Introduction to Political Economy 14.770
Problem Set 4 Solutions

Arda Gitmez

December 13, 2017

Question 1:

Consider the Dal Bó and Dal Bó (2011) / Dube and Vargas (2013) model of commodity prices and civil conflict. Assume that country X has two productive sectors, sector 1 and sector 2. Both of these sectors employ two factors of production: capital with a rental price r, and labor with a rental price w. The productive sectors involve many firms which maximize profits and use technologies characterized by constant returns to scale. The factor endowments in the economy are available in fixed amounts, $\overline{K}$ and $\overline{L}$.

Let y_1 be the output of sector 1, y_2 be the output of sector 2, and let p denote the relative price of good 1 in terms of good 2: p_1/p_2.

Government charges a tax rate to capital income resulting in revenue

$$R = \tau \cdot r \cdot \overline{K}$$

The third sector in the economy is the rent seeking sector. This sector only uses labor (L_s) and appropriates a fraction $s(L_s)$ of tax revenue, where $s'(L_s) > 0$, $s''(L_s) < 0$. The total appropriation from rent seeking is divided among those in that sector, which yields a per capita rent of

$$\frac{s(L_s)}{L_s}\left(\tau \cdot r \cdot \overline{K}\right)$$

Denote a_{iK} the capital requirements in the production of good i and similarly denote a_{iL} the labor requirements in the production of good i, so that making a unit of good i requires a_{iK} units of capital and a_{iL} units of labor.

1. *Write down the equilibrium conditions of the model assuming perfectly competitive markets in the two goods, and assuming that labor earners can move freely between the productive sectors and the rent seeking sector.*

We have five equilibrium conditions:

Zero profit condition firms 1 and 2 (follows from perfectly competitive markets and constant returns to scale production technology):

$$a_{1K} \cdot r + a_{1L} \cdot w = p \tag{1}$$

and

$$a_{2K} \cdot r + a_{2L} \cdot w = 1 \tag{2}$$

Market clearing conditions for inputs of production:

$$a_{1K}y_1 + a_{2K}y_2 = \overline{K} \tag{3}$$

and

$$a_{1L}y_1 + a_{2L}y_2 = \overline{L} - L_s \tag{4}$$

Finally, the fact that labor can move freely between productive and rent seeking sectors implies that earnings from each option must be equal:

$$w = \frac{s(L_s)}{L_s}\left(\tau \cdot r \cdot \overline{K}\right) \tag{5}$$

Equations (1)-(5) define an equilibrium. Note that we have have five quantities endogenously determined in equilibrium: factor prices r and w, output y_1 and y_2, and measure of people in the rent-seeking sector L_s.

2. *Assume that good 1 is more capital intensive than good 2, $a_{1K}/a_{1L} > a_{2K}/a_{2L}$. What is the effect of an increase in the relative price p on the number of people in the rent seeking sector?*

   There's the rigorous way of solving this (by taking derivatives etc.) but I'll present the more heuristic method below.

   You should start by realizing that Equations (1) and (2) pin down r and w. Since $a_{1K}/a_{1L} > a_{2K}/a_{2L}$, the only way these equations are satisfied when p increases is by increasing r and decreasing w. Thus:

$$p \uparrow \quad \Rightarrow \quad r \uparrow, w \downarrow$$

Next, realize that for Equation (5) to be satisfied with a higher value of r and lower value of w (where $\overline{K}$ is unchanged), we need $\frac{s(L_s)}{L_s}$ to decrease. Under the assumptions given in question, $\frac{s(L_s)}{L_s}$ is decreasing in L_s,[1] so we need an increase in L_s. Therefore,

$$p \uparrow \quad \Rightarrow \quad L_s \downarrow$$

This is in line with what we discussed – when the price of the capital intensive sector goes up (e.g. a positive oil price shock) the number of people in the unproductive sector (and therefore conflict) increases.

If you want to do it by taking derivatives, here are the calculations. By Equations (1) and (2):

$$\begin{pmatrix} r \\ w \end{pmatrix} = \frac{1}{a_{2L} \cdot a_{1L} - \left(\frac{a_{1K}}{a_{1L}} - \frac{a_{2K}}{a_{2L}}\right)} \begin{pmatrix} a_{2L} & a_{1L} \\ -a_{2K} & a_{1K} \end{pmatrix} \begin{pmatrix} p \\ 1 \end{pmatrix}$$

Therefore,

$$\frac{\partial r}{\partial p} = \frac{1}{a_{1L} - \left(\frac{a_{1K}}{a_{1L}} - \frac{a_{2K}}{a_{2L}}\right)} > 0$$

$$\frac{\partial w}{\partial p} = \frac{-a_{2K}}{a_{2L} \cdot a_{1L} - \left(\frac{a_{1K}}{a_{1L}} - \frac{a_{2K}}{a_{2L}}\right)} < 0$$

Now, differentiating Equation (5) with respect to p and rearranging we have:

$$\frac{dL_s}{dp} = \frac{L_s \left(\frac{s(L_s)}{L_s} \cdot \tau \cdot \overline{K} \cdot \frac{dr}{dp} - \frac{dw}{dp}\right)}{\left(\frac{s(L_s)}{L_s} - s'\left(L_s\right)\right) \cdot \tau \cdot r \cdot \overline{K}} > 0$$

3. *Now assume that there is a decline in the stock of capital in the economy, $\overline{K}$. What is the equilibrium effect of this capital stock reduction on the number of rent seekers and the production of the two goods? Explain the intuition behind the results.*

   I'll conduct the same approach: first solve by eyeballing the equations and then take derivatives.

[1] The numerator is concave and the denominator is linear!

Since p is unchanged, Equations (1) and (2) are unchanged, so r and w must remain unchanged. Therefore, for Equation (5) to hold with a lower value of $\overline{K}$, we need an increase in $\frac{s(L_s)}{L_s}$. Consequently, L_s must decrease:

$$\overline{K} \downarrow \quad \Rightarrow \quad L_s \downarrow$$

Next, realize that Equations (3) and (4) pin down y_1 and y_2. Since $a_{1K}/a_{1L} > a_{2K}/a_{2L}$, the only way these equations are satisfied when $\overline{K}$ decreases and $\overline{L} - L_s$ is by decreasing y_1 and increasing y_2. Therefore,

$$\overline{K} \downarrow, L_s \downarrow \quad \Rightarrow \quad y_1 \downarrow, y_2 \uparrow$$

This is again in line with our discussion in class. When there is a negative shock in capital stock, output of the capital-intensive sector decreases and that of the labor-intensive sector increases. Consequently, more people are employed in the labor-intensive sector and fewer people are involved in rent-seeking activities.

To show this by taking derivatives: Once again, argue that r and w must remain the same. Differentiating Equation (5) with respect to $\overline{K}$ and rearranging we have:

$$\frac{dL_s}{d\overline{K}} = \frac{s(L_s)}{\left(\frac{s(L_s)}{L_s} - s'(L_s)\right) \cdot \overline{K}} > 0$$

Using Equations (3) and (4):

$$\begin{pmatrix} y_1 \\ y_2 \end{pmatrix} = \frac{1}{a_{1K} \cdot a_{2L} - a_{2K} \cdot a_{1L}} \begin{pmatrix} a_{2L} & -a_{2K} \\ -a_{1L} & a_{1K} \end{pmatrix} \begin{pmatrix} \overline{K} \\ L - L_s \end{pmatrix}$$

This implies that

$$\frac{dy_1}{d\overline{K}} = \frac{a_{2L} + a_{2K} \cdot \frac{dL_s}{d\overline{K}}}{a_{1K} \cdot a_{2L} - a_{2K} \cdot a_{1L}} > 0$$

$$\frac{dy_2}{d\overline{K}} = -\frac{a_{1L} + a_{1K} \cdot \frac{dL_s}{d\overline{K}}}{a_{1K} \cdot a_{2L} - a_{2K} \cdot a_{1L}} < 0$$

Question 2:

Several recent papers have looked at the relationship between rainfall and conflict risk. In this exercise you will be asked to explore this relationship drawing on the debate between Miguel et al. and Ciccone.

Solutions courtesy of Matt Lowe.

1. *Briefly summarize the empirical strategy in Miguel et al (2004), their main specification and the argument made by Ciccone (2011).*

   Miguel et al (2004) regress conflict on growth and lagged growth, instrumenting for growth and lagged growth using rainfall growth and lagged rainfall growth (plus year and country fixed effects, country-specific linear time trends and controls). Ciccone (2011) argues that a functional form with rainfall in levels is more sensible (and nests Miguel's functional form), but that when doing this, we find that Miguel's result is driven by a nonsensical positive correlation between rainfall levels at $t-2$ and conflict at t. Ciccone shows more explicitly how the coefficients on rainfall growth rates can be misleading since they are not necessarily of the same sign of coefficients on rainfall levels, when the level relationship is the true relationship.

2. *Now skim through Miguel's response (Miguel and Satyanath, 2011). What are their counterarguments?*

   Their first argument is that Ciccone doesn't do the IV specification using the levels, and that in fact the main result from the IV holds up. This is not particularly persuasive since Ciccone's argument still stands that reduced form relationship of rainfall on growth does not fit well with the story that Miguel et al argue for.

   They make the additional argument that the instrument is not powerful for recent years of data, and so should not be used – this is a fair point (and in general, if results are sensitive to extending the time period, this does not invalidate the result for the shorter period. We can just think of this as heterogeneity – e.g. one story would be that as social insurance improves, the relationship between conflict and negative income shocks gets weaker).

   The third argument they make is that Ciccone does not justify theoretically that the levels relationship is the correct one. Whilst Miguel gives a reason why the growth specification may be preferred (drawing on the behavioral economics literature that "changes" are what matter for social unrest), it seems equally plausible to me at least that the absolute level of income (thus absolute level of rainfall) is what matters (e.g. this is true even with reference-dependent preferences if the reference point is fixed across time, and not just the last period, for example). Whether Ciccone's lack of a formal model should bother us is then not obvious.

3. *What is your stance on this debate? Is there any other specification you would like to try with the available data?*

   Open question. Would be good to see the relationship tested using within-country data (at least, the reduced form between conflict and rainfall), and can then control for country-year fixed effects.

4. *Excessive rain can be harmful for agriculture and for the economy as a whole, if it produces floods. Is this addressed in any of the papers above? How could it be?*

   This suggests that we might want to allow a non-linear relationship in the first stage – e.g. we could code a dummy equal to one for each decile of rainfall levels (using historic averages for deciles) and test for the non-linear effect of rainfall on income. If there is non-linearity, having a more flexible set of instruments (like this set of dummies) could increase power.

5. *Can you think of reasons why the exclusion restriction in Miguel et al. would not hold? If you had access to unlimited data, how would you check this?*

   Rainfall may affect conflict by making dirt roads untraversable. This may make it difficult for rebels to transport troops or for governments to put down rebellion. Miguel et al. test this by looking for affects on World Bank data of road usability (but I doubt this data is good quality). Sarsons (2015, JDevE) has a more direct test for the exclusion restriction by seeing whether the reduced form between rainfall and conflict still exists in dam-fed districts – i.e. those districts whose income is not sensitive to rainfall shocks. She finds that rainfall still has a negative correlation with conflict in these regions, suggesting that the exclusion restriction fails (for India at least).