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Deanship of Scientific Research

RESEARCH PROPOSAL

What Determines Specific Schooling Decisions in the USA? A Dynamic General Equilibrium Analysis

عنوان المشروع باللغة العربية (هنا)

Submitted under

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Principal Investigator, ***Dr. Muhammad Saifur Rahman, Assistant Professor***

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PROJECT INFORMATION

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UNDERTAKING OF THE RESEARCH TEAM

The research team undertakes that:

1. **This research proposal has not been submitted, either in part, or in full, or under different title to any funding agencies including KACST, Research Institute, Academic Development Centre, or any outside agency.**
2. **We stand to lose a chance to get financial support or any related action from the University if, at a later date, it is made known that a similar proposal submitted by us to another agency for funding.**
3. **We declare that whatever we have stated is true to the best of our knowledge and understanding.**
4. **We will inform the Deanship of Scientific Research if the PI decides to leave KFUPM for more than one academic semester at least one academic semester before his leave.**

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SUMMARY

Aggregate public school enrollment in primary education in the USA in the last 100 years has been roughly constant at 0.88 or 88% of the total enrollment. This contradicts with the conventional wisdom and the "popular press" which argues that there have been significant changes in the quality of education and the cost of education itself over this long period, although the latter claim has been challenged by a recent paper by Fernandez and Rogerson(2001). Also there appears to be a divergence between the qualities of education in private vs. public schools, indicated by various sources. This paper tries to investigate the reason why the fraction of public school enrollment has been constant over such a long period of time. I use a canonical model of schooling decisions which is widely used in literature and try to analyze the effect of income inequality, mean income and changes in the quality of education on the public enrollment. My approach sharply contrasts with the existing literature which mainly focuses on the role of schooling decisions on income inequality. Using a parametric model, I identify the threshold income level below which parents send their kids to public school and above which they send their kids to private school. Analytical results show how this threshold income level changes with the income inequality of the economy and how the changes in the threshold income effect the enrollment decisions. Under the assumption of no quality change in education and an unchanged real cost of education, I will show that the model calibrated to 1989 USA data can match the aggregate enrollment figures for the USA almost perfectly. I will then show that the model, applied to each individual state, can also match their enrollment decisions, although not uniquely. Finally, I will use Generalized Methods of Moments (GMM) to estimate the structural parameters of the model for both the national as well as for the state level data to assess the statistical fitness of the model. I will show that the paper draws support to the empirical work of Fernandez and Rogerson(2001).

المُلخص:

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1.0 INTRODUCTION

Public school enrollment in primary education in the USA in the last 100 years has been roughly constant at 88% of the total enrollment. This is despite significant changes in average income, income inequality and even according to some, changes in the quality of education. This paper tries to investigate the reason why the fraction of public school enrollment has been constant over such a long period of time. A very simple model will be developed to analyze the effect of income inequality, average income and changes in the quality of education on the public school enrollment. The model will define a threshold income level below which parents send their kids to public school and above which their send their kids to private school. Then, some calibration and empirical exercise will be conducted to match both national and state-level USA data on public school enrollment.

2.0 PROJECT OBJECTIVES

There are several objectives of this project. First, develop a theoretical model and develop several propositions regarding the determination of the threshold income and the effect of income inequality on the threshold income and schooling. Second, provide some numerical results that exploit the relationship between the threshold income, income inequality and schooling decisions. Third, carry out three kinds of empirical results. First, report the results from the calibration exercise where the model is calibrated to both USA national and state-level income data to see whether the model can predict enrollment figures that can match USA data. Second, GMM method will be applied to estimate the parameters of the model to see whether the model can generate private and public school enrollment similar to USA data. Finally, a panel GMM exercise will be carried out to for a robust estimation of the parameters of the model.

3.0 LITERATURE REVIEW

The literature on the relationship between income and schooling is extensive and falls into two broad categories. First, there are a long list papers that try to understand the relationship in a theoretical environment. For example, Glomm and Ravikumar(1992) makes a seminal contribution by analyzing the endogenous relationship between income inequality and how it is effected by parental choice of public versus private school. In another seminal paper, Epple and Romano (1996) setup a theoretical model where schooling decision and schooling financing (tax) is determined simultaneously. The authors define a threshold income level below which parents will send their children to public school. This threshold level will be a function of the tax that parents pay to finance public school education. On the empirical side, there is a long list of papers that try to identify the factors that effect schooling decisions. For Example, Goldhaber(1998) tries to investigate the relationship public school expenditure and private school enrollment and finds no strong relationship. Cohen-Zada and Justman(2005) finds a strong latent demand for religious education. Gemello and Osman(1984) analyze which economic, social, religious, and ethnic characteristics are significantly related to the private school choice. Fernandez and Rogerson(2001) finds that two most important determinants of spending per student are personal income and number of students. Also they find that the quality of public school education has remained almost unchanged.

The present paper differs from the previous literature in three aspects. First, it extends the literature developed by Glomm and Ravikumar(1992) but goes beyond their scope by looking at the effect of inequality on the threshold income. Second, the paper attempts to match USA national and state-level data with the model by using calibration as well as Generalized Method of Moments (GMM). Third, the paper analyzes the effect of inequality on the schooling decisions rather than vice versa which has been the norm in the literature. While the existing literature identifies the causal relationship between schooling and income by assuming that the former effect the latter, I will analyze how income inequality effects schooling decisions. So far Catalina (2006) is the only paper that has taken this approach.

4.0 Organization of the Paper

The paper is organized in the following; Chapter 1 explains the theoretical model and develops several propositions regarding the determination of the threshold income and the effect of income inequality on the threshold income and schooling. Chapter 2 provides some numerical results that exploit the relationship between the threshold income, income inequality and schooling decisions. Chapter 3 reports three kinds of empirical results. First, it reports the results from the calibration exercise where the model is calibrated to both USA national and state-level income data to see whether the model can predict enrolment figures that can match USA data. Second, GMM method will be applied to estimate the parameters of the model to see whether the model can generate private and public school enrolment similar to USA data. Finally, a panel GMM exercise will be carried out to for a robust estimation of the parameters of the model.

We consider a two period OLG model where population in each generation is normalized to unity. We will consider an altruistic environment where parents care about how much they are contributing towards their child's education. Parents enelastically supply 1 unit of time to work . They decide whether their child will go to private or public school. If children go to public school, the expenditure is carried out by the government. Parents do not provide any educational supplement. If private school is chosen,parents bears the entire expenditure. Government finances the public education by a flat income tax.Children are not allowed to work when they are young. They only accumulate human capital by going to school.Human capital accumulation of the child depends not on the financial input , but also on the Human capital of the parents. Households have initial income distribution given by $f(h)$ and $F(h)$ with support $\bar{h}$ and $\underline{h}$ such that $\left(\bar{h}, \underline{h}\right) \in [0, \infty]$ .Parents are homogenous in ability but heterogeneous in income. Children are homogenous in ability. The aggregate human capital is given by:

$$H = \int_{\underline{h}}^{\bar{h}} hf(h)\, dh = E(h) \tag{1}$$

Goods are produced by using human capital only, such that

$$y_t = H_t \tag{2}$$

Following Epple and Romano(1996), the utility function of the parents look like

$$U(c_t, q_t) = \left[\beta c_t^{-\rho} + (1-\beta) D_t^{-\rho}\right]^{-1/\rho} \tag{3}$$

where c_t is the consumption of the parents and D_t is the quality of education received by the children where $D_t = q_t$ if children attend private school and $D_t = E_t$ if children attend public school where q_t is the out-of- pocket expenditure of the parents and E_t is the per-pupil government expenditure on public education. E_t is the government constraint which is defined as follows:

$$E_t = \frac{k\tau H_t}{N_t} \tag{4}$$

where τ is the exogenously fixed flat income tax rate, k is an indicator for public education quality , H_t is the aggregate human capital(aggregate income) and N_t is the fraction of population

going to public school. N_t is defined as follows:

$$N = \int_0^{\overset{*}{h}} f(h)\, dh \tag{5}$$

where $\overset{*}{h}$ is the *threshold* income level below which all the parents send their kids to public school and vice versa

The human capital technology is defined as follows; for children attending public school,

$$h_{t+1}^{PB} = \theta q_t^{\gamma} h_t^{\delta} \tag{6}$$

and for children attending private school,

$$h_{t+1}^{PR} = \theta E_t^{\gamma} h_t^{\delta} \tag{7}$$

Here θ is the productivity parameter, γ and δ indicates the elasticity of h_{t+1} with respect to q_t (or E_t) and h_t.

Parents who send their kids to private school choose c_t and q_t , τ and h_t, to maximize

$$\left[\beta c_t^{-\rho} + (1-\beta) q_t^{-\rho}\right]^{-1/\rho} \tag{8}$$

subject to

$$c_t + q_t = (1-\tau) h_t \tag{9}$$

Parents who send their kids to public school choose c_t , given τ, h_t, E_t, to maximize:

$$\left[\beta c_t^{-\rho} + (1-\beta) E_t^{-\rho}\right]^{-1/\rho} \tag{10}$$

subject to

$$c_t = (1-\tau) h_t \tag{11}$$

Then the optimal choice for the parents who send their kids to private school looks like,

$$c_t = \frac{(1-\tau)}{\left[1+\left(\frac{\beta}{1-\beta}\right)^{1+\rho}\right]} h_t \tag{12}$$

$$q_t = \left[\frac{\left(\frac{\beta}{1-\beta}\right)^{1+\rho}}{1+\left(\frac{\beta}{1-\beta}\right)^{1+\rho}}\right](1-\tau)\, h_t \tag{13}$$

The indirect utility of the parents sending their kids to private school looks like:

$$V^{PR}(h_t;\tau) = \left[\beta\left\{\frac{(1-\tau)}{\left[1+\left(\frac{\beta}{1-\beta}\right)^{1+\rho}\right]} h_t\right\}^{-\rho} + (1-\beta)\left\{\left[\frac{\left(\frac{\beta}{1-\beta}\right)^{1+\rho}}{1+\left(\frac{\beta}{1-\beta}\right)^{1+\rho}}\right](1-\tau)\, h_t\right\}^{-\rho}\right]^{-1/\rho}$$

$$\Rightarrow V^{PR}(h_t;\tau) = \left[\beta\left\{\frac{1}{\left[1+\left(\frac{\beta}{1-\beta}\right)^{1+\rho}\right]}\right\}^{-\rho} + (1-\beta)\left\{\left[\frac{\left(\frac{\beta}{1-\beta}\right)^{1+\rho}}{1+\left(\frac{\beta}{1-\beta}\right)^{1+\rho}}\right]\right\}^{-\rho}\right]^{-1/\rho} (1-\tau)h_{tt} \tag{14}$$

Now for parents who send their kids to public schools, their optimal choice looks like,

$$c_t = (1-\tau)h_t \tag{15}$$

where,

$$E_t = \frac{k\tau H_t}{N_t} \tag{16}$$

Also, the indirect utility of the parents who send their kids to public schools look like,

$$V^{PB}(h_t;\tau) = \left[\beta\left\{(1-\tau)h_t\right\}^{\rho} + (1-\beta)\left\{\frac{k\tau H_t}{N_t}\right\}^{-\rho}\right]^{-1/\rho} \tag{17}$$

Similar to the linear case, the threshold level of income will be found by equating the indirect utility from public and private school, namely equating equation(32) and (34). The threshold level of income is defined as follows,

$$h_t^* = \tfrac{F.H_t}{N_t} \quad (35)$$

where,

$$F = \left\{ \left[\frac{1-\beta}{\{D(1-\tau)\}^{-\rho} - \beta.(1-\tau)^{-\rho}} \right]^{-1/\rho} k.\tau \right\} \quad (35)$$

Where,

$$D = \left[\beta \left\{ 1 + \left(\frac{\beta}{1-\beta} \right)^{1+\rho} \right\}^{\rho} + (1-\beta) \left\{ \frac{1+\left(\frac{\beta}{1-\beta} \right)^{1+\rho}}{\left(\frac{\beta}{1-\beta} \right)^{1+\rho}} \right\}^{\rho} \right]^{-1/\rho} \quad (36)$$

4.1 Definition of Competitive Equilibrium

A competitive equilibrium for the economy is a sequence of $\{c_{it}, q_{it}, h_{it+1}\}_{i=0}^{\infty}$, E_t, y_t , H_t and H_{t+1}such that

a) Given τ and h_t, parents in the private education regime choose c_t and q_t to maximize(4) subject to (5),

b) Given E_t, parents in the public school regime choose c_t to maximize() subject to (),

c) There exists a threshold level of income $\overset{*}{h}$ such that below which parents send their kids to public school and above which parents send their kids to private school.

d) Given N_t defined by (5) and H_t defined by (1),government balances its budget defined by (4).

e) Goods market clears, $c_t = y_t$

f) Human capital market clears,

$$H = \int_{\underline{h}}^{\bar{h}} h f(h)\, dh \quad (12)$$

Solving the private regime model yields the equilibrium allocation:

$$c_t + q_t = \frac{(1-\tau)h_t}{2} \quad (13)$$

The indirect utility of the parents who send their kids to private school is defined as follows:

$$V^{PR}(h_t, \tau) = 2 \ln \left\{ \frac{(1-\tau)h_t}{2} \right\} \quad (14)$$

Finally, the Human capital of the children going to private school is defined as follows:

$$H_{t+1}^{PR} = \theta \left\{ \frac{(1-\tau)}{2} \right\}^{\gamma} h_t^{\gamma+\delta} \quad (15)$$

The indirect utility of the parents who send their kids to private school is defined as follows:

$$V^{PB}(h_t, E_t, \tau) = \ln \left\{ (1-\tau)h_t \frac{k\tau H_t}{N_t} \right\} \quad (16)$$

Finally, the Human capital of the children going to public school is given by

$$H_{t+1}^{PB} = \theta \left\{ \frac{k\tau H_t}{N_t} \right\}^{\gamma} h_t^{\delta} \quad (17)$$

Proposition 1 *There exists a unique threshold level of income* $\overset{*}{h}$ *such that below which parents send their kids to public school and above which parents send their kids to private school*

Proof. The thresh hold income would be derived by identifying the parents who are just indifferent between sending their kids to private or

public school. These parents derive the same indirect utility by sending their kids to private or public school. By equating (14) and (16),

we get

$$2\ln\left\{\frac{(1-\tau)h_t}{2}\right\} = \ln\left\{(1-\tau)h_t\frac{k\tau H_t}{N_t}\right\} \Longrightarrow \overset{*}{h_t} = \left(\frac{4k\tau}{(1-\tau}\right)\left(\frac{H_t}{N_t}\right) \tag{18}$$

$$\Longrightarrow \overset{*}{h_t} = \left(\frac{4k\tau}{(1-\tau}\right)\left(\frac{H_t}{N_t}\right)$$

It is clear from (18) that the value of $\overset{*}{h}$ is unique. Also note that

$$\text{For any } h_t \prec \overset{*}{h_t}, 2\ln\left\{\frac{(1-\tau)h_t}{2}\right\} \prec \ln\left\{(1-\tau)h_t\frac{k\tau H_t}{N_t}\right\} \tag{19}$$

So these parents would send their kids to public school because of higher indirect utility. A similar thing happened when the inequality is

reversed and parents then send their kids to private school. ■

In order to probe further into the analysis, we will rearrange (18) as follows:

Assume $\left(\frac{4k\tau}{(1-\tau}\right) = C$. Then subbing (5) into (18) and reorganizing after eliminating the time subscript,

$$CH = \overset{*}{h}N = \overset{*}{h}\int_0^{\overset{*}{h}} f(h)\,dh \tag{20}$$

Now since $h \sim LN(\mu,\sigma^2)$, then $Ln\ h \sim N(\mu,\sigma^2)$ and $Ln\overset{*}{h} \sim N(\mu,\sigma^2)$. Again since, $H = E(h)$, we can write,

$$H = E(h) = e^{\mu+\sigma^2} \tag{21}$$

Furthermore,

$$\begin{aligned} N &= \int_0^{\overset{*}{h}} f(h)\,dh = E\left(1\left(h \le \overset{*}{h}\right)\right) = \Pr(h \le \overset{*}{h}) = \Pr(Lnh \le \overset{*}{Lnh}) \\ &= \Pr\left(\frac{Lnh-\mu}{\sigma} \le \frac{\overset{*}{Lnh}-\mu}{\sigma}\right) = \Phi\left(\frac{\overset{*}{Lnh}-\mu}{\sigma}\right) \end{aligned}$$

Define, $\overset{*}{m} = \frac{\overset{*}{Lnh}-\mu}{\sigma}$ and $m = \frac{Lnh-h\mu}{\sigma}$. Then the above expression can be written as

$$N = \Phi\left(\overset{*}{m}\right) \tag{22}$$

Where the right hand side is a *cdf* of a standard normal distribution with argument as $\overset{*}{m}$.

Furthermore, assume $\ln \overset{*}{h} = \overset{*}{Z}$. Then $\overset{*}{m} = \frac{\overset{*}{Z}-\mu}{\sigma}$ and $\overset{*}{h} = e^{\overset{*}{Z}}$. Finally subbing (20), (22) and (24) into (19):

$$Ce^{\frac{\sigma^2}{2}-\sigma\overset{*}{m}} = \Phi\left(\overset{*}{m}\right) \tag{23}$$

Equation (22) will be our main equation for analyzing various comparative statics issue.

Proposition 2 *For a given σ,an increase in μ leaves N_t unchanged but increases $\overset{*}{h}$.*

Proof. If we rearrange equation(7), we get the following expression:

$$Ce^{\frac{\sigma^2}{2}} = e^{\sigma\overset{*}{m}}\Phi\left(\overset{*}{m}\right) \tag{24}$$

Differentiate both side of (25) with respect to μ

$$\begin{aligned} 0 &= \Phi\left(\overset{*}{m}\right)\cdot e^{\sigma\overset{*}{m}}\cdot\sigma\cdot\frac{\partial\overset{*}{m}}{\partial\mu} + e^{\sigma\overset{*}{m}}\cdot\Phi'\left(\overset{*}{m}\right)\cdot\frac{\partial\overset{*}{m}}{\partial\mu} \\ \Rightarrow\ & \frac{\partial\overset{*}{m}}{\partial\mu}\left[\Phi\left(\overset{*}{m}\right)\cdot e^{\sigma\overset{*}{m}}\cdot\sigma + e^{\sigma\overset{*}{m}}\cdot\Phi'\left(\overset{*}{m}\right)\right] = 0 \end{aligned} \tag{25}$$

The expression within the bracket is not equals to zero. Hence,$\frac{\partial\overset{*}{m}}{\partial\mu} = 0$. Again,

$$\frac{\partial\Phi\left(\overset{*}{m}\right)}{\partial\mu} = \Phi'\left(\overset{*}{m}\right)\cdot\frac{\partial\overset{*}{m}}{\partial\mu} \tag{26}$$

Substituting the value of $\frac{\partial\overset{*}{m}}{\partial\mu}$ from (24)

$$\frac{\partial\Phi\left(\overset{*}{m}\right)}{\partial\mu} = 0, \text{ which implies from (21) that } \frac{\partial N}{\partial\mu} = 0 \tag{27}$$

Differentiate the definition of $\overset{*}{m}$ with respect to μ

$$\frac{\partial\overset{*}{m}}{\partial\mu} = \frac{1}{\sigma}\left(\frac{1}{\overset{*}{h}}\frac{\partial\overset{*}{h}}{\partial\mu} - 1\right) \tag{28}$$

Substituting the value of $\frac{\partial\overset{*}{m}}{\partial\mu}$ from (24)

$$\frac{1}{\sigma}\left(\frac{1}{\overset{*}{h}}\frac{\partial\overset{*}{h}}{\partial\mu} - 1\right) = 0$$

$$\Rightarrow \frac{\partial \overset{*}{h}}{\partial \mu} = \overset{*}{h} \succ 0$$

■

Proposition 3 *For a given μ, increasing σ increases N iff $\overset{*}{h} \prec e^{\sigma^2+\mu}$. It also increase $\overset{*}{h}$ iff $\overset{*}{h} \ln \overset{*}{h} \succ q$ where $q = \sigma^2 \left\{ \frac{\Phi\left(\overset{*}{m}\right)\left(\overset{*}{m}-\sigma\right)}{\sigma\Phi\left(\overset{*}{m}\right)+\Phi'\left(\overset{*}{m}\right)} \right\}$*

Proof. Differentiate both side of (25) with respect to σ :

$$C \cdot e^{\sigma \frac{\sigma^2}{2}} \cdot \sigma = \Phi\left(\overset{*}{m}\right) \cdot e^{\sigma \overset{*}{m}} \cdot \left(\overset{*}{m} + \sigma \frac{\partial \overset{*}{m}}{\partial \sigma} \right) + e^{\sigma \overset{*}{m}} \cdot \Phi'\left(\overset{*}{m}\right) \cdot \frac{\partial \overset{*}{m}}{\partial \sigma} \tag{29}$$

Subbing value from (25) on the left hand side and canceling terms,

$$\sigma\Phi\left(\overset{*}{m}\right) = \Phi\left(\overset{*}{m}\right) \overset{*}{m} + \frac{\partial \overset{*}{m}}{\partial \sigma} \left(\sigma\Phi\left(\overset{*}{m}\right) \right) + \Phi'\left(\overset{*}{m}\right) \cdot \frac{\partial \overset{*}{m}}{\partial \sigma} \tag{30}$$

Collecting terms, we get,

$$\sigma\Phi\left(\overset{*}{m}\right) = \Phi\left(\overset{*}{m}\right) \overset{*}{m} + \frac{\partial \overset{*}{m}}{\partial \sigma} \left(\sigma\Phi\left(\overset{*}{m}\right) \right) + \Phi'\left(\overset{*}{m}\right) \cdot \frac{\partial \overset{*}{m}}{\partial \sigma} \tag{30}$$

Subbing the value from (29),

$$\frac{\partial \Phi\left(\overset{*}{m}\right)}{\partial \sigma} = \Phi'\left(\overset{*}{m}\right) \left(\frac{\frac{\left(\sigma - \overset{*}{m}\right)}{\sigma}}{1 + \frac{\Phi'\left(\overset{*}{m}\right)}{\sigma\Phi\left(\overset{*}{m}\right)}} \right) \tag{31}$$

From the above equation, we see,

$$\frac{\partial \Phi\left(\overset{*}{m}\right)}{\partial \sigma} \succ 0 \text{ iff } \frac{\left(\sigma - \overset{*}{m}\right)}{\sigma} \succ 0 \Rightarrow \sigma \succ \overset{*}{m} \tag{32}$$

Subbing the value of $\overset{*}{m}$ from (21),

$$\frac{\partial \Phi\left(\overset{*}{m}\right)}{\partial \sigma} \succ 0 \text{ iff } \overset{*}{h} \prec e^{\sigma^2+\mu} \Rightarrow \frac{\partial N}{\partial \sigma} \succ 0 \text{ iff } \overset{*}{h} \prec e^{\sigma^2+\mu} \tag{32}$$

Also, from (29) after substituting the value of $\overset{*}{m}$ from (21) into (29),

$$\frac{\partial \overset{*}{m}}{\partial \sigma} = \frac{\frac{\sigma}{\overset{*}{m}} + \frac{\partial \overset{*}{h}}{\partial \sigma} - Ln\overset{*}{h}}{\sigma^2} = \frac{\Phi\left(\overset{*}{m}\right)\left(\sigma - \overset{*}{m}\right)}{\sigma\Phi\left(\overset{*}{m}\right) + \Phi'\left(\overset{*}{m}\right)} \tag{32}$$

$$\Rightarrow \frac{\partial \overset{*}{h}}{\partial \sigma} = \left[\sigma^2 \left\{ \frac{\Phi\left(\overset{*}{m}\right)\left(\sigma - \overset{*}{m}\right)}{\sigma\Phi\left(\overset{*}{m}\right) + \Phi'\left(\overset{*}{m}\right)} \right\} + Ln\overset{*}{h} \right] \cdot \frac{\overset{*}{h}}{\sigma} \tag{1}$$

The above equation implies that

$$\frac{\partial \overset{*}{h}}{\partial \sigma} \succ 0 \text{ iff } \sigma \left\{ \frac{\Phi\left(\overset{*}{m}\right)\left(\sigma - \overset{*}{m}\right)}{\sigma\Phi\left(\overset{*}{m}\right) + \Phi'\left(\overset{*}{m}\right)} \right\} + \frac{\overset{*}{h} Ln \overset{*}{h}}{\sigma} \succ 0 \tag{32}$$

$$\Rightarrow \overset{*}{h} \cdot Ln \overset{*}{h} \succ \overbrace{\sigma^2 \left\{ \frac{\Phi\left(\overset{*}{m}\right)\left(\sigma - \overset{*}{m}\right)}{\sigma\Phi\left(\overset{*}{m}\right) + \Phi'\left(\overset{*}{m}\right)} \right\}}^{q} \tag{2}$$

$$\Rightarrow \overset{*}{h} \cdot Ln \overset{*}{h} \succ q \tag{3}$$

Numerical Analysis
To be done later.
Empirical Analysis
To be done later. ■

4.1 Approach, Tasks and Phases

The theme of the study is shaped generally in this proposal. There are three major steps that need to be undertaken. First, I need to develop the model and derive all the necessary theoretical results. Second, I need to collect both aggregate and state-level education and income data for the USA. Third, I need to first calibrate my model to both aggregate and disaggregate USA data and later estimate my model using GMM. The final shape of the study may take more than 16 months, but the core task should be done according to the following schedule:

Table 1: APPROACH UTILIZED FOR ACHIEVING OBJECTIVES

TASK	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Model Development																
Analytical Results																
Data Collection and Compilation																
Numerical Analysis																
Estimation																
Compare Results and write the Paper																

Research tasks and activities should be divided into groups of assignments, listed in logical sequence and linked with the project objectives to be achieved (Table 2).

Table 2: MAPPING OF PHASES AND TASKS TO ACHIEVE OBJECTIVES

Objectives	Phases	Tasks
Develop the Model	**1**	Write down the specific model that will be used for numerical analysis and for estimation
Derive Analytical Results	**2**	Drive analytical results, check the results and consults with other experts in the discipline
Data Collection and Compilation	**3**	Identify the data source; check for the availability and if necessary, purchase the relevant data; clean the data for use and compile it
Numerical Analysis	**4**	Calibrate the model to both Aggregate and state-level USA data; carry out desired numerical experiments and check for robustness.
Structural Estimation	**5**	Estimate the Structural parameters of the model using GMM method; do this for both aggregate and state-level data.
Compare Results and write the Paper	**6**	Analyze and compare results with existing works. Finally write the paper

4.2 Research Methodology

The methodology would be consistent with research objectives. First, I will develop a theoretical dynamic general equilibrium model that could be used to address the schooling enrollment decisions. I will use that model to develop several propositions regarding the determination of the threshold income and the effect of income inequality on the threshold income and schooling. Second, I will provide some numerical results that exploit the relationship between the threshold income, income inequality and schooling decisions. Third, I will carry out three kinds of empirical analysis. First, I will report the results from the calibration exercise where the model is calibrated to both USA national and state-level income data to see whether the model can predict enrollment figures that can match USA data. Second, GMM method will be applied to estimate the parameters of the model to see whether the model can generate private and public school enrollment similar to USA data both at the aggregate as well at the state-level. Finally, a panel GMM exercise will be carried out to for a robust estimation of the parameters of the model.

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4.3 Management Plan

The Researcher Dr. Muhammad Saifur Rahman will collect the data and conduct the empirical analysis using standard calibration technique as well as using Generalized Methods of Moments (GMM) method. He will also run various simulations and write the report with involvement of 100% of academic year and summer.

4.4 Project Deliverables

The objective of the project is to understand the endogenous relationship between income inequality and schooling decisions. The present project will try to develop one theoretical model which will shed light on understanding this relationship. The model will then be estimated and empirical significance of the model would be investigated. Below, I highlight a road map for my research.

Table 3: PROJECT WORK PLAN

PHASES & TASKS		10										16						
PHASE I	Participation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Model Development	1. Develop the Macroeconomic Model. 2. cross check the correctness of the Model																
PHASE 2																	
Analytical Results	1. Develop several proposition for the model environment. 2. Check for the mathematical correctness of the Propositions																
PHASE 3																	
Task 2.1 **Data Collection**	1. Check for the availability of the data 2. If necessary, obtain special permission or provide financial resources to obtain the data																
Task 2.2 **Data Clean**	1. Clean the data for possible mistakes. 2. check for structural consistency of the data																
Task 2.3: **Data Compilation**	1. Record the data to use it with particular computer package(Stata, Matlab and Fotran) 2. Derive basic descriptive statistics to investigate the validity of the data set. Also compile data for submission to the committee in any acceptable form.																

PHASE 4																	
Task 4.1 **Calibration**	1. Calibrate the parameters of the model to aggregate and state-level data. 2. Compare the calibrated values with other existing work(E&R(1996))																
						10						16					
Task 4.2 **Numerical Analysis**	1. Conduct numerical simulation experiments that are validation of the theoretical results of the model. 2. Derive additional simulation results to compare the performance of the model with other existing works																
PHASE 5																	
Task 5.1 **Estimation for National Level Data**	1. Apply GMM with exact identification method to estimate the structural parameters of the model. 2. With the estimated model , simulate enrolment figures for the national level and compare it with the data																
Task 5.2 **Estimation for State Level Data**	1. Apply GMM with exact identification method to estimate the structural parameters of the model for each state. 2. With the estimated model , simulate enrolment figures for each state and compare it with the data																

						10								16				
Task 5.3 **Estimation for Panel Data**	1. Apply GMM with exact identification method to estimate the structural parameters of the model for the panel. 2. With the estimated model , simulate enrolment figures for each state and compare its robustness with a task 5.1																	
PHASE 6																		
Task 6.1 **Compare Results**	1. Compare results with other existing works(Fernandez and Rogerson(2001))																	
Task 6.2 **Write the Paper**	1. Write the paper. 2. Proof read it. 3. Submit the paper for international conference presentations 4. Submit the paper for possible journal publication																	

5.0 PROJECT EXECUTION

5.1 Requested Resources

For my research, I will need to buy a computer package called FORTRAN. FORTRAN is a very powerful programming package which can run simulations very efficiently and quickly. It can also conduct estimation exercises very efficiently. I will also need to buy an External Hard Drive which will be necessary to collect, carry and compile data. I will also need a scanner and a printer for my research work.

5.2 Proposed Budget

Proposed budget for my research SR 71,160.00

5.3 Equipment Justification

I will also need to buy an External Hard Drive which will be necessary to collect, carry and compile data. I will also need a scanner and a printer for my research work.

Table 4: PROPOSED BUDGET

SEE GUIDELINES BEFORE COMPLETING

SUMMARY PROPOSED BUDGET

(in Saudi Riyals)

PROJECT TITLE	What Determines Specific Schooling Decisions in the USA? A Dynamic General Equilibrium Analysis
DURATION	(max. 18) 18 MONTHS

ITEM	CATEGORY	NO.	COMPENSATION	INVOLVEMENT		TOTAL	DESCRIPTION
				MONTHS	BUDGET		
MANPOWER	CONSULTANTS		-				
	PRINCIPAL INVESTIGATOR		1200 / month	16	16 X 1200	19200.00	
	CO-INVESTIGATOR 1		1000 / month				
	CO-INVESTIGATOR 2		1000 / month				
	CO-INVESTIGATOR 3		1000 / month				
	CO-INVESTIGATOR 4		1000 / month				
	PHD STUDENTS		800 / month				
	MS STUDENTS		600 / month				
	UNDERGRADUATE STUDENTS		400 / month				
	TECHNICIANS		400 / month	12	12x400	4800.00	
	SECRETARIAL- CLERICAL		1,000 / year				
	OTHER		Two Months of Summer Compensation	2	2x13000	26000.00	
			TOTAL SALARIES			50000.00	MAX. 50,000
EQUIPMENT & MATERIAL	PC / LAPTOP (Standard)	6,000					
	WORK STATION / SPECIAL LAPTOP	-					
	PRINTER (Standard Laser)	1,500					
	SCANNER (Standard)	500					
	SOFTWARE	- Fortran				160.00	
	HARDWARE	- Portable Hard Drive				2000.00	
	EQUIPMENT	-					
	MATERIALS	-					
	CHEMICALS	-					
	SERVICES	- Possible Purchase of Data				4000.00	
			ITEM TOTAL			11160.00	
TRAVEL	INTL. CONFERENCES	-					
	PER DIEM LOCAL	-					
	PER DIEM OVERSEAS	-					
			ITEM TOTAL				
OTHERS	PUBLICATIONS	3,000					
	BOOKS & REFERENCES	2,500					
	STATIONARY	1,500					
			ITEM TOTAL			7000.0	
GRAND TOTAL						71,160.00	

6.0 REFERENCES

Acemoglu, Daron. and J-S Pischke, 2001. Changes in the Wage Structure, Family Income, and Children's Education, European Economic Review 45, 890-904.

Alderman, Harold., Peter F. Orazem. and Elizabeth M. Paterno, 2001. School Quality, School Cost, and the Public/Private School Choices of Low-Income Households in Pakistan. Journal of Human Resources No 36, page 304-326.

Behr, Todd., Constantinos Christofides. and Pattabiraman Neelakantan, 2004. The Effects of State Public K--12 Education Expenditures on Income Distribution. NEA Research Working Paper, April 2004.

Bergstrom, Theodore C., Daniel L. Rubinfeld. and Perry Shapiro, 1982. Micro-Based Estimates of Demand Functions for Local School Expenditures. Econometrica, Vol. 50, No. 5 , page 1183-1205.

Checchi, Daniele. and Tullio Jappelli, 2003. School Choice and Quality. Mimeo, University of York

Cohen-Zada, Danny. and Moshe Justman, 2005. The Religious Factor in Private Education, Journal of Urban Economics 57, 391--418.

Denzau, Arthur. and Kevin Grier, 1984. Determinants of local school spending: Some consistent estimates, Public Choice 44:2.

Eckstein, Zvi, and Éva Nagypál, 2004. The Evolution of U.S. Earnings Inequality: 1961-2002. Federal Reserve Bank of Minneapolis Quarterly Review, Vol. 28, No. 2, page 10--29.

Epple, Dennis and Richard E. Romano, 1996. Ends against the middle: Determining public service provision when there areprivate alternatives. Journal of Public Economics, No 62, page 297-325

Fernandez, Raquel. and Richard Rogerson, 2001. The Determinants of Public Education Expenditures: Longer- Run Evidence from the States. Journal of Education Finance, 27, page 567-584.

Gemello, John M. and Jack W. Osman, 1984. Estimating the Demand for Private School Enrollment, American Journal of Education, Vol. 92, No. 3. , pp. 262-279.

Glomm, Gerhard and B. Ravikumar, 1992. Public versus private investment in human capital: Endogenous growth and income inequality. Journal of Political Economy, No 100, page 818—834

Goldhaber, Dan, 1998. An Endogenous Model of Public School Expenditures and Private School Enrollment, Journal of Urban Economics?

Gutierrez-Sourdis , Catalina, 2006. Inequality and Education Decisions in Developing Countries. Mimeo, New York University Hoxby, Caroline Minter, 1996. Are Efficiency and Equity in School Finance Substitutes or Complements? Journal of Economic Perspectives, Volume 10, No 4, page 51-72

Long James E. and Eugenia F. Toma, 1988. The Determinants of Private School Attendance, 1970-1980. The Review of Economics and Statistics, Vol. 70, No. 2, page 351-357.

Munk, Inger, 2006. Does the Quality of Public Education Affect Private School Demand? Mimeo, London School of Economics

Murnane, Richard J., 1984. A Review Essay-Comparisons of Public and Private Schools: Lessons from the Uproar, The Journal of Human Resources, Vol. 19, No. 2.

Sullivan, Paul, 2006. A Dynamic Analysis of Educational Attainment,Occupational Choices, and Job Search, MPRA Paper No. 3896.

West, Edwin G, 1988. Parental Choice of School Characteristics: Estimation Using State Wide Data , Economic Inquiry, 26:4, 725-740.

7.0 RESUME

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EDUCATION

Ph. D. in Economics, Indiana University, Bloomington August, 2009
Dissertation Title: Essays on Dynamic Fiscal Policy: Theory and Empirics

- **Dissertation Committee:** Eric M. Leeper (Chair), Gerhard Glomm**,** Michael Kaganovich, Brian Peterson

M. A. in Economics, University of Iowa, Iowa City 2004
M.S.S in Economics, University of Dhaka, Bangladesh 1999
First Class Third Position
Thesis Title: Structural Adjustment in Bangladesh: An Analytical Overview
B.S.S in Economics, University of Dhaka, Bangladesh 1997
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WORKING PAPERS

- (**Job Market Paper**) "Government Spending and Consumption in the Presence of Borrowing Constraints"
- "Should Dynamic Scoring be Done with Heterogeneous Agent-Based Models? Challenging the Conventional Wisdom," CAEPR Working Paper No. 2008-024
  (Submitted to *Journal of Public Economics*)
- "Demographic Uncertainty and Welfare in a Life-cycle Model under Alternative Public Pension Systems," CAEPR Working Paper No. 2008-025
  (Submitted to *European Economic Review*)
- "Strategic Quality Choice and Charter School: Some Comments," Mimeo, Indiana University
  (Submitted to *Journal of Public Economics*)

RESEARCH IN PROGRESS

- "Government Spending and Consumption in the Presence of Borrowing Constraints: An Estimation of the DSGE Model using Bayesian Technique"
- "Who Bears the Public Debt? Understanding the Distributional Aspect of Government Debt Burden using a Heterogeneous Agent Model"
- "Robustifying the Generalized Taylor Rule: Understanding the Role of Regime Spillovers"
- "The Effect of Tax Policy under Alternative Fiscal Financing Schemes on Income Distribution and Growth: A Savers-Spenders Model Perspective"
- "What Determines Specific Schooling Decisions? Linking Theory with Data"

PUBLICATIONS

- "Medium-Term Outlook for Rice Production and Demand: Projections to 2020," with Paul Dorosh and Quazi Shahabuddin, IFPRI-FMRSP Working Paper No. 36, June 2001 (Reprinted as "Price Responsiveness of Food Grain Supply in Bangladesh and Projections 2020," The Bangladesh Development Studies, Volume XXVIII, March-June 2002, Nos. 1 & 2)
- "Bangladesh-EU Development Relationship: Major Features and Emerging Issues," with Mustafizur Rahman, CPD Occasional Paper Series, No. 5, Centre for Policy Dialogue, June 2000
- "Ageing in Bangladesh: Issues and Challenges," with Jakir Hossain, CPD Dialogue Reports No. 23, Centre for Policy Dialogue, May 2000

RESEARCH EXPERIENCE

Fall 2004 - Spring 2005	Research Assistant to Professor Gerhard Glomm, Department of Economics, Indiana University, Bloomington. Solving models, compilation of data and running simulations; data support.
Fall 2004	Research Assistant to Professor Eric Leeper, Department of Economics, Indiana University, Bloomington.
Summer 2002	Research Assistant to Professor John Geweke, Department of Economics, University of Iowa.
June 2000 - June 2001	Research Analyst, International Food Policy Research Institute (IFPRI)-FMRSP Project, Dhaka, Bangladesh. Model simulation, forecasting and data support, writing research papers.
January 2000 - June 2000	Research Associate, Centre for Policy Dialogue (CPD), Dhaka, Bangladesh. Writing dialogue reports, occasional papers, model simulation, forecasting and data support.
June 1998 - December 1998	Research Assistant, Dr. Nazmul Ehsan Fatmi, Professor, Department of Economics, University of Dhaka, Dhaka, Bangladesh. Designing survey for a "Socio-Economic Survey" for BEXIMCO group of industries (the largest group of industries in Bangladesh), conducting, compiling and publishing the survey results.

CONFERENCE AND SEMINAR PRESENTATIONS

- Midwest Macroeconomics Conference, May 2009
- 17th Annual Symposium of the Society for Non-linear Dynamics and Econometrics held at the Federal Reserve Bank of Atlanta, Georgia, April 16&17, 2009.
- Eighth Annual Missouri Economics Conference, University of Missouri-Columbia, March 2008
- Jordan River Conference, Indiana University, Bloomington, April 2008
- Selected for presentation at the Conference on Institutional and Social Dynamics of Growth and Distribution, Lucca, Italy, December 2007
- Selected for presentation at the First International Conference on Growth, Development and Poverty, Kathmandu, Nepal, December 2007
- Second Economics Graduate Students' Conference, Washington University at St. Louis, September 2007

REFERENCES

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