Family Social Norms and Child Labor

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Abstract

Child labor is a widespread phenomenon and therefore is of interest to both researchers and policy makers. Various reasons for the existence of child labor have been proposed with the goal of designing appropriate solutions. While household poverty is viewed as the main reason for child labor, we choose to focus on the phenomenon that parents who worked during own childhood are more likely to send their children to work. We also look at the effect of social norms on the parents' child labor decision and analyze both these effects on the supply of labor and equilibrium in the labor market. Finally, we suggest an explanation for the phenomenon of poor societies with similar income levels that differ significantly in literacy rates and propose policy improvements.

Keywords: Child Labor, Social norms, Intergenerational Transmission

JEL Classification: D13, D64, D91, J22, Z10

Introduction

Child labor is an issue of concern not only because it violates the rights of children who are powerless victims, but also because of its adverse long-term economic consequences. Therefore, it is important to understand its main causes and to determine suitable policies to diminish its scope.

Household poverty is usually claimed to be a major factor in explaining the persistence of child labor. Basu and Van (1998) showed that parents will send their children to work only if their income is below a subsistence level, a hypothesis they call the luxury axiom.

Dimova, Epstein and Gang (2015) examined agricultural child labor in the context of emigration, transfer payments and the ability to hire outside labor. Using Living Standards Measurement Survey (LSMS) data on the Kagera region in Tanzania they found support for the hypothesis that both emigration and transfer payments reduce child labor.

However, other papers have found mixed results for this hypothesis. For instance, Ray (2000) found that the hypothesis is rejected by Pakistani evidence, though weak support was found using Peruvian data. Bhalotra and Heady (2003) found that in both Ghana and Pakistan the daughters of land-rich households are more likely to be put to work than the daughters of land-poor households. Basu et al. (2010) found that since child labor is a major input on a family farm, transfer payments to poor households may be used to acquire agrarian assets, which may in fact increase the use of child labor.

Canagarajha and Coulombe (1997) found that child labor is negatively correlated with levels of household income, although the relationship is very weak. The effect of poverty on child labor is also analyzed through the effect of poverty on literacy rates. For example, Bhatty (1998) demonstrated the ambiguity of the effect of poverty on schooling by comparing several Third World countries to India. The Third World countries had higher levels of poverty than India but were found to have higher literacy rates. He also presented an example of a village in India which despite its extreme poverty had achieved literacy rates of above 99 per cent for both males and females.

This ambiguity points in the direction of some additional reason for child labor. In this paper, we will examine the effect of culture on the parents' choice of their children's division of time between education and labor.

In many studies of child labor, it is assumed that the allocation of children's time is determined by their parents (Basu and Van, 1998). Empirical studies show that parents who worked during

their own childhood are more likely to send their own children to work. Wahaba (2006) found that they were 10% more likely to do so. Emerson and Souza (2003) found that the likelihood of a child being sent to work is negatively correlated with the parents' age, the age at which the parents entered the labor force and the educational attainment of their parents, as well as that of their grandparents.

One offered explanation for this effect is that parents who themselves were sent to work as children view child labor as the social norm (Wahaba, 2006) and they will feel no shame in sending their own children to work. Thus, the social cost (in terms of, for example, guilt and shame) of sending a child to work is almost nonexistent for them. Another explanation states that since the parents could not accumulate human capital in their childhood, they are trapped in a cycle of poverty and therefore have no choice but to send their children to work as well.

It has also been suggested that children choose to imitate their parents or that parents want their children to follow in their path. For example, having children help out on the family farm may be perceived as an important value by the parents, and the parents may want to pass that value on to their children. Bhalotra and Heady (2003) found that in Ghana and Pakistan child labor increased with household ownership of land. The larger the farm, the greater was the tendency for children to be working.

The effect of parents' experience on the choices of their children was also examined in studies of the intergenerational transfer of preferences in welfare families. These studies emphasize the influence that parents who received welfare benefits have on the attitude of their children toward receiving welfare benefits. The children of these parents tend to be more exposed to information about the welfare system than information on the labor market (Lochner, 2008). This can also be seen in studies which found that a teenage girl's chance of becoming pregnant increases if she was born to a teenage mother (Khan and Anderson, 1992).

The current paper seeks to combine the idea of intergenerational transfer of behavior (examined in Epstein, 2007 on case of religion) with the decision of parents between child labor and schooling (examined in Epstein and Kahana, 2008).

We consider a model of intergenerational transmission of the phenomenon of child labor from parents to children. We analyze how parents' behavior is influenced by their childhood, including their parents' choices and the culture and social norms of the environment in which they grew up. The exposure of children to the choices, characteristics and behavior of their

parents and others in their environment increases the likelihood that they will adopt similar patterns of behavior when they become adults.[1]

The child labor decision of the parents is affected by the time allocation between labor and school that characterized their own childhood. In other words, the social norms the parents grew up with, will affect the choices they make for their own children. It is unusual that child labor exists as the exception; rather it usually exists as a widespread and accepted phenomenon in a particular social environment or ethnic group. Therefore, not only is child labor viewed as acceptable behavior in these contexts, deviating from this norm might involve a social cost as punishment for "going against the tide". Therefore, besides being influenced by their own childhood, parents are also assumed to have in mind an ideal allocation of their children's time between labor and schooling. This ideal allocation is determined by culture, social norms and the parents' preferences (see Epstein, 2007 for an example of the ideal level of a social trait in the case of religion).

The paper also explores the indirect effect of habit and social norms on the child labor market. This is accomplished by examining their effect on adult wages, child wages and the substitution between adults and children, which are all factors in the determination of child labor prevalence.

Based on the findings of the model, we are able to propose a policy that involves subsidizing adult wages in order to encourage parents to send their children to school (part-time or full-time).

The model

Children are assumed to be born without well-defined cultural preferences while parents are assumed to have well-defined preferences over the cultural traits acquired and developed by their children (as in Bisin and Verdier, 2000 and Epstein, 2007).

There are *N* identical households. Each household consists of two parents and two children. Parents are altruistic with respect to their children and determine their time allocation between labor and schooling. Parents are unskilled and always work, while children can be sent to work and/or to school. The utility function of the household is based on the Stone-Geary utility function (see Basu and Van, 1998 and Epstein and Kahana, 2008), where the

[1] Bell et al. (2017) found that exposure to innovation during childhood is a critical factor in determining who becomes an inventor. Moreover, children whose parents or parents' colleagues hold technological patents are more likely themselves to obtain patents and in that same field.

parents send their children to work only if the household's income is less than or equal to the subsistence level:

$$\textbf{(1)}\ U_p = \begin{cases} (c_p - s_p)(1 - e_p) - \left(e_{I-}e_p\right)^2 - a\left(e_g - e_p\right)^2 & if \quad c_p \geq s_p \\ c_p - s_p & if \quad c_p < s_p \end{cases}$$

where c_p is the consumption of the household and s_p is the subsistence level of income. Consumption is equally divided between parents and their children. The basic assumption is that parents value education (as in Basu and Van, 1998), and therefore the utility from consumption depends positively on the proportion of a day that the children dedicate to schooling. We denote a full workday by unity. $e_p \in [0,1]$ is the proportion of the day that a child works, which is decided by his parents. The child goes to school for the rest of the day, $1 - e_p$.

Parents have in mind an ideal proportion of the day that their children should be working, e_I, which is based on social norms, culture, tradition and personal preferences. $\left(e_{I-}e_p\right)^2$ is the parents' disutility when the proportion of the day that their child works, e_p , differs from their ideal proportion, e_I. The disutility stems from the parents' disappointment at not achieving their ideal. The choice of the parents is also affected by the proportion of the day that they worked during their childhood, e_g (which was chosen by their parents). $a\left(e_g - e_p\right)^2$ is the parents' disutility when e_p differs from e_g. This is due to the fact that the decision to send their children to work is also dependent on culture, tradition and social norms. Deviation from the existing social norm leads people to feel shame, guilt, pangs of conscience, etc. a is the measure of their disutility from a deviation.

The parents choose e_P in order to maximize utility, *U*, subject to the household's budget constraint:[2]

$$\textbf{(2)}\ c_p = 2w_A + 2\gamma w_A e_p$$

Like Basu and Van (1998), we assume that adults always work and that an unskilled adult and a child are perfect substitutes in production. Therefore, w_A is an adult's wage, and w_c is a child's wage, where $w_c = \gamma w_A$ and $0 < \gamma < 1$ is an adult equivalency correction.

The demand for labor by firm i which produces X is:

$$\textbf{(3)}\ f'(X) = f'(A_i + \gamma C_i) = \min\left(w_A, \frac{w_C}{\gamma}\right)$$

[2] For simplicity, we assume that the only cost of schooling is the child's lost wages, as in Epstein and Kahana (2008).

where A_i and C_i are the number of adults and children employed in firm i, respectively. We assume that $f' > 0$ and $f'' < 0$. The price of *X* is 1.

There are n identical firms and $w_A = \frac{w_C}{\gamma}$. Therefore, the aggregate demand for adults D^A, and the aggregate demand for children D^C, can be solved from:

$$(4)\ f'\left(\frac{D^A+\gamma D^C}{n}\right) = w_A = \frac{w_C}{\gamma}$$

The optimal proportion of the day that a child works, e_p, as chosen by the parents, is:

$$(5)\ e_p^* = \frac{2w_A(\gamma-1)+s_p+2e_I+2ae_g}{4\gamma w_A+2(a+1)}$$

e_I has a positive effect on the decision of the parents. In other words, parents will choose to send their children to work for more hours in a day as e_I increases:

$$(6)\ \frac{\partial e_p^*}{\partial e_I} = \frac{2}{4\gamma w_A+2(a+1)} > 0$$

e_g has a positive effect on the parents' decision:

$$(7)\ \frac{\partial e_p^*}{\partial e_g} = \frac{2a}{4\gamma w_A+2(a+1)} > 0$$

Thus, parents will choose a higher number of work hours for their children, i.e. a higher e_p^*, the more hours they worked during their own childhood, i.e. a higher e_g, which is consistent with Wahaba (2006).

The adult wage, w_A, has a negative and increasing effect on child labor:[3]

$$(8)\ \frac{\partial e_p^*}{\partial w_A} = \frac{2(\gamma-1)(4\gamma w_A+2(a+1))-4\gamma(2w_A(\gamma-1)+s_p+2e_I+2ae_g)}{(4\gamma w_A+2(a+1))^2} < 0$$

$$(9)\ \frac{\partial^2 e_p^*}{\partial w_A^2} > 0$$

In other words, the proportion of a day worked by a child, e_p^*, decreases with the adult wage, w_A, and at an increasing rate.

If w_A is sufficiently high or sufficiently low, then the parents will choose that the child not work at all or work a full day, respectively (corner solutions):

$$(10)\quad e_p^*(w_A) = \begin{cases} 0 \ \ if\ \frac{2w_A(\gamma-1)+s+2e_I+2ae_g}{4\gamma w_A+2(a+1)} \le 0 \Longrightarrow\ 2w_A(\gamma-1)+s_p+2e_I+2ae_g \le 0 \Longrightarrow w_A \ge \frac{2e_I+s_p+2ae_g}{2(1-\gamma)} \\ 1 \ \ if\ \frac{2w_A(\gamma-1)+s+2e_I+2ae_g}{4\gamma w_A+2(a+1)} \ge 1 \Longrightarrow\ 2w_A(\gamma-1)+s_p+2e_I+2ae_g \ge 4\gamma w_A+2a+2 \Longrightarrow \\ \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad w_A \le \frac{2e_I+s_p+2ae_g-2a-2}{2(\gamma+1)} \end{cases}$$

(11) i.e.

[3] For the proofs of (8)and (9) see appendix 1.

$$e_p^*(w_A) = \begin{cases} 0 & if \quad \bar{w}_A = \dfrac{2e_I + s_p + 2ae_g}{2(1-\gamma)} \\ 1 & if \quad \underline{w}_A = \dfrac{2e_I + s_p + 2ae_g - 2a - 2}{2(\gamma+1)} \end{cases}$$

while:

$$(12) \quad \bar{w}_A = \frac{2e_I+s_p+2ae_g}{2(1-\gamma)} > \underline{w}_A = \frac{2e_I+s_p+2ae_g-2a-2}{2(\gamma+1)}$$

The aggregate labor supply of adults, S^A, and of children, S^C, in the case of $w_A \geq \bar{w}_A$ is perfectly inelastic and only the $2N$ adults will work, and children will only go to school, i.e. $e_p^* = 0$, such that $S^A = 2N$, $S^C = 0$.

The aggregate labor supply of adults and children in the case that $w_A \leq \underline{w}_A$ is perfectly inelastic at the level of $2N(1+\gamma)$ and includes all $2N$ adults and all $2N$ children, who work a full day, such that $S^A + S^C = 2N(1+\gamma)$.

The aggregate labor supply of adults and children in the case that $\underline{w}_A \leq w_A \leq \bar{w}_A$ is decreasing and convex in the adult's wage and includes all $2N$ adults and part of the child labor supply.

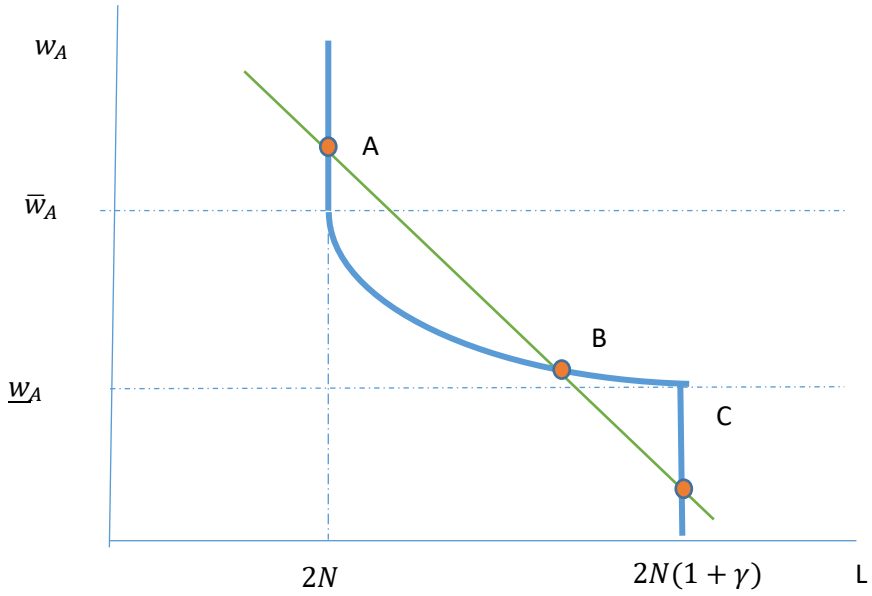

Figure 1 Multiple equilibria

Labor market equilibrium is located at the wage: $w_A^* = \frac{w_C}{\gamma}$ such that $D^A(w_A^*) = S^A = 2N$ *and* $D^C(w_A^*) = S^C(w_A^*) = 2N\gamma(w_A^*)$ and there are three possible equilibria: A, B and C. A and C are stable, while B is unstable.

We now examine the effect of the parents' ideal level of child labor, e_I, on labor supply.

(13) $\frac{d\bar{w}_A}{de_I} = \frac{2}{2(1-\gamma)} > 0$

(14) $\frac{d\underline{w}_A}{de_I} = \frac{2}{2(\gamma+1)} > 0$

(15) $\frac{d(\bar{w}_A - \underline{w}_A)}{de_I} > 0 \; since \; \bar{w}_A - \underline{w}_A = \frac{2e_I+s_p+2ae_g}{2(1-\gamma)} - \frac{2e_I+s_p+2ae_g-2a-2}{2(\gamma+1)} = \frac{(\gamma+1)(2e_I+s_p+2ae_g)-(1-\gamma)(2e_I+s_p+2ae_g-2a-2)}{2(1-\gamma)(\gamma+1)} = \frac{2\gamma(2e_I+s_p+2ae_g)+2(1-\gamma)(a+1)}{2(1-\gamma)(\gamma+1)} = \frac{\gamma(2e_I+s_p+2ae_g)+(1-\gamma)(a+1)}{(1-\gamma)(\gamma+1)}$

Proposition:

An increase in the parents' ideal level of child labor, e_I, will increase both $\bar{w}_A$ and $\underline{w}_A$, as well as the gap between them.

In other words, the higher is the parents' ideal level of child labor, the higher the adult wage will have to be for the working child to start going to school part-time and to leave the labor force completely. Thus, parents have their child work a full day up to a higher wage than before, and children leave the labor force at a higher wage than before. Moreover, the gap between $\bar{w}_A$ and $\underline{w}_A$ widens since $\bar{w}_A$ increases more than $\underline{w}_A$. In other words, the wage at which children are taken out of the labor force increases more than the wage at which parents start sending their working children to school part-time. The same is true for an increase in e_g, the extent to which the parents worked in their childhood.

Proposition:

An increase in the workday of the parents when they were children, e_g , will increase both $\bar{w}_A$ and $\underline{w}_A$, as well as the gap between them.

These two effects can explain the findings of Bhatty (1998) who found that two populations with identical wealth achieved different literacy rates. In other words, if parents in a society were child laborers themselves and have a high ideal level of child labor, it will take a higher level of income in order to shift their children from the labor market to school.

The effect of the weight a that the parents attribute to the disutility of deviating from what they experienced in their childhood, $(e_g - e_p)$, on the supply of labor is:

(16) $\frac{d\bar{w}_A}{da} = \frac{2e_g}{2(1-\gamma)} > 0$

In other words, the higher is a , the higher will be the w_A at which the parents stop sending their children to work. Despite the increase in the parents' utility due to more schooling, a higher adult wage is needed to compensate for the loss of the child's income.

$$(17) \quad \frac{d\underline{w}_A}{da} = \frac{2(e_g - 1)}{2(\gamma + 1)} < 0$$

The higher is a, the lower will be the w_A up to which the parents will send their children to work fulltime. This is because the child wage does not compensate the parents for the greater negative effect of deviating from e_g (due to the higher a) and since parents have positive utility from schooling they send their working children also to school (part-time) at a lower level of the adult wage (and thus lower child wage) than previously.

Proposition:

As the importance the parents attribute to the deviation of their child's labor from their labor experience as a child, i.e. $(e_g - e_p)$*, increases, the greater will be the range of* w_A *in which* $\frac{\partial e_p^*}{\partial w_A} < 0$.

In other words, the larger is a, the higher will be the threshold adult wage at which there is no child labor, $\overline{w}_A$, and the lower will be the maximal adult wage at which children work a full day, $\underline{w}_A$, and therefore the gap between them will increase. [4]

We now turn to the effect of the adult equivalency correction γ on the labor supply. An increase in γ raises $\overline{w}_A$ and reduces $\underline{w}_A$, and therefore the gap between them increases. In other words, since the child wage has increased relative to an adult's, the adult wage at which the parents can afford to send the working child also to school (part-time) is now lower. Parents can now afford schooling at a lower wage than before. However, the adult wage at which the parents would remove the child from the labor market is now higher since it is necessary to compensate for the greater income loss if they do so.

Proposition:

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[4] $\frac{d(\overline{w}_A - \underline{w}_A)}{da} > 0$ since:

$$\overline{w}_A - \underline{w}_A = \frac{2e_l + s_p + 2ae_g}{2(1-\gamma)} - \frac{2e_l + s_p + 2ae_g - 2a - 2}{2(\gamma+1)} = \frac{(\gamma+1)\left(2e_l + s_p + 2ae_g\right) - (1-\gamma)\left(2e_l + s_p + 2ae_g - 2a - 2\right)}{2(1-\gamma)(\gamma+1)}$$
$$= \frac{2\gamma\left(2e_l + s_p + 2ae_g\right) + 2(1-\gamma)(a+1)}{2(1-\gamma)(\gamma+1)} = \frac{\gamma\left(2e_l + s_p + 2ae_g\right) + (1-\gamma)(a+1)}{(1-\gamma)(\gamma+1)}$$

The greater the similarity between adult and child wages (because parents are uneducated), the lower will be the subsidy to the adult wage that is needed in order to encourage parents to begin sending their working children also to school (part-time), but the higher will be the subsidy needed in order to completely remove the child from the labor market.

Proof:

(18) i.e.

$$e_p^*(w_A) = \begin{cases} 0 & if \quad w_A \geq \dfrac{2e_I + s_p + 2ae_g}{2(1-\gamma)} = \bar{w}_A \\ 1 \;\; if & w_A \leq \dfrac{2e_I + s_p + 2ae_g - 2a - 2}{2(\gamma+1)} = \underline{w}_A \end{cases}$$

(19) $\frac{d\bar{w}_A}{d\gamma} = \frac{2e_I + s_p + 2ae_g}{2(1-\gamma)^2} > 0$

(20) $\frac{d\underline{w}_A}{d\gamma} = -\frac{2e_I + s_p + 2ae_g - 2a - 2}{2(\gamma+1)^2} < 0$

Conclusions

We have focused on the effect of parents' childhood work experience in the determination of their children's time allocation between labor and schooling. We also examined the effect of the parents' ideal level of child labor—as determined by social norms and culture—on the prevalence of child labor. We assume, as in Basu and Van (1998), that parents value education and analyze the effect of the parents' childhood work experience and ideals on equilibrium in the labor market as well.

We found that parents who worked during their own childhood will have a greater tendency to send their children to work, and the same is true in societies where parents have a higher ideal level of child labor.

In societies with a stronger ideal of child labor or in which parents worked in childhood, a higher adult wage will be needed to reduce child labor (whether the children work part-time or fulltime). In other words, the threshold adult wage at which working children begin to attend school part-time will be higher, as will the adult wage at which the child leaves the labor force completely. This can explain how two societies with the same income level might arrive at different levels of literacy and different levels of child labor.

We also found that the greater the importance parents attach to a deviation from their own childhood work experience, the lower will be the adult wage at which they will begin sending their working child to school part-time. Therefore, a policy aimed at encouraging them to send their working children to school will require a lower subsidy to adult wages. However, a larger subsidy will be required to remove the child entirely from the labor market, since the adult wage at which parents will send their children only to school is higher in this case.

In populations where children's abilities in the labor market are more similar to those of their parents (because parents are uneducated), parents will begin sending their working children to school part-time at a lower adult wage; however, the wage at which they completely remove the children from the labor market will be higher. This argues in favor of a policy that increases the adult wage only (such as a wage subsidy or a minimum wage mechanism for adults only).

In conclusion, policies aimed at reducing the prevalence of child labor should consider the effect of tradition, social norms and culture on child labor; otherwise a policy's effect may vary from one population to another even when they have the same income level.

Appendix 1

$$\frac{\partial e_p^*}{\partial w_A} = \frac{2(\gamma-1)(4\gamma w_A + 2(a+1)) - 4\gamma(2w_A(\gamma-1) + s_p + 2e_I + 2ae_g)}{(4\gamma w_A + 2(a+1))^2} < 0$$

Proof:

$$\frac{\partial e_p^*}{\partial w_A} < 0 \quad if \quad 2(\gamma-1)(4\gamma w_A + 2(a+1)) - 4\gamma(2w_A(\gamma-1) + s_p + 2e_I + 2ae_g) < 0$$

$$i.e. \quad if\ 2(\gamma-1)(4\gamma w_A + 2(a+1)) < 4\gamma\left(2w_A(\gamma-1) + s_p + 2e_I + 2ae_g\right)$$

$$8\gamma^2 w_A + 4\gamma a + 4\gamma - 8\gamma w_A - 4a - 4 < 8\gamma^2 w_A - 8\gamma w_A + 4\gamma s + 8\gamma e_I + 8\gamma a e_g$$

$$4\gamma + 4\gamma a - 4a - 4\gamma s_p - 4 < 8\gamma(ae_g + e_I) \quad /4$$

$$\gamma + \gamma a - a - \gamma s_p - 1 < 2\gamma(ae_g + e_I)$$

$$\frac{\gamma + \gamma a - a - \gamma s_p - 1}{2\gamma} < ae_g + e_I$$

i.e. $\frac{\partial e_p^*}{\partial w_A} < 0 \quad if\ \frac{\gamma(1-S_p)+a(\gamma-1)-1}{2\gamma} < ae_g + e_I$

Since $0 < \gamma < 1$, if $S > 1$ then $\gamma\left(1 - S_p\right) + a(\gamma-1) - 1 < 0 \Longrightarrow \frac{\gamma\left(1-S_p\right)+a(\gamma-1)-1}{2\gamma} < 0$.

Therefore $\frac{\partial e_p^*}{\partial w_A} < 0$ for every positive sum of the social norm effect and the dynasty effect ($ae_g + e_I$).

However, if $0 < S_p < 1 \Longrightarrow \gamma(1 - S_p) + a(\gamma - 1) - 1 < 0$.

This is so because $\gamma(1 - S_p) < 1 \; and \; a(\gamma - 1) < 0$.

Therefore, $\frac{\partial e_p^*}{\partial w_A} < 0$.

(An alternative proof: $\frac{\partial e_p^*}{\partial w_A} < 0 \quad if \; \frac{\gamma - \gamma s_p - 1 - 2\gamma e_I}{2\gamma e_g + 1 - \gamma} < a$

$\frac{\partial e_p^*}{\partial w_A} < 0 \quad if \; \frac{\gamma(1 - s_p) - 1 - 2\gamma e_I}{2\gamma e_g + 1 - \gamma} < a$ If $S > 1 \Longrightarrow \gamma(1 - s_p) - 1 - 2\gamma e_I < 0 \Longrightarrow$
$\frac{\gamma(1 - s_p) - 1 - 2\gamma e_I}{2\gamma e_g + 1 - \gamma} < 0 \Longrightarrow \frac{\partial e_p^*}{\partial w_A} < 0$

For every positive a ,

if $0 < S_p < 1 \Longrightarrow \; \gamma(1 - s_p) - 1 - 2\gamma e_I < 0 \; as \; well$ and $\frac{\partial e_p^*}{\partial w_A} < 0$.

This is because $\gamma(1 - s_p) < 1$.

$$\frac{\partial^2 e_p^*}{\partial w_A^2} > 0$$

Proof:

$$\frac{\partial^2 e_p^*}{\partial w_A^2} = \frac{\overbrace{(8(\gamma - 1)\gamma - 8\gamma(\gamma - 1))}^{0}(4\gamma w_A + 2(a + 1))^2 - 8\gamma\overbrace{(4\gamma w_A + 2(a + 1))}^{+}\overbrace{2(\gamma - 1)(4\gamma w_A + 2(a + 1)) - 4\gamma(2w_A(\gamma - 1) + s_p + 2e_i + 2ae_g)}^{-}}{(4\gamma w_A + 2(a + 1))^4}$$

From (8) we know that

$$2(\gamma - 1)(4\gamma w_A + 2(a + 1)) - 4\gamma(2w_A(\gamma - 1) + s_p + 2e_I + 2ae_g) < 0$$

Therefore $\frac{\partial^2 e_p^*}{\partial w_A^2} = \frac{0 - 8\gamma\left(\overbrace{4\gamma w_A + 2(a+1)}^{+}\right)\overbrace{2(\gamma - 1)(4\gamma w_A + 2(a+1)) - 4\gamma(2w_A(\gamma - 1) + s_p + 2e_I + 2ae_g)}^{-}}{(4\gamma w_A + 2(a+1))^4} > 0$

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