

# ADVANCED ECONOMETRIC COURSE

## PART I: BASIC ECONOMETRIC MODELS



### Problem Set 2: Instrumental Variable Estimators

#### Cartels and Price Fixing

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In the US, both Federal and state governments spent millions of dollars on anti-trust suits against Microsoft. Proving monopolistic behaviour is no easy task. Economists use econometric tools to determine whether shifts in prices and quantities indicate that a company or group of companies has market power (that is, that it is a price-setter rather than a price-taker). In this problem set, you will use market data to attempt to decide whether a cartel was at work in a nineteenth century market: the market for railroad transportation of grain.

Price-fixing was not illegal in the US until the Sherman Antitrust Act of 1890. This Act was a response to the market power of the railroad “robber barons,” which included such names as Vanderbilt and Forbes. Their cartel, the “Joint Executive Committee” (JEC), controlled the railroads which, among other things, carried grain from the farmlands of the Midwest to coastal ports. During this period, however, the price of shipping grain by rail still fluctuated. One reason for the price fluctuations is that the JEC price-fixing agreement collapsed into a price war a dozen times between 1880 and 1886. Economic historians attribute this to random fluctuations in each railroad’s market share that caused them to suspect each other of price-cutting. Another reason that prices fluctuated was that the Great Lakes periodically froze over, making shipping grain by boat impossible and temporarily increasing the demand for rail shipping services.

Economic theory predicts two telltale signs of a cartel. First, a cartel increases prices! To see if the JEC raised the price of shipping services above its competitive level, you will compare the price charged for shipping grain by rail during periods when the cartel was active and inactive. The second, more subtle, sign of market power is that price and output are at a point where demand is elastic (that is, the price elasticity is  $\leq -1$ ). [Suppose demand is inelastic, for example, the price elasticity is  $-0.5$ . Then a 1% increase in price leads to less

than a 1% decline in quantity demanded, so the increase in price more than compensates for the reduction in units sold so total revenue = price  $\times$  quantity goes up. Thus firms operating in a region of inelastic demand would want to raise prices at least to the point that demand becomes elastic, and if they form a successful cartel, they should be able to do so.] To examine whether demand is elastic or inelastic, you will estimate the own-price elasticity of demand for rail shipping of grain.

1. Estimate the own-price elasticity of demand by using OLS to regress the log of the quantity of grain shipped on the log of the price of shipping grain and the full set of month binary indicators.
  - a. What are the estimated demand elasticity and its standard error?
  - b. Explain why the interaction of supply and demand plausibly makes this estimator of the elasticity biased.
2. Consider two possibilities for instrumental variables: whether the railroad cartel was experiencing one of its periodic collapses (*cartel*), and whether the Great Lakes are closed because of ice (*ice*).
  - a. Use economic reasoning to argue whether *cartel* plausibly satisfies the two conditions for a valid instrument.
  - b. Use economic reasoning to argue whether *ice* plausibly satisfies the two conditions for a valid instrument.
3. Read Table 1, then compute and fill in the missing entries. Note that an additional blank column and blank row have been provided in case you have an additional specification and/or estimator you wish to report; you are not expected to fill in entries in the blank row when running regressions (1) – (5).
4. Write a brief essay (400 words or less) in which you:
  - Indicate which (if any) of the regressions in Table 1 provide the more reliable estimates of the demand elasticity, and why;
  - Draw a conclusion about whether or not there is evidence of cartel pricing;
  - Summarize what you consider to be the main threats, if any, to the internal validity of this study.

**Table 1: Estimates of the own-price elasticity of the demand for rail shipments of grain, 1880 – 1886**

	(1)	(2)	(3)	(4)	(5)	(6)
<i>Dependent variable:</i>	$\ln(P)$	$\ln(Q)$	$\ln(Q)$	$\ln(Q)$	$\ln(Q)$	
<i>Regressors:</i>						
<i>cartel</i>		–	–	–	–	
$\ln(P)$	–					
<i>F</i> -statistic testing coefficients on monthly indicators ( <i>p</i> -value)						
Estimation method	OLS	OLS	TSLs	TSLs	TSLs	
Instrumental variables	n/a	n/a	<i>cartel</i>	<i>ice</i>	<i>ice, cartel</i>	
First stage <i>F</i> -statistic	n/a	n/a				
<i>J</i> -test of over identifying restrictions	n/a	n/a	n/a	n/a		

**Notes:**

$\ln(P)$  is the logarithm of the price of transporting one ton of grain by rail and  $\ln(Q)$  is the logarithm of the quantity (weekly tonnage) of grain shipped. The entries in the rows labelled *cartel* and  $\ln(P)$  are the corresponding regression coefficient and, in parentheses, its heteroskedasticity-robust standard error, estimated using the regression method in the relevant column. All regressions contain a full set of monthly indicators, and the row labelled “*F*-statistic testing coefficients on monthly indicators (*p*-value)” gives the *F*-statistic (and its *p*-value in parentheses) testing the hypothesis that the coefficients on these monthly indicators are all zero. The penultimate row presents the first-stage *F*-statistic testing the hypothesis that the coefficients on the instruments are zero in the first-stage regression, when TSLs is used, and the final row presents the *J*-test of over identifying restrictions. All regressions contain an intercept, the value of which is not reported in the table. The data are weekly, 1880-1886, for a total of  $n = 328$  observations. Note that there are 13 “months” in a year in this dataset (see the variable definitions).

**DATA DESCRIPTION, FILE: grain.dta**

The data are weekly for the period 1880 to 1886, for a total of  $n = 326$  weeks.

Variable	Definition
<i>week</i>	week of observation: = 1 if 1/1/1880-1/7/1880, = 2 if 1/8/1880-1/14/1880, ... = 328 for final week
<i>price</i>	= weekly index of price of shipping a ton of grain by rail
<i>ice</i>	= 1 if Great Lakes are impassable because of ice, =0 otherwise
<i>cartel</i>	= 1 railroad cartel is operative, = 0 otherwise
<i>quantity</i>	= total tonnage of grain shipped in the week
<i>seas1 – seas13</i>	= Thirteen “month” binary variables. To match the weekly data, the calendar has been divided into 13 periods, each approximately 4 weeks long. Thus:  seas1 = 1 if date is January 1 through January 28, =0 otherwise seas2 = 1 if date is January 29 through February 25, =0 otherwise...  seas13 = 1 if date is December 4 through December 31, =0 otherwise

**STATA HINTS**

<code>ivreg y w1 w2 (x1 = z1 z2), r</code>	TSLS estimation of a regression of $y$ against one endogenous regressor ( $x1$ ) and two included exogenous regressors ( $w1$ and $w2$ ), using $z1$ and $z2$ as instruments, with heteroskedasticity-robust
<code>predict e1, residuals</code>	computes residuals from most recently estimated regression and saves them in the
<code>dis chi2(1,cstat)</code>	displays to the screen the probability in the tail of the chi-squared distribution with 1 degree of freedom, to the left of the value <i>cstat</i> .
<code>reg y x seas*, r</code>	OLS regression of $y$ on $x$ and on all variables which have a variable name beginning with the letters “seas” (robust standard errors)
<code>testparm seas*</code>	$F$ -test of the hypothesis that the coefficients are zero on all regressors with first four letters “seas” in the most recently run regression