Problem Set 2 - Econ-450-3

Due date: June 1, 2016. Send to mar.reguant@northwestern.edu.
Northwestern University, Spring 2016

Mixed Integer Programming

This problem set will give you baseline code to get started with mixed integer programming. The problem in itself is simple (a capacity constrained production game with entry, perfectly competitive). **Take it as a toy example.** The example follows the "Building Blocks" article by Jim Bushnell.

The baseline model is competitive, and therefore very straightforward to solve even without using these tools. These methods are also used in electricity papers with strategic behavior and many power plants, where it can be more useful (Bushnell, Mansur and Saravia (2008); Ito and Reguant (2016). I have also used them to estimate some functions with kinks, as these solvers also allow for some quadratic elements.

Setup

The baseline code has investment in three technologies, coal, gas and peak. Each hour, the market clears. Technologies set prices equal to marginal cost unless they are not producing at all, or producing at capacity. Investment is such that firms break even within each technology group.

The problem can be expressed as a complementarity problem, which will solve very fast with PATH solver. It can also be converted into a mixed integer program and use other solvers, generally less efficient, but more flexible. I have added code for Matlab using PATH.

Exercises

1. Add renewable energy to the program endogenously, as a new technology.
    - For this extension, you can assume capital cost of one unit is 100, marginal cost is zero.
    - Note that the data set has some wind series, you will need to make some assumptions on how much quantity one unit of wind investment gives you at each period.
    - Note: at most this should be one per unit of investment.
2. Introduce a subsidy for wind.
    - This means that wind gets the price plus a subsidy.
3. Introduce a carbon tax.
    - This means that coal, gas, and peak get taxed proportional to their emissions rates.
4. Find the optimal subsidy according to whatever goal you choose.
    - The optimal tax is equal to the cost of carbon (the externality, you can assume it is $30.
    - Subsidies can be inefficient, compared to the tax.
    - You need to find the second best.

Alternative

If you have a particular application in the context of your research, in which you think these tools can be helpful, you can also try to implement your own example.

Notes

The data set includes actual demand and prices for a period of 200 hours. Each day has a weight which add up to 8,760 (number of hours in a year). The data also contain two wind series, which need to be rescaled.

Handing your solution in

Please turn in the following via email to mar.reguant@northwestern.edu:

- A brief explanation of what you did.
- Your code.