ON THE ECONOMICS OF CLIMATE CHANGE AND CHILD PREFERENCE : MALTHUS MEETING BECKER

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Abstract

One of the biggest challenges of our time is climate change, and its implications on economics have been among the most widely contested scientific topics. Despite that, economists have largely overlooked the impacts of climate change on people's individual preferences until now. This paper intends to intervene in this domain to establish a connection between climate change and children's preferences for wealthy and poor families. In this paper, we employ a family optimization model based on Becker (1993). We also test the "Malthusian population trap" in reverse concerning population in the context of global climate change. In brief, we have extended Becker's theory to examine the impacts of pollution on the population, which is the reversal of the Malthus hypothesis. Interestingly, we find that the impact of global climate change on population growth is diverse which depends on family heterogeneity. Specifically, our result suggests that for poor households, the "income effect" owing to changes in adult and child wage rates was significantly more important, outweighing the effects of "pollution", whereas, for wealthy households, concern for "environmental quality" outweighs the income effect, since they had high initial income.

JEL Classification: D13, D50, Q50
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1. INTRODUCTION

Climate change is the most important threat to humanity, causing drought and wetter areas, resulting in more severe winters and hotter summers. Due to the severe effect of climate change, such as increasing temperatures, sea level rise, draughts, and famine, in the next 10 to 20 years, the most fundamental concern will be what those families will look like. (Royal Society 2020).

The current industrial society intrinsically destroys the world (the Atlantic 2014). In essence, everything that must be done by people to make life simpler, safer, and more comfortable worsens conditions for the biosphere. To sum it up, increasing sea levels and permafrost methane release will primarily result in food and water shortages, which we are already experiencing and will continue to do. There is a shortage of everything humans require to exist, including food, water, and that window, which causes a great deal of instability in the human system and increases the likelihood of bloodshed.

Numerous ecosystems will perish as the ocean rises and engulfs the shoreline and the towns we construct (IPCC 2018).

A growing number of individuals are preferring not to have children considering the grim realities of the climate issue. Some ladies feel utterly unprepared to become parents. There is also a term for it called "Birthstrike: mothering the world" (the Years Project 2019). A common assumption says the fertility rate will decline as the relative cost of having a kid rises, either because the absolute cost of having a child rises or because the cost of another activity drops (Pritchett 1994). But this is not true for financially unstable poor people who are mainly employed in the labor-intensive workforce where the number of the total workforce largely determines the income of the family. So, the fertility rate will increase as the relative benefits of having more children rise (Riphahn & Wiynck 2017).

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In a world affected by climate change, newborn babies' health deteriorates along with that of the natural world (the World Bank 2015). Poor people choose to have more kids because having more kids increases the likelihood that they can be replaced in the workforce, keeping it stable.

A study of 18,000 couples in China in 2016 revealed that climate change, particularly pollution, was associated with a 20% increased likelihood of infertility (the Guardian 2021). The following year UCLA researchers found that the number of births in the United States decreased in the nine months following an extreme heat event (UCLA 2018). Many impoverished countries that are located near the equator are suffering greatly as a result of climate change's negative effects (pnas 2021). Climate change will cause massive population movement in these places because it will make it very difficult to live in some of these locations of the world, make food and water sources less reliable, and increase the frequency and severity of storms and floods. We are aware that when infant mortality increases, individuals tend to have more children. Therefore, people in these areas could want to have more children to increase the possibility that the clan would survive (Casey et al 2019). Change can promote reproduction in addition to structural reorganization, eliminating the gender pay gap, and lowering infant mortality. As a result, climate warming may make inequality worse by raising schooling and lowering fertility in affluent Northern nations while doing the opposite in poorer tropical ones (UN 2020).

Malthusian population trap (Malthus 1798), states that the human population expands faster than the food supply until hunger, war, or sickness decreases the population. This idea is put to the test in this essay by revising the theory of fertility (Becker 1963), which employs the utility function to explain family economics. In this part, by considering climate change as a factor of Becker's fertility theory, we develop a reverse Malthusian hypothesis that is the effect of pollution on population growth which is proxied by the number of newborn children. This study has demonstrated that increasing pollution leads to an increase in the overall market wage rate, and that child preference decreases as pollution's effects become more severe in Skilled (Rich) and Unskilled (Poor) households. However, depending on the degree to which one group is able to control another, child preference may be greater or lower. In the case of poor households, the changes in adult wage rates as well as child wage rates are much more significant than the level of pollution, while in the case of wealthy households, the effects of skilled wage rates are insignificant due to their high initial wages and pollution effect dominates in case of child preference.

This remainder of the paper is organized as follows: Section 2 reviews literature focusing on the relationship between household child preference and income, and climate change's effect on income, showing pollution as the main factor of climate change and a brief discussion on Malthus and Becker's theories and their modifications. Section 3 discusses household optimization behaviour. We consider both skilled and unskilled households in this part. In section 4 we develop a multi-sector multi-factor market equilibrium model. A couple of comparative statics is carried out in section 5. Section 6 provides results and discusses these findings with appropriate interpretations

2. LITERATURE REVIEW

Life expectancy and child mortality are highlighted by long-term variations in fertility. There may be a connection between climate and fertility since climatic change will have an impact on mortality. Parents may raise fertility in these areas near the equator, where many developing nations are found, in order to guarantee that they reach some minimal desired level of fertility despite the high and unpredictable death rates. In conclusion, climate change may worsen inequality by raising schooling and lowering fertility in affluent northern nations while doing the opposite in poorer tropical ones (Gregory Casey et al 2019). Later on, an 'environmental research letter' published (IOPScience), cited a study (Murtaugh and Schlax, 2009) named 'quantified future emissions of descendants based on historical rates, based on heredity,' and concluded that having one fewer child has much greater potential to reduce emissions than commonly promoted strategies like comprehensive reforestation (Wynes & Nicholas 2017). However, for poor uneducated countries, the option can be relatively limited.

A study on family planning gave particular emphasis on the extra burden that climate change throws on communities already dealing with migration issues brought on in part by rapid population increase (Bryant, Carver, Butler, Anage 2009). For example, the lack of fresh water is undoubtedly a major issue or many nations, and reports frequently relate it to rapid population increase. Although some publications also include the consequences of growing pollution levels upon fresh water, the problem is often one of dwindling supply (due to climate change) in the face of increasing demand (due to population increase). The dual impacts of population increase and sea level rise in Bangladesh on the relative availability of fresh water have not gone unnoticed (Bryant et al 2009). To cite another example; the population of Tajikistan, the poorest nation in Emerging Europe, is predicted to more than quadruple by the end of the century. (bne IntelliNews 2022) The paper makes the premise that income is likewise affected by climate change. The poorer half will experience income effects from climate change more severely than many of us now anticipate. (OCED 2002) research with many big collaborations showed how existing poverty-related vulnerabilities will likely be impacted by climate change. Another analysis indicates how global warming has exacerbated economic inequality and is projected to do so in the future (Diffenbaugh & Burke 2019). UN acknowledging the gravity of this situation stated that 'The United Nations Development Program is committed to ending poverty and supporting countries' efforts to advance sustainable human development (UN 2007).

Next, the task is to identify how income influences population growth. According to a study (the Institute of Family Studies 2013), volunteers surveyed nearly ten thousand households to find out how income and population increase are correlated and concluded mixed results depending on many factors. The facts on fertility rates would lead one to believe that having children is a lesser good. Within nations, household income and fertility have a high negative link, and there is a large negative correlation between GDP and fertility globally. That is, wealthy nations have lower fertility rates than poor ones, and high-income families in a particular country have fewer kids than low-income couples do (Joseph Price, IFS 2013). Economist (T. Paul Schultz) raised a similar point; between nations, there is an inverse relationship between income per adult and fertility, and this negative relationship is typically observed between families as well (Yale University 2005). Numerous studies (NCBI 1993), (World Economic Forum 2015), (Kim, UniChicago 2010) show that fertility is lower in women with greater levels of education and frequently higher in women whose families own more land and assets.

This paper also identifies pollution as a key contributor to climate change. It is simple to figure out that pollution is one of the primary and most important causes of climate change, with other elements depending on it either directly or indirectly. In order to have a clearer perspective in this regard, it is crucial to establish Malthus and Becker's idea. We know from the research hypothesis that the human population grows faster than the food supply until famine, conflict, or disease causes the population to decline (Malthus 1798). This is referred to as population theory. However, this model has a few significant flaws. The validity of the hypothesis is still a topic of discussion among economists today. On the one hand, it is accurate since having more children increases pollution and the carbon impact (BBC 2019). While many detractors claim that the theory fails to take into account future technological advancements, the "green revolution" in agriculture, or scientific advancements that did not exist when this concept was being constructed. Next, the theory of fertility (Becker 1963) says that individuals have children in order to think about and enjoy the pleasure of their offspring (utility). In simple language, it discusses family economics using the utility function. Moreover, it omitted some significant outside factors like child labour, gender, or pollution. Becker's model is largely expanded in this study. We are revising Becker's theory to test the reverse Malthus hypothesis i.e., the impact of pollution on the population.

3. HOUSEHOLD BEHAVIOUR.

We have considered a small developing economy where the total population has been divided into two categories – skilled and unskilled. The skilled population enjoys higher wages (W_s) and forms the high-income household. On the other hand, the unskilled population earns (W) and forms the low-income household. In the unskilled household we have assumed the utility function as a monotonically increasing function of composite commodity X_p and also the number of children l_{cp}, as the number increases, the more will be the income from child labour and hence more utility. Similarly, in the case of skilled households, we include the environmental quality which is the function of Pollution along with the no of children and the composite commodities. As Pollution increases, the environmental quality decreases, and as a result, the utility falls. As number of children increases, families derive happiness from it. But as skilled households are more conscious about the pollution level so they trade off an extra child for the betterment of society[1]. We get the budget equation for the unskilled and skilled households by equating the total expenditure and the total earnings.

3.1 UNSKILLED HOUSEHOLDS

The utility of the representative unskilled household is given by the following:

$$U = U(X_p, I_{cp}) \tag{1}$$

Where X_p denotes the composite commodity and I_{cp} denotes the number of children in the family. The subscript p implies unskilled households.

The budget constraint is given by the following:

$$PX_p = h(Z)W + W_c I_{cp}(1-\phi(Z)) - \phi(Z) I_{cp} \tag{2}$$

Where p denotes the price index Z denotes the level of pollution and h(Z) denotes the efficiency of adult labour such that $h(Z) \in (0,1)$; $dh/dZ < 0$. $\varphi(Z)$ denotes the probability that the child will get diseased and the family has to incur expenditure on treatment, where, $d\varphi/dZ > 0$ and $\varphi \in [0,1]$

W_c implies the wage rate of child labour. The term $h(Z)W$ implies the total effective wage earned by the adults of the household, $W_c I_{cp}$ denotes the wage earned by the child labour and is the wage lost by the household if the child has diseases due to pollution, and $W_c I_{cp}\varphi(Z)$ represents the money spent by the household on the healthcare of children born with a disease due to pollution. We have considered that the health expenditure borne by the household is in unity.

Let, the utility function in the form of a Cobb-Douglas utility function i.e., $U = X_p^{\alpha} I_{cp}^{1-\alpha}$ so by taking the log on both sides the equation can be written as

$$U = \alpha \log X_p + (1-\alpha)\log I_{cp} \tag{3}$$

Now substituting in equation (3) we get,

$$U = \alpha \log\left(\frac{h(Z)W + W_c I_{cp}(1-\phi) - \phi(Z) I_{cp}}{P}\right) + (1-\alpha)\log I_{cp} \tag{4}$$

Now to find the first-order condition we differentiate the above equation to get,

$$I_{cp} = \left(\frac{1-\alpha}{\alpha}\right)\frac{PX_p}{\{\phi - W_c(1-\phi)\}} \tag{5}$$

This leads to the following lemma.

LEMMA 1: $I_{cp} > 0$ is implied by $\phi > W_c(1-\phi)$

Now taking the log on both sides of eq (5) we get,

$$\log I_{cp} = \log\left(\frac{1-\alpha}{\alpha}\right) + \log P + \log X_p - \log\{\phi - W_c(1-\phi)\} \tag{6}$$

Differentiating equation (4) with respect to Z we get,

$$\frac{1}{I_{cp}}\frac{\partial I_{cp}}{\partial Z} = \frac{1}{X_p}\frac{\partial X_p}{\partial Z} - \frac{1}{\{\phi - W_c(1-\phi)\}}\{\phi' + W_c\phi'\} \tag{7}$$

Using equation (2) we can find $\frac{\partial X_p}{\partial Z}$

$$P\frac{\partial X_p}{\partial Z} = Wh'(Z) - W_c I_{cp}\phi'(Z) + W_c\{1-\phi\}\frac{\partial I_{cp}}{\partial Z} - \phi\frac{\partial I_{cp}}{\partial Z} - \phi' I_{cp} \tag{8}$$

Substituting this equation in equation (7) we get,

$$\frac{\partial I_{cp}}{\partial Z} = \frac{\frac{I_{cp}}{P\times p}\left[Wh'(Z) - \phi' I_{cp}(1+W_c)\right] - \frac{I_{cp}\phi'(1+W_c)}{\{\phi - W_c(1-\phi_c)\}}}{1 + \frac{I_{cp}}{P\times p}\{\phi - W_c(1-\phi)\}} < 0 \tag{9}$$

Differentiating equation (6) with respect to W what we get,

$$\frac{\partial I_{cp}}{\partial W} = \frac{\frac{h(Z)}{P\times p}}{1 + \frac{I_{cp}}{P\times p}\{\phi - W_c(1-\phi_c)\}} > 0 \tag{10}$$

Differentiating equation (6) with respect to W_c what we get,

$$\frac{\partial I_{cp}}{\partial W_c} = \frac{(1-\phi)\left[\frac{I_{cp}}{P\times p} + \frac{1}{\phi - W_c(1-\phi)}\right]}{1 + \frac{I_{cp}}{P\times p}\{\phi - W_c(1-\phi)\}} > 0 \tag{11}$$

Thus, we get the following result

$$I_{cp} = I_{cp}\begin{pmatrix} Z & W & W_c \\ - & + & + \end{pmatrix} \tag{12}$$

Therefore, from the above equations, we obtain the following lemma I.

LEMMA 2: The demand for children in unskilled households varies inversely with the level of pollution, however, increases with the adult & child wage rate provided $\phi > W_c(1-\phi)$.

Proof: - We offer intuitive proof to support this lemma. Suppose that the level of pollution increases, then the health expenditure would also increase lowering the family income of the poor unskilled families. Thereby, unskilled people could afford to have fewer children.

1 The details about the derivation of budget equations for unskilled and skilled households are briefly described in sections 3.1 and 3.2 respectively

On the other hand, if the wage of the child increases, then the net family income would also increase so the parents can afford to have more children.

3.2 SKILLED HOUSEHOLDS

In what follows, we analyse the demand for children in skilled households. The skilled household's utility function is represented by the following:

$$V = V\begin{pmatrix} C_R & I_{cR} & E(\tilde{Z}) \\ + & + & + \end{pmatrix} \tag{13}$$

Where C_R implies composite consumption which includes the consumption of all the other goods that the household needs to consume to sustain itself. $\tilde{Z}$ is the pollution as perceived by the skilled families in the future and E is the environmental quality which is negatively related with $\tilde{Z}$. We must also note that, $E'<0$ and $E''=0$. The notation R implies skilled households and $\tilde{Z} = I_{cR}\bar{Z}$, skilled people perceive that pollution increases as the no. of children increases[2]. Here $\bar{Z}$ is the actual level of pollution. Now taking the logarithm of the utility function we write it as

$$V = \ln C_R + \ln I_{cR} + \ln E(\tilde{Z})$$
$$\therefore V = \ln C_R + \ln I_{cR} + \ln E(I_{cR}Z) \tag{14}$$

Here We have assumed a budget equation for the same which is as follows

$$PC_R = W_s - \phi(Z) I_{cR} \tag{15}$$

Here p denotes the price index, W_S implies the wage earned by the adults of the skilled household, I_{cR} represents the number of children. Unlike the unskilled household where there is no component of the wages earned by the children and the wage loss due to the diseased children as skilled people are rich and they won't let their children work and earn a wage. Similarly, the cost incurred by the household on the treatment of the diseased child and the health expenditure is in unity per child.

Now substituting equation (15) in equation (14) and differentiating with respect to we get,

$$\frac{1}{I_{cR}} = \frac{\phi(Z)}{PC_R} - \frac{E'Z}{E(\tilde{Z})} \tag{16}$$

Equation (16) is also the first-order condition. Now we differentiate equation (16) with respect to I_{cR} we get,

$$\frac{\partial I_{cR}}{\partial Z} = \frac{\left[\frac{\phi'(Z)}{PC_R} + \frac{\phi\phi' I_{cR}}{P^2 C_R^2} - \frac{E'}{E} + \frac{ZE'^2 I_{cR}}{E^2}\right] I_{cR}^2}{\left[\frac{-\phi^2 I_{cR}^2}{P^2 C_R^2} - 1 - \frac{E'^2 Z^2 I_{cR}}{E^2}\right]} < 0 \tag{17}$$

The above equation is less than 0 because of the term $\left[\frac{\phi'(Z)}{PC_R} + \frac{\phi\phi' I_{cR}}{P^2 C_R^2} - \frac{E'}{E} + \frac{ZE'^2 I_{cR}}{E^2}\right] > 0$ and $I_{cR}^2 > 0$ but $-\left[\frac{\phi^2 I_{cR}^2}{P^2 C_R^2} + 1 + \frac{E'^2 Z^2 I_{cR}^2}{E^2}\right] < 0$ so $\frac{\partial I_{cR}}{\partial Z} < 0$
From this, we may say that
$\therefore I_{cR} = I_{cR}\begin{pmatrix} Z & W_s \\ - & + \end{pmatrix}$ which gives rise to Lemma 3

LEMMA 3: Demand for children varies inversely with the level of pollution, however, it increases with the skilled wage rate.

Proof:- We offer intuitive proof to support this lemma, as the income of the skilled households increases, they will have more children, but if the pollution level increases then they may have less of children as they are concerned about the environment.

4. THE GENERAL EQUILIBRIUM ANALYSIS

The general equilibrium system consists of the following equations. The competitive industry equilibrium conditions for the two sectors are as follows.

$$Wa_{L1} + W_c a_{c1} + Ra_{k1} = 1 \tag{18}$$

$$W_s a_{s2} + Ra_{k2} = P_2 \tag{19}$$

where, a_{ji} is the input-output ratios. W, W_s, W_c respectively represents Wages of unskilled labours, skilled labours, and child labours and represents the interest rate. In equation (18) we have assumed the price of the good 1 as unity and P_2 is the relative price of P_1 . All the nominal variables are real. Here K is the capital and R is the interest on capital as capital is the borrowing to pay back. a_{c1}, a_{k1}, a_{L1} respectively represents the child labour, capital required and labour required per unit of production of output X_1 in sector 1. a_{S2} represents the skilled labour required per unit production of X_2 in sector 2. Equation (18) and (19) implies the zero economic profit condition. The full-employment conditions for adult unskilled labour, child labour, capital, and skilled labour are given by the following four equations, respectively.

$$a_{L1}X_1 = \bar{L}h(Z) \tag{20}$$

$$a_{c1}X_1 = \bar{L}(1-\phi(Z)) I_{cP}(Z, W, W_c) \tag{21}$$

$$a_{k1}X_1 + a_{k2}X_2 = K(R);\ K' > 0 \tag{22}$$

$$a_{s2}X_2 = \bar{S} \tag{23}$$

[2] *See the Section literature review and Interventions for empirical evidence.*

Here we assume that $\bar{S}$ is the total number of skilled labours who are earning the skilled wage rate W_S. $\bar{L}$ is the total labour in Sector 1 and Sector 2. The general equilibrium system is represented by equations (18) – (23). The same number of endogenous variables namely, $X_1, X_2, R, W_s, W \& W_c$. Hence the system is consistent. Equation (20) solves for X_1. X_2 is solved from equation (23). Substituting these values in equation (22), we obtain . Finally, equations (18), (19) and (21) solve for W, W_C and W_s .

This completes the determination of the equilibrium values in the system.

5. COMPARATIVE STATICS

In this section of this paper, we would now like to investigate how gradually increasing pollution (rise in Z) affect the demand for children in household, we solve the equations from (18) – (23) and obtain the following propositions,

Proposition 1: *An exogenous increase in the level of pollution leads to an increase in the market wage of both unskilled and skilled workers.*

Proof: As Pollution (Z) increases efficiency [h(Z)] decreases as a result the supply of adult labour decreases i.e. $[\bar{L}h(Z)]$ decreases in eqn (20), Hence as the supply decreases the Unskilled adult labour wage i.e. W increases. Similarly, from eqn (21) we see that due to increase in (Z) the supply of child labour i.e $\bar{L}(1-\phi(Z))l_{cP}(Z,W,W_c)$ decreases and hence the child labour wage W_c increases. Now as both W and W_c increases to keep the RHS constant of eqn (18) the interest rate R falls. Now as R falls to keep the RHS constant of eqn (19) the skilled wage rate W_S increases.

Proposition 2: *When market-based effects of pollution are into consideration, then pollution may lead to*

(a) a higher preference for children if the wage effect dominates the direct negative effect of pollution and vice-versa.

(b) for the skilled households, no of children may increase if the wage effect dominates but it may fall if the pollution effect dominates.

Proof: We offer an intuitive proof of the above propositions as follows. An increase in pollution leads to a fall in efficiency (Fall in h). It follows from equation (20) that the output of sector 1 falls (X_1 falls), whereas there is no change in the output of sector 2 (X_2 no change) as X_2 is independent of components h or Z as in equation (23). So, from equation (22) as X_1 decreases without any change in X_2 so the demand for capital falls which results in the fall of R . Now coming to equation (19) as R falls but P_2 remains constant, hence wages of skilled labour (W_S) must rise. Now coming to equation (18) as R falls, but the RHS is constant so to maintain the wages of unskilled labour (W) and wages of child labour (W_c) both of them must rise. So, from LEMMA 2 W as and W_c increases the demand for children must rise. Similarly for skilled households as wages of skilled labour (W_s) increases the demand for children increases but on the other hand as pollution level increases (Z) the demand for children will decrease [LEMMA 3]. Hence, we may conclude that a change in the adult wage rate and child wage rate in the unskilled household will have a more significant effect on the demand for children than the pollution factor. Whereas in the case of skilled household the effect of pollution on the demand for children is much more dominating than the wage rate as skilled people already has a high initial wage.

6. CONCLUSION

This paper made a modest attempt to explain the economics of climate change and child preferences. The primary goal was to determine how children's preferences for wealthy and impoverished homes were affected by the effects of climate change. Here we revised Becker's theory of fertility in order to verify the validity of the reverse Malthusian theory. To establish the effects of climate change, we used pollution as the main factor. To develop the model, we considered the cases of Rich or Skilled and Poor or Unskilled Labour. For rich families, the total utility was considered a function of skilled labour wage rate and the effects of efficiency due to pollution. For Poor households, we also took the factor of non-disabled child labour wage rate. The study came to the conclusion that family preferences for children vary inversely with pollution level but rise with wage rate. We have demonstrated that how rising pollution causes the market wage rate to rise overall, and how child preference declines as pollution's impacts worsen. Depending on how well one group can dominate another, however, the preference for children may be higher or lower. It could be inferred from this study that for poor households, changes in adult and child wage rates were much more significant, dominating the effects of pollution, whereas, for wealthy households, changes in skilled wage rates were trivial compared to the effects of pollution since they had high initial wages.

To fully grasp the impact of child preference due to climate change it is necessary to consider how adaptation to climate change may involve demographic change, change in technology, change in job roles, etc. These findings point to the necessity for further investigation and quantification of other significant channels in order to expand upon our findings.

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