A STUDY ON A MORAL HAZARD TRAP TO ECONOMIC GROWTH

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Ⅰ. Introduction

Modern theories of growth (Lucas 1985, Romer 1986, Barro 1988, Azariadis and Drazen 1988) deal with the incongruence between the neoclassical prediction and the above cited facts.[1] These models emphasize increasing returns to scale as a possible explanation for growth. While increasing returns can explain sustained growth, it cannot explain the observed growth patterns and non-convergence of growth equilibria. Also, its prediction about the correlation between market size

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We would like to thanks tow anonymous referees for helpful comments.
1) For a survey see Azariadis and Drazen (1988), Baumol (1986), Romer (1986), barro and sala-i-Marbin (1992), Aghion and Howitt (1992), Rebelo (1991), Rivera-Bating and Romer (1991) and Easterly (1993).

and growth is not supported by facts. Azariadis and Drazen explain these phenomena by adding and assumption about technology. They assume the existence of thresholds embodied in the production process. Given the existence of such exogenous thresholds they are able to explain multiple growth equilibria. Our work provides a very different explanation for multiple growth equilibria. This explanation can be viewed as an alternative or as a complement to previous works, since it emphasizes the consequences of information constraints on the market and not direct effects of technology on growth.

This paper analyzes patterns of growth within a dynamic general equilibrium model characterized by multiplicity of locally stable equilibria. This multiplicity is a direct outcome of an information asymmetry that creates a moral hazard problem.[2)]

Individuals live three periods. In the first period they borrow resouces which are invested in the formation of human capital. Investment in human capital is always risky, but there are a few options that an individual faces. These options are characterized by different rates of return and different variability. In the second period individuals supply the efficiency units they acquired in the first period, saving the resultant income net of loan repayments. Loan repayment can take two forms. Upon a successful completion an individual pays back the loan plus the interest. In the case where an individual's education fails to be resourceful, the individual pays the collateral. Both interest rate and collateral level are, of course, determined endogenously in the insurance market. In the third period individuals utilize their saving to purchase output for consumption.

One of the major criticism of the relevance of growth models for explaining growth, is the fact that they usually discuss a closed economy. This work will show that under the plausible assumption that capital transfer across countries is easier (faster) then technology transfer (technology is embodied in human capital), opening the capital market may not suffice to bring all countries to the same steady state. The opening up of the capital market increases income and reduces alternative returns. However, an individual facing relatively low reward to education (since the economy is less developed) may find these more favorable conditions insufficient to make investment in a riskier type of education attractive. The next generation will find the same reward scheme since the 'technological inheritance' have not improved. Perfect capital mobility improves income but not necessarily guarantees convergence across countries.[3)]

2) Galor and Ryder (1988) and Galor and Tsiddon (1988) describe other types of multiplicity that are more in the spirit of Azariadis and Drazen (1988)

3) A related objection to the relevance of growth models emerges from the interpretation of the recent

Ⅱ. The Model

Consider a perfectly competitive world in which economic activity is conducted in an uncertain environment and is extended over infinite discrete time, t = 1, 2, 3 ...

1. Production

In every period of time, a single non-durable good is produced using labor and capital. Labor is measured in efficiency units that are determined endogenously and capital is fully depreciated at the end of the production process each period. The production function exhibits constant return to scale in capital (K_t) and efficiency units N_{t-1}. Efficiency units are acquired via an education process that must take place a period in advance.

At time t output produced is

$Y_t = F(K_t, N_{t-1})$ where F is a CRTS production function. (1)

Producers in the good market operate in a perfectly competitive environment.

2. Individual

In every time period, a generation consisting of a fixed number of individuals (N) is born.[4] Individuals are identical within as well as across generations. Individuals live three periods. In the first period of life they borrow, utilizing the resource to finance a risky investment in human capital. The details of the loan and the education process are described below. In the second period

experience of the 'growth miracles'. It is commonly argued that their fast growth rate in the last three decades is based on export policies. If export is the major cause for growth our claims are less relevant empirically. Hence, it is comforting to know that the growth miracles of 1960-1982 are not Granger caused by export (Darrat 1986, Jung and Marshal 1985). Reality therefore is not necessarily against growth theory.

4) Exogenous population growth is excluded only for simplicity.

individuals are employed according to the outcome of the (risky) education they undertook. The resultant income, net of loan repayment,[5] is saved for consumption in the last period of life. Savings are lent to entrepreneurs in the riskless sector and to the risky education sector via a competitive financial market. The structure of this sector will be analyzed shortly. In the last period individuals utilize their savings for consumption.

Individuals born at time t are endowed with the vector l of initial labor endowment as measured in efficiency units.

$$l = (0, 1, 0) \tag{2}$$

Education in the first period, if successful, increases the number of efficiency units the individual obtains. In case of failure education is still necessary to ensure the usability of the unit of labor endowment.[6]

Preferences are represented by utility function of the form

$$U^t(C_t^t, C_{t+1}^t, C_{t+2}^t) = U(C_{t+2}^t)$$

where C_j^t is the consumption of an individual from generation t in period j. U obtains the usual properties i.e. $U'(\cdot) > 0$, $U''(\cdot) < 0$.

3. Education

Individuals born at time t utilize the first period of their life to acquire education in order to perform well when they join the work-force in their second period of life. Higher education has no intrinsic value, but may prove to be more productive than just the minimal necessary level. Throughout this work we normalize the minimum necessary level to one unit of efficiency.

There are two procedures used to acquire education.[7] Each education process requires the amount of L (the same for both)of the real resource. We assume that education, successful or not, is a prerequisite to join the work-force. Therefore, only very mild conditions on preferences are

5) Loan repayment, which is determined endogenously in this model, is shown later to have a different form and size in different states.

6) Education, therefore, is never useless.

7) As long as the number of producers is discrete the analysis remains the same. If one insists on a continuum of available procedures the analysis becomes more complex, though with essentially the same results.

necessary to guarantee that a loan of size L is actually taken. The two alternatives for education differ in their return and riskiness. There is a riskier project (r) that yields higher expected returns and a safer project (s) that yields lower expected returns. Returns to education are measured in terms of efficiency units. The two projects do not differ, however, in the case of failure. The two alternatives are mutually exclusive since they employ all the available time in the first period of life. The characteristics of the two types of education are summarized in equations (3) and (4).

$$(1-P^r)(1+R^r) + P^r > (1-P^s)(1+R^s) + P^s \tag{3}$$

$$(1-P^r) < (1-P^s) \tag{4}$$

where :

$(1+R^r)$: The number of efficiency units obtained by an individual after succeeding in the riskier educational program.

$(1-P^r)$: The probability of success in the riskier educational program

P^r : The probability of the risky education project's failure.

W : The wage per efficiency unit.

$(1+R^s)$, $(1-P^s)$, P^s : the corresponding values for the safe project.

An important characteristic of the education sector is the lack of complete observability. An outsider cannot see which project was chosen by a certain individual. Since an individual's actions are not observed, even ex-post, and they do affect the probability of success then a moral hazard problem arises. In this economy the only information known to an outsider is whether education succeeded or failed, and not what type of education was chosen. It is only this information that can be used in the design of a loan contract between a lender and a borrower.

Ⅲ. Temporary Equilibrium

1. Individual's Behavior[8)]

Let V_t^j be the expected utility for an individual born at time t in case j, $j=r$, s

8) The basic structure is as in Arnot-Stiglitz, 1987.

$$V_t^j = U\{(1+\rho_{t+2})[(1+R^j)W_{t+1}(K_{t+1}) - L - I_{t+1}L]\}\cdot(1-P^j) + U\{(1+\rho_{t+2})[W_{t+1}(K_{t+1}) - C_{t+1}]\}P^j \quad (5)$$

where :

ρ_{t+2} is the real return on savings in period $t+2$.

W_{t+1} is the real wage per efficiency unit in period $t+1$.[9)]

K_{t+1} is the capital-efficiency units ratio in period $t+1$.

C_{t+1} is the size of the collateral on the loan. The collateral can be either positive or negative (insurance) and is collected (distributed) in the case the education process failed.

An individual born in period t is characterized by two different indifference maps, each corresponding to one of the two types of education. Since these two options are mutually exclusive and must be decided ex-ante, each indifference map can be drawn separately in the net returns (states) space. Since we assume (for now) that W, R_j are constant, we can draw these indifference curves (slightly inverted) in the space (iL) - (L-C). (iL) is the cost of borrowing in case of success and (L-C) is the benefit from the limited liability in case of failure.[10)] Since this is a cost benefit description we expect these indifference map to be upward sloping. We prefer this exposition since it is helpful when looking at the financial structure of the education sector. Before we proceed further notation must be defined :

U_0^j - the utility derived from success when education is of type j.

$U_0^{j\prime}$, $U_0^{j\prime\prime}$ - the first and second derivatives of U_0^j

U_1^j, $U_1^{j\prime}$, $U_1^{j\prime\prime}$ - the corresponding values of the utility derived in case of failure of the education (type j) undertaken.

Using equations (6), (7) these indifference maps can be drawn as an upward sloping convex loci :

$$\left.\frac{\partial iL}{\partial(L-C)}\right|_{\substack{V^j\\W}} = (-L)\left.\frac{\partial i}{\partial C}\right|_{\substack{V^j\\W}} = \frac{U_1^{j\prime}(\cdot)p^j}{U_1^{j\prime}(\cdot)(1-p^j)} = \eta^j > 0 \quad (6)$$

$$\left.\frac{\partial iL}{\partial(L-C)^2}\right|_{\substack{V^j\\W}} = -\frac{p^jU_1^{j\prime}}{(1-P^j)U_0^{j\prime}}\cdot\left[-\frac{U_1^{j\prime\prime}}{U_1^{j\prime}} - \frac{U_0^{j\prime\prime}}{U_0^{j\prime}}\cdot\frac{p^jU_1^{j\prime}}{(1-p^j)U_0^{j\prime}}\right] < 0 \quad (7)$$

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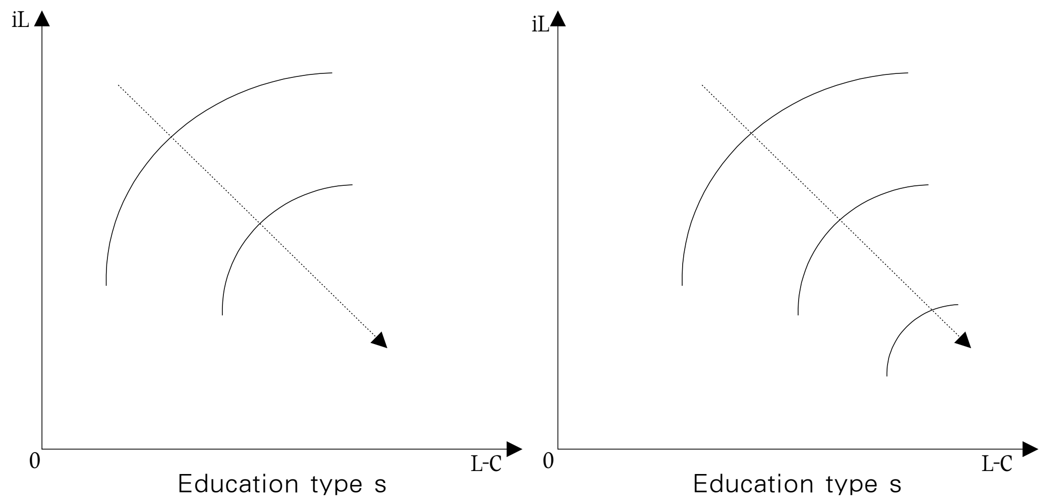
9) For simplicity we assume that $L << W_0$

10) (L-C) is the insurance which must be non-negative for risk averse individuals.

Figure 1



Equation (8) shows that the indifference map of the riskier education is steeper than the safer education's map.

$$\frac{\eta^{r}}{\eta^{r}} = \frac{P^{s}(1-P^{r}) \cdot U_{0}^{r\prime}}{(1-P^{s})P^{r} \cdot U_{0}^{s\prime}} < 1 \tag{8}$$

The explanation for equation (8) is that a decrease in the collateral is more probable to matter in the riskier case (since the probability of failing is higher). Therefore, an individual will agree to pay more interest for a given decrease in the collateral in order to keep his utility constant in the riskier case.

Individuals' choice, however, is done endogenously between the two projects. An individual that is offered any possible combination of interest payment (in case of success) and collateral size (in case of failure) is almost always not indifferent maps are convex and increase towards the bottom right, the relevant indifference curve for an individual's choice is a combination of two segments. When the collateral/loan ratio is high, a risk-averter tends towards the less risky project, while when the collateral is sufficiently low the better prospects of the risky asset dominate the decision and even a highly risk averse individual chooses the riskier project. This can be seen most easily with the help of figure 2. In figure 2 we draw two indifference curves with the same level of utility $U(\alpha)$. Because of the strict convexity and the fact that $U^{r}(\alpha)$ is always steeper than $U^{s}(\alpha)$ these indifference curves cross only once. The crosing point is fully characterized by equation (9).

$$U_0^s(1-P^s)+U_1^sP^s = U_0^r(1-P^r)+U_1^r\cdot P^r \quad (9)$$

$$U_1(P^s-P^s) = U_0^r(1-P^r)-U_0^s(1-P^s) \ \text{(since } U_1^r=U_1^s\text{)} \quad (9')$$

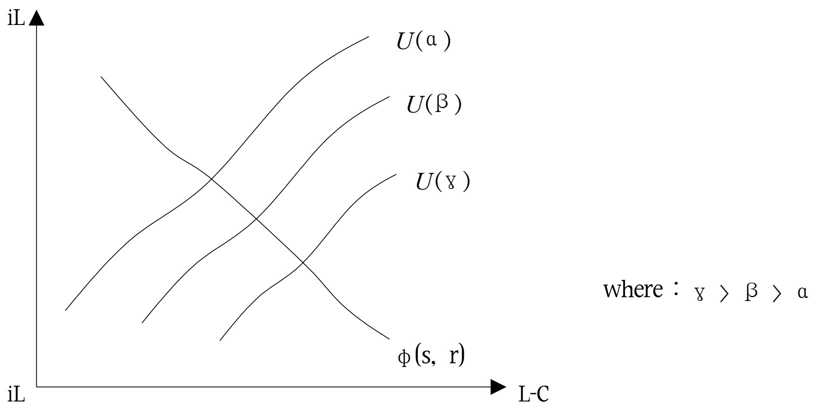
Define φ(s, r) as the set of all points where (9') holds. The locus φ(s, r) is downward sloping because :

$$\left.\frac{\partial(iL)}{\partial(L-C)}\right|_{\varnothing = constant} = \frac{U_1'\{\cdot\}(P^r-P^s)}{U_0^{r\prime}\{\cdot\}(1-P^r)-U_0^{s\prime}\{\cdot\}(1-P^s)} \quad (10)$$

The individual's attitude towards the two projects can be inferred from figure 2. When offered any combination of interest and collateral to the left of φ(s, r), the individual's choice is the safer project; when the choice is to the right of φ(s, r), the risky project is chosen.

An important characteristic of the choice-relevant indifference map (endogenous risk) is its non-convexity around φ(s, r).

Figure 2



2. The Financial Structure of the Education Sector

Since moral hazard arises in the market for loans because of the endogenous risk in the education sector, the financial arrangements that support an equilibrium need clarification. Our choice is the simplest possible competitive market. We assume that there exists many lenders in the educational loans market. Each lender serves as a financial intermediator between middle aged individuals (the generation that saves) and the young (the generation that borrows). Since risk is purely individualistic and population size is large, we assume each financial intermediator can provide a risk free return to lenders that is equal or greater than the risk free rate of return individuals can earn in the market for physical capital. Competition guarantees that each financial intermediator has zero profits.

Remark 1 : The competitive equilibrium is so simple in this case (unlike Arnot and Stiglitz, 1987) because the loan size is fixed and there is no use for funds above the level L. In the more general case, when education types differ also in investment or when there are alternative uses for the loan, the equilibrium must be defined as a price-quantity equilibrium. In fact, even this very simple case is a price-quantity equilibrium and not the standard price equilibrium. The price of a success relative to failure is the interest rate divided by the collateral. A competitive firm cannot offer this ratio since it will suffer losses. As we will immediately see, a competitive firm must specify the size of the collateral and the interest rate and not only their ratio.

The instantaneous zero profit condition for a competitive lender is :

$$- P^j(L - C_t) + (1 - P^j)\, i_t L = \rho_t L \qquad (11)$$

The zero profit condition is therefore an upward slopping straight line in the space (iL) - $(L-C)$, with different slopes for the different expected choices of individuals. If the lender expects a higher risk to prevail a unit decrease in the collateral must be accompanied by a higher increase in interest payment. Therefore the zero profit line is steeper when risk is higher. The two zero profit lines also have different intercepts. This difference emerges from two sources. It is affected by the alternative rate of return (investment in physical) and by the probabilities to succeed in the two cases. Thus, the higher the alternative returns, the higher the intercept; and the lower the probability to succeed, the higher the intercept.[11]

Since the space (iL) - $(L-C)$ is divided into two regions by $\varnothing$(s, r), we can draw the segments of the zero profit condition that are relevant for the individuals' choice. Figure (3) illustrates the situation.

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11) Imagine an economy with a given level of fixed capital. Since average returns in terms of efficiency units are higher in the case of the riskier project, and since the average is the result for the economy as a whole, the marginal productivity of physical capital is higher if the economy is engaged in the riskier project. $f'(k_t^r) > f'(k_t^s)$ for any k_t , where k_t^j is K_t / N^j_{t-1} .

Figure 3

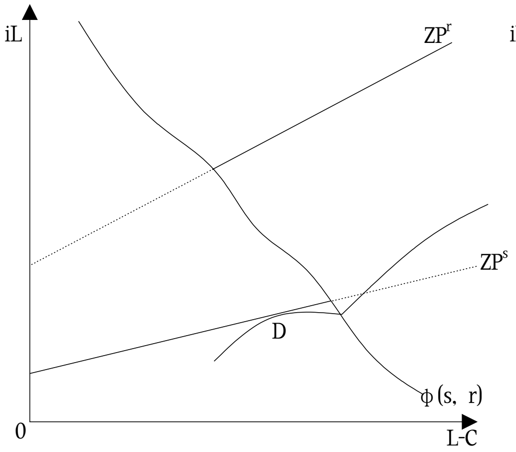
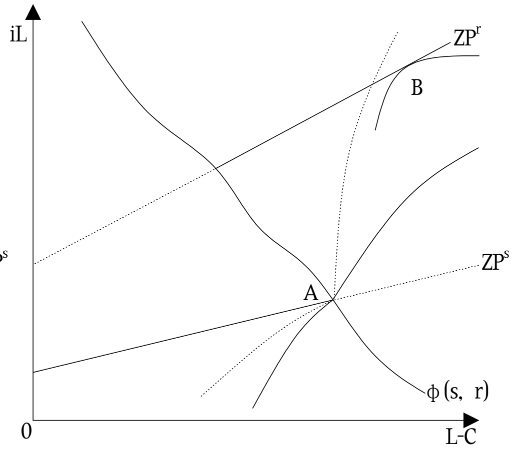


Figure 4



3. The Solution to the Choice Problem

Before we proceed to describe the dynamic equilibrium of this economy, we must first briefly describe some properties of the temporary equilibrium. Assume that the initial capital stock is $K_o > LN$. A temporary equilibrium can be one of the following three possibilities :

(a) An equilibrium without constraints in which all individuals prefer the safer project (point D on figure 3).

(b) A constrained equilibria in which all agents prefer a contract with a smaller collateral and higher rate of interest to finance the low risk education (point A on figure 4).

(c) An equilibrium in which all agents are not constrained and prefer the riskier education (point B on figure 4).

Since equilibria of types A and D are similar for the purpose of this study, we will discuss only equilibria of types A and B.

Remark 2 : Equilibria of type B are characterized by full insurance. Although education is risky, individuals' income is safe. If necessary, collateral is negative and therefore serves to insure individuals from and risk. This can be seen most easily from the tangency condition of the zero profit line and the utility indifference curve.

$$\text{slope of } ZP \equiv \frac{P^r}{1-P^r} = \frac{P^r}{1-P^r}\frac{U_1^{r}{}'(\cdot)}{U_1^{r}{}'(\cdot)} \equiv \text{slope of utility indifference curve} \tag{12}$$

which implies

$$U_1^{j}{}'(\cdot) = U_0^{j}{}'(\cdot) \tag{13}$$

Equation (13) can be satisfied only if insurance is complete. Full insurance is not essential to the argument of this paper. In fact, if there are more than two types of education processes that can be ranked in the same way as in equations (3) and (4), full insurance is guaranteed only at the highest quality education.

Lemma 1 : Assume $K_o (\rangle LN)$, R^j and P^j, satisfy (3) and (4) respectively. The likelihood that the economy will be in equilibrium with riskier education decreases with an increase in the global risk aversion.

Proof : Consider figure 4. Assume that the economy is at point A. Whether or not A is an equilibrium depends on two factors :

(a) The slope of the indifference curve of the riskier education at point A.

(b) The curvature of this indifference curve beyond point A.

For a given slope at point A, the curvature beyond A depends on the Arrow-Prat coefficient of risk aversion at two different points (see equation 7). But the slope of Ur at A also depends on previous risk aversion (the curvature before point A), therefore the global properties of risk aversion are important in the determination of the temporary equilibrium.

The temporary equilibrium is unique. For an exogenous alternative opportunities and income each individual invests in the same type of education. The outcome, which is the number of efficiency units available for next period production, is therefore the average of the specific education undertaken times the population size. In general, if the economy is in the quantity-constrained low-risk equilibrium, savings are affected by the distribution of income. We ignore this aspect in our discussion of dynamics by assuming that all income is saved for third period consumption. If equilibrium is of type B, then income is equally distributed (full insurance). Savings, therefore, are not altered by the individualistic risk in this case.

Ⅳ. Patterns of Growth and Government Intervention

Some of the more recent criticism of growth theory have suggested that in reality one does not observe the patterns of growth derived from a Solow type growth model (Azariadis and Drazen, 1988). Very rarely do we find that countries with a low level of income per capita grow faster than the well-to-do countries. Empirical experience, if it can be generalized[12] shows that the group of poor countries grow slower than middle and high income countries. The model presented above provides a possible explanation to this observation. If the set of non-dominant risky education projects is larger than two $\{R^j\}_1^m$, the expected pattern of growth is neither continuous (multiple equilibria)nor monotonically decelerating. Growth take offs can happen when income is sufficient, when the financial structure improves (i.e. when insurance gets closer to perfect competition rates), or when world capital is more available. In fact, this model predicts that growth rates are not stationary and therefore exercises of balanced growth can be questioned in this context.

Recent theory also criticizes growth models on the issue that they determine income in the long run but not growth rates (Barro 1988 Barro and Sala-i-Martin 1993, Lucas 1985, Romer 1986 and Rivera-Batiz and Romer 1991). The offered solution is that growth rates in the steady state are generated by increasing returns to capital which do not have dramatic effects on market structure since they appear as externalities (Lucas, Romer) or as government intervention (Barro). This model can easily be modified in the spirit of Azariadis and Drazen by incorporating a mechanism of sustained growth. Following Azariadis and Drazen, if the previous generation's knowledge has a positive impact on the current (expected) quality of education, the economy can experience steady growth. If a zero education equilibrium is possible and is locally stable[13], then this extension of our model will yield multiple equilibria in the rate of growth. This line of thought has not been pursued since we believe that one of the important characteristics of growth rates (beyond its existence!) is its irregularity.

The financial structure of the model presented in this paper can be replaced by a zero profit monopoly without the need for any changes. It can be further assumed that this

12) Azariadis and Drazen (1988) has some preliminary results. They also have results that connect growth to education. Their explanation is however substantially different.

13) We excluded this possibility from our model (by assumption) in order to keep the exposition clear. Only minor changes are necessary to incorporate this case.

financial-zero-profit-monopolist is the government itself. If the financial sector is the government (which miraculously seeks zero profits), then gross interest payments are the income tax on high wages and the collateral is the income tax (or transfer, since it can be negative) to the poor. Therefore, every young generation gets the education desired free and pays axes when middle-aged to finance the real costs of this education.[14] Note that we the choice of the specific type of education is kept in the hands of the individual.

This interpretation offers an interesting insight into the connection between the tax system and economic growth. It is usually argued that lump-sum taxes are the most efficient and that they are not used only because of some non economic non-quantifiable objectives. In our case, since there is non income-leisure choice and consumption is only in the last period, it can be expected that a proportional tax would do equally well. The result, however, is that neither of the above taxes are optimal. When the economy is in the high risk education equilibrium the optimal tax is (very) progressive[15], whereas when the economy is in the constrained equilibrium the optimal income tax tends to be progressive, though this is not always so.[16]

If the education sector is governmental, or at least government financed, can a government pull the economy out of the trap? More importantly, is a pareto improvement possible? The closed economy model is not rich enough to provide an answer to a pareto improvement, since there is no way to alter consumption patterns without changing utility. Nevertheless, the open economy model shows that there are cases where government intervention will in fact cause a pareto improvement.

Assume an economy is trapped in the low education equilibrium even though capital is perfectly mobile. The government can borrow abroad and run a deficit, while giving a contract that induces high education. In the future generation(s) the government can collect positive profits and pay back the loan. The first generation is not hurt since no additional taxes are collected and the world interest rate is fixed. Future generations will pay higher taxes then the taxes in the rest of the world, but their net income is higher than the net income when the education remains at the low level. It should be note, however, that a government cannot always operate in this way. If the

14) Since the real costs include interest payment, the government can step in at any time without affecting the income or welfare of any generation.

15) See remark 2. Full insurance means egalitarian distribution of income. This is not a claim for such a distribution since the paper ignores problems of adverse selection that arise naturally in an egalitarian environment. Moral hazard, nonetheless, creates and environment for egalitarian income distribution because of the informational constraints.

16) Optimal income tax is regressive if in the competitive equilibrium is constrained and $C > L \cdot (1+i)/(1+R^s)$.

necessary loan is too large, or the world interest rate is too high, it may be impossible to guarantee a pareto improvement.

Ⅴ. Conclusions

It is well known that the structure of the financial market affects growth and income. The model presented in this paper, however, demonstrates that if the financial market is characterized by moral hazard, even perfect competition is insufficient to guarantee growth and high income. In general there are many stationary states of income (or growth), and therefore the long run stationary state depends on the history of the economy. We have shown that this remains true even if capital is mobile across countries as long as technology advancement cannot be achieved at once. In some case government intervention can induce a pareto improvement.

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<국문초록>

경제성장에 대한 도덕적 해이트랩

심 경 섭
이 형 석
전 혜 린

본 논문은 국지적이며 안정적 균형의 복합성에 의해서 동태적인 일반균형모형에 특징지워진 성장모형의 패권과 정부개입을 분석하려 한 것이다. 이러한 복합성 모형은 정보의 불일치성에 관한 직접적인 결과로서 나타나는데 이는 도덕적 해이 문제를 야기시키게 된다. 또한 도덕적 해이는 성장과 소득에 관한 금융시장의 구조에도 많은 영향을 미치는 것으로 분석되고 있다.