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Population Dynamics and Economic Growth: Should we adopt different frameworks for poor and rich countries?

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Abstract

From the canonical model of Becker onward, models of population dynamics have been based on assumptions which fit the family structure of developed countries.
The aim of this paper is to develop a framework that fits the family structure of poor countries. The building blocks of the model incorporate elements essential to the determination of population dynamics in poor countries, i.e., child labor, intergenerational flows from children to parents, and the effects of child labor on children's health.
The main result of this paper is that the correlation between economic growth and fertility rates runs in inverse directions for poor and rich countries.

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I. Introduction

The literature on household behavior and family economics beginning with the seminal work of Becker appears to have some sort of fascination with the motive of One Size Fits All, regarding the assumptions on the budget constraint. Indeed, most models which analyze fertility rates are based on the assumption that intergenerational transfers are from parents to children.[1] This assumption is necessary, since without it, there is no interior solution to parents' utility maximization.[2]

Yet there is a small problem with this assumption: It does not hold for all households and families. More specifically, while this assumption is perfectly appropriate for rich countries, regarding poor countries, some scholars claim that it does not hold.

Can we retain the regular model and change only this assumption regarding intergenerational transfers? The answer is No. The framework must be modified, because when we switch assumptions, there is no longer an internal solution, and we need to make changes in the model.

The purpose of this paper is to present a model that adopts the assumption that intergenerational transfers are from children to parents, and that makes the minimal amount of changes relative to Becker's canonical model. Additionally, this paper will draw a comparison between the two types of model.

I should stress that not all poor countries or poor households present the specificity that transfers are from children to parents. In fact, in the literature on child labor, there is an entire debate on whether parents can survive without child labor, and whether net transfers are positive. On the one hand, Basu and Van (1998) claim that child labor is a necessity, and parents make use of it only because they have no other means of survival. There are, however, researchers who claim that this is not the case, and that child labor is used even when not necessary. There are even cases of an increase in the amount of child labor when income increases.[3]

Those researchers adopting the view that child labor is not a necessity may follow the stylized Beckerian model as presented in Baland and Robinson (2000), and assume that transfers are from parents to children. However, for those following the line of research that children in poor countries work under deplorable conditions

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[1] See for example Becker (1981); Barro and Becker (1989); Becker et al. (1990); Galor and Weil (2000); and Galor and Moav (2002).

[2] If net transfers were from children to parents, then parents would increase their fertility rates to the maximum possible, and there would be no interior solution.

[3] The models following the line of Basu and Van (1998) are those of Basu (1999), Edmonds (2005), and Edmonds and Pavcnik (2005). These models focus on the relationship between income and child labor, and do not analyze the relationship between income and fertility rates. Models that take the opposite position are for instance, those of Bhalotra and Heady (2003), Menon (2005), and Dumas (2007). A summary of the literature can be found in Edmonds (2008).

today, as they did in Europe in the 18th century, because families need their income in order to escape extreme poverty, the standard Beckerian model makes assumptions violating these facts. If the evidence in some poor countries is as described by those claiming that child labor is a necessity, then there is a need for a new model that does not assume that transfers are from parents to children.

I do not deny that the evidence on the sign of the transfers is not always clear-cut. In fact, the data I present is part of an intense social and political debate that started on the standard of living of the poor during the industrial revolution and that continues today on child labor. However, the evidence presented in this paper suggests that in some poor countries, child labor is a necessity today, as it was the case for some social classes at the onset of the industrial revolution.

Therefore the assumption of transfers flowing from parents to children is not always an accurate portrayal of these poor countries today or of what occurred in the 18th and 19th centuries in the West.[4] In these poor countries today, intergenerational transfers — particularly marginal transfers — might move from children to parents via child labor, just as in England at the onset of industrialization, in which the children of the proletariat living in misery started working at an early age. In poor countries, as was the case in England during the Industrial Revolution, children start working at age four, and until then, their costs are insignificant so that their marginal income value to their families is positive.[5] Therefore, the main element distinguishing poor and rich countries today is the significance of child labor: In some poor countries, child labor is a necessity for the family.[6]

The aim of this paper is to develop a model that fits the family structure of poor countries, in which child labor is a necessity.[7] This paper also presents evidence that for some countries, and in some periods, the data corroborates these assumptions.

The three main building blocks which are incorporated in this model for poor countries, and which are necessary for the determination of population dynamics are child labor, intergenerational flows from children to parents, and the effects of children's labor on their health. The health effect is incorporated, since many activities engaged in by children in poor countries are concentrated in hazardous work, which leads to health deterioration.[8] Thus, in this model, child labor has a negative effect on children's utility, essentially through a lasting health effect. Therefore, the utility function presented in this paper contains two changes as

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[4] See Caldwell (1981); Horrell and Humphries (1997); Dasgupta (1995); Nardinelli (1990); and Schellekens (1993).

[5] It should be clear that the existence of a gestation period does not necessarily mean that children are not a necessity for survival.

[6] Basu and Van (1998) coined it the "Luxury axiom".

[7] There are of course rich families in poor countries. This paper refers to poor households in poor countries, and as a matter of simplification, we coin it poor country.

[8] See ILO (2006).

compared to the canonical model: incorporating a health effect, and assuming that marginal transfers flow from children to parents.

These two "small" changes lead to a twist in the results of the model. The canonical model implies that, *ceteris paribus*, a decrease in income leads to a decrease in the number of children. In the new model, we can obtain the *opposite* relationship, i.e., a decrease in income leads to an increase in fertility rates. In consequence, the model presented in this paper can explain the increase in fertility rates concomitant with a reduction in incomes of the proletariat as occurred in the first half of the 19th century, and as still occurs in some poor countries today.

This paper is divided into four parts. Section II presents the canonical model, which fits rich countries. Section III presents facts related to the model. Section IV presents the new model, which fits the empirical evidence related to poor countries. Section V concludes.

II. Population and Income in the Standard Model

In the literature on economic growth and population dynamics, one can find many versions of the canonical model developed by Becker, all of which have in common the fact that marginal transfers flow from parents to children.[9] There is no doubt that this assumption is an accurate representation of what happens in rich countries, and therefore, I coin this type of model "rich countries", wherein children's income is not necessary for subsistence.

As I have just mentioned, models of population dynamics are all based on Becker. I will more specifically present the structure of the model used in Baland and Robinson (2000), because they already introduce child labor in their model, but they keep transfers to be from parents to children. This structure will permit us to stress the main building blocks of the standard model.

The framework of the model is dynamic in the sense that there is a continuity of generations; each generation of individuals lives two periods: first as children and second as adults. When agents are adults, they work, consume, and also get the net income from the children, which is assumed to be negative (see Baland and Robinson, 2000, p. 668)

In the first period of life, agents are children who first live with their parents, work, and consume. Then, in the next period they get their own income.

The utility function of the parent, W_p is a function of its own consumption, C_p and the utility function of each child, W.

[9] While the effects of intergenerational transfers on child labor have also been emphasized by Bommier and Dubois (2004) and by Rogers and Swinnerton (2004), their papers focus not on fertility rates, but rather on savings and transfers.

$$W_p = U(C_p) + n\delta W(C_c). \tag{1}$$

where *U* and *W* are both twice continuously differentiable, strictly increasing and strictly concave. $\delta < 1$ is a parameter measuring the extent to which parents are altruistic, and *n* is the number of children.

The budget constraint of the parent is:

$$C_p = A + nwl_c - \sigma n. \tag{2}$$

where A is the income earned by the parents; σ is the cost per child; w are the wages earned by children; l_c is the number of hours children are working, and $1 - l_c$ is the time children invest into increasing their human capital.[10] An increase in human capital leads to higher productivity in the next period. In consequence, we have that the budget constraint of the child, when being adult is:

$$C_c = wh(1 - l_c) \qquad h' > 0 \quad and \; h'' < 0. \tag{3}$$

Income of children is a function of wage, w, and their productivity h, which is an increasing function of the amount of human capital from the first period. They assume that the function h is twice continuously differentiable, strictly increasing and strictly concave and $h(0) = 1$.

Parents have to choose the amount of children, n and the amount of child labor, l_c, which maximize the utility function in equation (4):

$$W_p = U(A + nwl_c - \sigma n) + n\delta W(wh(1 - l_c)). \tag{4}$$

The two first-order conditions with respect to l_c and n are respectively

$$U'(C_p) = \delta W'(C_c)h'. \tag{5}$$

and

$$U'(C_p)[\sigma - wl_c] = \delta W(C_c). \tag{6}$$

In order to get an interior optimum for the number of children, it is necessary that:

$$[\sigma - wl_c] > 0.^{11} \tag{7}$$

[10] Baland and Robinson (2000) assume that A is exogenous, since it is based on past decisions.

[11] See Baland and Robinson (2000, p.673, equation 17), where this condition is explicitly stated.

All models presented in the literature on population dynamics and altruism, assume equation (7); that is, intergeneration transfers are from parents to children. Even in models which assume child labor, this assumption is essential in order to get an interior solution.[12]

This type of models leads also to the fact that an increase in income leads to an increase in the number of children. That is:

$$dn^* / dA > 0 . \tag{8}$$

The proof is in appendix A. In consequence, in these models, when there is a decrease in income of parents, due to lower wages as in the first half of the nineteenth century, the model predicts that parents decrease the number of children, contrarily to the facts.

This model also enables testing the effect of an increase in income on the rate of child labor. The literature on such effects shows that that this relationship can take many forms and is usually not monotonically decreasing (see Rogers and Swinnerton 2004). In this model, we find that dl_c / dA is zero (see Appendix A).

Are Equations (7) and (8) an accurate representation of what occurs in poor countries? In the next section, we show that Equations (7) and (8) do not correlate to historical evidence in poor countries.

III. Historical Evidence

Historical evidence suggests dissimilarities between poor and rich countries regarding two elements related to child-rearing. The first is that the necessity for child labor differs greatly.[13] The second is that intergenerational transfer directions are inverse for poor and rich countries. While child labor is a necessity for subsistence in some poor countries, this is not the case for rich countries. In other words, I will show that Equation (7) does not hold in some poor countries, i.e., the marginal costs of children are lower than their earnings. I start by presenting data on England in the 19th century and show that during industrialization, the correlations resemble those in poor countries today.

1. England during 19th century industrialization

Although England in the 19th century began its industrial development, and output increased continuously, wages of the working class, especially those working in the cotton industry, did not increase during this period. Instead, this period saw the proletarization and pauperization of the poor as has been developed in the

[12] See for instance this one by Baland and Robinson (2000), or Berdugo (2001).
[13] See for instance fig. 1 in Edmonds and Pavcnik (2005).

literature.[14] Therefore, during this period, a change in the familial context occurred that implied more child labor, as shown in the next subsection. These facts are also emphasized in the various works of Jane Humphries.

Child labor, Family income and intergenerational transfers

Child labor in the nineteenth century amounted to a significant part of the workforce in some British industries.[15] In the 1830s, in some regions such as Lancashire and Leeds, 36% of the workforce in the textile industry consisted of children under age 16.[16]

Child labor was needed in periods in which the salary of one person was not adequate for subsistence. Hence, children brought about an increase in the family income: "At no stage in this family history, had they been able to manage only on the husband's wage."[17] Moreover, in certain counties in England, there was a positive correlation between fertility and the percentage of children ages 9-14 who were employed.[18]

Two types of data permit us to verify the importance of flows from children to parents in the first half of the 19th century. The first data set is related to relative earnings of males as a proportion of the family income; the second concerns a comparison between earnings and spending.

About the relative earnings of men, we found that during the nineteenth century, the share of male factory workers' earnings in the family income went down from 60% in 1800 to 55% in 1820, 42% in 1825 reaching 39% in 1835. This was the period in which wages decreased and fertility rates increased.[19]

Therefore men's relative contribution fell suggesting the necessity of getting other households members into the labor force. As emphasized by Horrell and Humphries (1997):

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[14] For data on wages in the cotton industry, see Mitchell and Deane (1971) and Feinstein (1981). There are also data on wages in other sectors, which even increased (see Clark 2007). In fact, a long-running debate in the literature surrounds the evolution of wages and more generally, the standard of living in the first half of 19th-century England. Taking the confidence interval of Feinstein (1998) and the evidence presented by him on biological variables (height and mortality), the pessimist view for the first half of the century rests on solid ground.

[15] Children under 12 years of age constituted 8% of the labor force in the cotton industry, and children age 13-18 another 10%. See Evans (1990, p. 250).

[16] See Tuttle and Wegge (2002).

[17] Meyering (1990, p.141). Another possibility, raised by Parsons and Goldin (1989), is that parents are not altruistic and, therefore, prefer to put the children to work, giving the parents the possibility of working less. However, Basu and Van (1998, p. 416) take it for granted that "a family will send the children to the labor market only if the family's income from non-child labor sources drops very low".

[18] See Birdsall (1983, p. 116).

[19] In the second half of the nineteenth century, this share increased back to 69% in 1865, a time at which real wages increased, and fertility rates decreased. See Horrell and Humphries (1997, table 1, p. 31).

> "The contributions of women and children may *have been crucial* to most families during certain stages in the family life cycle … In only a few occupations were men earning enough to buy their families sustenance and to provide the roof over their heads; for most households the earnings of women and children were essential."[20]

In the same line of findings, Nardinelli (1980), using the Sadler report of 1832, shows that children were supporting their parents.

The second data set is based on earnings and spending of families in 19th-century England. The comparison of earnings and spending of poor families in the 19th century shows that the earnings of a working couple did not enable subsistence levels. Indeed, Neale (1975) has shown that between 1832 and 1850, the earnings of a working couple in Bath were lower than their cost of living.[21]

Due to the fact that cost of living exceeded earnings, families had to save before marrying, and brides had to bring dowry in order to survive the first years, until children could start working at the age of four. Thus, for working families in the first half of the 19th century, the marginal costs of children were lower than their benefits to the family. This was the case because the costs of raising children were very low. At this time, few proletariat children attended school, housing standards were poor, and food constituted the marginal cost of an additional child. Therefore, the marginal costs of a child were far lower than the marginal benefits, and for the poor in early 19th-century England, intergenerational flows moved from children to parents.[22] In the next section, I turn to current data on poor countries in the present.

2. Poor countries in the 20th century

The data in this section is mainly based on the Penn World series and on reports by Unicef and the ILO on child labor; it is also based on Edmonds (2008).[23] The evidence can be summarized as follows: First, child labor in poor countries, and

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[20] Horrell and Humphries (1997, pp. 35-42). See also Schellekens (1993, p.3), who claimed that "men's wages among the working class, and among unskilled laborer in particular, were not sufficient to support a family." Shammas (1984) claims that in the 1790s, adult equivalent caloric intakes were only just at minimum subsistence levels. Since real earnings of men fell until the 1830s, as discussed above, an increase in child labor was a necessity to keep people alive, and out of complete misery.

[21] Not surprisingly, data gathered on workers in Lille (France) display this same pattern (see Brezis 2001).

[22] However, flows changed direction at the end of the century. Indeed, the late 19th century saw a rise in the cost of raising children due to the enforcement of restrictions on child labor. Due to the 1868 Poor Law that made it an offense for parents to fail to supply their children with such necessities as food, lodging, and clothing, it became more costly to raise children. Moreover, in 1891, schooling was made compulsory, so that at the turn of the 19th century, the intergenerational flows were changing directions.

[23] The ILO's statistical Information and Monitoring Program on Child Labor (SIMPOC) is the organization charged with analyzing child labor around the world. The data is also based on questionnaires sent to families in each of the various countries.

especially in Africa constitutes a large part of the workforce. Second, child labor has considerable negative effects on children's health and their capacity to work as adults. Third, some poor families need child labor in order to survive.

A. Child labor and Family income

The ILO reports (2006) estimate the prevalence of child labor at 250 million in developing countries and indicate that 120 million are full time workers of which 80% are between the ages of 10 and 14 years old.

The Child Labor reports stress that child labor in this part of the world continues to amount to a significant part of the workforce. The difference in the percent of working children is quite wide among African countries, ranging all the way from 14% to 64%. Although, in many countries, the percent of working children is more than 50%.[24]

The number of hours spent working in some of the poor countries by children is quite considerable. It is striking that in some of the countries, such as Ethiopia and Mali, the number of hours worked by children, age 5-14, is above the maximum 35 hours of France for adults.

One of the main negative consequences of child labor is that it affects negatively the health of children.

B. Effects of child labor on health problems

The reports of ILO on Child Labor have stressed that a large part of child labor includes "working in hazardous work environment, in exploitative condition, work for long hours or work in activities that require intense physical effort, and work in servitude". Therefore, the main concern regarding child labor is on those activities that are detrimental to children's physical and mental development. Heavy work at an early age has a direct deterring effect on children's physical and mental development. The reports claim that:

> "Physically, children are not fit to long hours of strenuous and monotonous work. Moreover, children are especially vulnerable to accidents because they have neither the awareness of the danger nor the knowledge of the precaution to be taken at work. Because of their process of growth and development, children are more susceptible to occupational hazards; … and physical strain can cause irreversible damage to their growing bodies. Even seemingly light

[24] See Unicef Multiple Indicator Cluster Surveys, 2000; and Edmonds and Pavcnik (2005). See also Patrinos and Psacharopoulos (1997).

work can be dangerous for children who are exhausted at the end of a long working day."[25]

Hagemann et al. (2006, p.14) claims that: "the majority of working children are in hazardous work. This means they are engaged in activities that endanger their safety, health and moral development." The data from Unicef show that the incidence rate of children who got injured due to child labor can be as high as 79% in Senegal, 67% in Nigeria, and around 30% in countries as Ghana, Kenya, Uganda and Zambia.[26]

About the effects of child labor on their future income, some of the reports show that while child labor increases the income of parents, it affects negatively their own future income: "Besides the physical and mental risks to which these children are exposed, [labor] affects their capacity to work and earn income in the future." (Okpukpara and Odurukwe, 2006, p.23).

Kassouf et al. (2001) has shown that the younger a person starts working, the greater the probability that the individual reports being ill as an adult. In consequence, all these findings stress the negative impact of child labor on child health and how that persists into adulthood.

C. Intergenerational Transfers

The importance of child income in alleviating household poverty varies over countries (see Table 1). In most countries, the percent of families who would see at least a reduction of living standard is higher than 60%. But many families claim that without child labor, the household enterprise would stop operating, which would send the family to poverty. And even worse, some families claim even that they could not afford living without child labor.[27]

Okpukpara and Odurukwe (2006, p.23) even notes that: "Many families have no alternative other than to send their children to work because they see their earnings as an input into family survival". Edmonds and Pavcnik (2005, p.210, fig.1) shows that there is a strong negative correlation between living standard and child labor. In the same line of research, the Ilo survey (2006, Table 20) brings about the association between child activity options and household poverty status. This table shows that only poor families send their children to work despite the negative effect it will have on their health. In some areas of Nigeria, the child's income is some 30% of total household income (see Table 2).

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[25] ILO report (2006, pp.11-12). It is stressed that child labor in family farms or enterprises can also be dangerous.

[26] See Unicef Multiple Indicator Cluster Surveys, 2000.

[27] There are attempts to measure child labor productivity in the agriculture sector. See for instance, Jacoby (1993) and Rosenzweig (1977).

In conclusion, since on one hand, children's contributions constitute a significant portion of household income, and on the second hand, *variable* costs are low, then we get that net marginal transfers are negative for poor families relying on child labor to subsist; and it is this condition that is necessary in the standard models.[28] In the next section, we check the correlation between income and fertility rates.

D. Correlation between income and fertility rates

There are two types of data confirming a negative correlation between fertility rates and income. The first are time series presented in Table 3, the second are cross-section series presented in Table 4.

In Table 3, we present the countries that have had a reduction in real income per capita and had also an increase in fertility rates. Looking for instance at Gabon, from 1975 to 2000, there was a decrease in real income per capita from 2,053 to 1,043 and an increase in fertility rates from 4.65 to 4.92.[29]

This phenomenon cannot be explained by the regular standard model, in which a reduction in income leads to a reduction in the number of children, especially that there is almost no change in the level of education during these years.[30]

The second type of data is cross-section series on African countries. In Table 4, we show that in many African countries, there is a decrease in the number of children among the increasing quintiles. The reason given by Caldwell for this correlation is that: "fertility decline is associated with declining economic roles for children." (1983, p. 474). This is against the claim by Becker (1981, p.112): "Richer families in less developed countries have more children than poorer families".

The data presented in this section on England during the industrial revolution, and on poor countries nowadays have stressed (i) the importance of child labor, (ii) that as a consequence of work, children are hurt and health is damaged. (iii) In some countries and in some families, transfers are from children to parents. In the next section, we present a model incorporating these elements.

IV. Population and Income in the New Model

The model presented in section II assumed, as a necessary condition for an interior solution, that marginal net transfers to children be positive, a condition not met in some poor countries. Therefore, in this section, I develop a model without this

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[28] Indeed, the necessary condition for the canonical model to hold is not that total transfers to children are negative, but rather that marginal transfers are negative. The fact that some studies, as Stecklov (1999) state that total transfers to children are positive does not contradict the data shown in this paper that marginal transfers are negative.

[29] There are also some countries in which the correlation between output and fertility rates is positive; However, on the whole sample of countries, the correlation of these two series is of -0.36.

[30] See Lloyd et al. (2000).

condition, but which will be close to the basic framework presented in the above model.

There are two assumptions that are different in this framework compared to the previous one. The first assumption is that *net marginal* transfers are from children to parents, i.e., the costs of children are smaller than their income transferred to parents. The second assumption is that child labor has an effect on the health of children as stressed in the data presented in Section III above.

The utility function and budget constraint of parents are similar to the ones in the previous framework. As in the previous model, the utility of parents is a function of own consumption and the utility of children:

$$W_p = U(C_p) + n\delta W(C_c). \tag{1}$$

Income of parents is from salaries and child labor minus costs of children.

$$C_p = A + nwl_c - \sigma n. \tag{2}$$

Children as in the previous model, live two periods as individuals. In the first period, they get σ from their parents, and in the second period, when the child is already an adult, he is independent and gets to keep all his salaries, so that consumption is determined by his income.[31] The income of the child being now an adult is, among other elements, a function of how much his health has been deteriorated during his childhood. In consequence, the consumption in the second period is:

$$C_c = I - D_H. \tag{9}$$

where D_H is the amount of health deterioration, and I is the income amount in the case of no deterioration of health, i.e., D_H is zero.

The literature on health deterioration emphasizes two elements: number of working hours and the size of the family. The first element, the amount of hours worked, is shown to be affecting accident incidence.[32] Dembe et al. (2005) have analyzed the incidence rate as a function of number of hours worked, and have found that the function displays a non-linear relation, as shown in Figure 1.[33]

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[31] To keep this framework similar to Baland and Robinson, I assume σ to be exogenous, and not included in total consumption. Moreover, for matter of simplicity, w is constant and I omit the human capital function.

[32] See for instance, Dembe et al. (2005), Sparks et al. (1997), and Spurgeon and al. (1997).

[33] Furthermore, evidence that children have less stamina than adults leads to the fact that children's health is deteriorating more quickly, and as a result the linear part of the function is almost inexistent (see O'Donnell et al., 2002).

Therefore, the functional form of D_H takes a non-linear form related to hours worked, l_c.

The second element influencing the health of children and in consequence their future income is the size of the family, i.e., the "sibship" size. The literature in the field of sociology on this relationship is quite wide, and mainly focuses on the "resource dilution theory" which claims that the sibship size does dilute family resources and affects health and intellectual growth of children.[34]

The medical literature is somewhat different and focuses on externalities due to the size of the family. It stresses that "the negative consequences for health due to crowding is due to a greater exposure to diseases such as measles, chickenpox or diarrhea". It has been shown that infectious disease is more "likely to occur in crowded households with numerous children". In consequence larger families appear "to increase the child's risk of contracting the infection and the severity of the infection among those who do become ill".[35]

Therefore, we assume that health deterioration, D_H, is a positive function of both the number of children, n and hours worked, l_c, and we get:

$$D_H = \lambda n l_c^2 . \tag{10}$$

where λ is an exogenous parameter emphasizing cultural and social elements that influence health deterioration, and is not linked properly to the parameters endogenous to the family.

Parents have to choose the amount of children, n, and the amount of child labor, l_c which maximize the utility function in equation (11):[36]

$$W_p = U(A + nwl_c - \sigma n) + n\delta W(I - \lambda n l_c^2) . \tag{11}$$

The two first-order conditions with respect to l_c and n respectively are:

$$U'(C_p)w = 2n\delta\lambda l_c W'(C_c) . \tag{12}$$

and

$$U'(C_p)[wl_c - \sigma] + \delta W(C_c) = n\delta\lambda l_c^2 W'(C_c) . \tag{13}$$

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[34] On the literature on shibship size and resource dilution theory, see for example Guo and VanWey (1999) and Downey et al. (1999). The intuition behind the resource dilution theory is that when budgets are given, more children lead to fewer budgets allocated per child, and therefore increase the extent of health deterioration. See also King (1987).

[35] See Aaby (1988) and Aaby et al. (1984) both cited in Desai (1995, p.198).

[36] In appendix B, I present a more general functional form.

The following condition permits to get an interior optimum for the number of children, *n*:

$$[\, wl_c - \sigma \,] > 0 \,. \tag{14}$$

This condition is opposite to the one presented in the previous model (equation 7), and as we showed in section III, it is consistent with the situation found in poor countries.

The reason for obtaining inverse conditions can be explained intuitively. In the previous framework, which correspond to social behavior in rich countries, an increase in the number of children leads to higher utility through the utility of children, but reduces utility through its own consumption (net income from children is negative). In this framework, an increase in the number of children leads to higher utility through its own consumption, but decreases the utility through the utility of children due to the effect on health deterioration.

In the previous framework, we have shown that an increase in income leads to an increase in the number of children. What will be the relationship in this new framework? We show in appendix B that we can get the opposite result, that is, in some cases:

$$dn^* / dA < 0 \,. \tag{15}$$

In consequence, when there is a decrease in income of parents, due to lower wages as it happens in the nineteenth century or in some poor countries nowadays, we can get that parents increase the number of children.

Proposition

The conventional models of population growth, which are adapted for rich countries, always lead to a positive relationship between fertility rates and income. In this new model, which is adapted for poor countries, we obtain that under certain conditions, there is a negative relationship between fertility rates and income.

This proposition permits to explain some of the facts which seem to contradict the conclusions of the standard neo-Malthusian models. Some of the tables presented in section III stress a negative relationship between fertility rates and income. In the first half of the 19th century, wages had decreased and fertility rates had increased. Today, in some poor countries, we get the same correlation - income decreased and fertility rates increased.

This proposition states that the pauperization of the poor might lead to an increase in the number of children, and not to a reduction of it, as claimed by the standard model; Children lead to an increase in income. We get this result despite the fact that parents are altruistic, and that we have preserved most of the

assumptions of the conventional model, except for the sign of the intergenerational transfers.

V. Conclusion

Intergenerational transfers are part of a long-running debate on child labor and standards of living. On one hand, there are those who believe that during the Industrial Revolution parents sent children to work to prevent idleness, and who perceive child labor today as a natural way to employ children, and for whom the assumption on intergenerational transfers made by the standard model is perfectly adequate.

However, continuing the line of research of Caldwell and Basu, there are those who perceive child labor to be an economic necessity, and for whom parents send children to work because they have no choice. There are researchers who claim that during the industrial revolution, it is poverty which led parents to send the children to work in the mines or in the "dark Satanic Mill". [37] In consequence, for these researchers, the standard model cannot apply.

This paper develops a new model of the relationship between income, intergenerational transfers, and fertility rates, which is suitable in these circumstances. This paper does not claim that Becker's canonical model is passé. On the contrary, this paper claims that the canonical model of Becker is suitable not only for rich countries, but even for poor countries wherein intergenerational transfers are from parents to children.

However, there are also poor countries, wherein transfers are from children to parents. Some scholars would claim that this is a widespread phenomenon; others would declare that it is insignificant. In either case, there is a need for a framework that can be used in these cases, since then, the standard model cannot be applied. This is the purpose of this paper.[38]

This new model has shown that the conventional theorem that claims that an increase in income leads, *ceteris paribus*, to an increase in fertility rates does not necessarily hold in the new framework. In consequence, the results of this new model have policy implications. Increasing income does not necessarily lead to an increase in fertility rates as assumed in the standard model. An increase in income in poor countries wherein transfers are from children to parents, can lead to a reduction in fertility rates, even before the effect of quality-quantity tradeoff takes place.

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[37] as coined by Hobsbawm, 1964.

[38] Of course, a possible addendum to this framework is to combine both models in one more generalized one, and analyze the dynamics from one model to the other. I leave this task for future work.

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Appendix A (long version for refereeing; will be shortened for publication)

From equation(5) and (6), we get:

$$\xi = U'(A + nwl_c - \sigma n) - \delta W'(wh(1 - l_c))h'((1 - l_c)) = 0. \quad \text{(A1)}$$

$$\psi = U'(A + nwl_c - \sigma n)[wl_c - \sigma] + \delta W(wh(1 - l_c)) = 0. \quad \text{(A2)}$$

By taking the derivatives of A1 and A2, we get that:

$$\frac{\partial \psi}{\partial n} dn + \frac{\partial \psi}{\partial l_c} dl_c + \frac{\partial \psi}{\partial A} dA = 0. \quad \text{(A3)}$$

and

$$\frac{\partial \xi}{\partial n} dn + \frac{\partial \xi}{\partial l_c} dl_c + \frac{\partial \xi}{\partial A} dA = 0. \quad \text{(A4)}$$

So,

$$\frac{dl_c}{dA} = \frac{\frac{\partial \xi}{\partial n}\frac{\partial \psi}{\partial A} - \frac{\partial \psi}{\partial n}\frac{\partial \xi}{\partial A}}{\frac{\partial \psi}{\partial n}\frac{\partial \xi}{\partial l_c} - \frac{\partial \xi}{\partial n}\frac{\partial \psi}{\partial l_c}}. \quad \text{(A5)}$$

Since

$$\partial \psi / \partial A = U''(C_p)[wl_c - \sigma] > 0. \quad \text{(A6)}$$

$$\partial \psi / \partial n = U''(C_p)[wl_c - \sigma]^2 < 0. \quad \text{(A7)}$$

$$\partial \xi / \partial A = U''(C_p) < 0. \quad \text{(A8)}$$

$$\partial \xi / \partial n = U''(C_p)[wl_c - \sigma] > 0. \quad \text{(A9)}$$

In consequence,

$$dl_c / dA = 0. \quad \text{(A10)}$$

And substituting equation (A10) into equation (A3), we get:

$$dn / dA = -\frac{\partial \psi / \partial A}{\partial \psi / \partial n} = -1/[wl_c - \sigma] > 0. \quad \text{(A11)}$$

Appendix B (long version for refereeing; will be shortened)

The utility function (equation 11) can be rewritten in a more general form as:

$$W_p = U(A + nwl_c - \sigma n) + n\delta W(G(n, l_c)) \ . \tag{B1}$$

where in our specific case: $G(n, l_c) = I - \lambda n l_c^{\ 2}$, and in which:

$$\partial G / \partial n \le 0, \partial G / \partial l_c \le 0, \partial^2 G / \partial n^2 \le 0, \partial^2 G / \partial l_c^{\ 2} \le 0, \partial^2 G / \partial l_c \partial n \le 0$$

From equations (12) and (13), we get the two FOC equations:

$$\xi = U'(A + nwl_c - \sigma n)w + \delta W'(G(n, l_c))\frac{\partial G}{\partial l_c} = 0 \ . \tag{B2}$$

$$\psi = U'(A + nwl_c - \sigma n)[wl_c - \sigma] + \delta W(G(n, l_c)) + n\delta W'(C_c)\frac{\partial G}{\partial n} = 0 \ . \tag{B3}$$

Conditions for interior optimum are that:
$\partial G / \partial n \le 0, \partial G / \partial l_c \le 0, \partial^2 G / \partial n^2 \le 0, \partial^2 G / \partial l_c^{\ 2} \le 0,$

By taking the derivatives of B2 and B3, we get that:

$$\frac{dl_c}{dA} = \frac{\frac{\partial \xi}{\partial n}\frac{\partial \psi}{\partial A} - \frac{\partial \psi}{\partial n}\frac{\partial \xi}{\partial A}}{\frac{\partial \psi}{\partial n}\frac{\partial \xi}{\partial l_c} - \frac{\partial \xi}{\partial n}\frac{\partial \psi}{\partial l_c}} \ . \tag{B4}$$

and

$$\frac{dn}{dA} = \frac{\frac{\partial \psi}{\partial l_c}\frac{\partial \xi}{\partial A} - \frac{\partial \xi}{\partial l_c}\frac{\partial \psi}{\partial A}}{\frac{\partial \psi}{\partial n}\frac{\partial \xi}{\partial l_c} - \frac{\partial \xi}{\partial n}\frac{\partial \psi}{\partial l_c}} \ . \tag{B5}$$

From (B2) and (B3), we get the six following equations:

$$\partial \psi / \partial A = U''(.)[wl_c - \sigma] \le 0 \ . \tag{B6}$$

$$\partial\psi / \partial n = U''(.)[\, wl_c - \sigma\,]^2 + 2\delta W'(.) + n\delta[\, W''(.)(\frac{\partial G}{\partial n})^2 + W'(.)\frac{\partial^2 G}{\partial n^2}\,] \le 0 \qquad \text{(B7)}$$

$$\partial\psi / \partial l_c = U''(.)[\, wl_c - \sigma\,]nw + wU'(.) + \delta W'(.)\frac{\partial G}{\partial l_c} + n\delta[\, W''(.)\frac{\partial G}{\partial n}\frac{\partial G}{\partial l_c} + W'(.)\frac{\partial^2 G}{\partial n \partial l_c}\,] \qquad \text{(B8)}$$

$$\partial\xi / \partial A = U''(.)w \le 0\,. \qquad \text{(B9)}$$

$$\partial\xi / \partial n = U''(.)w[\, wl_c - \sigma\,] + \delta W''(.)\frac{\partial G}{\partial n}\frac{\partial G}{\partial l_c} + \delta W'(.)\frac{\partial^2 G}{\partial n \partial l_c} \le 0\,. \qquad \text{(B10)}$$

$$\partial\xi / \partial l_c = U''(.)nw^2 + \delta W''(.)(\frac{\partial G}{\partial l_c})^2 + \delta W'(.)\frac{\partial^2 G}{\partial l_c^{\,2}} \le 0\,. \qquad \text{(B11)}$$

- In case we assume that: $\partial\psi / \partial l_c \ge 0$

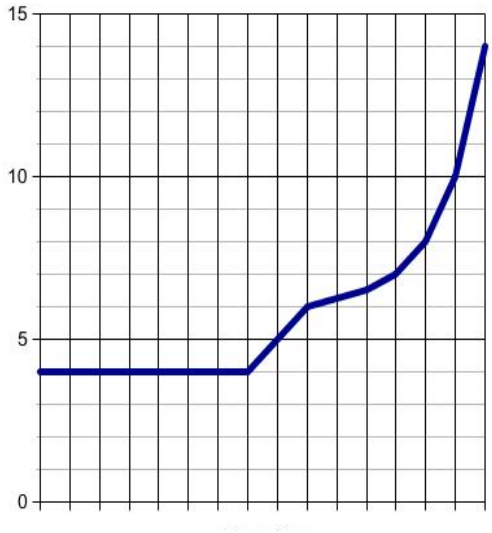
Then, the denominator of equation (B5) is positive, and the nominator is negative. Therefore:

$$dn / dA \le 0 \quad . \qquad \text{(B12)}$$

which proves the proposition, that under certain conditions, we get that $dn / dA \le 0$.

It is interesting to note that under these conditions, the sign of dl_c / dA is indeterminate, i.e., an increase in income can lead to an increase or to a decrease in the amount of child labor of each child.

Figure 1: Relative Incidence Rate of accidents as a function of hours worked



Source: Dembe et al., 2005, p. 593

TABLE 1

CONSEQUENCES TO HOUSEHOLD IF WORKING CHILDREN STOPPED WORK

	Attending school					Not attending school				
	Household living standard declines	Household cannot afford to live	Household enterprise cannot operate	Has no effects	other	Household living standard declines	Household cannot afford to live	Household enterprise cannot operate	Has no effects	other
Nigeria	30.7	2.1	19.0	N/A	48.3	23.9	1.7	22.1	N/A	52.3
Sri Lanka	16.3	1.0	31.1	46.9	4.8	45.8	3.6	15.6	30.2	4.8
Zimbabwe[1]	33.1	7.7	19.0	36.5	3.7					
Ghana[1]	43.8	4.9	21.6	28.9	0.6					
Malawi	N/A	N/A	N/A	N/A	N/A	15.5	5.0	7.2	25.1	47.2

Sources: Ilo Surveys on child labour, 2006.

Notes: (1) including both attending and not attending school.

TABLE 2

NIGERIA

AMOUNT CONTRIBUTED BY CHILDREN AND ITS PERCENTAGE OF THE HOUSE HOLD INCOME

Zone	Child's income per hour (N)	Child's income to household income (%)
NC	13	3.5
NE	5	9.7
NW	8	17.7
SE	10	38.0
SS	13	12.8
SW	29	10.7
Male	19	14.5
Female	14	19.1
Rural	19	16.0
Urban	17	9.3

Source: Ilo survey on child labour in Nigeria, 2006, Table 25.

TABLE 3

COUNTRIES WITH DECREASING Y AND INCREASING FERTILITY RATES

	Period (t,00)	y_t (In I$)	y_{2000} (In I$)	Annual growth rate	Fertility Rates t	Fertility Rates 2000
Burundi	1970-00	806	699	-0.47	6.55	6.95
Chad	1965-00	1165	830	-0.96	6.23	6.61
Congo Dem. Repub.	1975-00	1372	359	-5.2%	6.37	6.92
Gabon	1975-00	2053	1043	-2.67	4.65	4.92
Gabon	1970-00	1443	1043	-1.07	4.14	4.92
Liberia	1970-00	1982	472	-4.67	6.38	6.43

Sources: Penn World Table Version 6.2; and US Census Bureau, International Data Base.

Note: Real GDP per capita (y) is in international dollar in 2000 constant prices.

TABLE 4

AVERAGE HOUSEHOLD SIZE BY EXPENDITURE QUINTILE IN RURAL AND URBAN AREAS

Country	Year	Rural					Urban				
		Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5
Cameroon	2001	7.2	6.8	5.5	5.0	3.0	7.3	6.3	5.7	4.5	3.1
Ethiopia	2000	5.9	5.4	5.2	4.8	3.8	5.6	5.1	4.7	4.3	3.5
Malawi	2004	5.9	5.2	4.7	4.2	3.5	5.3	4.9	4.5	3.7	3.5
Niger	2005	10.1	9.4	8.5	7.6	6.4	9.3	9.4	9.1	8.2	6.1
Nigeria	2004	6.5	6.0	5.2	4.5	3.4	5.6	5.7	5.1	4.4	3.3
Sao Tome	2000	6.3	5.7	4.9	4.2	3.0	6.2	5.5	4.9	4.4	3.3
Sierra Leone	2002/3	8.2	7.6	7.5	6.8	6.3	8.4	7.6	7.1	7.2	7.4
Uganda	2002/3	6.4	5.9	5.8	5.3	4.0	5.7	4.6	4.3	4.0	3.0

Source: The World Bank, Africa development indicators, 2007.