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A Theoretical Framework of Financial Inclusion on Poverty Alleviation

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Abstract

In this paper, we develop a dynamic general equilibrium model, where agents are heterogeneous in terms of wealth and entrepreneurial talent, to study the effects of financial inclusion. From our structural analytical framework, we obtain some important properties, which are helpful to understand the effect of financial inclusion in capital allocation and poverty reduction. On the basis of this framework, one could make a quantitative evaluation of the policy impact of financial inclusion by calibrating the model with data of different countries.

Keywords: Financial Inclusion, Poverty Alleviation, General Equilibrium, Financial Friction

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1. Introduction

Financial inclusion has been a more and more concerned topic in terms of the development issues, particular for those low income and emerging market countries, where large group of individuals and firms have no access to financial services. World Bank (2014) told an appalling comparison that 51% of firms in advanced economies had bank loans and that rate in developing countries was only 34%. Therefore, some individuals with entrepreneurship could not start their own business to realize possible income increment because of shortage of necessary capital. On the other hand, firms tend to grow slowly in the lack of needed financial aids, keeping worker's wage relatively low for a long time. Consequently, such financial exclusion is harmful to poverty alleviation for low-income and emerging market countries. The channel of capital misallocation and occupational choice distortion, caused by financial exclusion, has not been successfully thoroughly analyzed.

This paper attempts to find out the endogenous mechanism that financial inclusion contributes to poverty reduction. We develop a dynamic general equilibrium model focusing on a continuum of agents being heterogeneous in terms of talent and initial wealth in each period, who can choose to be an entrepreneur or worker. Only a part of population has access to financial market. Among them, those who choose to be entrepreneur have to negotiate with lenders to get optimal credit contracts, which could be statically solved out from a lender's expected profit optimization problem under the constraint that the entrepreneur's opportunity cost is covered by the surplus from the credit market. We obtain several conclusions about the capital allocation and individual's income in different financial situations.

It is worthy to point out that our model is inspired by the work of Besley et al. (2018) and fills gaps of it. The first improvement is that we don't split the workers into two parts of wage labors and managers as it would bring complicated agent problem which was not considered in their model. It is more reasonable to tie the successful probability of enterprise with entrepreneur's talent than with management level indexed by the amount of managerial labor bought by entrepreneur. Moreover, our framework is a dynamic (multi-period) version of the static model of them, which not only considers the clearance of the labor market but also the capital market. In this sense, our objective functions of optimization problems are actually different from theirs.

The remainder of the paper is organized as follows. The next section provides a discussion of the related literature. Section three sets up the theoretical framework. Section four interprets and discusses the results of the model we construct in section three. Section five provides concluding remarks and points out further research direction.

2. Literature Review

There is a long history of ideas that the development of financial sector matters much for real economy. The earliest work about this area can be traced back to Gerschenkron (1962), who found that, for those developing countries, their banking systems plays an important role in promoting economic growth in the process of catching up with developed country. In his famous survey paper, Levine (2005) summarized pertinent theories and empirical evidences that financial development could boost economic growth. Cihak and Demirguckunt(2013) found a strong positive correlation between them by employing a comprehensive dataset including 205 economies from 1960 to 2010. In particular, a large body of work has focused on the poverty reduction effect of the financial development. Greenwood and Jovanovic (1990) verified the Kunznets Inverted-U Hypothesis between income distribution and financial development, i.e. the income of the poor would first decrease and then increase with the development of the financial sector, which had also been supported by subsequent researches such as Aghion and Bolton (1997), Lloyd-Ellis and Bernhardt (2000), Townsend and Ueda (2006), Chakraborty and Lahiri (2007). In the meantime, Jalilian and Kirkpartrick (2005), as well as Akhter et al.(2010) put forward that financial development could realize poverty reduction in the sense of economic growth and income equalization according to panel data across countries. Moreover, Galor and Zeira (1993), Ravallion (1997, 2001) thought that, financial development was not beneficial to poverty reduction, in the event that inequality effect of income distribution offset poverty reduction effect brought by economic growth.

The first theoretical framework about financial frictions' impact on economic growth was introduced by Banerjee and Newman(1993), who claimed that income distribution was influenced by individual's saving and risk, which was determined by her occupational choice being constrained by her initial endowments. Since then, there has been an extensive literature on how credit market frictions caused by transaction costs and information limitation lead to lending difficulty or even poverty trap, see Townsend and Ueda (2006) , Karlan and Zinman (2009), Banerjee and Duflo (2010). In particular, Demirguc and Levine (2008) and Bianchi (2010) found that, financial access for poor individuals with entrepreneurship would alleviate their poverty via starting business under financial supporting. In addition, Demirguc and Levine (2008) concluded that the more financial service provided to small or medium sized enterprises, the more jobs they would create, and the higher the wage level would be. However, some disputes have been rising in the past 20 years. Bianchi (2010) and Karlan and Zinman (2011) doubted the role that microfinance plays in alleviating poverty summarized before by using randomized assessment methodology. Burgess and Pande (2005) found a significant impact on poverty alleviation caused by expansion of bank branches in India via a natural experiment on bank-branching rules despite that Kochar (2011) doubted their findings. Honohan (2008) studied almost 160 economies worldwide and found that the increment in financial access significantly reduces poverty, but he also pointed out that the result could only apply to the simple regression with variable of financial access and would not be significant for multi-variable regression.

In last several years, there have been some advances in researches on the impact of financial inclusion on the poverty alleviation. By use of a unique natural experiment of the almost simultaneous openings of 800 branches of Banco Azteca in Mexico in pre-existing locations of Electra stores, Bruhn and Love (2014) found an important channel of labor market in which the financial access impacts poverty reduction. Dablanorris et al.(2015) analyzed the policy impact of the acceleration of financial deepening and inclusion on GDP and inequality in developing countries via a general equilibrium model, which was calibrated with data of three emerging and three low-income countries. They claimed that policy makers should pay attention to the issues of law, regulation and organization in the mean time of promoting the financial inclusion. Besley et al. (2018), based on their famous work of Besley et al.(2012), studied a general equilibrium model with contracting frictions due to moral hazard and limited liabilities. The Calibration of the model with US data showed that financial inclusion quantitatively mattered much more than contracting frictions, particularly in labor market, where worker’s wage would increase by 125% when financial inclusion changed from zero to full coverage. This conclusion apparently coincided with the empirical finding of Bruhn and Love (2014) but actually were different. Besley et al.(2018)’s simulation showed it was the expansion of firm size from financial inclusion increase that pushed labor’s wage increasing while Bruhn and Love (2014) focused on the channel that increased financial access helped existing business owners continue their operations instead of closing them and then becoming jobless. Our paper theoretically reveals these two channels at the same time.

3. The Model

3.1 Model description

We consider an economy with a population-continuum of agents who are heterogeneous in terms of talent and wealth. In our model, the economy evolves across periods and one period is divided into two phases. Each agent lives for one period and has an offspring. In the first phase of her living period, the agent chooses to be an entrepreneur or a worker. If she chooses to be an entrepreneur, she has to make an investment decision on capital and labor by which her enterprise needs to run. In the second phase, entrepreneurs and workers realize their income in terms of firm profit and wage respectively, then make consumption and bequest to maximize utility. It has to be noticed that the agent’s occupation and investment decision in the first phase, is based on the bequest she gets, which results from her predecessor’s decision on consumption and bequest in the second phase of the previous period.

3.2 Notations and terminology

ω_t: worker's wage in period t [2].

θ_t: agent's talent in period t, following a Pareto distribution $\zeta(\theta)$. The successor of an agent either inherits her talent with probability μ, or randomly gets new talent drawn from $\zeta(\theta)$.

a_t: agent's wealth at the beginning of period t [3].

l_t: labor hired by entrepreneur of (a,θ) in period t.

x_t: money borrowed by entrepreneur of (a,θ) in period t.

$C=(x,r,\Delta)$: the loan contract, where x is defined as above, r is the amount to be repaid for the loan, and Δ is the collateral. Denoting the ratio of collateral to wealth as τ, then we have $\Delta=\tau a$ (we assume $\tau=1$ hereinafter, i.e. full mortgage)[4].

k_t: productive capital invested by entrepreneur of (a,θ) in period t.

We have $k_t=x_t$ [5]. And so the Gross Loan Rate $r_L=\frac{r}{x}=\frac{r}{k}$.

In what follows, we will omit the subscript t without confusion on some notations.

$f(k,l,\theta)=\theta^{1-\eta-\beta}\cdot(k^{\alpha}\cdot l^{1-\alpha})^{\eta}$: the production function, where an entrepreneur with talent θ invests capital k and hires labor l to yield $f(k,l,\theta)$.

$u(c,b)=c^{1-\varepsilon}\cdot b^{\varepsilon}$: agent's utility function, where c is consumption and b is bequest to her successor.

$p(\theta)=\delta\theta^{\eta+\beta}$: probability of successful production, a function of talent θ. In what follows, we substitute $p(\theta)$ with p for simplicity.

We finally define ϕ as the competitiveness degree of credit market, where $\phi=1$ means perfectly competitive credit market[6] while $\phi=0$ says lenders monopoly[7]. We need to point out that it is exactly the bequest that makes wealth pass on among generations, endogenously resulting in the wealth distribution of the economy. Moreover, the use of aforementioned utility function is not our unique invention, but a necessity to simplify analysis and keep to convention. Actually, bequest is equivalent to short-term saving and the Cobb-Douglas form of utility function determines that the optimal bequest/saving ratio is exactly the ε. If we define

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[2] Wage theoretically should vary with each agent and depends on agent's wealth and talent. We simplify it as the equilibrium wage only varying with t.

[3] As a matter of fact, an agent's wealth at the beginning of period 2, a_2:, is equal to her predecessor's bequest to her at the end of the period 1. And her wealth at the end of the period 2 is a_2 plus her income (wage or firm profit) realized in period 2.

[4] τ is actually an index of perfectness of the property right. If $\tau=1$, it means the property right to wealth is perfect, and if $\tau=0.5$, the property right is half perfect.

[5] We do not allow the collateral wealth a as part of the capital, so $x_t=k_t$ instead of $x_t+a=k_t$.

[6] In other words, total surplus of the credit contract accrues to borrowers and lenders make no profit.

[7] In this case, borrowers only obtain the benchmark utility, i.e. outside opportunity cost while lenders get left surplus.

agent's wealth at the end of one period is Ψ, the utility function is then the linear function of Ψ. Therefore, the utility maximization is equivalent to the maximization of Ψ.

3.3 Model deduction

Phase I: Occupation Choice. An agent provides one-unit labor to the market if she chooses to be a worker. If she chooses to be an entrepreneur, she will encounter two options, one of which is to run her firm merely by her own wealth, and the other is to accept the loan contract of $\boldsymbol{C} = (x, r, \Delta)$ provided by the bank and then invest capital $k = x$ to run the firm.

Phase II: Production and Yield. The entrepreneur makes an investment of k capital and l labor for production to maximize the expected wealth. As mentioned before, the probability of successful production is p with production $f(k, l, \theta)$ and the probability of failure is $(1-p)$ with yield 0. Under the circumstance of failure, the entrepreneur has to repay the loan r with the collateral Δ, i.e. the wealth a [8]. After production, the wealth of worker and entrepreneur is as follows [9]:

$$\text{Success}\begin{cases} \text{wealth of worker} & & r_d a + \omega \\ \text{wealth of entrepreneur} & \begin{cases} \text{with loan} \\ \text{self} - \text{financing} \end{cases} & \begin{matrix} f(k,l,\theta) - \omega l - r + r_d a \\ f(k,l,\theta) - \omega l + r_d(a-k) \end{matrix} \end{cases}$$

$$\text{Failure}\begin{cases} \text{wealth of worker} & & r_d a \\ \text{wealth of entrepreneur} & \begin{cases} \text{with loan} \\ \text{self} - \text{financing} \end{cases} & \begin{matrix} \max\{r_d a - r, 0\} \\ r_d(a-k) \end{matrix} \end{cases}$$

When entrepreneur chooses to self-finance (autarky), her expected wealth is:
$$\Psi(a, \theta, k, l, \omega) = p[f(k,l,\theta) - \omega l + r_d(a-k)] + (1-p) r_d (a-k)$$

When entrepreneur accepts a loan, her expected wealth is:
$$\Psi(a, \theta, k, l, \omega) = p[f(k,l,\theta) - \omega l - r + r_d a] + (1-p)\max(0, r_d a - r)$$
and the expected profit of the lender (bank) is[10]:
$$\Pi(\boldsymbol{t}) = pr + (1-p)\min(r, r_d a) - r_d k$$

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[8] Accurately speaking, it should be the wealth a times the deposit rate r_d, i.e. $r_d a$.

[9] We assume workers earn nothing under the circumstance of failure because of no production. Moreover, we think the capital would be used up in the process of production.

[10] As bank plays a role of financial intermediary without utility function, we consider its maximization of expected profit instead of the expected wealth.

3.3.1 Self-financing (autarky) case

In the case of self-financing, the entrepreneur's optimization problem is:

$$\max_k \Psi(a,\theta,k,l,\omega) = \max_k\{p[f(k,l,\theta) - \omega l + r_d(a-k)] + (1-p)r_d(a-k)\}$$

i.e.

$$\max_k\{p[f(k,l,\theta) - \omega l] + r_d(a-k)\}$$

Defining the profit of the entrepreneur as $\pi(k,l,\theta,\omega) \equiv f(k,l,\theta) - \omega l$, we have:

Proposition 3.1 *In the self-financing(autarky) case, the capital k invested by entrepreneur, is determined by*[11]

$$\pi_k(k,l,\theta,\omega) = \frac{r_d}{p} \tag{1}$$

3.3.2 Loan case

3.3.2.1 Perfectly competitive credit market

In a perfectly competitive credit market, total surplus between lender and borrower in a loan contract accrues to borrower (entrepreneur), who only needs to maximize the final wealth for utility maximization, i.e. total surplus maximization. Meanwhile, an entrepreneur will enter into the credit market, i.e. accept the credit contract issued by a lender, only when her opportunity cost (outside option, denoted as υ) is satisfied.

Out constrained optimization problem could be written as:

$$\begin{aligned}\max_k\{\Pi(\boldsymbol{t}) + \Psi\} &= \max_k\{ p[f(k,l,\theta) - \omega l] - pr + pr_d a \\ &\quad + (1-p)\max(0, r_d a - r) + pr \\ &\quad + (1-p)\min(r, r_d a) - r_d k\} \\ &= \max_k p[f(k,l,\theta) - \omega l] + r_d(a-k)\end{aligned}$$

$$s.t. \qquad p[f(k,l,\theta) - \omega l - r + r_d a] + (1-p)\max(0, r_d a - r) \geq \upsilon$$

Solving above optimization problem yields:

Proposition 3.2 *In a perfectly competitive credit market, the capital k invested by entrepreneur, is determined by:*

$$\pi_k(k,l,\theta,\omega) = \frac{r_d}{p} \tag{2}$$

which is exactly the same as the self-financing(autarky) case.

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[11] We should mention here that under some capital level k, the entrepreneur will adjust the labor hired $l^*(k,\theta,\omega)$ to maximize her expected wealth, that is, $l^*(k,\theta,\omega) = \arg\max_l\{\Psi(a,\theta,k,l,\omega)\}$.

3.3.2.2 Imperfectly competitive credit market

In this case, the loan contract is decided by lender, and borrower(entrepreneur) will accept the contract only when her outside option can be satisfied. The entrepreneur's outside option, i.e. the opportunity cost depends on three aspects: 1. The expected wealth from other lenders; 2. The expected wealth without borrowing money, and 3. The expected wealth from being a wage labor, instead of being an entrepreneur. The optimization problem turns to

$$\max_k \Pi(\boldsymbol{t})$$
$$s.t.\begin{cases}\Psi(a,\theta,k,l,\omega) \geq \upsilon \\ \Pi(\boldsymbol{t}) \geq 0\end{cases}$$

i.e.

$$\max_k \quad pr + (1-p)\min(r, r_d a) - r_d k$$

$$s.t. \quad \begin{cases} p[f(k,l,\theta) - \omega l - r + r_d a] + (1-p)\max(0, r_d a - r) \geq \upsilon \\ pr + (1-p)\min(r, r_d a) - r_d k \geq 0 \end{cases}$$

By solving above optimization problem, we have:

Proposition 3.3 *In an imperfectly competitive credit market, the capital k invested by entrepreneur , is determined by*

$$\pi(k,l,\theta,\omega) = \frac{\upsilon + r_L k - r_d a}{p} \tag{3}$$

The total surplus of an imperfectly competitive credit market is the same as the one of a perfectly competitive credit market, and could be written as:

$$\mathcal{S}(a,\theta,\omega) = p\pi(k,l,\theta,\omega) + r_d(a-k)$$

Recalling the definition of the opportunity cost, we define $\upsilon(\phi,a,\theta,\omega)$ as

$$\upsilon(\phi,a,\theta,\omega) = \phi\mathcal{S}(a,\theta,w)$$

And the expected wealth in self-financing scenario is:

$$\Psi^{self}(a,\theta,\omega) = \max_k\{p\pi(k,l,\theta,\omega) + r_d(a-k): k \leq a\}$$

Then the opportunity cost is defined by

$$\upsilon(a,\theta,\omega) = \max\{\Psi^{self}(a,\theta,\omega), \upsilon(\phi,a,\theta,\omega), p\omega + r_d a\} \tag{4}$$

On the basis of (4), discussion on the result of proposition 3.3 yields:

Proposition 3.4 *In an imperfectly competitive credit market, if the entrepreneur's opportunity cost (outside option) is*

i) $\Psi^{self}(a,\theta,\omega)$*, the entrepreneur will not borrow from lender;*

ii) $\upsilon(\phi,a,\theta,\omega)$*, the expected wealth of the entrepreneur increases with the competitiveness degree of the credit market, as well as the capital borrowed; and*

iii) $p\omega + r_d a$*, the expected wealth of the entrepreneur increases with her own wealth, as well as her worker's expected wage.*

3.3.3 General equilibrium

We now expand the above single-period model to multi-period scenario, which is the general equilibrium case. The general equilibrium is defined as follows:

In each period, the labor market and the capital market realize clearing and the wealth passes on across generation via bequest until the distribution of wealth and talent no longer change.

We next expatiate the deduction process. Suppose the proportion of the population that could get access to financial service is $R(a,\theta) \in [0,1]$, and $H(a,\theta)$ is the joint probability density function of (a,θ), so the total financial inclusion coverage on population of an economy is defined as

$$\bar{\xi} \equiv \iint R(a,\theta)H(a,\theta)dad\theta \tag{5}$$

Furthermore, we define two indicative functions, one of which is to describe whether an agent has access to credit market, i.e. the measurement of financial inclusion in individual level, and the other one tells the occupation choice of agents:

$$I = \begin{cases} 0 & \text{entrepreneur can't obtain loan} \\ 1 & \text{enterpreneur can obtain loan} \end{cases}$$

$$\sigma(a,\theta,I,\omega) = \begin{cases} 1 & I = 1,\ \widehat{\Pi}(\upsilon(a,\theta,\omega);a,\theta,\omega) \geq 0, & \text{entrepreneur} \\ 1 & \Psi^{self}(a,\theta,\omega) \geq r_d a + p\omega, & \text{entrepreneur} \\ 0 & \text{Else,} & \text{worker} \end{cases}$$

As mentioned above, the lender's participation constraint is $\Pi(\boldsymbol{t}) \geq 0$. If we denote $\Pi(\boldsymbol{t})$ as $\widehat{\Pi}(v; a, \theta, \omega)$, which is $\widehat{\Pi}(v; a, \theta, \omega) \geq 0$.

3.3.3.1 The clearing of the labor market

The aggregate labor supply is

$$L^S(\omega) = \iint \{R(a,\theta)[1-\sigma(a,\theta,1,\omega)] + \left(1-R(a,\theta)\right)[1-\sigma(a,\theta,0,\omega)]\} \cdot H(a,\theta)dad\theta$$

To derive out the aggregate labor demand, we need to consider the capital investment first:

$$\hat{k}(a,\theta,I,\omega) = \begin{cases} \hat{k}(v(a,\theta,\omega); a,\theta,\omega) & I=1 \\ k^{self}(a,\theta,\omega) & I=0 \end{cases}$$

The labor demand is

$$\tilde{l}(a,\theta,I,\omega) = l^*\left(\hat{k}(a,\theta,I,\omega),\theta,\omega\right)$$

The aggregate labor demand is

$$L^D(\omega) = \iint R(a,\theta)\sigma(a,\theta,1,\omega)\tilde{l}(a,\theta,1,\omega)H(a,\theta)dad\theta + \iint \left(1-R(a,\theta)\right)\sigma(a,\theta,0,\omega)\tilde{l}(a,\theta,0,\omega)H(a,\theta)dad\theta$$

And let $L^D(\omega) = L^S(\omega)$, we can solve out the equilibrium wage $\omega^{equilibruim}$.

3.3.3.2 The clearing of the capital market

It is easy to see the condition for the capital market clears is

$$\iint \sigma(a,\theta,I,\omega)\hat{k}(a,\theta,I,\omega)H(a,\theta)dad\theta = \iint a \cdot H(a,\theta)dad\theta$$

3.3.3.3 The generation evolution of the distributions of agents' wealth and talent

This could be shown from $H_{t+1}(\bar{a},\bar{\theta})$, the distribution of (a,θ) in period $t+1$ and $H_t(a,\theta)$, the distribution of (a,θ) in period t:

$$H_{t+1}(\bar{a},\bar{\theta})da = \mu\int_a \mathbf{1}_{\{b=\bar{a}\}}H_t(b,\bar{\theta})db + \zeta(\bar{\theta})(1-\mu)\iint H_t(b,\theta)dbd\theta$$

Where $\mathbf{1}_{\{b=\bar{a}\}} = \begin{cases} 1 & b=\bar{a} \\ 0 & else \end{cases}$

Finally, we define the steady status of the system as that the distribution of agents' wealth and talent would no longer change:

$$\lim_{t \to \infty} H_t(a, \theta) = H(a, \theta) \tag{6}$$

And from the perspective of generation evolution, it is

$$H_{t+1}(\bar{a}, \bar{\theta}) = H_t(a, \theta) \tag{7}$$

4. Result Discussion

The following discussions focus on the closed-form solutions in static/single-period situation from proposition 3.1 to proposition 3. 4.

First of all, it is worthy to notice that capital allocation in both self-financing(autarky) and perfectly competitive credit market cases have the same form (proposition 3.1&3.2). This could be interpreted as follows: in the perfectly competitive credit market, the lenders have no market power on the decision of credit to entrepreneurs, that is, an entrepreneur could borrow arbitrarily as long as her objective is realized with satisfaction of the constraint condition (outside option) while the lender merely plays a role of non-for-profit financial intermediate. In this sense, we should virtually regard the capital lent to the entrepreneur as her own. Therefore, the capital allocation in equilibrium is exactly the same as the one in self-financing(autarky) case where an entrepreneur can decide at discretion how to allocate the wealth completely belonging to her.

Moreover, proposition 3.1 to 3.3 show that the capital will be allocated on a risk-adjusted basis to reflect the successful probability, i.e. the entrepreneur's talent. This is consistent with our intuition that the capital would flow to where it could be used with maximum efficiency. In particular, the marginal return to capital decreases with the entrepreneur talent both in self-financing(autarky) and perfectly competitive credit market. This finding is interesting but intuitively natural as the higher the entrepreneur's talent is, the more efficiently that she employs the capital. In other words, the change of the capital return brought by the change of entrepreneur's talent when it is relatively high is smaller than the one when it is relatively low.

Finally, proposition 3.4 gives us a significant property about the entrepreneur's expected wealth. In the event that the entrepreneur's outside option υ is $\Psi^{self}(a, \theta, \omega)$, we can easily get that her expected wealth by using her own wealth is greater than the one when she borrows[12],so she will not borrow. When the outside option is $\upsilon(\phi, a, \theta, \omega)$, it intuitively makes sense that the more competitive a market is or an entrepreneur borrowed, the more benefits she can get even though the capital borrowed is constrained by her initial wealth. If the outside option is $p\omega + r_d a$, then the more her workers' expected wage or her initial wealth is, the more she can

[12] as $\upsilon(a, \theta, \omega) = \max\{\Psi^{self}(a, \theta, \omega), \upsilon(\phi, a, \theta, \omega), p\omega + r_d a\}$.

earn as long as she has the access to the credit market. This can be understood from two aspects: 1. The worker's wage stands for the strength and competitiveness of an enterprise; 2. The initial wealth owned by an entrepreneur determines the upper limit of money she can borrow from lenders, which will be eventually reflected in the firm size. It could be summarized that there is a two-fold income-improvement effect caused by increasing financial inclusion. One is that more people will choose to be entrepreneur other than worker, resulting in more income for them, supporting the conclusion of Demirguc and Levine (2008) and Bianchi (2010). The other one is the firm size distribution will concentrate to large ones since entrepreneurs with more initial wealth would get more credits and this in turn, leads the equilibrium wage to higher level. It is extremely important to understand this significant finding revealed by our model about financial inclusion, i.e. it will realize poverty reduction by improving individual's income.

5. Conclusion

In this paper, we develop a dynamic general equilibrium model to explore implications of credit market with frictions. We start from a traditional occupational choice model, where agents are heterogeneous in wealth and talent by exploring optimal credit contracts and obtain some important properties about capital allocation and the expected wealth of entrepreneur. We then make a generalization by developing a dynamic (multi-period) version of our model, into which we introduce the total financial inclusion coverage measurement. In the dynamic version, we consider the market clearing in terms of labor and capital, together with the wealth transfer and talent evolution of the individual across generations. The final dynamic general equilibrium is given out by the steady state of the system, which is defined by remaining unchanged joint distribution of individual's wealth and talent.

Despite of relatively profound results in the static model (single-period version), we should point out that, as a matter of fact, the dynamic version of our model is more like an analytic framework, into which pertinent factors are incorporated. It is quite hard, even impossible to figure out close-form solution of those key variables such as wage, labor demand/supply in the final dynamic general equilibrium and so on. A possible and practical option is resorting to numerical solution, that is, to calibrate the model with data of some typical countries. For instance, we can approximate the U.S. data as perfectly competitive credit market, calibrate the model to obtain parameters, and then implement simulation by adjusting parameters of financial inclusion to explore the changes in wage and capital allocation. This would be challenging and tedious with high workload. We leave it to future research.

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Appendix: Proofs of Propositions

Proof of proposition 3.1: the Lagrange Multiplier is

$$\mathcal{L} = p\pi(k, l, \theta, \omega) + r_d(a - k)$$

which yield

$$\frac{\partial \mathcal{L}}{\partial k} = p\pi_k(k, l, \theta, \omega) - r_d = 0$$

$$\therefore \qquad \pi_k(k, l, \theta, \omega) = \frac{r_d}{p}$$

■

Proof of proposition 3.2: the Lagrange Multiplier is

$$\begin{aligned}\mathcal{L} = p\pi(k, l, \theta, \omega) + r_d(a - k) \\ + \lambda \Big\{ p[f(k, l, \theta) - \omega l - r + r_d a] \\ + (1 - p)\max(0, r_d a - r) - \upsilon \Big\}\end{aligned}$$

And the Lagrange Conditions are:

$$\frac{\partial \mathcal{L}}{\partial k} = p\pi_k(k, l, \theta, \omega) - r_d + \lambda \Psi_k(a, \theta, k, l, \omega) = 0 \qquad ①$$

$$\begin{aligned}\frac{\partial \mathcal{L}}{\partial \lambda} &= p[f(k, l, \theta) - \omega l - r + r_d a] + (1 - p)\max(0, r_d a - r) - \upsilon \\ &= \Psi(a, \theta, k, l, \omega) - \upsilon \quad \geq 0 \qquad ②\end{aligned}$$

We take a case by case discussion on the second Lagrange condition ②:

1. ② is an equality constraint

   $\Psi(a, \theta, k, l, \omega)$ takes the value υ, the original optimization problem is translated into a maximization problem of the lender's profit, which is contradictory to the case of perfectly competitive credit market[13].

2. ② is an inequality constraint

   From Kuhn-Tucker Theorem, we have $\lambda = 0$, and ① becomes

$$p\pi_k(k, l, \theta, \omega) - r_d = 0$$

$$\therefore \qquad \pi_k(k, l, \theta, \omega) = \frac{r_d}{p}$$

■

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[13] In perfectly competitive credit market, lender is non-for-profit.

Proof of Proposition 3.3: the Lagrange Multiplier is

$$\mathcal{L} = pr + (1-p)\min(r, r_d a) - r_d k$$
$$+\lambda\left\{p[f(k,l,\theta) - \omega l - r + r_d a] + (1-p)\max(0, r_d a - r) - \upsilon\right\}$$
$$+\gamma\left\{pr + (1-p)\min(r, r_d a) - r_d k\right\}$$

And the Lagrange Conditions are:

$$\frac{\partial \mathcal{L}}{\partial k} = (1+\gamma)\Pi_k(\boldsymbol{t}) + \lambda \Psi_k(a,\theta,k,l,\omega) = 0 \qquad ③$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = p[f(k,l,\theta) - \omega l - r + r_d a] + (1-p)\max(0, r_d a - r) - \upsilon \geq 0 \qquad ④$$

$$\frac{\partial \mathcal{L}}{\partial \gamma} = pr + (1-p)\min(r, r_d a) - r_d k \geq 0 \qquad ⑤$$

We firstly notice that ⑤ could not be an equality, otherwise it is same as in the perfectly competitive credit market case. Therefore, from Kuhn-Tucker Theorem, we have $\gamma = 0$.

Secondly, if ④ is an inequality constraint, then $\lambda = 0$, ① becomes

$$\Pi_k(\boldsymbol{t}) = 0$$

As $r = r_L k$, we have

$$\Pi_k(\boldsymbol{t}) = pr_L + (1-p)\frac{\partial \min(r_L k, r_d a)}{\partial k} - r_d = 0$$

Usually the lender will make $r = r_L k \leq r_d a$ to make sure the safety of the loan, then

$$\Pi_k(\boldsymbol{t}) = pr_L + (1-p)r_L - r_d = r_L - r_d = 0 \qquad \Longrightarrow \qquad r_L = r_d$$

Which means the loan rate is equal to the deposit rate, implying the lender could not make profit from credit. Contradiction!

So ④ is an equality constraint

$$p[f(k,l,\theta) - \omega l - r + r_d a] + (1-p)\max(0, r_d a - r) = \upsilon$$

$$\Rightarrow p[f(k,l,\theta) - \omega l - r_L k + r_d a] + (1-p)\max(0, r_d a - r_L k) = \upsilon$$

$$\Rightarrow p\pi(k,l,\theta,\omega) = \upsilon + r_L k - r_d a$$

$$\Rightarrow \pi(k,l,\theta,\omega) = \frac{\upsilon + r_L k - r_d a}{p}$$

And under the condition $r = r_L k \leq r_d a$, we also have $\Pi(\boldsymbol{t}) = (r_L - r_d)k$. As the loan rate $r_L > the\ deposit\ rate\ r_d$, we get $\Pi(\boldsymbol{t}) > 0$ and

$$k < \frac{r_d}{r_L} a < a$$

i.e. the loan is smaller than the own wealth of the entrepreneur.

■

Proof of Proposition 3.4

i) When the outside option v is $\Psi^{self}(a, \theta, \omega)$, from proposition 3.3

$$\pi(k, l, \theta, \omega) = \frac{v + r_L k - r_d a}{p} = \frac{p\pi(k, l, \theta, \omega) + k(r_L - r_d)}{p}$$

$$\Rightarrow \qquad k(r_L - r_d) = 0$$

As usually $r_d < r_L$, we have $k = 0$.

ii) When the outside option v is $\tilde{v}(\phi, a, \theta, \omega)$, from proposition 3.3

$$\pi(k, l, \theta, \omega) = \frac{v + r_L k - r_d a}{p}$$

$$= \frac{\phi[p\pi(k, l, \theta, \omega) + r_d(a - k)] + r_L k - r_d a}{p}$$

$$\Rightarrow \qquad p\pi(k, l, \theta, \omega) + r_d a - r_L k = \frac{\phi}{1-\phi}(r_L - r_d)k$$

The L.H.S of above equation is the expected wealth of the entrepreneur, which increases with ϕ and k.

iii) When the outside option v is $p\omega + r_d a$, from proposition 3.3

$$\pi(k, l, \theta, \omega) = \frac{v + r_L k - r_d a}{p} = \frac{p\omega + r_d a + r_L k - r_d a}{p}$$

$$\Rightarrow \qquad p\pi(k, l, \theta, \omega) + r_d a - r_L k = p\omega + r_d a$$

The L.H.S of above equation is the expected wealth of the entrepreneur, which increases with the workers' expected wage $p\omega$ and the entrepreneur's initial wealth a.