Discussion Papers In Economics And Business

Child Labor, Corruption, and Development

Toshiki Miyashita

Kohei Okada

Kei Takakura

Discussion Paper 20-20

January 2021

Graduate School of Economics
Osaka University, Toyonaka, Osaka 560-0043, JAPAN

Child Labor, Corruption, and Development*

Toshiki Miyashita,† Kohei Okada‡ and Kei Takakura§

Abstract

Employing an overlapping-generations model with endogenous education choice and corruption, we investigate how child labor and corruption influence human capital accumulation and development. We show that multiple steady-states exist in the economy. One steady-state has a high level of human capital, and the other has a low level of human capital. In the steady-state with a low level of human capital, child labor and corruption exist and welfare is low. In the steady-state with a high level of human capital, child labor and corruption are diminished and welfare is high. In addition, we show that it is difficult to steer an economy away from a poverty trap with child labor and corruption because bureaucrats of the current generation are opposed to policy changes such as reinforcement of monitoring and penal regulations. However, we can apply the Pareto-improving policy to this poverty trap, for e.g., the government receives funds from an international organization and distributes them among bureaucrats, which keeps them from being corrupt.

Keywords: Child labor, corruption, human capital accumulation, development

JEL Classification: D73, E24, I25, J13

*We thank Koichi Futagami, Shingo Ishiguro, Tasturo Iwaisako, Kouki Sugawara, Daishoku Kanehara, and the seminar participants at Osaka University and Kyoto University for their helpful comments and suggestions.

†Graduate School of Economics, Osaka University. Address: 1-7 Machikaneyama, Toyonaka, Osaka 560-0043, Japan E-mail: mysttsk@gmail.com

‡Graduate School of Economics, Osaka University. Address: 1-7 Machikaneyama, Toyonaka, Osaka 560-0043, Japan E-mail: koheiokadA337@gmail.com

§Graduate School of Economics, Osaka University Address: 1-7 Machikaneyama, Toyonaka, Osaka 560-0043, Japan E-mail: takakura.kei.0520@gmail.com

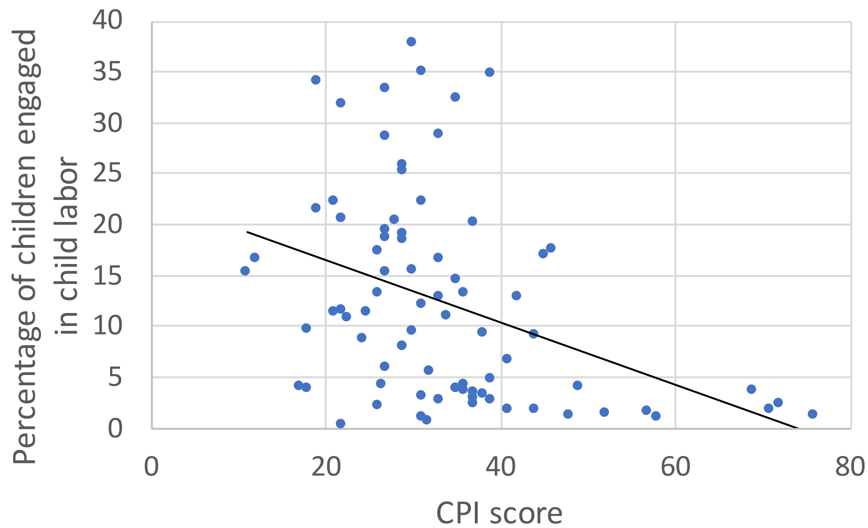

Figure 1: The relationship between Corruption Perceptions Index (CPI) score and percentage of children (aged 5-17 years) engaged in child labor. Source: CPI score: Transparency International. Percentage of children (aged 5-17 years) engaged in child labor : UNICEF

1 Introduction

In many developing countries, children are engaged in child labor. Sen (2019) reports Bangladesh, Chad, the Republic of the Congo, Ethiopia, India, Liberia, Myanmar, Nigeria, Pakistan, and Somalia to be the countries with the most widespread child labor in the world. For example, in the Republic of the Congo, although the country has ratified the United Nations Convention on the Rights of the Child and prohibits child labor, many children are engaged in mining. These children are employed illegally by informal firms. This is also the case in many other developing countries. Although the majority of them have ratified the United Nations Convention on the Rights of the Child and prohibit child labor[1], they have failed to expose firms that employ children. However, child labor is not a problem only in developing countries. It was once common in Europe and the US. According to Hazan and Berdugo (2002), in 1851 England and Wales, 36.6% of all boys and 19.9% of girls aged 10-14 worked. However, as the economy developed, child labor diminished in these countries.

To investigate the differences between developing and developed countries regarding child labor, we focus on corruption. Mauro (1995) and Banerjee (1997) reported that corruption, especially

[1] Liberia does not ratify the United Nations Convention on the Rights of the Child.

bribery is widespread in developing countries. They emphasize that corruption hinders economic development. We also show the correlation between corruption and child labor by employing the Corruption Perceptions Index (CPI). The CPI is an index published annually by Transparency International since 1995. The CPI currently ranks 180 countries "on a scale from 100 (very clean) to 0 (highly corrupt). Figure 1 shows the relationship between CPI and the percentage of children aged 5-17 years engaged in child labor. There is a statistically significant negative correlation between CPI and the percentage of children engaged in child labor[2] Many past studies, in their theoretical frameworks, show that corruption hinders economic development such as Blackburn et al.(2006). However, no studies have investigated the simultaneous relationship between corruption, child labor, and development.

We construct a simple overlapping-generations model with endogenous education choices, child labor, and corruption. Each individual lives for two periods. In the first period of their lives (childhood), individuals do not make any decisions. Thus, children engage in child labor and study at school under their parents' decision. In the second period (adulthood), individuals decide to accept or reject a contract with an illegal firm. Then, they determine children's time allocation between education and child labor, supply their own labor, pay income tax, and consume final goods. In this model, there are legal firms and only one illegal firm. Legal firms produce final goods using the effective labor of adult individuals but the illegal firm offers a contract for child labor with adult individuals. If they accept the contract, the illegal firm employs their children and produces final goods using their child labor. The government employs bureaucrats and sends them to each firm to expose illegal firms. However, bureaucrats are corrupt and accept bribes from illegal firms. If bureaucrats are corrupt and accept bribes, they do not expose the illegal firm; thus, child labor remains. The equilibrium dynamics of this economy are characterized by the level of human capital. We show that multiple steady-states exist in the economy. One steady-state has a high level of human capital, while the other has a low level. In the steady-state with a low level of human capital, child labor and corruption exist and the welfare level is low. However, in the steady-state

[2] We estimate simple regressions, in which the percentage of children (aged 5-17 years) engaged in child labor (child labor) as the dependent variable is a function of the CPI score (CPI). The following equation provides simple estimation results using ordinary least squares:

$$Child\ labor = 22.66(7.63) - 0.31(-3.71)CPI,$$

where the figures in parentheses are the values of t-statistics. The equation above suggests that the percentage of children engaged in child labor has a negative correlation with the CPI score.

with a high level of human capital, child labor and corruption have been ended and the welfare level is high. In addition, we investigate how government policy affects the economy. Then, we show that it is difficult to steer an economy away from a poverty trap with child labor and corruption because bureaucrats of the current generation are opposed to policy changes such as reinforcement of monitoring and penal regulations. However, we can apply the Pareto improving policy to this poverty trap, that is, the government borrows funds from an international organization. The model reveals that if the interest rate is substantially low, the proposed policy is enforceable and the government can repay the subsidy resources.

This study is related to research on child labor and corruption. Dessy (2000), Hazan and Berdugo (2002), and Sugawara (2010) investigated the relationship between child labor, human capital accumulation, and economic development. However, they did not consider the endogenous decision process of bureaucrats and the contract between an individual and an illegal firm. Blackburn et al. (2006), Blackburn and Sarmah (2007), Blackburn and Forgues-Puccio (2007), and Akimoto (2018, 2019) show that corruption plays an important role in economic development. However, they do not focus on the relationships between corruption, education, and child labor. Eicher et al. (2009) and Varvarigos and Arsenis (2015) investigated how education and corruption affect economic development. However, they do not refer to the relationship between child labor and corruption. Numerous studies have shown that child labor and corruption are harmful to economic development. However, no studies have investigated the relationship between child labor, corruption, and economic development, generating the motivation for our study.

The remainder of this paper is organized as follows: Section 2 presents the basic structure of the model, and Section 3 analyzes the equilibrium and dynamics. Section 4 analyzes welfare. Section 5 presents the conclusions.

2 The model

2.1 Individuals

There are two types of individuals: households and bureaucrats. Households supply their labor to the private sector and make their children engage in child labor. Conversely, bureaucrats are employed by the government and work in the public sector. We assume that only households have access to the illegal firm; they volunteer their children for hire to the illegal firm because they have connections with the illegal firm[3]. Hence, bureaucrats cannot make their children engage in child labor. For simplicity, we assume that children whose parents are households (bureaucrats) become households (bureaucrats) during any consecutive period. Children born in period t become active workers in period $t+1$.

2.1.1 Households

We consider a two-period overlapping generations model: childhood and adulthood. Both parents and children have one unit of time. During adulthood, households allocate their children's time between child labor l_t and schooling e_t. They devote one unit of time to working in the private sector and earn income according to their human capital. They also pay income tax and consume all remaining disposable income. We assume that the population size of households is one and is constant over time. Households derive their utility from consumption c_t^H and the child's human capital h_{t+1}. Thus, the utility function of households in generation t is

$$u_t^H = \log c_t^H + \log h_{t+1}. \tag{1}$$

Parents encourage their children to engage in child labor in illegal firms. They collect the income earned from child labor and use it for their own consumption. Then, the budget constraint of households is

$$c_t^H = (1-\tau)w_t h_t + a_t l_t. \tag{2}$$

Let w_t, h_t, a_t, and τ represent the wage rate in the legal sector, adult human capital, receipts per child's working time in the illegal sector, and income tax rate levied on each household, respectively. For simplicity, we assume that the income tax rate τ is constant over time. The production function

[3] We consider the situation where households live in a rural area and bureaucrats live in an urban area. Our model implicitly assumes that illegal firms employ traffickers and gather children in rural areas. Gregory (2017) and Miki et al.(2010) report that traffickers link households who supply child labor with an illegal firm. Traffickers gather children by negotiating with their parents in small rural villages for cacao farms in the Ivory Coast.

of human capital is

$$h_{t+1} = \phi e_t, \tag{3}$$

where $\phi > 0$ is a constant parameter. The time constraint of children is

$$e_t + l_t = 1. \tag{4}$$

l_t and a_t are determined by the contract between households and the illegal firm, which will be explained later. From this contract, c_t^H is also determined.

2.1.2 Bureaucrats

We consider the behavior of bureaucrats. We denote the size of the population of bureaucrats as N. Bureaucrats derive their utility from consumption c_t^B. Then, the utility function of bureaucrats in generation t is

$$u_t^B = \log c_t^B. \tag{5}$$

We assume that bureaucrats supply one unit of time to engage in the public sector. The government hires bureaucrats and sends them to each firm to expose illegal firms. If bureaucrats encounter an illegal firm, they decide whether to expose it or set it free by taking the bribe. Then, the budget constraint of bureaucrats is classified into the following two cases: If bureaucrats, who encounter illegal firms, are not corrupt and do not take bribes, their budget constraint is

$$c_t^B = (1 - \tau) I_t, \tag{6}$$

where I_t denotes the bureaucrat's income from the government. If bureaucrats, who encounter illegal firms, are corrupt and take bribes, their budget constraint is

$$c_t^B = (1 - \tau) I_t + b_t, \tag{7}$$

where b_t is the amount of the bribe.

We assume that corruption is found out at a probability of $\eta \in (0,1)$ after bureaucrats collect bribes for their own consumption. According to the literature on corruption, such as Varvarigos and Arsenis(2015), when bureaucrats are corrupt, they suffer psychological distress $\delta \log c_t^B$, where $\delta \in (0,1)$. Where bureaucrats are corrupt, $c_t^B = I_t + b_t$ holds. Therefore, their expected utility in generation t is given by

$$u_{c,t}^B = (1-\eta)\log[(1-\tau)I_t + b_t] + \eta(1-\delta)\log[(1-\tau)I_t + b_t]. \tag{8}$$

However, if bureaucrats are not corrupt, they only obtain income $(1-\tau)I_t$. Therefore, when bureaucrats are not corrupt, their utility $u_{n,t}^B$ in generation t is given by

$$u_{n,t}^B = \log(1-\tau)I_t. \tag{9}$$

2.2 Private sector

2.2.1 Legal firm

We assume that the legal sector is perfectly competitive. The number of firms is infinite and one unit of mass. Legal firms produce final goods $Y_{a,t}$ only from adult labor. The production function of a legal firm is

$$Y_{a,t} = AL_t, \tag{10}$$

where A and L_t represent a technological parameter and the total labor demand for households belonging to adulthood, respectively. In equilibrium, $L_t = h_t$ holds. Hence, the zero-profit condition yields $w_t = A$.

2.2.2 Illegal firm

We assume that there exists only one illegal firm that hires children from households and produces final goods $Y_{c,t}$. We also assume that the government cannot, by itself, distinguish between legal and illegal firms. Therefore, the government must send bureaucrats to all firms. Once households offer their children for labor to the illegal firm, the illegal firm enters into an agreement with the households. The illegal firm determines the amount of labor l_t it will require from the child and the wage rate it will pay a_t. Moreover, if the illegal firm encounters corrupt bureaucrats, it can escape detection of its child labor practices by bribing them. The production function of an illegal firm is:

$$Y_{c,t} = Bl_t, \tag{11}$$

where B denotes the technological parameters. Hence, we obtain the illegal firm's profit as follows:

$$\pi_t = (B - a_t)l_t. \tag{12}$$

2.3 Public sector

2.3.1 Government

The government sends bureaucrats to each firm to expose the illegal firms. The government employs bureaucrats and pays them salaries, which are financed by tax revenues from both households and bureaucrats. Thus, the government ' s budget constraint is:

$$\tau w_t h_t + \tau N I_t = N I_t. \tag{13}$$

Employing $w_t = A$, we can rewrite (13) as follows:

$$I_t = \frac{\tau A h_t}{(1-\tau)N}. \tag{14}$$

We assume that the government has no means to detect whether bureaucrats are acting honestly or not. Therefore, if corrupt bureaucrats take a bribe from an illegal firm and report that they cannot find child labor at a particular firm, the government takes them at their word.

3 Equilibrium

The decision-making process during any period proceeds as follows: First, each household gives birth to one child and raises them. Second, each household negotiates with the illegal firm to engage their child in child labor. Then, the illegal firm makes an offer (a_t, l_t) to the households. We assume that the illegal firm has bargaining power to make offers that satisfy the households' participation constraint. If the households decline this offer, then this decision-making process ends with no child labor in this economy. If households accept the offer, the game unfolds to the corruption phase, i.e., bureaucrats are sent to inspect all firms. If bureaucrats encounter a legal firm, they report to the government in that way. However, some of them encounter the illegal firm. In this case, negotiations between bureaucrats and the illegal firm begin. The illegal firm offers a bribe to the bureaucrats. If bureaucrats decline this offer, they report to the government, which generates no corruption and child labor in the economy. However, if bureaucrats accept the bribe, the amount of the bribe is determined and the decision-making process ends.

3.1 Equilibrium path

To see the equilibrium path, we consider the case in which bureaucrats are corrupt. From (8) and (9), bureaucrats are corrupt if:

$$\begin{aligned} & u^B_{c,t} \geq u^B_{n,t}, \\ \Leftrightarrow \ & (1-\tau)I_t + b_t \geq [(1-\tau)I_t]^{\frac{1}{1-\delta\eta}}. \end{aligned} \tag{15}$$

Next, we consider the determination of the amount of bribe b_t. There is a large number of legal firms and only one illegal firm in the economy. We assume that the total firm size is one. Hence, the number of bureaucrats assigned to investigate the illegal firm is N. Let us define the profit that the illegal firm obtains as $\pi^*_t \equiv \max_{\{a_t, l_t\}} \pi_t$, which represents the maximized profit when households accept the child labor offer. When bureaucrats are corrupt, the illegal firm pays an amount of bribe (b_t) to bureaucrats. Then, its net profit becomes $\pi^*_t - Nb_t$. If bureaucrats expose the illegal firm without taking the bribe, its profit becomes zero. Conversely, if bureaucrats accept a bribe from an illegal firm, $\pi^*_t - Nb_t \geq 0$ holds. Here, we assume that bureaucrats have all bargaining power against the illegal firm,[4] that is, bureaucrats can determine the amount of bribe b_t on their own terms. A substantially high amount of bribe makes the illegal firm reject the offer. Therefore, bureaucrats

[4] This is not an important assumption. We can consider the opposite case in which the illegal firm has all bargaining power in Appendix A. What is important in this case is that the illegal firm can pay the bribe that the corrupt bureaucrats may ask for.

ask for bribe b_t as follows:

$$\max_{b_t} \quad u^B_{c,t} = (1-\eta)\log[(1-\tau)I_t + b_t] + \eta(1-\delta)\log[(1-\tau)I_t + b_t],$$
$$\text{s.t.} \quad \pi^*_t - Nb_t \geq 0. \tag{PCI}$$

(PCI) represents the participation constraint of the illegal firm and (PCI) binds at the optimum. Therefore, we obtain the optimal bribe amount as follows:

$$b_t = \frac{1}{N}\pi^*_t. \tag{16}$$

The illegal firm and households determine the amount of child labor and the wage rate. Here, we assume that the illegal firm has bargaining power against the households. Therefore, if the illegal firm makes an offer (a_t, l_t) that satisfies the households' participation constraint, households will accept the offer. If households offer their children for labor and do not take them to school, they get child labor income $a_t l_t$. From (1) to (4), for the households that supply child labor, we can obtain the following utility $u^H_{c,t}$ as:

$$u^H_{c,t} = \log[(1-\tau)w_t h_t + a_t l_t] + \log\phi(1-l_t). \tag{17}$$

When households reject the offer from the illegal firm and do not supply child labor; in that case, $l_t = 0$ holds. Thus, if households do not supply child labor, we can obtain the following utility $u^H_{n,t}$ as follows:

$$u^H_{n,t} = \log(1-\tau)w_t h_t + \log\phi. \tag{18}$$

From (12), the illegal firm maximizes the following profit:

$$\max_{a_t, l_t} \ (B - a_t)l_t$$
$$\text{s.t.} \ u^H_{c,t} \geq u^H_{n,t}. \tag{PCH}$$

(PCH) represents the participation constraint of households and binds at the optimum. This optimization problem yields the optimum amount of child labor and the wage rate of child labor. By using $w_t = A$, we obtain the following solutions:

$$l_t = 1 - \sqrt{\frac{(1-\tau)Ah_t}{B}}, \tag{19}$$

$$a_t = \sqrt{(1-\tau)ABh_t}. \tag{20}$$

Because $0 \leq l_t \leq 1$ holds, we define $\bar{h} \equiv \frac{B}{(1-\tau)A}$ such that the level of child labor l_t is equal to zero. Substituting (19) and (20) into (12), we obtain the maximized profit of the illegal firm π_t^* as follows:

$$\pi_t^* = \frac{\left[B - \sqrt{(1-\tau)ABh_t}\right]^2}{B}. \tag{21}$$

We note that the maximized profit π_t^* is equal to zero when $h_t = \bar{h}$.

From (14), (15), (16), and (21), bureaucrats are corrupt and households supply child labor when the following inequality holds:

$$u_{c,t}^B \geq u_{n,t}^B,$$

$$\Leftrightarrow \quad \underbrace{\frac{\left(B - \sqrt{(1-\tau)ABh_t}\right)^2}{NB}}_{LHS(h_t)} \geq \underbrace{\left(\frac{\tau A h_t}{N}\right)^{\frac{1}{1-\delta\eta}} - \frac{\tau A h_t}{N}}_{RHS(h_t)}. \tag{22}$$

Let us define the left-hand side of (22) as $LHS(h_t)$ and the right-hand side of (22) as $RHS(h_t)$. We define $\hat{h}$ as the value of h_t such that (22) holds with equality. $LHS(h_t)$ is decreasing in $h_t \leq \bar{h}$, and $LHS(h_t)$ is always not less than 0. $RHS(h_t) = 0$ holds when $h_t = 0, \frac{N}{\tau A}$. Moreover, $RHS(h_t)$ is increasing in h_t when $RHS(h_t) \geq 0$; therefore, when $h_t \geq \frac{N}{\tau A}$ holds. To ensure the existence of $\hat{h}$, we assume the following:

Assumption 1.

$$\frac{N}{\tau} \leq B.$$

Assumption 1 ensures two conditions: one is that $LHS(h_t)$ and $RHS(h_t)$ cross each other only once, and the other is that the level of bureaucrats' utility when they are corrupt is always greater

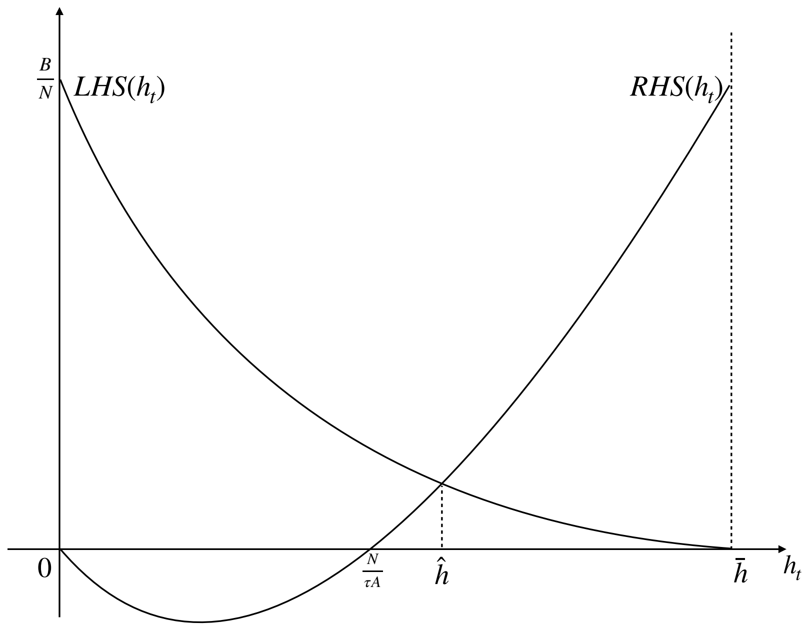

Figure 2: The determination of $\hat{h}$

than 0. For more detail, see Appendix C.

If $h_t \geq \hat{h}$ holds, then $LHS(h_t) \leq RHS(h_t)$ holds, as in (22). In this case, corruption and child labor do not exist in the economy. From (4), (19), and (22), we obtain the education level that households choose as follows:

$$e_t = \begin{cases} \sqrt{\frac{(1-\tau)Ah_t}{B}} & \text{if} \quad h_t \leq \hat{h} \\ 1 & \text{if} \quad h_t > \hat{h} \end{cases}. \tag{23}$$

3.2 Dynamics

In this section, we derive the dynamics of the model. From (3) and (23), we obtain,

$$h_{t+1} = \begin{cases} \Phi(h_t) & \text{if} \quad h_t \leq \hat{h} \\ \phi & \text{if} \quad h_t > \hat{h} \end{cases}, \tag{24}$$

where $\Phi(h_t) \equiv \phi\sqrt{\frac{(1-\tau)Ah_t}{B}}$.

The phase diagram is shown in Panels A through D in Figure 3. Two types of steady-state may exist. The first is the intersection point of $h_{t+1} = \Phi(h_t)$ and the 45° line. We define this type of steady-state as E_1 and its human capital level as h_1^*. If there exists a steady-state E_1, child labor and corruption coexist in the economy. The other is the intersection point of $h_{t+1} = \phi$ and 45 degree line, defined by E_2. We denote the human capital level of E_2 as h_2^*. If there exists a steady-state E_2, child labor and corruption do not exist in the economy. In particular, Panel B in Figure 3 shows the case of multiple steady-states [5]. From (24), we obtain the steady-state values as follows:

$$h_1^* = \frac{(1-\tau)\phi^2 A}{B}, \tag{25}$$

$$h_2^* = \phi. \tag{26}$$

Then, we obtain the following Proposition 1.

Proposition 1. *Assume that $\tau > 1 - \frac{B}{\phi A}$ holds. Let us define $\Lambda(\tau)$ and $\Omega(\tau)$ as follows:*

$$\Lambda(\tau) \equiv 1 - \frac{\log \frac{\tau(1-\tau)\phi^2 A^2}{BN}}{\log \frac{(1-\tau)(\phi A - 2B)\phi A + B^2}{BN}},$$

$$\Omega(\tau) \equiv 1 - \frac{\log \frac{\tau \phi A}{N}}{\log \frac{\phi A + B - 2\sqrt{(1-\tau)\phi A B}}{N}}.$$

Then, the following inequality holds:

$$\Omega(\tau) < \Lambda(\tau).$$

Therefore, we can derive the following results, respectively.

1. *If $\delta\eta < \Omega(\tau)$, the economy converges to the steady-state E_1.*

2. *If $\Omega(\tau) \leq \delta\eta \leq \Lambda(\tau)$, there exist multiple steady-states in the economy.*

3. *If $\delta\eta > \Lambda(\tau)$, the economy converges to the steady-state E_2.*

Proof. See Appendix C. □

Panel A in Figure 3 shows the case when $\delta\eta < \Omega(\tau)$, and the economy converges to the steady-state E_1. Panel B in Figure 3 shows the case in which multiple steady-states exist. Panel C in Figure 3 shows the case in which the economy converges to the steady-state E_2.

[5] By setting numeral values: $\beta = 0.5, \delta = 0.5, \eta = 0.5, \tau = 0.5, \phi = 1.4, A = 1.1, B = 1, N = 0.5$ into the dynamics, we can confirm the existence of multiple steady-states.

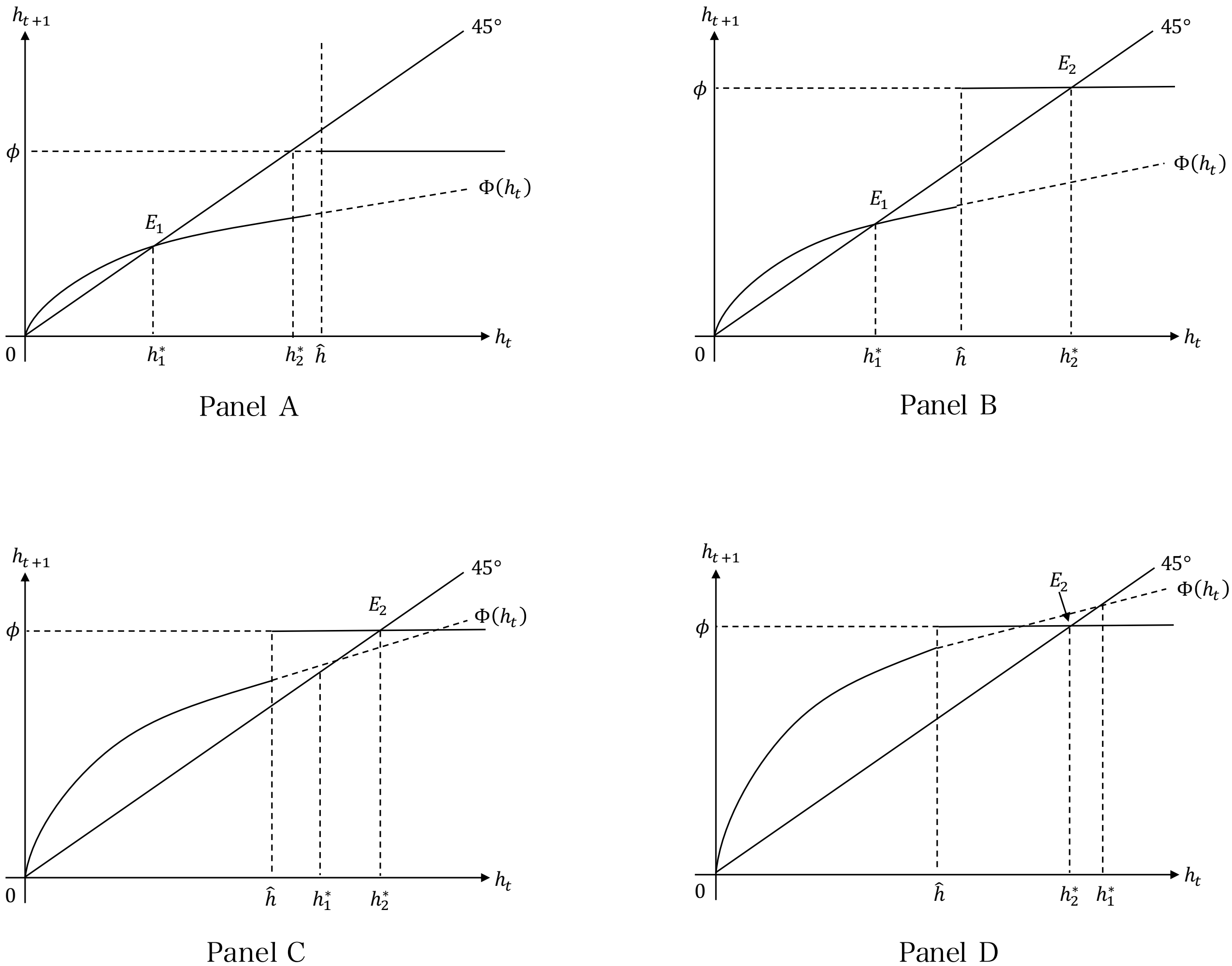

Figure 3: The dynamics of h_t

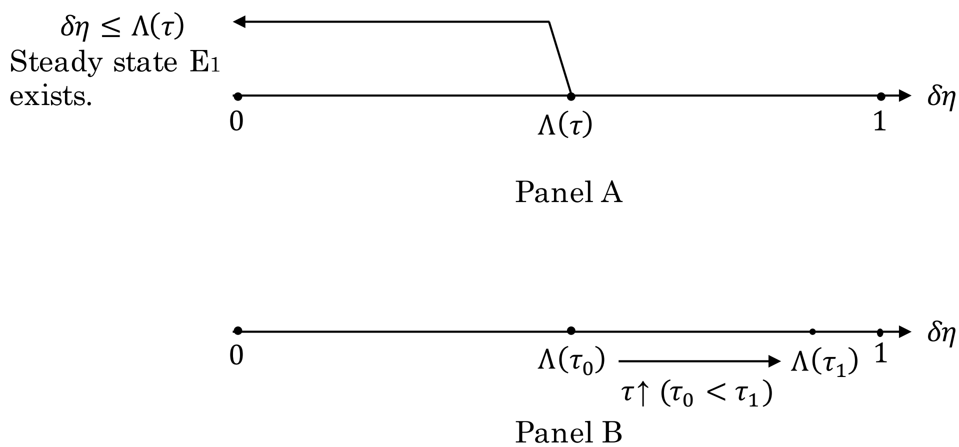

Figure 4: The area of $\delta\eta \leq \Lambda(\tau)$ and the effect of change of τ on $\Lambda(\tau)$

The intuition of Proposition 1 is as follows: if the psychological distress δ or the probability that corruption is discovered η is small, bureaucrats are corrupt, and this, in turn, leads to the existence of lower human capital in the steady-state. Moreover, if δ or η take substantially small values, such as $\delta\eta \leq \Omega(\tau)$, there exists only a steady-state in which bureaucrats become corrupt. Panel A of Figure 3 shows this case. Conversely, if the psychological distress or the probability that corruption is discovered is large, bureaucrats are not corrupt, and this leads to the existence of higher human capital in the steady-state. If δ or η take sufficiently high value, there only exists the steady state in which bureaucrats are not corrupt. If δ or η takes middle value, there exist multiple steady state.

Panel A in Figure 4 indicates the area of $\delta\eta \leq \Lambda(\tau)$, such that a lower human capital steady-state exists in the economy. If $\delta\eta \leq \Lambda(\tau)$, then there exists a lower human capital steady-state E_1. This means that the economy may converge to E_1. To discuss the policy that the government steers the economy away from the poverty trap, we focus on only $\Lambda(\tau)$. We obtain Lemma 1 as follows:

Lemma 1. *Assume that* $\tau > 1 - \frac{B}{\phi A}$ *and* $\phi A > 2B$, $\frac{\partial \Lambda(\tau)}{\partial \tau} > 0$ *holds when* $\Lambda(\tau) \leq 1$.

Proof. See Appendix D. □

Since $\frac{\partial \Lambda(\tau)}{\partial \tau} > 0$ holds, an increase in τ expands the area of $\delta\eta \leq \Lambda(\tau)$ in Panel B of Figure 4. Therefore, higher rates of income tax τ cause a higher incidence of corruption.

From Proposition 1, there exist multiple steady-states for some ranges of $\delta\eta$ when $\tau > 1 - \frac{B}{\phi A}$. Next, we discuss the case of $\tau \leq 1 - \frac{B}{\phi A}$. First, we obtain Assumption 2 to ensure that $0 < 1 - \frac{B}{\phi A}$.

Assumption 2.

$$\frac{B}{\phi A} < 1.$$

Then, we obtain the following Lemma 2.

Lemma 2. *Given any initial human capital h_0, if $\tau \leq 1 - \frac{B}{\phi A}$, the economy converges to the steady-state E_2.*

Proof. From (25) and (27), $h_1^* > h_2^*$ holds when $\tau \leq 1 - \frac{B}{\phi A}$; that is, this corresponds to Panel D in Figure 3. □

Panel D in Figure 3 shows the dynamics when $\tau \leq 1 - \frac{B}{\phi A}$. From Panel D in Figure 3, regardless of any initial human capital h_0, the economy converges to the steady-state E_2, where child labor and corruption do not exist. If the tax rate τ is sufficiently low such that $\tau < 1 - \frac{B}{\phi A}$ holds, the household's disposable income is sufficiently high such that parents do not supply child labor in this steady-state.

4 Welfare and government policy

We compare the welfare levels in the steady-states E_1 and E_2. To investigate this case, we focus on case2 of Proposition 1. We discuss the welfare levels of households and bureaucrats, respectively. Then, we obtain the following proposition:

Proposition 2. *Assume that $\tau > 1 - \frac{B}{\phi A}$ holds. The welfare levels of both households and bureaucrats in the steady-state E_2 are higher than those in the steady-state E_1.*

Proof. See Appendix E. □

From Proposition 1, if the steady-state E_1 exists, $\tau > 1 - \frac{B}{\phi A}$ holds. In steady-state E_1, the level of human capital is lower than that in steady-state E_2. Lower human capital leads to a lower household income. This generates child labor and corruption in steady-state E_1. In addition, the welfare levels of both households and bureaucrats in steady-state E_2 are higher than those in steady-state E_1. Therefore, if households have an initial level of human capital h_0 that is lower than the threshold $\hat{h}$, the economy suffers from child labor, corruption, and low levels of welfare.

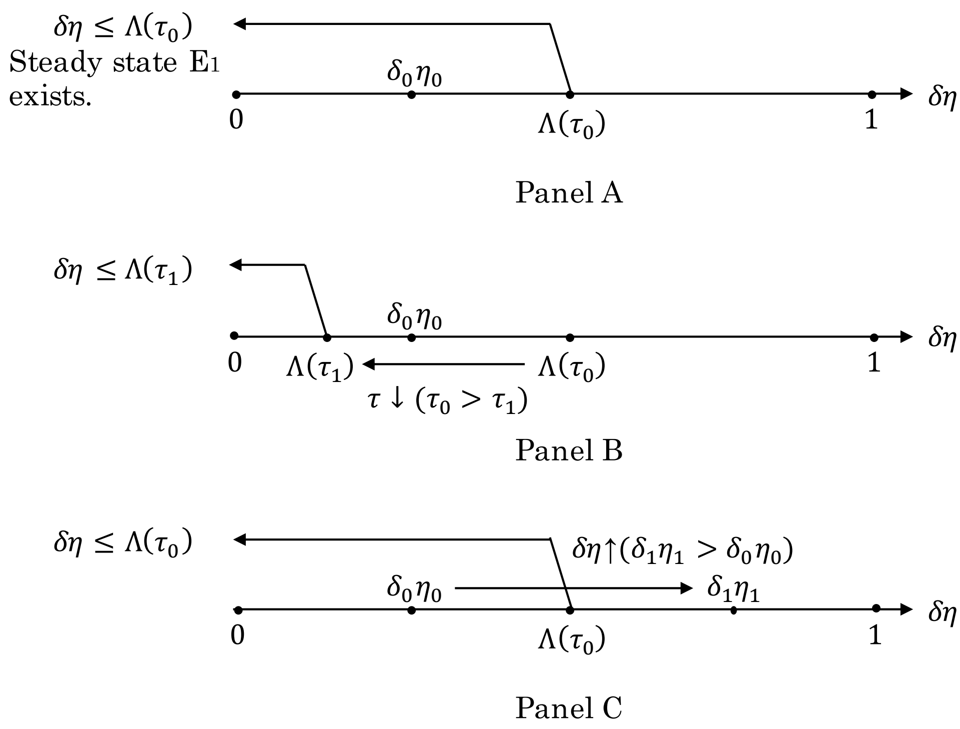

Figure 5: Policy changes

Next, we consider how government policy affects the economy. We assume that the government can change the values of psychological distress δ and the probability of revelation of corruption η[6]. We obtain the following proposition.

Proposition 3. *Suppose that $\phi A > 2B$ holds, the steady-state E_1 exists, and the initial economy is in the steady-state E_1. If the government changes the values of δ, η, and τ to satisfy $\tau \leq 1 - \frac{B}{\phi A}$ or $\delta\eta > \Lambda(\tau)$, the economy converges to the steady-state E_2, and the welfare levels of both households and bureaucrats in E_2 are improved from those in E_1.*

Proof. See Appendix F. □

Let us assume that δ, η, and τ are chosen to satisfy $\delta\eta \leq \Lambda(\tau)$ before the government enforces a change in policy. We denote the initial values of δ, η, and τ as δ_0, η_0, and τ_0, respectively. As shown in Panel A of Figure 5, if $\delta_0\eta_0 < \Lambda(\tau)$ holds, then the steady-state E_1 exists. We assume that the government decreases the initial tax rate τ_0 to τ_1 (i.e., $\tau_0 > \tau_1$). This change is shown in Panel B

[6]Changing the value of the psychological distress δ means that the government can increase the penalty for corruption. On the other hand, changing the probability of corruption revelation η is that, for example, the government asks some international organizations to investigate bureaucrats' income.

of Figure 5. If τ_1 is sufficiently low such that $\delta_0\eta_0 \geq \Lambda(\tau_1)$ holds, the steady-state E_1 vanishes and the economy converges to the steady-state E_2. From Lemma 2, the steady-state E_1 also vanishes if $\tau \leq 1 - \frac{B}{\phi A}$ holds. As shown in Appendix F, the welfare levels of both households and bureaucrats in E_2 are improved from those in E_1 if $\phi A > 2B$ holds.

Next, we consider a situation in which the government increases the values of psychological distress δ_0 and the probability of revelation of corruption η_0 to δ_1 and η_1, respectively (i.e., $\delta_1 > \delta_0$ and $\eta_1 > \eta_0$). These changes are shown in Panel C of Figure 5. If $\delta_1\eta_1$ is sufficiently high, such that $\delta_1\eta_1 \geq \Lambda(\tau_0)$ holds, the steady-state E_1 vanishes and the economy converges to the steady-state E_2. As shown in Appendix F, the welfare levels of both households and bureaucrats in E_2 are improved from those in E_1, regardless of the values of δ and η. Therefore, the government can improve the welfare levels of future generations by steering the economy away from steady-state E_1. In our model, the improvement in welfare levels is based on the human capital level. If $\delta\eta > \Lambda(\tau)$ holds, bureaucrats are not corrupt and child labor does not exist in the equilibrium. Conversely, if $\tau \leq 1 - \frac{B}{\phi A}$ holds, households allocate their children's time to education. In both cases, the economy converges to the steady-state E_2. Then, the increase in human capital raises the income of households and bureaucrats, and their welfare levels also increase. However, government policies cannot immediately affect the level of human capital because the level of human capital is historically given at an initial point in time. Hence, we obtain the following proposition.

Proposition 4. *Assume that the economy is initially in a steady-state E_1. The welfare level of bureaucrats in the initial generation decreases if τ decreases or $\delta\eta$ increases. Conversely, the welfare level of households increases if τ decreases.*

Proof. See Appendix G. □

Bureaucrats' income is financed by income tax revenue. Therefore, if the tax rate τ decreases, bureaucrats' income decreases and their welfare levels also decrease (see (14)). In addition, bureaucrats are corrupt and receive a bribe in steady-state E_1. Hence, the increase in psychological distress δ and the probability of revelation of corruption η make bureaucrats difficult to be corrupt. Then, the welfare levels of bureaucrats of the current generation decrease. Therefore, the policies described in Proposition 3 are not Pareto-improving in this economy.

Hereafter, we discuss the Pareto-improving policy. Let us consider the situation in which the government provides a subsidy x to bureaucrats of the current generation and does not charge the resource of this subsidy to the current generation. We assume that x is exogenously given and that it does not change the government budget constraint. From (6), the budget constraint of bureaucrats when they are not corrupt and do not take bribes is given by

$$c_t^B = (1-\tau)I_t + x. \tag{27}$$

From (7), the budget constraint of bureaucrats when they are corrupt and receive the bribe is given by

$$c_t^B = (1-\tau)I_t + b_t + x. \tag{28}$$

Considering subsidy x, we can rewrite the Proposition 1 as follows.

Proposition 5. *Assume that $\tau > 1 - \frac{B}{\phi A}$ holds and x is exogenously given. There exists a steady-state E_1 in this economy if the following inequality holds:*

$$\delta\eta \leq 1 - \frac{\log\left[\frac{\tau(1-\tau)\phi^2 A^2}{BN} + x\right]}{\log\left[\frac{(1-\tau)(\phi A - 2B)\phi A + B^2}{BN} + x\right]} \equiv \hat{\Lambda}(x,\tau), \tag{29}$$

where $\frac{\partial \hat{\Lambda}(x,\tau)}{\partial x} < 0$ holds.

Proof. See Appendix H. □

From $\frac{\partial \hat{\Lambda}(x,\tau)}{\partial x} < 0$, the range of $\delta\eta > \hat{\Lambda}(x,\tau)$ expands in Panel B of Figure 6 if x takes a positive value. Then, if x is sufficiently high, such that $\delta_0\eta_0 > \hat{\Lambda}(x,\tau_0)$ holds, the steady-state E_1 vanishes and the economy converges to the steady-state E_2. From Proposition 2, the welfare levels of both households and bureaucrats in E_2 are improved from those in E_1. Therefore, the government can improve the welfare levels of future generations by providing a sufficiently high subsidy x to bureaucrats. In addition, this policy increases the welfare levels of bureaucrats in the current generation because subsidies increase their income. However, the government must collect the resources of this subsidy xN. If the government can obtain this resource from an international organization and distribute this resource to bureaucrats for the current generation,

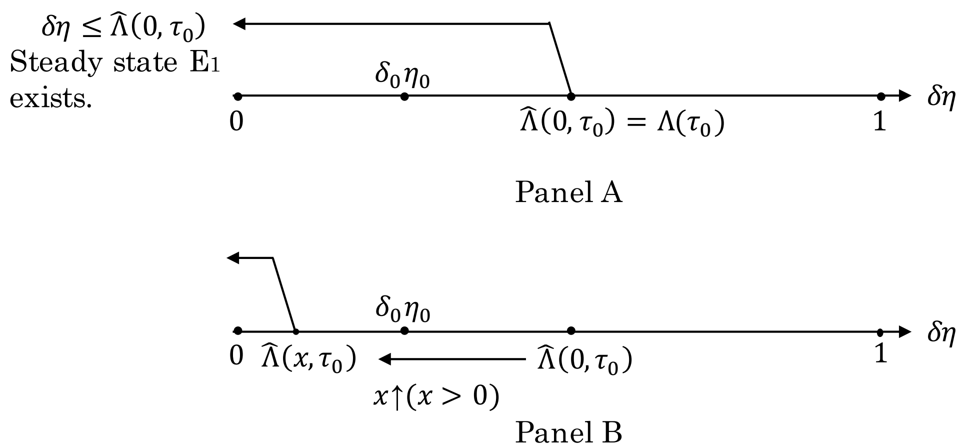

Figure 6: The effect of x

the economy immediately escapes from the poverty trap along with corruption, child labor, and low welfare. Therefore, the support of international organizations in developing countries that suffer from corruption and child labor is important for the economic development of these countries.

As shown in Propositions 3 and 4, it is difficult for developing countries to steer the economy away from a poverty trap through policy change because the welfare levels of bureaucrats of the current generation decrease. However, we show that developing countries can escape the poverty trap if international organizations support them. As shown in Proposition 5, if international organizations give some funds to the country in the poverty trap in the proposed model, the government can enforce the Pareto-improving policy by providing subsidies to bureaucrats of the current generation. Therefore, the support of international organizations is necessary for the development of poor countries.

5 Conclusion

We constructed an overlapping-generations model with endogenous education choices, child labor, and corruption. We investigated how child labor and corruption influence human capital accumulation and development. We show that multiple steady-states exist in this economy. One steady-state has a high level of human capital and the other has a low level of human capital. In the steady-state with a low level of human capital, child labor and corruption exist and the welfare level of households is low. In the steady-state with a high level of human capital, child labor and corruption are diminished and the welfare level is high. In addition, we showed that it is difficult to steer an economy away from a poverty trap with child labor and corruption because bureaucrats of the current generation are opposed to policy changes. However, we can apply the Pareto improving policy to this poverty trap, that is, ensure the government receives funds from an international organization.

Appendix

Appendix A: The illegal firm has all bargaining power over bureaucrats

The illegal firm determines the amount of the bribe b_t by solving

$$\max_{b_t} \pi_t^* - N b_t$$
$$\text{s.t.} \quad (1-\delta\eta)\log((1-\tau)I_t + b_t) \geq \log(1-\tau)I_t, \tag{PC'}$$

where (PC') represents the participation constraint of bureaucrats; that is, they never refuse an offer when it is satisfying. Because (PC') is binding at the optimum, we obtain b_t as follows:

$$b_t = \begin{cases} 0 & \text{if} \quad I_t < 1 \\ [(1-\tau)I_t]^{\frac{1}{1-\eta\delta}} - (1-\tau)I_t & \text{if} \quad I_t \geq 1 \end{cases}.$$

If corruption and child labor exist in the economy, we obtain the following condition:

$$\pi_t^* - N b_t \geq 0.$$

Then, we also obtain the following condition:

$$(1-\tau)I_t + \frac{1}{N}\pi_t^* \geq [(1-\tau)I_t]^{\frac{1}{1-\eta\delta}},$$
$$\Leftrightarrow \quad \frac{1}{N}\pi^* \geq [(1-\tau)I_t]^{\frac{1}{1-\delta\eta}} - (1-\tau)I_t.$$

From, (14),(15),(16), and (21) we obtain

$$\frac{\left(B-\sqrt{(1-\tau)ABh_t}\right)^2}{NB} \geq \left(\frac{\tau A h_t}{N}\right)^{\frac{1}{1-\delta\eta}} - \frac{\tau A h_t}{N}.$$

This is the same condition as (22).

Appendix B: Assumption 1

First, when Assumption 1 holds, $LHS(h_t)$ and $RHS(h_t)$ intersect only once; therefore, there exists only one $\hat{h}$. $LHS(h_t)$ decreases with respect to h_t and is equal to zero at $h_t = \bar{h}$. $RHS(h_t)$ is not less than zero when $h_t \geq \frac{N}{\tau A}$ and increases with respect to $h_t = \frac{B}{(1-\tau)A} \geq \frac{N}{\tau A}$. Therefore, if $\bar{h} \geq \frac{N}{\tau A}$ holds, $LHS(h_t)$ and $RHS(h_t)$ intersect only once. This occurs when $(1-\tau)\frac{N}{\tau} < B$ holds. Second, we assume that the level of bureaucrats' utility when they are corrupt is always not less than 0. This is because if the level of bureaucrats' utility is smaller than 0, the level of bureaucrats' utility when corruption is found is smaller than that when corruption is not found.[7] To exclude this case from consideration, the level of bureaucrats' utility must always be less than 0. From (8), the utility level of bureaucrats when they are corrupt $u^B_{c,t}$ is not less than zero if

$$(1-\eta)\log[(1-\tau)I_t + b_t] + \eta(1-\delta)\log[(1-\tau)I_t + b_t] \geq 0$$
$$\Leftrightarrow \quad (1-\tau)I_t + b_t \geq 1. \tag{30}$$

Applying (14), (15), (16), and (21), this inequality holds when $\frac{N}{\tau} \leq B$. Consolidating $\frac{(1-\tau)N}{\tau} \leq B$ and $\frac{N}{\tau} \leq B$, we obtain $\frac{N}{\tau} \leq B$ as in Assumption 1.

Appendix C: Proof of Proposition 1

This economy can have two types of equilibrium: one has corruption and child labor, and the other has neither. If $h_t \leq \hat{h}$ ($h_t > \hat{h}$) holds, then the equilibrium with (without) corruption and child labor exists. Figure 7 shows various cases that can take place; Panel A, C, and E in Figure 7 show the relationship between $LHS(h_t)$ and $RHS(h_t)$ while Panel B, D, and F in Figure 7 show the

[7] The utility level of bureaucrats where corruption is not found is given by $\log[(1-\tau)I_t + b_t]$ and that where corruption is found is given by $(1-\delta)\log[(1-\tau)I_t + b_t]$. Therefore, if $\log[(1-\tau)I_t + b_t] < 0$, then $\log[(1-\tau)I_t + b_t]$ is smaller than the discounted value $(1-\delta)\log[(1-\tau)I_t + b_t]$. This means that bureaucrats obtain higher utility when corruption is found.

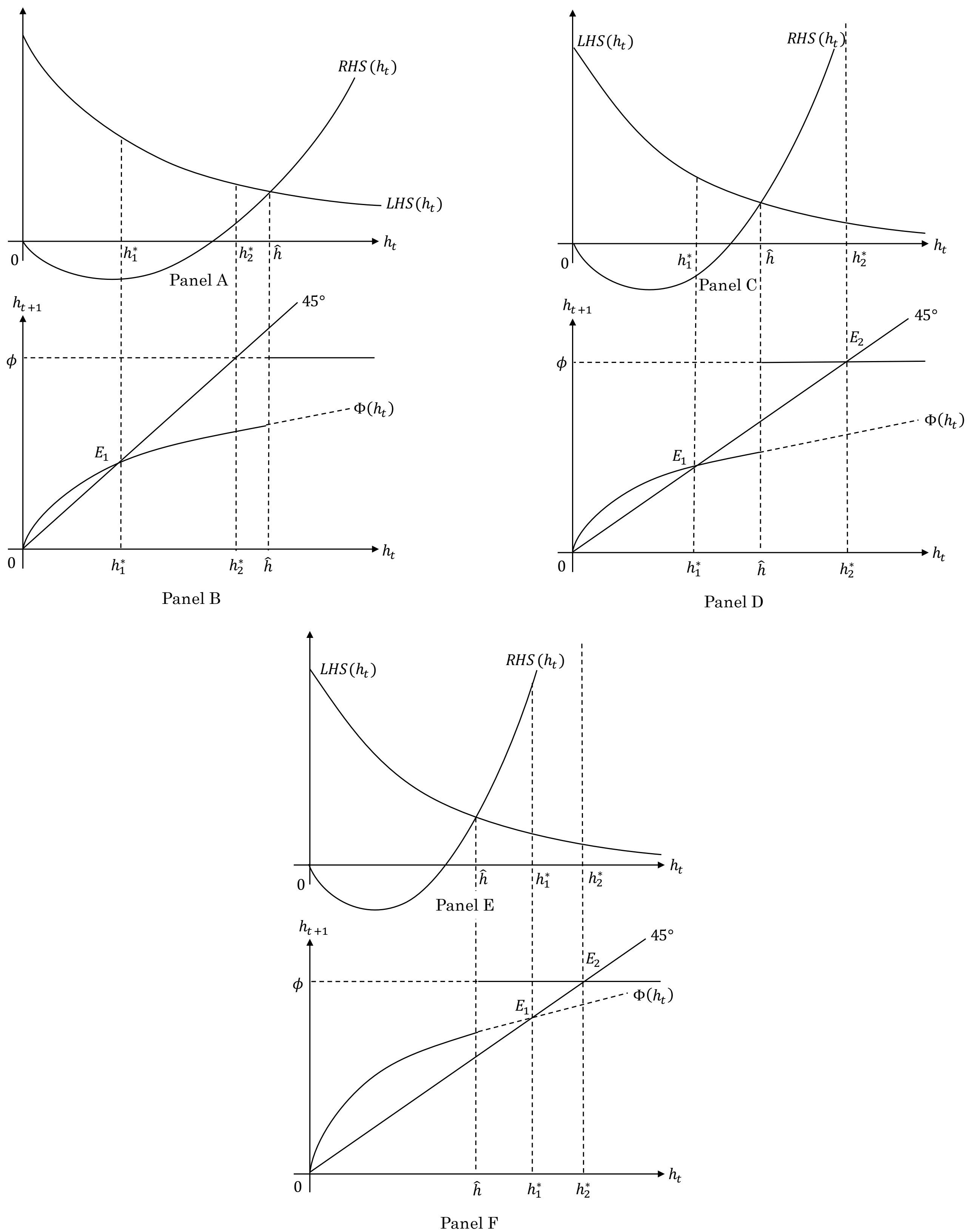

Figure 7: Positional relationship of h_1^*, h_2^*, and $\hat{h}$

phase diagrams of the level of human capital h_t. Panel A and B in Figure 7 show the case where only steady-state E_1 exists, Panel C and D show the case where there exist multiply steady-states, and Panel E and F show the case where only steady-state E_2 exists.

First, we show that if $\delta\eta < \Omega(\tau)$, there exists only a steady-state E_1. As shown in Panel B of Figure 7, all economies converge to the steady-state E_1, where the economy suffers from child labor and corruption if $h_1^* \leq h_2^* \leq \hat{h}$. As shown in Panel A of Figure 7, this case occurs when $LHS(h_2^*) > RHS(h_2^*)$. From (22) and (27), we can rewrite $LHS(h_2^*) > RHS(h_2^*)$ as follows:

$$\begin{aligned} & LHS(h_2^*) > RHS(h_2^*), \\ \rightarrow \quad & \delta\eta < 1 - \frac{\log \frac{\tau\phi A}{N}}{\log \frac{\phi A + B - 2\sqrt{(1-\tau)\phi AB}}{N}} \equiv \Omega(\tau) \end{aligned} \tag{A1}$$

Then, we must show that if $\tau > 1 - \frac{B}{\phi A}$ holds, there exists $\delta\eta$ such that (A1) holds; that is, $\Omega(\tau) > 1$. $\Omega(\tau)$ is not less than zero if

$$\begin{aligned} \Omega(\tau) = 1 - \frac{\log \frac{\tau\phi A}{N}}{\log \frac{\phi A + B - 2\sqrt{(1-\tau)\phi AB}}{N}} \geq 0, \\ \Leftrightarrow \quad \left[\tau - \left(1 - \frac{B}{\phi A}\right)\right]^2 \geq 0. \end{aligned} \tag{A2}$$

Note that (A2) holds when $\tau = 1 - \frac{B}{\phi A}$. Because the right-hand side of (A1) is always greater than zero when $\tau > 1 - \frac{B}{\phi A}$ holds, there must exist $\delta\eta > 0$ such that $\delta\eta < \Omega(\tau)$ holds.

Second, we show that if $\Omega(\tau) \leq \delta\eta \leq \Lambda(\tau)$ holds, then there exist multiple steady-states. As shown in Panel D of Figure 7, there exist multiple steady-states if $h_1^* \leq \hat{h} \leq h_2^*$, that is, $\tau > 1 - \frac{B}{\phi A}$. Panel C in Figure 7 states that this case occurs if $LHS(h_1^*) \geq RHS(h_1^*)$ holds at $h_t = h_1^*$, but $LHS(h_2^*) \leq RHS(h_2^*)$ holds at $h_t = h_2^*$. By using (22), (25), and (27), we can rewrite as follows:

$$\begin{aligned} & LHS(h_1^*) \geq RHS(h_1^*), \\ \rightarrow \quad & \delta\eta \leq 1 - \frac{\log \frac{\tau(1-\tau)\phi^2 A^2}{BN}}{\log \frac{(1-\tau)(\phi A - 2B)\phi A + B^2}{BN}} \equiv \Lambda(\tau), \end{aligned} \tag{A3}$$

and

$$LHS(h_2^*) \leq RHS(h_2^*),$$
$$\rightarrow \quad \delta\eta \geq 1 - \frac{\log \frac{\tau\phi A}{N}}{\log \frac{\phi A + B - 2\sqrt{(1-\tau)\phi AB}}{N}} = \Omega(\tau). \tag{A4}$$

We can prove that $\Omega(\tau) < \Lambda(\tau)$ for any $\tau > 1 - \frac{B}{\phi A}$. We show this later. $\Lambda(\tau)$ is greater than or equal to zero if

$$\Lambda(\tau) \equiv 1 - \frac{\log \frac{\tau(1-\tau)\phi^2 A^2}{BN}}{\log \frac{(1-\tau)(\phi A - 2B)\phi A + B^2}{BN}} \geq 0,$$
$$\rightarrow \quad \left[\tau - \left(1 - \frac{B}{\phi A}\right)\right]^2 \geq 0. \tag{A5}$$

Note that (A5) holds when $\tau = 1 - \frac{B}{\phi A}$. Because the right-hand side of (A3) is always greater than zero when $\tau > 1 - \frac{B}{\phi A}$, and therefore $\Lambda(\tau) > 0$, there must exist $\delta\eta \geq 0$ such that $\delta\eta \leq \Lambda(\tau)$ holds. Combining the fact that $\Omega(\tau) < \Lambda(\tau)$ for any $\tau > 1 - \frac{B}{\phi A}$ and (A5), there must exist $\delta\eta$ such that $\Omega(\tau) \leq \delta\eta \leq \Lambda(\tau)$ holds.

Third, we show that if $\delta\eta > \Lambda(\tau)$, there exists only a steady-state E_2. As shown in Panel F of Figure 7, all economies converge to the steady-state E_2 if $\hat{h} < h_1^* \leq h_2^*$. As shown in Panel E of Figure 7, this case occurs when $LHS(h_1^*) < RHS(h_1^*)$. From (22) and (25), we can rewrite $LHS(h_1^*) < RHS(h_1^*)$ as follows:

$$LHS(h_1^*) < RHS(h_1^*),$$
$$\rightarrow \quad \delta\eta > 1 - \frac{\log \frac{\tau(1-\tau)\phi^2 A^2}{BN}}{\log \frac{(1-\tau)(\phi A - 2B)\phi A + B^2}{BN}} \equiv \Lambda(\tau). \tag{A6}$$

Because $\Lambda(\tau)$ is equal to 0 at $\tau = 1 - \frac{B}{\phi A}$ from (A5), there exists $\Lambda(\tau) < \delta\eta \leq 1$ such that (A6) holds.

Finally, we show that $\Omega(\tau) < \Lambda(\tau)$ for any $\tau > 1 - \frac{B}{\phi A}$. Rewriting (22), $LHS(h_t) \geq RHS(h_t)$ if

$$\delta\eta \leq 1 - \frac{\log \frac{\tau A h_t}{N}}{\log \frac{A h_t + B - 2\sqrt{(1-\tau)ABh_t}}{N}} \equiv \Psi(h_t, \tau). \tag{A7}$$

We define the right-hand side of (A7) as $\Psi(h_t, \tau)$. Substituting $h_t = h_1^*$ into $\Psi(h_t, \tau)$, we obtain

$$\Psi(h_1^*, \tau) = 1 - \frac{\log \frac{\tau(1-\tau)\phi^2 A^2}{BN}}{\log \frac{(1-\tau)(\phi A - 2B)\phi A + B^2}{BN}} = \Lambda(\tau). \tag{A8}$$

As the same way, substituting $h_t = h_2^*$ into $\Psi(h_t, \tau)$, we obtain

$$\Psi(h_1^*, \tau) = 1 - \frac{\log \frac{\tau \phi A}{N}}{\log \frac{\phi A + B - 2\sqrt{(1-\tau)\phi AB}}{N}} = \Omega(\tau). \tag{A9}$$

Because $\phi = h_2^* > h_1^* = \frac{(1-\tau)\phi^2 A}{B}$ if $\Psi(h_t, \tau)$ is strictly decreasing in h_t, we conclude that $\Psi(h_2^*, \tau) = \Omega(\tau) < \Lambda(\tau) = \Psi(h_1^*, \tau)$. Differentiating $\Psi(h_t, \tau)$ with respect to h_t, we obtain

$$\begin{aligned} \frac{\partial \Psi(h_t, \tau)}{\partial h_t} = & - \frac{1}{h_t \left[\frac{Ah_t + B - 2\sqrt{(1-\tau)ABh_t}}{N} \right]^2} \\ & \times \left\{ \log \frac{Ah_t + B - 2\sqrt{(1-\tau)ABh_t}}{N} - \frac{Ah_t - \sqrt{(1-\tau)ABh_t}}{Ah_t + B - 2\sqrt{(1-\tau)ABh_t}} \log \frac{\tau A h_t}{N} \right\}. \end{aligned} \tag{A10}$$

From (5), (7), (14), (16), and (21), we have $\log[(1-\tau)I_t + b_t] = \log \frac{Ah_t + B - 2\sqrt{(1-\tau)ABh_t}}{N}$. In the same way, (5), (8), and (14), we have $\log(1-\tau)I_t = \log \frac{\tau A h_t}{N}$. Therefore, the curly braces in (A10) can be rewritten as:

$$\begin{aligned} \frac{\partial \Psi(h_t, \tau)}{\partial h_t} = & - \frac{1}{h_t \left[\frac{Ah_t + B - 2\sqrt{(1-\tau)ABh_t}}{N} \right]^2} \\ & \times \left\{ \log[(1-\tau)I_t + b_t] - \frac{Ah_t - \sqrt{(1-\tau)ABh_t}}{Ah_t + B - 2\sqrt{(1-\tau)ABh_t}} \log(1-\tau)I_t \right\}. \end{aligned}$$

Therefore, we have since $b_t \geq 0$

$$\begin{aligned} & \log(I_t + b_t) \geq \log I_t \\ \Rightarrow \quad & \log \frac{Ah_t + B - 2\sqrt{(1-\tau)ABh_t}}{N} \geq \log \frac{\tau A h_t}{N}. \end{aligned}$$

Moreover, the coefficient of the second term $\frac{Ah_t - \sqrt{(1-\tau)ABh_t}}{Ah_t + B - 2\sqrt{(1-\tau)ABh_t}}$ is less than or equal to 1 if

$$\begin{aligned} &\frac{Ah_t - \sqrt{(1-\tau)ABh_t}}{Ah_t + B - 2\sqrt{(1-\tau)ABh_t}} \leq 1 \\ \Leftrightarrow \quad & h_t \leq \frac{B}{(1-\tau)A} = \bar{h}. \end{aligned}$$

Note that $\bar{h}$ represents the value of $l_t = 0$. Because we consider the case in which $\tau > 1 - \frac{B}{\phi A}$, we have $h_2^* = \phi < \bar{h}$ holds.

Because Assumption 1 holds, $\log \frac{Ah_t + B - 2\sqrt{(1-\tau)ABh_t}}{N}$ is always greater than or equal to zero for any h_t. Therefore, because the coefficient of the second term $\frac{Ah_t - \sqrt{(1-\tau)ABh_t}}{Ah_t + B - 2\sqrt{(1-\tau)ABh_t}}$ is not greater than one, we have

$$\begin{aligned} &\log \frac{Ah_t + B - 2\sqrt{(1-\tau)ABh_t}}{N} \geq \log \frac{\tau A h_t}{N} > \frac{Ah_t - \sqrt{(1-\tau)ABh_t}}{Ah_t + B - 2\sqrt{(1-\tau)ABh_t}} \log \frac{\tau A h_t}{N} \\ \Rightarrow \quad & \log \frac{Ah_t + B - 2\sqrt{(1-\tau)ABh_t}}{N} - \frac{Ah_t - \sqrt{(1-\tau)ABh_t}}{Ah_t + B - 2\sqrt{(1-\tau)ABh_t}} \log \frac{\tau A h_t}{N} > 0. \end{aligned}$$

Because the curly brace part of (A10) is greater than 0, the differentiation of $\Psi(h_t, \tau)$ with respect to h_t is negative. Therefore, $\frac{\partial \Psi(h_t,\tau)}{\partial h_t} < 0$ when $h_t \leq \bar{h}$ and $\Psi(h_2^*, \tau) = \Omega(\tau) < \Lambda(\tau) = \Psi(h_1^*, \tau)$.

Hence Proposition 1 has been proved.

Appendix D: Proof of Lemma 1

From (A3), we obtain $\frac{\partial \Lambda(\tau)}{\partial \tau}$ as follows

$$\frac{\partial \Lambda(\tau)}{\partial \tau} = \frac{-\frac{1-2\tau}{\tau(1-\tau)} \log \frac{(1-\tau)(\phi A - 2B)\phi A + B^2}{BN} + \frac{(\phi A - 2B)\phi A}{(1-\tau)(\phi A - 2B)\phi + B^2} \log \frac{\tau(1-\tau)\phi^2 A^2}{BN}}{\left[\log \frac{(1-\tau)(\phi A - 2B)\phi A + B^2}{BN}\right]^2}. \tag{A11}$$

$\tau > 1 - \frac{B}{\phi A}$ can be rearranged as $1 - 2\tau < \frac{2B}{\phi A} - 1$, and $\phi A > 2B$ can be rearranged as $\frac{2B}{\phi A} - 1 < 0$. By combining them, we obtain $1 - 2\tau < 0$. In addition, $\frac{(1-\tau)(\phi A - 2B)\phi A + B^2}{BN} > 1$ holds if $\tau < \frac{(\phi A - 2B)\phi A + B^2 - BN}{(\phi A - 2B)\phi A}$ holds. We show that $\frac{(\phi A - 2B)\phi A + B^2 - BN}{(\phi A - 2B)\phi A} > 1$ holds under Assumption 1. Then, we obtain

$$\frac{(\phi A-2B)\phi A+B^2-BN}{(\phi A-2B)\phi A}-1=\frac{B^2}{(\phi A-2B)\phi A}\left(1-\frac{N}{B}\right). \tag{A12}$$

From Assumption 1 and $\tau \in (0.1)$, $\frac{N}{B}<1$ holds. From $\frac{N}{B}<1$, $\phi A>2B$, and (A12), $\frac{(\phi A-2B)\phi A-BN}{(\phi A-2B)\phi A}>1$ holds. Hence, $\tau<\frac{(\phi A-2B)\phi A-BN}{(\phi A-2B)\phi A}$ holds. Then, $\frac{(1-\tau)(\phi A-2B)\phi A+B^2}{BN}>1$ holds. Therefore, the first term of the numerator in (A11) is greater than 0. From (27) and $\frac{(1-\tau)(\phi A-2B)\phi A+B^2}{BN}>1$, $\frac{\tau(1-\tau)\phi^2A^2}{BN}>1$ holds if $\Lambda(\tau)<1$ holds. Therefore, the second term of the numerator of (A11) is greater than zero when $\Lambda(\tau)<1$. Hence, $\frac{\partial\Lambda(\tau)}{\partial\tau}>0$ holds if $\tau>1-\frac{B}{\phi A}$, $\phi A>2B$, and $\Lambda(\tau)\leq 1$ holds.

Appendix E: Proof of Proposition 2

Let us define the welfare level of the household as $u_c^H(h_t)$ when child labor exists. Employing (17), (19), (20), and $w_t=A$, we obtain $u_c^H(h_t)$ as follows:

$$u_c^H(h_t)=\log(1-\tau)Ah_t+\log\phi. \tag{A13}$$

Substituting (27) into (A13), we obtain the welfare level of the household in the steady-state E_1 (i.e., $h_t=h_1^*$) as follows:

$$u_c^H(h_1^*)=\log\frac{(1-\tau)^2\phi^3A^2}{B}. \tag{A14}$$

We define the welfare level of the household as $u_n^H(h_t)$ when child labor does not exist. From (18) and $w_t=A$, we obtain $u_n^H(h_t)$ as follows:

$$u_n^H(h_t)=\log(1-\tau)Ah_t+\log\phi. \tag{A15}$$

Substituting (27) into (A15) and rearranging it, we obtain the welfare level of households in the steady-state E_2 (i.e., $h_t=h_2^*$) as follows:

$$u_n^H(h_2^*)=\log(1-\tau)A\phi^2. \tag{A16}$$

From (A14) and (A16), we find that $u_n^H(h_2^*) > u_c^H(h_1^*)$ holds when $\tau > 1 - \frac{B}{\phi A}$.

Let us define the welfare level of the bureaucrat as $u_c^B(h_t)$ when child labor exists. From (8), (14), (16), and (21), we obtain $u_c^B(h_t)$ as follows:

$$u_c^B(h_t) = (1-\delta\eta)\log\left\{\frac{\tau A h_t}{N} + \frac{[B - \sqrt{(1-\tau)ABh_t}]^2}{BN}\right\}. \tag{A17}$$

Substituting (27) into (A17) and rearranging it, we obtain the welfare level of the bureaucrat in the steady-state E_1 (i.e., $h_t = h_1^*$) as follows:

$$u_c^B(h_1^*) = (1-\delta\eta)\log\frac{(1-\tau)(\phi A - 2B)\phi A + B^2}{BN}. \tag{A18}$$

We define the welfare level of the bureaucrat as $u_n^B(h_t)$ when child labor does not exist. From (9) and (14), we obtain $u_n^B(h_t)$ as follows:

$$u_n^B(h_t) = \log\frac{\tau A h_t}{N}. \tag{A19}$$

Substituting (27) into (A19) and rearranging it, we obtain the welfare level of the bureaucrat in the steady-state E_2 (i.e., $h_t = h_2^*$) as follows:

$$u_n^B(h_2^*) = \log\frac{\tau\phi A}{N}. \tag{A20}$$

Note that $\delta, \eta \in (0,1)$, and $\delta\eta < 1$ hold. Therefore, $\frac{u_c^B(h_1^*)}{1-\delta\eta} > u_c^B(h_1^*)$ holds. From (A18) and (A20), we find that $u_n^B(h_t) > \frac{u_c^B(h_1^*)}{1-\delta\eta}$ holds when $\tau > 1 - \frac{B}{\phi A}$. Hence, $u_n^B(h_2^*) > u_c^B(h_1^*)$ holds if $\tau > 1 - \frac{B}{\phi A}$ holds.

Appendix F: Proof of Proposition 3

Let us assume that the government decreases the initial tax rate τ_0 to τ_1 (i.e., $\tau_0 > \tau_1$). As shown in Appendix E, if $\tau > \frac{B}{\phi A}$ holds, then $u_n^H(h_2^*) > u_c^H(h_1^*)$ holds. From (A14) and (A16), we find that $\frac{\partial u_n^H(h_2^*)}{\partial \tau} < 0$ holds. Therefore, $u_n^H(h_2^*)\big|_{\tau=\tau_1} > u_c^H(h_1^*)\big|_{\tau=\tau_0}$ holds. From (A14) and (A16), we find that $u_n^H(h_2^*)$ and $u_c^H(h_1^*)$ are independent of δ and η.

As shown in Appendix E, if $\tau > \frac{B}{\phi A}$ holds, then $u_n^B(h_2^*) > u_c^B(h_1^*)$ holds. From (A18) and (A20), we find that $\frac{\partial u_n^B(h_2^*)}{\partial \tau} < 0$ holds if $\phi A > 2B$ holds. Therefore, $u_n^B(h_2^*)\big|_{\tau=\tau_1} > u_c^B(h_1^*)\big|_{\tau=\tau_0}$ holds. As shown in Appendix E, regardless of the values of δ and η, $u_n^B(h_2^*)\big|_{\tau=\tau_1} > u_c^B(h_1^*)\big|_{\tau=\tau_0}$ holds.

We assume that there exists a steady-state E_1 and the initial economy is in the steady-state E_1 when $\tau = \tau_0$. Then, if the government decreases the initial tax rate τ_0 to τ_1 such that it satisfies $\tau_1 > 1 - \frac{B}{\phi A}$ or $\delta\eta > \Lambda(\tau_1)$, the steady-state E_1 vanishes, that is, the dynamics change from that of Panel B in Figure 3 to that of Panels C and D. Then, the economy converges to the steady-state E_2. In addition, if the government increases δ or η such that $\delta\eta > \Lambda(\tau_0)$ holds, the steady-state E_1 vanishes, and the economy converges to the steady-state E_2. Hence, if the government changes τ, δ, η such that multiple steady-states do not exist and the economy converges to the steady-state E_2, the level of welfare in the steady-state E_2 is improved from that of E_1.

Appendix G: Proof of Proposition 4

If the initial economy is in the steady-state E_1, the human capital of this generation is given by h_1^*. Note that even if τ or $\delta\eta$ changes, the human capital of this generation h_1^* does not change. From (A17), we obtain $\frac{\partial u_c^B(h_t)}{\partial \tau}\Big|_{h_t=h_1^*} > 0$, $\frac{\partial u_c^B(h_t)}{\partial \delta}\Big|_{h_t=h_1^*} < 0$, and $\frac{\partial u_c^B(h_t)}{\partial \eta}\Big|_{h_t=h_1^*} < 0$. Therefore, the welfare level of bureaucrats in the initial generation decreases if τ decreases or $\delta\eta$ increases.

Appendix H: Proof of Proposition 5

From (5) and (28), the utility of bureaucrats when they are not corrupt and do not receive the bribe is given by

$$u_{n,t}^B = \log[(1-\tau)I_t + x]. \tag{A21}$$

From (5) and (29), the utility of bureaucrats when they are corrupt and receive the bribe is given by

$$u_{c,t}^B = (1-\eta)\log[(1-\tau)I_t + b_t + x] + \eta(1-\delta)\log[(1-\tau)I_t + b_t + x]. \tag{A22}$$

From (A21) and (A22), bureaucrats are corrupt if

$$
\begin{aligned}
& u_{c,t}^{B} \geq u_{n,t}^{B}, \\
\Leftrightarrow\ & (1-\tau)I_t + b_t + x \geq [(1-\tau)I_t + x]^{\frac{1}{1-\delta\eta}}. \qquad \text{(A23)}
\end{aligned}
$$

Substituting (16) into (A23), we obtain

$$
(1-\tau)I_t + \frac{1}{N}\pi_t^* + x \geq [(1-\tau)I_t + x]^{\frac{1}{1-\delta\eta}}. \qquad \text{(A24)}
$$

Bureaucrats are corrupt when (A24) holds. From (14), (A24), and (21), bureaucrats are corrupt and households supply child labor when the following inequality holds:

$$
\underbrace{\frac{1}{N}\left[Ah_t + B - 2\sqrt{(1-\tau)ABh_t} + x\right]}_{\equiv \widehat{LHS}(h_t)} \geq \underbrace{\left(\frac{\tau A h_t}{N} + x\right)^{\frac{1}{1-\eta\delta}}}_{\equiv \widehat{RHS}(h_t)}, \qquad \text{(A25)}
$$

holds. Let us define the left-hand side of (A25) as $\widehat{LHS}(h_t)$ and the right-hand side of (A25) as $\widehat{RHS}(h_t)$. As shown in Appendix C, if $\widehat{LHS}(h_1^*) \leq \widehat{RHS}(h_1^*)$, there exist multiple steady-states. From (A25) and (25), we can rewrite $\widehat{LHS}(h_1^*) \leq \widehat{RHS}(h_1^*)$ as follows:

$$
\begin{aligned}
& \widehat{LHS}(h_1^*) \leq \widehat{RHS}(h_1^*), \\
\rightarrow \quad & \delta\eta \leq 1 - \frac{\log\left[\frac{\tau(1-\tau)\phi^2 A^2}{BN} + x\right]}{\log\left[\frac{(1-\tau)(\phi A - 2B)\phi A + B^2}{BN} + x\right]} \equiv \hat{\Lambda}(x,\tau). \qquad \text{(A26)}
\end{aligned}
$$

From (A26), we obtain

$$
\frac{\partial \hat{\Lambda}(x,\tau)}{\partial \tau} = -\frac{1}{[\log(\Upsilon + x)]^2}\left[\frac{\log(\Upsilon + x)}{\Gamma + x} - \frac{\log(\Gamma + x)}{\Upsilon + x}\right], \qquad \text{(A27)}
$$

where $\Gamma \equiv \frac{\tau(1-\tau)\phi^2 A^2}{BN}$ and $\Upsilon \equiv \frac{(1-\tau)(\phi A - 2B)\phi A + B^2}{BN}$. Then, we obtain

$$
\Upsilon - \Gamma = \frac{[(1-\tau)\phi A - B]^2}{BN} > 0. \qquad \text{(A28)}
$$

Therefore, $\Upsilon > \Gamma$ holds, and we can obtain $\frac{\log(\Upsilon + x)}{\Gamma + x} > \frac{\log(\Gamma + x)}{\Upsilon + x}$. Hence, from (A27), $\frac{\partial \hat{\Lambda}(x,\tau)}{\partial \tau} <$ holds.

References

[1] Akimoto, K. (2018). Dynamic analysis of bureaucratic quality and occupational choice. Journal of Macroeconomics, 55, 199-214.

[2] Akimoto, K. (2020). Corruption, mortality rates, and development: policies for escaping from the poverty trap. Journal of Economics, 1-26.

[3] Banerjee, A. V. (1997).A Theory of Misgovernance. The Quarterly Journal of Economics 112(4), 1289-1332.

[4] Blackburn, K., Bose, N., Haque, M. E. (2006). The incidence and persistence of corruption in economic development. Journal of Economic Dynamics and Control, 30(12), 2447-2467.

[5] Blackburn, K., Forgues-Puccio, G. F. (2007). Distribution and development in a model of misgovernance. European Economic Review, 51(6), 1534-1563.

[6] Blackburn, K., Sarmah, R. (2008). Corruption, development and demography. Economics of Governance 9, 341-362.

[7] Dessy, S.E., (2000). A defense of compulsory measures against child labor. Journal of Development Economics 62, 261-275.

[8] Eicher, T., Garcia-Peñalosa, C., van Ypersele, T., (2009). Education, corruption, and the distribution of income. Journal of Economic Growth 14, 205-231.

[9] Gregory, A., (2017). Chocolate and Child Slavery: Say No to Human Trafficking This Holiday Season. Huffington Post. Retrieved from https://www.huffpost.com/entry/chocolate-and-child-slave_b_4181089

[10] Hazan, M., Berudugo B., (2002). Child labor, fertility, and economic growth. The Economic Journal 112, 810-828.

[11] Mauro, P. (1995). Corruption and growth. The quarterly journal of economics, 110(3), 681-712.

[12] Miki M., U Roberto, R., Helle, F., Svante Karlshoj, I., ; David, B., (2010). The Dark Side of Chocolate. Copenhagen, Denmark, Bastard Film & TV.

[13] Sugawara, K. (2010). Intergenerational transfers and fertility: Trade-off between human capital and child labour. Journal of Macroeconomics, 32(2), 584-593.

[14] Sen Nag, Oishimaya. (2019). Worst Countries For Child Labor. Retrieved from https://www.worldatlas.com/articles/worst-countries-for-child-labor.html

[15] Varvarigos, D., Arsenis, P., (2015). Corruption, fertility, and human capital. Journal of Economic Behavior & Organization 109, 145-162.