

PROBLEM SET 7: INSTRUMENTAL VARIABLES

MGMT 737

1. **Compliers and Weak IV:** We explore Angrist and Evan (1998), who study the impact of children on parents' supply. This paper has two instruments: 1) whether the first two children of a mother are the same sex *Same sex*; 2) whether the second (successful) pregnancy is twins *Twins-2*. The 1980 Data for this paper is available in the repository in a csv `ang_ev_1980.csv`.

I was not able to perfectly match AE's sample but it is very close. As a result, the point estimates are not identical, but are close enough that you should be able to feel confident. You may use pre-built estimation packages unless otherwise stated.

More than 2 children is `morekids`, *Number of children* is `kidcount`, *worked for pay* is `mom_worked`, *Weeks worked* is `mom_weeks_worked` and the two dummy instruments are `samesex` and `twins_2`.

- (a) Replicate the coefficients from Table 5, Column 1, rows 1-4, using a linear regression.
→ Report your answer for row 1 as `problem_1a` in your code.
 - (b) Replicate the coefficients from Table 5, Column 2, rows 3-4, using 2SLS. Convince yourself you could construct this estimate by hand using the result in the previous answer.
→ Report your answer for row 3 as `problem_1b` in your code.
 - (c) Replicate the coefficients from Table 5, Column 7, rows 1-4, using a linear regression.
→ Report your answer for row 1 as `problem_1c` in your code.
 - (d) For the endogenous variable "More than 2 children", what is the complier share for each of the two instruments?
→ Report your answer as `problem_1d` in your code.
 - (e) For the endogenous variable "More than 2 children" and each of the two instruments, what is the average share of the complier population with an education greater than high school (`moreths`)? What about different mother race shares?
→ Report your answer for `moreths` as `problem_1e` in your code.
 - (f) Using the Same sex instrument, construct the Weak IV robust Anderson-Rubin confidence intervals using the algorithm outlined in Chernozhukov and Hansen (2007) (see the slides)
→ Report the size of the confidence interval from your answer as `problem_1f` in your code.
2. **Kitagawa test** Now we implement the Kitagawa (2015) test for instrument validity. We will focus on the *worked for pay* outcome as our endogenous variable Y , more than two children as our endogenous variable, and our two instruments will be as before (same sex and twins). Implement the procedure below for both instruments.

- (a) Let $P(y, d) = n_1^{-1} \sum_{i: Z_i=1} 1(Y_i = y, D_i = d)$, where n_1 is the number of observations where $Z_i = 1$ in the sample, and $Q(y, d) = n_0^{-1} \sum_{i: Z_i=0} 1(Y_i = y, D_i = d)$, where n_0 is the number of observations where $Z_i = 0$ in the sample. $n = n_0 + n_1$. Estimate $P(y, d)$ and $Q(y, d)$ and report them for the 4 possible pairs of (y, d) .
→ Report $P(1, 1)$ as `problem_2a` in your code.
- (b) Next, we want to calculate the following statistic (Note that this is simplified relative to the general Kitagawa case because Y is binary):

$$T = \left(\frac{n_0 n_1}{n} \right)^{1/2} \max \left\{ \sup_{y \in \{0,1\}} \left\{ \frac{Q(y, 1) - P(y, 1)}{\xi \vee \sigma_{P,Q}(y, 1)} \right\}, \sup_{y \in \{0,1\}} \left\{ \frac{Q(y, 0) - P(y, 0)}{\xi \vee \sigma_{P,Q}(y, 0)} \right\} \right\}$$

where ξ is a trimming constant that you pick, \vee denotes the “max” between the two objects, and

$$\sigma_{P,Q}^2(y,d) = (1 - \hat{\lambda})P(y,d)(1 - P(y,d)) + \hat{\lambda}Q(y,d)(1 - Q(y,d)), \quad \hat{\lambda} = n_1/n.$$

Estimate σ for each of the four possible pairs of (y,d) , and then calculate the T based using a $\xi = 0.1$. Report this T statistic.

→ Report your answer for T as `problem_2b` in your code.

- (c) Now, we need to construct critical values for the statistic T . First, take the subsample of n_1 observations where $Z_i = 1$. Sample a new set of n_1 observations from this subsample, with replacement using weights $H(y,d) = \hat{\lambda}P + (1 - \hat{\lambda})Q$. (E.g. the weight of drawing each observation is a function of this combined probability). Use this new data to construct a new empirical distribution P^* . Similarly construct a new sample of n_0 observations based on the subsample of observations where $Z_0 = 0$ using $H(y,d)$. Use this to construct Q^* . Then, calculate the T statistic above, but using P^* and Q^* in place of P and Q .

→ Report your answer for T^* as `problem_2c` in your code.

- (d) Repeat this last process 500 times and construct a distribution of the T^* . We reject the null of instrument validity (exclusion and monotonicity) at the 5 percent level if T is greater than the 95th percentile of the distribution of T^* . Identify what quantile T sits in the distribution of T^* .

→ Report the quantile as `problem_2d` in your code.