Appendix

7.1 A Benchmark Model: Social Planer's Problem

In this section, we provide optimality conditions for social planer's problem of benchmark model with perfect information. We discuss SSP with two different scenarios: with a perfect competitive capital market (in a new classical fashion) and without a capital market.

7.1.1 Without a Capital Market

The social planer makes consumption, investment and labor decisions for each location i in each period t. In period $t+1$, the firm in location i can not borrow any capital other than social planer's investment in last period. At the same time, labor demand also meets natural constraint $\overline{L_i}$.

$$\max_{\{C_t, Y_{ft}, K_{it}, L_{it}, X_{j\to i,t}, Y_{i\to f,t}, Y_{it}, M_{it}\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\log C_t\right)$$

Subject to the following conditions:

$$C_t + \sum_{i=1}^{N} [K_{it+1} - (1-\delta_i)K_{it}] \leq Y_{ft} \tag{16}$$

$$Y_{ft} = \left(\sum_{i=1}^{n} a_i^{\frac{1}{\sigma}} Y_{i\to f,t}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \tag{17}$$

$$Y_{i\to f,t} + \sum_{j=1}^{N} X_{i\to j,t} = Y_{it} \tag{18}$$

$$Y_{it} = A_{it}((K_{it})^{\alpha_i} L_{it}^{1-\alpha_i})^{\theta_i} M_{it}^{1-\theta_i} \tag{19}$$

$$M_{it} = \Pi_{j=1}^{N} X_{j\to i,t}^{\gamma_{ji}}, \text{ where } \sum_{j=1}^{N} \gamma_{ji} = 1 \tag{20}$$

$$L_{it} \leq \overline{L_i} \tag{21}$$

At stage $t = 0$, K_{i0} is given as endowment at each location. The household uses all endowment to produce Y_{f0}, and balance C_0 and K_{i1}^s for all i. Then this process continues to infinity. Notice that we can reduce state space dimension by combining (16), (17) and combining (18), (19) and (20):

$$\max_{\{C_t, K_{it}, L_{it}, X_{j\to i,t}\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\log C_t\right)$$

Subject to the following conditions:

$$C_t + \sum_{i=1}^{N}[K_{it+1} - (1-\delta_i)K_{it}] \leq \left(\sum_{i=1}^{n} a_i^{\frac{1}{\sigma}} Y_{i\to f,t}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \tag{22}$$

$$Y_{i\to f,t} + \sum_{j=1}^{N} X_{i\to j,t} = A_{it}(K_{it}^{\alpha_i} L_{it}^{1-\alpha_i})^{\theta_i}(\Pi_{j=1}^{N} X_{j\to i,t}^{\gamma_{ji}})^{1-\theta_i}, \text{ where } \sum_{j=1}^{N}\gamma_{ji} = 1 \tag{23}$$

$$L_{it} \leq \overline{L_i} \tag{24}$$

$$\begin{aligned}\mathcal{L} = \sum_{t=0}^{\infty}\beta^t \Bigg\{ & \log C_t + \mu_t \cdot \left[\left(\sum_{i=1}^{n} a_i^{\frac{1}{\sigma}} Y_{i\to f,t}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} - C_t - \sum_{i=1}^{N}(K_{it+1} - (1-\delta_i)K_{it})\right] \\ & + \sum_{i=1}^{N}\lambda_{it}\cdot\left[A_{it}(K_{it}^{\alpha_i} L_{it}^{1-\alpha_i})^{\theta_i}(\Pi_{j=1}^{N} X_{j\to i,t}^{\gamma_{ji}})^{1-\theta_i} - Y_{i\to f,t} - \sum_{j=1}^{N} X_{i\to j,t}\right] \\ & + \sum_{i=1}^{N}\xi_{it}\cdot\left[\overline{L_i} - L_{it}\right]\Bigg\}\end{aligned}$$

First order conditions are given by:

$$[C_t]: \quad \frac{1}{C_t} = \mu_t \tag{25}$$

$$[K_{it}]: \quad \beta[\mu_t(1-\delta_i) + \lambda_{it}\alpha_i\theta_i\frac{Y_{it}}{K_{it}}] = \mu_{t-1} \tag{26}$$

$$[L_{it}]: \quad \lambda_{it}(1-\alpha_i)\theta_i\frac{Y_{it}}{L_{it}} = \xi_{it} \tag{27}$$

$$[Y_{i\to ft}]: \quad \lambda_{it} = \mu_t\left(\sum_{i=1}^{n} a_i^{\frac{1}{\sigma}} Y_{i\to f,t}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1}{\sigma-1}} a_i^{\frac{1}{\sigma}} Y_{i\to f,t}^{\frac{-1}{\sigma}} \tag{28}$$

$$[X_{j\to it}]: \quad \lambda_{it}\cdot(1-\theta_i)\gamma_{ji}\frac{Y_{it}}{X_{j\to it}} - \lambda_{jt} = 0 \tag{29}$$

Once C_t and K_{it+1} are pinned down, Y_{ft} is also determined. M_{it} is pinned down by $X_{j\to it}$. So as Y_{it} and $Y_{i\to ft}$.

7.1.2 With a Capital Market

One might concern that dysfunction capital market might be too strict, so in this section we discuss social planer's problem with a functioning capital market. In this scenario, the social planer decides consumption C_t, capital distribution K_{it} and total investment decision