

# Econ7115: Structural Models and Numerical Methods in Economics

## Assignment W01

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1. Consider the following equilibrium system of the Armington model:

$$w_i L_i = \sum_{n=1}^N \frac{1}{1+t_{in}} \lambda_{in} X_n, \quad \lambda_{in} = \frac{\left(\frac{w_i \kappa_{in}}{A_i}\right)^{1-\sigma}}{\sum_{k=1}^N \left(\frac{w_k \kappa_{kn}}{A_k}\right)^{1-\sigma}}, \quad \kappa_{in} = \tau_{in} (1+t_{in}). \quad (1)$$

$$X_n = w_n L_n + \sum_{i=1}^N \frac{t_{in}}{1+t_{in}} \lambda_{in} X_n. \quad (2)$$

(a) Suppose that  $t_{in} = 0$  for all  $(i, n)$ .

- Derive the equilibrium system for  $(w_i)_{i=1}^N$ .
- Derive the Jacobian matrix of the equilibrium system above.
- Consider the following parameterization:  $N = 3$ ,  $\sigma = 4$ ,  $A = [3; 1; 1]$ ,  $L = [1; 2; 5]$ , and  $\tau_{in} = 2$  for all  $i \neq n$ .
  - Please solve for the equilibrium outcomes  $(w_i)_{i=1}^3$  using the *Newton's method*, with the normalization  $\sum_{i=1}^3 w_i = 1$ . Compare your solution with that using `fsolve` in the Matlab (Note: if you do not use Matlab, you can compare your answer with that derived by any packaged nonlinear solver)
  - Consider reducing  $\tau_{in}$  for all  $i \neq n$  from 2 to 1.2. Please derive the welfare in each country with respect to these changes in  $\tau_{in}$ .

(b) Suppose that  $t_{in} = 0.05$  for all  $i \neq n$ . Consider again the following parameterization:  $N = 3$ ,  $\sigma = 4$ ,  $A = [3; 1; 1]$ ,  $L = [1; 2; 5]$ , and  $\tau_{in} = 2$  for all  $i \neq n$ .

- Please derive the first-order effect of  $\log(1+t_{in})$  on  $\log \lambda_{in}$  for all  $i \neq n$  in this general equilibrium system. Compare these GE effects with the reduced-form partial elasticity,  $1 - \sigma$ .

- Suppose that  $t_{in} = 0.25$  for all  $i \neq n$ . Please derive the first-order effect of  $\log(1 + t_{in})$  on  $\log \lambda_{in}$  for all  $i \neq n$  in this general equilibrium system.
2. Consider an extension of the Armington model discussed in class: production uses both labor and intermediates, *i.e.* the unit cost of producing in country  $i$  can be expressed as

$$c_i = \frac{w_i^\beta P_i^{1-\beta}}{A_i}, \quad \beta \in (0, 1], \quad (3)$$

where  $\beta$  is the value-added share and  $P_i$  is the price index of the final consumption goods in country  $i$ .

- Please derive the equilibrium system of this extension.
- Please derive the linear system that can be used to compute the Jacobian matrix of the equilibrium system above.