

Sector Choices in Incomplete Markets: The Role of Idiosyncratic Production Risk and Financial Imperfections

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Goal

This paper investigates how uninsurable labor earnings risk affects individuals' education and sector choices. Unlike other incomplete market models, in this paper, the idiosyncratic earnings risk comes from the sector-specific production risk, which transmits differentially across sectors due to financial imperfections. In our context, this means that only state-owned enterprises (SOE) can get access to the credit market, while privately-owned enterprises (POE) are subject to natural borrowing limit and can only use the self-financing channel to counter production risks.

Problems Remain to Be Solved

- Whether to explicitly model people's schooling choices since it only affects the rate of human capital accumulation but can greatly complicate the model.
- What is the proper way to aggregate the household side state variables to obtain the variables in the production side?
- How to use the idiosyncratic production risk and credit market imperfections to pin down sector specific labor earnings risk? Since it is a macro model, it seems necessary to introduce some equilibrium (and/or invariant distribution) concepts. To do that, some explicit aggregation rules in the household side are unavoidable.
- To model the production side, since there is heterogeneity in firms, do I need to distinguish producers from workers who make sector choices? Or should I just let the workers employed in the private sector essentially be self-employed and run business and directly be affected by production risks.

Related Literature

- Papers that investigate how uninsurable risks affect people's job (or occupation or industry) mobility: [Cubas and Silos \(2020\)](#); [Kambourov and Manovskii \(2009\)](#); [Dillon \(2018\)](#); [Neumuller \(2015\)](#); [Hawkins and Mustre-del Rio \(2016\)](#); [Cubas et al. \(2023\)](#); [Cubas and Silos \(2017\)](#); [Low et al. \(2010\)](#); [Liu \(2019\)](#); [Altonji et al. \(2013\)](#); [Dvorkin and Monge-Naranjo \(2019\)](#); [Lee and Wolpin \(2006\)](#).

- Papers that study individuals' human accumulation choices in incomplete markets: [Singh \(2010\)](#); [Krebs \(2003\)](#); [Park \(2018\)](#); [Huggett et al. \(2011\)](#); [Stantcheva \(2017\)](#); [Huggett et al. \(2006\)](#).
- Papers that study the effects of financial imperfections and production side literature: [Buera et al. \(2011\)](#); [Angeletos and Calvet \(2006\)](#); [Krusell et al. \(2000\)](#); [Midrigan and Xu \(2014\)](#); [Song et al. \(2011\)](#).

Papers that are most relevant in terms of modelling ingredients

- Take the same general equilibrium framework as in [Heckman and Lochner \(1998\)](#) but add sector choices and uninsurable risks.
- Use the same on-the-job human capital accumulation process (and some notations) as in [Huggett et al. \(2011\)](#) but explicitly model schooling choice, according to which people are categorized into different skill groups.
- Use the similar idea of the human capital transferability matrix and switching costs in [Dvorkin and Monge-Naranjo \(2019\)](#).

1. Individuals' Optimization Problem

Overview of the Setup: Individuals take all the factor prices as given. In the first period (when the agent turns 18), he (as a high school graduate) needs to first choose whether to attend college, according to which they are classified as high-skilled or low-skilled groups. Then in each working period, the worker draws a transitory labor income shock, then chooses which sector he wants to work in, how much percentage of time he allocates to accumulate on-the-job human capital and how much income he wants to consume. During his working period, the accumulation of on-the-job human capital follows a (deterministic) skill-specific process. Human capital is of a general form, meaning that it can be carried over to another sector (though with some switch cost) when he decides to change his sector. After retirement, he depends on his savings for a living. All individuals are subject to the natural borrowing limit, the same concept as in [Aiyagari \(1994\)](#).

1.1. Working Periods: Decisions on Sector and Human Capital Accumulation

At date t , individuals of cohort c become age $\underline{a} = 18$. At this age, individuals differ from each other only in an endowment vector $\mathbf{x}_t = (h_{\underline{a}t}, k_{\underline{a}t}, \theta)$, where $h_{\underline{a}t}$, $k_{\underline{a}t}$ denote his initial human capital stock and wealth level, respectively, and θ is his learning ability drawn from a distribution $G(\theta)$. Together, the initial conditions are drawn from the joint distribution ξ . He needs to make a choice on whether to go to college based on different discounted lifetime utility. Attending college makes an individual a high-skilled worker (labeled as H) while engaging in the labor market directly means that he is a low-skilled worker (labeled as L).

For those workers in the labor market (from age $\underline{a}^L = 18$ for L -type workers and age $\underline{a}^H = 22$ for H -type workers to the retirement age $a^r = 60$), in each period, he needs to choose between two

different occupations or sectors, $j \in \{S, P\}$ —whether to work in state-owned enterprises (labeled as S) or privately owned companies (labeled as P). **From individuals' point of view, sectors differ from each other in the aspect of mean earnings and the idiosyncratic earning risks** (which are originated from sector's idiosyncratic production risks and potentially amplified by financial imperfection in the credit market) and mean earnings (which are pinned down by the general equilibrium).

After retirement at the age of $a^r = 60$, the individual depends only on his savings and live up to $\bar{a} = 70$ years old.

Let's first talk about people's sector decisions and human capital decisions after choosing whether to attend college. In period t , each individual aged a who is currently in skill group $\tau \in \{L, H\}$ and in sector $j_{at} \in \{S, P\}$ faces the following problem:

$$V_{at}(\tau, j_{at}, h_{at}, k_{at}, \theta) = \max \{W_{at}^S(\tau, j_{at}, h_{at}, k_{at}, \theta), W_{at}^P(\tau, j_{at}, h_{at}, k_{at}, \theta)\}, \quad (1)$$

where the choice-specific value function W_{at}^S , and W_{at}^P are defined by

$$W_{at}^j(\tau, j_{at}, h_{at}, k_{at}, \theta) = \max_{c_{at}, l_{at}, j_{a+1, t+1}} \{u(c_{at}) + \beta EV_{a+1, t+1}(\tau, j_{a+1, t+1}, h_{a+1, t+1}, k_{a+1, t+1}, \theta)\}, \quad (2)$$

subject to,

$$c_{at} + k_{a+1, t+1} = k_{at}(1 + r_{t+a-1}) + e_{at} - T_{a, t+a-1}, \quad a = \underline{a}^\tau, \dots, \bar{a} \text{ and } k_{\bar{a}+1} = 0; \quad (3)$$

$$e_{at} = w_{t+a-1}^j h_{at} l_{at} \text{ if } a < a^r, \text{ and } e_a = 0, \text{ otherwise}; \quad (4)$$

$$h_{a+1} = {}^1 \begin{cases} h_{at} + \theta [h_{at}(1 - l_{at})]^{\alpha_\tau} & \text{if } j_{a+1, t+1} = j_{at}, \\ \phi_{j_{at} j_{a+1, t+1}} h_{at} + \theta [\phi_{j_{at} j_{a+1, t+1}} h_{at}(1 - l_{at})]^{\alpha_\tau} & \text{if } j_{a+1, t+1} \neq j_{at}. \end{cases} \quad (5)$$

Notations:

- r_{t+a-1} : the return to savings; (Right now, I am thinking about a constant deposit rate.)
- $T_{a, t+a-1}$: taxes (not so sure how to deal with it);
- l_{at} : the choice variable indicating how much time is allocated to work, while all the other time is allocated to accumulate on-the-job human capital (total time is normalized to 1);
- e_{at} : labor earnings;
- w_{t+a-1}^j : sector-specific wage rate (The only source of stochasticity in our model. Come from the production side! Still not so sure how to model it. But for now, we can separately model

¹I am still unsure how to model the human capital accumulation process. I can actually take a more general specification as in Heckman and Lochner (1998) (for the non-switchers):

$$h_{a+1, t+1} = A^\tau(\theta) (1 - l_{a, t})^{\alpha_\tau} (h_{at})^{\beta_\tau} + (1 - \sigma^\tau) h_{a, t}^S,$$

which incorporates human capital depreciation and can better differentiate the effects of schooling τ and ability θ . Maybe, in solving and estimating the model, I should try this more sophisticated specification as well.

the partial equilibrium model, with $\ln(w_t^j) = \rho \ln(w_{t-1}^j) + \varepsilon_t^j$, where ε_t^j is a normal distributed random variables. Its variance implies the sector-specific labor earning risks.)

- $\phi_{j_{at}j_{a+1,t+1}}$: human capital transferability parameter (two parameters, ϕ_{SP}, ϕ_{PS}) indicating the remaining human capital if the individual switches from sector j_{at} to sector $j_{a+1,t+1}$;
- θ : ability, drawn from $G(\theta)$ (can be estimated in the last step using SMM to match some key moments, as in [Huggett et al. \(2011\)](#));
- α_τ : schooling-specific human capital accumulation parameter.

Several remarks:

- The two human capital transferability parameters fully characterize the sector switching cost. Here, human capital is not sector-specific because occupations and industries can overlap between SOEs and POEs.
- The most important formulation is the deterministic human capital process. Maybe, when I later solve the model, I can first try some easy specification as in [Dvorkin and Monge-Naranjo \(2019\)](#). In their paper, the human capital evolution process can be fully characterized by a human capital transferability matrix, and stochasticity is brought in by multiplying occupation-specific labor market opportunities shocks.
- As in [Heckman and Lochner \(1998\)](#), h and $A^\tau(\theta)$ represent ability to “earn” and ability to “learn”, respectively, measured after completion of school. They embody the contribution of schooling to subsequent learning and earning in the schooling-level τ -specific skills as well as any initial endowments.

1.2. Schooling Choice

Assume that in period t , an individual turns $\underline{a} = 18$ years old. Then he needs to choose whether to attend college by comparing the following value functions:

$$\tau = \operatorname{argmax} \left\{ V(L, j_{\underline{a}t}, h_{\underline{a}t}, k_{\underline{a}t}, \theta), V(H, j_{\underline{a}+4,t+4}, h_{\underline{a}t}, k_{\underline{a}t}, \theta) - D^H \right\}, \quad (6)$$

where D^H is the discounted direct cost of schooling (It can also be incorporated in to the value function, i.e., $V(H, j_{\underline{a}+4,t+4}, h_{\underline{a}t}, k_{\underline{a}t} - D^H, \theta)$).

Questions: What is the aim to introduce people’s schooling choice? In the current model, people’s schooling choice only affects the rate of human capital accumulation, α_τ . But in [Heckman and Lochner \(1998\)](#), the human capital is skill-specific, that is, h^L and h^H are two kinds of human capital, and their production is skill-biased, so this setup has more implications on inequality issues. But right now, human capital in my model is quite general, so it seems unnecessary to introduce schooling choice, which may significantly complicate the whole model.

Maybe I should check the data and see if there is a significant difference in sector mobility patterns and wage process across different skill groups defined by education level! And then decide whether to explicitly model people's schooling choice.

2. Production Side of the Model

2.1. Stop Here for Now

In the initial proposal, I will just stop here. Even though I want to build a general equilibrium model and let the FOC of the production pin down the capital rental rate and wage rate of per unit of efficient human capital. However, I find it necessary to read more papers on the production side problems and especially how to model the financial imperfections.

In the next two or three weeks, I think I will try to play with the data and identify people's wage process, sector mobility patterns, and in the meantime, read more production side papers.

2.2. Aggregation

The first step trying to embed this decision problem within a general equilibrium framework is to aggregate individual-level variables to aggregate variables. To do this, I will introduce the following notations: Let c index cohort. Let t_c denote the time when the cohort becomes $\underline{a} = 18$ years old so that they start to be studied in this paper. Let P_{a_c} consists of all histories of factor prices faced by cohort c , that is, $P_{a_c} = (w_{t_c}, w_{t_c+1}, \dots, w_{t_c+a-\underline{a}}, r_{t_c}, r_{t_c+1}, \dots, r_{t_c+a-\underline{a}})$, where the wage rate include both the state sector and the private sector.

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