

Exam #2

Economics 435

Spring 2003

Please make certain I can understand your answer. For example, circle or put boxes around your final answers, be careful to write clearly, etc. If I don't understand you, I will assume you are wrong.

Also, be sure to ask me if you are uncertain over what a question means.

1 A few short questions

- a) You have a data set of adults who are no longer in school. You are trying to estimate the return to schooling by estimating a regression of wages on whether the person attended university, but you are concerned about bias due to endogeneity. Will high school grades make a good instrumental variable? Explain.
- b) Suppose I estimate an OLS regression of the time series variable y_t on x_t and find strong evidence that the residuals are serially correlated. Does this imply my coefficient estimates are inconsistent?
- c) You have a panel data set on Canadian cities in 1982 and 1987. For each city and in each year, you observe the city's crime rate $crm rte_{it}$ and unemployment rate $unem_{it}$. You believe that the two are related in the following way:

$$crm rte_{it} = \beta_0 + \delta_0 d87_t + \beta_1 unem_{it} + a_i + u_{it}$$

where $d87_t$ is a year dummy variable for 1987, and a_i is a city fixed effect.

You decide to estimate an OLS regression of $\Delta crm rte_i$ on $\Delta unem_i$.¹ Let $\hat{\beta}_1$ be the OLS coefficient on $\Delta unem_i$. What are the *minimal* assumptions on u_{it} necessary for $\hat{\beta}_1$ to be a consistent estimator of β_1 ?

2 Mismeasurement in the CPI

It is well known that the consumer price index (CPI), which is used to calculate inflation rates, has some serious issues with mismeasurement. As a result, measured inflation rates are not exactly the same as the true increase in the cost of living.² Let a_i be the actual inflation rate in country i ,

¹In case it isn't obvious, $\Delta crm rte_i = crm rte_{i,87} - crm rte_{i,82}$ and $\Delta unem_i$ is defined similarly.

²Just a reminder on how the CPI works, for those of you that have forgotten. The government puts together a representative basket of goods (in other words, a shopping list for a typical family), then determines how much that basket of goods costs. Divide that number by the cost of the basket in some base year (it doesn't matter what year), then multiply by 100. The inflation rate is just the growth rate of the CPI.

let m_i be the measured inflation rate, and let g_i be the growth rate in per capita GDP. There is a linear relationship between actual inflation and growth:

$$g_i = \beta_0 + \beta_1 a_i + u_i \quad (1)$$

where the usual OLS assumptions hold (i.e., that you have a random sample of n countries, that $E(u_i|a_i) = 0$, and that there is some variation in a_i in the sample).

Unfortunately, you cannot observe a_i in your data set. Instead you try to measure the effect of inflation on growth by estimating an OLS regression of g_i on m_i . Let $\hat{\beta}_0$ be the intercept and $\hat{\beta}_1$ be the slope from that regression.

a) One source of measurement error is simply human imperfection - the people gathering the prices will write a number down incorrectly, or they will happen to “go shopping” on a day when a particular item is on sale. Suppose that this leads to classical measurement error, i.e., that

$$m_i = a_i + v_i \quad (2)$$

where the measurement error has the properties that $E(v_i|a_i, g_i, u_i) = 0$ and $E(v_i^2|a_i, g_i, u_i) = \sigma_v^2$. Find $\text{plim } \hat{\beta}_1$.

b) Explain what this means: is this coefficient an consistent estimator of β_1 , and if not, in what direction is the (asymptotic) bias? Options are “up”, “down”, “towards zero”, and “away from zero”.

c) Another source of measurement error is that the CPI has difficulty accounting for quality improvements in products. In particular items like computers and televisions become more and more powerful and useful, but price indices often must treat, for example, a 66 MHz 486 computer from 1990 as the same good as a 3 GHz Pentium 4 in 2003. As a result, some have estimated that the CPI overstates inflation by quite a bit. Suppose that the CPI always overstates inflation by $\gamma \geq 0$ percentage points, i.e.,

$$m_i = (1 + \gamma)a_i \quad (3)$$

Find $\text{plim } \hat{\beta}_1$.

d) Explain what this means: is this coefficient an consistent estimator of β_1 , and if not, in what direction is the (asymptotic) bias? Options are “up”, “down”, “towards zero”, and “away from zero”.

e) Unfortunately it’s more complicated than that. Because the CPI tends to overestimate the rate of inflation in high-technology goods, and because the basket of goods in such countries includes more high-technology goods in countries which are technologically advanced, the CPI overstates inflation by more in those countries than in other countries.

To keep things as simple as possible, suppose that h_i equals one when a country is “technologically advanced” and zero when it is not. Suppose that a country’s level of technological advance affects its growth:

$$g_i = \beta_0 + \beta_1 a_i + \beta_2 h_i + u_i \quad (4)$$

where the usual OLS assumptions hold. Although in principle, the effect of high-technology on growth could be positive or negative, let’s assume that $\beta_2 \geq 0$. Also assume that a_i and h_i are uncorrelated.

Also suppose that inflation is measured correctly in low-technology countries but is mismeasured by $\lambda \geq 0$ percentage points in high-technology countries.

$$m_i = a_i + \lambda h_i \quad (5)$$

As before, you only observe g_i and m_i (note that you do not observe h_i), and estimate a simple OLS regression of g_i on m_i . Find $\text{plim } \hat{\beta}_1$.

f) Determining the direction of (asymptotic) bias here is somewhat complicated, so we will focus on a few special cases. First, when inflation has no direct impact on economic growth ($\beta_1 = 0$), what is the direction of asymptotic bias (upwards/downwards/towards zero/away from zero/none)? Second, when technology has no affect on economic growth ($\beta_2 = 0$), what is the direction of asymptotic bias? Third, when inflation is measured correctly for both high and low technology countries ($\lambda = 0$), what is the direction of asymptotic bias?

g) Suggest an easy-to-obtain proxy variable for h_i , and describe the regression you would estimate to get an improved estimate of β_1 (there are many correct answers).

3 Estimating the demand for cigarettes

Suppose that you observe, for a cross section of US states, the sales tax rate on cigarettes (t_i), and log quantity of cigarettes purchased in that state (q_i). Let p_i^D be the log price paid by the consumer and let p_i^S be the log price received by the producer, so that $p_i^D = p_i^S + t_i$.

Assume that the tax rate is exogenous and that both the supply and demand curve are log-linear:

$$\begin{aligned} p_i^S &= \alpha_0 + \alpha_1 q_i + v_i \\ q_i &= \beta_0 + \beta_1 p_i^D + u_i \end{aligned}$$

where $\alpha_1 \geq 0$ and $\beta_1 \leq 0$. Notice that the supply curve has price on the left side and quantity on the right side. This will make the math easier.

a) Suppose you only have data on taxes and quantity (no prices), and you estimate an OLS regression of q_i on t_i . Let $\hat{\beta}_1$ be the OLS coefficient on t_i . Under what conditions will $\hat{\beta}_1$ be a consistent estimate of the price elasticity of demand?

b) Interpret these conditions in economic terms. A really good answer would include a supply/demand graph, words like elastic, inelastic, incidence, etc.