GCOE Discussion Paper Series

Global COE Program
Human Behavior and Socioeconomic Dynamics

Discussion Paper No.77

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August 2009

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Perverse effects of a ban on child labour in an overlapping generations model*

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August 19, 2009

Abstract

Despite the International Programme on the Elimination of Child Labour, child labour remains particularly common in developing countries. Why has the Programme failed to achieve the expected outcome? To address this question, we construct a two-period overlapping generations model with the detection probability in regard to the ban on child labour, which depends on government expenditure. By analyzing this model, we show that whether the ban on child labour has a suppression effect or not depends on the human capital level of parents. We also demonstrate the human capital dynamics in the model and show that there exist multiple equilibria: one is the poverty trap, which has a higher incidence of child labour and a low level of human capital; the other is the equilibrium that has a lower level of child labour and a high level of human capital. Finally, we incorporate public education into the model and obtain the expenditure rate for monitoring child labour and education, which minimizes the level of child labour.

JEL classification: I21, I28, O11

Keywords: ban on child labour, detection probability, human capital

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*We are grateful to Ken-ichi Hashimoto, Jyunichi Itaya, Noritaka Kudoh, Tadashi Morita, Yoshiyasu Ono, Yasuyuki Sawada and seminar participants at Osaka University and Hokkaido University, and the spring meeting of the Japanese Economic Association at Kyoto University. All remaining errors are naturally our own.

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1 Introduction

Because child labour damages children's psychological and physical growth and restricts their opportunity to obtain an education, various regulations or conventions have been established in order to eliminate child labour. Convention 138 of the International Labour Organization (ILO) provides a definition of child labour. Under the Convention, child labour should be restricted to light work that does not prevent a child from being educated in school. One hundred and fifty member nations have signed Convention 138, and each individual nation passes laws to prevent the problem and makes an international treaty with other nations. This includes child labour regulation, that is, governments monitor firms/persons that employ children and fine them for doing so. For example, in India, the government issues fines of between Rs 10,000 and Rs 20,000 per year for firms, whereas in Thailand, the government issues fines of up to 200,000 Baht or imposes a one-year prison sentence for a person or a firm that employs children who are fifteen years old or less.[1]

Despite these regulations, in developing countries, many children are involved in economic activities. In percentage terms, the proportion of children aged between 5 and 14 years who work amount to 19 % in Asian and Pacific countries, 16 % in Latin American countries, 29 % in Caribbean countries, 29 % in Sub-Saharan African countries, and 15 % in Middle Eastern and North African countries. (See the Statistical Information and Monitoring Programme on Child Labour (SINPOC).)

We consider why the regulation of child labour does not achieve its expected outcome. To address this question, this paper introduces the detection probability of a government that investigates child labour. For this purpose, we set up a two-period overlapping generations model with human capital, in which we assume that the detection probability depends on government expenditure. Then, we examine how changes in government expenditure affect the individual decision making of households in relation to child labour. In the model, parents are the decision makers for all members in a family. Parents derive their utility from consumption in their old age, and the level of human capital of their children. However, they rely not only on their own income but also on labour income from their children. Thus, they allocate their children's endowed time between child labour and education, that is, they must send their children to workplaces, for example factories or farms.

[1] In the United States, the Department of Labor fined the Wal-Mart Store $135,540 for violating the youth employment provisions of the Fair Labor Standards Act in 2005.

Numerous studies have examined the incidence of child labour. For example, Gupta (2000) examined the wage determination of a child worker. He showed that firms enforce lower wage rates for children, which results in an increased number of child labourers when the firms have the bargaining power over the child wage. Rogers and Swinnerton (2008) examined issues on exploitation child labour by farms. They showed that the policy that reduces exploitative child labour is Pareto improving.[2] In contrast to these studies, in our work, we focus our attention on the ban on child labour and examine how the ban on child labour affects the incidence of child labour.

Our analysis builds primarily on previous research by Basu and Van (1998) and Basu (2005). Assuming substitutability in production between child labour and adult labour, Basu and Van (1998) showed that there exist multiple equilibria in the labour market: in one equilibrium, children work, whereas in the other equilibrium, they do not work. They showed that regulation of firms simply increases the volume of child labour and leads the economy to the worse equilibrium. Basu (2005) also showed that an increase in the fine for employing children leads to an increase in child labour. We also assume substitutability in production between child and adult labour, and then incorporate the detection probability in regard to the ban on child labour into the present model. In contrast with the results of the above-mentioned authors, we show that whether the government's regulation increases the incidence of child labour depends on the human capital level of parents.

The crux of the problem of child labour from an economic development perspective is that it restricts the opportunity for children to have an education and prevents the economy from developing. For example, using Zambian data, Jensen and Nielsen (1997) showed that poverty forces households to keep their children away from school. In addition, using data from Peru, Patrinos and Psacharopoulos (1997) showed that even if they do not work, many children still will not go to school at all. Furthermore, SIMPOC data indicate that there is a higher incidence of child labour in developing countries compared with developed countries (ILO (2002)). In this paper, we present a theoretical model that supports these empirical results and examine the effects of public education on the incidence of child labour.

This paper is organized as follows. Section 2 develops the model. Section 3 characterizes

[2]The Convention concerning the Prohibition and Immediate Action for the Elimination of the Worst Forms of Child Labour, known in short as the Worst Forms of Child Labour Convention, was adopted by the ILO in 1999. By ratifying this Convention 182, a country commits itself to taking immediate action to prohibit and eliminate the worst forms of child labour. For analysis of the Worst Forms of Child Labour, see Basu and Chau (2004), Dessy and Pallage (2005) and Sugawara (2008).

the equilibrium and analyzes the impacts of government regulation on child labour. Section 4 analyzes the dynamics of this economy. Section 5 states some extensions. Section 6 concludes the paper.

2 The Model

Consider an infinite-horizon economy composed of households, perfectly competitive firms and a government. A new generation of a unit mass referred to as generation t is born in period $t-1$. Time is indexed by $t = 1, 2, \cdots$. Generation $t \geq 1$ is composed of a continuum of N_t units who live for two periods, childhood and adulthood.

Firms

We assume that there are two sectors: the illegal sector and the legal sector, both of which produce the same goods in the economy. A fraction of firms, $p \in (0, 1)$, operates in the illegal sector, whereas $1-p$ firms operate in the legal sector. In what follows, we express the status of firms by using indexes I and L, where I denotes the firms of the illegal sector and L denotes those of the legal sector. In the illegal sector, firms employ children illegally and produce goods by using child labour and the human capital of adult agents according to the following production technology:

$$y_t^I = w_c l_t + w_A h_t,$$

where w_c, l_t, w_A and h_t, respectively, represent the productivity of children, the incidence of child labour, the productivity of adults and the level of human capital of adult agents. We assume that individuals have full information about the types of firms. Accordingly, parents who want their children to work send their children to the illegal sector.

In the legal sector, firms employ only the human capital of adult agents and produce goods according to the following production technology:

$$y_t^L = w_A h_t.$$

We assume that the productivity of adults is the same in both sectors. Thus, adult agents are indifferent between working in the legal sector or in the illegal sector. Then, a fraction, $p \in (0, 1)$, of adults work in the illegal sector and $1-p$ work in the legal sector. We also assume that $w_c < w_A$; that is, the wage rate of adults is higher than that of children. Because the firms in the legal sector do not hire children, children work only in the illegal sector.

Government

We assume that the government has the authority to ban child labour. The government levies income tax on households and uses the funds for the ban on child labour. The government enforces the child labour ban through monitoring. In each period, the government randomly selects firms and monitors them to inspect whether they employ children. For example, the Ministry of Labour and Social Security in the Republic of Turkey carried out such a program enforcing the supervision of child labour from 1994. Accordingly, the number of working children aged fifteen years old or less decreased between 1997 and 1999 in Turkey (OECD 2003). We denote the probability of detection of child labour as $\pi(g)$ (where $0 \leq \pi(g) \leq 1$), where g shows the expenditure required for the government to carry out the inspection program. The probability of detection also has the following properties: $\pi'(g) > 0$, $\pi''(g) < 0$, $\pi(0) = 0, \lim_{g\to\infty} \pi(g) = 1, \lim_{g\to 0} \pi'(g) = \infty$, and $\lim_{g\to\infty} \pi'(g) = 0$. If a firm employs children, it is certain that the authority will find this out.The effective probability of detection is decided by $p\pi(g_t)$, because only the illegal sector employs children. When the government finds incidents of child labour by monitoring firms, the detected firms are fined an amount equivalent to the output produced by the children. Noting that the aggregate amount of fines is $\pi(g)w_c l_t$, the budget constraint of the government is as follows:

$$g = T_t + p\pi(g)w_c l_t^d,$$

where T_t shows lump-sum transfers between households and the government. When $T_t > 0$, it indicates a per capita lump-sum tax, whereas when $T_t < 0$, it indicates a per capita lump-sum subsidy. When we assume that child labour is distributed uniformly in the illegal sector, the equilibrium of the child labour market becomes $\frac{l_t^d}{p} = l_t$. Therefore, the budget constraint of the government is as follows:

$$T_t = g_t - \pi(g_t)w_c l_t. \tag{1}$$

Households

An agent is endowed with one unit of labour in childhood and adulthood, respectively. Parents (generation $t-1$) allocate the time endowment of their children (generation t) between working time, l_t, and schooling time, e_t. In each period, the sum of the time spent working and the time spent in schooling must be unity and each time commitment must lie between zero and unity:

$$l_t + e_t = 1, \quad 0 \leq l_t \leq 1, \quad 0 \leq e_t \leq 1. \tag{2}$$

Adult agents of generation $t+1$ are also endowed with one unit of time. They supply their whole time and human capital to firms and earn the effective wage income, $w_A h_t$.

Following Galor and Weil (2000), Holtz-Eakin, Lovely and Tosun (2000) and Tabata (2003), we assume that the time spent in schooling increases the agents' level of human capital. For simplicity, we assume that agents born in period t obtain human capital as follows:

$$h_{t+1} = (\delta + \gamma e_t)^{\sigma}, \quad \delta > 0,\ \gamma > 0,\ 0 < \sigma < 1, \tag{3}$$

where γ and σ express, respectively, the parameters of efficiency of education and the adjusted elasticity of the human capital with respect to an educational level. When $e_t = 0$, the level of human capital is δ^{σ}. Therefore, δ expresses the adjusted innate ability of human beings.

In what follows, we distinguish between families by using indexes $i = c, f$. $i = c$ indicates a family that can obtain wage income from child labour. It indicates that, despite the ban on child labour, the government cannot completely find out the child labour of each family. Thus, some families can evade the ban and receive wage income from child labour. $i = f$ indicates a family that does not obtain a wage income from child labour. It indicates that because the government has found out the child labour, the family cannot receive the wage income from their children working in the illegal sector.

We assume that adult agents consume all of their family income; that is, the wage income from their own labour and that from child labour. Consequently, the budget constraints become as follows:

$$c^t_{i,t+1} = \begin{cases} w_A h_{t+1} - T_{t+1}, & \text{if } \ i = f, \\ w_A h_{t+1} + w_c l_{t+1} - T_{t+1}, & \text{if } \ i = c. \end{cases} \tag{4}$$

Each agent of generation t has preferences over his or her consumption in each state, $c^t_{i,t+1}$, and the level of human capital of his or her children, h_{t+2}. The probability of the agent's consumption becoming $c^t_{f,t+1}$ is $\pi(g_{t+1})$, which is the level of probability that the government will find out the child labour of each family. Meanwhile, the agent's consumption is $c^t_{c,t+1}$ with a probability of $1 - \pi(g_{t+1})$. We assume that each agent has the following expected lifetime utility function:

$$U_t = \pi(g) \log c^t_{f,t+1} + (1 - \pi(g)) \log c^t_{c,t+1} + \beta \log h_{t+2}, \tag{5}$$

where $\beta \in (0,1)$ indicates the degree of altruism towards their children.

As parents are the decision makers of families, they determine the allocation of their children's time by maximizing (5). Hence, the optimization problem of each parent of generation t can be expressed as follows:

$$\begin{aligned}\max_{l_{t+1}} U_{t+1} &= \pi(g)\log(w_A h_{t+1} - T_{t+1}) + (1-\pi(g))\log(w_A h_{t+1} + w_c l_{t+1} - T_{t+1}) \\ &+ \beta \log(\delta + \gamma(1 - l_{t+1}))^{\sigma}, \\ &\quad \text{s.t.} \quad 0 \ \leq l_{t+1} \ \leq \ 1.\end{aligned}$$

The first-order condition with respect to l_{t+1} is given by:

$$\frac{\partial U_{t+1}}{\partial l_{t+1}} = \frac{(1-\pi(g))w_c}{w_A h_{t+1} + w_c l_{t+1} - T_{t+1}} - \frac{\beta\sigma\gamma}{\delta + \gamma(1-l_{t+1})} \lesseqqgtr 0, \ (\textit{with equality if } 0 < l_{t+1} < 1). \quad (6)$$

The first term on the right-hand side of (6) represents the marginal benefit of child labour. The second term on the right-hand side of (6) represents the marginal cost of child labour.

3 Equilibrium and the effect of the ban on child labour

In this section, we first examine how parents allocate the time of their children, given the human capital level of the parents and the detection probability of child labour. Then, we examine how changes of government expenditure affect the incidence of child labour.

By using (1) and (6), we obtain the following relationship between child labour and human capital:

$$\begin{aligned} & l_{t+1}(g; h_{t+1}) = l_{t+1} \\ &= \begin{cases} 1, & \text{if } \ h < \tilde{h}, \\ \dfrac{(1-\pi(g))w_c(\gamma+\delta) - \beta\gamma\sigma(w_A h_{t+1} - g)}{\gamma w_c(\beta\sigma(1+\pi(g)) + (1-\pi(g)))}, & \text{if } \ \tilde{h} \leq h < \bar{h}, \\ 0, & \text{if } \ \bar{h} \leq h, \end{cases} \end{aligned} \quad (7)$$

where: $\tilde{h} \equiv \frac{(1-\pi(g))w_c(\frac{\delta - \beta\gamma\sigma}{\beta\gamma\sigma}) + g}{w_A}$, and: $\bar{h} \equiv \frac{(1-\pi(g))w_c(\frac{\delta+\gamma}{\beta\gamma\sigma}) + g}{w_A}$. As can be seen from (7), the time allocation of child labour depends on the human capital level of the parents, h_{t+1}, and the government expenditure level, g. When the level of human capital is sufficiently low, that is, $h_{t+1} < \tilde{h}$, parents cannot earn sufficient income and must rely on child labour to assist their family. Therefore, the parents force their children to work instead of obtaining an education. In contrast, when the level of human capital is sufficiently high, that is, $\bar{h} \leq h_{t+1}$, parents can earn sufficient income and they do not need to send their children to a factory or farm. Therefore, the parents send their children to school to obtain an education. Figure 1 depicts this relationship and shows that child labour, l_{t+1}, decreases with an increase in the human capital level of parents, h_{t+1}, when h_{t+1} is in the internal $[\tilde{h}, \bar{h}]$.

Next, let us examine how changes in government expenditure influence the decision making of parents. We can state the following lemma for this effect.

Lemma 1 *An increase in government expenditure raises the level of child labour if and only if* $h_{t+1} < \hat{h}$, *where* $\hat{h} \equiv \frac{(\frac{\beta\sigma(1+\pi(g))+(1-\pi(g))}{\pi'(g)})+(1-\beta\sigma)g-2w_c\frac{\delta+\gamma}{\gamma}}{(1-\beta\sigma)w_A}$.

Proof. Differentiating l_{t+1} with respect to g, we have:

$$\frac{\partial l_{t+1}(g;h_{t+1})}{\partial g} = \frac{(1-\beta\sigma)\beta\gamma\sigma g + \beta\gamma\sigma(\frac{\beta\sigma(1+\pi(g))+(1-\pi(g)}{\pi'(g)}) - \beta\sigma[2w_c(\delta+\gamma)+\gamma(1-\beta\sigma)w_A h_{t+1}]}{\gamma w_c[\beta\sigma(1+\pi(g)+(1-\pi(g)]^2}.$$

As the denominator takes a positive value, the numerator determines the sign of this derivative. The sign of the numerator is positive if and only if $h_{t+1} < \hat{h}$; that is, an increase in government expenditure raises the level of child labour. ■

This lemma indicates that government expenditure has two effects on child labour. One is an "income effect". Increases in government expenditure decrease the family income because they must either raise the level of lump-sum taxes or reduce the level of lump-sum transfers due to the balanced budget requirement of the government. This increases the burden on families that rely on child labour. Therefore, this effect has a positive impact on the incidence of child labour. The other effect is a "substitution effect". As an increase in detection probability decreases the expected income from child labour, it decreases the benefit of child labour. Therefore, this effect has a negative impact on the incidence of child labour. The impact of increases in lump-sum taxes imposes a much heavier burden on the families with a lower level of human capital than on the family with higher levels of human capital. Thus, the positive income effect dominates the negative substitution effect.

We can classify the effects of the government expenditure on child labour into the following three cases according to the levels, $\tilde{h}, \hat{h}$ and $\bar{h}$. To compare $\hat{h}$ with $\tilde{h}$ and $\bar{h}$, it is convenient to define the following functions: $\tilde{H}(g) \equiv (1-\pi(g))(1-\beta\sigma)w_c\frac{\delta-\beta\gamma\sigma}{\beta\gamma\sigma}$, $\hat{H}(g) \equiv \frac{\beta\sigma(1+\pi(g))+(1-\pi(g))}{\pi'(g)} - 2w_c\frac{\delta+\gamma}{\gamma}$, and $\bar{H}(g) \equiv (1-\pi(g))(1-\beta\sigma)w_c\frac{\delta+\gamma}{\beta\gamma\sigma}$. It can be easily seen that the order of $\tilde{h}$, $\hat{h}$ and $\bar{h}$ is the same as the order of $\tilde{H}(g)$, $\hat{H}(g)$ and $\bar{H}(g)$.

Noting that $\pi(0) = 0, \lim_{g\to\infty}\pi(g) = 1, \lim_{g\to 0}\pi'(g) = \infty$, and that $\lim_{g\to\infty}\pi'(g) = 0$, we can easily obtain that: $\tilde{H}'(g) < 0, \tilde{H}(0) = (1-\beta\sigma)w_c\frac{\delta-\beta\gamma\sigma}{\beta\gamma\sigma}$, and $\lim_{g\to\infty}\tilde{H}(g) = 0$, and, also that $\bar{H}'(g) < 0, \bar{H}(0) = (1-\beta\sigma)w_c\frac{\delta+\gamma}{\beta\gamma\sigma}$, and $\lim_{g\to\infty}\bar{H}(g) = 0$. Furthermore, it is obvious that

$\tilde{H}(g) < \bar{H}(g)$. On the other hand, as

$$\hat{H}'(g) = \frac{1}{(\pi'(g))^2}\Big(\underbrace{-((\pi'(g))^2(1-\beta\sigma)}_{(-)} \underbrace{-\pi''(g)(\beta\sigma(1+\pi(g)) + (1-\pi(g))}_{(+)} \Big),$$

the sign of $\hat{H}(g)$ is ambiguous. However, we can show that $\lim_{g\to 0}\hat{H}(g) = 0$ and $\lim_{g\to\infty}\hat{H}(g) = \infty$. Therefore, intersection points of the graphs of $\tilde{H}(g)$ and $\hat{H}(g)$ and those of the graphs $\hat{H}(g)$ and $\bar{H}(g)$ exist. We assume that there is a unique intersection point of the graphs of $\tilde{H}(g)$ and $\hat{H}(g)$. Let g_A denote the value at which $\tilde{H}(g_A) = \hat{H}(g_A)$. Similarly, let g_B denote the value at which $\hat{H}(g_B) = \bar{H}(g_B)$. These relationships are depicted in Figure 2.

Figure 3 depicts the case of $\tilde{H}(g) < \hat{H}(g) < \bar{H}(g)$ that shows the regime $g_A < g < g_B$. In this regime, the income effect of government expenditure dominates the substitution effect if the level of human capital is low, and vice versa. Figure 4 depicts the case of $\tilde{H}(g) > \hat{H}(g)$ that shows the regime $g_B < g$. In this regime, the substitution effect always dominates the income effect. Figure 5 depicts the case of $\hat{H}(g) > \bar{H}(g)$ that shows the regime $g < g_A$. In this regime, the income effect always dominates the substitute effect. The following proposition formalizes this observation.

Proposition 1 *When the government expenditure is sufficiently small (large), an increase in the government expenditure decreases (increases) the incidence of child labour.*

When the government expenditure, g, is sufficiently small, each family can receive the lump-sum transfers from the government. Thus, parents prefer that their children obtain an education to them working. In contrast, because $\lim_{g\to 0}\pi'(g) = \infty$, the marginal effect of the detection probability is sufficiently large when the government expenditure is small. Thus, when the government expenditure is small, the negative substitution effect dominates the positive income effect, and vice versa.

4 Dynamics of human capital

In this section, we examine the dynamics of human capital. Using (2), (3) and (7), the dynamics of the per capita human capital is represented as follows:

$$h_{t+1} = \Gamma(h_t) = \begin{cases} \delta^\sigma \equiv \Gamma_1(h_t) & \text{if } \ h_t \le \tilde{h}, \\ \Gamma_2(h_t) & \text{if } \ \tilde{h} < h_t \le \bar{h}, \\ (\delta+\gamma)^\sigma \equiv \Gamma_3(h_t) & \text{if } \ \bar{h} < h_t. \end{cases} \tag{8}$$

where: $\Gamma_2(h_t) \equiv \left(\frac{w_c\beta\sigma(1+\pi(g))(\delta+\gamma)+\beta\gamma\sigma(w_A h_t-g)}{w_c(\beta\sigma(1+\pi(g))+(1-\pi(g))}\right)^{\sigma}$. We can easily show that $\Gamma_2'(h) > 0$ and $\Gamma_2''(h) < 0$. The steady state is expressed as the stationary level of the per capita human capital, h, such that $h = \Gamma(h)$. There can be several patterns of dynamics. To avoid unnecessary complexity, we focus on some interesting cases, which are described in Figures 6 and 7.

Figure 6 shows the case where the following condition holds:

$$\Big(w_A\delta^{\sigma}-g\Big)\Big(\frac{\beta\gamma\sigma}{\delta-\beta\gamma\sigma}\Big) < (1-\pi(g))w_c < \left(\frac{w_c(1+\pi(g))(\frac{\delta+\gamma}{\gamma})-g}{(\beta\gamma\sigma)^{\frac{\sigma}{1-\sigma}}w_A^{\frac{1}{1-\sigma}}(\sigma^{\frac{1}{1-\sigma}}-\sigma^{\frac{\sigma}{1-\sigma}})}\right)^{\frac{\sigma}{1-\sigma}} - w_c\beta\sigma(1+\pi). \quad (9)$$

In this case, there are three steady states. As $\delta^{\sigma} < \hat{h}$, the graph of $\Gamma_1(h_t)$ intersects with the 45-degree line once. We denote this intersection as E_1 and define the level of h at E_1 as h^*. In addition, the appendix proves that the graph of $\Gamma_2(h_t)$ has intersections with the 45-degree line. Thus, we denote these intersections as E_2 and E_3, respectively, and define the levels of h at E_2 and E_3 as h^{**} and h^{***}. It is easily confirmed that E_1 and E_3 are the stable steady-state equilibria. E_1 is the steady state characterized by low income and low education. E_3 is the steady state characterized by high income and high education. E_2 is the unstable steady-state equilibrium and shows the threshold level of human capital. When the initial level of human capital is lower (higher) than h^{**}, the economy will converge to $E_1(E_3)$. Therefore, the initial per capita human capital h_0 is crucial for the destiny of the economy.

On the other hand, Figure 7 shows the case where the following condition holds:

$$(1-\pi(g))w_c < (w_A\delta^{\sigma}-g)\Big(\frac{\beta\gamma\sigma}{\delta-\beta\gamma\sigma}\Big). \quad (10)$$

In this case, as $\delta^{\sigma} > \tilde{h}$, only the graph of $\Gamma_2(h_t)$ intersects with the 45-degree line. Thus, the dynamical system in Figure 7 has a unique steady-state equilibrium, E_3, characterized by high income and high education.

Our concern is to examine how changes in government expenditure affect the dynamics of the economy. For this purpose, we focus our attention on the economy that has multiple equilibria. The following proposition shows the condition that derives the poverty trap equilibrium; that is, the steady state characterized by low income and low education.

Proposition 2 *Suppose that* $\frac{w_A}{w_c} > \frac{\delta-\beta\gamma\sigma}{\delta^{\sigma}\beta\gamma\sigma}$, *the poverty trap equilibrium exists when government expenditure is sufficiently large.*

Proof. Suppose $\Omega_1(g) \equiv (1-\pi(g))w_c(w_A\delta^{\sigma}-g)$ and $\Omega_2(g) \equiv (\frac{\beta\gamma\sigma}{\delta\beta\gamma\sigma})$, the poverty trap equilibrium exists if and only if $\Omega_1(g) < \Omega_2(g)$, as on the left-hand side of (9). Noting that $\Omega_1(0) < \Omega_2(0)$

holds when $\frac{w_A}{w_c} > \frac{\delta-\beta\gamma\sigma}{\delta^\sigma\beta\gamma\sigma}$ holds and that $\lim_{g\to\infty}\pi(g) = 1$, then: $\Omega_1(g) = \Omega_2(g)$ at the point $g^* \equiv \delta^\sigma$. Therefore, $\Omega_1(g) > \Omega_2(g)$ exists when $g^* < g$ holds. ■

Proposition 2 shows that if the relative wage rate differential between an adult and a child is large, that is, if the wage rate of a child is low in comparison to the adult wage, a higher amount of government expenditure can lead the economy to the poverty-trap equilibrium. When the wage rate of children is sufficiently low, the income effect dominates the substitution effect, and, thus, the level of government expenditure has a significant impact on individual decision making in relation to child labour. When the government expenditure, g, is sufficiently small, each family can receive lump-sum transfers from government. On the other hand, each family has to pay tax (see Proposition 1) when the government expenditure is sufficiently large. Therefore, it imposes a great tax burden on each family when the level of government expenditure is sufficiently large. This effect leads to a higher incidence of child labour and moves the economy into the poverty trap.

As shown by Lemma 1, when the level of human capital is smaller (higher) than the critical level of human capital $\hat{h}$, an increase in government expenditure increases (decreases) the level of child labour. It is convenient to analyze the facts in three cases: (i) $\hat{h} < \tilde{h}$, (ii) $\tilde{h} < \hat{h} < \bar{h}$, and (iii) $\bar{h} < \hat{h}$. Figures 8, 9 and 10 respectively show the cases (i), (ii) and (iii). These figures show that changes in the level of child labour have a substantial impact on the dynamical system of the economy. When the level of human capital is smaller than the critical level, $\hat{h}$, the dynamical system shifts downward, and vice versa. Therefore, we show that government expenditure have possibility to expand the level of human capital to take off the poverty trap.

5 Education Policy

In this section, we incorporate the education policy of the government into the model. Most developing countries attempt to improve the efficiency of education in parallel with controlling child labour. For example, India, Nicaragua and The Philippines have implemented return-to-school programs, Brazil and Mexico have provided financial support for education, and Egypt and The Philippines have improved educational infrastructure. Thus, we examine how public education policy can increase the efficiency of education. The budget constraint of the government is rewritten as follows:

$$\pi(g)w_c l_t + T_t = g + u, \tag{11}$$

where u shows the level of public education. The government increases the efficiency of education as follows: $\gamma'(u) > 0, \gamma''(u) < 0$ and $\gamma(0) = \gamma$. Then, the human capital accumulation equation becomes as follows:

$$h_{t+1} = (\delta + \gamma(u)e_t)^{\sigma}. \tag{12}$$

We assume that the government divides its revenue between expenditure on monitoring of child labour and public education. Thus, we have the following constraints:

$$g = \phi(\pi(g)w_c l_t + T_t), \tag{13}$$

$$u = (1-\phi)(\pi(g)w_c l_t + T_t), \tag{14}$$

where ϕ denotes the share of the government expenditures devoted to monitoring. ¿From (13) and (14), we have the following relationship:

$$u = \frac{1-\phi}{\phi} g. \tag{15}$$

Taking $\pi(g), u$ and h_{t+1} as given, agents maximize (5) subject to (2), (4), (11), (12) and (13). Solving this problem in a similar way to that employed in section 2, we obtain the level of child labour as follows:

$$l_{t+1}(g; h_{t+1}) = l_{t+1}$$
$$= \begin{cases} 1, & \text{if } h < \tilde{h}^*, \\ \dfrac{(1-\pi(g))w_c(\gamma(\frac{1-\phi}{\phi}g) + \delta) - \beta\gamma(\frac{1-\phi}{\phi}g)\sigma(w_A h_{t+1} - \frac{1}{\phi}g)}{\gamma(\frac{1-\phi}{\phi}g)w_c(\beta\sigma(1-\pi(g)) + (1-\pi(g)))}, & \text{if } \bar{h}^* < h < \tilde{h}^*, \\ 0, & \text{if } \bar{h}^* < h, \end{cases} \tag{16}$$

where $\tilde{h}^* \equiv \frac{(1-\pi(g))w_c(\frac{\delta - \beta\sigma\gamma(\frac{1-\phi}{\phi}g)}{\beta\sigma\gamma(\frac{1-\phi}{\phi}g)}) + g}{w_A}$ and $\bar{h}^* \equiv \frac{(1-\pi(g))w_c(\frac{\delta + \gamma(\frac{1-\phi}{\phi}g)}{\beta\sigma\gamma(\frac{1-\phi}{\phi}g)}) + g}{w_A}$.

We examine how the increase in public education affects the level of child labour. The following proposition shows how a change in the ratio ϕ affects the incidence of child labour.

Proposition 3 *There exists a unique* $\phi^* \in (0,1)$ *such that* $\frac{\partial l_{t+1}}{\partial \phi} < 0 \ \ \forall \phi \in [0, \phi^*]$ *and* $\frac{\partial l_{t+1}}{\partial \phi} > 0 \ \ \forall \phi \in [\phi^*, 1]$.

Proof. Differentiating l_{t+1} with respect to ϕ, we have the following:

$$\frac{\partial l_{t+1}}{\partial \phi} = \frac{\Omega(\phi)}{g w_c \gamma'(\frac{1-\phi}{\phi}g)(-1+\phi)^2\phi^2(1-\pi(g) + \beta\sigma(1+\pi(g)))},$$

where: $\Omega(\phi) \equiv -(g^2\beta\gamma'(\frac{1-\phi}{\phi}g)\sigma - (1-\pi(g))w_c\delta)\phi^2 + 2g^2\beta\gamma'(\frac{1-\phi}{\phi}g)\sigma\phi - g^2\gamma'(\frac{1-\phi}{\phi}g)\sigma$. As the denominator is positive, the numerator determines the sign of these derivatives. As $\Omega(0) =$

$-g^2\gamma'(\frac{1-\phi}{\phi}g)\sigma < 0$ and $\Omega(1) = w_c\delta(1-\pi(g)) > 0$, noting that $\Omega(\phi)$ is a quadratic function with respect to ϕ, we have a unique $\phi^* \in (0,1)$ such that $\Omega(\phi) = 0$. It follows that $\Omega(\phi) < 0 \ \forall\phi \in [0,\phi^*]$ and $\Omega(\phi) > 0 \ \ \forall\phi \in [\phi^*, 1]$. This proves the proposition. ■

This proposition shows that there exists a ratio of expenditure, ϕ^*, between monitoring child labour and education, that achieves the minimum level of child labour. This ratio does not depend on the level of human capital. As stated in section 3, an increase in government expenditure has a positive "income effect" and a negative "substitution effect" on the incidence of child labour. In addition to these effects, it has a negative "education effect" on the incidence of child labour because public education increases the marginal cost of child labour. When the government expenditure ratio, ϕ, is small, the "substitution effect" and the "education effect" dominate the "income effect" because the government spends more on public education than on monitoring child labour. When the government expenditure ratio, ϕ, is large, the "income effect" dominates the "substitution effect" and the "education effect" because the government spends less on public education than on the monitoring of child labour. Therefore, we obtain the expenditure rate, ϕ, that minimizes the level of child labour.

The dynamics of this economy is given as (8). To examine how public education policy affects the dynamics, we analyze its effects on inequalities (9) and (10), taking public education into account. Note that inequality (9) (resp. (10)) holds if and only if the efficiency of education, γ, is small (resp. large). The poverty trap does not appear if the efficiency of education is sufficiently large, as Proposition 2 shows. Therefore, an inequality can change from (9) to (10) if the government increases the efficiency of education. Thus, public education can help the economy escape from the poverty trap of the low-education and low-development equilibrium.

6 Conclusion

In this paper, we have analyzed how government expenditure on monitoring to detect firms illegally employing children affects the incidence of child labour. For this purpose, we set up a two-period overlapping generations model. In the model, there exist two sectors: one is the legal sector that produces output by using the human capital of adult agents, and the other is the illegal sector, which produces output by using the human capital of adult agents and child labour. We assumed that the government bans child labour and monitors firms to prevent child labour. However, despite the monitoring, the government will not detect all instances of child labour. We also assumed that the detection probability in relation to child labour depends on the level of government expenditure. Then, we examined how the change in government expenditure affected the incidence of child labour.

In the first part of the paper, we analyzed the above basic model and showed that government intervention in relation to the ban on child labour has perverse effects when the level of human capital is sufficiently low, that is, an increase in the government expenditure on monitoring and detection increases the level of child labour. In the second part of this paper, we extended our model by taking account of public education to enhance the efficiency of education. By analyzing the model, we obtained the expenditure ratio between monitoring child labour and education that minimizes the level of child labour. Public education also provides a possible means by which the economy can escape from the poverty trap.

Appendix

Appendix

In this appendix, we show that there exist three steady states that satisfy $h = \Gamma(h)$ if and only if inequalities (9) hold. First, we consider the property of $\Gamma_1(h)$. As shown in Figure 5, when $\delta^\sigma < \hat{h}$, the graph of $\Gamma_1(h)$ intersects with the 45-degree line once. ¿From the definition of $\hat{h}$, the inequality $\delta^\sigma < \hat{h}$ holds when $w_A\delta^\sigma - g_{t+1}(\frac{\beta\gamma\sigma}{\delta-\beta\gamma\sigma}) < (1-\pi(g_{t+1}))w_c$.

Next, let us consider the property of $\Gamma_2(h)$. ¿From (8), the relation $h = \Gamma_2(h)$ is rearranged as:

$$h^{\frac{1}{\sigma}} = \frac{w_c\beta\sigma(1+\pi(g_{t+1}))(\delta+\gamma) + \beta\gamma\sigma(w_A h - g_{t+1})}{w_c(\beta\sigma(1+\pi(g_{t+1})) + (1-\pi(g_{t+1}))}. \tag{17}$$

In addition, we define the value of h that satisfies $\frac{1}{\sigma}h^{1-\frac{1}{\sigma}} = \frac{\beta\gamma\sigma w_A h}{w_c(\beta\sigma(1+\pi(g_{t+1}))+(1-\pi(g_{t+1}))}$, as h'. If $h'^{\frac{1}{\sigma}} = \frac{w_c\beta\sigma(1+\pi(g_{t+1}))(\delta+\gamma)+\beta\gamma\sigma(w_A h'-g_{t+1})}{w_c(\beta\sigma(1+\pi(g_{t+1}))+(1-\pi(g_{t+1}))}$ holds, then the graphs on the left-hand side and right-hand side have two intersections. ¿From the above equation, the condition $\frac{1}{\sigma}h'^{1-\frac{1}{\sigma}} > \frac{\beta\gamma\sigma w_A h'}{w_c(\beta\sigma(1+\pi(g_{t+1}))+(1-\pi(g_{t+1}))}$ holds when:

$$w_c(1-\pi(g_{t+1})) < \beta\sigma\Big((\frac{w_c(1+\pi(g_{t+1}))(\frac{\delta+\gamma}{\gamma} - g_{t+1})^{1-\sigma}}{\sigma w_A})^\sigma - (1+\pi(g_{t+1}))\Big). \tag{18}$$

Thus, the graph of $\Gamma_2(h)$ intersects with the 45-degree line twice if and only if (18) holds. Therefore, noting that $\Gamma_2(\hat{h}) = \delta^\sigma$, the graph of $\Gamma(h)$ has three intersections with the 45-degree line if and only if inequalities (9) hold.

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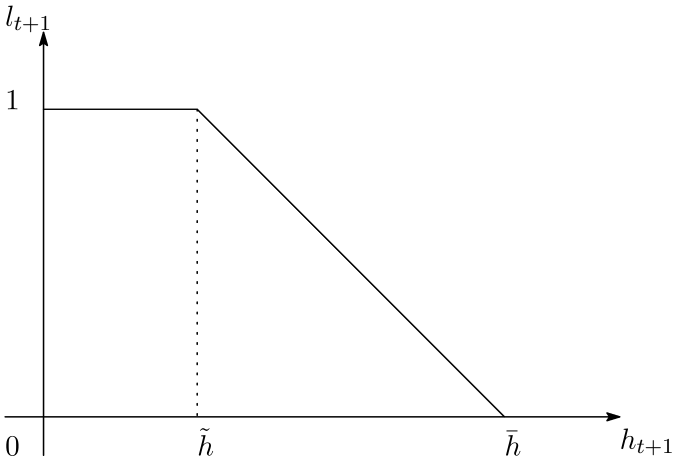


Figure 1: The incidence of child labour

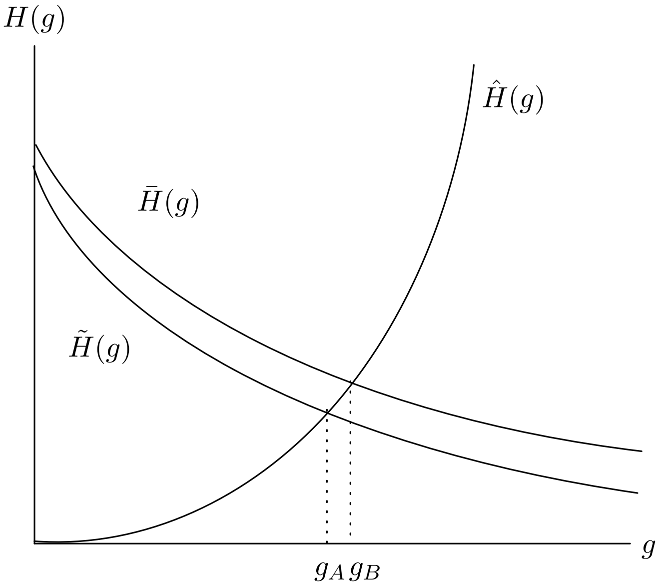


Figure 2:

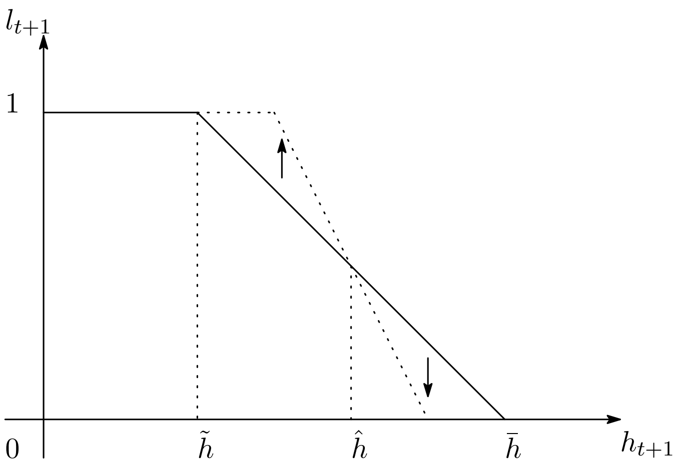


Figure 3: The effect of a ban on child labour in the case where $\tilde{h} < \hat{h} < \bar{h}$

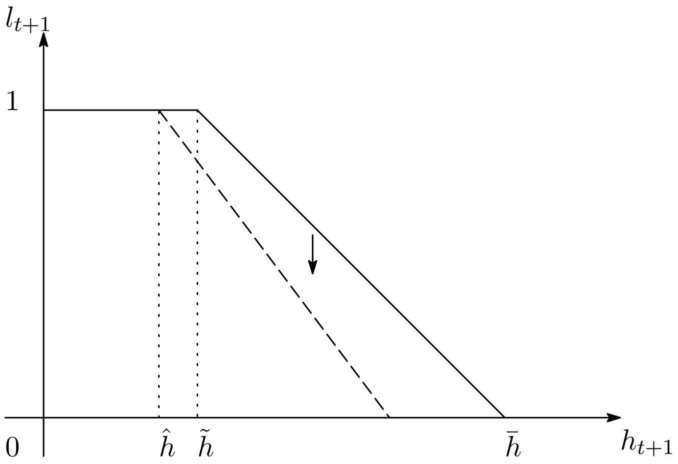


Figure 4: The effect of a ban on child labour in the case where $\hat{h} < \tilde{h} < \bar{h}$

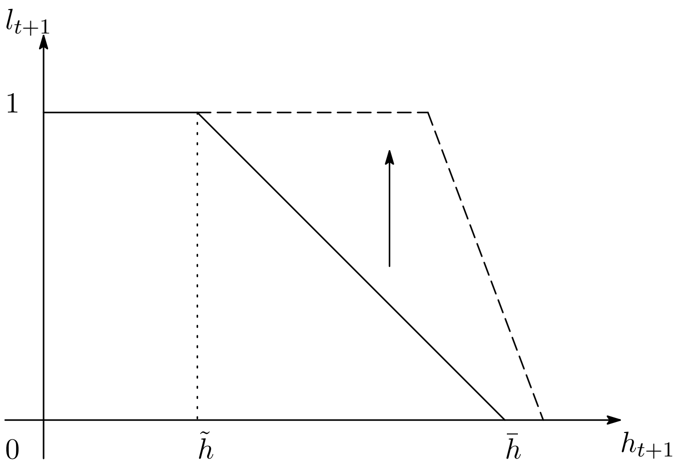


Figure 5: The effect of a ban on child labour in the case where $\tilde{h} < \bar{h} < \hat{h}$

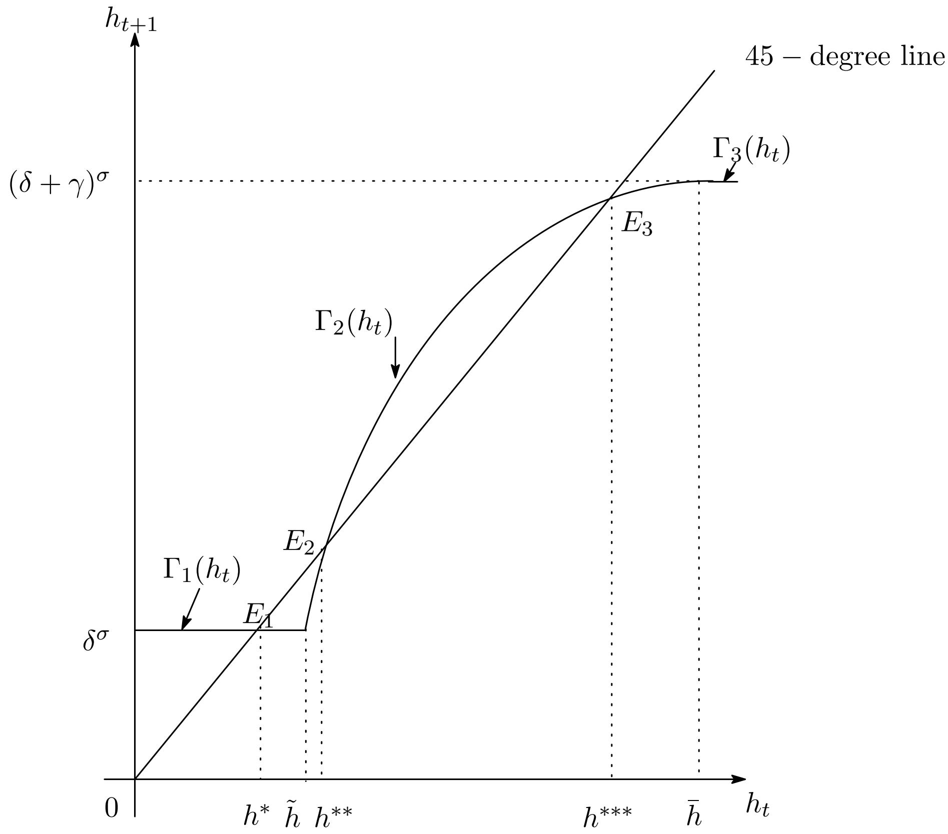


Figure 6: Dynamics of human capital in the case where $\delta^\sigma < \tilde{h}$

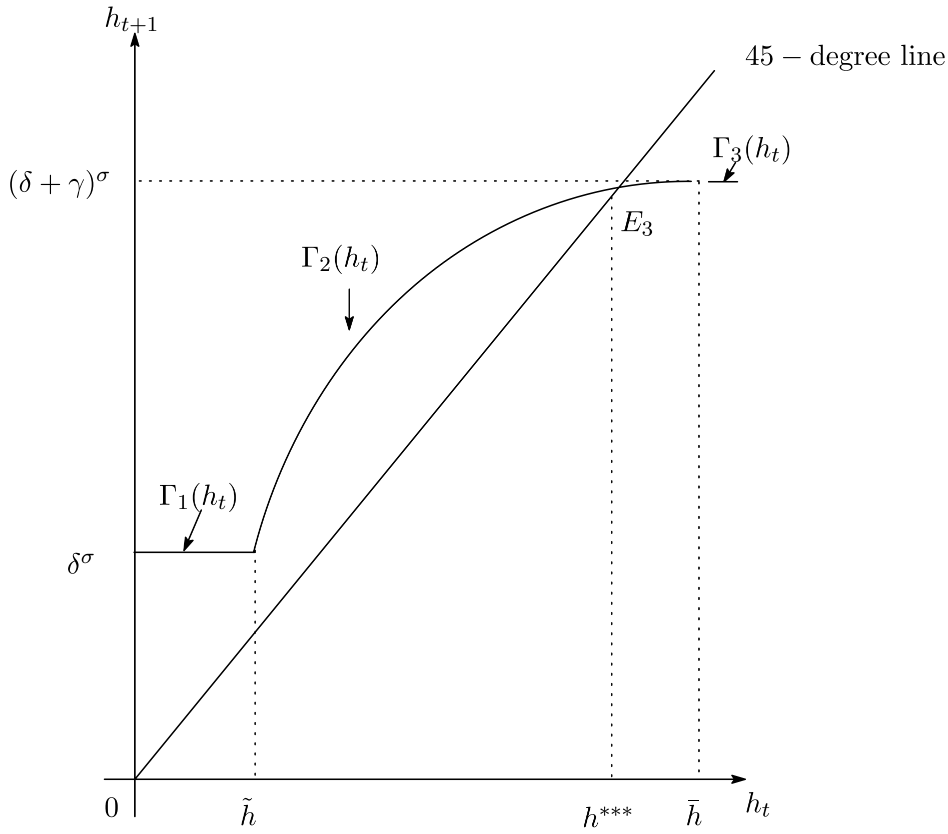


Figure 7: Dynamics of human capital in the case where $\delta^\sigma > \tilde{h}$

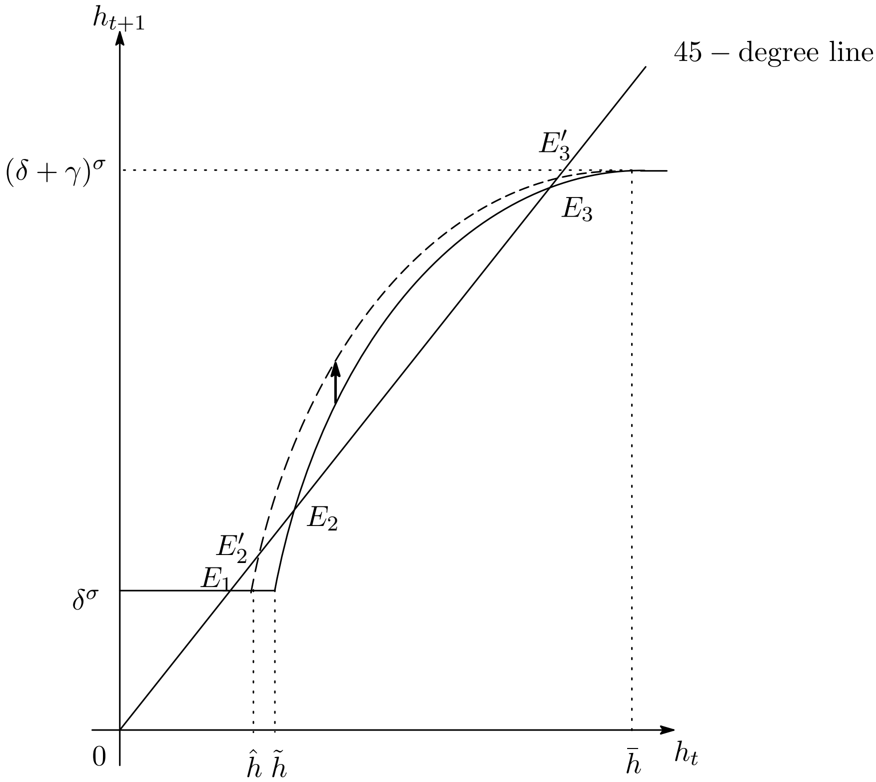


Figure 8:

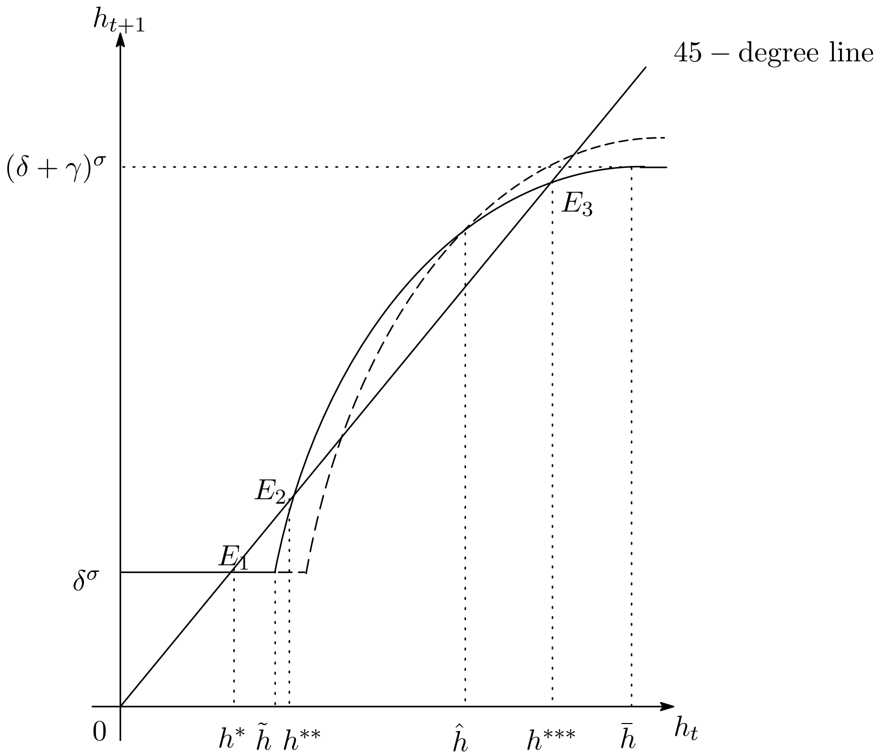
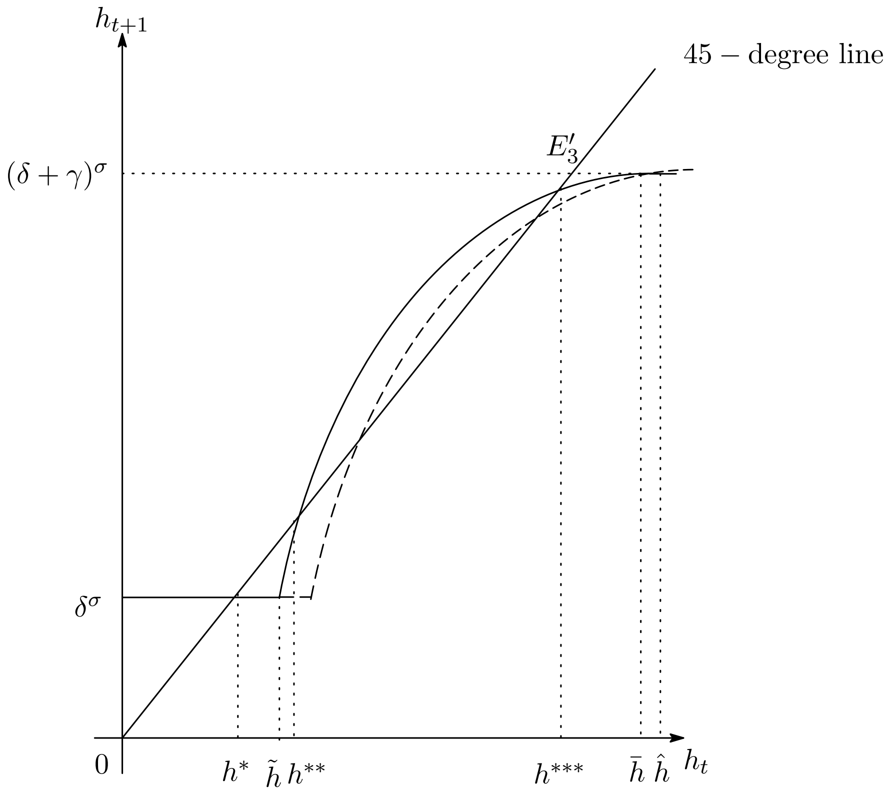


Figure 9:



h_{t+1}
$45-$ degree line
E_3'
$(\delta+\gamma)^\sigma$
δ^σ
0
h^*
$\tilde{h}$
h^{**}
h^{***}
$\bar{h}$
$\hat{h}$
h_t

Figure 10: