Problem Set #1
MACS 30150, Dr. Evans
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Question 1

(a) I chose "Monetary policy according to HANK" by Greg Kaplan, Benjamin Moll and Giovanni L. Violante from the *American Economic Review 2018.*(Kaplan, Moll and Violante 2018)

(b) A detailed citation of the article is given in the **References** below.

(c) The purpose of this paper is to develop the Heterogeneous Agent New Keynesian (HANK) model. Like other New Keynesian models, this model consists of households, producers, monetary authority(central bank), and government but as the innovation, it represents household consumption and saving behavior explicitly. Here, for simplicity, I provide the model of households.

$$\max \quad E_0 \int_0^\infty e^{-(\rho+\zeta)t} u(c_t, \ell_t) dt \tag{1}$$

$$s.t.\ \dot{b}_t = (1-\tau_t) w_t z_t \ell_t + r_t^b(b_t) b_t + T_t - d_t - \chi(d_t, a_t) - c_t \tag{2}$$

$$\dot{a}_t = r_t^a a_t + d_t \tag{3}$$

$$b_t \geq -\underline{b},\ a_t \geq 0 \tag{4}$$

$$\chi(d,a) = \chi_0 |d| + \chi_1 \left| \frac{d}{a} \right|^{\chi_2} a \tag{5}$$

The utility of households(u) is determined by consuming (c_t) and supplying labor (ℓ_t). ζ is the probability of the death of household from Poisson intensity and ρ is discount rate.

Households can distribute their income to liquid assets b and illiquid assets a as savings in order to self-insure against idiosyncratic income risk. z_t is idiosyncratic labor productivity and w_t is wage. τ_t is labor earnings tax rate and T_t is government transfers. r_t^a and r_t^b are returns from each asset. $\chi(\cdot)$ represents the function of transaction cost and d_t is the cost of depositing. Households maximize (1) subject to (2)-(5).

(d) In the household model above, aggregated two-asset(liquid-illiquid) structure, idiosyncratic labor productivity z_t and death rate ζ are exogenous. Other variables are determined inside the whole models (i.e., determined from producers model, monetary authority model and/or government model).

(e) HANK model is dynamic, nonlinear and stochastic.

(f) HANK model is very innovative in terms of taking income inequality into the model. Thus, it is better to add other indicators that represents how monetary policy affect the widening income gap into the model. Also, this paper may take natural interest rate into the model in addition to nominal interest rate.

Question 2

(a) I provide a model of marriage based on Gray Becker's household production function. (Becker 1965)

$$Z = f(\ell_m, \ell_f, x)$$

Here, $f(\cdot)$ is a production function, ℓ_m and ℓ_f are the time used for their household (i.e., leisure time), and x is the input of goods into the function. m stands for male and f is female. If the two individuals get married, they maximize their utility function($U(Z)$) subject to their household production and budget constrain.

I assume that someone decides to get married if the output from the aggregated household production function is larger than the output from the simple sum of each output from the function. That is,

$$\begin{cases} M_i = 1 & \text{if } Z_{mf} \geq Z_m + Z_f \\ M_i = 0 & \text{if } Z_{mf} < Z_m + Z_f \end{cases}$$

Here, M_i is the marriage decision of person i ($M_i = 1$ means getting married and $M_i = 0$ is not). Z_{mf} is the output from the aggregated function and Z_m, Z_f are the output from each individual's function. For simplicity, I assume male and female have the same production function. Suppose their production function is the Cobb-Douglas, then, I have

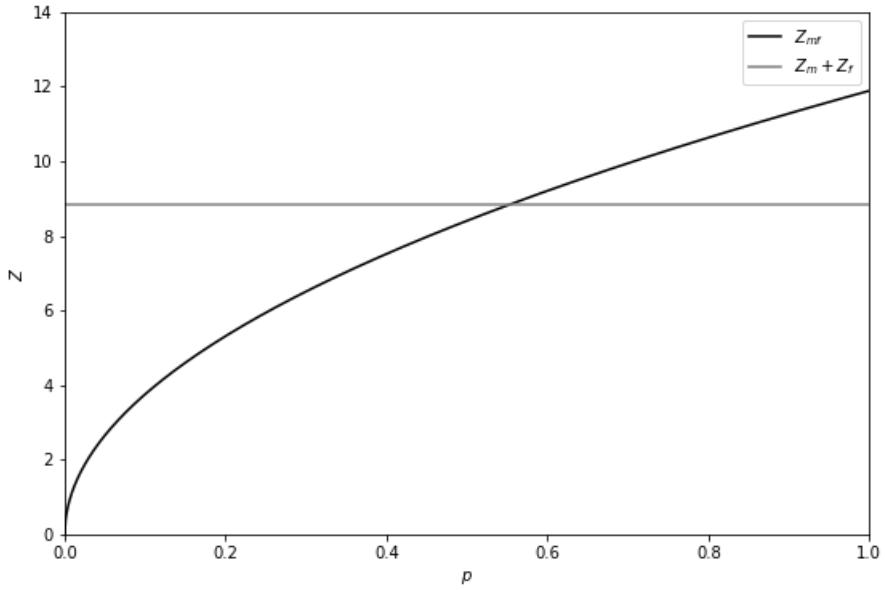
$$\begin{aligned} Z_i &= A_i \ell_i^{\alpha} x_i^{\beta} \\ Z_{mf} &= A_{mf} \ell_{mf}^{\alpha'} x_{mf}^{\beta'} \\ &= A_{mf} (\sum p_i \ell_i)^{\alpha'} (\sum x_i - q)^{\beta'} \end{aligned}$$

Here, A is the total factor productivity, p is the ratio that someone may give up using his/her own time when get married (GIVE UP ratio, $0 \leq p \leq 1$), q is the amount of common goods in the household. α and β are the output elasticities of time and goods, respectively. I assume when someone is single the function shows constant return to scale (i.e., $\alpha + \beta = 1$) but when got married the function displays returns to scale are increasing (i.e., $\alpha' + \beta' > 1$). Also, p is determined by age, income level and education. That is,

$$p_i = g(age_i, income_i, educ_i)$$

(b) As I mentioned above, the binary decision of marriage is determined inside the model.

(c) I present the numerical simulation for this model. Suppose $A_i = A_{mf} = 0.2, \ell_i = 16, x_i = 24, q = 19.2, \alpha = 0.2, \beta = 0.8, \alpha' = 0.5, \beta' = 0.7$ and both p is the same, then the marriage decision is determined as the change of p. The figure below shows the simulation:



In this simulation, when people think they can give up about half of their free time ($p = 0.55$) after getting married, they would decide to get married.

(d) The key factor that influences this outcome is the amount of the household production (Z). Since the amount from married household Z_{mf} depends on the GIVE UP ratio p which is determined by age, income level and education, p and its explanatory variables also influence the marriage decision.

(e) Although many people might think that affinity (or love) toward his/her partner is the most important factor, it is difficult to measure such factor numerically and to compare other factor or person. On the other hand, the household production can be estimated and simulated numerically by calibrating parameters. Also, intuitively, this household production catches some aspects of the real marriage life. For example, when someone got married, s/he has to sacrifice their own leisure time and to do something for other household members (e.g., cooking for their parter or taking care of children).

(f) I can conduct a preliminary test by comparing some results from survey data with simulation results by calibrating the parameters. For example, the simulation result I showed part (c) is that when the GIVE UP ratio p is more than about 0.55, people choose to get married. Then, in the survey, we would ask

various status participants about how much your own time you tolerate to give up when get married. If the result of the survey is close to the simulation result, the factor may be significant in real life.

References

Becker, Gary S, "A Theory of the Allocation of Time," *The economic journal*, 1965, pp. 493–517.

Kaplan, Greg, Benjamin Moll, and Giovanni L. Violante, "Monetary Policy According to HANK," *American Economic Review*, March 2018, *108* (3), 697–743.