sexton at (916) 955-7853 or (916) 939-7853.
- For clarifying questions about the exam, students should send a Chat to the host of the zoom meeting, which will rotate during the exam period.
- Students must scan and email their final answers to Christy Hansen (clhansen@primal.ucdavis.edu) within 20 minutes of the conclusion of the exam period.

QUESTION 1.

In November 2018 Californians passed Proposition 12, which established minimum space requirements for breeding hogs (sows) in California and also elsewhere in the U.S. for pork products intended to be sold into California. Prop 12's requirements are set to go into effect on January 1, 2022, and recently there have been multiple news reports, editorial opinion writing about Prop 12, and claims that pork would disappear from California grocery shelves or cost dramatically more to purchase if it were available at all. This question will ask you to use standard consumer, producer, and market theory to understand how proposition 12 will affect hog producers and pork consumers. For parts A – C you can assume "well behaved" preferences so that indifference curves are smooth, downward sloping, and exhibit diminishing marginal rate of substitution.

A. Suppose the most dire predictions are true and the pork prices in CA rise by 50%. Use your static model of consumer behavior to illustrate this effect. Let your two goods be pork (X—horizontal axis) and all other goods (Z). Depict the price change of this magnitude and show how consumption will change.

B. Show graphically how to decompose the price change in part A into income and substitution effects. Draw a new graph for this part.

C. You could use your graphs in part B to derive demand functions for pork. Let us suppose we have both the Marshallian (uncompensated) and Hicksian (compensated) demand functions, and you have been tasked with computing the welfare effect to California consumers from 50% higher pork prices. What welfare concept should you use? Given your choice, depict the change in economic welfare graphically using the appropriate demand function.

D. Now let us think about hog producers. There is general agreement that it will cost more per hog or per kilogram of pork meat to produce pork for California under Prop 12 rules. The following seem like reasonable assumptions: (i) hog producers have substantial fixed costs for buildings and equipment, (ii) marginal costs per hog (H) raised are strictly increasing in H, i.e., MC(H) > 0, MC'(H) > 0, (iii) hog producers are perfect competitors. Ignore Prop 12 for the moment, and show the relevant MC, average variable cost (AVC) and average total cost (ATC) curves for a typical hog producer, given the information provided. Show the producer's profit-maximizing production of hogs, H*, given market price per hog of P_H, and show graphically the magnitude of the profit earned.

E. Prop 12 of course only applies to pork coming into CA, about 9% of US pork consumption. Describe in words how you think US pork producers and the market will respond to implementation of Prop 12's rules on January 1. Will *any* hog producers convert to the Prop 12 rules—i.e., are the predictions of empty grocery shelves true? Will all of them convert? Only some convert? How will prices respond? You can draw graphs if you want, but your thoughtful understanding of market processes is what is most important here.

QUESTION 2

For parts A through C below, you may assume that you are working with a normal random variable that you observe *n* times. Each observation is an independent draw from the population that is known to be *Normal*(μ,σ^2). Equivalently, Y_1, Y_2, …., Y_n are independent and identically distributed *Normal*(μ,σ^2) random variables. The expected value of *Y* is μ and the variance of *Y* is σ^2.

A. You are interested in testing a hypothesis about the expected value of this normal random variable. It is known that the variance of the random variable is $\sigma^2 = 81$. You will have *n=9* observations, and wish to test the null hypothesis that the expected value of this random variable is *10*.

   Your alternative hypothesis is that the expected value is *not* equal to *10*.

   i. Give an appropriate test statistic, assuming that you would like the probability of a Type-I error to be *0.05.*
   ii. For your test, what is the probability of rejecting the hypothesis when it is true? What is the probability of rejecting the hypothesis when it is false, and the expected value is actually 7? What is the probability, in this case, of making a Type-II error?

B. Since the true expected value is unknown, for problems such as the one in part A, it was necessary to use an *estimator* of the expected value. The set of possible estimators is infinite, if we do not limit our consideration to those we have shown to have desirable properties. Give examples of estimators of the expected value of a normal random variable, from this infinite set of possibilities, that have the properties given in each part below:

   i. BLUE
   ii. Unbiased and consistent, but not efficient
   iii. Unbiased but not consistent
   iv. Biased but consistent
   v. Biased and inconsistent
   vi. Biased, asymptotically unbiased, and consistent
   vii. Biased, asymptotically unbiased, and not consistent

C. For part A, you calculated the probability of rejecting the hypothesis that the expected value is 10 when in fact it is 7. Suppose you did not trust your calculation, and wanted to use a program such as R or Stata to estimate this probability with a computer simulation.

   i. Explain how you would do so. You do not need to write a program or give the detailed commands, if you prefer just to give a verbal answer, but either way, your answer should be complete enough for someone to carry out the simulation based on your instructions.
   ii. What properties will you be willing to claim for your estimated probability? Specifically, is it unbiased? Is it consistent?

D. It turns out that there are some problems with your data set. First, you discover that there is one expected value for odd-numbered observations and a different expected value for even-number observations.
   i. Give a model that would allow you to estimate both expected values using ordinary least squares.
   ii. Are your estimates unbiased? Are they consistent? Are they BLUE?

E. Continuing to use the new assumptions from part D, it is now also discovered that the variance of each odd-numbered observation differs from the variance of each even-numbered observation.
   i. How would you modify your OLS estimator from part D to account for this? You may assume that $\sigma^2 = 81$ for odd-numbered observations and $\sigma^2 = 64$ for even-numbered observations.
   ii. Are your estimates unbiased? Are they consistent? Are they BLUE?

QUESTION 3.

A. Initial empirical analysis of consumer demand consisted of separately estimated demand equations for each good. Explain why estimating consumer demand relationships as a system of equations is preferable to such single demand equation estimation. Be specific.

B. "Most demand estimation applications of the AIDS model use cross-sectional and/or time-series variation to estimate the income and price parameters that are the basis for elasticity estimates." Explain what it means to "use cross-sectional variation" as the basis for estimating an income elasticity using data from a household survey.

C. Almas et al. (2019)[1] use a modified "single equation" AIDS model to estimate income elasticities for food in rural Kenya. The following is a description of this modified specification (p.12), where the "outcome of interest" is the budget share devoted to all food purchases.

The linearized AIDS is given by the following equation:

$$\omega_{hv} = \alpha + \beta \ln z^*_{hv} + \gamma(\ln p^f_v - \ln p^n_v) + \xi' \mathbf{X_{hv}} + \varepsilon_{hv} \qquad (1)$$

where ω_{hv} is the outcome of interest for household h in village v. z_{hv} denotes the monthly non-durable expenditure, and $\ln z^*_{hv} = \ln \frac{z_{hv}}{a^*(\mathbf{p_v})}$, where $\ln a^*(\mathbf{p_v})$ is the Stone price index: $\ln a^*(\mathbf{p_v}) = \overline{w^f} ln p^f_v + \overline{w^n} ln p^n_v$. p_v is a village price, where superscripts f and n refer to food and non-food prices, respectively. $\overline{w^x}$ is the average budget share for good $x \in \{f, n\}$ in the sample. X_{hv} is a vector of baseline demographic control variables[7], and ε_{hv} is an idiosyncratic error term.

i. Write down the standard linearized AIDS model specification that was first introduced by Deaton and Muellbauer (1980) using this same notation. Define any additional notation you introduce.

ii. What are the key differences between this Almas et al. (2019) specification and the standard linearized AIDS specification? (Hint: Do not compare a linearized AIDS model to the non-linearized AIDS model. Instead, focus on how their linearized AIDS model in equation (1) above is different than the standard linearized AIDS model from part (i).)

iii. With these differences in mind, describe <u>one</u> specific limitation of this modified approach with respect to consumer demand theory.

[1] Almås, Ingvild, Johannes Haushofer, and Jeremy P. Shapiro. "The income elasticity for nutrition: Evidence from unconditional cash transfers in Kenya." No. w25711. *National Bureau of Economic Research*, 2019. (here)

D. As an alternative to an estimation approach based on cross-sectional variation, Almas et al. (2019) leverage experimental variation in income introduced by large cash transfers of different random amounts that were distributed to households in randomly-selected villages. As they explain:

> For our main estimation, we use only endline data and apply $\ln UCT_{hv}$ as an instrument for $\ln z^*_{hv}$. $\ln UCT_{hv}$ is log of the randomly assigned cash transfer amount received by household h in village v. To deal with possible zeroes in the expenditure data, we use the inverse hyperbolic sine transform wherever we mention logs (Bur-

i. What econometric problem does this instrumental variable approach aim to fix? Where specifically does this problem comes from?
ii. What does it mean to "apply lnUCT_{hv} as an instrument for lnz^*_{hv},"? As part of your answer, write down what the first stage specification would look like for a 2 stage least squares (2SLS) version of this IV approach.
iii. Based on the standard criteria for instrumental variables and what you know about the context of this problem, do you think ln*UCT* is likely to be a good instrument? Explain.

E. The authors compare the elasticity estimates from their preferred IV approach with estimates from a version of equation (1) that is based only on cross-sectional variation in income. To do this, they (1) include lnz^*_{hv} directly in the regression rather than its predicted value using lnUCT_{hv} as an instrument and (2) only include data from control village households in the estimation.

i. Explain carefully why this alternative approach produces income elasticity estimates that are based only on cross-sectional variation in the data.
ii. The authors find that their income elasticity estimates change under this alternative approach. Whereas the estimated income elasticity using their preferred IV approach is 0.78 (std error= 0.126), it increases to 0.91 (std error= 0.029) when using only cross-sectional variation. Which of these two estimated income elasticities do you think is more credible? Justify your answer carefully.