Applied Econometrics II
Heinz School, Carnegie Mellon University
90-771, Spring 2004-5

Solution #1

Using the coalgas dataset from the course website, we are going to build a model of the natural gas market in the US. As is the case for coal, the domestic production of natural gas is highly geographically concentrated in the US, and the costs of shipping natural gas (in this case via pipelines) is quite high and increasing in distance from the supplying states.

Natural gas is used both to generate electricity and directly to heat homes (as well as in chemical plants and in other industrial applications).

1. **Please estimate demand and supply for natural gas using OLS. Be sure to explain which variables you are including in your models and why. Evaluate the slopes of the demand and supply curves (are they in the "right" direction, significant, what elasticities do they imply).**

   Please see pages 7 through 10 of the SAS output.

   In the demand curve belong the log of quantity (because a demand curve relates price and quantity for the demand side of a market), population and income (because these pretty much always shift demand for goods), cooling degree days (because natural gas may be used to generate electricity for cooling), and heating degree days (because natural gas is used to heat homes and businesses).

   In the supply curve belong gtop5 and gadj as crude measures of the costs of transporting natural gas among states.

   The demand curve estimations (by OLS) on pages 7 and 8 reveal a downward-sloping demand curve with a very high elasticity, -18 and -6 on pages 7 and 8 respectively. As one would expect, when we include more demand shifters in the demand curve, this causese the demand curve slope to rise. Including more demand shifters moves these variables out of the error term. This means that the error term contains relatively more variation from the supply side, which is "good" variation with which to identify the demand slope.

   The non-price variables in the demand curve on page 8 seem to have reasonable signs. Income, population, heating degree days, and cooling degree days all seem to increase demand as economic theory would predict.

The supply curve estimated by OLS appears on pages 9 and 10. The supply elasticity on these two pages is -18 and -26, respectively. With the inclusion of the supply shifters, the supply curve becomes more positively sloped, as expected and for reasons similar to the ones above. Notice that the supply curve slope parameter is significant in these regressions: using OLS, we would reject the usual economic theory that supply curves are either flat or slope up!

The non-price variables in the supply curve on page 10 have reasonable coefficients. States which are among the top 5 gas producers or which border the top 5 gas producers have a higher supply (ie lower price for each quantity), and the supply is higher in the top5 than in the adjacent.

The estimate of the slope of the supply curve is contrary to economic theory (ie it seems to slope down) even with the controls for supply shifters. The demand curve does seem to slope downward, but the demand curve as estimated is quite flat, with an elasticity of -6 even with demand shifters included.

It seems that both the supply and demand estimations are producing biased estimates, due to simultaneous equations bias and this bias is particularly evident in the supply curve estimation.

2. **Please redo these analyses using two stage least squares.**

   The analyses are done with two stage least squares on pages 13 and 14. The analysis is done again using three stage least squares on pages 15-18: notice that the 3SLS command first estimates the model by 2SLS and then by 3SLS, so there is a repetition of the analysis of pages 13 and 14.

   Looking at the 2SLS demand estimates on page 13 and the 3SLS demand estimates on page 18, we see a demand curve with a more negative slope than under the OLS estimates. The estimated demand elasticity is about -4. Again, the coefficients on the demand shifters seem reasonable: population, income, heating degree days, and cooling degree days all seem to increase demand for gas, although cooling degree days does not have a big enough effect to achieve statistical significance.

   Looking at the 2SLS supply estimates on page 14 and the 3SLS supply estimates on page 17, we see a supply curve with a slope closer to zero and no longer significantly different from zero. The estimated supply elasticity is about -50, using the 3SLS results. The supply shifters again have the "right" sign and pattern, supply is greatest in top 5 producing states, second greatest in adjacent states, and least in distant states. In these regressions, we cannot reject the null hypothesis of a flat supply curve, so most likely the supply curve for natural gas is flat.

3. **Please redo the analyses in 2 accounting for the fact that coal is a substitute for natural gas in the generation of electricity.**

If coal and natural gas are substitutes in the production of electricity, then coal price should appear in the demand curve for natural gas and natural gas price should appear in the demand curve for coal. On pages 20-23 are the 2SLS and 3SLS estimates of natural gas demand and supply. Notice that we must instrument for coal price, since it is endogeneous — once we permit coal and gas markets to be related then the prices and quantities in the two markets are jointly determined.

If coal and gas are substitutes, we would expect to see a positive coefficient on coal price in the natural gas demand equation. Looking at pages 21 and 23, we do see a positive coefficient, but not a significant one. The coefficient is quite large, but insignificant, so it is difficult to know what to think. Our best estimate is that coal and gas are substitutes, pretty strong ones, but there is not enough information in the data to be sure that they are not substitutes at all. Notice that the demand elasticity for gas is pretty much unchanged at -4 or -5.

4. **Who will pay a 10% tax on natural gas?**

   Consumers. A flat supply curve means consumers pay 100% of any tax.

5. **Is the 10% tax likely to affect the market for coal? Why or why not?**

   Probably. The estimates indicate that the coal and gas markets are connected on the demand side — coal and gas seem to be substitutes in demand. So, a 10% tax on gas is likely to increase the demand for coal, as power companies switch over from gas-fired to coal-fired plants (and maybe as consumers switch over from gas-fired to electric furnaces, over time). It is hard to be certain about this, however, since the effect of coal price on gas demand was statistically insignificant