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The Economics of Child Labor

Xinye Zheng

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THE ECONOMICS OF CHILD LABOR

BY

XINYE ZHENG

A Dissertation Submitted in Partial Fulfillment
of the Requirements for the Degree
of
Doctor of Philosophy
in the
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ACCEPTANCE

This dissertation was prepared under the direction of the candidate's Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Economics in the Andrew Young School of Policy Studies of Georgia State University.

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ABSTRACT

THE ECONOMICS OF CHILD LABOR

BY

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In this dissertation, we first develop a simple two-period model to examine the parent's optimal choice of children's time. We identify factors such as wage rate, school fees, education returns, degree of children's altruism toward their parents and the parents' discounting rate that influence the parents' optimal choice, and discuss their impacts on the optimal choice.

Children's time is an important resource for rural households in developing economies, and it is typically allocated by the parents. Two basic uses for this resource are: working in the labor market and attending schools. Schooling today may make children more productive in the future. The opportunity cost of schooling is the forgone wage rate in the labor market. Allocation of children's time is therefore mainly determined by education return, wage rate in labor market and school fees.

Many existing models in the literature cannot explain the coexistence of schooling, poverty and the coexistence of child labor and affluence. We extend our basic model to

explain the above two paradoxes. We show that, when education return is high and the household is willing to endure extra hardship caused by the child attending school, the coexistence of schooling and poverty can emerge. On the other hand, when the wage rate for child labor and schooling fees are higher than education return, affluence and child labor can co-exist.

Governments have adopted various policy tools to fight against child labor, among which the compulsory education law and free education programs stand out. Our basic model is then extended to examine how these two types of government policies may impact child labor. We show the relative performance of the two policies depend crucially on several factors, including the enforcement and the costs to the household of the compulsory education law. We use the recent Chinese experience in changing the compulsory education law to free education plan to illustrate and verify our theoretical prediction.

CHAPTER 1. INTRODUCTION

Size and Distribution of the Child Labor

According to the International Labor office (ILO), there were at least 190.7 million children between 5 and 15 doing regular jobs across the world in 2004 (ILO 2006). The major part of child labor is from Asia and the pacific area. In 2004, among 650 million children in this area, 122.3 million were working in labor market. The second largest part was from sub-Saharan Africa. Among its 186.8 million children population, 49.3 million were in the labor market. In other words, one in five children in this area was in the labor market. Overall, 15.8% of children population in the world was working in labor market, as illustrated in Table 1.

Table 1. Distribution of Economically Active Children between Ages 5-14 (million)

Region	Children population	Economically active children	Activity ratio (%)
Asia and Pacific	650	122.3	18.8
Latin America and Caribbean	111	5.7	5.4
Sub-Saharan Africa	186.8	49.3	26.4
Others	258.8	13.4	5.2
Total of the world	1201.6	190.7	15.8

Source: ILO (2006): "the End of Child Labor, within Reach", p. 8, Geneva, International Labor Organization. It can be obtained at http://www.ilo.ch/public/english/standards/relm/ilc/ilc95/pdf/rep-i-b.pdf

We should be very careful in interpreting the figures provided in Table 1. This is because the data in Table 1 is pooled across the world and may not be able to give a clear picture of the distribution of child labor in the world. In Table 2, we use the data from

UNICEF to show how child labor is distributed in different countries. The mean child labor rate in UNICEF survey data is 22% which is higher than 15.8% in ILO data. This is possibly because most of UNICEF surveys are in developing countries and happen to be highly related to child labor. The distribution of child labor is very uneven. For example, the lowest rate in this survey is Romania whose active rate is only 1%. On the other hand, there are 10 countries suffering 50% active rates. In these 10 countries, over half of the children are unable to attend school. In the extreme cases, over 60% of children in Togo and Niger are in the labor market and therefore cannot receive education.

Table 2. Child Labor in Selected Countries

Countries	child labor %	Countries	child labor %
Romania	1	Gambia	22
Jamaica	2	Albania	23
Trinidad and Tobago	2	Viet Nam	23
Indonesia	4	Burundi	24
Timor-Leste	4	Guatemala	24
Bahrain	5	Lao People's Democratic Republic	24
Colombia	5	Benin	26
Ecuador	6	Kenya	26
Egypt	6	Zimbabwe	26
Lebanon	6	Equatorial Guinea	27
Bangladesh	7	Comoros	28
Brazil	7	Congo, Democratic Republic	28
Venezuela	7	Moldova, Republic of	28
Azerbaijan	8	Madagascar	30
Iraq	8	Mali	30
Paraguay	8	Mongolia	30
Swaziland	8	Nepal	31
Syrian Arab Republic	8	Rwanda	31
Dominican Republic	9	Somalia	32
Mauritania	10	Tanzania	32

Nicaragua	10	Senegal	33
Bosnia and Herzegovina	11	Afghanistan	34
Morocco	11	Uganda	34
Philippines	11	Côte d'Ivoire	35
Zambia	11	Nigeria	39
Sudan	13	Ethiopia	43
India	14	Costa Rica	50
Sao Tome and Principe	14	Cameroon	51
Uzbekistan	15	Guinea-Bissau	54
Mexico	16	Central African Republic	56
Lesotho	17	Burkina Faso	57
Malawi	17	Chad	57
Tajikistan	18	Ghana	57
Guyana	19	Sierra Leone	57
Bolivia	21	Togo	60
Angola	22	Niger	66

Source: UNICEF(2006): "State of the World's Children report", table 9, Child Protection, pp.134-35. This information can be obtained at http://www.unicef.org/sowc06/pdfs/sowc06_table9.pdf

Based on the UNICEF Multiple Indicator Cluster Survey data, Edmonds and Pavcnik find that for 124 million children aged 5-14 years in 36 countries in 2000, the school attending rate was 69.5% (Edmonds and Pavcnik 2005). Of course, attending school does not mean an absence of child labor. The same study concludes that "almost 68% of children ages 5-14 years report working in either market work or domestic work (Edmonds and Pavcnik 2005) ." They also find that children doing market work spend, on average, 26 hours on work per week. And children doing domestic work, on average, spend 16 hours on work per week.

We should not make the mistake of believing that child labor is only a contemporary phenomenon. As a matter of fact, child labor has been an indispensable part of human economic activities. We take Britain and the U.S. as examples. During the

period of industrial revolution, many factory laborers in the U.K. were children and youth. For example, Tuttle (1999) clearly documents the size of employment of children in the textile industries in Britain in the 19th century, as shown below in Table 3.

Table 3. Distribution of Children in Textile Industries in Britain in 19th Century

Industries	Year 1835	Year 1838	Year 1839	Year 1843	Year 1845
Cotton	49%	46%	46%	39%	40%
Wool	47%	50%	50%	42%	46%
Worsted	64%	59%	60%	43%	46%
Flax	58%	55%	54%	48%	53%
Silk	56%	56%	62%	47%	56%

Source: Tuttle (1999) p.96.

From Table 3 we can see that, a major part of employment in textile industries in the 19th century was child labor. In 1835, the lowest ratio of child labor as a share of total employment was 49% in the cotton industry. The highest was 64% in the worsted industry. Ten years later, according to Tuttle (1999), there was no big change of the employment pattern in textile industries.

Similar to the situation in Britain, children had been an important part of employment in the history of the U.S. For example, Goldin and Sokoloff (1982) suggest that, among manufacturing jobs in the northeast America, 20% were filled by children. Hindman (2002) offers a historical dataset from which we can have a better understanding of the distribution of child labor in the history of the United States, which we list in Table 4.

Table 4. Child labor in the United States: 1870-1930 (unit: 1,000)

Year	Workers,10-14	Children as % of workforce	Activity rate of children, %
1870	765	5.92	15.98
1880	1,118	6.43	19.56
1890	1,504	6.50	21.38
1900	1,750	6.02	21.66
1910	1,622	4.34	17.81
1920	1,417	3.34	13.32
1930	667	1.37	5.56

Source: Hindman (2002), table 2.1, p. 31.

Table 4 shows that child labor played an important role in the history of the American economy. From 1880 to the 1900s, over 6% in labor forces were children between 10 and 14 years old. During the same period, almost one fifth of children were in the labor market to make earnings. Even in the 1930s, child labor was still an important phenomenon in the U.S., since 5.56% of children were working.

The size and distribution of child labor have important implications. First, working as child labor means that less time can be allocated to study. Education is widely regarded as a basic means to make people more productive in the future. Child labor therefore has a negative impact on future productivity. Second, in a more broad sense, the striking size, coupled with the conviction that child labor equals child abuse, makes it morally unacceptable to some people in the developed countries. As a response to this uneasiness, governments in many countries have proposed or considered to take actions against child labor. One of the actions taken has been to restrict the imports of goods from developing countries in which child labor has been pervasive. For example, in 1995, the Child Labor Deterrence Act, also titled "Harkin bill," was proposed in the United

States Congress. The goal of this bill was to ban all imports of goods from countries where the production process is related partially or completely to child labor.

In developing countries, however, the situation of child labor is more complicated. Child labors contribute significantly to the incomes of households. Some children work at home, or at their parents' farmland. The majority of them, on the other hand, work outside their home villages or towns. The jobs that they take vary from coal mining to carpet making. Incomes from children constitute a large part of the total income for some households.

Child labor contributes significantly to poverty though, in itself, it is widely believed to be a product of poverty. Most of the countries with pervasive child labor practice are also those that lack formal arrangements for social security. In many developing countries, children are usually not only regarded as productive assets, but also a source of old age support for their parents. However, a significant part of child labors often work in hazardous environments, where they face high risks of accidents and injuries. Once injured in an accident, the children's families are affected negatively, since their families would have to bear all the subsequent financial burdens: loss of important income sources as well as old age support. These compounding effects mean that the child labor is often the cause of poverty.

Theories on Determinants of Child Labor

Several factors have been mentioned as driving forces to the existence of child labor. On the supply side, poverty has been widely recognized as the leading force of child labor. In addition, incomplete capital market is also believed to contribute to child labor.

On the demand side, technological changes and globalization are widely believed to have important impact on the demand for child labor. Technological changes can either increase or decrease the demand for child labor by influencing the relative productivity between capital and child labor. Globalization, as argued by some scholars, may increase the demand on child labor. Lower communication costs and cheaper transportation bills are driving developing economies to specialize in labor intensive industries where their comparative advantages lie. This in turn results in higher demand for unskilled labor. The demand on child labor that is typically unskilled therefore increases as a consequence. The study on the determinants of child labor can be conducted through another perspective. For example, the decisions on choosing child labor or schooling are essentially made by parents, and interests of parents may be in conflict with those of the children. If we model parents as agents and children as principals, the issues on child labor can be studies from the perspective of agency theory.

Numerous articles have been written from the perspectives we mentioned above as efforts to understand the determinants of child labor. In what follows, I give a brief summary of the literature. A more detailed account of various aspects of child labor may be found in Basu and Van (1998), Lopez-Calve (2001), and Brown et al. (2003).

Poverty and Child Labor

As mentioned above, a widely observed fact is that there exists a negative relationship between child labor and GDP per capita. A natural step is to treat child labor as an undesirable consequence of poverty (Basu and Van 1998; Eswaran 1996). For example, Basu and Van (1998) first argue that households send their children to work only if parents' income is lower than the subsistence level with which the households can

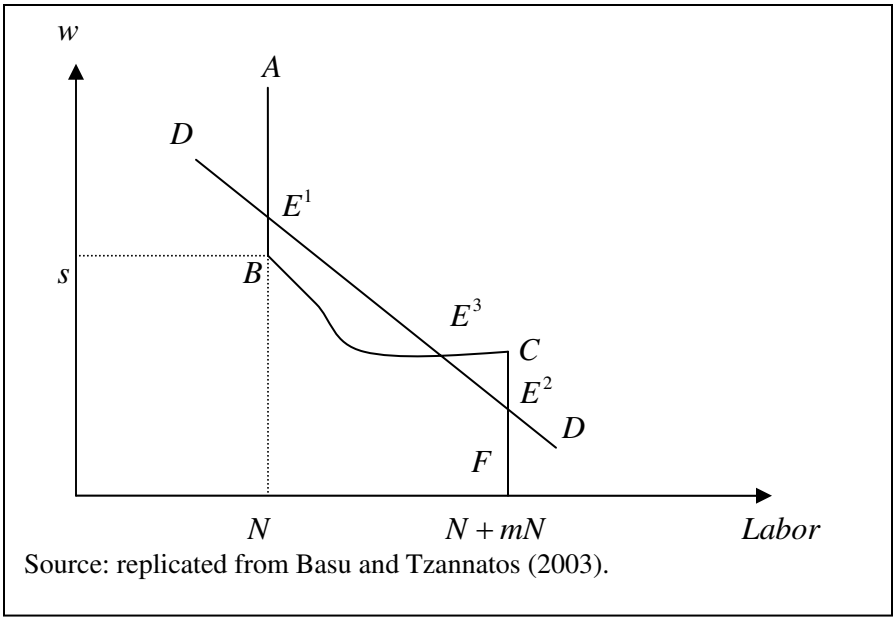
survive. This is the so-called "subsistence hypothesis" (Nielsen and Dubey 2002). In other words, child labor is highly sensitive to changes in household incomes. The only reason for child labor is the poverty of the households. And child labor would be withdrawn from the labor market if income increases to a point at which a household can survive without support from the earnings made by the children. In Basu and Van (1998), costs and benefits should have no role to play in the determination of child labor or schooling.

Basu and Van (1998) observe three important phenomena about child labor. First, child labor is highly related to poverty. Second, child labor can be used to substitute for unskilled adult labor. And third, education is a good that most parents would like their children to consume, if they can afford it. In Basu and Van (1998), schooling and leisure are assumed as luxury goods. Education can only be consumed when the adult income is high enough in a household. When adult labor cannot earn enough income, or for some reasons the household falls into poverty, a child is forced to do work in the labor market in order to help the household to survive.

Let us look at the model in Basu and Van (1998). Assume that there are N households in an economy. And each and every household consists of one adult and m children. In addition, the production process is assumed to use labor as the only input. To capture the substitution effect between child and adult labor, they assume that each adult can provide one unit of labor for a working day. The amount of labor that each child can provide is γ unit, where $\gamma < 1$. The wage rates are w and w^c for adult and child labor respectively. At equilibrium, we have $w^c = \gamma w$. The child labor can be used to substitute for adult labor. They call this "substitution axiom."

The household is assumed to behave in the following ways. The adult labor works for full days. If the household consumption level is under a level called "subsistence consumption," s, children will be sent to labor market to earn additional earnings. They call this property "luxury axiom."

Figure 1. Effect of Subsistence Consumption on Child Labor



Source: replicated from Basu and Tzannatos (2003).

In Figure 1, the vertical axis is the adult wage w and the horizontal axis is the labor supply. The adult labor is assumed inelastic, so line AB is the labor supply when household consumption level is higher than the subsistence level, s. When consumption level is lower than s, children begin to work in labor market so total labor supply starts to increase until $N + mN$ is reached. So in Figure 1, curve ABCF is the labor supply curve in this economy.

When a standard labor demand schedule is added into Figure 1, there are three equilibria in the labor market, E^1, E^2 and E^3. The equilibrium at E^3 is not stable. We are in particular interested in the other two. At E^1, the adult wage rate is high and there is no child labor since schooling or child leisure are affordable for households. At E^2, the adult wage rate is low and many children are driven to the labor market.

Two important policy implications can be derived from Basu and Van (1998). First, as they clearly state that "a ban can worsen the condition of the labor households" (Basu and Van 1998). The reason is that, if E^2 is the equilibrium, a ban on child labor may reduce the income level of the households and therefore bring a threat to the survival of the households. Second, if the adult wage is interpreted as the amount of income the households can get by farming land; this model suggests that child labor can be caused by economic shocks in poor economies.

Incomplete Capital Market and Child Labor

As we advanced previously, child labor is believed to be closely related to poverty. Poverty is, at the same time, highly related to economic shocks such as flood, drought, illness etc. Withdrawing children from school and sending them to work is one of the alternative strategies widely used in dealing with risks by households in developing countries (Jacoby and Skoufias 1997). Households may also borrow money in the capital market to deal with shocks. Through borrowing, households can keep their children in school in a crisis. In the future, households can use the returns from education to pay off their debts accumulated. Households can be made better off if the education return is higher than the sum of the principal and the interest. Child labor therefore can be caused by incompleteness in the capital market (Baland and Robinson 2000; Jarafey and Lahiri

2002; Parsons and Goldin 1989; Ranjan 2001). According to this argument, children's time is regarded as an asset. As an asset, children's time can either be used today to earn wage income in the labor market, or be "saved" in school so that children become more productive in the future. The gained productivity will be treated as the return from education. The decision households need to make is therefore an intertemporal choice. By sending children to school, the current income will be lower, since households incur losses in wage rate in the labor market. The benefit is to receive a higher income in the future. By sending a child to the labor market, on the other hand, households receive wage income today but suffer from lower returns in the future since uneducated people generally are less productive and earn incomes at a lower wage rate. In this context, with income shocks, households have to make a decision between borrowing money from capital markets and sending children to the labor market. If the capital market is perfect, an efficient outcome will be realized. If households cannot borrow money freely from capital market, an inefficient outcome can result.

Note that, to some extent, the first two hypotheses about child labor follow the same argument. The "poverty hypothesis" says that households need incomes earned by their children in labor market to make households survive. The second argument essentially says that child labor is a device to smooth out household consumptions. In other words, what the second hypothesis has done is just explicitly pointing out "what" causes child labor in a poor household.

Globalization and Child Labor

Globalization, "the process by which an increasing share of world production is traded internationally, and the productive systems of different countries become

increasingly integrated (Cigno, Rosati, and Guarcello 2002)," is widely regarded as an important component of determinants of child labor. There are several mechanisms through which globalization exert its impacts on the demand or supply of child labor. First, it seems that a higher level of international trade signals a higher degree of globalization. This is associated with a higher income per capita with the poorest also benefiting from a higher degree of globalization (Dollar and Kraay 2002). According to Basu and Van (1998), the income effect may drive down child labor participating rate, since the increased expenditure per capita makes education affordable to households. In addition, globalization is also related to a lower interest rate and a better access to the capital market. A better functioning capital market can put households in a better position to fight economic shocks. This in turn reduces child labor, as argued by Ranjan (2001) and Jafarey and Lahiri (2002).

Globalization, on the other hand, may work in a different direction. The demand for child labor in the labor market critically depends upon wage rate and productivity of unskilled labor. An increase in the demand for child labor drives up wage rate in the labor market, resulting in an increase in child labor. This is because a higher share of children's time will be allocated to labor market since the return from labor market is relatively higher. For example, Krueger (1990) argues that trade liberalization increases the demand on labor in developing countries. This in turn increases wage rate and induce a higher demand for child labor.

The Agency Problem and Child Labor

Note that the decision on schooling or working for children is made by their parents. In addition, the benefit from schooling can only be realized in the future when

children are able to make independent decisions, while the wage earned in the labor market by child labor is under the control of parents today. An agency problem is apparently involved. From this perspective, the key issue is that children can not make credible agreement on whether they are going to share their education returns with their parents in the future.

In many developing countries, children are treated as parents' productive assets. Children are not goods but instruments, similar to bonds or stocks. In other words, they are viewed as assets that can bring back returns in the future (Neher 1972; Nerlove, Razin, and Sadka 1987; Nugent 1985; Schultz 1972; Srinivasan 1988; Willis 1980).

However, without guaranteed children's altruism toward their parents, the financial support the parents can get from their children in the future will be uncertain. One of the effects of uncertainty in children's altruism on parents' behaviors is that the parents invest less than under certain altruism (Chakrabari, Lord, and Rangazas 1993). The capital asset view implicitly assumes that children have altruistic preferences. Otherwise, it would be difficult to explain children's altruistic behaviors. If the parents believe that there will be uncertainty in the future about children's altruism, they may not send their children to school. The rational choice for parents, instead, is to let their children work.

Empirical Findings on Determinants of Child Labor

Empirical Findings on Poverty and Child Labor

Supportive findings

Several empirical studies seem to confirm the relevance of "luxury axiom" and "substitution axiom" to child labor. For example, regarding "luxury axiom," Edmonds

(2005) observes that there is a dramatic decline in the child labor participating rate in Vietnam between 1993 and 1997. The Vietnam economy expanded quickly with an annual rate as high as 9% during that period. According to Basu and Van (1998), quick economic growth and increased expenditure should be helpful for children to run away from labor market. Edmonds finds that 80% of the decline in child labor can be explained by the increased expenditure per capita. This empirical finding is consistent with what Basu and Van (1998) predicts.

Using data collected from Tanzania, Jensen and Nielsen (1997) find evidence supportive to the "luxury axiom" (Jensen and Nielsen 1997). Using data on sub-African areas collected by ILO, Admassie (2002) tests empirically the poverty hypothesis. He finds that the relationship between child labor and poverty is negative and significant. Edmonds and Pavcnik (2006)'s empirical results show that the positive effect of openness on reduction of child labor is mainly from income effect (Edmonds and Pavcnik 2006).

On the "substitution axiom," an empirical study on child labor in India finds that "child-adult wage ratio affects the distribution of children across different economic activities significantly in all estimations (Nielsen and Dubey 2002)." Ray (2000) finds that higher wage rate for adults reduced child labor in Peru, but not in Pakistan. These findings are inconsistent with the poverty hypothesis.

On the role poverty plays in determining child labor, using data in Indonesia, one study finds that "there are some dimensions of child labor which are not related to poverty" (Pyriambada, Suryahadi, and Sumarto 2002). Ray (2002), based on evidence from Ghana, clearly rejects the presence of a causal relationship between poverty and child labor. Furthermore, Bhalatro and Heady (2003) find that children in land-rich

households are more likely to work than children in land-poor households. In addition, Swaminathan (1998) finds that the magnitude of child labor increases with economic growth in West India. All these suggest that, as Deb and Rosati (2004) point out; "substantial unobserved heterogeneity and a general lack of significant explanatory power from income, wealth and credit availability" are still problems that need to be resolved in the study of child labor.

The Empirical Findings on Incomplete Capital Market and Child Labor

Regarding the incomplete capital market hypothesis, empirical studies show that child labor can be partly explained by imperfect function of capital market (Beegle, Dehejia, and Gatti 2003; Guarcello, Mealli, and Rosati 2003). Jensen and Nielson (1997) also find that savings and assets have significant impact on school attendance (Jensen and Nielsen 1997).

The Empirical Findings on Globalization and Child Labor

Edmonds and Pavcnik (2006) test empirically the relationship between trade and child labor. Their findings show that there is a negative relationship between child labor and openness. For example, a 10% increase in openness is related to a 7% decline in child labor participating rate. They also show that openness is particularly helpful in reducing child labor in poorer countries.

Neumayer and Soysa (2005) empirically test the impact of FDI on the incidence of child labor. Their results show that "Both trade openness and the stocks of FDI per GDP are highly significant and negatively associated with the labor force participating rate of children (Neumayer and de Soysa 2005)."

The Empirical Findings on Agency Problem and Child Labor

The empirical studies on agency problem and child labor are relatively less abundant. The existing studies seem to confirm that there are some roles that agency problem plays. For example, empirical evidence shows that there exists a so-called "gender gap" puzzle (Alderman and King 1998). The education return is almost the same, especially for female and male children who attend primary schools only; however, there is a huge gap between the school attendance rate for girls and boys. For example, Psacharopouslos and Tzannatos (1992) show that the ratio of female to male wages in 14 Latin American countries was low and varied significantly. The mean value of this ratio is 65% with the lowest of 57.4% in Uruguay and the highest of 85.6% in Mexico. This "gender-gap" is explained by a hypothesis that girls in developing countries will become members of other families after they get married.

A Simple Dynamic Framework on Child Labor

The studies mentioned above are useful in understanding child labor, though there are still several important issues that remain unsolved. For example, if child labor is caused by poverty, how do we explain the coexistence of poverty and schooling? A more difficult question is that the observed existence of child labor in a rich household that apparently can afford education but does not choose to do so. In addition, how do we understand the observed "gender gap"?

We believe that the answer to these questions lies in the development of a more balanced model. On child labor, the decision of whether or not to send their children aged between 5 and 15 to work is made by the parents. It is therefore useful to understand how parents make such decisions. A reasonable assumption to be made in this context is that

the parents need old age support from their children. This is based on the fact that, in developing countries, 95% of the child labor takes place where formal pension systems notoriously fail to work.

In this study, we follow the idea that a child is regarded as a financial asset to the parents. If a child stays in school, the child can study some disciplines or learn certain skills. Alternatively, a child may drop out of school and join the labor force. Though there are immediate gains by sending their children to work, the parents realize potential higher returns from education in the future: educated human capital is more productive in the future than the uneducated, and thus commanding a higher income. When making decisions on a child's education, namely, keeping the child in school or sending him to the labor market, the parents weigh the costs and benefits of education. This is a standard problem of intertemporal allocation of economic resources.

The remainder of this dissertation is composed of four chapters. We first develop a dynamic model through which we can examine the impacts of several important variables in Chapter 2. As we mentioned above, if the decision parents make is optimal, the time of children, as an economic resource, should be optimally allocated between two competing uses: working in labor market or schooling. The benefit from schooling, knowledge accumulated, should be balanced, at the margin, against the opportunity costs of schooling. In our model, studying at school, the costs incurred consist of the forgone wage rate in the labor market and the related fees paid to school.

Our simple model allows us to tackle the observed two puzzles. We know that the framework developed by Basu and Van (1998) is unable to explain not only the coexistence of poverty and schooling, but also child labor in rich households. We show in

Chapter 3 that, again, the allocation of children's time is determined by the relative returns from schooling and child labor. Our analysis in this chapter suggests that children who stay in school must be very productive in learning. Children who provide child labor in a rich household are those either unproductive in schooling, or specialized in the production activities which are important in the future earnings.

In Chapter 4, we try to understand the failure of governmental interventions in fighting child labor. We analyze why traditional public policy tools, such as child labor law or compulsory education law, fail to reduce child labor or promote schooling. We also show that the transition from these traditional measures to incentive programs could be a good strategy in fighting child labor.

And Chapter 5 concludes this study.

CHAPTER 2. AN ECONOMIC MODEL OF CHILD LABOR

Time of the Child Is an Important Resource for Parents

Knowledge accumulation and child labor are negatively related. As we discussed earlier, the time of a child can be put into two purposes. The time a child owns is limited for each and every child and only part of their time can be used to study in school or work in the labor market. In most of the developing countries, households live in different villages. It is rare that every village has an elementary school, not to mention a middle school. The general case is that several villages share an elementary school. Children go to school and go back home by foot on every school day. Every day can be divided into two sections, morning and afternoon. During the non-school time, children usually give a hand to their parents, doing various jobs such as babysitting, food-making, working on farms, and etc. Sometimes, children are required to help parents to do farming work. For example, during the planting and harvesting seasons, children may need to stop attending school and allocate more time to farming activities since, farming is very sensitive to season and weather change in most agricultural societies.

The children aged 5 to14 years, as laborers, help their parents a lot by either going out or working at labor markets, staying at home to do housework, or working on the farmland. First, children are important income earners in many households in developing countries. As the ILO data show, there are many children actively working in the regular industries ranging from mining to carpet making. The incomes children earn not only are important sources of family income, but also function as risk reduction. Since the income

from land depends greatly on weather condition and are essentially highly unstable, the income the children bring back from work can hedge the income from farming. Second, children can take many responsibilities within the family. For example, children can take care of the elderly and the infants in the family; they also can prepare food for the adults who are working in the fields. These home-nursing type of jobs are in general commercialized in advanced countries, but are still an important part of home production in developing economies. Third, children can work in the field even though their productivity may be lower compared with adults. Most of the field productions are not hard to learn and usually require a lot of labor input. With guidance and instructions, children can do a good job in planting and harvesting. This means a lot to the parents because, in agricultural communities, the outputs are mainly determined by labor inputs.

The aforementioned uses of children's time may not be optimal for parents though. Alternatively, the children can go to school and acquire knowledge and skills. In most of the developing countries, same as in developed societies, the school system consists of three levels, namely, elementary, middle and tertiary school. In this study, child labor is defined as a working child who is less than 15 years old. Our study, therefore, focuses on children's schooling behaviors at the elementary and junior middle levels only. Schooling surely means a lot to children, i.e., they can make friends, become knowledgeable, etc. What concerns us, however, is how to make the children more productive in the future. The term "being more productive" is defined as the children making higher salaries or becoming more productive in farming the land than those who do not attend schools. In other words, the benefit from education in this model is measured in economic value only, though we fully recognize the value of education in terms of non-economic achievements.

Apparently, the schooling and working compete with each other for the time of a child. If the child spends more time in school, less time can be used to help his parents in taking care of the household's members or farming land. If the child spends more time at home or land, less time can be used in schooling. The allocation of the time therefore depends on the benefits related to the two economic activities.

Model Settings

The Knowledge Accumulation Function

The knowledge accumulation is a function of the time the child allocates to schooling and the child's ability to study. The knowledge the child owns is therefore jointly determined by the time allocated to schooling and his talent. On the one hand, if the child does not go to school, then his knowledge level will be non-increasing since the child does not have a chance to be exposed to knowledge or skills. On the other hand, if the child spends some time in school, the knowledge production function works in a way that the knowledge increases along time input at a decreasing rate.

The impact of these two factors on the growth of knowledge, s can be captured by the following function, $s = g(\alpha, q)$, where α is child's time going to school and q is the talent the child has. In this way, we define knowledge as a function of talent and the time invested in studying.

The Benefit from Child Labor

In our model, we measure all the benefits the parents receive from sending their children to the labor market by wages. This is suitable for the case in which the child works in the labor market and earns a competitive wage rate, w, as in the model. For simplicity, we also assume that the parents receive a shadow rate w when the child works

at home or farm land. In other words, when the parents enjoy some leisure because some tasks are undertaken by the child, the benefit they get is measured by the wage rate w and the time the child spends in the tasks.

The Benefit from Schooling

As shown in numerous studies, the return from schooling is high in developing countries. For example, study shows that the returns to all levels of education are much higher than that of physical capital (Psacharopoulos 1994). What determines the high rate of return from schooling is the increased knowledge which makes the child more productive as input in the process of production.

The knowledge or the skills the child learns in school make the child able to earn a higher wage rate in the labor market since, as we mentioned above, his productivity is higher than those relatively less educated. In a primitive economy, little gain can be realized by schooling. This is because the demand on educated labor is small given that agricultural production is not complicated. In an advanced economy, the basic education is a prerequisite to obtain qualification of entering the labor market because it is hard for illiterate people to find jobs. The schooling therefore has been increasingly important as the economies move to an advanced stage. In this study, we assume that the schooling does contribute to the improvement in productivity of a child when he becomes an adult.

The Trade-Off between Schooling and Child Labor

As we noted before, there is a cash flow going into the family as the child stays in the labor market. The benefits, however, are by no means free since the child has to be kept away from schooling in order to make such benefits. In other words, the parents can harvest benefits today by paying a cost such that the child will be less productive than an

educated counterpart in the future. On the other hand, if the child stays at school mastering knowledge or developing skills, the forgone cost is the wage rate in the child labor market. The net benefit from schooling in the future labor market is the opportunity cost of child labor at the current time.

To summarize, at the early age of a child, the parents need to make a decision on keeping the child in school or sending him to the labor market. This decision is determined by the benefits and costs of the two alternative uses of the child's time. If there is no future benefit from education, the parents have no reason to keep the child in school. This is the case we may observe in a primitive economy. The future benefit, however, is not a guarantee for schooling. This is because in the future, the parents may not be able to obtain the benefit from their child's education. We know that the child will become an adult and make decisions independently though he may consult his parents under some contexts.

The Relationship between Parents and the Child

The parents correctively expect that the decision-making on the return from education will be shifted to the child from their hands in the future. This expectation has an important impact on the parents' behaviors. If the parents are certain that they will be supported by their child or the child has altruistic preference, they expect that they will be able to harvest the benefit from schooling. In other words, keeping a child in school can be treated as an investment. The parents can collect all the money earned by the child in the labor market and deposit it into a bank. The parents will claim the principal and interests when they become old. Alternatively, the parents may choose to keep the child in school to be trained. The educated child will be more productive in the future labor

market. If the parents are selfish, the child can go to school if and only if their share from the educated child's income is no less than the principal and interests from the earnings of the child make from the labor market. If the parents believe that the child will not support them in the future, they will not support the child to stay at school since the value of the knowledge the child acquires is zero for the parents in the future.

The Basic Model

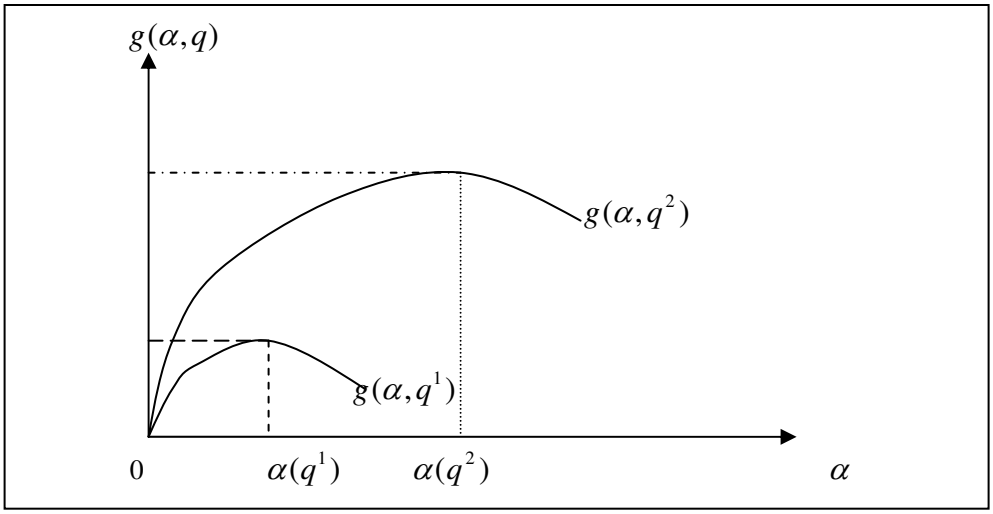
In this section, we use a simple model to examine how the parents make their decision on allocating the child's time. There are two types of agents in our model: the parents and the child. There are periods in our model: $t = 1,2$. During period 1, the child is unable to make any important decisions. During period 2, however, the child is able to make all important decisions by himself.

We normalize the time of child to 1. The time of the child goes either to schooling or the labor market. As we mentioned earlier, the child's knowledge, s, accumulates according to the function $s = g(\alpha, q)$, where α is the child's schooling time and q is the quality of the child's talent. This function is assumed to have the following properties: $g'_{\alpha} > 0,\ g''_{\alpha} < 0$ and $g'_{q} > 0,\ g''_{q} < 0$.

We also assume that $g''_{\alpha,q} > 0$, this is an intuitively appealing property reflecting a more talented child learns more quickly than a less talented child learns. Our assumptions have two important implications. First, for any given time allocated to study, we have $s^{q_1} = g(\overline{\alpha}, q^1) < s^{q_2} = g(\overline{\alpha}, q^2)$ if $q^1 < q^2$. This is illustrated in the following Figure 2. Second, $g'_{\alpha}(\alpha, q^1) < g'_{\alpha}(\alpha, q^2)$ holds if $q^1 < q^2$. In particular, if $g'_{\alpha}(\alpha^1, q^1) = g'_{\alpha}(\alpha^2, q^2) = 0$, then, $\alpha^1 < \alpha^2$ and therefore $g(\alpha^1, q) < g(\alpha^2, q)$.

This is also illustrated in Figure 2. Each and every point of α, the knowledge production function of a more talented child, $g(\alpha, q^2)$, grows faster than that of a less talented child, $g(\alpha, q^1)$. In addition, the former reaches its maximum value with a larger share of time allocated to study than the latter.

Figure 2. Qualities of Talent and Knowledge Growth Function



As we discussed earlier, the accumulated knowledge will make the child more productive in the future labor market. We assume the wage rate in the second period is determined by the knowledge accumulated, s in the first period. The wage level, w_2, of the second period takes a form $F(s)$. Note that $s = g(\alpha, q)$

therefore $w_2 = F(s) = F[g(\alpha, q)]$. We assume that $F' > 0$ and $F'' \leq 0$ reflecting a positive relationship between w_2 and the accumulated knowledge.

Schooling is by no means free since, first, in most of developing counties the parents need to pay a tuition fee, c . What's more, there is an opportunity cost. The forgone cost if a child goes to school is the wage rate in labor market, w_1.

For the parents, the return from period 2 is discounted by a parameter, $\delta \in [0,1]$, which measures time preference of parents. If $\delta = 1$, the parents treat the future income and present income equally, and if $\delta = 0$, the future income means nothing for them. In addition, we use a parameter θ, measuring the degree of altruism of the child toward his parents, to capture the share of wage rate w_2 returning to the parents. If $\theta = 1$, all the income the child makes goes to the pocket of the parents. If $\theta = 0$, the parents receive no future income from their child.

The net benefit function that the parents face is

$$(1) \qquad w_1 - (w_1 + c)\alpha + \delta\theta w_2$$

where $w_2 = F(s) = F(g(\alpha, q))$. In the following analysis, we assume that there is a linear relationship between w_2 and the knowledge level of s [1]. Therefore, the parents' problem becomes

$$(2) \qquad \underset{\alpha}{Max} : w_1 - (w_1 + c)\alpha + \delta\theta g(\alpha, q)$$

s.t.

$$(3) \qquad \alpha - 1 \le 0$$

$$(4) \qquad -\alpha \le 0$$

The solution to the above problem is summarized by the following proposition.

Proposition 2, 1: Let q be given, the solution, α^*, to problem (2) is characterized as follows:

[1] Results obtained in this chapter will not change if F is assumed to be strictly concave in s .

$(i), \alpha^* = 0,$ if and only if $\frac{\partial g(0,q)}{\partial \alpha} \leq \frac{w_1 + c}{\delta \cdot \theta}$;

$(ii), \alpha^* = 1,$ if and only if $\frac{\partial g(1,q)}{\partial \alpha} \geq \frac{w_1 + c}{\delta \cdot \theta}$;

$(iii), 0 < \alpha^* < 1,$ if and only if $\frac{\partial g(1,q)}{\partial \alpha} < \frac{w_1 + c}{\delta \cdot \theta} < \frac{\partial g(0,q)}{\partial \alpha}$.

Before we present a proof of proposition 2, 1, we first bring forth an intuitive discussion of the solution and possible policy implications of this result. .

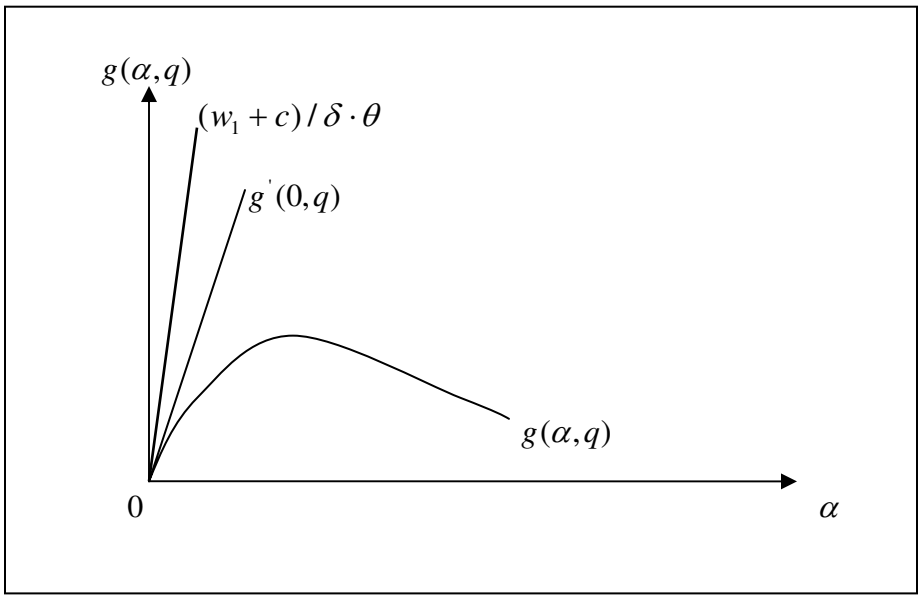
For (i) of Proposition 2, 1, we first note that $\frac{\partial g(0,q)}{\partial \alpha} \leq \frac{w_1 + c}{\delta \cdot \theta}$ is the necessary condition for $\alpha^* = 0$. When all time of the child goes to the labor market, this condition must hold. To achieve $\alpha^* = 0$, the marginal benefit from education should be smaller than the forgone costs. Otherwise, the household could be better off by reallocating the time between labor market and schooling.

Note that $\frac{\partial g(0,q)}{\partial \alpha} \leq \frac{w_1 + c}{\delta \cdot \theta}$ is also the sufficient condition for the household to choose $\alpha^* = 0$. Given knowledge growth function is concave and strictly increasing, for all $\alpha > 0$, we have $\frac{\partial g(\alpha,q)}{\partial \alpha} < \frac{\partial g(0,q)}{\partial \alpha} \leq \frac{w_1 + c}{\delta \cdot \theta}$. This guarantees that the household chooses $\alpha^* = 0$ since the profit is maximized in this case. In other words, at $\alpha = 0$, the growth function increases at the greatest rate. The growth rate of knowledge is decreasing as α increases. We know that at $\alpha = 0$, the benefit from education is smaller than its forgone cost, $\frac{(w_1 + c)}{\delta \cdot \theta}$. For all $\alpha > 0$, the benefit, smaller than that of $\alpha = 0$, will be smaller than the forgone cost. For example, let's assume

$g'(0,q) = 100$ and $(w_1 + c)/\delta \cdot \theta = 150$, which apparently satisfy condition (9). And the household's choice is $\alpha = 0$. If there is a small increase in schooling time, say, $\varepsilon > 0$, we must have $g'(\varepsilon, q) < 100$ since the function is concave. The increase in schooling time means a loss. The household therefore would prefer $\alpha = 0$ rather than $\alpha = \varepsilon$.

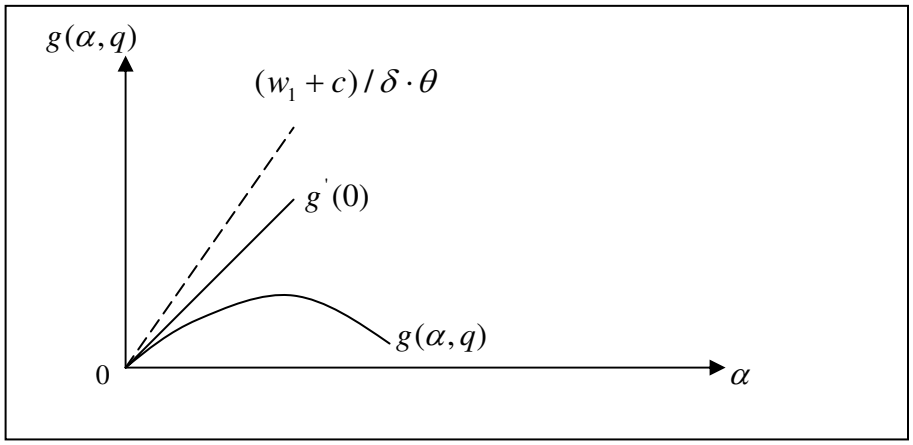
Note that it's the relative returns determine the allocation of the child' time. There are basically two cases satisfying condition (8). The first case is that the growth rate of knowledge function is big. This means that the child is smart. There will be considerable return from education if the child goes to school. The forgone cost, $\frac{(w_1 + c)}{\delta \cdot \theta}$, is even bigger however. For example, in Figure 3, the growth rate, $\frac{\partial g(0,q)}{\partial \alpha}$, is not small. This benefit, however, is not big enough to compensate for the loss in opportunity cost. The resource, the time of the child, should be allocated to labor market since the benefit is relatively higher than that of schooling.

Figure 3. Child Labor: Caused by High Opportunity Costs



Another case is that the small forgone costs do not guarantee schooling. In the following diagram, we can see that, the opportunity costs are low. The marginal benefit from education, however, is even smaller (see Figure 4).

Figure 4. Child Labor: Caused by Low Education Returns



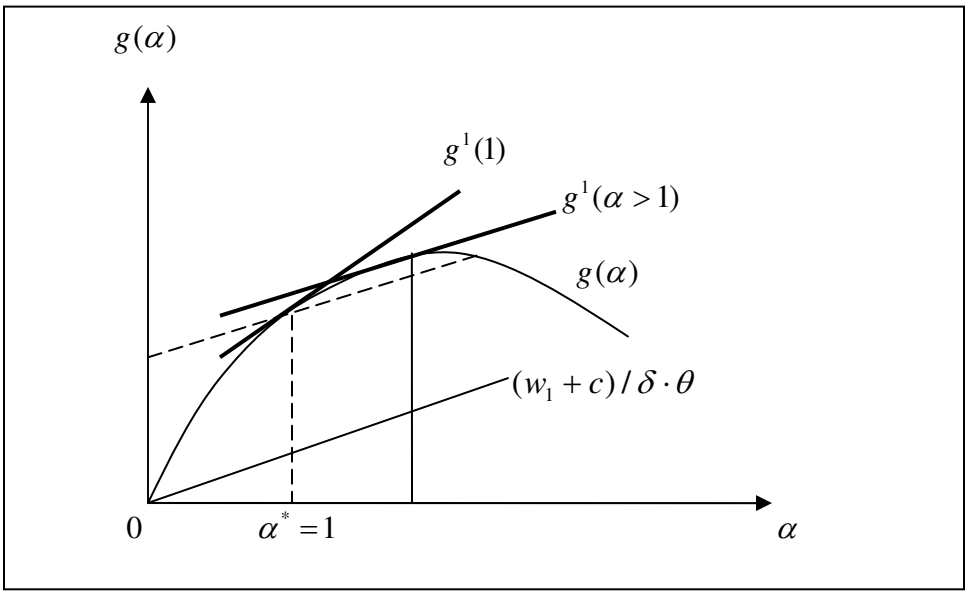
Some policy implications can be derived from this discussion. For example, in the first case, if the wage rate in labor market is high or the school fees are high, even smartest child may be attracted out of school and enter labor market. On the other hand, even if the wage rate in labor market and school fees are low, the child labor may appear since the return from schooling is even smaller. Imagine in an extreme case, where both of school fees and wage rate are zero, the household may not choose to send the child to school if the benefit from school is extremely low.

Regarding (ii) of Proposition 2, 1, we first note that $\frac{\partial g(1,q)}{\partial \alpha} \geq \frac{w_1 + c}{\delta \cdot \theta}$ is the necessary condition for $\alpha = 1$. This is because, to make $\alpha = 1$, the benefit when all time is devoted to schooling should not be smaller than its forgone cost, wage rate in labor

market plus school fees. Otherwise, the household can be better off by reducing the amount of the child's time allocated into schooling and increasing the time in labor market. By doing so, the benefit from education in the second period does not change, while the household's income in the first period will increase since more time allocated to labor market and the wage income should be higher.

Note that $\frac{\partial g(1,q)}{\partial \alpha} \geq \frac{w_1 + c}{\delta \cdot \theta}$ is also the sufficient condition for $\alpha = 1$. Given knowledge growth function is concave and strictly increasing, for all $\alpha < 1$, we have $\frac{\partial g(\alpha,q)}{\partial \alpha} > \frac{\partial g(1,q)}{\partial \alpha} > \frac{(w_1 + c)}{\delta \cdot \theta}$. This guarantees that the household chooses $\alpha = 1$ since the profit is maximized in this case. For example, for any value of $\alpha < 1$, a small increase in schooling time $\varepsilon > 0$ will make the household better off since from $\frac{\partial g(1,q)}{\partial \alpha} \geq \frac{w_1 + c}{\delta \cdot \theta}$, we have $\varepsilon \cdot \frac{\partial g(1,q)}{\partial \alpha} \geq \varepsilon \cdot \frac{w_1 + c}{\delta \cdot \theta}$. Note that the LHS is the marginal benefit of one more unit of schooling time and the RHS is the marginal cost incurred by spending additional unit of time at school.

Figure 5. Full-time Schooling, High Education Returns

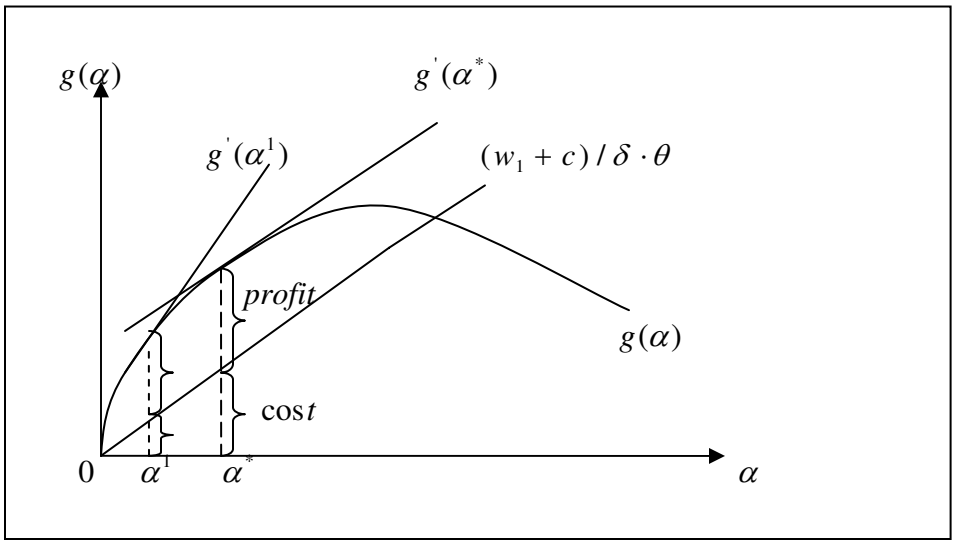


In Figure 5, we assume that the knowledge growth function is increasing even at point $\alpha = 1$.For example, $g'(1) > 0$ implies that $\alpha = 1$ is located on the left side of $\alpha > 1$ where $g'(\alpha) = 0$. Apparently, the household is forced to choose $\alpha = 1$ since the point where marginal cost equalizes marginal benefit is just unattainable. In the above diagram, at point $\alpha = 1$, the marginal benefit is bigger than marginal cost. This can be easily observed in the diagram. At $\alpha = 1$, $\frac{\partial g(1,q)}{\partial \alpha} > \frac{(w_1 + c)}{\delta \cdot \theta}$. To make these two equal, given the marginal cost is fixed, a bigger α is necessary to make $\frac{\partial g(\alpha,q)}{\partial \alpha}$ smaller. In the diagram, this requires that $\frac{\partial g(\alpha,q)}{\partial \alpha}$ become flatter. For example, $g^1(\alpha > 1)$. Which is

smaller than $g'_{\alpha}(1)$ which has same slope as that of $\frac{(w_1 + c)}{\delta \cdot \theta}$. This is, however, unattainable since total time the child possesses is 1.

Regarding (iii) of Proposition 2, 1, we first note that $\frac{\partial g(1,q)}{\partial \alpha} < \frac{w_1 + c}{\delta \cdot \theta} < \frac{\partial g(0,q)}{\partial \alpha}$ is the necessary condition for the optimal solution α^*. At the optimum α^*, the marginal benefit is equal to the marginal cost. The specific value of α depends on the value of $\frac{w_1 + c}{\delta \cdot \theta}$, located in the range $(\frac{\partial g(1,q)}{\partial \alpha}, \frac{\partial g(0,q)}{\partial \alpha})$. At equilibrium, the household cannot be better off by changing the allocation of time between schooling and working in the labor market. For example, if the growth rate is higher than the marginal cost, the household can allocate more time to schooling. The growth rate will become smaller given the growth function is concave. In this case, the household will be surely better off. In addition, it's easy to get that $\frac{\partial g(1,q)}{\partial \alpha} < \frac{w_1 + c}{\delta \cdot \theta} < \frac{\partial g(0,q)}{\partial \alpha}$, which is also the sufficient condition for optimal choice α^*.

Figure 6. An Illustration on the Allocation of Time



Apparently, in Figure 6, α^1 is not the optimal choice since at that point the marginal benefit is bigger than the marginal cost $\frac{w_1 + c}{\delta \cdot \theta}$. One more unit of time would therefore make households better off. All choice of α is inefficient until the optimal value of α^* is reached where marginal benefit equalizes marginal cost.

Comparative Statistics Analysis

In the previous section, we characterized the solution to the parents' problem and presented an intuitive discussion of the solution and its policy implications. We further exemplify in the following that exogenous variables vary across households and regions, and that they are subject to changes as time goes on. How do they affect optimal choice made by the parents? We notice that the parents' optimal choice of α depends on several factors such as wage rate w_1, school fees c, the discount factor δ, and the degree of a child's altruism toward his parents θ.

In this section, we examine how various such aforementioned factors may impact on the optimal choice of α^* by the parents.

To study the impact of exogenous variables on parents' choice on the allocation of child's time, we focus on the interior solution and totally differentiate equation, (10), $\delta \cdot \theta \cdot g_{\alpha}^{'}(\alpha, q) = w_1 + c$ to obtain the following:

$$(11) \qquad \theta \cdot g_{\alpha}^{'}(\alpha, q) \cdot d\delta + \delta \cdot g_{\alpha}^{'}(\alpha, q) \cdot d\theta + \delta \cdot \theta \cdot g_{\alpha}^{''}(\alpha, q) d\alpha + \delta \cdot \theta \cdot g_{q}^{''}(\alpha, q) dq = dw_1 + dc$$

Effects of Wage Rate w_1 ***On*** α^*

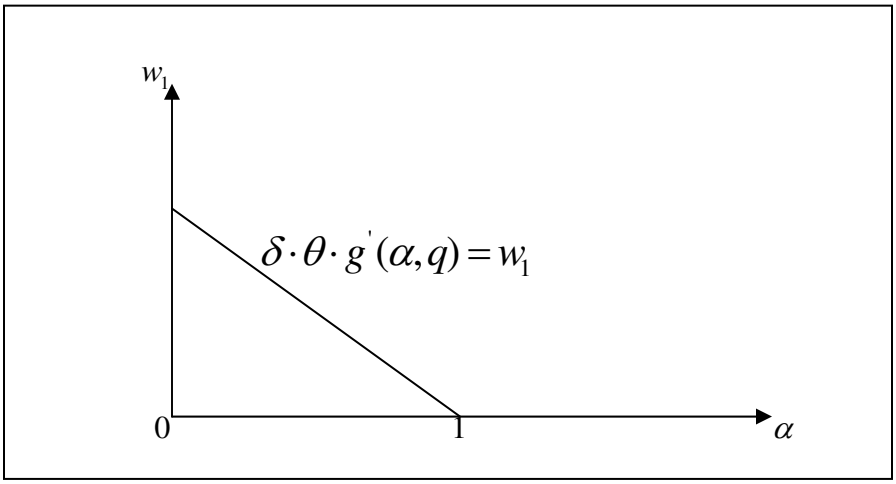
We first examine the impact of wage rate in the labor market, w_1, on the optimal α.

Proposition 2, 2, there exists a negative relationship between the wage rate, w_1 and the optimal choice of a child's time allocated to study in school.

This result can be easily derived from the above equation. To examine the impact of wage rate w_1 on α^*, we note that $\frac{d\alpha^*}{dw_1} = \frac{1}{\delta \cdot \vartheta \cdot g''_\alpha(\alpha, q)}$. From our assumption, $g''_\alpha(\alpha, q) < 0$. Note that both δ and θ are positive, so we must have $\frac{d\alpha^*}{dw_1} < 0$. This implies that when wage rate in labor market increases, the optimal time allocated to study will decrease, given other factors unchanged.

Proposition 2, 2 is illustrated in Figure 7. Given other factors remain unchanged, a higher wage rate w_1 would result in a smaller α.

Figure 7. Wage Rate and Schooling Time



This is not a surprising result and is consistent with conclusions in the existing literature (Nielsen and Dubey 2002). In our model, the time of a child is treated as an

asset and can be invested into two "markets." If it goes to labor market, as we discussed earlier, the return is the wage rate in labor market; and if it goes to school, then the return is the potential increase in the future productivity of an educated child. At equilibrium, the returns from these two should be equalized. An increase in wage rate in labor market makes the education relatively unattractive. As a consequence, more time will be mobilized out of education and allocated into labor market.

The empirical studies showing a negative relationship between wage rate in the labor market and schooling time have been widely observed in many developing countries. Duryea and Arends-Kuenning (2003) find that, in Brazil, "an increase in the state average wage of less skilled men is associated with a significant decrease in the probability of attending school (p. 1174)." This finding is seemingly consistent with our conclusion. In India, Nelson and Debry (2002) conclude that a 10% increases in the wage rate of child-adult labor would lead to a 5% of the 5-9 years old and 2% of the 10-14 years old children being withdrawn from schooling. Blinder and Scrogin (1999), in a study on child labor and wage rate in Mexico, conclude that "the likelihood of working in the labor force increases with the child's predicted wage."

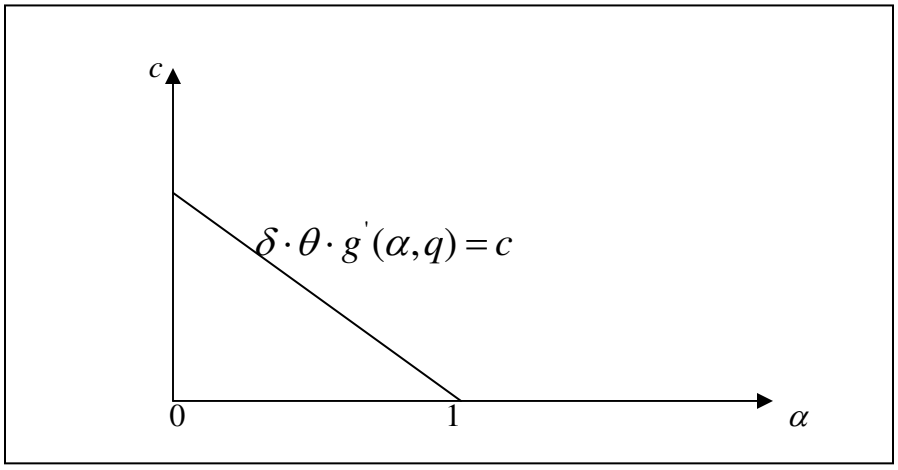
Effects of Tuition Fee c On α^*

The impact of an increase in tuition fee on the optimal schooling time is summarized in the following proposition.

Proposition 2, 3, there exists a negative relationship between the optimal schooling time and tuition fee.

From equation (11), we obtain $\frac{d\alpha^*}{dc} = \frac{1}{\delta \cdot \vartheta \cdot g''_\alpha(\alpha, q)}$. Since both δ and θ are positive, and $g''_\alpha < 0$, we have $\frac{d\alpha^*}{dc} < 0$. This negative relationship between tuition fee and schooling time can be illustrated in Figure 8.

Figure 8. School Fees and Schooling Time



Tuition fee in our model is the price that the household needs to pay as an exchange of being able to study at school. An increase in tuition fee makes the education more expensive and reduces the net return to education. Given that other factors remain unchanged, a reduction in net return from education makes education less attractive. In this regard, a change in tuition fee has the same impact on the optimal allocation of time of the child as a change in wage rate. The two factors, however, work in different ways, and therefore have different policy implications.

The negative relationship between school fee and schooling time is consistent with empirical studies. The empirical findings in Bellew and King (1993) show that

lower school fee contributed to most of the increased enrollment rates in a region of Bangladesh. In 1982, before the implementation of free education plan for girls, the girls' enrollment rate in the experiment area was 27%, which was almost the same as the national average. In 1987, the girls' enrollment rate in the experiment area increased to 44%, doubling the national average (Bellew and King 1993).

Another example is presented in related education in China. Brown and Park (2002)'s study shows that, in rural China, a household needs to pay 550 Yuan for two children, one in primary school and the other in lower-secondary school. The school fee accounts for 50% of expenditure per capita in the areas they surveyed (Brown and Park 2002). They find that, except for those of being dropped out from schools, parents of 47% girls and 33% boys attributed the reasons of unable to send their children to school to the failure to pay school fees (Brown and Park 2002).

Several field studies lend their support to our result. For example, a study conducted by Gansu Basic Education Program,[2] which is jointly funded by China and the UK, shows that school fees are a major force driving children out of school (Bray, Ding, and Huang 2004). Starting from 2004, the Chinese Central government initialized an ambitious program, Free Education Plan, which offers free primary education for households in western China. The Chinese government acknowledged that part of the reasons of high dropout rate in rural China is expensive school fees. Only nine western provinces were qualified to receive benefits offered by this free education plan due to limited budget. We may expect that this plan has positive impact on schooling time and it will be a good tool to fight against child labor. There is not yet any empirical evidence supporting this conclusion since the program has only been implemented for two years.

[2] More information on this program can be obtained at http://www.gbep.org/en/.

As we noted earlier, the policy covers only nine western provinces and many of the neighboring provinces are left out. For example, Shannxi is one of the nine provinces that receive category grants from the central government to finance their primary and lower-secondary schools. One of its neighbors, Henan Province, located in middle China, is not qualified for the plan. At the border line along these two provinces, an interesting phenomenon has been observed. In several neighboring communities, households pay different school fees. For households living in Shannxi Province, education is free for all children. On the other hand, households living in Henan Province have to pay school fees in order to receive education services. The difference in payments of school fees, therefore, should have different impacts on schooling time of households, according to our Proposition 2, 3. Our result predicts that the enrollment rate in Shannxi is higher than that of Henan. It would be interesting to see if our results hold empirically should the data becomes available.[3]

The Talent of a Child and the Optimal α^*

The impact of the change in the talent of a child on the optimal schooling time is summarized in the following proposition.

Proposition 2, 4, there exists a positive relationship between schooling time and quality of the talent of a child.

From equation (11), we obtain $\frac{d\alpha^*}{dq} = -\frac{g''_q(\alpha, q)}{g''(\alpha, q)}$. Since $g''_\alpha < 0$ and $g''_q(\alpha, q) > 0$, we must have $\frac{d\alpha^*}{dq} > 0$.

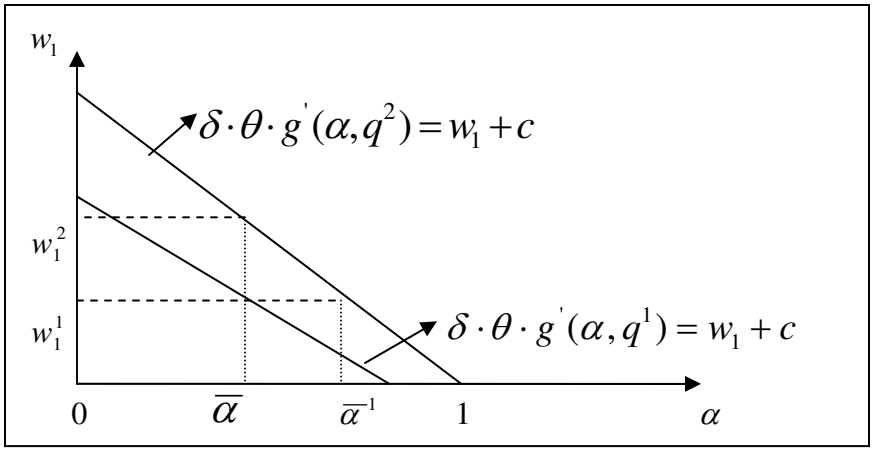
[3] The empirical study can be done by using an estimation strategy called "difference-in-difference". This method has been widely used to examine the impact of compulsory law on school attendance in the U.S. (Angrist and Krueger 1991; Margo and Finegan 1996; Moehling 1999)

From $\frac{d\alpha^*}{dq} > 0$, we can see that an increase in the quality of talent of a child will result in an increase in the allocated time for schooling. This is intuitive: an increase in quality of talent makes each and every unit of time more valuable and therefore makes "investment" in education more profitable. A higher return from schooling time makes education more attractive and child labor less attractive than before. More time will be allocated to schooling when other things remain unchanged.

The difference in the quality of talent, q, matters in determining the growth rate of knowledge. Recall that, for any given unit of time, $\overline{\alpha}$,

$s^{q_1} = g(\overline{\alpha}, q^1) < s^{q_2} = g(\overline{\alpha}, q^2)$ when $q^1 < q^2$.

Figure 9. Qualities of Talent and Schooling Time



From Figure 9, we can see that, when the prevailing wage rate is w_1^1, the optimal time allocated to schooling, given the talent q^1, is $\overline{\alpha}$. When the talent changes, from q^1

to q^2, however, at the same wage rate w_1^1, $\overline{\alpha}$ is no longer optimal. This is because the future benefit of schooling has increased while the cost to schooling remains unchanged. The optimal choice for schooling time must increase from $\overline{\alpha}$ to $\overline{\alpha}^1$, as indicated in the diagram.

The Discounting Factor δ and α^*

The impact of the change in the discounting factor δ on the choice of optimal schooling time is summarized in the following proposition.

Proposition 2, 5, an increase in δ results in an increase in schooling time.

From equation (11), we obtain $\frac{d\alpha^*}{d\delta} = -\frac{g'}{g''}$. We must have $\frac{d\alpha^*}{d\delta} > 0$ since $g'_\alpha > 0$ and $g''_\alpha < 0$.

Note that δ reflects the time preference of the parents. A change in δ reflects a change in the factor by which the parents discount their future benefits. An increase in δ means that parents discount their future benefit less than before. For any given knowledge function, g, an increase in δ from δ_1 to δ_2, means an increase in the benefit from same unit of time. As a consequence, a change in δ has significant impact on the return of schooling time; an increase in δ makes schooling time more attractive. At equilibrium, more time will be allocated to schooling as a response to the increase in the return to schooling.

Child's Altruism towards Their Parents And α^*

The impact of the change in the child's altruism toward their parents on the optimal schooling time α^* is summarized in the following proposition.

Proposition 2. 6, an increase in θ results in an increase in schooling time.

From equation (11), we obtain $\frac{d\alpha^*}{d\theta} = -\frac{g'}{g''}$. We must have $\frac{d\alpha^*}{d\theta} > 0$ since $g'_\alpha > 0$ and $g''_\alpha < 0$.

In our model, θ is the share of the child's future income given to the parents. An increase in θ, will result in a bigger share of the child's earned income going to the parents. From the perspective of the parents, it thus makes schooling more attractive, resulting in allocating more time to schooling.

This result is consistent with the findings by Chakrabarti et al. (1993), which show that uncertainty on children's altruistic preference is negatively related to children's schooling. θ can be interpreted as a measure of altruistic preference of children toward their parents. In one extreme, children do not have any altruistic preference towards their parents, $\theta = 0$ can be interpreted as when the parents receive no benefits from their children. When the value of θ increases, the altruistic preferences of children toward their parents become stronger and stronger.

Concluding Remarks

In this chapter, we model the time of child as an economic resource. We show that at equilibrium, allocation of a child's time between schooling and labor market is determined by factors such as knowledge growth rate, wage rate in labor market, school fees, parents' discount factor and child's altruistic preference toward the parents. This result is summarized in our proposition 2.1. We also analyze how changes in the exogenous variables such as wage rate, school fees etc., affect the schooling time at equilibrium. The results are summarized in our Proposition 2, 2 to Proposition 2, 6. Our

results suggest that, as an economic resource, allocation of a child's time is related to its marginal benefit and marginal costs. The results obtained in this chapter allow us to examine several important issues in later chapters.

CHAPTER 3. POVERTY, CREDIT CONSTRAINT AND CHILD LABOR

Introduction

The theoretical and empirical literature regarding the relationship between poverty and child labor has been accumulating since Basu and Van (1998). In their classic paper, Basu and Van (1998) examine the impact of parents' income on child labor. They assume that the leisure of a child is a luxury good and can only be consumed by households whose incomes are higher than the subsistence level. Parents would send their child to the labor markets if their consumption level is too low. So child labor is explicitly assumed to be a consequence of poverty.

There are two types of empirical findings that are not consistent with what Basu and Van (1998) predict. The first type is that child labor is not only related to poverty, but also in some circumstances associated with the rich. On the role poverty plays in child labor, by using data in Indonesia, one study finds that "there are some dimensions of child labor which are not related to poverty" (Pyriambada, Suryahadi, and Sumarto 2002). Ray (2002), based on evidence from Ghana, clearly denies the presence of a causal relationship between poverty and child labor.

In addition, Andvig (1999) finds that, using ILO statistics, there is only a weak link between GDP per capita and child labor participating rate. According to Andvig (1999), if we use GDP per capita, in term of PPP, there is a huge variation in child labor for countries that are in the same income level. For example, in South African countries including Zambia, Nigeria, Madagascar, Niger and Burkina Faso, GDP per capita is about

800 dollars in every country. However, there are significant differences in child labor participation rates in these countries. The lowest participation rate of child labor in this group is about 15% in Zambia. The rates for Nigeria, Madagascar, and Niger are 25%, 35%, and 45% respectively. The highest rate is greater than 55%; that happens in Burkina Faso. On the other hand, Zimbabwe has a much higher GDP per capita than Zambia. Its child labor participation rate, however, is also higher than that of Zambia.

What's more, some findings show that there is a negative relationship between wealth and child labor. Bhalatro and Heady (2003) find that children in land-rich households are more likely to work than children in land-poor households. In addition, Swaminathan (1998) finds that the magnitude of child labor increases as economic grows in west India. Bray et al. (2004) report a similar pattern in rural Gansu, China. They find that some relatively rich households require their children to leave school and take care of family business (Bray, Ding, and Huang 2004).

Another finding is that schooling can be observed in some very poor households. For example, in rural China, some of the very poor households send their children to school (GBEP 2004; Tang 2002). Some households fall into debt in order to support their children's education. Additionally, some survey and empirical studies show that some households still keep their children in school even when falling into poverty (GBEP 2004; Tang 2002; Zhang and Yuan 2005).

All these findings suggest that, as Deb and Rosati (2004) point out, "substantial unobserved heterogeneity and a general lack of significant explanatory power from income, wealth and credit availability" are still to be resolved in the study of child labor.

There is a line of literature that argues that child labor is caused by the incompleteness of capital market in developing economies. As we pointed out in Chapter 1, the incomplete capital market is highly related to the argument in Basu and Van (1998). Child labor means a lower level of education and lower income in the future, people may ask why households do not borrow from capital markets and keep children in school. If both interest rates and return from education are acceptable, schooling should be a better choice than child labor for households. The existing literature suggests that incomplete capital market is a by-product of poverty. Communities where poverty is pervasive in general suffer dysfunctional capital market. For example, Ranjan (1999; Ranjan 2001) and Jarafey and Lahiri (2002) use a two-period model to investigate how imperfect capital markets in developing economies affect child labor. The main conclusion from their studies is that child labor is caused by the dysfunction of the capital market.

Our model allows us to reconcile the difference between what is predicted in Basu and Van (1998) and the empirical findings in two ways, and also examine the roles incomplete capital markets play at the same time. We first discuss conditions under which full-time child labor may be a rational choice for rich households. We then explore conditions under which children may take full-time schooling in poor households.

As we assumed in Chapter 1, a typical household consists of two types of agents: the parents and the child. In order to examine the role capital markets play in determining child labor or schooling, we assume that there is a capital market. The parents live in two periods. In the first period, the parents earn an income, y. In addition, they can borrow, b, from capital market. If $b < 0$, the household has some saving. In the second period, their only incomes are saving and the support from the earning of their child. We also

assume that, if the income of the parents, y, is lower than a specific level, say subsistence consumption in Basu and Van (1998), y_0, then the household suffers additional disutility which is related to the time allocated to schooling.

In this context, the problem facing a typical household is the following.

(3,1) $$\max_{\alpha,b} U_1(x_1) + \gamma\alpha^2 + \beta U_2(x_2), \text{ where } \gamma = \min\{(y - y_0), o\}$$

Such that,

$x_1 + c\alpha = y + b + (1-\alpha)w_1$ And

$x_2 = g(\alpha) - (1+r)b$, where x_1 is the consumption level in the first period and x_2 is the consumption level in the second period.

$\alpha \le 1,\ \alpha \ge 0$

The remaining of this chapter is organized as follows. We will, in section 2, use the framework we developed in chapter 2 to throw some light on the "wealth paradox" of child labor. Section 3 is designed to investigate why poor households send their children to school. We will examine the impact of incompleteness of capital market on child labor in section 4. And the last section will be devoted to the discussion of some policy implications.

Child Labor in Rich Households

As we mentioned previously, child labor may occur in wealthy households. Child labor in rich families was called "Wealth Paradox "of child labor by Bhalotra and Heady(2003) . Indeed, child labor in rich households should be a paradox in the framework offered by Basu and Van (1998). This is because child labor is resulted only when households are poor and unable to afford schooling. Child labor is a measure to

help the households to survive. A rich household apparently does not need income from child labor. Child labor in a rich household, from the perspective of Basu and Van (1998), therefore, is nothing but a paradox.

If the time of a child, however, is treated as an asset, schooling or working in labor market is not related to wealth status. The allocation between schooling and child labor as we argued in Chapter 2 is a choice based on carefully balancing costs and benefits.

According to our assumptions, the problem facing a wealthy household is the following.

$$(3,2) \qquad \max_{\alpha,b} U_1[y + w_1 - (w_1 + c)\alpha + b] + \beta U_2[g(\alpha) - (1+r)b], \qquad if\ , y \geq y_0$$

The constraints facing the household are: $0 \leq \alpha \leq 1$. The saving or borrowing of this household need not to be limited since a wealthy household is in general free of limited financial resource problem.

The solution to this problem is summarized in the following proposition.

Proposition 3, 1: the solution to Problem (3, 2) is characterized as follows:

(i), $\alpha^* = 0$, $b = b^*$ if and only if $U_1^{'}(\cdot) = \beta U_2^{'}(\cdot)(1+r)$ and

$$\frac{\partial g(0)}{\partial \alpha} < (w_1 + c)(1+r)$$

(ii), $\alpha^* = 1$, $b = b^*$ if and only if $U_1^{'}(\cdot) = \beta U_2^{'}(\cdot)(1+r)$ and

$$\frac{\partial g(1)}{\partial \alpha} > (w_1 + c)(1+r)$$

(iii), $0 < \alpha^* < 1$, $b = b^*$ if and only if $U_1^{'}(\cdot) = \beta U_2^{'}(\cdot)(1+r)$ and

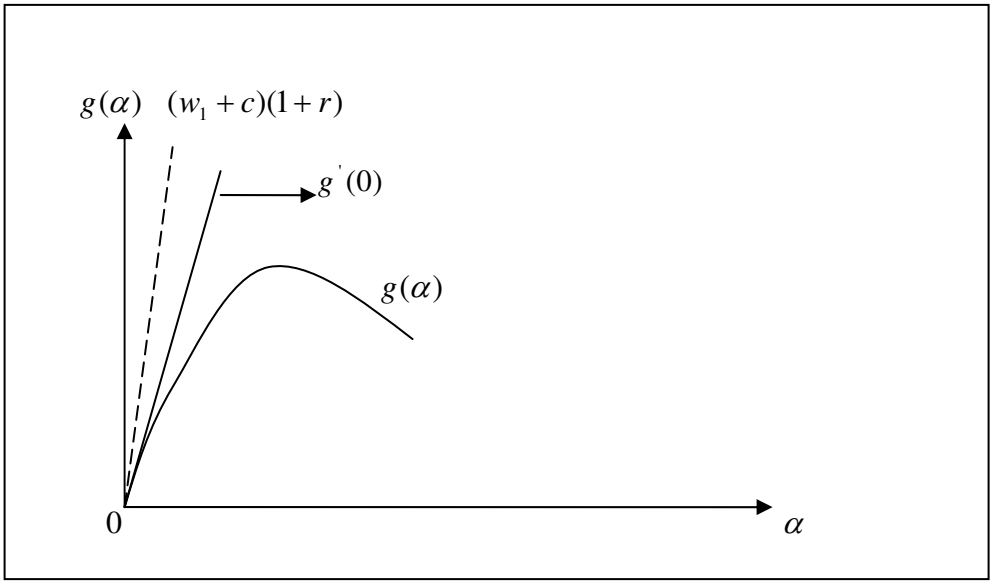
$$\frac{\partial g(1)}{\partial \alpha} < (w_1 + c)(1+r) < \frac{\partial g(0)}{\partial \alpha}.$$

Proof: see the Appendix II.

Proposition 3, 1, is essentially the same as Proposition 2.1 except that the role of capital market is explicitly stated here. For example, since δ can be defined as $\delta = \frac{1}{(1+r)}$, we can see that, for the optimal choice of schooling time, Proposition 3,1 is exactly the same as Proposition 2.1 if all of the child's future earning goes to the parents ($\theta = 1$ in this case). The key issue is that, as an economic resource, time of the child should be efficiently allocated across the two periods.

Regarding (i) of Proposition 3, 1, we first note that the optimal borrowing $b = b^*$ is determined by $U_1^{'}(\cdot) = \beta U_2^{'}(\cdot)(1+r)$ which states that the borrowing is optimally allocated across the two periods. On the optimal choice of schooling time, we note that $g^{'}(0)$ is the future earning of the child when his education time is zero. And $(w_1 + c)(1+r)$ is the opportunity cost forgone by one more unit of time allocated into schooling, measured in the second period term.

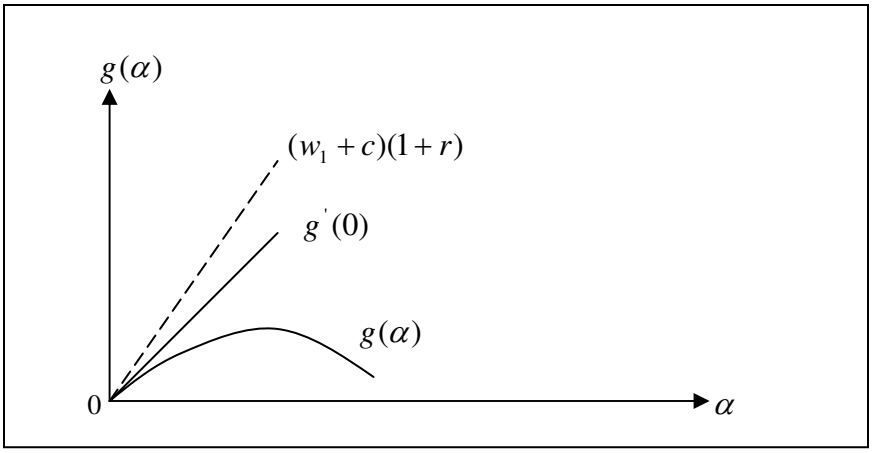
Figure 10. Child Labor: Caused by Higher Opportunity Costs



$g'(0) < (w_1 + c)(1 + r)$ is the necessary condition under which the rich household chooses zero unit of time for schooling. In other words, if we observe that all time of a child is allocated into labor market, condition $g'(0) < (w_1 + c)(1 + r)$ must be in place.

We know that knowledge growth function g is strictly increasing and concave, if we make the assumption that $g'(0)$ is big (a regular assumption), then $(w_1 + c)$ must be very big in order to meet condition $g'(0) < (w_1 + c)(1 + r)$. This result shows that both wage rate in labor market and school fees have negative impacts on schooling. In Figure 11, we can see that $g'(0)$ is big, which suggests that the growth rate of knowledge growth function is big. Total time of the child is allocated into labor market, however, since the return from education is smaller than the opportunity costs.

Figure 11. Child Labor in a Wealthy Household



Alternatively, if $(w_1 + c)(1 + r)$ is small, $g'(0)$ must be even smaller. In Figure 11, we offer alternative explanation to the child labor in wealthy households. In this case, the opportunity cost $(w_1 + c)(1 + r)$ is not very high. The growth rate of knowledge function at the origin, however, is even smaller than return from forgone cost. In practice, if the child in a wealthy household is not very smart, namely a small $g'(0)$, even though the opportunity cost is small, we would observe that the child labor presents in a rich household.

This result can be used to explain some observed "wealth paradox" (Bhalotra and Heady 2003) We know that w_1 represents the wage rate in the labor market, but it can also be interpreted as all returns children can obtain in the production process. For example, children can harvest some skills though learning by doing (Swaminathan 1997). If children specialize in some types of production activities, and learn some skills and experiences which will be useful in the future, the return from education could be relatively small. In this context, child labor could be a rational choice.

Regarding (ii) and (iii) of Proposition 3, 1, as we mentioned above, they are essentially the same as their counterparts in Proposition 2.1. And it's of little relevance to our interests in this section. For the discussions on these two parts, please refer to those on (ii) and (iii) of Proposition 2, 1 in chapter 2.

In this section, a dynamic framework is used to show that the parents' choice is determined by the benefits and costs associated with education and child labor. The child labor therefore may not be related to poverty. It's instead determined by net benefits from the two competing uses of the time of a child.

Schooling in Poor Households

In this section, we incorporate the role capital market plays in allocating the time of a child between labor market and schooling. We first show that the choice parents make when they are not suffering from constraints in capital market. Then we examine how the capital market influences the parents' choice over schooling and child labor. We are more interested in the parents behaviors when $y < y_0$ and role capital market plays.

When Capital Market Is Perfect

When households can borrow money as long as they want and as much, the maximization problem facing them is the following

$$(3,3)\ \underset{\alpha,b}{Max}\, U_1[y + w_1 + b - (w_1 + c)\alpha] + (y - y_0)\alpha^2 + \beta U_2[g(\alpha) - (1+r)b], \qquad if\ , y < y_0$$

$\alpha \le 1,\ \alpha \ge 0$ where b is the amount the household can borrow under a given interest rate r in the capital market.

The solution to this maximization problem is summarized in the following proposition.

Proposition 3, 2: the solution to Problem (3, 2) is characterized as follows:

(i), $\alpha^* = 0$, $b = b^*$, if and only if

$U_1^{'}(\cdot) = \beta U_2^{'}(\cdot)(1+r)$ and $\dfrac{\partial g(0)}{\partial \alpha} < (w_1 + c)(1+r)$

(ii), $\alpha^* = 1$, $b = b^*$ if and only if

$U_1^{'}(\cdot) = \beta U_2^{'}(\cdot)(1+r)$ and

$$\frac{\partial g(1)}{\partial \alpha} > (w_1 + c)(1+r) + 2(y_0 - y) / \beta U_2^{'}(g(1) - (1+r)b^*)$$

(iii), $0 < \alpha^* < 1$, $b = b^*$ if and only if

$U_1^{'}(\cdot) = \beta U_2^{'}(\cdot)(1+r)$ and

$$\frac{\partial g(1)}{\partial \alpha} < (w_1 + c)(1+r) + 2(y_0 - y)\alpha / \beta U_2^{'}(g(\alpha) - (1+r)b^*) < \frac{\partial g(0)}{\partial \alpha}$$

Proof: see the Appendix II.

Regarding (i) of Proposition 3, 2, we are not going to discuss the implications of this condition for two reasons. First, this is the same as those of Proposition 3.1., which says that, for a poor household, the necessary condition for household to allocate all of their time to schooling is $\frac{\partial g(0)}{\partial \alpha} < (w_1 + c)(1+r)$. Household can be made better off by allocating one more unit of time to schooling otherwise. On the other hand, if $\frac{\partial g(0)}{\partial \alpha} < (w_1 + c)(1+r)$ holds, we must have $\alpha^* = 0$. Given the nature of knowledge growth function, we must have $\frac{\partial g(0)}{\partial \alpha} > \frac{\partial g(\alpha)}{\partial \alpha}, for \quad \alpha > 0$. If $\alpha^1 > \alpha^* = 0$, the marginal benefit is $g^{'}(\alpha^1)$. We know that $g^{'}(\alpha^1) < g^{'}(0) < (w_1 + c)(1+r)$, so choosing $\alpha^1 > \alpha^* = 0$ will make the households worse off.

We are particularly interested in (ii) of Proposition 3, 2. This is because it precisely gives condition under which a poor household would allocate all time of their child into schooling: if and only if the marginal benefit at $\alpha = 1$ is greater than the associated marginal costs. As we mentioned earlier, this can not occur in Basu and Van (1998) in which education is assumed to be a luxury good.

Note first that, in order to make $\alpha^* = 1$, it's necessary to have $\frac{\partial g(1)}{\partial \alpha} > (w_1 + c)(1+r) + 2(y_0 - y)/\beta U_2^{'}(g(1) - (1+r)b^*)$, which states that at $\alpha = 1$, the benefit should be big enough to cover the marginal costs, which consist of two terms. The first part of the forgone costs is $(w_1 + c)(1+r)$, measuring the forgone wage rate and associated school fees plus their interests measured in the second period. For a poor household, as we argued, schooling means additional hardship. This additional difficulty is measured by $2(y_0 - y)/\beta U_2^{'}(g(1) - (1+r)b^*)$. Note that this additional hardship is linear with the "degree of poverty' measured by $(y_0 - y)$. A bigger gap between y_0, the general subsistence level of consumption, and y, in the parents' income means bigger difficulty to send their child to school. In addition, the optimal borrowing b^* also plays important roles in determining the allocation between schooling and labor market. A bigger value of b^* means a lower value of $2(y_0 - y)/\beta U_2^{'}(g(1) - (1+r)b^*)$, and therefore lower marginal costs.

Regarding (iii) of Proposition 3, 2, first note that $\frac{\partial g(1)}{\partial \alpha} < (w_1 + c)(1+r) + 2(y_0 - y)\alpha/\beta U_2^{'}(g(\alpha) - (1+r)b^*) < \frac{\partial g(0)}{\partial \alpha}$ is the necessary condition for a poor household to choose $\alpha^* \in (0,1)$. As before, $g^{'}(\alpha)$ is the benefit from $\alpha^* \in (0,1)$ and the marginal costs consists of two parts: $(w_1 + c)(1+r)$ and the additional hardship $2(y_0 - y)\alpha/\beta U_2^{'}(g(\alpha) - (1+r)b^*)$. Note that the additional hardship increases as α increases. For any value of $\alpha^* \in (0,1)$, the marginal benefit must be equal

to the marginal costs. The household will be better off otherwise by reallocating between schooling and child labor.

The Impact of Imperfect Capital Market on Child Labor

In this section, we examine the impact of credit constraint on schooling and child labor. In the previous section, the optimal borrowing and schooling time is determined at the same time. We want to know what households' response is if they cannot borrow freely in capital market. This capital constraint can be modeled as $b \le \bar{b}$ where $\bar{b}$ is the maximum amount a household can borrow from market.

In this context, the maximization problem facing the poor households is the following

$$(3,4)\ \max_{\alpha,b} U_1[y + w_1 + b - (w_1 + c)\alpha] + (y - y_0)\alpha^2 + \beta U_2[g(\alpha) - (1+r)b]$$

$\alpha \le 1,\ \alpha \ge 0$ and $b \le \bar{b}$, where b is choice variable and $\bar{b}$ is the maximum the household can borrow with the given interest rate r in the capital market.

The solution to this problem is summarized in the following proposition.

Proposition 3, 3: the solution to Problem (3, 3) is characterized as follows:

(i), $\alpha^* = 0,\ b = \bar{b}$ if and only if

$U_1'(\cdot)/\beta U_2'(\cdot) > (1+r)$ and

$$\frac{\partial g(0)}{\partial \alpha} < (w_1 + c)U_1'(y + w_1 + \bar{b})/\beta U_2'(g(0) - (1+r)\bar{b})$$

(ii), $\alpha^* = 1,\ b = \bar{b}$ if and only if

$U_1'(\cdot)/\beta U_2'(\cdot) > (1+r)$ and

$$\frac{\partial g(1)}{\partial \alpha} > (w_1 + c)(1+r) + [2(y_0 - y)]/\beta U_2'(g(1) - (1+r)\bar{b})$$

(iii), $0 < \alpha^* < 1$, $b = \bar{b}$ if and only if

$U_1^{'}(\cdot) / \beta U_2^{'}(\cdot) > (1+r)$ and

$$\frac{\partial g(\alpha)}{\partial \alpha} > (w_1 + c)(1+r) + 2(y_0 - y)\alpha / \beta U_2^{'}(g(\alpha) - (1+r)\bar{b})$$

Proof: see the Appendix II.

We first note that the credit constraint in capital market increases the marginal costs in all these three cases. This is mainly because the shortage of credit in the first period puts parents in a difficult position. The shortage of fund can only make household to suffer more, or reduce schooling and increase child labor at the same time, or take the two actions simultaneously.

Regarding (i) of Proposition 3, 3, first note that given the household can only borrow $\bar{b}$, which is smaller than the amount the poor household desires, b^*, in the first period, $g^{'}(0) < (w_1 + c)U_1^{'}(y + w_1 + \bar{b}) / \beta U_2^{'}(g(0) - (1+r)\bar{b})$ is the necessary condition for a poor household chooses no schooling. Under this condition, $g^{'}(0)$ is the benefit when schooling time is zero. $(w_1 + c)U_1^{'}(y + w_1 + \bar{b}) / \beta U_2^{'}(g(0) - (1+r)\bar{b})$ is the marginal cost when schooling time is zero. It's interesting that $(w_1 + c)U_1^{'}(y + w_1 + \bar{b}) / \beta U_2^{'}(g(0) - (1+r)\bar{b})$ is bigger than $(w_1 + c)(1+r)$ since $U_1^{'}(y + w_1 + \bar{b}) / \beta U_2^{'}(g(0) - (1+r)\bar{b}) > (1+r)$ (will be discussed in detail in the next section). This suggests that the credit constraint makes the marginal cost bigger than in the case of free credit constraint.

Regarding (ii) and (iii) of Proposition 3, 3, we need to note again that, the credit constraint increases the marginal costs of schooling.

The Impact of Credit Constraint on Child Labor

As we illustrated in the previous section, the credit constraint increases the marginal costs of schooling. In this section, by comparing the conditions in section 2 and 3, we will be able to find the impact of capital market on the allocation of time between schooling and child labor.

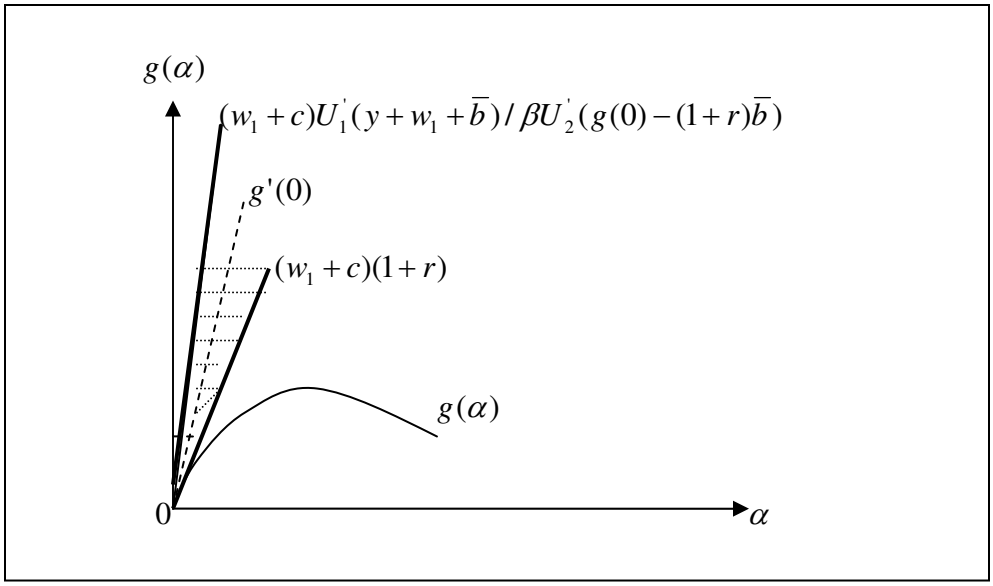
When $\alpha = 0$

In this case, we denote the solution to the optimal choice (α^f, b^f), where f represents the credit constraint is free. This is apparently associated with (i) of Proposition 3.2. Similarly, we use (α^{nf}, b^{nf}) where nf represents credit constraint not-free, which is associated with (i) of Proposition 3.3. b^f is therefore uniquely determined by condition (2) (see appendix). And $\alpha^f = 0$ if and only if condition (11) is guaranteed. In addition, when the credit constraint is in place, we have $b^{nf} = \bar{b}$ and $\alpha^{nf} = 0$ if and only if condition (17) holds. We rewrite condition (11) and (17) as the following.

$$(11)' \qquad g_f'(0) < (1+r)(w_1 + c)$$

$$(17)' \qquad g_{nf}'(0) < (w_1 + c)U_1'(y + w_1 + \bar{b}) / \beta U_2'(g(0) - (1+r)\bar{b})$$

Figure 12. the Impact of Credit Constraint on Schooling Time



Note from condition (15) $U_1'(\cdot)/\beta U_2'(\cdot) > (1+r)$ we have $U_1'(y+w_1+\bar{b})/[\beta U_2'(g(0)-(1+r)\bar{b})] > (1+r)$. In other words, the opportunity cost of schooling when credit constraint in place is bigger than that of without the constraint. For example, when the growth rate at $\alpha = 0$ is $g_f'(0) = g_{nf}'(0) = g'(0)$, and the constraint is in effect, the parents would not send their child to school since the forgone opportunity cost is higher. From Figure 12, we can see that, $g'(0) = g_{nf}'(0) < (w_1+c)U_1'(y+w_1+\bar{b})/\beta U_2'(g(0)-(1+r)\bar{b})$. Under this condition, sending child to school is not a rational choice. On the other hand, the parents would send their child to school in the case of free credit constraint. This is because we have $g'(0) = g_f'(0) > (w_1+c)(1+r)$.

Formally, we are always able to find a value M that satisfies $(w_1 + c)(1+r) < M < (w_1 + c)U_1^{'}(y + w_1 + \bar{b}) / \beta U_2^{'}(g(0) - (1+r)\bar{b})$. If $g_{nf}^{'}(\alpha) = M$, then we must have $\alpha^{nf} = 0$ and $\alpha^{f} > 0$ is guaranteed.

Any value of M in the shadowed area between lines $(w_1 + c)U_1^{'}(y + w_1 + \bar{b}) / \beta U_2^{'}(g(0) - (1+r)\bar{b})$ and $(w_1 + c)(1+r)$ satisfies the above condition. The shadowed area in the above diagram represents the efficiency loss caused by the credit constraints. In other words, if the opportunity cost is $(w_1 + c)(1+r)$, for all M in the shadowed area, we have $\alpha^{f} > 0$ while $\alpha^{nf} = 0$.

The net efficiency loss can be easily illustrated in the diagram. It's the credit constraint that makes the forgone opportunity cost increase from $(w_1 + c)(1+r)$ to $(w_1 + c)U_1^{'}(y + w_1 + \bar{b}) / \beta U_2^{'}(g(0) - (1+r)\bar{b})$.

If the household is free to borrow in the first period, $\alpha^{f} > 0$ will be chosen. In this case, the trade-off facing the household is the loss in the wage income from the child labor, $\alpha^{f} w_1$, which will be compensated by the increased accumulation of knowledge growth. At the equilibrium, the marginal benefit and the marginal cost is equalized. There is no room to make the household better off.

The household apparently can reallocate the borrowing across time and realize some gains. Since the marginal cost is smaller than the marginal benefit, more borrowing is preferred if there is no constraint.

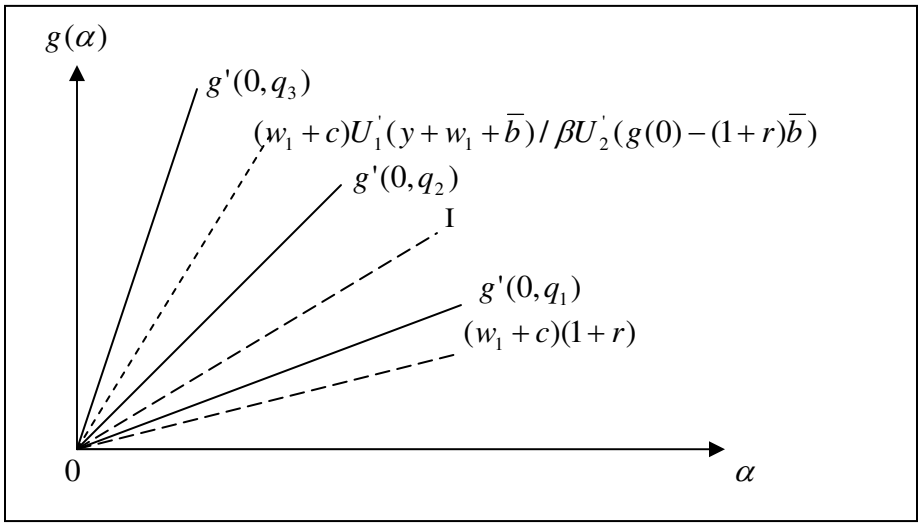
Suppose the household wants to borrow b^* amount of money in capital market, but only $\bar{b} < b^*$ is available. In this case, the marginal utilities of each unit of the borrowing are not the same in the two periods. The net benefit of borrowing in the first period $U_1^{'}(y + w_1 + \bar{b})/(1+r)$ is bigger than its counterpart in the second period, $\beta U_2^{'}(g(0) - (1+r)\bar{b})$. In the first period, if the household can borrow one more unit of b, which is $\bar{b} < b < b^*$, and pay out $(1+r)b$ in the second period, the household then can be better off. Recall that the household is struggling to make their ends meet, and if they can borrow from capital market, there is no need to send their child to the labor market to earn wage income and at the same time suffers loss in knowledge growth function. For example, suppose the household can borrow whatever they want, they give up wage income $\alpha^f w_1$ in the first period, but they harvest $g(\alpha^f)$ in the second period. Now under the credit constraint, the household has to send the child to the labor market. The child's working time changes from $(1-\alpha^f)$ to 1. And the household income also increases from $(1-\alpha^f)w_1$ to w_1. However, to obtain the increased income $\alpha^f w_1$, the price the household has to pay is the lower knowledge level $g(0)$ which is apparently lower than $g(\alpha^f)$.

In other words, the constraint has important impact on both variables. First, the constraint limits the household's ability to borrow and reduce the resources available to the household in the first period. It also reduces the burden of the household in the second period since the debt needed to be paid off is smaller. Second, the shrink in resource available caused by the constraint in the first period forces the household to withdraw the child from school and send him or her to the labor market. In the first period, the

household's income increases since the child works more than before. However, their income in the second period decreases because the uneducated labor is less productive.

Note that this can be used to show when there are several children with different ability to learn in a community, who is going to be sent to the labor market.

Figure 13. the Impact of Credit Constraint on Children with Different Qualities of Talent



Suppose there are three children in a community.[4] At point $\alpha = 0$, the three children have different growth rate in their knowledge growth function, $g'(0,q_3) > g'(0,q_2) > g'(0,q_1)$. Again, if the household is free to borrow, the opportunity cost is $(w_1 + c)(1+r)$. If household is restricted to borrow only $\bar{b} < b^*$, the marginal cost increases from $(w_1 + c)(1+r)$ to $(w_1 + c)U_1'(y + w_1 + \bar{b})/\beta U_2'(g(0) - (1+r)\bar{b})$.

[4] This can also be implied to a household which has more than one child.

In Figure 13, when the household is free to borrow, the opportunity cost facing the household in this community is $(w_1 + c)(1 + r)$, then all three children will choose $\alpha^f > 0$ since at $\alpha = 0$, all marginal benefits of three children are bigger than $(w_1 + c)(1 + r)$. When the available fund becomes smaller but is still bigger than $\bar{b}$, the opportunity cost line increases to line I in the diagram. In this case, the child whose quality is q_1 will choose $\alpha = 0$ since his or her marginal benefit is smaller than the marginal costs. The other two children, however, will still choose $\alpha^f > 0$ since both of $g'(0, q_3)$ and $g'(0, q_2)$ are bigger than $(w_1 + c)(1 + r)$. When the available fund is only $\bar{b}$, the opportunity cost line increases to line $(w_1 + c)U_1'(y + w_1 + \bar{b}) / \beta U_2'(g(0) - (1 + r)\bar{b})$ in the diagram. In this case, only the smartest child stays in school since we still have $g'(0, q_3) > (w_1 + c)U_1'(y + w_1 + \bar{b}) / \beta U_2'(g(0) - (1 + r)\bar{b})$. The other two have to choose $\alpha = 0$, otherwise both of them will suffer losses.

When $\alpha^* = 1$

We now turn to examine what the impact of credit constraint on household' choice is when $\alpha = 1$. Note that from (ii) of Proposition 3, 2, $g'(1) > (1 + r)(w_1 + c) + 2(y_0 - y) / \beta U_2'(g(1) - (1 + r)b^*)$ should hold when household is free to borrow and all time goes to schooling. And from (ii) of Proposition 3, 3, $g'(1) > (w_1 + c)(1 + r) + [2(y_0 - y)] / \beta U_2'(g(1) - (1 + r)\bar{b})$ must hold when $\alpha = 1$ and the household is restricted by limited credit, $\bar{b}$, in the capital market. We therefore have the following conditions.

(10) $g^{'}(1) > (w_1 + c)(1+r) + 2(y_0 - y)/\beta U_2^{'}(g(1) - (1+r)b^{*})$,

(16) $g^{'}(1) > (w_1 + c)(1+r) + 2(y_0 - y)/\beta U_2^{'}(g(1) - (1+r)\bar{b})$

By assumption, we have $(1+r)\bar{b} < (1+r)b^{*}$,

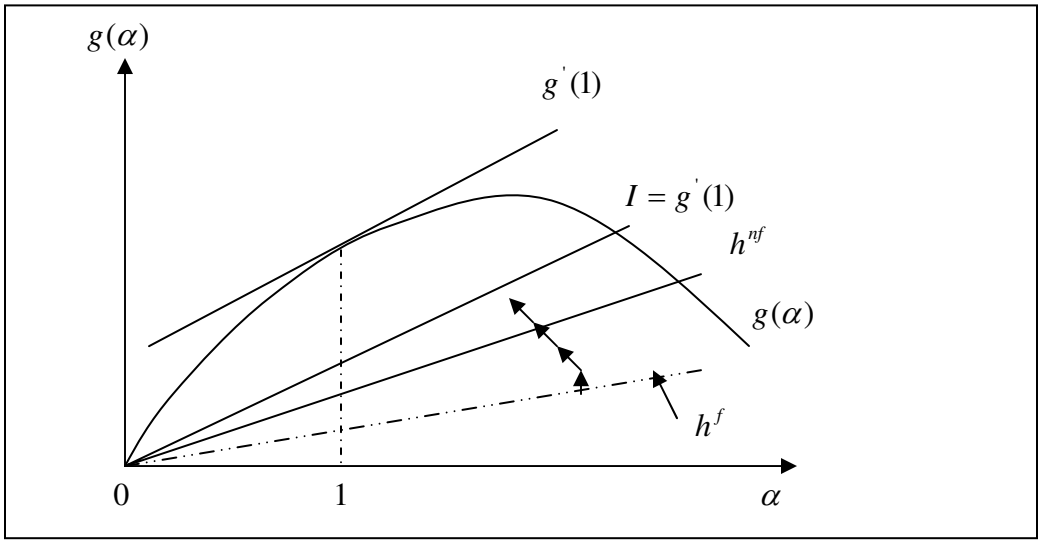
and $[g(\alpha) - (1+r)\bar{b}] > [g(\alpha) - (1+r)b^{*}]$. Since utility function is strictly increasing and strictly concave, we therefore have $U_2^{'}[g(\alpha) - (1+r)\bar{b}] < U_2^{'}[g(\alpha) - (1+r)b^{*}]$. Given $2(y_0 - y)$ is positive, we will in turn

have $2(y_0 - y)/U_2^{'}[g(1) - (1+r)\bar{b}] > 2(y_0 - y)/U_2^{'}[g(1) - (1+r)b^{*}]$.

We first denote the solution to (10) $\alpha^{f} = 1$. Since the maximum amount of time can be allocated to schooling is 1, and condition (10) is the necessary condition for household to choose $\alpha = 1$, an increase in the RHS of (10) may not have an impact on $\alpha^{f} = 1$ until the increase is big enough to overweight the benefit, $g^{'}(\alpha^{f} = 1)$.

Given $2(y_0 - y)/U_2^{'}[g(1) - (1+r)\bar{b}] > 2(y_0 - y)/U_2^{'}[g(1) - (1+r)b^{*}]$, (16) therefore represents an increase in the RHS of (10). There are two possibilities to obtain the impact of credit constraint.

Figure 14. the Credit Constraint Has no Impact on Schooling Time



We define the marginal cost functions as following:

When the household is free of credit constraint:

$h^f = (w_1 + c)(1+r) + 2(y_0 - y)/\beta U_2'(g(1) - (1+r)b^*)$.

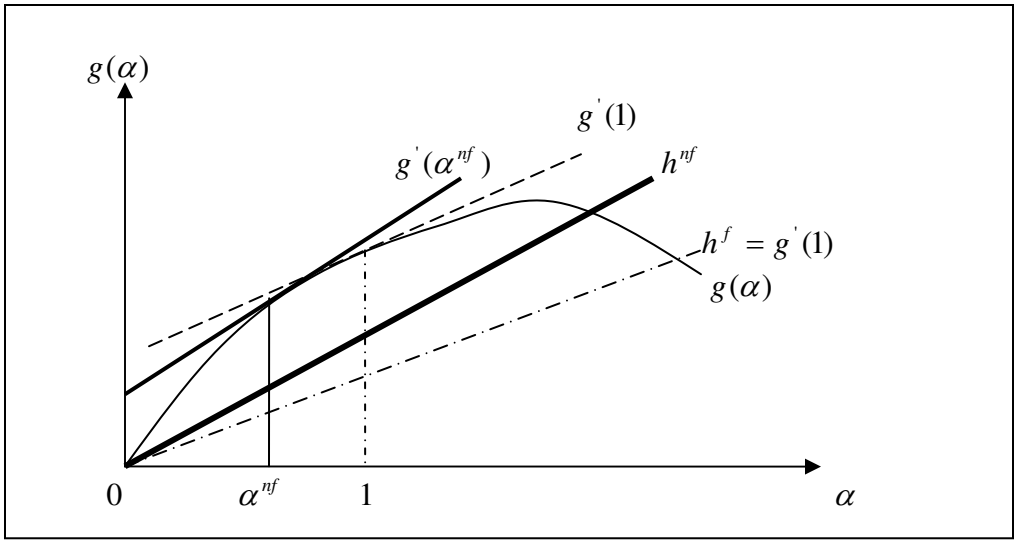
When credit constraint is in place:

$h^{nf} = g'(1) > (w_1 + c)(1+r) + 2(y_0 - y)/\beta U_2'(g(1) - (1+r)\bar{b})$

In Figure 14, condition (10) is held. The benefit $g'(1)$ at $\alpha = 1$ is bigger than the marginal costs of $\alpha = 1$, $h^f = (w_1 + c)(1+r) + 2(y_0 - y)/\beta U_2'(g(1) - (1+r)b^*)$. From the diagram, we can see that the slope of $g'(1)$ is greater than that of h^f. A reduction in constraint from b^* to $\bar{b}$ makes the marginal cost line change from h^f to h^{nf}. If the gap between b^* to $\bar{b}$ is not big and the increase in h^f is limited, the credit constraint will have no impact on household's choice. In the diagram, there is no change in schooling time until h^f moves to areas beyond the line I that has the same slope as $g(\alpha = 1)$.

There is another possibility in which the credit constraint does reduce the schooling time, however.

Figure 15. The Credit Constraint Reduces the Schooling Time



If there is no difference between $g'(1)$ and h^f, the credit constraint may have important impact on schooling time. Let's assume that at margin, $g'(1)$ is equal to h^f. The shortage of credit results in a bigger slope of h^f than before. In Figure 15, the credit constraint first leads h^f to change to h^{nf}, which has bigger slope than h^f.

Given the new marginal cost h^{nf}, at point $\alpha = 1$, the marginal benefit is $g'(1)$ while the cost is h^{nf}. A loss would occur if the household still chooses $\alpha = 1$. This is because $g'(1)$ is equal to h^f and the latter is smaller than h^{nf}.

As a response to the change in marginal costs, a rational choice for the household is to reduce schooling time to a point where the marginal benefit is not smaller than newly increased marginal cost, h^{nf}. Under credit constraint, the household would choose α^{nf} unit of time for schooling.

In this case, the credit constraint clearly has negative impact on schooling time and leads to child labor[5]. From the diagram we can see that the schooling time is 1 and there is no child labor before the credit constraint come into place. With credit constraint, $(1-\alpha^{nf})$ unit of time would be allocated to labor market in order to receive wage income in the labor market, $(1-\alpha^{nf})w_1$.

We know that the household chooses $\alpha = 1$ when they are free to borrow. The choice, α^{nf}, is not the optimal choice since household can but does not choose it. The net benefit from $\alpha = 1$ should be bigger than that from α^{nf}. We have $\pi(\alpha = 1) > \pi(\alpha = \alpha^{nf})$. Since $\pi(\alpha = 1, b = b^*) = U_1[y + b^* - c] + (y - y_0) + \beta U_2[g(1) - (1+r)b^*]$ and

$$\pi(\alpha = \alpha^{nf}, b = b^*) = U_1[y + \bar{b} + w_1 - (w_1 + c)\alpha^{nf}] + (y - y_0)(\alpha^{nf})^2 + \beta U_2[g(\alpha^{nf}) - (1+r)\bar{b}]$$

according to $\pi(\alpha = 1) > \pi(\alpha = \alpha^{nf})$, we have

$$(19) \qquad \{U_1[y + b^* - c] - U_1[y + \bar{b} + w_1 - (w_1 + c)\alpha^{nf}]\} +$$
$$\beta U_2[g(1) - (1+r)b^*] - \beta U_2[g(\alpha^{nf}) - (1+r)\bar{b}] > (y_0 - y)[1 - (\alpha^{nf})^2]$$

Since on the RHS of condition (19), $(y_0 - y)[1 - (\alpha^{nf})^2]$ is positive, the LHS must be positive too. To make LHS positive we need

$$(20) \qquad [g(1) - g(\alpha^{nf})] > (1+r)(b^* - \bar{b})$$
$$(21) \qquad (b^* - \bar{b}) > w_1(1 - \alpha^{nf}) + c(1 - \alpha^{nf})$$

[5] This result can be applied in a household with many children. The smartest child will be the last one to be pushed out by the credit constraint according to our above analysis.

The LHS of (19) is the increased benefit when schooling time increases from α^{nf} to 1. The RHS is the opportunity costs when $(1-\alpha^{nf})$ unit of time allocated to schooling.

When the available credit for this household is $\bar{b}$ rather than b^*, the opportunity cost line increases from h^f to h^{nf}. The schooling time should decrease from $\alpha = 1$ to α^{nf}. With the new constraint h^{nf}, $\alpha = 1$ is not an optimal choice any more since the benefit is smaller than the cost. To match the increased costs, the growth rate should be bigger and therefore $\alpha < 1$ should be chosen. In this case, the household should choose α^{nf} where the marginal benefit equalizes the marginal costs.

Without credit constraint, household borrow b^* in the first period and pay back $(1+r)b^*$ in the second term. At the same time, the household allocates all time of the child in schooling in the first period and harvest an education return $g(1)$ in the second period. When the household cannot freely borrow any more, the maximum amount of credit available is $\bar{b}$. There is a shortage of borrowing $(b^* - \bar{b})$ in the first period. In order to make the household survive, $(1-\alpha^{nf})$ unit of time have to be withdrawn from schooling and allocated to labor market. By doing so, the household receives a wage income $(1-\alpha^{nf})w_1$ in first period. This is surely a make up for the reduction in the credit. The price needs to be paid, however, is lower education return in the second period, since the education return decreases from $g(1)$ to $g(\alpha^{nf})$.

In addition, $(1-\alpha^{nf})$ unit of time allocated to labor market brings additional benefits to the household. Recall that, for each and every α, the poor household suffers additional hardship $(y - y_0)\alpha^2$. When $\alpha = \alpha^f = 1$, the additional hardship is $(y - y_0)$

which is negative since $y < y_0$. When credit constraint is in place, $\alpha = \alpha^{nf} < 1$, the additional hardship becomes $[(y - y_0)(\alpha^{nf})^2]$, which is clearly smaller than $(y - y_0)$.

Overall, the credit constraint has significantly changed household's choice from $(\alpha = 1, b = b^*)$ to $(\alpha = \alpha^{nf}, b = \bar{b})$. This change surely has negative impact on household's welfare.

Interior Solutions

We now turn to discussion of cases with interior solutions. Note that from (iii) of Proposition 3, 2 , $g'(\alpha) = (w_1 + c)(1 + r) + 2(y_0 - y)\alpha / \beta U_2'(g(\alpha) - (1 + r)b^*)$ must hold. This condition is numbered (12) in our proof of Proposition 3, 2 (see Appendix II). From (iii) of Proposition 3, 3, $g'(\alpha) > (w_1 + c)(1 + r) + 2(y_0 - y)\alpha / \beta U_2'(g(\alpha) - (1 + r)\bar{b})$ must hold. This condition is numbered (18) in the proof of Proposition 3.3 (see Appendix II).

(12) $\quad g'(\alpha) = (w_1 + c)(1 + r) + 2(y_0 - y)\alpha / \beta U_2'(g(\alpha) - (1 + r)b^*)$

(18) $\quad g'(\alpha) > (w_1 + c)(1 + r) + 2(y_0 - y)\alpha / \beta U_2'(g(\alpha) - (1 + r)\bar{b})$

Recall that we have

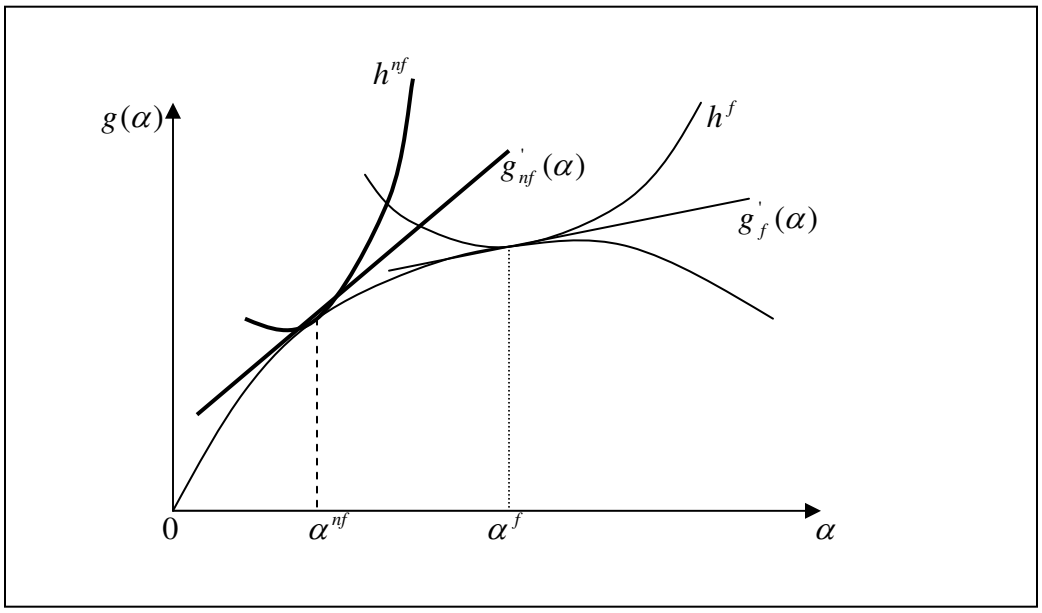
$2(y_0 - y)\alpha / U_2'[g(\alpha) - (1 + r)\bar{b}] > 2(y_0 - y)\alpha / U_2'[g(\alpha) - (1 + r)b^*]$.

Comparing (12) and (18), we find that the credit constraint has negative compact on the schooling time. If the household is restricted by credit constraint, then α becomes smaller compared with that of free credit constraint. It's easy to see that the RHS of (18)

is bigger than that of (12). Mathematically, in order to make $g^{'}(\alpha)$ bigger, α has to be smaller.

The reason is that, one more unit of borrowing will be valued more in the first period. The marginal benefits of one more unit of schooling is bigger than the marginal cost of borrowing, paid by the factor of (1+r) in the second period.

Figure 16. The Credit Constraint and Schooling Time



Again, we first define the marginal cost functions h^{f} and h^{nf} as the following:

$$h^{f}(w_1, c, \alpha) = (w_1 + c)(1+r) + 2(y_0 - y)\alpha / \beta U^{'}_{2}(g(\alpha) - (1+r)b^{*}) .$$

$$h^{nf}(w_1, c, \alpha) = (w_1 + c)(1+r) + 2(y_0 - y)\alpha / \beta U^{'}_{2}(g(\alpha) - (1+r)\bar{b})$$

The efficiency loss caused by credit constraint can be easily illustrated by the diagram. Without the credit constraint, the optimal solutions are (α^f, b^*). The optimal choice is $(\alpha^{nf}, \bar{b})$ when the credit constraint is in place. In Figure 16, all choices between α^{nf} and α^f are preferred to α^{nf}. These choices, however, are not feasible since the household needs the wage income earned by allocating child's time to the labor market. In other words, the credit constraint limits the resources available to the family necessary for its sustainability. The household has no choice but to allocate $(a^f - \alpha^{nf})$ unit of time to the labor market and earn $(a^f - \alpha^{nf})w_1$ in order to compensate for the loss in available credit, $(b^* - \bar{b})$ in the first period.

In the second period, compared with constraint free case, the principal and interest paid out are smaller. The gain in accumulation of knowledge growth is also smaller, however. In one case, without credit constraint, α^f unit of time is chosen and the knowledge level is therefore $g(\alpha^f)$. Alternatively, with credit constraint, α^{nf} unit of time will be chosen and the knowledge level in this case is $g(\alpha^{nf})$.

Note that the change from α^f to α^{nf} also has additional impact on the household. With α^f, the household suffers additional hardship $(y - y_0)(\alpha^f)^2$. When the schooling time decreases to α^{nf}, the household suffers less hardship than before. With α^{nf}, the additional hardship is $(y - y_0)(\alpha^{nf})^2$. The change in the hardship is $(y - y_0)[(\alpha^{nf})^2 - (\alpha^f)^2]$, which is positive. This positive change is because, for a poor household, higher schooling time means bigger hardship. When schooling time is reduced, household suffers less.

Overall, the credit constraint reduces the schooling time. Bigger share of the child's time going to the labor market has negative impact on the welfare of the household since when $(\alpha^{nf}, \bar{b})$ is available the household chooses (α^{f}, b^{*}).

Concluding Remarks

The model developed in this chapter allows us to examine the impacts of wage rate, school cost and capital market at the same time. In this chapter, we first show that the so-called "Child Labor Paradox" could be a rational choice for a household. We then show conditions under which poor households may choose full-time schooling for their children. In addition, we incorporate capital market into our model and examine its impact on schooling time and child labor. The discussion in this chapter has some useful policy implications. For example, if child labor is more related to future benefit, wage rate and school costs than to poverty, policies aim to reduce child labor should focus on relative returns from alternative uses of the child's time. Also, as we have shown in our model, completeness of capital market indeed has important role to play in the allocation of the child's time. If it functions smoothly, the interest rate can be lower and the capital market can be accessed easily, both of which could make b bigger that by all means are helpful to reduce child labor and encourage schooling. This provides an indirect way to reduce child labor. Since accessibility to the capital market and lower interests are important, any policies targeting at these two goals in rural areas would be helpful in fighting against child labor.

CHAPTER 4. GOVERNMENT POLICIES AND CHILD LABOR

Introduction

Child labor law, compulsory education law, international labor standards and trade sanctions have been the major weapons widely adopted as policy tools to fight child labor since 1703 when the first child labor law was legislated in Britain.

Child labor law and compulsory education law have been the most important and common measures to fight child labor (Grootaert and Kanbur 1995). These measures, however, do not work well in reducing the size of child labor (details will be provided later). International labor standard and trade sanction, as part of the trade policy in the developed countries to reduce child labor in developing economies are by no means desirable. The goal of both measures is to control child labor in developing countries by restricting the demand for goods that use child labor as inputs. These two policies in general are ineffective in diminishing child labor. In addition, children may encounter some negative welfare consequences caused by trade sanction. For example, an effective trade sanction could reduce the demand on exporting goods manufactured by child labor. The prices of these goods would be lower, therefore the wage rate for child labor will decrease accordingly. The trade sanction therefore makes the child labor worse off (Udry 2003). What's more, some extremely negative and unexpected outcomes could also emerge. For example, as Basu and Tzannatos (2003) mention, the efforts to stop child labor in carpet industry in Nepal have successfully driven children out of this industry. However, children who lost jobs in the carpet industry moved to prostitution. Apparently,

the change in the structure of child labor from carpet to prostitution cannot be treated as a welfare improvement.

Given the shortcomings of the "regulate and command" type of policy tools, people started to think of alternative strategies, such as incentive programs, to reduce child labor. In the past two decades, one widely used measure was to make schooling more attractive or more profitable. In order to do so, various measures have been used in many countries. For example, in some rural areas in Mexico, a mother is qualified for a grant of 225 pesos if her daughter is enrolled in the ninth grade. The goal of this program is to reduce the opportunity costs of schooling. Since 225 pesos account for two-thirds of wage rate a girl in ninth grade would earn in the labor market, the benefit of working in the labor market is reduced significantly. The empirical study shows that the program has important impact on enrollment rates (Schultz 2001).

In the past 20 years, China has experienced a transition from traditional measures such as compulsory education law to incentive program such as "Free Education Plan." As part of the efforts to fight against the wide existence of child labor and low school attendance in rural areas, the People's Republic of China passed its "Compulsory Education Law" in 1986. All parents, according to this law, are required to send their children to school for at least 9 years to complete primary and lower-secondary schooling. In addition, the rural school system has since then been mainly financed by local communities. The educational surcharges have been levied by local governments to finance the build-up of school facilities and salary of teachers. School fees have been collected from students in order to make school operate smoothly. A survey on schooling in poor areas in China shows that the average amount of school fees paid by a typical

household is about 500 Yuan, which is equivalent to half of the expenditure per capita in the household (Brown and Park 2002). The Compulsory Education Law and its related efforts did not work well because of two important reasons. First, major punishment for failure to obey this law was to be fined. The fine actually never materialized due to lack of a mechanism to implement the law. Second, school fees paid to schools made education service extremely expensive. The school fees made the education services unaffordable to many households in rural China.

Twenty years later after the compulsory education law took effect, child labor and high school dropout rate are still a problem facing policy-makers in China. In 2005, the Chinese central government initiated a newly designed program called "Free Education Plan (FEP)." This new plan differentiates itself radically from compulsory education law in that it makes the primary and lower-secondary education free for households. In other words, the central government pays for all education related expenditures. The parents therefore need not to pay school fees any more.

The transition from compulsory law to free education in China is one of the newest policy innovations in using incentive tools to fight child labor. It differs from the traditional "regulate or command" scheme. The new governmental policies are designed to offer incentives to households. Within the changed environment, households would automatically choose the results the society desires. In China, the compulsory education law forced households to send their children to school. Households were still free to make any decisions that served their interests best. As a result, child labor and low school attendance remained unsolved. The free education plan follows a different path. The free education services make schooling relatively more attractive, or cheaper to consume, than

before. Households may therefore voluntarily choose to allocate more time of their children's time to schooling. A lower level of child labor could result in this way.

In this chapter we extend our basic model to examine and compare the impacts of these two governmental tools on child labor. We first model, in section 2, the impacts of these two policy tools on schooling time. In section 3, we show why compulsory education law may not work. Section 4 is designed to examine the effectiveness of free education plan. In the last section, we will take China as an example to illustrate and verify our theoretical predictions.

Compulsory Education Law and Free Education Program

In this section, we model the impact of the two governmental tools on schooling time. The key issues regarding compulsory education plan are: first, each and every child should finish a minimum amount of schooling time; and second, failing to do so would result in a punishment such as a fine, etc. On the other hand, the key issue regarding a free education program is that parents do not need to pay school fees, which makes education more attractive than before.

Compulsory Education Law

The core of this policy is to require that all children stay at school for some minimum time. Extending our earlier model of Chapter 2, for the current context, the parents' problem becomes

$$\underset{\alpha\in[0,1]}{Max}[w_1-(w_1+c)\alpha]+\delta\cdot\theta\cdot g(\alpha)$$

s.t. $\alpha \geq \hat{\alpha}$, where $\hat{\alpha}$ is the required minimum time a child must spend on schooling.

To analyze the impact of the policy, we need to analyze the solution to the above problem. For this purpose, we first write down the Lagrange function to the above maximization problem: $L = [w_1 - (w_1 + c)\alpha] + \delta \cdot \theta \cdot g(\alpha) - \lambda(\hat{\alpha} - \alpha)$

The solution is characterized by the following relations:

$-(w_1 + c) + \delta \cdot \theta \cdot g'(\alpha) + \lambda = 0$

$\hat{\alpha} - \alpha \le 0, \qquad (= 0, if\ \lambda > 0)$ and

$\lambda \ge 0$.

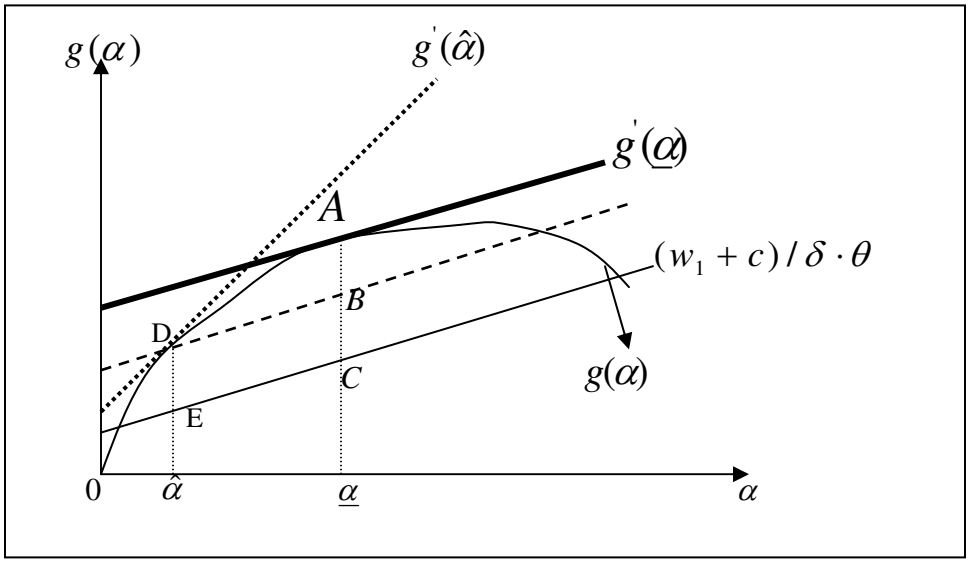
Government policy has no impact

We first analyze the case in which the policy has no impact on the optimal choice of α; that is, the optimal choice of α^* is characterized by $\delta \cdot \theta \cdot g'(\alpha^*) = w_1 + c$. In this case, apparently, we have $\lambda = 0$ in the above relations.

Two scenarios satisfy the condition $\delta \cdot \theta \cdot g'(\alpha) = w_1 + c$. First, the parents' choice is exactly the same as that required by the government, $\hat{\alpha}$.

Secondly, $\hat{\alpha}$ is lower than the choice the parents make. If the parents choose $\alpha = \underline{\alpha} > \hat{\alpha}$, we have $\delta \cdot \theta \cdot g'(\underline{\alpha}) = w_1 + c$. Given $\underline{\alpha} > \hat{\alpha}$, we must have $g'(\hat{\alpha}) > g'(\underline{\alpha})$ since the knowledge growth function is increasing and concave. $\delta \cdot \theta \cdot g'(\hat{\alpha}) > \delta \cdot \theta \cdot g'(\underline{\alpha}) = w_1 + c$. This means that at point $\hat{\alpha}$, the marginal benefit from education is larger than the marginal cost. It's therefore not optimal to choose $\hat{\alpha}$. This can be seen clearly from Figure 17.

Figure 17. Compulsory Law Has no Impact on Schooling Time



In Figure 17, the parents choose $\underline{\alpha}$ where the marginal benefit equalizes the marginal cost. In the diagram, when $\alpha = \underline{\alpha}$, the slope of knowledge growth function is equal to $(w_1 + c)/\delta \cdot \theta$. The net benefit the parents receive is AC.

When $\alpha = \hat{\alpha}$, the slope of knowledge growth function is larger than $(w_1 + c)/\delta \cdot \theta$, suggesting that the marginal benefit from education is greater than its marginal cost. $\alpha = \hat{\alpha}$, therefore, is not an optimal solution to the parents. They would allocate more time of the child to education until $\alpha = \underline{\alpha}$ where optimal condition holds. The gain from $\alpha = \hat{\alpha}$ to $\alpha = \underline{\alpha}$ can be shown by looking at the net benefit the parents receive in these two cases. When $\alpha = \hat{\alpha}$, the net benefit is only DE, which is equal to BC. So the profit AB can be obtained by moving from $\hat{\alpha}$ to $\underline{\alpha}$.

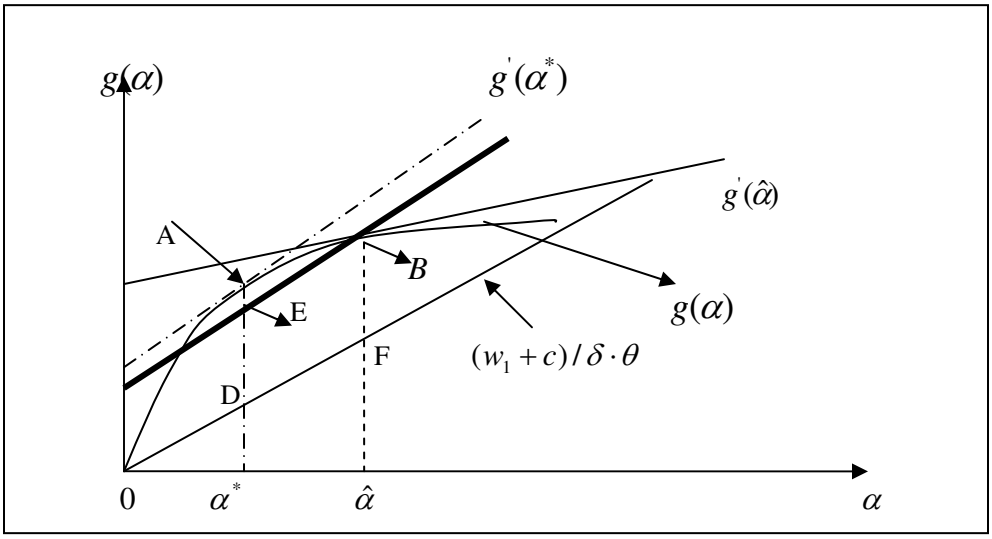
Government policy has an impact

When the government policy has an impact, it must satisfy $\lambda > 0$ in the relations characterizing the solution. Since $\lambda > 0$, and $-(w_1 + c) + \delta \cdot \theta \cdot g'(\alpha) + \lambda = 0$, it's must be true that $-(w_1 + c) + \delta \cdot \theta \cdot g'(\hat{\alpha}) < 0$, that is $\delta \cdot \theta \cdot g'(\hat{\alpha}) < (w_1 + c)$.

Note that, on the absent of the governmental regulation, the parents would choose α^* such that $\delta \cdot \theta \cdot g'(\alpha^*) = (w_1 + c)$. Given that g' is a decreasing function of α, if must be true that $\alpha^* < \hat{\alpha}$.

In Figure 18, we can see that, without governmental intervention, the optimal choice for the parents is point α^* where the marginal benefit, $g'(\alpha^*)$, is equal to the marginal cost $(w_1 + c)/\delta \cdot \theta$.

Figure 18. Compulsory Law Has Impact on Schooling Time



As illustrated Figure 18, at point $\hat{\alpha}$, where the marginal benefit is $g'(\hat{\alpha})$ and the marginal cost remains unchanged as $(w_1 + c)/\delta \cdot \theta$, the line $\alpha \cdot (w_1 + c)/\delta \cdot \theta$ has a steeper slope than line $g'(\hat{\alpha})$.

When α^* is the choice, the profit is the distance between A and D. When $\hat{\alpha}$ is the choice, the profit is the distance between B and F. The government regulation apparently has a negative impact on the household income since the profit at $\hat{\alpha}$ is smaller than that at point α^*. In other words, when schooling time increases from $\hat{\alpha}$ to α^*, profit decreases from AD to ED(where ED is equal to BF).

The compulsory education law and household's choice

Recall that the household will incur significant loss if the marginal benefit is smaller than the marginal cost at the level of schooling time required by the government. The households would choose α^* rather than $\hat{\alpha}$ regulated by the government if they were free to make decisions. The easiest way to increase demand on education based on our simple model is to lower the school fees. The government, however, may be constrained by the financial resource available.

The evolution of education policies in China provides a natural experiment on how government policies influence the education decisions household make. In the past two decades, the major policy tool used in compulsory education is that the parents are required by the law to send their children to schools. The school operation is financed jointly by the public funds and school fees collected from the parents. Alternatively, starting from 2003 and still in process, the governments offer a free education program.

We first analyze the behaviors of households whose optimal α^* is smaller than what government requires, $\hat{\alpha}$, given the potential punishment received if fail to comply

with the obligations specified in the compulsory law and other regulations. We then examine the impact of newly established education policy, free education, on the behavior of households in the next section and make some comparisons on these two policies.

Since 1986, the households in China have been assigned the responsibility to have their children educated for at least 9 years. The households are expected to keep their children in schools no matter what the price of the education services are. This arrangement can be justified since the households and the children benefit most from the education even though education has positive externalities. However, this policy suffers from two problems. First, the governments, in particular local governments, have no incentives to make the schools operate efficiently. The increased costs can only be covered by charging the household a higher school fees. Second, the dropout rate in primary and lower-secondary stages of school is not small. This is because the increased school fees make schooling relatively unattractive. What's more, the means used by the governments to force households to send their children to schools are limited. According to Section 1,in Article 11, *the Law of Compulsory Education*: "the parents must send their children in school….." In addition, article 40 of *the Implication Rule of the Law of Compulsory Education* says, if fail to meet the obligation to send their children to school, the parents will be fined. But this was never effectively implemented. The government should take other more effective means to force the students to go back to schools.

In this context, the household whose α^* is smaller than $\hat{\alpha}$ would expect a penalty, or fines from the government when they make decision on α^*. In other words, when a household chooses α^*, at the same time, it would expect that there is a possibility, π,

of being fined for the amount of F . A bigger difference between α^* and $\hat{\alpha}$ means a higher fine. Since detecting the failure of compliance by the households is expensive, the government may not be able to find out all failures in their jurisdictions. The household, therefore, has the opportunity of $(1-\pi)$ if it fails to comply with the law but successes in avoiding being punished by the government.

$$\underset{\alpha\in[0,1]}{Max}(1-\pi)\{[w_1-(w_1+c)\alpha]+\delta\cdot\theta\cdot g(\alpha)\}+\pi\{[w_1-(w_1+c)\alpha]+\delta\cdot\theta\cdot g(\alpha)+F(\alpha-\hat{\alpha})\}$$

This is equivalent to

$$\underset{\alpha\in[0,1]}{Max}[w_1-(w_1+c)\alpha]+\delta\cdot\theta\cdot g(\alpha)+\pi F(\alpha-\hat{\alpha})$$

The added term is used to capture the effect of the fine specified in the law. Note that when $\alpha\geq\hat{\alpha}$, this term automatically disappear.

The FOC for this maximization problem is

$$\delta\cdot\theta\cdot g'(\alpha)+\pi F=(w_1+c)$$

The LHS of the FOC is marginal benefit of additional unit of time goes to schooling. Compared with the case without government penalty, the marginal benefits increases from $\delta\cdot\theta\cdot g'(\alpha)$ to $\delta\cdot\theta\cdot g'(\alpha)+\pi F$. The second term is the reduction in the fine if one more unit of time goes to schooling. This is to say that each and every unit of time has more value to the household than before. The RHS is again the marginal cost of schooling.

Alternatively, if we treat the LHS as the marginal cost of child labor, the first term is the opportunity cost forgone when one more unit of time goes to labor market. The second term is the increased expected fines incurred for one more unit of child labor.

We write the FOC as

(4,1) $\delta \cdot \theta \cdot g^{'}(\alpha) - w_1 = (c - \pi F)$

The Free Education Plan and the Household's Behavior

The key of the Free Education Plan is, as we mentioned earlier, the household does not need to pay school fees any more. In this context, the maximization problem facing the household is the following

$$\underset{\alpha}{Max} : w_1(1-\alpha) + \delta \cdot \theta \cdot g(\alpha)$$

The FOC is $-w_1 + \delta \cdot \theta \cdot g^{'}(\alpha) = 0$, the optimal choice of α is therefore determined by

(4,2) $\delta \cdot \theta \cdot g^{'}(\alpha) - w_1 = 0$.

The Impacts of Two Governmental Policies

Based on (4, 1) and (4, 2), it's hard to tell which way is more effective to increase schooling time. The parents' choice in these two cases apparently is determined by the value of $(c - \pi F)$. To summarize, we have proposition 4, 1.

Proposition 4, 1, the relative performance of Free Education Plan and Compulsory Education Law is summarized in the following:

(i), Free Education Plan has better performance than Compulsory Education Law in increasing α if and only if $(c - \pi F) > 0$.

(ii), Compulsory Education Law has better performance than Free Education Plan in increasing α if and only if $(c - \pi F) < 0$.

(iii), there is no difference between Free Education Plan and Compulsory Education Law in increasing α if and only if $(c - \pi F) = 0$.

The LHS of (4, 1) is exactly the same as that of (4, 2), and it can be interpreted as the net benefits from education. If $(c - \pi F) > 0$, the LHS of (4, 1) is bigger than that of (4, 2). Given w_1 is fixed, the only way to increase the LHS of (4, 1) is to make $g'(\alpha)$ bigger. In this case, the optimal choice of schooling time, denoted by α_{law}, should take a bigger value than that of free education plan, denoted by α_{free}, according to the concavity of growth function, $g(\alpha)$.

Following the similar procedure, we can easily obtain (ii) and (iii) of Proposition 4, 1.

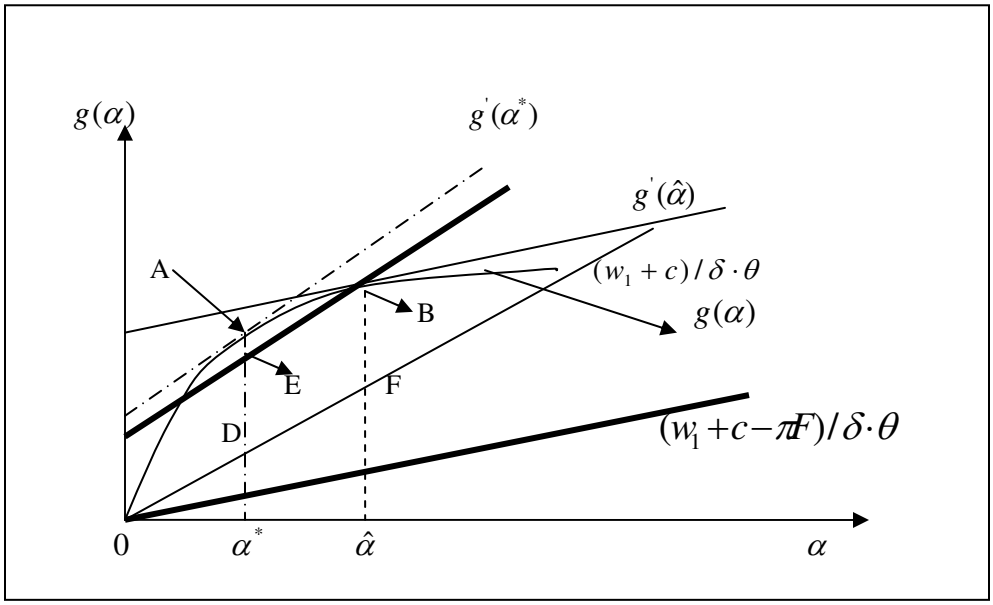
The Effectiveness of Compulsory Education

To see the impact of this policy, we rewrite (4, 1) as $g'(\alpha) = (w_1 + c - \pi F)/\delta \cdot \theta$. Compared with the case without fines, the RHS now becomes smaller. This means that the marginal cost of schooling is smaller than before. This is illustrated in Figure 19.

Recall that without governmental intervention the household would choose α^* since at that point $g'(\alpha^*) = (w_1 + c)/\delta \cdot \theta$. From $g'(\alpha) = (w_1 + c - \pi F)/\delta \cdot \theta$, we can see that, for each and every unit of time goes to schooling, the marginal cost become smaller.

We copy the diagram here and draw the new marginal cost line, $(w_1 + c - \pi F)/\delta \cdot \theta$ in the diagram. Apparently, the line $(w_1 + c - \pi F)/\delta \cdot \theta$ has a smaller slope than $(w_1 + c)/\delta \cdot \theta$ does.

Figure 19. Free Education Plan and Schooling Time



Since $g'(\hat{\alpha}) < (w_1 + c)/\delta \cdot \theta$, we are always able to find a specific value of πF such that $g'(\hat{\alpha}) = (w_1 + c - \pi F)/\delta \cdot \theta$. The government can either increase the amount of fine, F, or alternatively increases π in order to reduce the marginal benefits of child labor. By this way, the goal of compulsory education can be reached. Each and every child receives at least a level of education, $\hat{\alpha}$.

Theoretically, this policy seems work very well since it has positive impact on schooling and therefore a useful weapon to fight child labor. It's hard, however, to find evidence to support this claim.

Empirical Findings in Global Context

As we mentioned earlier, child labor has been widely treated as something bad and many laws or policies had been proposed to reduce it. This anti-child labor movement started as early as in the early 19th century in the U.K. In 1802, a bill called "The Health and Morals of Apprentices Act" was passed in Parliament of the United

Kingdom. The basic goal of this bill was to deal with child labor which subjected children to suffer dehumanizing conditions in factories.

In the United States, the first child labor law was passed by the State of Massachusetts in 1837. The goal of the law was to forbid firms to hire children under 15 years old who failed to have three months of schooling in the previous year. Employers who violated this law would be subjected to a $50 fine (Moehling 1999). Following Massachusetts, the State of Vermont initialized its child labor law in 1867. The last state to adopt a child labor law was the State of Mississippi, which passed its version of a child labor law in 1918. It took almost 80 years to make child labor laws effective in all areas of the United States. At the same time, similar laws were passed in the European countries. For example, France in 1842, Belgium in 1886, Demark in 1873, and Germany in 1839, passed the similar legislations as responses to child labor (Hobbs, Mckechnie, and Lavalette 1999).

Two hundred years later after the United Kindom passed its first child labor law, child labor is still the topic of ongoing debate. For example, some law-makers in the United States once issued a legislation to ban all import of goods made by child labor. Even in developing countries, governments try hard to fight child labor. For example, Weiner (1991) documents that the Sri Lankan government enforced compulsory education in the 1920's and 1930's in order to reduce child labor (p. 173). The recent case on fighting child labor comes from China. In 1986, the Chinese Congress passed a law called "The Act of Compulsory Education" which stipulates that all children should receive at least 9 years of education. In other words, all children should finish lower-secondary education in China, according to the law.

The effectiveness of compulsory measures against child labor could be easily justified based on sound theoretical models (Dessy 2002). There is also some supportive evidence available. As shown in Table 4, Chapter 1, the child labor participating rate in the U.S. reached its highest level in 1900, when 21.66% of American children were working. This ratio decreased to 5.56% in 1930. Several studies attributed this dramatic decline in child labor participating rate to the legislations of child labor or compulsory education laws. For example, Angrist and Krueger (1991) tested empirically the impact of compulsory education law on school attendance. They find that the laws have statistically significant and positive impact on school attendance. Their findings are supportive to the hypothesis that the child labor law works well in reducing child labor. By following the same estimation strategies used by Angrist and Krueger (1991), Margo and Finegan (1996) find similar results, that the education compulsory law has important impact on school attendance (Margo and Finegan 1996).

Some empirical findings, however, suggest that the link between laws and lower child labor participating rate is weak. For example, Moehling (1999) concludes that the dramatic decline of child labor participating rate was "not driven by the legislative success of the child labor movement" (p. 95). Moehling clearly states that "the state child labor law contributed little to the long-run decline in the child labor" (p.74).

Many studies found that factors, such as technological changes, increased wages in the labor market and that increases in supply of unskilled immigrants were more important than laws in explaining the decline of child labor (Brown, Christiansen, and Philips 1992; Goldin 1979; Osterman 1979, 1980; Parsons and Goldin 1989). For example, Brown et al. (1992) "found that child labor was virtually eliminated in

technologically advanced urban canneries well before it was reduced in the technologically lagging rural canneries and well before the effective application of legal restrictions." Based on evidence in Britain, Nardinelli (1980) convincingly shows that the hypothesis that law played an important role in reducing child labor in textile industries in 19th century Britain should be rejected.

Empirical Findings in China

In the context of compulsory education law in China, many government documents and empirical studies find evidence against the statement that the compulsory education policy is a useful policy tool. First, according to the data released by the Department of Education (MOE), the enrollment rate in rural China was only 94.3% (MOE 2004), which suggests that the number of children stay out of school is surprisingly high. For example, in 2003, the total of primary schools students was 116.897 million (Statistics Yearbook of China 2004), then there were over 7 millions, or 5.7% of children at the same age stay out of schools.

In the Province of Guangdong, one of the richest provinces in China, according to the report of its census agency, the enrollment rate is only 98.3%. In the relatively poor area of Guangdong, the enrollment rate went down to 95.6%. Another study (Li and Yang 2006) shows that in Longchuan County, Yunnan Province, the class enrolled in 1999 had 52 students on the roster. In 2004, the same class shrunk to only two students. According to these authors, 98% of students dropped out of school. This is not a special case. Another class started with 37 students in 2000, but had only 12 students left in 2005. The authors also report that in Dehong Prefecture, to which Longchuan County belongs, the average dropout rate is 30% in rural areas.

The dropout rate significantly increases in lower-secondary education. In the study we mentioned above, Li and Yang (2006) find that in one of the middle schools in Ruili City, the dropout rate is fairly high. For example, in 2002, the 7th grade has 428 students enrolled. The number of students had decreased to only 251 by the 10th grade, in 2004.

In a widely-cited study, the information Yuan et al. (2004) provided was shocking. The sample in their study consists of 33 counties located in 17 provinces. Among the 33 counties, special attention was paid to 6 counties. The authors visited all lower-second schools in every township in all these 6 counties. The dropout rates in different counties are summarized in Table 5.

Table 5. Dropout rates in Selected Counties in China

School	Dropout rate %	School	Dropout rate %
East China A	9.38	Northeast China E	28.93
East China B	50.47	Northeast China F	69.61
East China C	48.96	Northeast China G	55.92
East China D	39.34	Northeast China H	74.37
East China E	41.97	Northeast China I	18.11
Northeast China A	30.00	North China A	4.54
Northeast China B	73.23	North China B	39.05
Northeast China C	70.91	South Middle China	20.52
Northeast China D	54.36	Sample AVERAGE	42.92

Source: Yuan et al. (2004), p. 15.

What Yuan et al. found is really astonishing. In the 17 samples, 7 counties have dropout rates higher than 50%. In other words, 40% of schools experience losses of over 50% of their students at the lower-secondary stage. In one extreme case, a county in Northeast China lost 74.37% of their enrolled students.

Note that the counties in the sample are located in the relatively rich areas in China. If we accept the assumption that dropout rate is negatively related to GDP per capita, as suggested in their studies, the dropout rates in western and middle China could be even higher. The overall dropout rate in lower-secondary education could be much higher than the sample average in this study, 42.92%.

Why Does Compulsory Education Law Fail?

The evidence in the empirical studies is not providing support to the Law of Compulsory Education. It seems that the threat that households will be fined if they fail to guarantee compulsory education for their children does not work very effectively. This should not be a surprise, since the threat made by the governments is not credible. First, the fine F is hardly a good measure. As we mentioned in Chapter 1, child labor is sometimes related to poverty. In practice, governmental agencies may not fine a very poor household that fails to follow compulsory education law. In addition, the effectiveness of the mechanism to enhance schooling specified in the compulsory education law critically depends on the credibility of the threat. If all households believe that the threat will actually be enforced, the opportunity cost of child labor will be higher. When the child goes to labor market, the household receives wage rate, w_1 and a saving in school fees, c, while suffers a potential loss, πF. The equilibrium choice for the households will be $\hat{\alpha}$, required by the governments. If the potential loss has never been realized before the parents make their decision, the household may feel that the marginal benefit of child labor is not as low as in the case with potential loss. As a response, the households should move back to α^*.

The key issue here is π, the probability of being fined by the government. If households believe that they will be fined for sure if they fail to send their children to school, then $\pi = 1$. Then what the government needs to do is to find a value of F, which makes $\hat{\alpha}$ guaranteed. If the households believe that there is no fine will be enforced whatever they do, then $\pi = 0$. In this case, the value of F does not matter since the product of π and F is zero and the cost line goes back to the original one. Some evidence supports our argument of $\pi = 0$. For example, as argued in Landers and Solmon (1972) and Eisenberg (1988), the Compulsory Schooling Legislation failed to increase school attendance in the history of the United States. The basic reason was that the laws were imperfectly enforced. The United Kindom had the similar experience. For example, Tuttle (1999) claims that "it appears that the Education laws were as ineffective as the Factory Acts in deterring families from making the collective decision for children to work (Tuttle 1999)."

Effectiveness of Free Education Plan

The Dropout Rates and School Fees

The dropout rates in primary and lower-secondary schools in rural China force the Chinese policy makers to think of alternative ways to provide education service in rural China. If the dropout rates remain unchanged, due to the huge population base in China, millions of illiterates will result under the existing education system. Such a big illiterate population will in turn become a big problem for the society. First, the economy may suffer a shortage of skilled labor that has already alarmed researchers and business community (Farrell and Grant 2005). Second, given the trend of the population size getting smaller in the future, the future generation needs to be more productive in order to

improve or maintain the current living standards. In this context, maintenance of certain living standards turns out to be a formidable task for the society if a big part of the labor force consists of millions of untrained workers.

Many efforts have been made by the Chinese governments since 2001. The governments first reorganized the school finance system in 2001. The responsibility to finance schools was shifted from township governments to counties in order to reduce the disparities within the same county. At the same time, the central government significantly increased education grants for the relatively poor western region of China. These efforts have been working in reducing debt burden of schools and have been helpful to keep the schools operating smoothly.

These efforts, however, are less useful to reduce the financial burdens facing the households with children in schools. The high dropout rates in the rural areas are widely regarded as the consequences of high school fees charged to the households (Cai, Liu, and Tao 2005; Li 2005; Statistics Bureau of Hunan Province 2002).

Using a data set consists of 361,000 observations from 120 villages in 10 provinces; Cai et al. (2005) conclude that schools fees take up a significant share of the total income for rural households in China. In 1995, on average, each household spent 10% of total income on education. This share increased to 16% in 1999. In addition, from 1995 to 1999, in all 10 provinces, the mean value of this share increased year after year. There are also cases in which the share is bigger than 1, which shows all household income is not enough to pay school fees (Cai, Liu, and Tao 2005).

The empirical findings in Li (2005) show that the mean values of education expenditures per student in primary and lower-secondary schools were 389 Yuan and 924

Yuan respectively (Li 2005). The mean value of household education expenditure is 1,404 Yuan. In other words, 20.03% of households' total income goes to education. In addition, 21.84% of the households borrow from friends to pay school fees (Li 2005).

Poor households experience more hardship to pay for the education expenditures. And the expenditure on education is a burden for not only rural people, but also poor households in urban areas. A report released in 2002 by the Statistics Bureau in Hunan Province shows that, in the 205 poor urban households surveyed, the average education expenditure is 2,408 Yuan while the average household income is only 3,885.2 Yuan. This means that urban poor families have to allocate 62% of their incomes to pay education fees. In the same government document, the surveyed 60 rural poor households spent, on average, 2,324 Yuan on education while the average income is only 2,523.8 Yuan. This means that the poor households in rural areas spent 92.1% of their incomes on education. What's more, several households failed to pay school fees even after exhausting all of their incomes.

Once the negative impact of high school fees on dropout rates is realized, the State Counsel, the central government, issued a new policy in 2005: *The State Counsel's Decision on Financing Compulsory Education in Rural Areas* (State Counsel 2005). This is the so-called "Free Education Plan." The core of this new policy is to abolish all school fees in the rural areas of China. Textbooks are also free for poor students. There are some subsidies for students in boarding schools. The costs are shared by the central government and provincial governments. For the western region, the share between the central government and the provinces is 8:2. For the middle region, the share is 6:4.

How Does Free Education Plan Change the Household's Choice?

Our simple model can be used to examine the impact of the Free Education Plan on schooling time. Again, we focus on the case where household's choice α^* is less than the level, $\hat{\alpha}$, required by the government.

The profit from α^* is $netbebefit(\alpha^*) = w_1 - (w_1 + c_1)\alpha^* + \delta \cdot \theta \cdot g(\alpha^*)$

The profit from $\hat{\alpha}$ is $netbenefit(\hat{\alpha}) = w_1 - (w_1 + c_1)\hat{\alpha} + \delta \cdot \theta \cdot g(\hat{\alpha})$ where c_1 is the school fees charged to the households before the Free Education Plan was initialized.

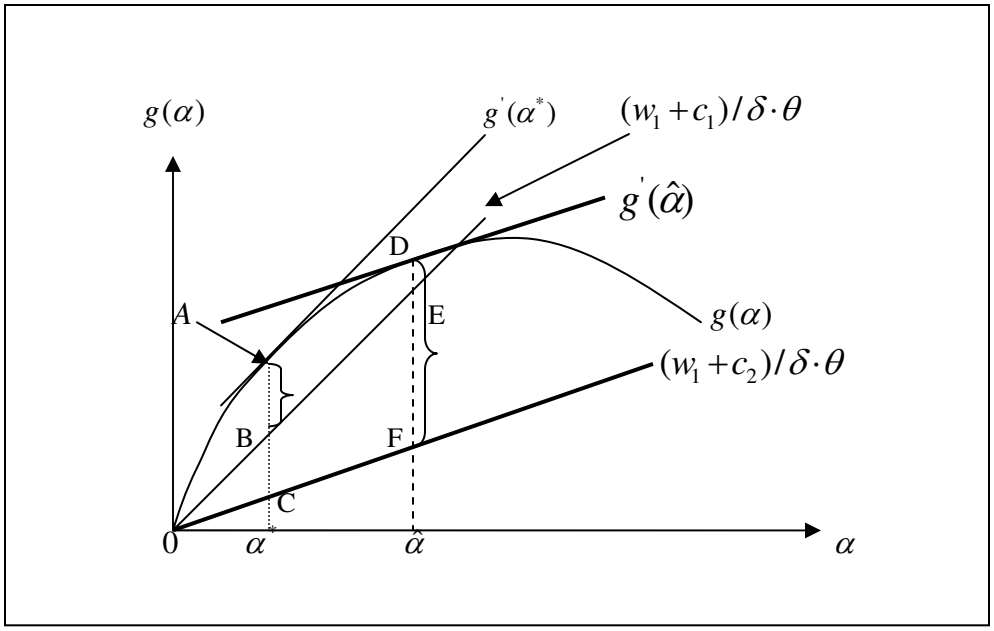
We know that when $\hat{\alpha}$ is available while α^* is chosen, We have $netbenefit(\alpha^*) > netbenefit(\hat{\alpha})$: the profit from α^* is bigger than the profit from $\hat{\alpha}$. From $netbenefit(\alpha^*) > netbenefit(\hat{\alpha})$, we have

$w_1 - (w_1 + c_1)\alpha^* + \delta \cdot \theta \cdot g(\alpha^*) > w_1 - (w_1 + c_1)\hat{\alpha} + \delta \cdot \theta \cdot g(\hat{\alpha})$. This can be rearranged as

(1) $\delta \cdot \theta \cdot g(\alpha^*) + w_1(\hat{\alpha} - \alpha^*) + c_1(\hat{\alpha} - \alpha^*) > \delta \cdot \theta \cdot g(\hat{\alpha})$

In (1), the LHS side is the benefit of choosing α^*. The first term is the benefit when α^* unit of time goes to schooling and the second term is the wage earned by the difference between $\hat{\alpha}$ and α^*. The third term is the school fees saved by not attending to schools. The RHS is the benefit forgone and therefore the cost of choosing α^*.

Figure 20. the Loss in Benefit Caused by Compulsory Education Law



In Figure 20, when α^* is chosen, the profit is AB. If following the law, the profit is DE.

With the Free Education Plan, the school fees decrease from c_1 down to c_2. In the new context, choosing α^* is not an optimal choice any more. At α^*, we know that $g'(\alpha^*) = [(w_1 + c_1)/\delta\cdot\theta] > [(w_1 + c_2)/\delta\cdot\theta]$, one more unit of α will be profitable since the marginal benefit is larger than the marginal cost. This process will continue until point $\hat{\alpha}$ is reached.

In other words, when the school fees change from c_1 to c_2, the necessary condition for the household to choose $\hat{\alpha}$ rather than α^* is $netbenefit(\alpha^*) < netbenefit(\hat{\alpha})$, so we have

(2) $\quad \delta\cdot\theta\cdot g(\hat{\alpha}) > \delta\cdot\theta\cdot g(\alpha^*) + w_1(\hat{\alpha}-\alpha^*) + c_2(\hat{\alpha}-\alpha^*)$

In (2), the LHS is the total benefit from $\hat{\alpha}$ while the RHS is the costs of choosing $\hat{\alpha}$. For the RHS, the first term is the benefit from education when α^* unit of time goes to school. The second term and the third term are the wage income forgone and the increased school fees when $(\hat{\alpha} - \alpha^*)$ unit of time increased to schooling respectively.

By combining (1) and (2), we can find the maximum value of school fees c in order to make $\hat{\alpha}$ chosen by the household. We therefore have

$$(w_1 + c_2)(\hat{\alpha} - \alpha^*) < \delta \cdot \theta \cdot g(\hat{\alpha}) - \delta \cdot \theta \cdot g(\alpha^*) < (w_1 + c_1)(\hat{\alpha} - \alpha^*)$$

$$(w_1 + c_2) < \delta \cdot \theta \cdot [g(\hat{\alpha}) - g(\alpha^*)]/(\hat{\alpha} - \alpha^*) < (w_1 + c_1)$$

$$(3) \qquad (w_1 + c_2) < \delta \cdot \theta \cdot g'(\hat{\alpha}) < (w_1 + c_1)$$

From (3), we can find that the maximum value of c_2 is[6]

$$(4) \qquad c_2 < \delta \cdot \theta \cdot g'(\hat{\alpha}) - w_1$$

(4) states that if the governments want the households automatically choose $\hat{\alpha}$, the highest school fees that can be collected from the households is $[\delta \cdot \theta \cdot g'(\hat{\alpha}) - w_1]$.

The effectiveness of Free Education Plan

As we argued earlier in this chapter, to fight child labor, reducing school fees is a better weapon than compulsory education law. As Weiner (1991) concludes, "The Kerala government has made no special effort to end child labor. It is the expansion of the school system rather than the enforcement of labor legislation that has reduced the amount of child labor (p. 177)." Since more funds went into mass education, Kerala's education performance is remarkable. According to the World Bank (1995), the dropout rate was almost zero. Literacy rates for both males and females significantly increased. The

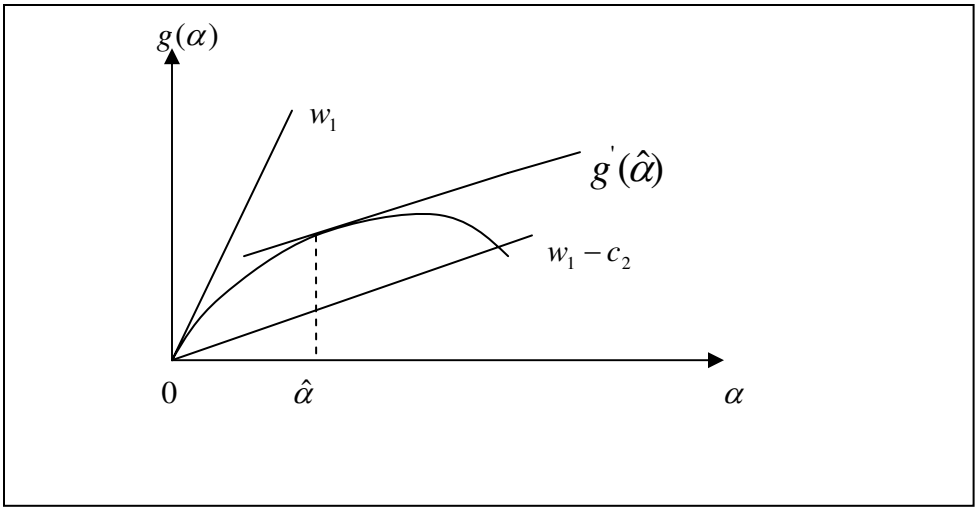
[6] Alternatively, the maximum c can be determined by choosing a value of c to make $\delta \cdot \theta \cdot g(\hat{\alpha}) = (w_1 + c)$ hold.

strategy to lower school fees was proved a good tool to fight child labor. In 1971, the child labor participating rate in Kerala was 1.9%, much lower than those of other states in India, which stood at 7.1% according to Weiner (1991).

We now focus on the analysis of effectiveness of free education plan. Note that $[\delta \cdot \theta \cdot g^{'}(\hat{\alpha}) - w_1]$ represents the net benefit from education for given school fees c_2. It can be positive or negative. If the wage rate in labor market is high or the growth rate in $\hat{\alpha}$ is low, subsidies may be necessary to attract households to allocate $\hat{\alpha}$ unit of time in schooling.

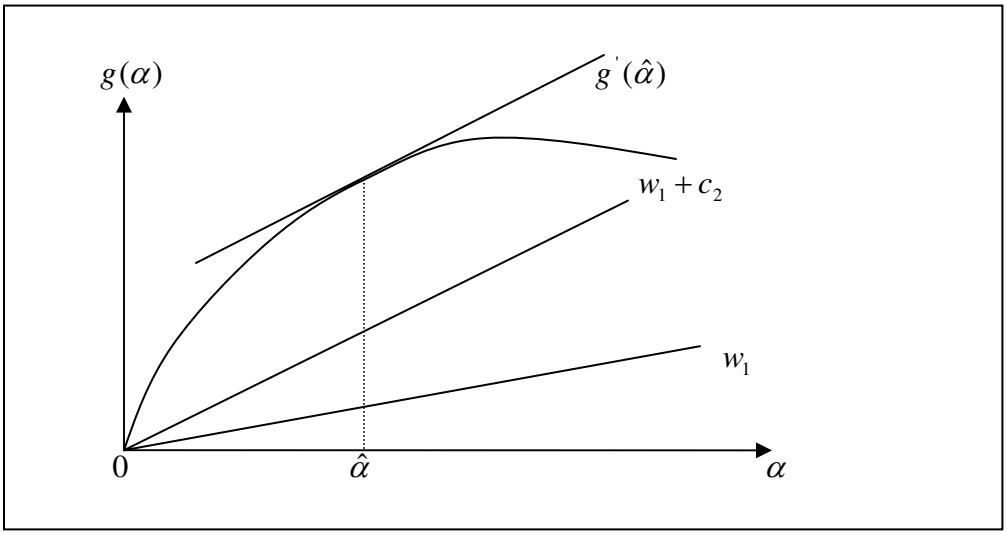
We first consider a case where the wage rate is high while the growth rate at $\hat{\alpha}$ is modest, so $[\delta \cdot \theta \cdot g^{'}(\hat{\alpha}) - w_1]$ is negative. In this case, c_2 should be negative. The governments therefore should subsidize the households in order to make $\hat{\alpha}$ chosen. In the real life, if a child cannot learn much from schooling and the child labor in labor market is well paid, to draw this child back from labor market, some compensation (negative school fees) may be necessary rather than charging the household school fees (see Figure 21).

Figure 21. The Case Schooling Time Should Be Subsidized



We now consider another scenario where the wage rate is low while the growth rate at $\hat{\alpha}$ is high. The value $[\delta \cdot \theta \cdot g'(\hat{\alpha}) - w_1]$ is positive. The governments therefore have some rooms in this case to charge the households school fees. For example, in Figure 22, a positive c_2 can be charged at the same time when the required $\hat{\alpha}$ is satisfied.

Figure 22. The Case Schooling Time with School Fees

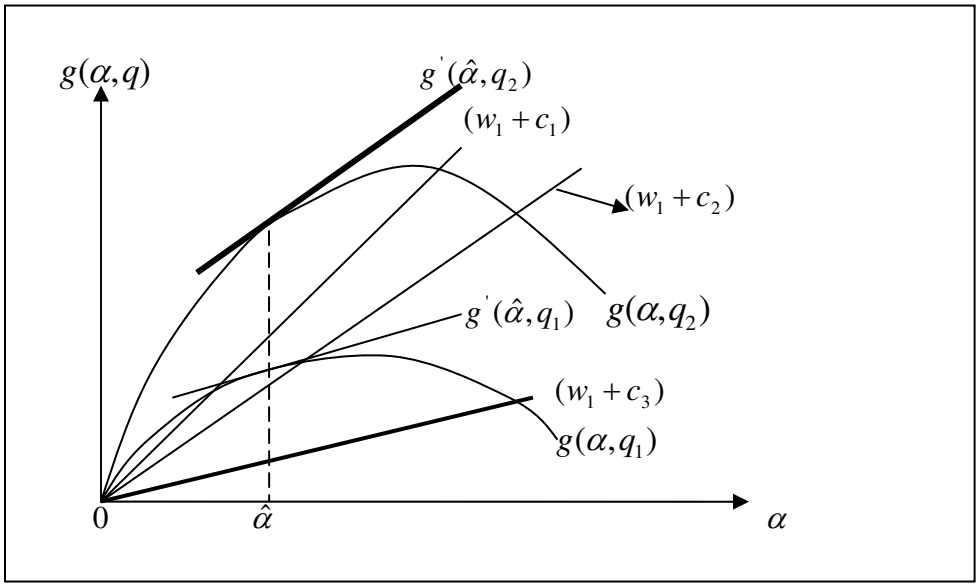


The Free Education Plan has different impact on the children who differ in the abilities to study. For example, where there are two children, and everything else is identical except for the ability to learn. Suppose that child 2 is smarter than child 1 and can accumulate more in any given time allocated to schooling, so we have $g'(\hat{\alpha}, q_2) > g'(\hat{\alpha}, q_1)$. When both are facing the opportunity cost $(w_1 + c_1)$, $\hat{\alpha}$ will not be chosen since, for the two children, the marginal benefits are smaller than the marginal costs at $\hat{\alpha}$.

When the school fees decrees from c_1 to c_2, child 2 will choose $\hat{\alpha}$ since at this point $g'(\hat{\alpha}, q_2) = (w_1 + c_2)$. Child 1, however, will not choose $\hat{\alpha}$ since child 1's marginal gain is still lower than his marginal costs at $\hat{\alpha}$. In other words, the school fees are cheaper than before, but not cheap enough.

When school fees further decrease to c_3, child 1 will choose $\hat{\alpha}$. It's easy to see that in Figure 23, under the new constraint, child 2 will choose the level higher than what governments require.

Figure 23. School Fees and Schooling Time when Children Differ in Quality of Talent



The Efficiency and Redistribution Effects of These Two Policy Tools

The Efficiency

According to Blundell et al. (2001), the returns from education can take three forms: the private return, the social return and the labor productivity. Since Schultz (1961), Becker (1964), and Nelson and Phelps (1966) introduced the concept of treating education as human capital, education has long been taken as an investment. As we argue in the early chapters, when time of the child is allocated into schooling, the skills or stock of knowledge will increase. The growth of knowledge is by no means free. To harvest the gain, the households have to suffer forgone cost, the wage income in labor market and the school fees paid to school.

The private return from education is simply the increase in individual earnings that results from allocating an additional unit of time to schooling. According to Card (1999), this return is about 6 to10%. The social return from education is the increase in total earnings brought about by one more additional unit of time allocated to schooling. The difference between social and private returns from education is called the education externalities.

The education externalities play an important role in economic growth. For example, Lucas (1988) argues that worker's productivity depends on the aggregate level of skills and knowledge all workers own. Barro (1991; 1997; 2001) also explores the role of education in the same direction. In addition, Mankiw, Romer and Weil (1992) argue that the difference in human capital plays an important role in explaining the huge disparities among different counties. More interestingly, Romer (1990) argues that there are dynamic externalities. His idea is that economies with more skilled laborers would

generate more ideas and grow faster. In other words, he emphasizes the role human capital stock plays in creating and adopting new technologies. The empirical evidence is supportive to this idea.

The empirical studies find evidence that support the hypothesis that there exist positive externalities. Rauch (1993) was the first who tried to estimate the social return from education and found positive externalities of 3-5%. By using micro data collected in Kenya, Manda et al. (2004) find empirical evidence to show that an increase in education benefits all workers. This is a sign that human capital has positive externalities. Dalmazzo and Blasio (2004), using data from local labor market in Italy, also find evidence to support the positive externalities.

In addition, there is some evidence on the dynamic externalities. For example, in examining the role of human capital stock in economic growth, Benhabib and Spiegel (1994) find significantly positive effects.

As far as the Free Education Plan is concerned, it seems that justifying the increases in budgetary funds should be easily made. In 2004, there were over 112.46 million students in primary schools and 65.2751 million students in lower-secondary schools (MOE 2005). As an important component of the Free Education Plan, the central government initiated, in December 2005, a new program to help students to enjoy education services freely. The estimated amount of newly added budget funds is about 218.2 billion Yuan, according to the information released by the State Counsel in 2005 (Lv 2005). This new fund will be used to compensate for the schools' deficits resulting from the Free Education Plan. The schools experience cash shortages once the Free

Education Plan takes effect. This is because the school fees played important roles in balancing schools budgets.

The plan and its related financial package are supposed to increase the time allocated to schooling. To achieve this goal, the plan reduces the opportunity costs of schooling and therefore makes the schooling more attractive. As a response to the changes in the relative returns between child labor and schooling, the households allocate more units of time of their children into schooling since the opportunity cost of schooling becomes smaller than before. This in turn results in reductions in child labor.

In terms of efficiency, we first note that if the social time discount factor is smaller than those of households, the Free Education Plan can be justified easily. Without this plan, some households would not choose $\hat{\alpha}$, the level the governments require. If the opportunity costs decrease from $(w_1 + c_1)$ to $(w_1 + c_2)$, the households would now choose α^*. The private gain caused by this change in policy is $\delta \cdot \theta \cdot [g(\alpha^*) - g(\hat{\alpha})]$ while the cost is $(c_1 - c_2)$. From the perspective of society, the net benefit is the gap between $\delta \cdot \theta \cdot [g(\alpha^*) - g(\hat{\alpha})]$ and $(c_1 - c_2)$. We know that households and the government may differ in the value of δ. For example, the rural households may have smaller life expectancies than the average of the society. If the government represents the interests of the average, the expected benefit could be greater than the costs incurred under the new scheme. In this case, we may have

$$\delta \cdot \theta_{private} \cdot [g(\alpha^*) - g(\hat{\alpha})] < (c_1 - c_2) \text{ and}$$

$$\delta \cdot \theta_{society} \cdot [g(\alpha^*) - g(\hat{\alpha})] > (c_1 - c_2)$$

In the 2003 China Statistics Yearbook, the national life expectancy of China is 71.4 years. However, all life expectancies in nine provinces in western China are lower than 71.4 years. The smallest margin, 0.2 years, is in the case of Sichuan, a relatively rich province in this area. There are four provinces whose life expectancies are 5 years lower than 71.4. The life expectancy in Tibet is only 62.52 years, which is the lowest and different from the national average by 7.03 years (see Table 6).

Table 6. Difference in Life Expectancy in Provinces in China

National and provinces	Life expectancy	Male Life expectancy	Difference with the national average	Difference between Male and the average
Average	71.4			
Sichuan	71.2	69.25	-0.2	-2.15
Guizhou	65.96	64.54	-5.44	-6.86
Yunnan	65.49	64.24	-5.91	-7.16
Tibet	64.37	62.52	-7.03	-8.88
Shanxi	70.07	68.92	-1.33	-2.48
Gansu	67.47	66.77	-3.93	-4.63
Qinghai	66.03	64.55	-5.37	-6.85
Ningxia	70.17	68.71	-1.23	-2.69
Xinjiang	67.41	65.98	-3.99	-5.42

Source: China Statistics Yearbook of Population, 2003, pp. 269.

If we accept the idea that most of the households' decisions in rural China are made by the fathers, the $\theta_{private}$ may go down further. We also add the male life expectancies in the nine provinces in question in the above table. We find that the difference between the life expectancies and the national average becomes even bigger. The smallest margin increases from 0.2 to 2.15 years. In addition, among these 9 provinces, there are 4 provinces whose male life expectancies are 6 years lower than 71.4

years. Again, Tibet's male expectancy is the lowest: 62.52 years, which is 8.88 years lower than the national average.

In this context, if the households in the 9 provinces use $\theta_{private}$ to make education decisions, for each value of school fees c, there exist expected benefits. For the same value of c, however, the benefit would be bigger from the perspective of government since θ_{public} is greater than $\theta_{private}$. In this sense, Free Education Plan in itself is efficiency-enhancing.

Second, if we accept the theoretical arguments and the empirical findings on human capital externalities, the Free Education Plan is a good way for governments to internalize the externalities in education. The households do not incorporate the externalities of α has. The Nash equilibrium of schooling time therefore is inefficient. To restore the efficiency, one way is to assign some responsibilities of financing education by levying taxes on those benefited from increased education level.

Third, from the perspective of demographics, the Free Education Plan has important policy implications. We know that the so-called "one family, one child" policy has been well implemented in urban areas only. In the rural China, limited methods or policy tools are available for governments to enforce the population control policy. The size of the rural population grows faster than the urban population. At the same time, most of dropouts take place in rural areas. As time goes on, the share of educated population shrinks while the share of unskilled population grows. In other words, the Chinese society may experience a pension crisis since the uneducated labor force will be less productive and less able to provide enough resources to the elders.

The Equity

The Free Education Plan also has important implications for equity issue. In terms of equity the society at least can gain in two ways. First, this plan has income redistribution effect. With the education compulsory law, in order to enjoy the gain at α^*, the households have to pay school fees c_1. So the first gain is the saved school fees c_1. Second, the households also get the increased gain $\delta \cdot \theta \cdot [g(\hat{\alpha}) - g(\alpha^*)]$ without paying any costs [the opportunity cost is $w_1(\hat{\alpha} - \alpha^*)$].

These two gains have important impact on the households and the income distribution in China. Given the high private return from education (Psacharopoulos 1994), each and every household with children in schools in rural China will benefit from the Free Education Plan. There are, of course, variations in the gains since households differ in the magnitude of $(\hat{\alpha} - \alpha^*)$. Households that have bigger differences in terms of $(\hat{\alpha} - \alpha^*)$ would benefit more.

More importantly, the implementation of the Free Education Plan would bring significant transfers to the relatively poor groups in rural areas. As mentioned earlier, the education expenditures impose a huge burden on rural households. For example, Cai et al. (2005) find that, on average, rural households have to allocate 16% of their incomes to pay for school fees in primary and lower-secondary education. Even in Guangdong, Zhejiang and Jiangsu, the richest provinces in China, rural households have to spend 10 to 13% of their net income in education. In the relatively poor areas, households spend even bigger shares of their income on education. In 1999, in Jilin, Hunan and Anhui, rural households spent over 20% of their income in paying school fees. In an extreme case, for rural households in Anhui, the sample mean of education expenditure as a share of total

income is 26%. In other words, households need to pay over one quarter of income for education fees.

Table 7. Education Expenditures in Selected Provinces in China

Province	Education expenditure	Education expenditure as a share of total income %
Guangdong	465	10
Zhejiang	233	12
Jiangsu	376	13
Henan	506	13
Shanxi	421	14
Gansu	137	15
Sichuan	243	16
Jilin	216	21
Hunan	245	21
Anhui	595	26

Source: Cai et al (2005), p. 4.

From the above table, we can see that in the nine provinces surveyed, all rural households spent at least 10% of their income on education in 1999. With the Free Education Plan, the education expenditure burden is relieved. The households in Guangdong Province have 10% more resources available than before. The households in Anhui Province gain even more, since 26% of their income is saved under this plan. The Free Education Plan therefore significantly reduces the education burden for rural households. Since there is a huge inequality between rural and urban areas (reference will be provided), the reduction in education fees in rural areas can serve as an instrument to curb the rising inequality problem in China.

Compulsory Education Law and Free Education Plan

If empirical evidence on education externalities found in other economies can be applied to China, we may believe that there are huge inefficiencies in the old compulsory

education law system. First, in terms of efficiency, the failure in implementing compulsory education law led to a reduction in the accumulation of knowledge. This in turn resulted in losses in education externalities for the society. Second, in terms of equity, the law assigned the responsibility of sending children to school to the households. This resulted in heavy financial burdens on rural households in China. As we mentioned above, in some areas, households had to spend 26% of their income in education fees.

The Free Education Plan does a better job in terms of both efficiency and equity. First, as we argued earlier, a higher level of knowledge will be produced since this plan provides strong incentives for rural households to keep their children in schools rather than make them work in the labor market. Second, this plan is also equity-enhancing. The abolishment of school fees means that there is, on average, a 16% increase in income for rural households. This implies that rural households have more revenues to spend on items such as housing, clothing and other goods.

In short, we conclude that as a policy tool, the Free Education Plan should be preferred to the traditional compulsory education law.

CHAPTER 5. CONCLUSION

Child labor is an important phenomenon in many developing countries. As we know, child labor is widely believed to have impotent impacts on societies. For example, it is negatively related to the accumulation of human capital. Huge efforts have been made to understand the determinants of child labor and make policy proposals to keep children away from labor markets. In the existing literature, poverty, credit constraint, globalization, and agency problem in the household are mentioned as major factors causing child labor. These explanations are surely useful to understand child labor. There are some observed facts are not consistent with what the theories predict, however. For example, we do observe the co-existence of poverty and schooling. We also observe that child labor exists in wealthy households. To solve the observed paradoxes, we need to develop some new theories.

In this dissertation, we develop a simple two-period model to examine the parents' optimal choice of children's time. We have made three contributions to the existing literature. First, we identify factors such as wage rate, school fees, education returns, degree of children's altruism toward their parents and the parents' discounting rate that influence the parents' optimal choice, and discuss their impacts on the optimal choice. Our study shows that, at equilibrium, the allocation of children's time is determined by the wage rate, school fees, education returns, degree of children's altruism and parents' discounting rate. In other words, as an economic resource, the allocation of children's time is determined by the relative returns from competing uses.

Our second contribution is that we provide a solution to the observed paradoxes. Many existing models in the literature cannot explain the coexistence of schooling, poverty and the coexistence of child labor and affluence. We show that, when education return is high and the household is willing to endure extra hardship caused by the child's attending school, the coexistence of schooling and poverty can emerge. On the other hand, when the wage rate for child labor and schooling fees are higher than education return, affluence and child labor can co-exist.

The third contribution we have made in this dissertation is that we provide a framework to evaluate governmental policies. As we know, governments have adopted various policy tools to fight against child labor, among which the compulsory education law and free education programs stand out. We show that the relative performance of the two policies depends crucially on several factors, including the enforcement and the costs to the household of the compulsory education law. We use the recent Chinese experience in changing the compulsory education law to a free education plan to illustrate and verify our theoretical prediction.

Appendix I

Proof of Proposition 2. 1:

Proposition 2. 1: Let q be given, the solution, α^*, to problem (2) is characterized as follows:

$(i), \alpha^* = 0,$ if and only if $\frac{\partial g(0,q)}{\partial \alpha} \le \frac{w_1 + c}{\delta \cdot \theta}$;

$(ii), \alpha^* = 1,$ if and only if $\frac{\partial g(1,q)}{\partial \alpha} \ge \frac{w_1 + c}{\delta \cdot \theta}$;

$(iii), 0 < \alpha^* < 1,$ if and only if $\frac{\partial g(0,q)}{\partial \alpha} < \frac{w_1 + c}{\delta \cdot \theta} < \frac{\partial g(1,q)}{\partial \alpha}$.

The maximization problem and constraints

(2) $$\underset{\alpha}{Max} : w_1 - (w_1 + c)\alpha + \delta\theta g(\alpha, q)$$

s.t.

(3) $\alpha - 1 \le 0$

(4) $-\alpha \le 0$

The Lagrange is the following:

$$L = w_1 - (w_1 + c)\alpha + \delta\theta g(\alpha, q) - \lambda_1(\alpha - 1) - \lambda_2(-\alpha)$$

F.O.Cs,

(5) $$(-1)(w_1 + c) + \delta \cdot \theta \cdot \frac{\partial g(\alpha, q)}{\partial \alpha} - \lambda_1 + \lambda_2 = 0$$

(6) $\lambda_1(\alpha - 1) \le 0, \quad (= 0, if\ \lambda_1 > 0 \quad)$

(7) $\lambda_2(-\alpha) \le 0, \quad (= 0, if\ \lambda_2 > 0 \quad)$

1, Proof of (i) of Proposition 2, 1.

We first show that $\frac{\partial g(0,q)}{\partial \alpha} \le \frac{w_1 + c}{\delta \cdot \theta}$ is the necessary condition for households choosing $\alpha^* = 0$.

When $\lambda_2 > 0$, it's easy to show that $\alpha = 0$ and $\lambda_1 = 0$. From (5), we have $\delta \cdot \theta \cdot \frac{\partial g(\alpha, q)}{\partial \alpha} + \lambda_2 = (w_1 + c)$. Since $\lambda_2 > 0$, we have the following:

(8) $$\frac{\partial g(0,q)}{\partial \alpha} \le \frac{w_1 + c}{\delta \cdot \theta}.$$

We now turn to show that $\frac{\partial g(0,q)}{\partial \alpha} \le \frac{w_1 + c}{\delta \cdot \theta}$ is also the sufficient condition for households choosing $\alpha^* = 0$.

When $\alpha^* = 0$, we suppose we have $\frac{\partial g(0,q)}{\partial \alpha} > \frac{w_1 + c}{\delta \cdot \theta}$ rather than $\frac{\partial g(0,q)}{\partial \alpha} \le \frac{w_1 + c}{\delta \cdot \theta}$, then an increase in the amount of time at margin will make the household better off since at $\alpha = 0$, the marginal benefit, $\frac{\partial g(0,q)}{\partial \alpha}$ is larger than the marginal cost, $\frac{w_1 + c}{\delta \cdot \theta}$. We thus have that $\frac{\partial g(0,q)}{\partial \alpha} \le \frac{w_1 + c}{\delta \cdot \theta}$ is the sufficient condition for $\alpha^* = 0$.

2, Proof of (ii) of Proposition 2, 1.

When $\lambda_1 > 0$, we have $\alpha = 1$ by condition (6) and $\lambda_2 = 0$ by condition (7). In addition, from (5), $\delta \cdot \theta \cdot \frac{\partial g(\alpha, q)}{\partial \alpha} = \lambda_1 + (w_1 + c)$. Since $\lambda_1 > 0$, we therefore have

(9) $\frac{\partial g(1,q)}{\partial \alpha} \geq \frac{w_1 + c}{\delta \cdot \theta}$, when $\alpha^* = 1$.

Following the similar procedure we used in the previous section, it's easy to find that $\frac{\partial g(1,q)}{\partial \alpha} \geq \frac{w_1 + c}{\delta \cdot \theta}$ is also the sufficient condition for $\alpha^* = 1$,

3, Proof of (iii) of Proposition 2, 1.

$(iii), 0 < \alpha^* < 1,$ if and only if $\frac{\partial g(1,q)}{\partial \alpha} < \frac{w_1 + c}{\delta \cdot \theta} < \frac{\partial g(0,q)}{\partial \alpha}$.

When $\lambda_1 = 0$ and $\lambda_2 = 0$, from (5), we have

(10) $\frac{\partial g(\alpha, q)}{\partial \alpha} = \frac{w_1 + c}{\delta \cdot \theta}$ when $0 < \alpha^* < 1$.

When $0 < \alpha^* < 1$, suppose that we have $\frac{\partial g(1,q)}{\partial \alpha} > \frac{w_1 + c}{\delta \cdot \theta}$, or $\frac{w_1 + c}{\delta \cdot \theta} > \frac{\partial g(0,q)}{\partial \alpha}$, rather than $\frac{\partial g(1,q)}{\partial \alpha} < \frac{w_1 + c}{\delta \cdot \theta} < \frac{\partial g(0,q)}{\partial \alpha}$.

First, if $\frac{\partial g(1,q)}{\partial \alpha} > \frac{w_1 + c}{\delta \cdot \theta}$, then choosing $\alpha^* = 1,$ rather than $0 < \alpha^* < 1$, would make the households better off since at $\alpha = 1$, the marginal benefit is larger than the marginal cost. An increase in the schooling time would be a better choice.

Second, if $\frac{w_1 + c}{\delta \cdot \theta} > \frac{\partial g(0,q)}{\partial \alpha}$, which suggests that at $\alpha = 0$, the marginal cost is larger than the marginal benefit, a decrease in the schooling time would make household better off.

The above analysis shows that $\frac{\partial g(1,q)}{\partial \alpha} < \frac{w_1 + c}{\delta \cdot \theta} < \frac{\partial g(0,q)}{\partial \alpha}$ is the sufficient condition for $0 < \alpha^* < 1$.

Appendix II

Proofs of Propositions in Chapter 3

1, Proof of Position 3, 1

The Lagrange is the following

$$L = U_1[y + w_1 - (w_1 + c)\alpha + b] + \beta U_2[g(\alpha) - (1+r)b] - \lambda_1(\alpha - 1) - \lambda_2(-\alpha)$$

The K-T conditions

(1) $U_1^{'}(\cdot)(w_1 + c)(-1) + \beta U_2^{'}(\cdot)g^{'}(\alpha) - \lambda_1 + \lambda_2 = 0$

(2) $U_1^{'}(\cdot) - \beta U_2^{'}(\cdot)(1+r) = 0$

(3) $\alpha - 1 \le 0, \quad (= 0, if \quad \lambda_1 > 0)$

(4) $-\alpha \le 0, \quad (= 0, if \quad \lambda_2 > 0)$

1, 1, Proof of (i) of Proposition 3, 1:

As we mentioned above, we are interested in conditions under which the rich households allocates zero unit of their children's time in schooling.

To do so, we first let $\lambda_2 > 0$, then we immediately have $\lambda_1 = 0$ and $\alpha = 0$. From equation (1), we then have $U_1^{'}(\cdot)(w_1 + c) = \beta U_2^{'}(\cdot)g^{'}(\alpha) + \lambda_2$. This means that $U_1^{'}(\cdot)(w_1 + c) > \beta U_2^{'}(\cdot)g^{'}(\alpha)$ since we have $\lambda_2 > 0$. Combined with (2), it's easy to get

(5) $\dfrac{\partial g(0)}{\partial \alpha} < (w_1 + c)(1+r)$.

(5) is therefore the necessary condition for $\alpha^{*} = 0$.

When $\alpha^{*} = 0$, suppose that $\dfrac{\partial g(0)}{\partial \alpha} \ge (w_1 + c)(1+r)$, then we find that an increase in the schooling time would make household better off. This is because that, in this case,

at $\alpha = 0$, the marginal benefit is larger than the marginal cost. From this analysis, we can conclude that (5) is also the sufficient condition for $\alpha^* = 0$.

1, 2, Proof of (ii) of Proposition 3, 1:

When will a wealthy household choose no child labor? To answer this question, we need to check what will happen when condition (3) is bidding. To make (3) bidding, λ_1 should be bigger than zero. In this case, it's easy to get $\alpha = 1$ and $\lambda_2 = 0$. Then by (1), we have

$\beta U_2^{'}(\cdot) g^{'}(\alpha) = \lambda_1 + U_1^{'}(\cdot)(w_1 + c)$. Combining with (2), we have the necessary condition for $\alpha = 1$:

(6) $\dfrac{\partial g(1)}{\partial \alpha} > (w_1 + c)(1 + r)$.

It's easily to find that (6) is the necessary condition for $\alpha^* = 1$. In the same way, we can find that (6) is also the sufficient condition for $\alpha^* = 1$.

1, 3, Proof of (iii) of Proposition 3, 1:

Now we try to find the necessary condition for interior solutions. When $\lambda_1 = 0$ and $\lambda_2 = 0$ hold, we have the necessary condition

(7) $\dfrac{\partial g(\alpha)}{\partial \alpha} = (w_1 + c)(1 + r)$. This is apparently the necessary condition for $0 < \alpha^* < 1$.

We also need to show that (7) is also the sufficient condition for $0 < \alpha^* < 1$.

We first suppose that $\dfrac{\partial g(1)}{\partial \alpha} > (w_1 + c)(1 + r)$,or $(w_1 + c)(1 + r) > \dfrac{\partial g(0)}{\partial \alpha}$,

rather than $\dfrac{\partial g(1)}{\partial \alpha} < (w_1 + c)(1 + r) < \dfrac{\partial g(0)}{\partial \alpha}$.

Note that if $\frac{\partial g(1)}{\partial \alpha} > (w_1 + c)(1+r)$, then choosing $\alpha^* = 1$ would make the household better off since the marginal benefit is larger than the marginal cost at $\alpha = 1$.

When $(w_1 + c)(1+r) > \frac{\partial g(0)}{\partial \alpha}$, which suggests that at $\alpha = 0$, the marginal cost is larger than the marginal benefit. Choosing zero schooling time would make the household better off.

We therefore conclude that $\frac{\partial g(1)}{\partial \alpha} < (w_1 + c)(1+r) < \frac{\partial g(0)}{\partial \alpha}$ is also the sufficient condition for $0 < \alpha^* < 1$.

2, Proof of Proposition 3, 2.

The Langrage function is

$$L = U_1[y + w_1 + b - (w_1 + c)\alpha] + (y - y_0)\alpha^2 + \beta U_2[g(\alpha) - (1+r)b] - \lambda_1(\alpha - 1) - \lambda_2(-\alpha)$$

The Kuhn-tuck conditions are the following:

(2) $U_1^{'}(\cdot) - \beta U_2^{'}(\cdot)(1+r) = 0$

(3) $\alpha - 1 \le 0, \quad (= 0, if \quad \lambda_1 > 0)$

(4) $-\alpha \le 0, \quad (= 0, if \quad \lambda_2 > 0)$

(9) $U_1^{'}(\cdot)(w_1 + c)(-1) + 2(y - y_0)\alpha + \beta U_2^{'}(\cdot) g^{'}(\alpha) - \lambda_1 + \lambda_2 = 0$

((2), (3) and (4) are the same as those in previous section and are listed here for convenience)

We rearrange condition (2) as

(2) $U_1^{'}(\cdot) = \beta U_2^{'}(\cdot)(1+r)$.

2, 1, Proof of (i) of Proposition 3, 2:

When $\lambda_2 > 0$, we immediately have $\alpha = 0$ and $\lambda_1 = 0$, from (9) and (2), we have the necessary condition for $\alpha = 0$

(11) $\frac{\partial g(0)}{\partial \alpha} < (w_1 + c)(1 + r)$.

It's easy to show that (11) is also the sufficient condition for $\alpha^* = 0$.

2, 2, Proof of (ii) of Proposition 3, 2:

When $\lambda_1 > 0$, we immediately have $\alpha = 1$ and $\lambda_2 = 0$, from (9) and (2), we have the necessary condition for $\alpha = 1$

(10) $\frac{\partial g(1)}{\partial \alpha} > (w_1 + c)(1 + r) + 2(y_0 - y) / \beta U_2^{'}(g(1) - (1 + r)b^*)$.

It's easy to show that (10) is also the sufficient condition for $\alpha^* = 1$.

2, 3, Proof of (iii) of Proposition 3, 2:

When $\lambda_1 = 0$ and $\lambda_2 = 0$, from (9) and (2), we have the necessary condition for the optimal choice of α:

(11) $\frac{\partial g(\alpha)}{\partial \alpha} = (w_1 + c)(1 + r) + 2(y_0 - y)\alpha / \beta U_2^{'}(g(\alpha) - (1 + r)b^*)$. Given α cannot take 0 and 1, we must have

$\frac{\partial g(1)}{\partial \alpha} < (w_1 + c)(1 + r) + 2(y_0 - y)\alpha / \beta U_2^{'}(g(\alpha) - (1 + r)b^*) < \frac{\partial g(0)}{\partial \alpha}$ as the necessary condition for $0 < \alpha^* < 1$.

Following procedures we used previously, we can easily show that (11) also the sufficient condition for $0 < \alpha^* < 1$.

3, Proof of Proposition 3, 3:

The maximization problem facing the poor households is the following

$$(3,4)\ \underset{\alpha,b}{Max} U_1[y + w_1 + b - (w_1 + c)\alpha] + (y - y_0)\alpha^2 + \beta U_2[g(\alpha) - (1+r)b]$$

$\alpha \le 1,\ \alpha \ge 0$ and $b \le \bar{b}$, where b is the choice variable and $\bar{b}$ is the maximum the household can borrow at the given interest rate r in the capital market.

$$L = U_1[y + w_1 + b - (w_1 + c)\alpha] + (y - y_0)\alpha^2$$
$$+ \beta U_2[g(\alpha) - (1+r)b] - \lambda_1(\alpha - 1) - \lambda_2(-\alpha) - \lambda_3(b - \bar{b})$$

The Kuhn-tuck conditions

(3) $\alpha - 1 \le 0, \quad (= 0, if \quad \lambda_1 > 0)$

(4) $-\alpha \le 0, \quad (= 0, if \quad \lambda_2 > 0)$

(9) $U_1^{'}(\cdot)(w_1 + c)(-1) + 2(y - y_0)\alpha + \beta U_2^{'}(\cdot) g^{'}(\alpha) - \lambda_1 + \lambda_2 = 0$

(13) $U_1^{'}(\cdot) - \beta U_2^{'}(\cdot)(1+r) - \lambda_3 = 0$

(14) $b - \bar{b} \le 0, \quad (= 0, if \quad \lambda_3 > 0)$

We want to know what will happen if the household suffers from the constraints in borrowing. In other words, the household wants to borrow more, but fails to get the funds they want. So, constraint (14) is bidding, namely, $\lambda_3 > 0$.

Given (14) is bidding, we have

(15) $U_1^{'}(\cdot) > \beta U_2^{'}(\cdot) \cdot (1+r)$.

Note that, given (15) hold, we have three scenarios:

Scenario 1, $\lambda_2 > 0$ and $\lambda_1 = 0$;

Scenario 2, $\lambda_1 > 0$ and $\lambda_2 = 0$;

Scenario 3, $\lambda_1 = 0$ and $\lambda_2 = 0$.

Proof of (i) of Proposition 3, 2:

Case 1, $\lambda_2 > 0$,

We immediately have $\alpha = 0$ by (4) and $\lambda_1 = 0$ by (3). We therefore, from (9), have the following:

$\beta U_2^{'}(\cdot) g^{'}(\alpha) + \lambda_2 = U_1^{'}(\cdot)(w_1 + c) + 2(y_0 - y)\alpha$ and

$\beta U_2^{'}(\cdot) g^{'}(\alpha) < U_1^{'}(\cdot)(w_1 + c) + 2(y_0 - y)\alpha$ since $\lambda_2 > 0$.

Combined with (15), this becomes

$\beta U_2^{'}(\cdot) g^{'}(\alpha) < \beta U_2^{'}(\cdot)(1+r)(w_1 + c) + 2(y_0 - y)\alpha$.

The necessary condition for $\alpha = 0$ is the following:

(17) $\dfrac{\partial g(0)}{\partial \alpha} < (w_1 + c) U_1^{'}(y + w_1 + \bar{b}) / \beta U_2^{'}(g(0) - (1+r)\bar{b})$.

Again, following the way used previously, it's easy to show that (17) is also the sufficient condition for $\alpha^{*} = 0$.

Proof of (ii) of Proposition 3, 2:

Case 2, $\lambda_1 > 0$,

By $\lambda_1 > 0$, we immediately have that $\alpha = 1$ and $\lambda_2 = 0$, so from (9), we have

$2(y - y_0)\alpha + \beta U_2^{'}(\cdot) g^{'}(\alpha) + \lambda_1 = U_1^{'}(\cdot)(w_1 + c)$.

$\beta U_2^{'}(\cdot) g^{'}(\alpha) > U_1^{'}(\cdot)(w_1 + c) + 2(y_0 - y)\alpha$, since $\lambda_1 > 0$. Combined with condition (15), we then have

$\beta U_2^{'}(\cdot) g^{'}(\alpha) > U_1^{'}(\cdot)(w_1 + c) + 2(y_0 - y)\alpha > \beta U_2^{'}(\cdot)(1+r)(w_1 + c) + 2(y_0 - y)\alpha$. So the necessary condition for $\alpha = 1$ is

(16) $g^{'}(1) > (w_1 + c)(1+r) + [2(y_0 - y)] / \beta U_2^{'}(g(1) - (1+r)\bar{b})$.

Again, following the same way, it's easy to show that (16) is also the sufficient condition for $\alpha^* = 1$.

Proof of (iii) of Proposition 3, 2:

Case 3, $\lambda_1 = 0$ and $\lambda_2 = 0$

From (9), we have $\beta U_2^{'}(\cdot) g^{'}(\alpha) = U_1^{'}(\cdot)(w_1 + c) + 2(y_0 - y)\alpha$. Combining with condition (15), we obtain the necessary condition for the optimal choice of $0 < \alpha^* < 1$

(18) $$g^{'}(\alpha) > (w_1 + c)(1 + r) + 2(y_0 - y)\alpha / \beta U_2^{'}(g(\alpha) - (1 + r)\bar{b})$$

Again, following the same way used previously, it's easy to show that (18) is also the sufficient condition for $0 < \alpha^* < 1$.

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