Econ7115: Structural Models and Numerical Methods in Economics
Assignment W05

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Zi Wang
HKBU

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1. Consider the equilibrium system of $\left(w_i, X_i^j, P_i^j, L_i^j\right)$ for the workhorse trade model satisfying:

   - Trade share and price index:

$$\lambda_{in}^j = \frac{T_i^j \left(L_i^j\right)^{\theta^j \psi^j} \left(c_i^j \kappa_{in}^j\right)^{-\theta^j}}{\sum_{h=1}^N T_h^j \left(L_h^j\right)^{\theta^j \psi^j} \left(c_h^j \kappa_{hn}^j\right)^{-\theta^j}}, \quad P_n^j = \left[\sum_{i=1}^N T_i^j \left(L_i^j\right)^{\theta^j \psi^j} \left(c_i^j \kappa_{in}^j\right)^{-\theta^j}\right]^{-\frac{1}{\theta^j}}, \tag{1}$$

   where

$$c_i^j \equiv w_i^{\gamma_i^j} \prod_{k=1}^J \left(P_i^k\right)^{\gamma_i^{k,j}}, \quad \kappa_{in}^j \equiv \tau_{in}^j \left(1 - s_i^j\right) \left(1 + e_{in}^j\right) \left(1 + t_{in}^j\right). \tag{2}$$

   - Labor market clearing:

$$L_i^j = \frac{\gamma_i^j}{w_i} \sum_{n=1}^N \frac{\lambda_{in}^j X_n^j}{\left(1 - s_i^j\right) \left(1 + e_{in}^j\right) \left(1 + t_{in}^j\right)}, \quad \sum_{j=1}^J L_i^j = L_i. \tag{3}$$

   - Total expenditure:

$$X_i^j = \alpha_i^j Y_i + \sum_{k=1}^J \gamma_i^{j,k} \sum_{n=1}^N \frac{\lambda_{in}^k X_n^k}{\left(1 - s_i^k\right) \left(1 + e_{in}^k\right) \left(1 + t_{in}^k\right)}, \tag{4}$$

   where

$$Y_i = w_i L_i + \sum_{j=1}^J \sum_{n=1}^N \left[-\frac{s_i^j}{1 - s_i^j} + \frac{e_{in}^j}{\left(1 - s_i^j\right) \left(1 + e_{in}^j\right)}\right] \lambda_{in}^j X_n^j + \sum_{j=1}^J \sum_{n=1}^N \frac{t_{ni}^j}{\left(1 - s_n^j\right) \left(1 + e_{ni}^j\right) \left(1 + t_{ni}^j\right)} \lambda_{ni}^j X_i^j. \tag{5}$$

Please express the equilibrium system in relative changes.

2. The "data" folder contains data for seven major economies with 44 sectors. Sector 1 to 22 are tradable goods subject to tariffs, while Sector 22 to 44 are services that are not subject to tariffs. Following are details of the data files:

   - cal_elasticities: calibrated values of ψ^j and θ^j
   - finalshare: α_n^j
   - vashare: γ_i^j
   - IOshare: $\gamma^{k,j}/\left(1-\gamma_i^j\right)$
   - TradeFlow2017: X_{in}^j
   - tariff_prewar2017: t_{in}^j

   We assume that $s_i^j = e_{in}^j = 0$ for all (i, n, j). There are two policies documented in the "data" folder:

   - tariff_Trump: $t_{CHN,USA}^{j'} - t_{CHN,USA}^j$ for $j = 1, \ldots, 22$
   - tariff_China: $t_{USA,CHN}^{j'} - t_{USA,CHN}^j$ for $j = 1, \ldots, 22$

   Please

   - Compute welfare changes under Trump's tariffs.
   - Compute welfare changes under both Trump's tariffs and China's retaliation.
   - Under both Trump's tariffs and China's retaliation, compute $\left(s_{CHN}^{j'}\right)_{j=1}^{22}$ that maximizes the Chinese welfare, comparing them with $\left(s_{CHN}^{j'}\right)_{j=1}^{22}$ under pre-war tariffs.