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THREE ESSAYS ON THE QUANTITY-QUALITY MODEL OF FERTILITY FOR INDIA: THEORETICAL EXTENSIONS AND EMPIRICAL TESTING

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ABSTRACT

The Quantity-Quality (Q-Q) model of fertility looks at a household's choice of number of children, which is not made in isolation but rather is related to several other factors. The premise of the tradeoff is that parents with healthier, better educated children face less uncertainty about the child's survival probability and success as an adult; hence they are satisfied with lower levels of childbearing which leads to smaller family sizes.

The first essay of my dissertation, "***Managing Above Replacement Fertility: Simulating Incentives To Trigger The Quantity-Quality Tradeoff***" applies the Quantity-Quality model to speed up the demographic transition and investigates incentives for curbing high fertility behavior in developing nations to ease the burden of a rapidly growing population. This static model contributes to the existing research by actually testing the Q-Q hypothesis for various well-known functional forms, such as the Cobb Douglas function, the Leontief function and the Stone Geary function. Using simulations with data from India, I estimate the income and price elasticities for the different forms of household utility to demonstrate the change in fertility and schooling. I also run comparative static exercises to analyze the outcome of policy experiments and test the hypothesis that policy initiatives may not always yield anticipated results; one of the key findings is that simply subsidizing qualitative improvements in children (reducing cost of education alone without other investments in family planning etc.) may be insufficient to trigger the Q-Q tradeoff to curtail above replacement TFR. Reduction in parent's out-of-pocket childcare costs to increase quality may prompt greater childbearing as children are now cheaper to raise.

The second essay, "***Model Of Childbearing With 2-Sided Altruism: A Calibration Exercise For Developing Countries***" incorporates child labor and old age security into the dynamic Quantity-Quality framework of fertility, as revenue earned from children and lack of social safety nets for the elderly are important determinants of fertility behavior. The study extends earlier economic modeling to 3 time periods and 3 generations with bi-directional gifts and bequests and develops a OLG structural model with dynastic households to examine how intergenerational altruism affects the individual decision maker's choice of fertility and educational investment in their children. I calibrate the parameters to solve for the household decision variables after tracing the consumption, fertility, transfers to elderly, schooling and child labor behavior from 1967 to 2007 and conduct comparative statics exercises to test different policy implements like conditional cash transfers, mid-day meal schemes and fertility reduction subsidies. Empirical estimation results using incidence of child labor as well as old age dependency on monetary transfers from one's children suggest that increasing child quality may in the long run reduce the demand for quantity as income-earning potential and the probability of survival to adulthood for children increases, this in turn will offset the parent's propensity to have greater number of children to recompense for future uncertainty.

The third essay of the dissertation is entitled "***Raising Quality May Reduce Quantity: Testing The Tradeoff With Evidence From India***". India is the second most populous country in the world and is currently undergoing its demographic transition with the average number of children per woman gradually declining. However the birth rate is still above replacement level and the current study uses an extension of the traditional Quantity-Quality model of fertility to understand childbearing behavior in the subcontinent. Earlier empirical studies on the Q-Q tradeoff just explore how greater number of children is usually associated with lower levels of child quality but this econometric analysis examines the reverse direction of causality using the nationally representative Demographic Health Survey (NFHS-3) for 2005-06. With number of children ever born as an indicator of fertility preference, I use ordered responses to examine the most important predictors of the target variable and find that parental quality is one of the crucial determinants of child quantity within a household. This indicates that greater investment in quality for a certain generation affects their childbearing choices once they become parental decision makers, so the Q-Q hypothesis can be augmented beyond a single generational perspective that in the long run may lead to smaller family sizes.

My dissertation research provides a significant contribution to the field of economic and demographic study of fertility behavior. I conduct a static analysis, a dynamic modeling exercise as well as an empirical testing of the Quantity-Quality model with regards to childbearing and the policy implications from the findings will hopefully help motivate further work in this area.

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ACKNOWLEDGEMENT

As I started to write this section, I was reminded of all the elegant speeches people make at award ceremonies and grand receptions where they publicly announce their thank-you's to everyone, but fancy words seem to be failing me right now, so all I can do is try and express my debt of gratitude towards some incredible individuals who have kept me company on the journey so far and made life delightfully interesting.

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DEDICATION

To my parents,

- Anima & Suranjan Sen -

for being who you are & allowing me to be who I am.

Chapter 1

OVERVIEW

1.1 Introduction

The current world population is above 7 billion and projections estimate that by 2050, we will be 9 billion strong. Ehrlich & Holdren (1971) enhanced the understanding of how human population growth and pressures on natural resources are strongly interrelated. There are multiple factors that contribute to environmental impact but three primary sources can be established from the IPAT relationship. Daily & Ehrlich (1992) formalize the equation as $\{I = P * A * T\}$ where (I) is the total negative impact on the environment, which may be expressed in terms of resource depletion or waste accumulation; (P) represents the size of the human population; (A) stands for affluence, referring to the level of consumption by that population; and (T) is the technology, symbolizing the processes used to obtain resources and transform them into useful goods and wastes. Subsequent research indicates that the assumption of a simple multiplicative relationship among the main factors generally does not hold. Approaches which allow for different weighting to be assigned to each factor have been more successful in accounting for impact and this led to the evolution of the equation to its present Stochastic Impacts by Regression of Population, Affluence and Technology (STIRPAT) form.

The IPAT/STIRPAT structure helps to unravel the causes affecting the core problem which could help suggest more permanent solutions rather than just temporary patches for the superficial symptoms. In addition to highlighting the contribution of population to environmental problems, the formula draws attention to the fact that environmental problems involve more than pollution and are driven by multiple factors acting together to produce a compounding effect. Of the three main factors discussed above, the current paper concentrates on the population aspect as a growing society may exert significant pressure on the scarce resources. Given the burden of an expanding population it becomes essential that we try to investigate the primary causes behind high growth and analyze ways to counteract the resultant adverse effects.

1.2 Motivation

According to the Demographic Balancing Equation, population change is a function of births or fertility, deaths or mortality and net migration. Since mortality rates have declined over time and migration cannot be a solution in a globally closed system, then the only available option to counteract the pressure of high population growth is through fertility. To attain population growth deceleration via fertility management, we must incentivise smaller family sizes which entails two main steps: first we need to identify the determinants of fertility and next we must apply feasible and effective policy instruments to alter excessively high childbearing preferences.

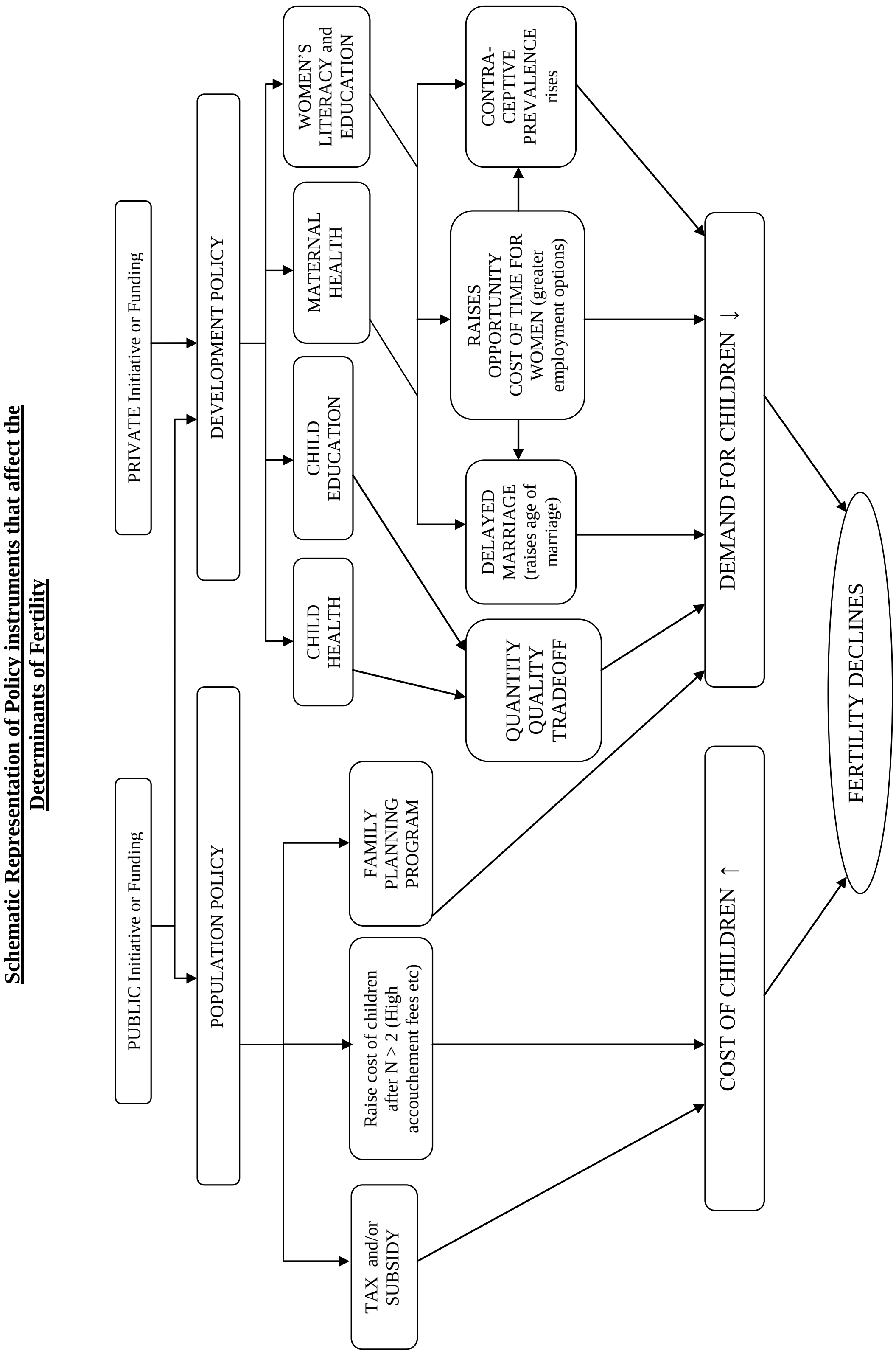

Figure 1.1: Schematic Representation of Policy Instruments that affect Fertility

The rationale behind the study is represented in Figure 1.1[1] where population and development policy is governed by public and private initiatives and eventually filters down to fertility determinants. A few of the relationships that may be examined in this context are whether a tax or a subsidy is more effective, is targeting the child or the mother a better option, should we concentrate on only cost of children (price) or demand for children (quantity) or both etc.

Some specific interesting questions that arise with regards to policy instruments affecting fertility are: What kind of funding is involved; is it a publicly funded initiative or is it a privately funded project? What is the type of policy we are considering; i.e. is it a population policy or is it a development policy? Further are we using an incentive mechanism or a disincentive scheme like a choice between taxes and subsidies? Also what is the timing of the policy; is it a one-shot instrument or are we looking at a longer planning horizon? Finally how are the changes being brought about; are we affecting the prices and cost of rearing a child or are we altering people's preferences and demand for number of children? All of these eventually filter into fertility decline for the system. For the purposes of the current research, I would like to focus on the Quantity-Quality (Q-Q) tradeoff which has child health and child education as the two main factors affecting it. The premise of the Q-Q model is that parents with healthier, better educated children are satisfied with smaller family sizes; hence greater quality corresponds to lower quantity to create the inverse relationship.

1.3 Review of Literature

A lot of research is already underway to better understand the issue of overpopulation and excessively high fertility and this is reflected in academic literature. Some of the recurring themes are:

1.3.1 Demographic Change & Fertility Transition

Historically most countries in the developed world underwent a massive change in their demographic and social structure which propelled their economies from slow to rapid and sustainable economic growth. In order to replicate this trend in the present day developing nations, we need an integrated framework to examine fertility behavior and population dynamics. There are many studies on the fertility revolution and demand for children like the fundamental work by Becker, Easterlin & Crimmins, Schultz and others; these help to develop micro-foundations for structural models at the household and institutional level. In most societies mothers allocate a disproportionate amount of time to child care and children act as vessels for human capital investment to be transferred across generations hence changes in wages, income, male versus female productivity, altruism etc. all are important factors affecting costs of child bearing.

[1] There are more linkages possible but for the purposes of this paper, I am focusing only on a subset of them.

Over time mortality decline, innovations in contraceptive methods, rising direct costs of children, anti-child labor laws, increase in opportunity cost of child bearing (with women's labor force participation), free or compulsory primary education, development of social insurance and old age support systems led to a decrease in fertility. The goal is to shift fertility control from social and biological motivations to a state where family size is regulated and limited by decisions of the individual households. Conscious fertility control involves averting births so that actual fertility is below the reproductive potential and natural fertility levels but this faces several hurdles like lack of access to family planning services and lack of motivation by parents.

Blandy (1974) conducts a welfare analysis of reducing fertility to find that different societies have varying child raising costs and deep rooted psychic satisfactions from children. Government intervention in household reproductive choices like better access to contraceptives and health provisions are always beneficial but evaluating the other anti-natalists policies is more complicated; public subsidies on contraceptives to avoid unplanned births is a major expense from tax revenues and bribing parents to limit family sizes is administratively cumbersome as they both may lead to redundant expenses on families who would have used contraceptives or had fewer children by default.

Becker & Murphy (1988) posit that children form an essential part of society but are practically incapable of managing their own welfare in the early stages of life so they rely mainly on parental altruism. Parents invest in their offspring's human capital and expect some degree of old age support and work out an efficient way of maximizing the combined resources of the family. In reality parents and children cannot always make efficient arrangements and so poorer families who are unable leave bequests under-invest in children's human capital which is why we need interventions from the state to increase efficiency of family arrangements. The dynamics of self regulating fertility and population is depicted in Aberenthy (2002) where she states that population growth without a concurrent rise in capital will be damaging to society as it will increase poverty and inequality. People who correctly perceive future contracts and economic opportunities usually restrict their family size but miscalculations and imperfect foresight leads to excess fertility. The paper first considers population growth as a cause of poverty, then proposes poverty to be a determinant of fertility and after incorporating migration, national values and inequality, concludes that extreme poverty and deprivation will feed back into the loop to restore the balance between population and the resource base.

1.3.2 Quantity-Quality Tradeoff – Theoretical Models

The existing body of work in Q-Q models is very diverse and detailed and provides a good foundation to build upon. The seminal article by Becker (1960) determined that demand and supply for children are both generated by parents in the presence of uncertainty which causes divergence between actual and desired fertility. This continued discrepancy in realized and desired births leads to unsustainable population growth rates.

Becker & Lewis (1973) investigate the negative correlation between child quality and child quantity and claim that this inverse relation exists irrespective of whether the choice of the two variables are made jointly or independently. Rosenweig & Wolpin (1980) test the predictive power of the Q-Q model using household data from India. It is a well-documented result that parents prefer to have similar levels of quality for their children and increasing income reduces quantity and raises quality in the long run. Since shadow prices are unobservable, empirically testing the interaction hypothesis is a complicated task. They use the 'natural experiment' of twin-births since multiple births from a single pregnancy is usually an unanticipated case of rise in child quantity units. Their model is an extension of the basic three choice variable Becker-Lewis framework. The findings are important from a policy standpoint as they show the impact of fertility on schooling and other household expenditures and they verify the hypothesis that exogenous increase in family size has a negative effect on quality investment for schooling and other commodities.

Edlefsen's (1983) study looks at the income compensated price effects in the Q-Q models and stresses that if child quantity and quality are assumed to be net substitutes with respect to all other goods and services, then the price effect will always be negative. Second order conditions alone are insufficient to infer whether rising costs make parents substitute away from number of children but the own income compensated price effects are all negative. These are normal goods so demand for fertility decreases with a rise in direct cost of quantity. The impact of a rise in price of the interaction term is difficult to sign since it has both a cross substitution effect and an own substitution effect so raising the cost of the factor that influences both the quantity and the quality of children will not only deter fertility but also reduce investments in child quality.

Given that households are the decision making unit, Becker & Barro (1988) re-examined the economic theory behind determinants of fertility behavior in the presence of altruism and other inter-generational factors. The paper analyzes the link between fertility and capital accumulation given wage and interest rates in an open economy. Parental utility is a function of own consumption, number of offspring and their subsequent utility. Assuming two periods of life, namely childhood and adulthood, we look at each adult as a single parent decision maker who realizes his/her fertility choice at the beginning of adulthood and faces a tradeoff between benefit of an additional child and cost of providing for it. Incorporating intergenerational welfare considerations, the model links consumption, fertility, and total number of descendants over all generations. The dynastic family head implicitly conducts a cost-benefit analysis of each additional descendant given a certain lifetime earnings constraint and the arbitrage condition causes fertility to respond to interest rate changes and degree of altruism.

Barro & Becker (1989) acts as a sequel to the earlier paper where the authors extend their previous work and look at family size as a decision variable for parents maximizing their lifetime utility functions. They look at the determination of interest rates, wage rates, population growth and income growth in closed economies and calculate dynamic time paths of fertility, capital-labor ratio, wages, interest rate and per capita consumption. This paper integrates population growth with economic growth for cases when fertility decisions are endogenous. They trace the path for optimal economic growth in the presence of child-rearing costs, taxes, technology, changes in preferences, and shocks to the initial levels of population and the capital. For altruistic parents in the presence of intergenerational transfers and endogenous fertility decisions, they found that a rise in income increases fertility initially but a rapid rate of progress usually causes fertility to fall. As population growth rate is endogenous, temporary changes in the parameters could have permanent effects. A positive relation between interest rates and fertility implies that rise in cost of child rearing will reduce the steady state interest rate and this will eventually lower the steady state value of population growth and raise the per capita capital.

The two sided altruism idea in term of gifts and bequests is well discussed in Kimball (1987) and Abel (1987). Using the Buiter-Carmichael-Burbidge utility function, the papers solve the static steady state and test the dynamic efficiency of the economy in terms of per capita income, consumption, recursive altruistic utility etc. and derive the tax and transfer conditions under which gift motives and bequest motives operate.

1.3.3 Quantity-Quality Tradeoff – Applications & Extensions

Shifting to some empirical studies, Becker & Tomes (1976) incorporate child endowments of inherited ability, public subsidies and luck into the Q-Q model. Improvements in income should raise parental investments in the child and parents could either compensate children with poorer endowments by helping with non-human capital or just reinforce those with higher endowments by investing in human capital.

Millimet & Wang (2011) examined the causal relationship between the quantity and quality of children but find little support for the tradeoff using data from the Indonesia Family Life Survey. Intra-household resource allocation theory suggests that there is interdependence between choice of number of children and investments in child specific human capital and predicts a negative relationship between the two. This paper focuses on child health as the outcome variable in the model and uses number of children as the treatment variable; the main findings are that height distributions differ significantly across households with varying number of children but not BMI.

Depending on the country and the timeline, different researchers have either verified the Q-Q model or questioned its validity. The tradition of testing the Q-Q model using twins continues in Li et al. (2008) where exogenous variation in family size is denoted by the twin birth after accounting for unobserved family preferences, birth spacing and inter-child reallocation. With Chinese Population Census data they verify the Q-Q tradeoff for developing countries by demonstrating the negative relation between family size and child outcomes even after controlling for birth order and the effect is more prominent in rural areas which have restricted access to public education. Qian (2009) explores the impact of relaxing China's One Child Policy on school enrollment of the first child. The additional child option led to school enrollment of the first born going up and the effect was stronger for households with children of the same sex in rural China but the effect on the younger sibling is not known as they were too young when the survey was conducted.

Most of the empirical evidence that exists in the realm of Q-Q tradeoff in fertility runs unidirectional tests on how rise in family size (unanticipated exogenous shifts like birth of twins) affects parental investments in children's human capital but there is very little work examining the reverse causality. The current research proposes to investigate this very linkage and aims to see how improving parental quality or child quality in terms of health and education may reduce the demand for child quantity.

1.3.4 Education, Human Capital Investment & Income

Human capital investment is an indispensable input if we are to raise future income earning potential of an individual. Becker & Tomes (1986) model permits assets, earnings and consumption to be transferred to descendants and after comparing different countries empirically they find that all earnings advantages or disadvantages pewter out within three generations. Under perfect capital markets we find adult earnings depend upon human capital and some degree of luck or chance. On the other hand imperfect capital markets mean poor families cannot access loans to supplement the limited resources and face difficulties in financing quality investments in their children. The inverse relation between family size and parental earnings has a negative impact on the intergenerational mobility of earnings.

Becker, Murphy & Tamura (1990) uses endogenous fertility with increasing returns to human capital to show that societies where human capital investments bring in more proceeds tend to have an abundance of human capital and small families; conversely places with limited human capital have larger families with lower investments in each member. Saving across generations occurs either in the form of multiple children, greater investment per child or physical capital accumulation and one of two stable steady states may emerge; a Malthusian equilibrium with large families and low human capital or a Development equilibrium of small families with growing human and physical capital. Tamura (2006) also builds a general equilibrium model for fertility and human capital accumulation under uncertainty with a structural form of young adult mortality, use of cross-country data yields numerical solutions and empirical testing of the assertion shows that technological progress raises educational demand.

Schulz (2005) studies the link between fertility and income and finds an inverse association between income per adult and fertility, among countries and across households. Fertility is found to be lower among women with higher education or ownership of assets or land. Akman (2002) looks at the various socio-cultural factors like marriage (age, stability) and family (composition) that affect demand and supply of children. Education (especially that of women) and residence (urban/rural) are two other socioeconomic factors that affect fertility. Pick et al. (1989) analyzes fertility determinants in the Mexican states of Veracruz, Tabasco, and Campeche and run regression models, where the dependent variables of children ever born and child-woman ratio are highly affected by religion, economic prosperity, literacy and urbanization.

For China, Rosenzweig & Zhang (2009) examine how their population control policy affected investment in children and claim that the One Child Policy only had a modest contribution towards the nation's human capital development. Looking at twinning by birth order, the tradeoff between family size and average child quality net of the endowment deficits shows a negative impact on schooling progress like grades, expectations about college as well as health indexes due to the presence of an extra child; this is a result of the close spacing of twin births which puts pressure on the family budget constraint and inhibits spending on children.

Studying the fertility decline and policy measures in some of the developing countries, Cutright (1983) draws attention to an interesting correlation that we have few examples of nations with low literacy and low fertility, while there are many examples of nations with low literacy and high fertility. The author stresses on the importance of improving health and education in order to make family planning programs successful. Kang (2011) looks at South Korean data to find that Q-Q tradeoffs in educational investments is not gender neutral as girls' education suffers from large family sizes but boys have no adverse impact, this may reflect the son preference that is predominant in Korean households. Intra-household time allocation in education for Philippines is related to birth order as per Ejrnaes & Portner (2004). As Philippines implements mandatory primary schooling between ages of 7 and 13 with most elementary schools being public and tuition free, children born later get more benefits than their lower birth order siblings, birth order dominates if families hold land but effects are lower if parents are more educated.

1.3.5 Programs with Direct impact on Fertility (Instruments, Interventions & Incentives)

There are some direct impact programs that are already in place around the world and these may be replicated or extended for other countries. Tan et al. (1978) looks at the fertility reduction program implemented by Singapore in 1973 and investigates their five social disincentive policies. Singapore is the first nation in the world to actually implement direct policies that curb population growth with the disincentives as follows: higher accouchement fees where delivery charges were increased for increasing birth orders; lower school admission priority for children of fourth and higher birth orders; reduced maternity leave where women had to use own annual leave time or take unpaid leave from the third child onwards; revised taxation policy where relief for fourth and subsequent children was withdrawn; new government housing allocation policy which gave low priority to larger families.

Gertler & Molyneaux (1994, 2000) analyze the Indonesian fertility decline in the eighties and its causes. The National Family Planning Coordinating Board was instrumental in promoting two-child families by encouraging women to delay marriage and use contraceptives which in turn was supplemented by better education and information dissemination, economic advances and higher disposable income, better transportation, proper contraceptive subsidies, family planning programs and a synchronous supply and demand system of birth control aids. On the other hand, the One Child Policy in China is an extreme example of a family planning policy which relied more on strict enforcement rather than some form of incentive mechanism.

Many developing countries have devoted a lot of resources towards public programs, integrated incentives and family policy to curtail fertility. Kangas (1970) and Hossain (1989) scrutinize some of these policies on population control and health. For Bangladesh, the direct and cross effects of subsidies for family planning and secondary school have been very useful for reducing fertility and raising education; their calculated elasticities confirm that directing resources towards the poorest household will lead to cost effective means of achieving policy goals. Generally though, financial rewards are provided to potential contraceptive users, family planning service personnel etc. but the incentives are individual centric and not for the group or community as a whole. Instead of simply targeting recipients or providers, some other possibilities consist of annual or deferred rewards for reproductive age married couples if they avoid having offspring, assigning savings account to women who go for three or four years without pregnancies, distributing family planning bonds to couples who agree to limit their family size etc.

1.3.6 Programs with Indirect effect on Fertility (Conditional Cash Transfer)

Some real world applications of the Q-Q model can be seen with the cross program effects of Bosca Escola and PROGRESA in Brazil and Mexico respectively. Denes (2003) looks at the impact of the Bosca Escola where even though fertility reduction was not a direct aim, by improving the quality of life for children through higher education and better health care, they may have initiated a Q-Q tradeoff. In many Latin American countries, primary education is not a priority since child labor is prevalent as it generates substantial supplemental income. The Bosca Escola program attempted to stem the school dropout rates by providing financial compensation to households; along with raising school enrollment and educational attainment it helped regulate fertility behavior. The 2002 IFPRI evaluation of the Programa de Educación, Salud y Alimentación reviews the performance of this large scale government anti-poverty endeavor. With deprivation and malnutrition plaguing the nation, PROGRESA was aimed at supporting families with educational, health and nutritional support so they could pull themselves out of poverty. With proper targeting, they managed to reduce poverty in the poorest section of the population, improve health and nutritional status and communities benefited from positive program effects on schooling as well. Both these programs tried to improve education or economic well-being and their attempts to provide better child quality set off a chain reaction series that could ultimately reduce fertility.

1.3.7 Motives for Fertility - Old Age Security & Child Labor

Old age security is a major factor contributing to the reproductive behavior in less developed countries. Absence of capital markets that allow inter-temporal borrowing and lending forces parents to consider their children as an asset for transferring income to old age. Some conditions under which old age security becomes an important motive for fertility are: underdeveloped capital markets, uncertainty about accumulation of assets, lack of private or public insurance program for the elderly or the disabled, faith in children's loyalty towards parents, absence of proper labor markets, underdeveloped markets for consumables targeted to the elderly etc.

Galor (2011) consolidates the theoretical basics and testable implications for demographic transition models and asserts that capital market development was a crucial element as it reduced parental dependence on children as sole means of old age security due to lack of any form of social assistance for the elderly. Nugent (1985) recognizes that if a parent is uncertain about own ability to be self-supporting in old age and lacks a more reliable and effective source of support then their default option is to rely on the offspring with the idea that more children will result in greater income. Similarly Zhang & Nishimura (1992) look at children's altruism for a overlapping two-generation model with endogenous fertility. Children are interpreted as capital goods and their prime purpose is to grow up and provide gifts to their elderly retired parents. Lack of capital markets to transfer income from the present to the future leads to this excess demand for children; alternatives like proper capital market or a pay as you go public pension program should be introduced in this economy to test the old age security hypothesis.

The labor force participation by children and their economic contribution to household income also plays an important role in determining fertility. Edmonds & Pavcnik (2005) examines occurrence of child labor in the global context and compares the employers of children, time allocation between work and school, living standards, credit market imperfections etc. in various low income countries. Children help the household by earning wages due to extreme poverty and the best solution is economic development; this however is a long run process and we need short run results to counter this issue.

Policies like child labor bans or compulsory school attendance are rarely effective as enforcement is problematic and the incentives may still remain to employ children in the local labor markets. International pressures like restricting trade or issuing sanctions against countries that allow child labor are only partially successful and the problem still persists at a large scale. Though anti-child labor policy may reduce birth rates and raise school enrollment, the welfare ramifications may not be conducive and so we must follow alternatives like promoting land redistribution, female education and employment. According to Doepke (2004) there is a great degree of cross country variation in terms of timing and speed for the economic and demographic transition; this is partly because of different government policies like school subsidies and child labor regulations that affects the opportunity cost of education. Comparing Brazil, Korea and England it becomes apparent that presence of child labor makes the child's time valuable in areas other than schooling as the opportunity cost of education changes and given the enforcement problems associated with child labor bans, compulsory schooling seems to be a more efficient regulation.

The child labor situation in rural India is investigated at the district level by Rosenzweig & Evenson (1977). They use a simultaneous equation system to model household time allocation and find that Indian families have a large number of children because the unskilled labor wages are greater than the returns obtained from investing in schooling. Focusing on elderly dependency, Vlassoff & Vlassoff (1980) provides an insight into the mindset of people who believe that a large family indicates prosperity and ensures old age security. Traditionally children are expected to provide support and economic security to the older generation once they reach adulthood and this dependence is an important determinant of family size and composition. Hence for any fertility reduction initiative to be truly successful in India, it must find counteracting measures against these particular motivations for large family sizes.

1.3.8 Country specific case studies for India

With the current population being disproportionately young, India is beginning to feel the effects of the demographic dividend where its youthful work force may turn from an asset to a burden as they age and multiply. With the poorest and most populous states consistently growing, India threatens to surpass China's population size in the years to come if its population momentum goes unchecked.

The Indian government has long been concerned with its population growth and this has been mirrored in their explicit population policies. The annual population growth rate in the 1940's was low enough to make the administration believe that India would soon follow the trajectory of the developed nations who witnessed industrialization and rising living standards accompanied by a drop in population size. By the 1950's India became one of the first countries to start a national government sponsored family planning program with hospitals and health care centers providing birth control information; unfortunately though these were modest efforts and no aggressive steps were taken to encourage contraceptive use and limit family sizes. In the 1960's and 1970's it was recognized that high population growth rate was a major stumbling block for economic development and this led to the national population policy which integrated measures to reduce poverty, increase general welfare and promote family planning.

The Fifth Five Year Plan (1974-1978) introduced education about the population problems within school curriculums to increase awareness and during the 1980's family planning programs[2] were implemented at the district and sub-district levels using financial assistance from the state and central governments. However India's population continued to rise dramatically as per the 1991 census. Part of this failure results from unrealistic targets and the centralization of the family planning programs which fails to incorporate regional differences. The common fertility pattern in India still deviates from the ideal two child family due to early age of marriage for women, strong son preference, child labor, lack of formal old age security among other reasons. In the recent decade there have been renewed attempts like the pilot study in Satara district of Madhya Pradesh to slow down the birthrates by using cash bonus programs and encouraging use of contraceptives to delay childbearing. Whether these financial inducements will yield results fast enough is yet to be seen.

Given India's high population density and above replacement fertility rate, Jain & Nag (1986) review the relationship between female education and fertility and try to suggest the most effective strategy to reorient the Indian educational structure in order to affect fertility. Robert MacIver's quote of "When you educate a man you educate an individual; when you educate a woman you educate a whole family" seems very appropriate in this context and it is also supported by demographic literature where female education has been shown to be more important than male education with regards to its effect on fertility. However, female education lags far behind its male counterpart in India and the slogan 'Development is the best contraceptive'

[2] Birth control measures included improvement and extension of primary healthcare centers, reorganization of public welfare facilities in urban slums and rural areas, reservation of hospital beds for tubal ligature operations, remodeling of IUD rooms etc. along with the controversial government enforced sterilizations.

popularized by the Indian delegation at the 1974 Bucharest Conference on Population is yet to be realized. Even today, the design and implementation of development programs rarely take fertility control into account. In the current article the authors examine how education sector policies can help to reduce fertility by analyzing macro and micro level Indian data. They find that female education monotonically increases age at marriage as well as contraceptive use, which in turn decreases fertility and so educational policy should be given high priority. Female educational investment may not be the most cost effective means of reducing fertility but it will yield substantial returns in the long run since the population problem is not a short term phenomena. Finally this paper also hypothesizes that primary and post-primary education enhances women's status within and outside the family and this will increase their exposure to the new information and ideas spread via the written word.

Dreze & Murthi (2001) analyzes the link between female education and fertility in India by regressing TFR (total fertility rates) data on literacy rate and several other explanatory variables and their multivariate approach suggests a negative relationship between the two. However Parikh & Gupta (2001) study the data from the states of Andhra Pradesh and Uttar Pradesh and find that in the absence of overall development, literacy alone is not sufficient to cause significant reductions in fertility. Another perspective on this can be observed from McNay, Arokiasamy & Cassen (2003) where the authors assert that there is considerable diffusion of knowledge and so contraceptive usage is on the rise even among uneducated women.

Bhat (2002) echoes this thought and finds that fertility has dropped significantly among illiterate women in India and there is a rise in school enrollment and attainment of primary education among their children. Also the detrimental effect of larger family size on education is found to have a greater impact on the female child and the first born child of either sex as they may be withdrawn early from school to supplement the family income or look after their younger siblings. The explanatory factors for household schooling decision in India from Ota & Moffatt (2007) include the number, age and gender of a child's siblings along with community and household characteristics; so a policy just targeting low income households will be insufficient to achieve universal primary education.

Singh, Verma & Roy (2004) look into the policy implications at the state level in India. They concentrate on the state of Maharashtra and look at the evolution of contraceptive choice with regards to population policy, infrastructure, IEC (information, education and communication) and socio-cultural factors. Chacko (2001) is mainly interested in the determinants of contraceptive use among married women in rural West Bengal, India. She uses primary survey data and demonstrates that a woman's age, number of living sons, area of residence and her religious affiliation help determine her fertility behavior and the paper also provides excellent advice for policy planners. Stephenson & Tsui (2003) ask the question about how community level parameters influence reproductive health outcomes and evaluate multilevel models using data from the state of Uttar Pradesh in India. They discover that communities and networks affect reproductive wellness via their links to socio-economic conditions and health infrastructure.

1.3.9 Miscellaneous

Faith and religion plays a major role in the lives of many, so beliefs of developing country residents may significantly affect their fertility behavior. This is evident from Schultz (1997) which concentrates on low income countries in Asia, Africa and the Middle East and finds that religious affiliations play an important role in fertility change. Moulasha & Rao (1999) examine the religion specific differentials in fertility and family planning. Higher fertility may be a consequence of religious prohibition of the use of birth control and attitudes towards the importance of children, family and gender.

India may be a secular society but religion does play a dominant role in everyday life. With Hinduism and Islam being the two leading religious sects; as per the NFHS we find Muslim women have about 1.1 more children than Hindu women which could be due to their longer reproductive span, shorter postpartum amenorrhea and abstinence periods, younger mean age of first birth and lower use of modern contraceptive methods. However it was also found that Hindu's do fare better in terms of residence in urban areas, higher literacy and educational attainment, more gender neutral work status for the spouses etc. so the religious factors are highly correlated with socio-economic status.

McQuillan (2004) traces the influence of religion and cultural practices of the Catholic population in the western hemisphere from the early days of high fertility to its subsequent decline and compares it with the fertility patterns in the Muslim world today. To answer the central question of when does religion affect fertility, there are three suggested elements: religion stipulates behavioral norms that have links to fertility outcomes; religious groups ought to be able to communicate its teachings to its members and enforce compliance; and followers or members must feel a strong attachment to the community. With economic prosperity and development, the religious institutions may no longer be prime movers in the western civilization but they continue to play a very dominant role in demographic behavior and social and political conditions for the poorer countries of the world.

The spatial fertility pattern for India over five decades shows that the decline in child bearing has been low to moderate in most regions with a rapid transition in only a few pockets as per Guilmoto & Rajan (2001). The spatial structuring of reproductive behavior in India demonstrates three separate fertility profiles with clusters of early, intermediate and late fertility decline among districts. The first cluster are the forerunners of fertility decline and include Tamil Nadu, Kerala, contiguous coastal areas of Andhra Pradesh and Karnataka, Goa, Maharashtra along with parts of Punjab, Jammu & Kashmir and Himachal Pradesh. The second cluster has districts with slower fertility profiles and have some overlaps with states in the first group. The third cluster are the late decliners like Bihar, Madhya Pradesh, Rajasthan, Uttar Pradesh and most of Assam, Meghalaya and Arunachal Pradesh. The authors discover that in spite of the spatial autocorrelation, fertility transition did not uniformly affect social structure and vertical diffusion within districts.

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Chapter 2

MANAGING ABOVE REPLACEMENT FERTILITY: SIMULATING INCENTIVES TO TRIGGER THE QUANTITY-QUALITY TRADEOFF

Abstract

The current paper applies the Quantity-Quality model to speed up the demographic transition and investigates incentives for curbing high fertility behavior in developing nations to ease the burden of a rapidly growing population. This static model contributes to the existing research by actually testing the Q-Q hypothesis for various well-known functional forms, such as the Cobb Douglas function, the Leontief function and the Stone Geary function. Using simulations with data from India, I estimate the income and price elasticities for the different forms of household utility to demonstrate the change in fertility and schooling. I also run comparative static exercises to analyze the outcome of policy experiments and test the hypothesis that policy initiatives may not always yield anticipated results; one of the key findings is that simply subsidizing qualitative improvements in children (reducing cost of education alone without other investments in family planning etc.) may be insufficient to trigger the Q-Q tradeoff to curtail above replacement TFR. Reduction in parent's out-of-pocket childcare costs to increase quality may prompt greater childbearing as children are now cheaper to raise.

2.1 Introduction

A rapidly growing population is one of the major challenges faced by several developing countries since it drains their already limited resources. This makes managing the population growth rate vital for national welfare and development. In the words of Garrett Hardin: "The quality of life and the quantity of it are inversely related" and given that mortality rates have already declined, as per the classical demographic transition theory, the only way to curb unsustainable population growth rates, is by reducing fertility. There are several schools of thought on population dynamics ranging from the pro-natalist to passivists and alarmists but this paper does not endorse any particular stand. It just uses the pressures of rapidly expanding population and depletion of nonrenewable resources as a driving impetus for working towards stable growth. Population pressure is a global issue but we must look for solutions locally since each country is unique with respect to its problems and policy needs. Once we identify the background factors that filter into the proximate determinants of fertility, we can propose feasible and effective policy instruments which may potentially incentivize smaller family sizes and reduce the burden of high population. This will help developing countries to speed up the demographic transition and move to a sustainable fertility time-path, which in turn should help reduce the population pressure on our scarce resources. With this ideology in mind, the paper will attempt to investigate some feasible policy instruments to moderate population growth rates in developing countries. Specifically this study contributes to existing research by developing a static model of household behavior and applying various well-known functional forms, such as the Cobb Douglas, the Leontief and the Stone Geary functions to estimate the Quantity-Quality (Q-Q) model of fertility and compares the impact of different policy experiments.

The paper is organized as follows: Section 2.2 describes the background and motivation; Section 2.3 is devoted to the main research questions; Section 2.4 defines the methodology for the Static model and reports the analytical results; Section 2.5 illustrates the simulations exercises along with the data; finally Sections 2.6, 2.7, 2.8 and 2.9 discuss the policy implications, conclusions, limiting concerns and plans for future extensions. The detailed derivations and graphs are provided in the Appendix.

2.2 Background & Motivation

One of the fundamental driving forces in the domain of economics is scarcity. Scarcity arises since our infinite demands are constrained by the finiteness of resources available to us. These ever increasing demands are made by the growing population which in turn is a direct result of fertility behavior.

By the standard Demographic Balancing Equation we have:

$$[Population_{t+1} - Population_t](\Delta P) = NaturalIncrease_t(NI) + NetMigration_t(NM)$$

where $NaturalIncrease_t(NI) = Births_t(B) - Deaths_t(D)$

and $NetMigration_t(NM) = Immigration_t(I) - Emigration_t(E)$

Hence Population growth formula is expressed as: $\Delta P \equiv NI + NM = B - D + I - E$

With fertility, mortality and migration being the main components of population growth, Singh et al. (1986) provide an interesting summary of how we make the transition from the problem of high population growth to the proposed solution of incentivizing behavior directed at reduced fertility. Fertility regulation to ensure population growth deceleration can potentially be brought about by improved communication with the general public to influence their demographic predispositions, provision of services to encourage desired behavior, incentives or disincentives to regulate trends and tendencies, appropriate social institutions and opportunities or coercive action by administrative bodies. Given these broad mechanisms, I want to analyze the tradeoff between child quality and quantity to counteract the causes of high population growth and focus on India which is a developing country with above replacement fertility (TFR>2.1).

The emphasis on India is motivated by several factors. With a population of more than 1 billion people, it is the second most populous country in the world. In 2011, it had a population growth rate of 1.36% and on average, women in India have 2.6 births during their lifetimes. In spite of a booming economy, per capita income is quite low due to the large size of India's population. The current population is relatively young (by 2020, the average age of an Indian is expected to be 29 years), which means that the country may soon face issues where its youthful work force could turn from an asset to a burden as they age and multiply. The common fertility pattern differs from the Ministry of Health and Family Welfare's suggested ideal of a 2-child family due to early age of marriage, son bias, child labor, lack of formal old age security among other factors. According to the U.S. Census Bureau, based on current trends with the poorest and most populous states consistently growing, India could surpass China and become the world's largest country by 2025.

Past literature provides a strong background to examine the issue of rapid population growth and above replacement fertility rates in the context of the Quantity-Quality model.

2.3 Research Question

My research will contribute to the existing body of work in several important ways. The main objective involves identifying some of the feasible and effective policy instruments and target variables that may help to reduce high fertility and unsustainable population growth rates in developing countries. Specifically how can the Quantity-Quality model of fertility be used in collaboration with other financial incentive schemes and family planning programs to incentivize smaller family sizes in developing countries with above replacement fertility rates?

In my static framework, I assess how the Q-Q model on fertility reacts to different functional forms of the household utility function. Further I look at income and price elasticities to compare household responsiveness to different interventions and try to measure the impact of various potential policy reforms. I also test the hypothesis that policy initiatives may not always give the anticipated results and use simulations to examine the effect of certain public subsidy schemes related to investments in child health and education.

Social welfare programs including fertility regulation initiatives must satisfy the three basic criteria: maximum benefit for given expenditure which depends on scale of the scheme and interaction across the program; cost effectiveness irrespective of it being in the private or public sector; and ensuring equity across different disadvantaged groups. Different instruments may act as complements or substitutes and the cross program effects can be tested by comparing the elasticity's of change and counter factual analysis since these proposed schemes may not have any real world counterparts. The social planner or regulatory agency must maximize social welfare but since the parental response is the key variable, we must focus on the decision making individual or the parent to understand policy effectiveness.

2.4 Methodology

Following the seminal article by Becker (1960), children can be interpreted as durable goods that yields some return, and demand for children is made in the presence of uncertainty[3] regarding the gender of the child, survival probability and success as an adult, which can lead to a divergence between actual and desired fertility. Demand and supply are both generated by the same agents, i.e. parents, and their decision is affected by income, tastes, knowledge and costs. The parental decision-making process with respect to childbearing is an optimization exercise in which parents choose the number of children (quantity) and health and educational status of their children (quality) but in the static analysis, we cannot separate out spacing of births in a household.

2.4.1 General Theoretical Framework

A general framework for the Quantity-Quality model for a parent or household follows:

$$\max_{n,q,y} U = U(n, q, y)$$

subject to

$$I = p_n.n + p_q.q + p_{nq}.nq + p_y.y$$

where (U) is the Utility function, (n) is the quantity of children, (q) is the quality measure where all children are homogenous and (y) is a composite of all other market commodities; (p_n) represents market price of goods and services for each child independent of child quality (food, shelter), (p_q) stands for investment cost in quality of child independent of number of children (computer, car ride to school), (p_{nq}) is the interaction term for price of quality inputs per child so its value rises with both q and n (tuition fees for school) and finally (p_y) is the price of market goods and services; also (I) is full money income while (R) is real income of the household; (π_i) stands for the shadow cost values with $i = n, q, nq$.

The marginal costs of quantity and quality are represented by the respective shadow price values, i.e. $MC_n = \pi_n = p_n + p_{nq}q$ and $MC_q = \pi_q = p_q + p_{nq}n$ while that for all other market goods and services simply is $MC_y = \pi_y = p_y$.

Here the budget constraint is nonlinear and can be modified to: $R = \pi_n n + \pi_q q + p_y y = I + p_{nq}nq$.

The solutions to the primal problem: $n = n^*(\pi_n, \pi_q, p_y, R)$; $q = q^*(\pi_n, \pi_q, p_y, R)$; $y = y^*(\pi_n, \pi_q, p_y, R)$ are plugged into the Indirect Utility function:

$$\psi = \psi(n^*(\pi_n, \pi_q, p_y, R), q^*(\pi_n, \pi_q, p_y, R), y^*(\pi_n, \pi_q, p_y, R)) = \psi(\pi_n, \pi_q, p_y, R)$$

[3]Ex-ante parents are not sure about having a male or female offspring, they do not know whether the child will at all survive into adulthood or if the child will grow up to be successful as an adult.

which defines the amount of utility we attain after consumption is optimized. Then using Roy's identity we can solve for the Marshallian demands as follows:

$$\frac{-\frac{\partial\psi(\pi_n,\pi_q,p_y,R)}{\partial\pi_n}}{\frac{\partial\psi(\pi_n,\pi_q,p_y,R)}{\partial R}} = n(\pi_n,\pi_q,p_y,R); \frac{-\frac{\partial\psi(\pi_n,\pi_q,p_y,R)}{\partial\pi_q}}{\frac{\partial\psi(\pi_n,\pi_q,p_y,R)}{\partial R}} = q(\pi_n,\pi_q,p_y,R); \frac{-\frac{\partial\psi(\pi_n,\pi_q,p_y,R)}{\partial p_y}}{\frac{\partial\psi(\pi_n,\pi_q,p_y,R)}{\partial R}} = y(\pi_n,\pi_q,p_y,R)$$

Using both nominal and shadow costs of quality and quantity and ignoring gender/birth-order differences as per Becker & Lewis (1973) and Edlefsen (1983), I find that raising child quality is costly because if there are more children, the same investment has to be made in each of them to ensure homogeneous quality and increasing quantity is costly because if each child is of higher quality, this makes the additional unit more expensive. I then try to compare the different utility functions to distinguish the kind of tradeoffs that result from the underlying utility mechanism. Imposing conditions of Homogeneity, Cournot aggregation and Engel aggregation, I solve the system and conduct some comparative static exercises after setting the model parameters. The own price, cross price and income elasticity values can be estimated to provide insights into the households fertility behavior and that could have important policy prescriptions.

2.4.2 Functional Specification for Static Model

The general Quantity-Quality model can be applied to different utility functions (Cobb Douglas, Leontief and Stone Geary or Linear Expenditure). The decision making parents maximize their objective function and calculate their optimal consumption for each case as per the procedure described in Section 2.4.1.

The functional forms under consideration are:

Cobb Douglas case

Utility: $U = n^{\beta_n} q^{\beta_q} y^{\beta_y}$

Indirect Utility: $\psi = R(\frac{\beta_n}{\pi_n})^{\beta_n}(\frac{\beta_q}{\pi_q})^{\beta_q}(\frac{\beta_y}{P_y})^{\beta_y}$

Demand Equations:

$n = \frac{\beta_n R}{\pi_n}$

$q = \frac{\beta_q R}{\pi_q}$

$y = \frac{\beta_y R}{\pi_y}$

Leontief Utility case

Utility: $U = \min\{\frac{n}{\beta_n}, \frac{q}{\beta_q}, \frac{y}{\beta_y}\}$

Indirect Utility: $\psi = \frac{R}{\beta_n \pi_n + \beta_q \pi_q + \beta_y P_y}$

Demand Equations:

$n = \frac{\beta_n R}{\beta_n \pi_n + \beta_q \pi_q + \beta_y P_y}$

$q = \frac{\beta_q R}{\beta_n \pi_n + \beta_q \pi_q + \beta_y P_y}$

$y = \frac{\beta_y R}{\beta_n \pi_n + \beta_q \pi_q + \beta_y P_y}$

Stone Geary Utility case

Utility: $U = (n - \gamma_n)^{\beta_n}(q - \gamma_q)^{\beta_q}(y - \gamma_y)^{\beta_y}$

Indirect Utility: $\psi = [R - \pi_n \gamma_n - \pi_q \gamma_q - P_y \gamma_y](\frac{\beta_n}{\pi_n})^{\beta_n}(\frac{\beta_q}{\pi_q})^{\beta_q}(\frac{\beta_y}{P_y})^{\beta_y}$

Demand Equations:

$n = \gamma_n + (\frac{\beta_n}{\pi_n})[R - \pi_n \gamma_n - \pi_q \gamma_q - P_y \gamma_y]$

$q = \gamma_q + (\frac{\beta_q}{\pi_q})[R - \pi_n \gamma_n - \pi_q \gamma_q - P_y \gamma_y]$

$y = \gamma_n + (\frac{\beta_y}{P_y})[R - \pi_n \gamma_n - \pi_q \gamma_q - P_y \gamma_y]$

2.4.3 Analytical Solutions

Here I consider the static version of the Quantity-Quality model where we cannot separate out the spacing of births in a household and the analytical solutions show how the relevant demand functions change with respect to the exogenous price and income parameters. Since the financial instrument (tax, subsidy etc.) will be applied to the prices and must impact fertility so the partial derivatives of interest are: $(\partial lnn/\partial lnp_{nq})$ and $(\partial lnn/\partial lnp_n)$; where the former expression captures the impact on fertility from changing the price of goods and services for children that affect both quantity and quality and the latter shows the impact of raising the price of child quantity on the demand for children.

Notation for Budget Shares and Elasticities:-

$\theta_{nq} = \frac{P_{nq} nq}{R}, \theta_n = \frac{n\pi_n}{R}, \theta_q = \frac{q\pi_q}{R}, \theta_y = \frac{yP_y}{R}; \widetilde{S}_n = \frac{P_n n}{R}; \widetilde{S}_q = \frac{P_q q}{R}$

$e_{nn} = \frac{\partial n/n}{\partial \pi_n/\pi_n}, e_{nq} = \frac{\partial n/n}{\partial \pi_q/\pi_q}, e_{ny} = \frac{\partial n/n}{\partial P_y/P_y}, e_{nR} = \frac{\partial n/n}{\partial R/R};$

$e_{qn} = \frac{\partial q/q}{\partial \pi_n/\pi_n}, e_{qq} = \frac{\partial q/q}{\partial \pi_q/\pi_q}, e_{qy} = \frac{\partial q/q}{\partial P_y/P_y}, e_{qR} = \frac{\partial q/q}{\partial R/R};$

$e_{yn} = \frac{\partial y/y}{\partial \pi_n/\pi_n}, e_{yq} = \frac{\partial y/y}{\partial \pi_q/\pi_q}, e_{yy} = \frac{\partial y/y}{\partial P_y/P_y}, e_{yR} = \frac{\partial y/y}{\partial R/R}.$

General Utility function

- $\frac{\partial lnn}{\partial lnP_n} = \frac{P_n(e_{nn}-\theta_{nq}e_{qr}e_{nn}+\theta_{nq}e_{nr}e_{qn})}{\pi_n\Big[1-\theta_{nq}e_{qr}-\theta_{nq}e_{nr}-\frac{P_{nq}qe_{qn}}{\pi_n}-\frac{P_{nq}ne_{qn}}{\pi_q}+\frac{\theta_{nq}e_{nR}e_{qn}P_{nq}q}{\pi_n}+\frac{\theta_{nq}e_{qR}e_{nq}P_{nq}n}{\pi_q}}$

$$-\frac{\theta_{nq}e_{nR}e_{qq}P_{nq}n}{\pi_q} - \frac{\theta_{nq}e_{nn}e_{qR}P_{nq}q}{\pi_n} + \frac{e_{nq}e_{qn}P_{nq}^2nq}{\pi_n\pi_q} - \frac{e_{nn}e_{qq}P_{nq}^2nq}{\pi_n\pi_q}\Big]$$

- $\frac{\partial lnn}{\partial lnP_{nq}} = \frac{\Big[e_{nR}\theta_{nq}+\frac{(1-e_{qR}\theta_{nq})e_{nn}P_{nq}q}{\pi_n}+\frac{(1-e_{qR}\theta_{nq})e_{nq}P_{nq}n}{\pi_q}+\frac{e_{nR}\theta_{nq}e_{nq}P_{nq}q}{\pi_n}+\frac{e_{nR}\theta_{nq}e_{qq}P_{nq}n}{\pi_q}\Big]}{\Big[1-e_{qR}\theta_{nq}-e_{nR}\theta_{nq}\Big]}$

Cobb Douglas Utility function

- $\frac{\partial lnn}{\partial lnP_n} = \frac{-P_n(1-\theta_{nq})}{\pi_n\Big[1-2\theta_{nq}+\frac{\theta_{nq}P_{nq}n}{\pi_q}+\frac{\theta_{nq}P_{nq}q}{\pi_n}-\frac{P_{nq}^2nq}{\pi_n\pi_q}\Big]}$
- $\frac{\partial lnn}{\partial lnP_{nq}} = \frac{\Big[\theta_{nq}-\frac{P_{nq}q}{\pi_n}-\frac{\theta_{nq}P_{nq}n}{\pi_q}+\frac{P_{nq}^2nq}{\pi_n\pi_q}\Big]}{\Big[1-2\theta_{nq}+\frac{\theta_{nq}P_{nq}n}{\pi_q}+\frac{\theta_{nq}P_{nq}q}{\pi_n}-\frac{P_{nq}^2nq}{\pi_n\pi_q}\Big]}$

Leontief Utility function

- $\frac{\partial lnn}{\partial lnP_n} = \frac{-\beta_nP_n}{[(1-\theta_{nq})(\beta_n\pi_n+\beta_q\pi_q+\beta_yP_y)+\beta_nP_{nq}q+\beta_qP_{nq}n]}$
- $\frac{\partial lnn}{\partial lnP_{nq}} = \frac{\theta_{nq}(\beta_n\pi_n+\beta_q\pi_q+\beta_yP_y)-\beta_nqP_{nq}-\beta_qnP_{nq}}{[(1-\theta_{nq})(\beta_n\pi_n+\beta_q\pi_q+\beta_yP_y)+\beta_nP_{nq}q+\beta_qP_{nq}n]}$

Stone Geary Utility function

- $\frac{\partial lnn}{\partial lnP_n} = \Big[\beta_n(\frac{P_n}{\pi_n})(\frac{R}{n\pi_n})\{-1+(\frac{\gamma_q}{q})(\frac{q\pi_q}{R})+(\frac{\gamma_y}{y})(\frac{yP_y}{R})\}\{1-\beta_q(\frac{P_{nq}n}{\pi_q})(1-\frac{\gamma_n}{n})\}$

$$-\beta_q(\frac{\gamma_n}{n})(\frac{R}{\pi_qq})(\frac{n\pi_n}{R})(\frac{P_n}{\pi_n})\beta_n(\frac{P_{nq}q}{\pi_n})\{1-\frac{R}{n\pi_n}+(\frac{\gamma_q}{q})(\frac{q\pi_q}{R})(\frac{R}{n\pi_n})+(\frac{\gamma_y}{y})(\frac{yP_y}{R})(\frac{R}{n\pi_n})\}\Big]$$

$$/\Big[\{1-\beta_n(\frac{P_{nq}q}{\pi_n})(1-\frac{\gamma_q}{q})\}\{1-\beta_q(\frac{P_{nq}n}{\pi_q})(1-\frac{\gamma_n}{n})\}-\beta_n\beta_q(\frac{P_{nq}n}{\pi_q})(\frac{P_{nq}q}{\pi_n})\{1-\frac{R}{q\pi_q}$$

$$+(\frac{\gamma_n}{n})(\frac{n\pi_n}{R})(\frac{R}{q\pi_q})+(\frac{\gamma_y}{y})(\frac{yP_y}{R})(\frac{R}{q\pi_q})\}\{1-\frac{R}{n\pi_n}+(\frac{\gamma_q}{q})(\frac{q\pi_q}{R})(\frac{R}{n\pi_n})+(\frac{\gamma_y}{y})(\frac{yP_y}{R})(\frac{R}{n\pi_n})\}\Big]$$

- $\frac{\partial lnn}{\partial lnP_n} = \Big[\beta_n(\frac{P_{nq}q}{\pi_n})\{1-\frac{R}{n\pi_n}+(\frac{\gamma_q}{q})(\frac{q\pi_q}{R})(\frac{R}{n\pi_n})+(\frac{\gamma_y}{y})(\frac{yP_y}{R})(\frac{R}{n\pi_n})\}\{1-\beta_q(\frac{P_{nq}n}{\pi_q})(1-\frac{\gamma_n}{n})\}+\beta_n(\frac{P_{nq}n}{\pi_q})(\frac{P_{nq}q}{\pi_n})$

$$*\beta_q\{1-\frac{R}{q\pi_q}+(\frac{\gamma_n}{n})(\frac{n\pi_n}{R})(\frac{R}{q\pi_q})+(\frac{\gamma_y}{y})(\frac{yP_y}{R})(\frac{R}{q\pi_q})\}\{1-\frac{R}{n\pi_n}+(\frac{\gamma_q}{q})(\frac{q\pi_q}{R})(\frac{R}{n\pi_n})+(\frac{\gamma_y}{y})(\frac{yP_y}{R})(\frac{R}{n\pi_n})\}\Big]$$

$$/ \Big[\{1-\beta_n(\frac{P_{nq}q}{\pi_n})(1-\frac{\gamma_q}{q})\}\{1-\beta_q(\frac{P_{nq}n}{\pi_q})(1-\frac{\gamma_n}{n})\} - \beta_n\beta_q(\frac{P_{nq}n}{\pi_q})(\frac{P_{nq}q}{\pi_n})\{1-\frac{R}{q\pi_q}$$

$$+(\frac{\gamma_n}{n})(\frac{n\pi_n}{R})(\frac{R}{q\pi_q}) + (\frac{\gamma_y}{y})(\frac{yP_y}{R})(\frac{R}{q\pi_q})\}\{1-\frac{R}{n\pi_n} + (\frac{\gamma_q}{q})(\frac{q\pi_q}{R})(\frac{R}{n\pi_n}) + (\frac{\gamma_y}{y})(\frac{yP_y}{R})(\frac{R}{n\pi_n})\}\Big]$$

The analytical solutions depict how changing the price of quantity or quality affects fertility rates. However there could be several stages in the underlying mechanism that are not evident from the elasticity expression alone; making it impossible to sign the partial derivatives of the demand functions with respect to exogenous parameters. The implication of these partials cannot be determined in the general case, for instance raising the cost of education for children (P_{nq}) could either make parents reduce investment in quality as schooling becomes prohibitively costly and raise quantity or conversely parents may react to costlier education by reducing childbearing hence the net result depends on the strength of the individual effects. So I use the three basic functional forms, assign parameter values and then solve for the magnitude and direction of change to see how the number of children and quality of their education is affected as prices fluctuate.

2.5 Empirical Analysis

Since the impact of variation in prices and income cannot be ascertained directly from the analytical solutions due to the substitutability between child quality and quantity, the estimation strategy used for empirical evaluation involves running simulations for each system generated by the different forms of the utility function using national level data from India.

2.5.1 Data

The numerical analysis and resulting arguments in this study are applicable for any developing country with above replacement fertility rates but the models are specifically tested for India. The study region has 35 main administrative divisions (28 States and 7 Union Territories) and reflects a great deal of heterogeneity with respect to its historical background, geographical features, demographic factors, cultural norms and economic practices; this diversity is reflected in the large scale spatial variation with respect to the fertility transition. The variables employed in this study are mainly demographic variables like fertility; adult and child consumption; educational parameters and human capital investment; along with employment hours and wage rates; income measures and market interest rates for discounting. The primary data source is the National Sample Survey Organization's 64th Round of Household Consumer Expenditure in India (2007-2008) and the World Bank database on national level development indicators for India (1961-2010); supporting material is also collected from Statistical Reports and Bulletins from the Government of India (GOI), Planning Commission; Census of India (2001) from the GOI, Ministry of Home Affairs.

2.5.2 Simulation Exercise

The three static model systems[4] with different functional forms of utility are solved by running multiple iterations after selecting the exogenous parameters. Given the form of the utility function, the corresponding demand equations, marginal cost relations and budget constraint can be used to construct a system of 6 equations in 6 unknowns from which we can arrive at solutions for the partial derivatives. Each simulation exercise solves for the set of endogenous variables $(n, q, y, \pi_n, \pi_q, R)$ given prices (P_n, P_q, P_{nq}, P_y), income (I) and shares of each item $(\beta_n, \beta_q, \beta_y)$. In addition to these parameters, the Stone Geary form has a linear expenditure function where each good has an associated subsistence requirement $(\gamma_n, \gamma_q, \gamma_y)$. Derivation of the discounted present values of the variables is briefly described below.

The time line for an individual is constructed for a less developed country keeping in mind the lower life expectancy, fewer years of compulsory education etc. The lifecycle design can be expressed by separating out the different stages of life as per Figure 2.1 where:

Times: $T_0 = 0 \rightarrow$ Born; $T_1 = 18 \rightarrow$ Become young adult and start work; $T_2 = 20 \rightarrow$ Have children; $T_3 = 26 \rightarrow$ Children start school; $T_4 = 38 \rightarrow$ Children finish school; $T_5 = 60 \rightarrow$ Become old adult and retire from work; $T_6 = 65 \rightarrow$ Die.

Periods: $T_0 - T_1 \rightarrow$ Childhood; $T_1 - T_5 \rightarrow$ Young adulthood; $T_5 - T_6 \rightarrow$ Old adulthood.

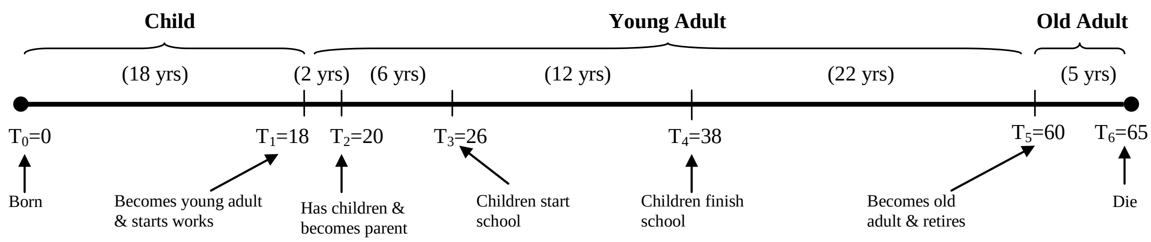


Figure 2.1: Lifecycle of an individual in a household

For the common parameters, after normalizing the cost of market consumption basket for each adult (P_y), I selected the system parameters using household expenditure data from 2007-08. All cumulative values of prices and quantities are discounted as per the time line described above using the market real interest rate of 6.87% for the year 2007, which acts as a proxy for social rate of time preference. The lifetime earnings (I) for an adult parent is calculated at the present value for 2007; cost of schooling per year (P_{nq}) refers to the 2006-07 mean educational expenses for rural and urban areas on tuition, exam fees, uniform and coaching; cost of food, clothing and shelter for entire childhood (P_n) is estimated using the fraction of consumption allocated for children in a household; cost of educational expenses excluding school fees per year (P_q) is set at the rural-urban average for per capita non-school expenditure for 2006-07 including books, stationery, transport and other expenses.

[4]System of equations and unknowns for each functional form of utility is described in Appendix I.

Now the budget shares for the three goods ($S_n = \frac{\pi_n n}{R} = 0.015896903, S_q = \frac{\pi_q q}{R} = 0.002507036, S_y = \frac{P_y y}{R} = 0.981596102$) add to unity ($\sum S_i = 1$). For the Cobb Douglas Specific Parameters, the beta values are equal to the budget shares for the three goods ($\beta_n = S_n, \beta_q = S_q, \beta_y = S_y$) and add to unity with ($\beta_n + \beta_q + \beta_y = 1$). In the case of the Leontief Specific Parameters, the budget shares ($S_n = \frac{\beta_n \pi_n}{\beta_n \pi_n + \beta_q \pi_q + \beta_y P_y}, S_q = \frac{\beta_q \pi_q}{\beta_n \pi_n + \beta_q \pi_q + \beta_y P_y}, S_y = \frac{\beta_y P_y}{\beta_n \pi_n + \beta_q \pi_q + \beta_y P_y}$) can be used to residually calculate the beta values ($\beta_n, \beta_q, \beta_y$) after normalizing the share for all non-child goods and services with ($\frac{\beta_n}{n} = \frac{\beta_q}{q} = \frac{\beta_y}{y}$). With the Stone Geary Specific Parameters, the budget shares for each good ($S_n = \frac{\pi_n \gamma_n}{R} + \beta_n \frac{[R - \pi_n \gamma_n - \pi_q \gamma_q - P_y \gamma_y]}{R}, S_q = \frac{\pi_n \gamma_n}{R} + \beta_n \frac{[R - \pi_n \gamma_n - \pi_q \gamma_q - P_y \gamma_y]}{R}, S_y = \frac{\pi_n \gamma_n}{R} + \beta_n \frac{[R - \pi_n \gamma_n - \pi_q \gamma_q - P_y \gamma_y]}{R}$) are solved for the beta values ($\beta_n, \beta_q, \beta_y$) with ($\beta_n + \beta_q + \beta_y = 1$). Subsistence levels ($\gamma_n, \gamma_q, \gamma_y$) are determined as per the national minimum standards. At least 2 years in primary schooling is set for elementary education while parents are expected to have at least one offspring in their lifetime. The lower bound unit for the consumption basket is set at the poverty line for India and the present value of minimum requirements is estimated at an average for the rural and urban regions for 2005-06.

Further I assign starting values to the choice variables; expected number of children over a person's lifetime (n_0) is set at half the TFR for 2007 as each individual here is assumed to be part of a couple; years of schooling per child (q_0) is fixed at the national standard for average years of schooling and expected lifetime consumption (y_0) can be calculated residually from balancing the budget with discounted present value of lifetime income; the shadow prices ($\pi_{n0} = P_n + P_{nq} q_0, \pi_{q0} = P_q + P_{nq} n_0$) and real income ($R_0 = I + P_{nq} n_0 q_0$) are evaluated at the respective price and income values generated above. Table 2.1 shows the parameters and variables that are calibrated for the static model simulation exercise.

Calibration Specification (*Normalising* P_y=1)						
Starting Values	n_0	q_0	y_0	R_0	π_{n0}	π_{q0}
	1.371	5.1	514835.9805	524488.615	6081.506	257.82586
Common Parameters	δ	r	I	P_n	P_q	P_{nq}
	0.9357	0.068729	523568.04	5410.04	77.32	131.66
Cobb Douglas Specific Parameters	β_n	β_q	β_y			
	0.015896903	0.002507036	0.981596102			
Leontief Specific Parameters	β_n	β_q	β_y			
	0.000002662984014	0.000009905902166	1			
Stone Geary Specific Parameters	β_n	β_q	β_y	γ_n	γ_q	γ_y
	0.004557875286	0.001614602234	0.993827565	1	2	22871.63
	0.010635235	0.001604744786	0.987760062	0.5	2	22871.63

Table 2.1: Parameter calibration results

The simulation results of the different functional forms of the Q-Q model can be used to see the effects of potential policy experiments and price and income fluctuations. Policies that impact fertility via the Q-Q tradeoff filter into the model via their effect on nominal prices, nominal income, shadow prices and real income. Each policy could have cross program effects that may trickle down further in the system. I first examine how varying the cost of child necessities, schooling expenses and income affects an individuals choice of child quality and child quantity directly. After gauging the impact of possible policy instruments affecting the household's decision variables, I then estimate the own price elasticity, cross price elasticity and income elasticity for fertility and schooling with each functional form and interpret the differences arising from the underlying behavioral assumptions.

2.5.3 Results from Comparative Statics

Variation in prices (P_{nq}, P_n) and income (I) could affect the household's decision regarding the number of children and the educational investment made in children. The simulations results for quantity of children, level of schooling, the shadow prices and real income with the signs of the derivatives are summarized under Table 2.2.

The slopes or the derivatives indicate the direction of change that would result if policies were put in place to affect the prices or income faced by a decision making individual from a developing country household. All the partials share the same signs across different functional forms of utility except ($\partial lnq/\partial lnP_n$) which differs for the Leontief case as here goods are consumed in fixed proportions so an increase in price reduces consumption of all items equi-proportionately.

The relationships indicate that raising (P_n) makes consumption requirements of children more expensive which reduces the number of children, increases the shadow price of quantity but lowers the shadow price of quality as well as real income. On the other hand, increasing (P_{nq}) makes education costlier and has a negative impact on both the number of children and investments in their quality with a rise in the shadow price of quantity, the shadow price of quality and real income. Finally, an increase in nominal full income (I) causes increments in both quantity and quality as the budget constraint gets relaxed.

The only exception is the impact of raising (P_n) on quality levels of children where in the Cobb Douglas and Stone Geary cases, as child consumption becomes costlier parents have fewer children and allocate the resultant excess income to child quality; but for the Leontief case as all goods must be consumed in the same proportion so an increase in (P_n) makes quantity of children more expensive which reduces all demands for quantity of children, quality of children and other non-child consumables.

Since my target variable is fertility, I am interested in seeing how the change in (P_n) and (P_{nq}) affects the household's choice of (n). Raising (P_n) makes child quantity more costly and this follows the usual trend that higher price leads to lower quantity demanded. However, an interesting finding is that if (P_{nq}) decreases then fertility may not decline. There is a tradeoff between the rise in quality of the child and the reduction in parent's own out of pocket cost to raise quality and depending on the net effect, policy initiatives to reduce (P_{nq}) may not always give the anticipated results. This result implies that subsidizing (P_{nq}) may raise (n) or the quantity of children and so using government investments reducing cost of education as the sole instrument will be insufficient in reducing fertility via the Quantity-Quality tradeoff.

Utility Fn. → / Slopes or Derivatives ↓	**STONE GEARY***	**COBB DOUGLAS**	**LEONTIEF**	*Comments*
$\partial \ln n / \partial \ln P_n$	**(-)**	**(-)**	**(-)**	Same sign (-)
$\partial \ln n / \partial \ln P_{nq}$	**(-)**	**(-)**	**(-)**	Same sign (-)
$\partial \ln n / \partial \ln I$	**(+)**	**(+)**	**(+)**	Same sign (+)
$\partial \ln q / \partial \ln P_n$	**(+)**	**(+)**	**(-)**	Different sign (+/-)
$\partial \ln q / \partial \ln P_{nq}$	**(-)**	**(-)**	**(-)**	Same sign (-)
$\partial \ln q / \partial \ln I$	**(+)**	**(+)**	**(+)**	Same sign (+)
$\partial \ln \pi_n / \partial \ln P_n$	**(+)**	**(+)**	**(+)**	Same sign (+)
$\partial \ln \pi_n / \partial \ln P_{nq}$	**(+)**	**(+)**	**(+)**	Same sign (+)
$\partial \ln \pi_q / \partial \ln P_n$	**(-)**	**(-)**	**(-)**	Same sign (-)
$\partial \ln \pi_q / \partial \ln P_{nq}$	**(+)**	**(+)**	**(+)**	Same sign (+)
$\partial \ln R / \partial \ln P_n$	**(-)**	**(-)**	**(-)**	Same sign (-)
$\partial \ln R / \partial \ln P_{nq}$	**(+)**	**(+)**	**(+)**	Same sign (+)

**Note: Stone Geary case is evaluated for both* (γ_n=0.5) *and* (γ_n=1).

Table 2.2: Policy Experiments with Static Model Simulations

2.5.4 Price & Income Elasticities

The elasticities values indicate the responsiveness of quantity demanded with a percentage change in price or income. Magnitudes of elasticity differ across functional forms due to the nature of consumption behavior as described by the demand and utility structure. The Cobb-Douglas, Leontief and Linear or Stone Geary are some of the most frequently used functional forms which are all special cases of the Constant Elasticity of Substitution (CES) function. As its name suggests, the CES utility function exhibits a constant elasticity of substitution between quality of children, quantity of children and all other non-child goods and services.

The Stone Geary and Leontief forms represent the two extremes for convex utility functions. If we remove the subsistence requirements then in absence of the lower bounds, the Stone Geary structural form collapses to the standard Cobb Douglas case. Generally the linear expenditure form has perfect substitutability between the factors after subsistence requirements have been met while at the other end the Leontief function is characterized by zero substitutability because goods and services must be used in fixed proportions to maintain the level of utility. Hence even as the price ratios change or the budget constraint relaxes, the ratio of child and non-child goods consumed remain unchanged. The Cobb Douglas function represents a middle ground with imperfect substitutability between (n, q, y).

The values of price and income elasticity coefficients represented in Table 2.3 can be interpreted as impact of changing nominal prices (P_n, P_{nq}), nominal income (I), shadow prices (π_n, π_q) and real income (R) on quantity or fertility behavior (n) and quality or schooling investment (q). Under usual circumstances, the own price elasticity is greatest for the Stone Geary case followed by the Cobb Douglas scenario and finally the Leontief displays least elasticity. However the Static model constructed here has a Stone Geary function where the subsistence requirement for children $(\gamma_n = 1)$ is close to the national average fertility rate per parent[5] $(n_0 = 1.371)$. Hence each individual can meet their desired family size simply by attaining a small amount in excess of the lower bound. This makes the linear form less elastic than it would be otherwise.

Comparing across goods, the own price elasticity of fertility with respect to (P_n) and (π_n) is significantly less than one for the Leontief and Stone Geary cases but close to one for the Cobb Douglas case; on the other hand the cross price coefficients for fertility with respect to schooling (P_{nq}) is close to zero for all three systems. For educational investments, the schooling fees represented by (P_{nq}) is only part of the cost so the magnitude does not include the full own price elasticity of schooling as impact of (P_q) is not captured here. Overall the cross price elasticity of schooling is negative but low, as (P_n) and (π_n) rises net expenditure on children goes up so less is left over to invest in education or child quality. The income elasticities for the Cobb Douglas and Leontief cases are approximately close to unity which is verified from the standard properties of the utility function but the value is low for the Stone Geary case as any relaxation of the budget gets redistributed among all goods to meet subsistence needs.

[5] TFR=2.742 for India in 2007 but this value is reported for women who constitute one half of a couple hence the TFR is halved to represent the per capita average number of children for each parental unit.

ELASTICITY	Utility Fn. / Magnitude of Elasticity**	STONE GEARY*	COBB DOUGLAS	LEONTIEF
Own Price Elasticity of Fertility w.r.t. Nominal Price	$\partial \ln n / \partial \ln P_n$	**-0.272**	**-0.882**	**-0.050**
Cross Price Elasticity of Fertility w.r.t. Nominal Price	$\partial \ln n / \partial \ln P_{nq}$	**-0.053**	**-0.109**	**-0.038**
Income Elasticity of Fertility w.r.t. Full Money Income	$\partial \ln n / \partial \ln I$	**0.286**	**0.998**	**0.962**
Own Price Elasticity of Fertility w.r.t. Shadow Price	$\partial \ln n / \partial \ln \pi_n$	**-0.271**	**-0.990**	**-0.052**
Cross Price Elasticity of Fertility w.r.t. Shadow Price	$\partial \ln n / \partial \ln \pi_q$	**0.000**	**0.000**	**-0.039**
Income Elasticity of Fertility w.r.t. Real Income	$\partial \ln n / \partial \ln R$	**0.287**	**1.000**	**0.963**
Cross Price Elasticity of Schooling w.r.t. Nominal Price	$\partial \ln q / \partial \ln P_n$	**-0.007**	**0.000**	**-0.024**
Own Price Elasticity of Schooling w.r.t. Nominal Price	$\partial \ln q / \partial \ln P_{nq}$	**-0.423**	**-0.693**	**-0.012**
Income Elasticity of Schooling w.r.t. Full Money Income	$\partial \ln q / \partial \ln I$	**0.643**	**0.998**	**0.988**
Cross Price Elasticity of Schooling w.r.t. Shadow Price	$\partial \ln q / \partial \ln \pi_n$	**-0.007**	**0.000**	**-0.026**
Own Price Elasticity of Schooling w.r.t. Shadow Price	$\partial \ln q / \partial \ln \pi_q$	**-0.602**	**-0.990**	**-0.013**
Income Elasticity of Schooling w.r.t. Real Income	$\partial \ln q / \partial \ln R$	**0.644**	**1.000**	**0.990**

*Note: Estimates for Stone Geary case is evaluated for (γ_n=1) but the elasticities are different for (γ_n=0.5).
**Note: Elasticity magnitudes are rounded at 3 decimal places.

Table 2.3: Price & Income Elasticity for Static Model Simulations

The difference in the elasticity magnitudes can be understood better if we interpret them in light of the properties of the utility functions.

Leontief: In this case, the goods (n, q, y) are not substitutes so they must be consumed in fixed proportions. Income elasticity is close to unity hence raising income makes a parent proportionately increase demand of all three items in their consumption basket. All price elasticities are at 5% or lower so a price hike for a good does not greatly affect the demand for the good itself as the net increase in expenses means consumption of all goods must go down and so the price effect is weakened. Hence raising the price of fertility or schooling has a small negative effect on demand because of the low degree of substitutability between quantity and quality.

Cobb Douglas: This is the most commonly used functional form and goods (n, q, y) are imperfect substitutes. The income elasticities are almost unity hence a small rise in income results in a large hike in quantity or quality investments. The own price elasticity of fertility and schooling with respect to the shadow prices is also close to unity but the variation with nominal prices is less sensitive. The cross price elasticities however are very low and almost negligible so a change in price of quality has a minor impact on quantity of children.

Stone Geary: For the linear expenditure system, there is a lower bound $(\gamma_n, \gamma_q, \gamma_y)$ that has to be met. Income elasticities are positive but less than half for fertility and just above half for schooling because relaxing the budget constraint means that extra funds must first be allocated towards meeting the minimum necessities. Own price elasticity of fertility is much lower than that for education because the subsistence level is very close to the normal demand for number of children; this allows greater flexibility in choosing the schooling level as compared to the lower bound for childbearing which is more restrictive. The cross price elasticities for both quantity and quality are close to zero.

The uncharacteristically lower elasticity values in the Stone Geary case can be explained by looking at the subsistence parameters[6]; for $(\gamma_n = 1)$ we have each person having at least one child whereby a couple has two children and this is very close to the national TFR hence leaving little room for adjustment. If $(\gamma_n = 0.5)$ then each parent requires half unit of fertility resulting in the couple being satisfied with one child and re-running the model with the adjusted $(\beta_n, \beta_q, \beta_y)$ parameters yields higher price and income elasticity values. Hence higher fertility costs raises the expenditure of attaining the lower bound in case of higher threshold requirement leaving very little left over income for spending on non-subsistence items.

2.5.5 Implications of Findings

The different functional forms are useful in describing various types of households and different families may have different priorities, allocation rules or consumption patterns. Families that always choose some goods in a specific proportion may be classified by Leontief preferences where as households that must meet a minimum threshold of some items to survive will be represented by a Stone Geary utility.

From Table 2.3, looking across the row, the elasticity values indicate how different utility functions yield different response mechanisms and demonstrates the heterogeneity in individual preference. Along the column, the values show how a given decision making individual who has a particular utility function is affected by price and income fluctuations while picking their choice variables. The partial derivatives for number of children and schooling share the same sign across

[6]If (γ_n) is positive then childless couples are not meeting subsistence requirement but they form a very small fraction of the sample and can be ignored for the purposes of this analysis.

functional forms but understanding not just the direction but the degree of change in fertility from changing the price structure could be beneficial in informing public policy. For all three systems, Cobb Douglas, Leontief and Stone Geary, we find that own price elasticity of fertility exceeds the cross price effect so a program targeted directly at fertility will have greater effect than one focussed on education which indirectly filters into fertility choice. So family planning programs will be more effective in fertility regulation than conditional cash transfer schemes. Following up on the policy implications of the comparative static results, even though educational policy subsidizing schooling may result in higher fertility as a consequence; this impact is fairly small scale as seen from the values of cross price elasticity ranging between 3% to 10%. The signs and magnitudes of elasticity values can be used to inform family planning policies targeting fertility behavior.

Theories on the properties of utility functions suggest that real income elasticity of quantity and quality should be unity for the Cobb Douglas case and this is established above ($\partial lnn/\partial lnR = 1$ and $\partial lnq/\partial lnR = 1$). In principle the responsiveness of these goods to money income and real income should vary but ($\frac{I}{R} = 0.998$) hence in practice the difference is negligible. For the Stone Geary case on the other hand, demand for quality (0.64) is more income responsive than demand for quantity (0.28) but in general, income elasticities are much lower as compared to the Leontief and Cobb Douglas form. This is because even if income rises by the same amount in all three functional cases; percentage rise in disposable income is same as net rise in income for the non-subsistence scenarios where as in the Stone Geary case, if the budget constraint is relaxed then amount spent for meeting threshold requirements remains fixed hence percentage rise in flexible income is much lower. So there exists some stickiness in consumption, more for prices and less for income, which explains the lower elasticity values in the linear expenditure structure.

From the price elasticity calculations, several interesting inferences can be drawn. Impact of policies such as China's one child restriction which makes multiple children prohibitively costly ($\partial lnn/\partial lnP_n$) is larger for the Cobb Douglas case and has a smaller influence for the Leontief, while with the Stone Geary the response is at an intermediate level. Systems like conditional cash transfers are designed to lower costs of education and from ($\partial lnn/\partial lnP_{nq}$) we find that effect on fertility may be low but there is a difference in responsiveness between the functional forms; educational programs meant to boost investment in human capital as per ($\partial lnq/\partial lnP_{nq}$) may have minor consequences in the Leontief structure but there is more feedback from the other systems. Comparing shadow and nominal price cross effects ($\partial lnq/\partial lnP_n$ and $\partial lnq/\partial ln\pi_n$) on quality or schooling of children, the results are almost identical for each type of utility with negligible adverse impact of raising price of childbearing on educational attainment of the child.

2.6 Policy Relevance & Recommendation

The purpose of the study is to find feasible and effective instruments that may be used in policy planning to induce desired fertility behavior. Any coercive and non-voluntary policy that infringes upon individual freedoms with regard to reproductive rights would be considered repressive and unacceptable. A spectrum of factors may potentially affect the fertility of individuals and policies range from direct financial incentives to sociocultural development mechanisms that ensure effectiveness and ethical justice and at the same time help to manage the population pressure.

Assuming that undistorted behavior is optimal for the household but related externality makes the choice socially suboptimal, every financial instrument will have some associated costs and depending on the type of policy, dead weight losses are incurred by either the household or the administrating body. Any scheme that induces the household to internalize the cost will alter their choice of quantity or quality and result in a dead weight loss for the family as their first best option is now distorted; also any subsidy payment or enforcement cost will result in additional expenditure from the government budget and cause dead weight loss in terms of public finance.

Two of the commonest policy instruments include either a penalty disincentive scheme or a subsidy incentive program. The use of financial incentive or disincentive will affect the price $(P_n, P_{nq}, \pi_n, \pi_q)$ and income (R, I) structure of the economy and the empirical analysis above is an attempt to replicate such scenarios to explain the variation in demand (n, q) as it reacts to such changes. At first glance, the results may show that an incentive or a disincentive scheme will have a symmetric effect on fertility but closer observation indicates otherwise. The price effect of a policy intervention is identical if income is held constant, however any financial instrument will change the income levels. A penalty on high fertility will create a loss in income while a subsidy for lower child bearing will result in income gain, hence different schemes will not have similar effects and the public responsiveness to potential policies must be tested in advance.

Disincentive schemes may be more effective with quicker response rates but a penalty may change the marginal cost for each child and cause loss of income from paying the fines, fees or bribes if one were to exceed the limit. Behavioral studies show that positive incentives are politically more popular than negative reinforcements; so social programs that make smaller families more appealing could encourage a decrease in fertility over a smaller time horizon. Some other possible micro-level policies deterring fertility involve making child schooling mandatory (perhaps with costs of education to be privately borne by parents) or subsiding women's education (so their opportunity cost of time and wages rise).

The findings from this paper supplemented by arguments from past literature implies that better educated, healthy and financially secure individuals tend to have fewer children as predicted by the Quantity-Quality tradeoff models for fertility. Hence Education, Health and Economic Well-being should all be important areas of focus and policy makers should incorporate this into their decision making process during incentive design and budget allocation. Specifically population regulation via education subsidies alone is inefficient as parents will find children cheaper to raise and may increase childbearing; to reduce fertility via the Q-Q tradeoff we must improve child quality in conjunction with other family planning initiatives as well.

2.7 Conclusion

Scarcity is the motive power behind most population research including the current analysis and one of the chief social concerns involves allocation of scarce resources among alternative competing claims. Resource constrained economies can reduce their ecological footprint and human impact by three means: changing consumption behavior, population regulation or technological innovation. Using the Q-Q tradeoff entails improving child quality levels in terms of health and education, which will directly raise children's wellbeing and as a byproduct reduce the demand for quantity in the long run; higher quality raises income-earning potential and survival probability and at the same time could generate a stable population with replacement rate fertility.

Over time both population growth rates and fertility rates have been on the decline but the absolute population size is still growing. Even after identifying the problem of overpopulation and the aim of population stabilization, any policy that we implement will need a significant response interval. The articles surveyed use a variety of policy instruments ranging from financial incentives to targeted socio-cultural development and try to ensure effectiveness and ethical justice at the same time. Generally, education either generates awareness of birth control techniques or increases the opportunity cost of time for parents and this is found to deter high fertility. Better health implies that mortality rates (both maternal and child) are lower and this reduces the precautionary demand for children as there is less uncertainty about survival till adulthood while higher income or economic well-being seems to be inversely related to fertility.

Socio-cultural factors play an indispensable role in curtailing population growth and for a more time efficient response rate we should include an incentive or disincentive mechanism where desired fertility behavior is rewarded and the converse is met with negative sanctions. Though incentives or disincentives have different structures, they should essentially aim for the same goal. However disincentives are not looked upon favorably because they do not better the quality of life for people and increase the relative deprivation, so incentive schemes are more preferable. Another issue that must be considered is the length of the planning horizon since this may affect policy choice (tax or subsidy etc.) as per time efficiency; enforcement of policy depends on comparing the relative effectiveness of the instruments given turnover time of the government in power and responsiveness of potential parents.

Monetary or equivalent benefits and penalties or financial disincentives may encourage families to modify their fertility downwards. Commonly used incentives are tax exemptions or direct cash payments which may be one time or deferred schemes. Studies claim that direct payments are part of the program costs for family planning programs while indirect tax exemptions or pension plans are costs borne by society as a whole in order to attain fertility reduction and this must be kept in mind during policy making and budget allocation.

Much research has already been undertaken to better understand ways to curb high population growth by reducing fertility, and my study contributes to the existing literature in several important ways. First, most of the empirical testing in the past has focused on how a higher number of children may lead to lower investments in child quality, but I look at the reverse direction of causality and investigate how increasing child quality may in the long run reduce the demand for quantity as income-earning potential and the probability of survival to adulthood for children increases. Secondly I solve the Q-Q model for different functional forms and run simulations to show how changes in prices and income affect the households decision to invest in number of offspring and their schooling levels. Finally I investigate the impacts of different policy experiments and test the hypothesis that policy initiatives may not always give the anticipated results as simply subsidizing qualitative improvements in children will not necessarily curtail fertility rates; the reduction in parent's out-of-pocket childcare costs to increase quality in terms of health and education may trigger greater childbearing as children are now cheaper to raise.

2.8 Limitations & Concerns

The results of the study are confined by the data limitations; since 2011 estimates from the recent Indian Census are not available as yet they are being substituted by 2001 indicators. At the policy implementation level, most of the public funding is diverted to critical areas that need immediate attention and very little is left over for family planning policies. Moreover no matter what plan is employed there will be a significant time lag before we see results because fertility decline is a slow process; this may hamper long term planning and policy execution as every five years a newly elected government may come to power and have a different agenda and outlook.

2.9 Future Extensions

This paper aims to find cost-effective and time efficient policy interventions that have an impact on the determinants of fertility so we can incentivize smaller family sizes for countries suffering from unsustainably high population growth rates due to high fertility. Once we identify appropriate target variables and effective instruments, the counterpart of the model could be applied to below replacement countries to see how parallel policy instruments may be applied to boost birth rates when fertility is viewed as too low. The current findings may also be extended to other developing nations that are facing similar problems after we account for their geographic location and position in the time path of demographic transition. The policy experiments can further be tested for more advanced forms or specifications of the utility function.

Appendix I

The three Static model systems with different functional forms of utility are:

Cobb Douglas Utility function

6 unknowns: n, q, y, π_n, π_q, R

6 equations:

- $n = \frac{\beta_n R}{\pi_n}$
- $q = \frac{\beta_q R}{\pi_q}$
- $y = \frac{\beta_y R}{\pi_y}$
- $R = I + P_{nq} nq$
- $\pi_n = P_n + P_{nq} q$
- $\pi_q = P_q + P_{nq} n$

10 parameters: δ, r, I, P_n, P_q, P_{nq},P_y ,β_n, β_q, β_y with ($\beta_n + \beta_q + \beta_y = 1$)

Leontief Utility function

6 unknowns: n, q, y, π_n, π_q, R

6 equations:

- $n = \frac{\beta_n R}{\beta_n \pi_n + \beta_q \pi_q + \beta_y P_y}$
- $q = \frac{\beta_q R}{\beta_n \pi_n + \beta_q \pi_q + \beta_y P_y}$
- $y = \frac{\beta_y R}{\beta_n \pi_n + \beta_q \pi_q + \beta_y P_y}$
- $R = I + P_{nq} nq$
- $\pi_n = P_n + P_{nq} q$
- $\pi_q = P_q + P_{nq} n$

10 parameters: δ, r, I, P_n, P_q, P_{nq},P_y ,β_n, β_q, β_y with ($\frac{\beta_n}{n} = \frac{\beta_q}{q} = \frac{\beta_y}{y}$)

Stone Geary Utility function

6 unknowns: n, q, y, π_n, π_q, R

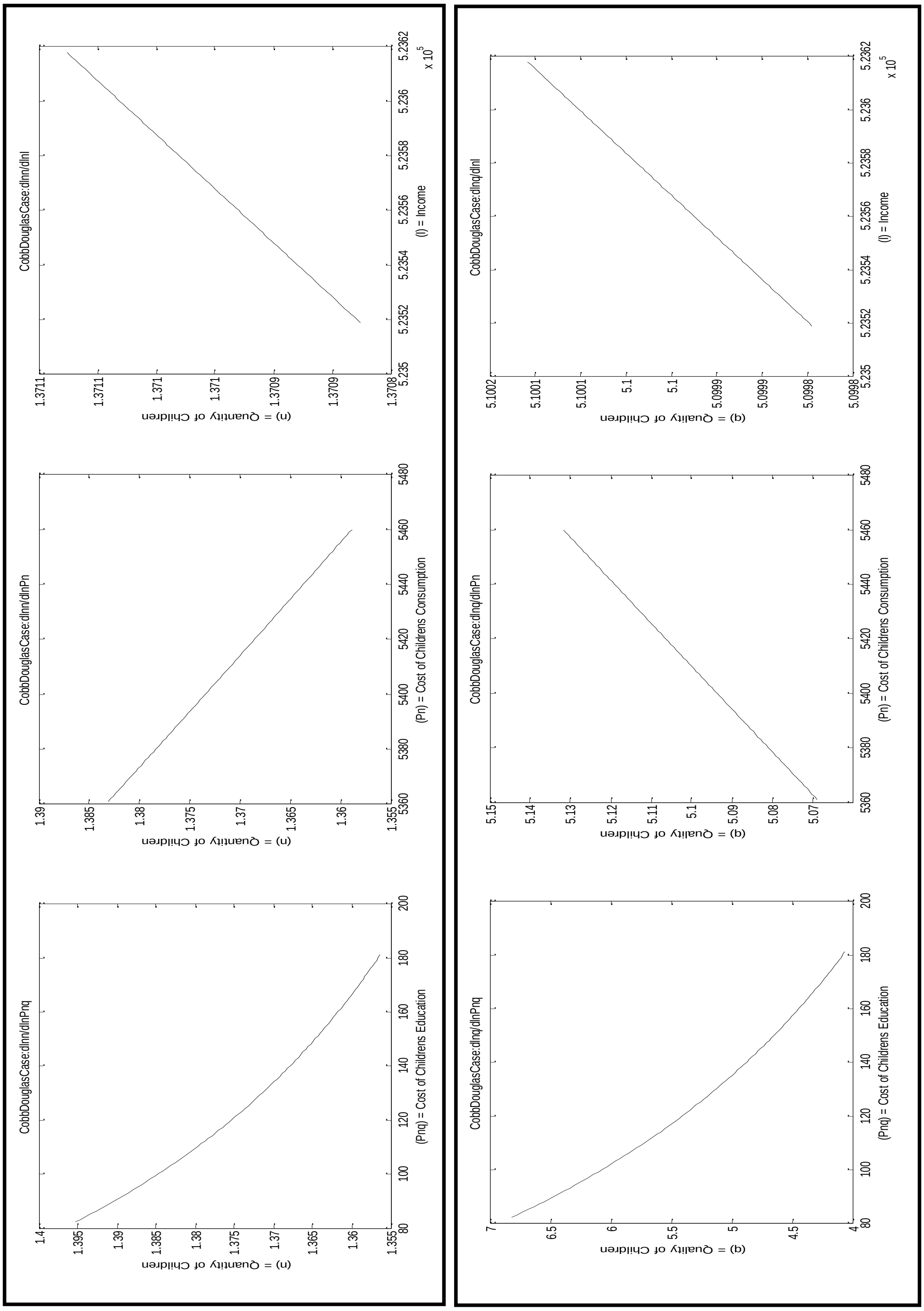
6 equations:

- $n = \gamma_n + (\frac{\beta_n}{\pi_n})[R - \pi_n \gamma_n - \pi_q \gamma_q - P_y \gamma_y]$
- $q = \gamma_q + (\frac{\beta_q}{\pi_q})[R - \pi_n \gamma_n - \pi_q \gamma_q - P_y \gamma_y]$
- $y = \gamma_n + (\frac{\beta_y}{P_y})[R - \pi_n \gamma_n - \pi_q \gamma_q - P_y \gamma_y]$
- $R = I + P_{nq} nq$
- $\pi_n = P_n + P_{nq} q$
- $\pi_q = P_q + P_{nq} n$

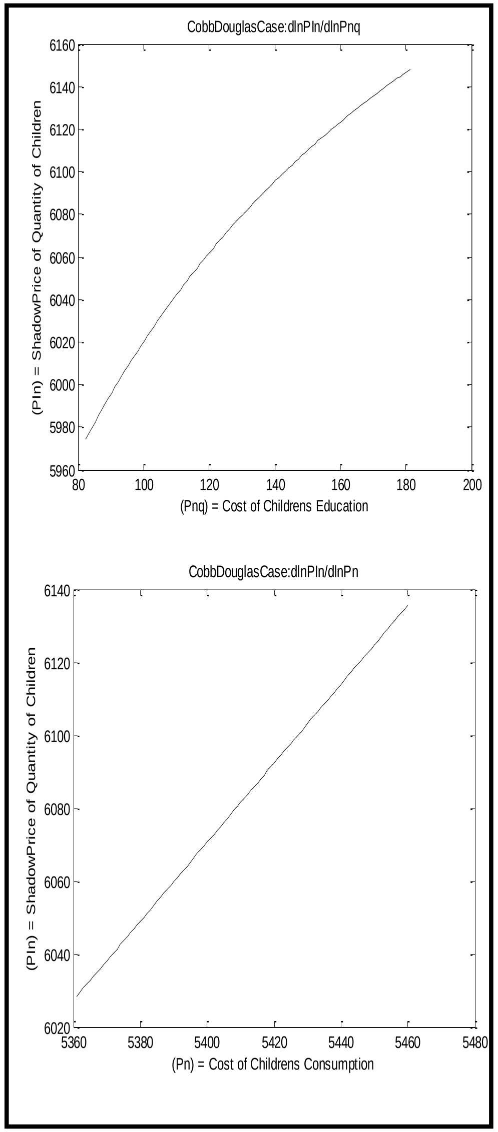
13 parameters: δ, r, I, P_n, P_q, P_{nq}, P_y, γ_n, γ_q, γ_y , β_n, β_q, β_y with ($\beta_n + \beta_q + \beta_y = 1$)

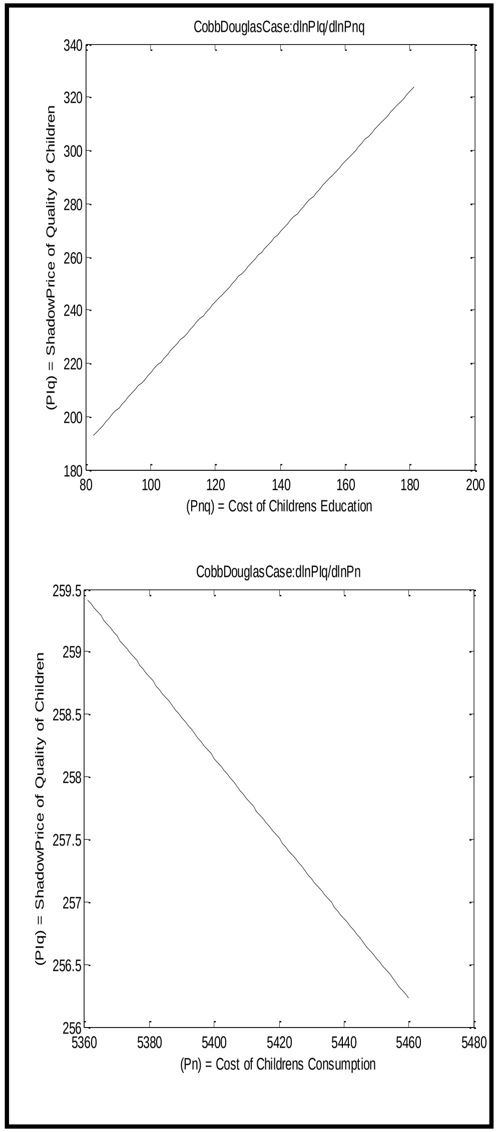
Appendix II

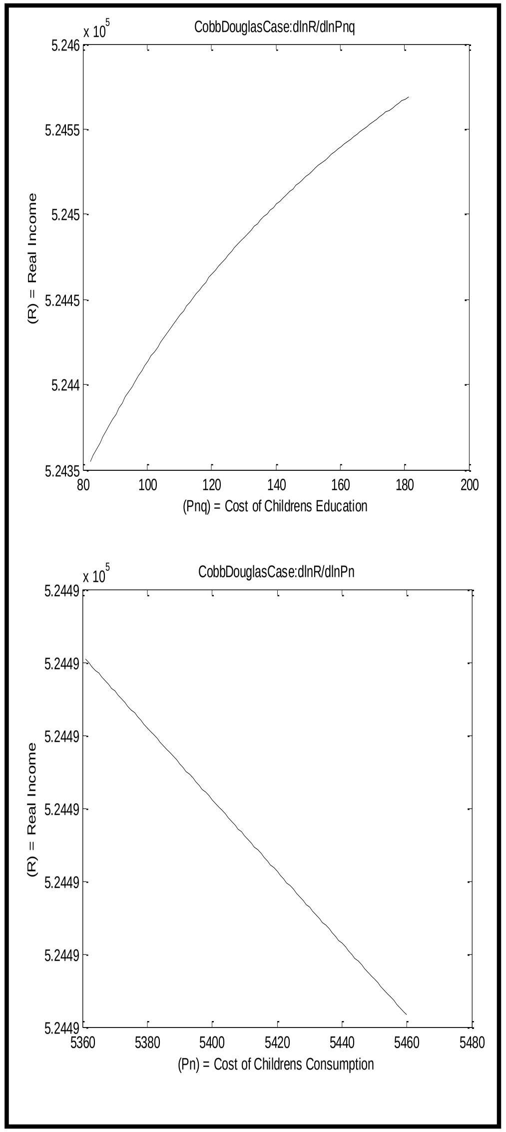
COBB DOUGLAS CASE (β_n=0.015896903;β_q=0.002507036;β_y=0.981596102)



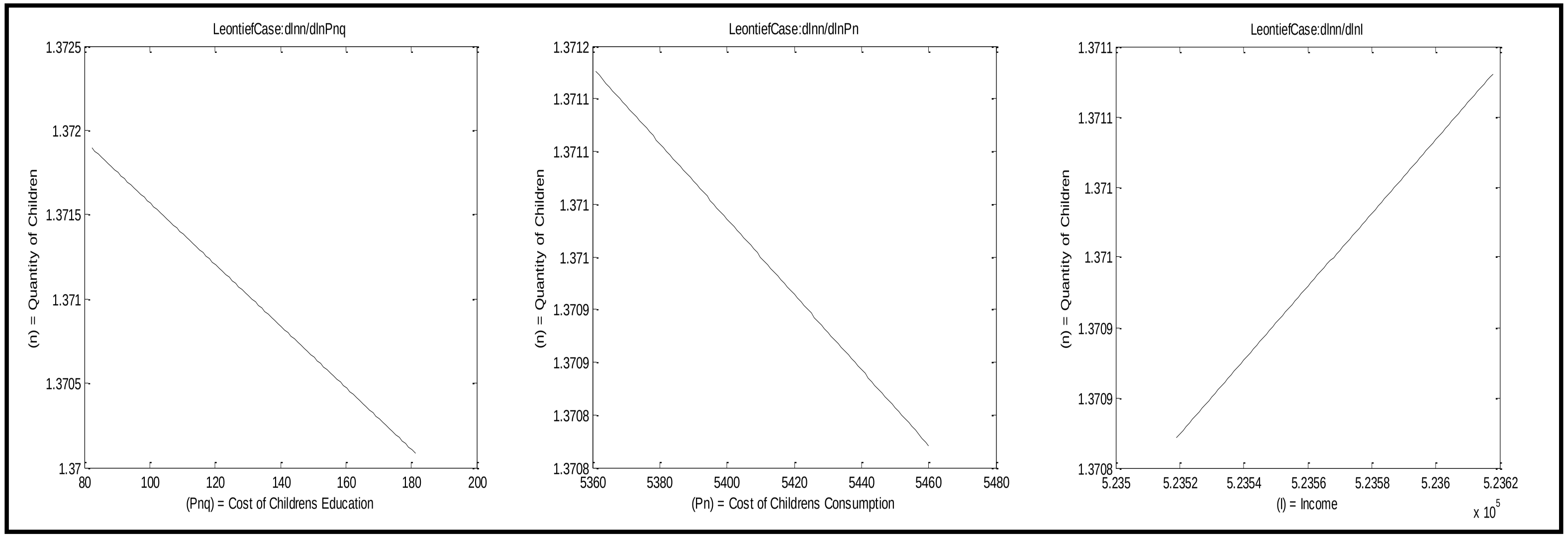
COBB DOUGLAS CASE (β_n=0.015896903;β_q=0.002507036;β_y=0.981596102)

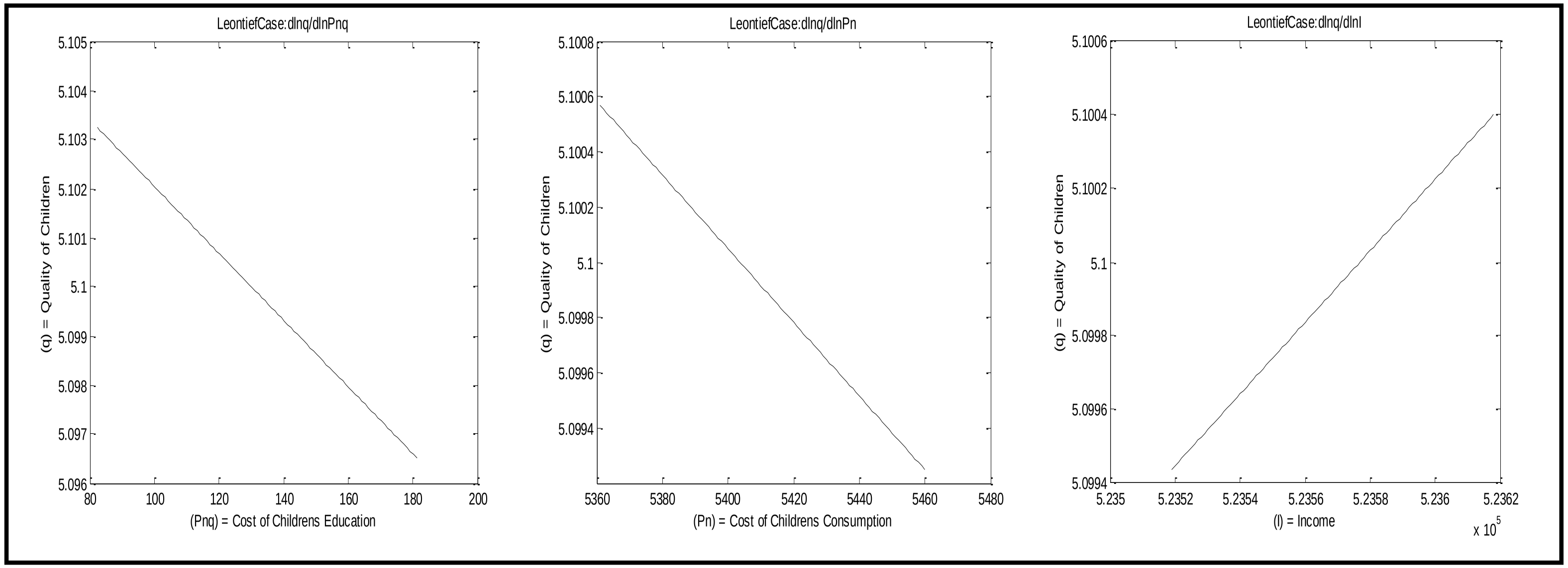




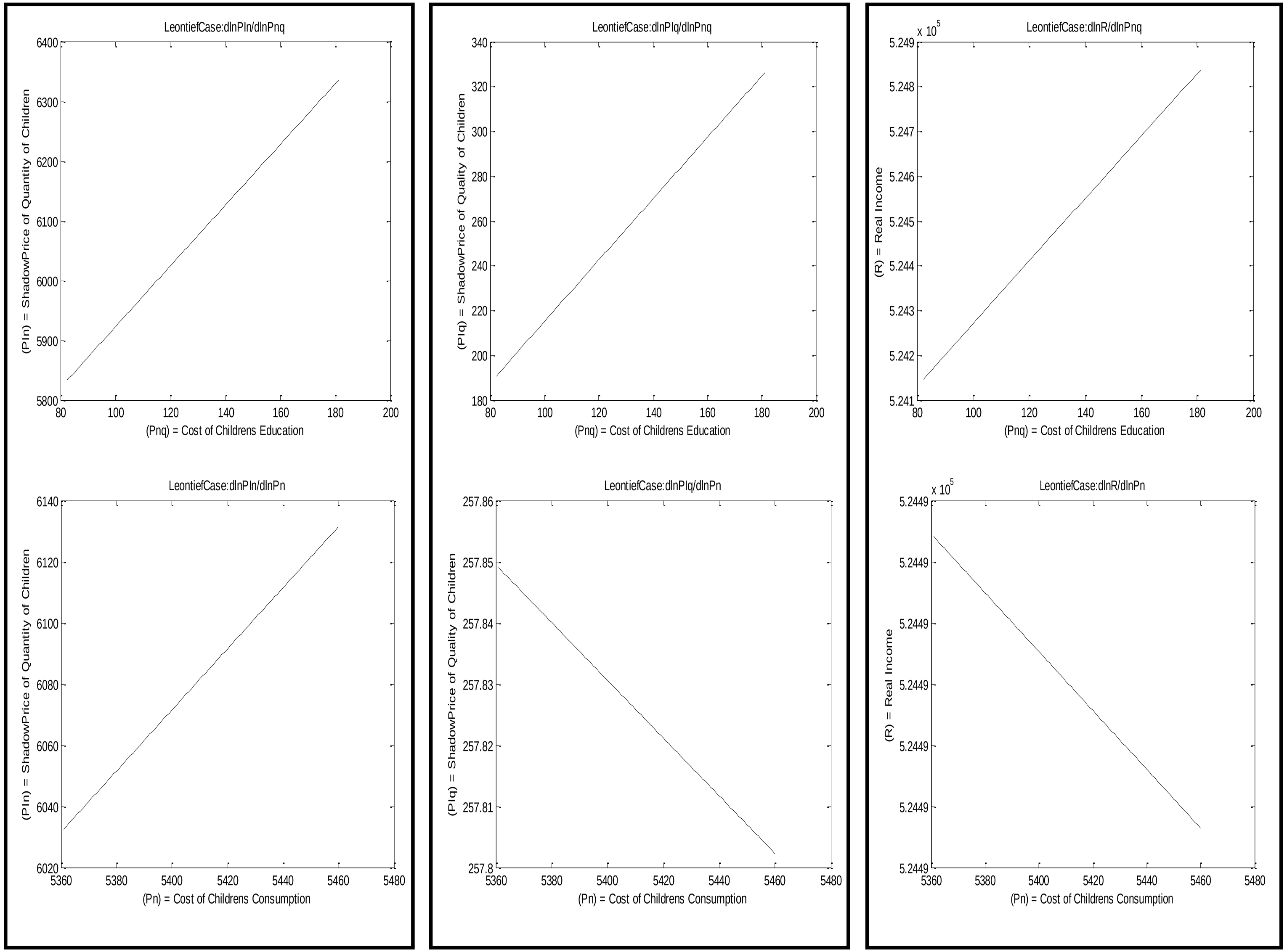


LEONTIEF CASE (β_n=0.000002662984014; β_q=0.000009905902166; β_y=1)

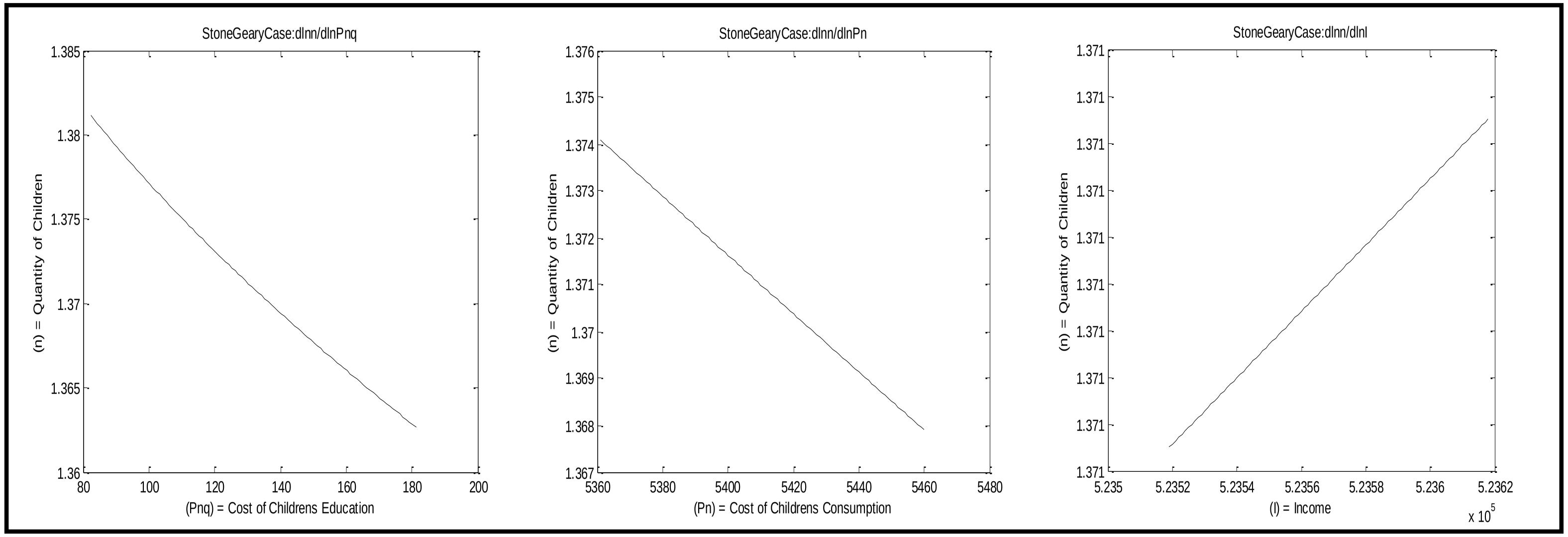


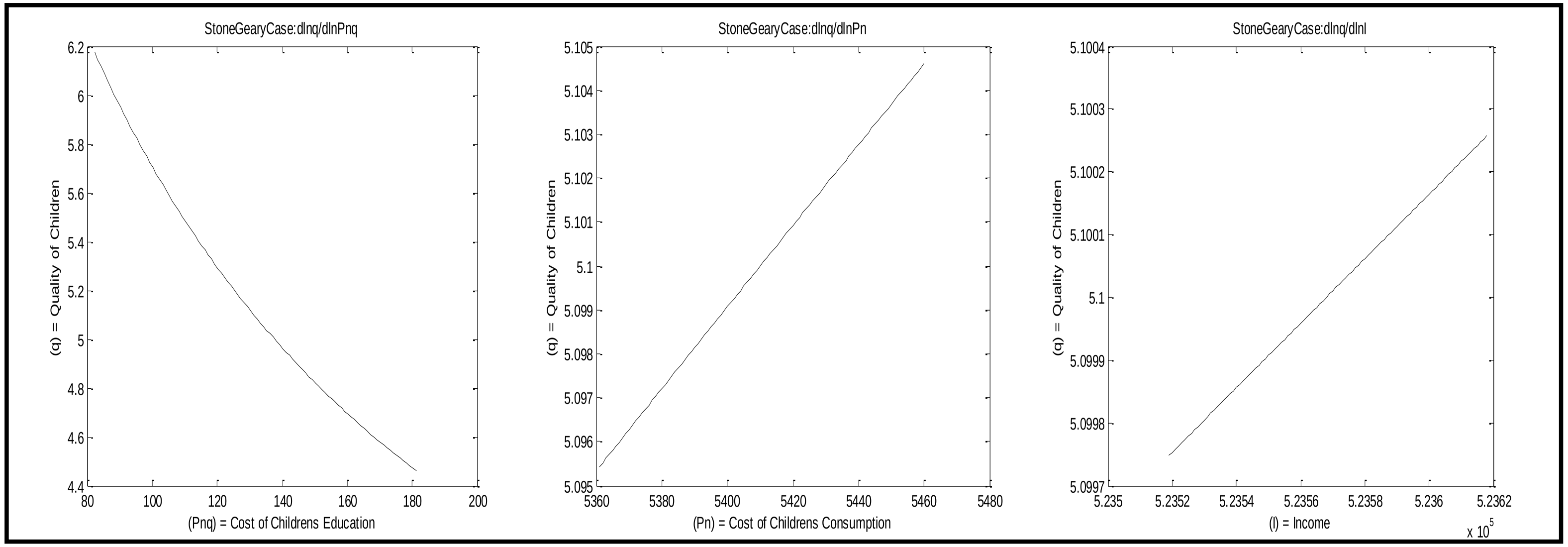


LEONTIEF CASE (β_n=0.000002662984014; β_q=0.000009905902166; β_y=1)

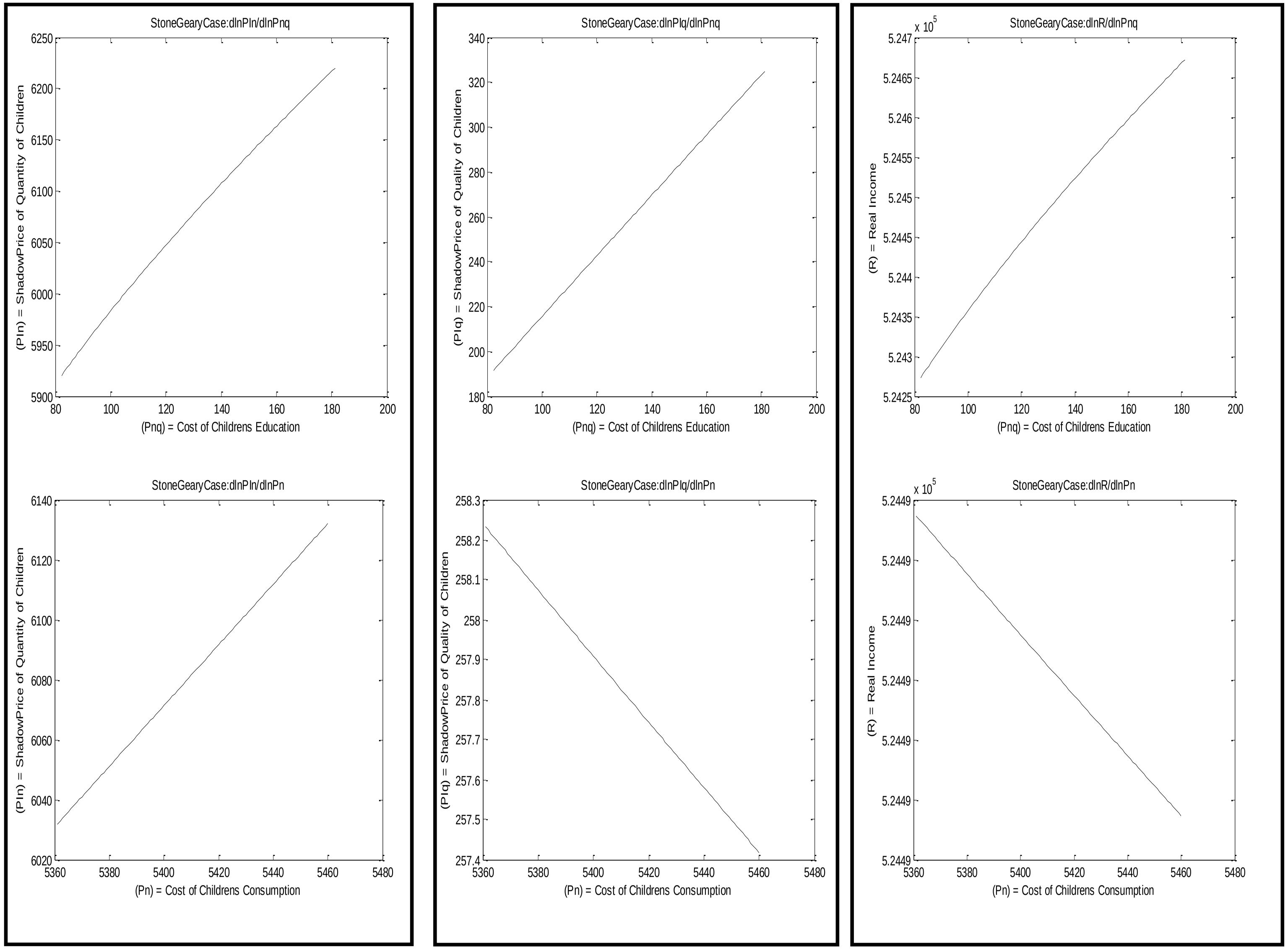


STONE GEARY CASE (β_n=0.004557875286; β_q=0.001614602234; β_y=0.993827565)





STONE GEARY CASE (β_n=0.004557875286; β_q=0.001614602234; β_y=0.993827565)



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Chapter 3

MODEL OF CHILDBEARING WITH 2-SIDED ALTRUISM: A CALIBRATION EXERCISE FOR DEVELOPING COUNTRIES

Abstract

The current paper incorporates child labor and old age security into the dynamic Quantity-Quality framework of fertility as revenue earned from children and lack of social safety nets for the elderly are important determinants of fertility behavior. The study extends earlier economic modeling to 3 time periods and 3 generations with bi-directional gifts and bequests and develops a OLG structural model with dynastic households to examine how intergenerational altruism affects the individual decision maker's choice of fertility and educational investment in their children. I calibrate the parameters to solve for the household decision variables after tracing the consumption, fertility, transfers to elderly, schooling and child labor behavior from 1967 to 2007 and conduct comparative statics exercises to test different policy implements like conditional cash transfers, mid-day meal schemes and fertility reduction subsidies. Empirical estimation results using incidence of child labor as well as old age dependency on monetary transfers from one's children suggest that increasing child quality may in the long run reduce the demand for quantity as income-earning potential and the probability of survival to adulthood for children increases, this in turn will offset the parent's propensity to have greater number of children to recompense for future uncertainty.

3.1 Introduction

With the global population exceeding the 7 billion mark; escalating pollution levels, natural resource depletion and degradation, rising food prices are all important issues but we need to tackle the root cause of the problem with ways to encourage smaller family sizes in countries with high fertility and unsustainable population expansion. Rapid population growth is a global issue but we must look for solutions locally since each developing country is unique with respect to its problems and policy needs. Once we identify the background factors that filter into the proximate determinants of fertility, we should be able to propose feasible and effective policy instruments which may potentially incentivize smaller family units and reduce the burden of high population. This will help developing countries to speed up the demographic transition and move to a sustainable fertility time-path and stable population growth rate.

Social, economic and institutional characteristics differ greatly between developing countries but we can identify some common factors that may cause high levels of childbearing and rapid population growth: prevalence of child labor leading to a higher demand for children as they contribute to family income; lack of awareness on birth control issues or lack of access to contraceptives; gender bias and preference for boys leading to multiple births until the desired number of boys is reached; and high mortality causing higher rates of fertility due to precautionary demand for children as insurance against future uncertainty. Reliance on one's offspring for contributing to household income via child labor earnings and expectation of financial support after retiring in the absence of social security are major motivations for greater child bearing; so policy reforms and interventions affecting fertility alone will be ineffective without provision of appropriate social safety nets. With this ideology in mind, the paper will attempt to investigate some feasible policy instruments that may trigger the Quantity-Quality (Q-Q) tradeoff in developing countries like India.

The paper is organized as follows: Section 3.2 describes the background and motivation; Section 3.3 provides an overview of the main research questions; Section 3.4 defines the methodology for the Dynamic model by constructing the theoretical framework; Section 3.5 illustrates the estimation strategy and Section 3.6 includes the empirical analyses; Section 3.7 explains the various policy experiments conducted; finally Sections 3.8, 3.9, 3.10 and 3.11 discuss the relevance of results with recommendations, conclusions, limiting concerns and future extensions. The detailed derivations for the optimization exercise and inter-generational timeline are provided in the Appendix.

3.2 Background & Motivation

By the Demographic Balancing Equation fertility, mortality and migration are the main components of population growth; since increasing mortality or promoting migration are unacceptable or impractical options, fertility reduction is the only available alternative and to motivate it we need government intervention. Fertility regulation to ensure population growth deceleration can potentially be brought about by improved communication with the general public to influence their demographic predispositions, provision of services to encourage desired behavior, using incentives or disincentives to regulate trends and tendencies, creating appropriate social institutions and opportunities or coercive action by administrative bodies. Given these broad mechanisms, this paper will analyze the tradeoff between child quality and quantity to counteract the causes of high population growth. Child wellbeing is determined by health and educational investments made in children. Theory and analysis suggest that higher quality level of children raises the value of each child hence parents are satisfied with fewer units of children.

The existing body of work in Q-Q models provides a good foundation to build upon. Becker & Barro (1988, 1989) re-examined determinants of fertility behavior in presence of inter-generational factors and two sided altruism and the concept of gifts and bequests is also well discussed in

Kimball (1987) and Abel (1987). Old age security is a major factor contributing to the reproductive behavior in less developed countries. Lack of inter-temporal capital markets forces parents to consider children as assets for transferring income to old age and studies recognize that if a parent is uncertain about own ability to be self-supporting in old age and lack a more reliable and effective source of support then default option is to rely on the offspring with the idea that more children will result in greater income. Children's economic contribution to household income also plays an important role in determining fertility. Labor force participation by children often is crucial for the household as wage earning helps to battle extreme poverty; so policies like child labor bans or compulsory school attendance are rarely effective as enforcement is problematic and the incentives may still remain to employ children in the local labor markets.

A lot of work is already in progress as per past literature and the dynamic Quantity-Quality model provides a very strong theoretical background to construct a more detailed and extended framework for examining a household's fertility behavior.

3.3 Research Question

The rationale behind the study is that childbearing in developing countries is determined by several socio-cultural components and they need to be better understood in order to identify feasible and effective policy instruments that may help to reduce high fertility and rapid population growth in developing countries. The main objective involves raising quality level of children in a family to offset the parent's propensity to have greater number of children as a way of recompensing for future uncertainty. Specifically how can the Quantity-Quality model of fertility be used in presence of child labor, lack of old age security and intergenerational transfers to incentivize smaller family sizes in developing countries with above replacement fertility rates?

3.4 Methodology

To motivate the intergenerational distributional analysis, I present an extension of the Becker & Barro (1988,1989) and Abel (1987) models where I incorporate a 3 period structure of childhood, young adulthood and old adulthood; allow for the possibility of child labor and include an additional feature of two sided altruism into the dynastic utility function. I assume that children may or may not work, young adults are definitely employed and old adults have retired from the labor market. This expands on the idea that parents improve child quality only for altruistic reasons since child labor can contribute to household income and better educated children may earn higher wages and potentially provide greater old age security.

Some additional restrictions are imposed on the model to make it more tractable. I abstract away from borrowing constraints but in reality households are credit constrained; the elderly have no savings and must depend entirely on transfers received from their offspring to survive;

old adults obtain the same amount from each child and so having greater number of children increases their total contribution which is the sole source of support; all young adult parents have a combination of altruism and selfishness towards their children and their parents; participating in the labor market detracts from a child's human capital accumulation; each adult has children without "marriage" as including men and women separately does not change the essence of the study; the single parent household makes all decisions at the start of young adulthood and has all children at one go hence bypassing the issue of spacing of births. Therefore each consumer lives for 3 periods, has (n) children and one parent and provides them with bequests and gifts respectively as reflected in the two-sided utility function.

3.4.1 OLG Structure

The time line of the overlapping generations is constructed for a less developed country keeping in mind the lower life expectancy, fewer years of compulsory education etc. The OLG design and demographic composition of the dynastic family can be expressed by separating out the old adult grandparents, young adult parents and children as per Figure 3.1 where:

Times: $T_0 = 0 \rightarrow$ Born; $T_1 = 18 \rightarrow$ Become young adult and start work; $T_2 = 20 \rightarrow$ Have children; $T_3 = 26 \rightarrow$ Children start school; $T_4 = 38 \rightarrow$ Children finish school; $T_5 = 60 \rightarrow$ Become old adult and retire from work; $T_6 = 65 \rightarrow$ Die.

Periods: $T_0 - T_1 \rightarrow$ Childhood; $T_1 - T_5 \rightarrow$ Young adulthood; $T_5 - T_6 \rightarrow$ Old adulthood.

This dynamic analysis of fertility and population change tries to integrate the Quantity-Quality tradeoff whereby reducing number of children in favor of increased investments in quality will raise a child's future earning potential who will then grow up with a better education, earn more and invest more in their own children and the chain reaction will bring the economy to replacement rate fertility and a stable population.

3.4.2 Theoretical Framework

I use a Buiter-Carmichael-Burbidge[7] Utility function which is additively separable in terms of own consumption, children's welfare and old adult parent's well-being; hence allowing the young adult parent or the dynastic head to make fertility decisions in the presence of altruism, child labor and old age security transfers and I then solve for the endogenous variable time-paths. The representative agent of generation (t) is an individual who was born and raised in period $(t-1)$ as a child, becomes a young adult in period (t) at the start of which she/he makes all decisions and finally becomes an old adult in period $(t+1)$.

In this 3 period model, a generation (t) young adult maximizes utility (U_t) which depends on own current period consumption utility (V_t) as well as that of his/her parents and all future

[7] This utility function truncates the backward tail as long dead ancestors are irrelevant to current consumption but retains concern for the utility of all descendants.

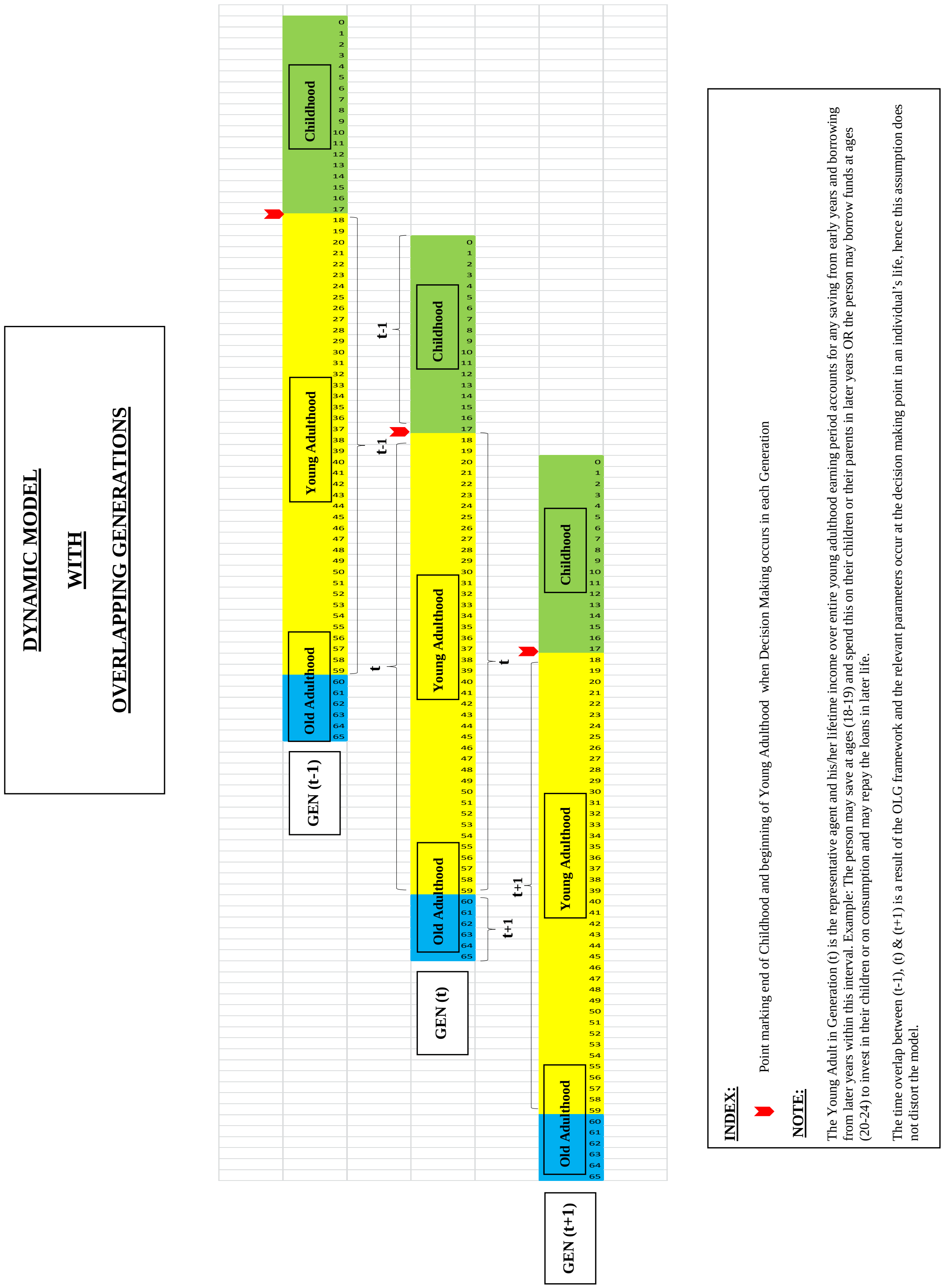

Figure 3.1: OLG Visualization for Dynamic model

descendants. An individual's welfare depends on their consumption at each stage of life but since expenses in their youth[8] for their food, shelter and clothing (C_{1t-1}) is held constant at (β) we can implicitly suppress the utility from childhood necessities. So the utility in generation (t) is a function of consumption (C_{2t}) as a young adult consumer in period (t); consumption ($C_{3t+1} = n_t g_{t+1}$) as an old adult consumer in period ($t+1$) which depends on the number of children (n_t) one chooses to have as young adult and the amount of transfer[9] (g_{t+1}) received from each child in old age, this is discounted at rate (θ); consumption of parents as part of benefit from parental old age security adds to own utility but is discounted by the degree of altruism towards the past generation (ϕ); and finally consumption of children which is inversely proportional to the number of offspring at the rate (ε) and is discounted at the degree of altruism towards future generations (α).

$$U_t = f(V_t, U_{t-1}, U_{t+1}) \Rightarrow U_t = f(V_t, f(V_{t-1}, U_{t-2}, U_t), U_{t+1}) \Rightarrow U_t = f(V_t, V_{t-1}, U_{t+1})$$

As people do not care about the deceased, we can eliminate terms relevant for the grandparents (U_{t-2}) of generation (t) young adult and also drop (U_t) since it appears on the left. Further parental utility increases at a diminishing rate in the number of children with altruism towards children taking a constant elasticity form $a(n_t) = \alpha(n_t)^{-\varepsilon}; 0 < \alpha < 1; 0 < \varepsilon < 1$. Hence the resulting utility can be expressed as a simpler function:

$$U_t = V_t(C_{1t-1}, C_{2t}, C_{3t+1}) + \phi V_{t-1}(C_{1t-2}, C_{2t-1}, C_{3t}) + \sum_{i=1}^{n_t} \psi_i(U_{t+1}, n_t)$$

where $V_t(C_{1t-1}, C_{2t}, C_{3t+1}) = V_t(\beta, C_{2t}, C_{3t+1}) = V_t(C_{2t}, C_{3t+1}) = V_t(C_{2t}) + \theta V_t(C_{3t+1})$ and $\psi_i(U_{t+1}, n_t) = a(n_t)U_{t+1} = \alpha(n_t)^{-\varepsilon}U_{t+1}$.

Setting the total time devoted to adult labor (L) and normalizing it to unity, the fraction of time devoted to child labor can be estimated as ($l_t \epsilon [0, 1]$). There is a bequest of non-depreciable capital i.e. investment in education to raise future earnings that a young adult parent may have inherited (k_{t-1}) or may endow their own offspring with (k_t). I further assume that child labor detracts from their young adult human capital (h_{t-1}) accumulation at the rate (γ) and this affects their adult earnings.

$$h_{t-1} = f(\underset{(+)}{\beta}, \underset{(-)}{l_{t-1}}, \underset{(+)}{k_{t-1}}) \backsimeq f(l_{t-1}, k_{t-1}) = (1 - l_{t-1})^{\gamma} k_{t-1}$$

With (R_t) as the gross rate of return on savings or capital from period ($t-1$) to (t) and a certain minimum wage (e) that is earnings independent of skill level, the young adults of generation (t) can allow their own children to participate in the child labor market to earn the child wage rate

[8] Parents bear the entire cost of raising each child into young adulthood.

[9] All children contribute the same amount to their parents so the transfer g_t is same for all siblings and this is analogous to a simultaneous move Cournot game where each player chooses their own contribution without knowledge of the other players choices.

(w_t^c) and they themselves face an adult wage rate (w_t^A) which is contingent on the rate of return to human capital.

$w_t^A = e + (1 + R_t)h_{t-1} = e + (1 + R_t)(1 - l_{t-1})^\gamma k_{t-1}$

This filters into the expanded form of the budget constraint which includes consumption costs, expenditure on bequests to children and gifts to parents; this must be repeated for every future generation and is cumulative over the growing stream of descendants.

$C_{2t} + n_t\beta + g_t + n_tk_t = w_t^A + n_tw_t^cl_t \Rightarrow C_{2t} + n_t\beta + g_t + n_tk_t = e + (1 + R_t)(1 - l_{t-1})^\gamma k_{t-1} + n_tw_t^cl_t$

3.4.3 Dynamic Model Specification

The infinite horizon optimization exercise for the dynamic model can be set up as:

$$\max_{C_{2t},g_t,l_t,k_t,n_t} U_t = V_t(C_{2t}) + \theta V_t(n_tg_{t+1}) + \phi[V_{t-1}(C_{2t-1}) + \theta V_{t-1}(n_{t-1}g_t)]$$

$$+\sum_{i=0}^{\infty} \alpha^{i+1}[\prod_{j=0}^{i}(n_{t+j})^{1-\varepsilon}][V_{t+i+1}(C_{2t+i+1}) + \theta V_{t+i+1}(n_{t+i+1}g_{t+i+2})]$$

$$+\phi\sum_{i=0}^{\infty} \alpha^{i+1}[\prod_{j=0}^{i}(n_{t+j})^{1-\varepsilon}][V_{t+i}(C_{2t+i}) + \theta V_{t+i}(n_{t+i}g_{t+i+1})]$$

subject to

$$Gen(t) : C_{2t} + n_t\beta + g_t + n_tk_t = e + (1 + R_t)(1 - l_{t-1})^\gamma k_{t-1} + n_tw_t^cl_t$$

$$Gen(t+1) : n_t[C_{2t+1} + n_{t+1}\beta + g_{t+1} + n_{t+1}k_{t+1}] = n_t[e + (1 + R_{t+1})(1 - l_t)^\gamma k_t + n_{t+1}w_{t+1}^cl_{t+1}]$$

$$Gen(t+2) : n_tn_{t+1}[C_{2t+2}+n_{t+2}\beta+g_{t+2}+n_{t+2}k_{t+2}] = n_tn_{t+1}[e+(1+R_{t+2})(1-l_{t+1})^\gamma k_{t+1}+n_{t+2}w_{t+2}^cl_{t+2}]$$

$$Gen(t+3) : n_tn_{t+1}n_{t+2}[\ldots\ldots\ldots] = n_tn_{t+1}n_{t+2}[\ldots\ldots\ldots]$$

$$\vdots$$

$$t \rightarrow \infty$$

where

- $n_{t-1}g_t = g_t + (n_{t-1} - 1)\bar{g}_t^{siblings}$
- $C_{1t} = \beta$
- $C_{3t} = n_{t-1}g_t$
- $w_t^A = e + (1 + R_t)h_{t-1}$
- $h_{t-1} = (1 - l_{t-1})^{\gamma} k_{t-1}$; $0 \leq \gamma \leq 1$;$0 \leq l_{t-1} \leq 1$

Solving the model yields the first order conditions from which we can deduce the arbitrage equations of cost and benefits in marginal utility for the representative generation (t) .

3.5 Estimation Strategy

To get closed form solutions for endogenous variables, I estimate a simpler version of the overlapping generation model by imposing further restrictions. I assume decision making young adult cares only for utilities that are realized within their lifetime and directly affected by their choices, i.e. own utility as a young and old adult, utility of own parents as old adults and utility of one's children as young adults. The elasticity of utility with respect to consumption is assumed constant with $V_t(C_t) = \frac{1}{\sigma}C_t^{\sigma}$ where (σ)[10] is same for a young and an old adult across time periods and generations.

3.5.1 Simpler Version of Dynamic Model

The Dynamic Model can be simplified for numerical estimation as:

$$\max_{C_{2t}, g_t, l_t, k_t, n_t} U_t = V_t(C_{2t}) + \theta V_t(C_{3t+1}) + \phi V_{t-1}(C_{3t}) + \alpha(n_t)^{1-\varepsilon} V_{t+1}(C_{2t+1})$$

$$= \frac{1}{\sigma}(C_{2t})^{\sigma} + \theta\frac{1}{\sigma}(n_t g_{t+1})^{\sigma} + \phi\frac{1}{\sigma}(n_{t-1}g_t)^{\sigma} + \alpha(n_t)^{1-\varepsilon}\frac{1}{\sigma}(C_{2t+1})^{\sigma}$$

subject to

$$C_{2t} + n_t\beta + g_t + n_t k_t = e + (1 + R_t)(1 - l_{t-1})^{\gamma} k_{t-1} + n_t w_t^c l_t$$

$$n_t[C_{2t+1} + n_{t+1}\beta + g_{t+1} + n_{t+1}k_{t+1}] = n_t[e + (1 + R_{t+1})(1 - l_t)^{\gamma} k_t + n_{t+1} w_{t+1}^c l_{t+1}]$$

[10] $\sigma = \frac{V_t'(C_t)}{V_t(C_t)}C_t$ can be interpreted as the inter-temporal elasticity of substitution with respect to consumption.

3.5.2 Analytical Solutions

After truncating the OLG model and excluding distant future generations, the first order conditions[11] solved from the Lagrangian of the simplified model yields a system of 7 equations in 7 unknowns. The endogenous variables can be solved by assigning parameter values to the 19 exogenous variables under the assumption that the young adult is the only decision making agent in the whole structure.

7 unknowns: C_{2t}, g_t, l_t, k_t, n_t, λ_t, λ_{t+1}

7 equations:

- $C_{2t} = \frac{(1-l_{t-1})^{\gamma}(1+R_t)[e+(1+R_{t-1})(1-l_{t-2})^{\gamma}k_{t-2}-C_{2t-1}-g_{t-1}]}{[\theta\phi^{\sigma/1-\sigma}+(\alpha/\sigma)(1-\varepsilon)n_{t-1}^{1-\varepsilon}]}$
- $g_t = \frac{(1-l_{t-1})^{\gamma}(1+R_t)[e+(1+R_{t-1})(1-l_{t-2})^{\gamma}k_{t-2}-C_{2t-1}-g_{t-1}]}{\phi^{1/1-\sigma}n_{t-1}[\theta\phi^{\sigma/1-\sigma}+(\alpha/\sigma)(1-\varepsilon)n_{t-1}^{1-\varepsilon}]}$
- $\lambda_t = \left[\frac{(1-l_{t-1})^{\gamma}(1+R_t)[e+(1+R_{t-1})(1-l_{t-2})^{\gamma}k_{t-2}-C_{2t-1}-g_{t-1}]}{[\theta\phi^{\sigma/1-\sigma}+(\alpha/\sigma)(1-\varepsilon)n_{t-1}^{1-\varepsilon}]}\right]^{\sigma-1}$
- $\lambda_{t+1} = \left[\frac{(1-l_t)^{\gamma}(1+R_{t+1})[e+(1+R_t)(1-l_{t-1})^{\gamma}k_{t-1}-C_{2t}-g_t]}{[\theta\phi^{\sigma/1-\sigma}+(\alpha/\sigma)(1-\varepsilon)n_{t-1}^{1-\varepsilon}]}\right]^{\sigma-1}$
- $l_t = 1 - \frac{1}{(1+R_{t+1})^{1/\gamma}}\left\{\frac{[\theta\phi^{\sigma/1-\sigma}+(\alpha/\sigma)(1-\varepsilon)n_t^{1-\varepsilon}]}{[\theta\phi^{\sigma/1-\sigma}+(\alpha/\sigma)(1-\varepsilon)n_{t-1}^{1-\varepsilon}]}\right\}^{\sigma-1/\sigma\gamma}$

$$* \left\{\frac{(1-l_{t-1})^{\gamma}(1+R_t)[e+(1+R_{t-1})(1-l_{t-2})^{\gamma}k_{t-2}-C_{2t-1}-g_{t-1}]}{\left[e+(1+R_t)(1-l_{t-1})^{\gamma}k_{t-1}-(1+\frac{1}{\phi^{1/\sigma-1}n_{t-1}})(1-l_{t-1})^{\gamma}(1+R_t)\left[\frac{e+(1+R_{t-1})(1-l_{t-2})^{\gamma}k_{t-2}-C_{2t-1}-g_{t-1}}{\theta\phi^{\sigma/1-\sigma}+(\alpha/\sigma)(1-\varepsilon)n_{t-1}^{1-\varepsilon}}\right]\right]}\right\}^{\sigma-1/\sigma\gamma}$$

- $k_t = \frac{w_t^c(1-l_t)}{\gamma}$
- $e+(1+R_t)(1-l_{t-1})^{\gamma}k_{t-1}-(1+\frac{1}{\phi^{1/\sigma-1}n_{t-1}})\left[\frac{(1-l_{t-1})^{\gamma}(1+R_t)[e+(1+R_{t-1})(1-l_{t-2})^{\gamma}k_{t-2}-C_{2t-1}-g_{t-1}]}{[\theta\phi^{\sigma/1-\sigma}+(\alpha/\sigma)(1-\varepsilon)n_{t-1}^{1-\varepsilon}]}\right]$

$$= n_t\beta - \frac{w_t^c n_t}{\gamma} + (1+\frac{1}{\gamma})\frac{w_t^c n_t}{(1+R_{t+1})^{1/\gamma}}\left\{\frac{[\theta\phi^{\sigma/1-\sigma}+(\alpha/\sigma)(1-\varepsilon)n_t^{1-\varepsilon}]}{[\theta\phi^{\sigma/1-\sigma}+(\alpha/\sigma)(1-\varepsilon)n_{t-1}^{1-\varepsilon}]}\right\}^{\sigma-1/\sigma\gamma}$$

$$* \left\{\frac{(1-l_{t-1})^{\gamma}(1+R_t)[e+(1+R_{t-1})(1-l_{t-2})^{\gamma}k_{t-2}-C_{2t-1}-g_{t-1}]}{\left[e+(1+R_t)(1-l_{t-1})^{\gamma}k_{t-1}-(1+\frac{1}{\phi^{1/\sigma-1}n_{t-1}})(1-l_{t-1})^{\gamma}(1+R_t)\left[\frac{e+(1+R_{t-1})(1-l_{t-2})^{\gamma}k_{t-2}-C_{2t-1}-g_{t-1}}{\theta\phi^{\sigma/1-\sigma}+(\alpha/\sigma)(1-\varepsilon)n_{t-1}^{1-\varepsilon}}\right]\right]}\right\}^{\sigma-1/\sigma\gamma}$$

19 parameters: C_{2t-1}, g_{t-1}, l_{t-1}, l_{t-2}, k_{t-1}, k_{t-2}, R_{t-1}, R_t, R_{t+1}, n_{t-1}, w_t^c, e, β, θ, α, γ, ϕ, ε, σ

The analytical solutions depict how decisions regarding consumption, elderly transfers, child labor, educational investment and fertility are made by the young adult. However it is impossible to calculate the magnitudes of the 7 choice variables unless values of all 19 exogenous parameters are known; for this I must ascertain the behavioral indicators like altruism, elasticity etc. by calibrating the model.

[11] 7 F.O.C. listed in Appendix I.

3.6 Empirical Analysis

The numerical analysis and resulting arguments are applicable for any developing country with intergenerational transfers in the presence of above replacement fertility rates but the models are specifically tested for India. The variables employed in this study are mainly demographic variables like fertility; adult and child consumption; educational parameters and human capital investment; along with employment hours and wage rates; income measures and market interest rates for discounting. The young adult makes all decisions for the household at the start of the current period so the choices are relevant for time period (t) and these are the unknowns that the model solves for while all variables from the earlier periods $(t-2)$ and $(t-1)$ are known.

3.6.1 Data

The primary data source is the National Sample Survey Organization's 43rd to 64th Round of Household Consumer Expenditure in India (1986-2008) and the World Bank database on national level development indicators for India (1961-2010); supporting material is also collected from IPEC Report by International Labor Organization (2007); releases and bulletins by the GOI, Ministry of Labor and Employment; GOI, Central Statistics Office and Ministry of Statistics and Programme Implementation.

The results of the study are confined by the data limitations in the calibration strategy; since estimates are required for 3 generations over 3 time periods they are being substituted by indicators from 1967 to 2007[12]. The OLG model by definition has overlaps between generations so the active time-periods for each generation are not mutually exclusive. Representing the length of each generation as 20 years, I set $(t-2) = 1967$, $(t-1) = 1987$ and $(t) = 2007$.

3.6.2 Calibration of Parameters

In order to solve for the endogenous decision variables in period (t) for the dynamic Q-Q model, all the model parameters (C_{2t-1}, g_{t-1}, l_{t-2}, l_{t-1}, k_{t-2}, k_{t-1}, R_{t-1}, R_t, R_{t+1}, n_{t-1}, w_t^c, e, β, θ, α, γ, ϕ, ε, σ) must be known from previous $(t-2)$ and $(t-1)$ periods.. Most of these parameters can be calculated from the available data but certain preferential attributes like parental altruism are more difficult to pin down and need to be calibrated. All cumulative values of consumption costs, educational expenses and wage rates are discounted using the market real interest rate of 6.87% for the year 2007 as per the time line described earlier; the entire model uses this as a proxy for social rate of time preference to get consistent discounted present values. Further since all young adults make their decisions at the start of adulthood, so discounting begins from age 18 and corresponding time-periods can be computed for all future life events.

The lagged variables from past time periods can be estimated from household and national level datasets. The fertility parameter represents the expected number of children over a person's

[12]Detailed timeline depicted in Appendix II.

lifetime and is set at half the TFR as each individual is assumed to be part of a couple within the dynamic model with dynastic utility. The average number of children (n_{t-1}) born to a young adult parent at the start of their adulthood is set at half the TFR for 1987. The rates of return on investments in human capital (R_{t-1}, R_t, R_{t+1}) is fixed at the real interest rate adjusted for inflation as measured by the GDP deflator. To arrive at a measure of child labor ($0 \leq l_{t-2} = l_{t-1} \leq 1$) which defines the fraction of time in childhood spent working, I normalize 8 hours of work per day as unity out of the total available 24 hours and approximate the incidence using the participation rate in market work by children of ages 5-14 years for 1986-87.

The total consumption expenditure of a household is distributed among the individual members using adult equivalent weights which estimates the fraction of consumption allocated for children, young adults or old adults. The cumulative consumption expenditure (C_{2t-1}) of a young adult from age 18-60 years is constructed using the present value for 1987. The cost of basic consumption necessities (food, clothing, shelter) for a child is aggregated from birth to start of adulthood for ages 0-18 years when the parent is between 20-38 years and is assumed to be the same across generations ($C_{1t} = C_{1t-1} = C_{1t+1} = \beta$). The contribution by a young adult towards the consumption expenses of an old adult ($g_{t-1} = \frac{C_{3t-1}}{n_{t-2}}$) is equated to the discounted amount of transfers from 1987 when the old adult is aged 60-65 corresponding to the young adult's age of 40-45. For investment in child's education (k_{t-2}, k_{t-1}) between 6-18 years to raise their future earnings when they become young adults, the relevant parental age is 26-38 and it is measured by the household expenditure on schooling, books, stationary etc. for 1967 and 1987. (w_t^c) refers to the child wage rate of 2007 which yields total discounted income from employing a child full time in regular contract employment status at the labor market over entire childhood as the child remains part of the parents household till age 18. Lifetime earnings (e) that are independent of human capital for the young adult spanning over ages 18-60 is calculated using minimum wage rates for years 1987 and 2008 and averaged to get the present value. Table 3.1 shows the parameters and variables that can be derived directly from the data.

Derivation of Lagged Variables (*from data*)			
Young Adult Consumption	C_{2t-1}		
	36073.946		
Old Adult Consumption	g_{t-1}		
	832.7792		
Fertility	n_{t-1}		
	2.071		
Child Labor	l_{t-2}	l_{t-1}	
	0.1406	0.1406	
Child Expenses	k_{t-2}	k_{t-1}	β
	878.6377	1144.133	11965.55
Rate of Interest	R_{t-1}	R_t	R_{t+1}
	0.065601	0.068691	0.071926
Wages	e	w_t^c	
	143457.1406	31355.30667	

Table 3.1: Exogenous parameters estimated from data

For the behavioral indicators, the elasticity (σ) showing how utility responds to variation in consumption is assumed to be 0.5 and (γ) or the fraction showing how time spent away from child labor enhances investment in human capital can be solved from the first order conditions at 0.5. Parameters for elasticity with respect to the number of children (ε) by young adult parents, degree of altruism towards children (α), degree of altruism towards elderly (ϕ) and the premium value (θ) put on own old age consumption by a young adult are more difficult to quantify as there is no standard way to measure these preferential factors for a representative household.

In order to specify the remaining parameters, I calibrate the model via back calculation. For this exercise, I consider the parameters $(\varepsilon, \theta, \alpha, \phi)$ to be unknown and assign year 2007 values to the actual endogenous variables of time period (t). The average number of children born to a young adult parent is set at half the TFR for 2007 ($n_t = 1.371$) while the present value of consumption expenditure of a young adult is discounted over the intervening 42 years using the adult equivalent measure for the household ($C_{2t} = 70778.583$). The discounted contribution to elderly consumption is constructed using 2002 levels as proxy ($g_t = 2279.598$) and the remaining unknown of investment in child's education is evaluated at the rural-urban average for 2006-07 estimate ($k_t = 4674.6646$). With these variables in place, the system of 7 simultaneous equations listed in Section 2.6.2 can be solved for the 7 unknowns (ε, θ, α, ϕ, l_t, λ_t, λ_{t+1}).

Model Parameterization Results		
Parameters	Notation	Values
Premium rate for own old age consumption	θ	0.8772
Rate of human capital accumulation	γ	0.5
Degree of altruism towards children	α	0.4881
Degree of altruism towards elderly parents	ϕ	0.124
Elasticity of number of children	ε	0.2419
Elasticity of consumption	σ	0.5

Table 3.2: Results of parameter estimation

Table 3.2 above shows one combination of parameters that reflect the household decision makers choices but the same exercise can be repeated for other variations in preferences. Selection of these parameters can be conducted as either a grid search process or via an iterative process; I use the former method as the latter is unable to narrow down the parameters sufficiently to replicate reality while the trial and error technique can be used to adjust the model so the time (t) solutions represents 2007 realized data hence allowing replication for predicting future values at ($t + 1$). Examining the parameters shows that they do follow the inequality of ($\theta > \alpha > \phi$) whereby young adult decision makers care more about their own old age consumption than about the well being of their offspring or their elderly parents. Altering the preferential parameters may lead to very different outcomes so the same model can be applied to solve for household behavioral choices under various circumstances.

3.6.3 Numerical Solutions

The simultaneous equation system can be solved to identify decision making rules for the households, this computation of equilibrium can either be consistent with a transitional approach or for a stationary steady state. Given that India is on the demographic transition trajectory from high fertility and low human capital towards a state of low fertility and high human capital, the dynamic OLG is gauging evolution of household choices over time so the transition equilibriums provide a more accurate image of society. The variables represented in this setup are: consumption expenditure of young adults (C_{2t-1}, C_{2t}), contribution towards parent's or old adult's welfare (g_{t-1}, g_t), fraction of childhood spent in child labor (l_{t-2}, l_{t-1}, l_t), educational investments by young adult parents in their children to raise their future earning potential (k_{t-2}, k_{t-1}, k_t), rate of return on investments in human capital over time (R_{t-1}, R_t, R_{t+1}), number of children born to young adults of a particular time period (n_{t-1}, n_t), child wage rate (w_t^c), minimum earnings of a young adult independent of human capital (e), basic consumption cost for children (β), elasticity of altruism towards children as number of children increase (ε), young adult parent's degree of altruism towards children (α), young adult's degree of altruism towards old adult parents (ϕ), degree of discounting own old age consumption by young adult (θ), elasticity of consumption in own utility (σ) and fractional share of loss from participation in child labor (γ). I use discounted present values of all cumulative prices and quantities using the average market interest rate as per the years under consideration.

After calculating and estimating the values of the 19 exogenous parameters (C_{2t-1}, g_{t-1}, l_{t-2}, l_{t-1}, k_{t-2}, k_{t-1}, R_{t-1}, R_t, R_{t+1}, n_{t-1}, w_t^c, e, β, θ, α, γ, ϕ, ε, σ), I select suitable starting amounts and assign them to the choice variables and Lagrange multipliers ($C_{2t}, g_t, l_t, k_t, n_t, \lambda_t, \lambda_{t+1}$) to determine convergent solutions for the endogenous decision variables as recorded in Table 3.3.

Household Decision Results		
Variables	Notation	Values
Current Young Adult Consumption Expenditure	$\mathbf{C_{2t}}$	70337
Contribution to Old Adult's Consumption Expenditure	$\mathbf{g_t}$	2239.8
Fraction of Time spent in Child Labor	$\mathbf{l_t}$	0.2372
Cumulative Investment in Child Education	$\mathbf{k_t}$	4783.3
Fertility Choice (TFR/2)	$\mathbf{n_t}$	1.3754

Table 3.3: Computation of household decision making equilibrium from the Dynamic Q-Q model

The discounted current period consumption for young adults is at Rs. 70337 and the contribution towards elderly transfers equals Rs. 2239.80 and both are similar to the values realized in the Indian economy in 2007. The model shows that investment in education of Rs. 4783.30 is slightly greater than what was realized but this may be accounted for by the large income inequality so that poverty level households react differently from the average income households towards children's human capital accumulation choices. The two most interesting results are that child labor incidence is at 0.2372 which is quite high while the average number of children each person has is 1.3754 making the total fertility rate to be 2.7508; this verifies that greater incidence of child labor is correlated with above replacement fertility behavior for the representative household.

3.6.4 Implication of Findings

The Lagrange multipliers signify the change in the optimal value of the objective function due to the relaxation of a given constraint and is often referred to as the shadow price. For instance, the partial of the Lagrangian with respect to (l_t) can be interpreted as follows: $\lambda_t w_t^c$ symbolizes the marginal benefit from making children work an additional unit while $\lambda_{t+1}(1+R_{t+1})\gamma k_t$ is the cost of investing an extra unit of money on the child which will yield future returns.

Every decision making young adult must make allocation decisions between own current consumption and own future consumption as well as make a choice between one's own consumption and that of one's children. The results will help breakdown the discount rate[13] for intergenerational transfers $(-\frac{\partial C_{2t+1}}{\partial C_{2t}})$ versus the within generation transfer $(-\frac{\partial C_{3t+1}}{\partial C_{2t}})$. From the first order condition in (l_t), it is evident that in the absence of child labor $(l_t = 0)$ the intergenerational discount rate equals the market discount rate $(\frac{\lambda_{t+1}}{\lambda_t} = \frac{1}{(1+R_{t+1})})$ but for existence of child labor $(l_t > 0)$ in the system the intergenerational discount rate exceeds the market rate of interest $(\frac{\lambda_{t+1}}{\lambda_t} < \frac{1}{(1+R_{t+1})} \Rightarrow \frac{\lambda_t}{\lambda_{t+1}} - 1 > R_{t+1})$. Replacing the solution for the Lagrange multipliers shows that the inequality[14] holds and verifies the presence of child labor in the system; however the difference is not too large indicating that there may be other motivations for the incidence of underage labor force activity.

Usually existence of child labor is accounted for by the fact that people discount the future more and prioritize the revenue earned today but in my setup it is not child labor which is guiding the intergenerational transfer rates but rather poverty and survival needs that is driving child labor and discount rates. Hence parents send the children to work in order to meet subsistence requirements in this credit constrained environment and give lower importance to the child's subsequent earning potential in the future.

3.7 Policy Experiments

A range of different scenarios can be tested including changing the child wage rates, affecting the adult wage rates, altering the rate of return to investments in human capital or perhaps changing the various altruism and elasticity parameters; each of these would result in different levels of fertility, consumption, education and employment so they can be used to analyze the impact of policy instruments in comparison to the baseline outcomes. Presently, I use the model to analyze

[13] $\frac{\partial C_{2t+1}}{\partial C_{2t}} = (\frac{\lambda_{t+1}}{\lambda_t})^{1/\sigma - 1} = 0.9025$ and $\frac{\partial C_{3t+1}}{\partial C_{2t}} = (\frac{\lambda_{t+1}}{\phi \lambda_t})^{1/\sigma - 1} = 0.0138$.

[14] $\left\{\frac{\lambda_{t+1}}{\lambda_t} = 0.923076\right\} < \left\{\frac{1}{(1+R_{t+1})} = 0.9329002\right\} \Rightarrow \left\{\frac{\lambda_t}{\lambda_{t+1}} - 1 = 0.083333\right\} > \{R_{t+1} = 0.071926\}$

how introduction of a fertility reducing subsidy, variation in conditional cash transfer amounts and provision of mid-day meals at schools could affect the household's decision regarding the number of children and the educational investment made in children; each of these interventions affect the budget constraint for the household and filter into the decision making process. The baseline values are set at the solutions to the dynamic model with ($C_{2t} = 70337, g_t = 2239.8, l_t = 0.2372, k_t = 4783.3, n_t = 1.3754$). The following exercises are just a few examples to show how the decision rules of the households will react to policy reforms.

3.7.1 Fertility Reduction Subsidy

Currently the average number of children born to a young adult is 1.3754 which yields a TFR of 2.7508 and this is greater than the replacement fertility rate of 2.1. Now since each young adult parent represents half of a couple, the fertility is represented by halving the total fertility rate. The model incorporates the fact that the initial fertility level (n_0) is above replacement and a subsidy (s) is implemented with the aim to reduce child bearing to the target level (n_t) which is at replacement of 1.05. This implies that if a family reduces their child bearing, they receive a financial reward and this leads to a reduction in births as $n_t < n_0$. The net effect of a one time subsidy on the budget constraint is as follows:

$$C_{2t} + n_t\beta + g_t + n_t k_t = e + (1 + R_t)(1 - l_{t-1})^{\gamma} k_{t-1} + n_t w_t^c l_t + s(n_0 - n_t)$$

I allow the household to still choose for their fertility level endogenously but the government or administrative agency is expected to select that subsidy level which will induce the young adult to respond favorably and the system should arrive at replacement fertility. This can be interpreted as a two stage game where in the first step the policy maker chooses the level of subsidy and the next step is where households make their decisions about consumptions, transfers, investment in education and child bearing. The set of choice variables for the household remains unchanged at ($C_{2t}, g_t, l_t, k_t, n_t, \lambda_t, \lambda_{t+1}$) but the government must solve the game by backward induction in order to anticipate how the public will react to the policy measure so they must infer the values of ($C_{2t}, g_t, l_t, k_t, s, \lambda_t, \lambda_{t+1}$). The optimization exercise is repeated to solve the new set of first order conditions for the appropriate level of subsidy and yields $s = 39250$.

This means that each family will require a monetary transfer of Rs. 39250 to bring about the decline in child bearing $n_0 - n_t = 1.3754 - 1.05 = 0.3254$ which is approximately a 30% reduction in fertility per person. Now by unitary method, a 50% reduction in fertility would entail a subsidy amount of about Rs. 65416.66.[15] If each person reduces fertility by half then the couple together lower their child bearing by one so this shows the economic subsidy required is Rs. 1.3 lakhs for each unit of fertility they forgo as compared to the base level behavior. The parents face a loss when they choose to have fewer children so the marginal cost for a couple not having an additional child must include the value derived from existence of one's progeny, an assessment of expected support from elderly transfers that are now forgone as well as equivalent

[15] Subsidy for 50% reduction of fertility = $\frac{39250 \times 0.5}{0.3} = 65416.66$.

value of the income from child labor that is sacrificed; all these components must be balanced out by the marginal benefit which provides an estimate for net worth of a child. Hence while the amount may be justified to be a realistic valuation of the payoff needed to reduce fertility, in practical terms the subsidy scheme may be prohibitively costly to implement in order to manage high fertility behavior.

Another concern that arises is the timing of the subsidy payment made to the young adult parent or decision maker. My model requires all choices and monetary allocations to be made at the start of young adulthood for each generation but in reality individuals make decisions continuously over time. The subsidy payment in the dynamic framework occurs at the start of the planning horizon so the budget constraint is reorganized prior to optimal decision making but it may lead to a moral hazard problem as people have no incentive to comply to the fertility limitations once they receive their subsidy. One option could be delayed payment with the assurance that young adult parents will receive their subsidy income via an escrow account or a bond that matures after the end of their reproductive careers; this could act as a collateral so they incur losses if they renege on the previously agreed upon contract. The current case explores a one shot instrument but the policy can be extended over multiple periods to consider the effects of an indefinite fertility reduction subsidy on future fertility outcomes.

3.7.2 Conditional Cash Transfer to Lower Child Labor

Conditional transfers are usually part of anti-poverty programs and could be contingent on several criteria like minimum attendance of children at school, participation in health clinics or contribution to other social campaigns. Such transfers usually target multi-dimensional human development gains and since the grants are transmitted directly to the households they plug leakages, ensure transparency and raise accountability of the recipient. Implementation of such services also requires a well developed infrastructure to transmit the funds and mechanisms to monitor compliance. The scope of such conditional financial packages can be expanded considerably to address several issues and the money helps protect families against temporary disruptions in household earnings.

Child labor is a critical issue in several developing nations including India. Here the goal of conditional cash transfer (CCT) is to provide the family with an influx of money so they can afford to withdraw their children from the labor market; indirectly it raises the probability that parent will send the children to school instead and this rise in education is expected to trigger the Q-Q tradeoff to eventually reduce fertility.

I examine the situation where a CCT is put in place conditional on the child being kept out of the labor market with the intention of promoting school attendance. The underlying assumption is that this kind of child labor is detrimental for the child and is above and beyond the dimensions of basic household chores and occasional involvement in family duties. The young adult parents face a choice of either keeping the child in school and receiving the extra CCT income and in the process forgoing the earnings from the child's participation in the labor market versus sending the child to work at a market wage rate and losing out on the benefits from the CCT payments. The transfer amount (c) is expected to lower the child labor rate from its initial level (l_0) which is at 0.2246 to a lower amount (l_t). This financial transfer to ensure $l_t < l_0$ results in a modified budget constraint:

$$C_{2t} + n_t\beta + g_t + n_t k_t = e + (1 + R_t)(1 - l_{t-1})^{\gamma} k_{t-1} + n_t w_t^c l_t + c(l_0 - l_t)n_t$$

or

$$C_{2t} + n_t\beta + g_t + n_t k_t - n_t l_0 c = e + (1 + R_t)(1 - l_{t-1})^{\gamma} k_{t-1} + n_t w_t^c l_t - n_t l_t c$$

or

$$C_{2t} + n_t(\beta - l_0 c) + g_t + n_t k_t = e + (1 + R_t)(1 - l_{t-1})^{\gamma} k_{t-1} + n_t(w_t^c - c)l_t$$

or

$$C_{2t} + n_t\overline{\beta} + g_t + n_t k_t = e + (1 + R_t)(1 - l_{t-1})^{\gamma} k_{t-1} + n_t\overline{w_t^c} l_t$$

So the left hand side reflects how the quantity dependent cost of children $\overline{\beta} = (\beta - l_0 c)$ is affected while the right hand side shows the impact on child wages $\overline{w_t^c} = (w_t^c - c)$. Assuming that the CCT lowers the cost of child quantity ($\beta = 11965.552$), it should reduce the burden of caring for the offspring hence relaxing the family's economic constraints and making it less necessary for the child to work. On the other hand the CCT agreement also reduces the earnings from child employment and this makes the effective child wage rate fall.

The timing of payment is also a factor in this case, the model assumes one time transfers at start of the current period but the program may be designed to provide payoffs at intervals after confirming that the conditions are being satisfied. The transfer minimizes child labor leading to a reduction in income from child wages hence it must compensate for this loss by augmenting the budget; this supplemental income is best expressed as a percentage of the child wage rate (w_t^c) which has already been discounted so further present value calculation is not required. The CCT programs being tested in this paper replicate the successful interventions that have been in place in other countries and are being applied to the Indian context; they are based on similar policies in Brazil (5% of w_t^c), Mexico (10% of w_t^c) and Nicaragua (20% of w_t^c) given the discounted present value of market wage rate for children in India is Rs. 31355.30667.

CCT calculation			
Variable	**CCT$_1$** *(5% of w_t^c)*	**CCT$_2$** *(10% of w_t^c)*	**CCT$_3$** *(20% of w_t^c)*
c	1567.7653	3135.5306	6271.0613
$\overline{\beta}$	11613.4319	11261.3118	10557.0716
$\overline{w_t^c}$	29787.5413	28219.7760	25084.2453

Comparative Statics for Conditional Cash Transfers			
	Child Labor **(l_t)**	Educational Investment **(k_t)**	Fertility Choice **(n_t)**
BASELINE	0.2372	4783.3	1.3754
CCT$_1$ *(5% of w_t^c)*	0.1862	4847.9	1.3203
CCT$_2$ *(10% of w_t^c)*	0.1253	4936.7	1.2614
CCT$_3$ *(20% of w_t^c)*	0.0930	5213.3	1.1313
** Note: C_{2t} and g_t remain unaffected by the transfers.*			

Table 3.4: Solutions to household decision making under different levels of CCT

The net income changes with incremental CCT inflows and people's response to the policy can be reviewed by examining the variation in child labor rates, fertility behavior and educational investment levels as reported in Table 3.4. From the first panel, it is evident that each of the CCT's yield different levels of child quantity expenditures and effective child wage rates. Using these adjusted values, the dynamic OLG model can be refitted and the solutions to the comparative static exercise traces the transformation in the young adult parent's decision making behavior. The second panel clearly shows that as the amount of conditional transfer goes up, it becomes profitable for the parents to stop sending the children to the labor market; the trends indicate that as CCT rises the time spent by children in labor force participation declines. These children who are now freed from employment can utilize the time by investing in education which in turn raises their human capital development, parents with better quality children find that they face less uncertainty regarding the success or survival of the child during adulthood and hence are now satisfied with fewer number of births. The chain reaction eventually leads us from financial transfers to poor families who are forced to engage in child labor towards better educated healthier children and households that self select lower fertility levels.

3.7.3 Mid-day Meal Schemes to Raise School Attendance

The mid-day meal schemes were introduced by the Government of India[16] as a way of checking school drop out rates along with providing nutrition to schools students at the elementary level. Public schools sponsored by the state are expected to provide a daily balanced meal of rice, lentils ,vegetables, eggs and fruits to children as many of the students come from extremely poor families that lack the resources to cater to their health and educational needs. The primary objectives of the school lunch program were to avoid classroom hunger, address malnutrition, raise school enrollment and ensure attendance. The project encourages students to remain in school which has the added benefits of keeping them out of the labor market; the educational investment raises human capital of the children and has the potential to trigger the Q-Q tradeoff and lead to lower child bearing.

The strategy behind the program is that if a child is sent to school then the parent can avert the cost of one meal (Rs. 5[17] per child per day), so there is a financial gain but on the other hand the household may lose income from employing the child as she/he is no longer available to work during the day time school hours. Further the scheme provides the afternoon meal each day so it is effectively a daily transfer but to incorporate it into the model, I tally the cumulative value of financial expenses saved on each offspring by the young adult and convert it to a one time transfer (m) that enters the household financial accounts. This benefit from diverted domestic lunch expenditure must be discounted over all childhood schooling years from ages 6-18. Feeding the child at school affects cost of quantity β and it is manifested in the budget constraint as per:

$$C_{2t} + n_t\beta + g_t + n_t k_t = e + (1 + R_t)(1 - l_{t-1})^{\gamma} k_{t-1} + n_t w_t^c l_t + n_t m$$

[16]Supreme Court ruling in 2001 directed State Governments to implement the Mid-day Meal Scheme in government assisted primary schools.

[17]As per State Human Resource Department Data.

or

$$C_{2t} + n_t(\beta - m) + g_t + n_t k_t = e + (1 + R_t)(1 - l_{t-1})^{\gamma} k_{t-1} + n_t w_t^c l_t$$

or

$$C_{2t} + n_t\overline{\beta} + g_t + n_t k_t = e + (1 + R_t)(1 - l_{t-1})^{\gamma} k_{t-1} + n_t w_t^c l_t$$

On the left hand side now the cost of child quantity changes to $\overline{\beta} = (\beta - m)$ so the mid-day meals at school lowers the cost of child quantity from the initial level ($\beta = 11965.552$). After applying the new child costs to the model, Table 3.5 illustrates the consequences of the mid-day meal scheme on the household choices. Compared to the status quo, introducing the free school lunch leads to a decrease in child labor as children are drawn back from the labor market; this is also supplemented by a rise in educational investment and decline in child bearing. The secondary impact on fertility could be a direct causal effect or an indirect fallout from the Q-Q hypothesis. The mid-day meal scheme was targeted to reduce hunger and encourage universal primary education and it has several ancillary benefits; though the endeavor has been a success it faces many challenges as the program is often difficult to sustain in the absence of community support and private-public partnerships.

Comparative Statics for Mid-day Meal Scheme			
	Child Labor **(l_t)**	Educational Investment **(k_t)**	Fertility Choice **(n_t)**
BASELINE	0.2372	4783.3	1.3754
Mid-Day Meal *m = 4306.9206* *$\overline{\beta}$ = 7652.6320*	0.1535	5308.2	1.2878
** Note: C_{2t} and g_t remain unaffected by the transfers.*			

Table 3.5: Solutions to household decision making under Mid-day Meal Scheme

The results generated from the dynamic version of the Q-Q model can be used to analyze the effects of potential policy experiments. Possible policy instruments affecting the household decision variables could have cross program effects that may trickle down further in the system. Policies could either directly impact fertility or filter into the model via the Q-Q tradeoff after altering the child labor involvement rates or the school enrollments so the appropriate instruments must be chosen after gauging the model's response to them.

3.8 Results & Recommendations

The purpose of the study is to find feasible and effective instruments that may be used in policy planning to induce desired fertility behavior. A spectrum of factors may potentially affect the fertility of individuals and policies range from direct financial incentives to sociocultural development mechanisms that ensure effectiveness and ethical justice and at the same time manage the population pressure. Presence of inter-generational transfers implies that revenue earned from child labor and lack of social security for the elderly are important determinants of fertility behavior.

With respect to elderly transfers since the current model does not allow for savings, so in the absence of social security or alternative source of earnings the contributions from children must be non-zero as accommodating corner solutions would not allow any consumption for the old adults. Findings indicate that provision of old age benefits and financial security net may allow people to become more independent and rely less on some form of economic gifts from their offspring, hence young parents will have fewer children as they are not their sole source of income after they grow old and retire from employment.

Child labor can be interpreted differently depending on the degree and time intensity of the activity that the child is involved in. Certain schools of thought claim that some amount of work at low levels may not be detrimental and could actually be beneficial for the child as it raises their human capital and productivity. Children may learn responsibility, punctuality and pick up skills that could actually help them in their later lives provided the work does not encroach upon their physical, mental and emotional development. However for the purpose of this study, I specifically consider labor force participation by children that detracts from their human capital accumulation leading to adverse impact on their future earning potential and general wellbeing. The revenue earned from child labor contributes to household income, so it is not that parents do not care about their children's wellbeing and discount their future, rather it is dire poverty and survival needs that forces a parent to send their child to work. So we need better enforcement of the child labor laws and must promote benefits of education that will encourage parents to send the children to school instead of the labor market.

The policy experiments tested in light of the dynamic Q-Q model are predominantly social programs with positive incentives to make smaller families more appealing and could encourage a decrease in fertility over a shorter time horizon. Disincentive schemes may be more effective with quicker response rates but a penalty changes the marginal cost for each child and causes loss of income from paying the fines, fees or bribes if one were to exceed the limit. Most of the families under consideration are already financially constrained so additional negative sanctions may not be socially optimal. The commonest policy instruments include providing subsidies to households who restrict their fertility behavior within acceptable bounds, establishing conditional cash transfers to regulate labor force participation by children and implementation of mid-day meal schemes to encourage school enrollment and attendance. Even though these instruments have different objectives, they all play a role in reducing above replacement fertility so it is possible to harness the skills or resources of various sectors and programs to leverage the Q-Q tradeoff.

The findings from this paper supplemented by arguments from past literature implies that better educated, healthy and financially secure individuals tend to have fewer children as predicted by the Quantity-Quality tradeoff models for fertility. Hence Education, Health and Economic Well-being should all be important areas of focus and policy makers should incorporate this into their decision making process during incentive design and budget allocation.

3.9 Conclusion

Over time both population growth rates and fertility rates have been on the decline but the absolute population size is at 7 billion and still growing. As per the classic demographic transition theory mortality rates have already fallen so the only way to curb high population growth is by reducing fertility. Much research has already been undertaken to better understand the causes of high fertility behavior and this study will contribute to the existing research in several ways. Incidence of child labor as well as old age dependency on monetary transfers from one's children implies that revenue earned from child labor and lack of social security for the elderly are important determinants of fertility behavior.

The dynamic structural model with OLG examines dynastic household decision making units and extends the earlier literature where the life-cycle analysis only considers two time periods with altruism as the parent's prime goal for investing in child quality. This study is particularly important for three reasons: first, old age dependence and child labor are highly prevalent in most developing economy family structures but previous studies do not at look at the simultaneous presence of both factors in fertility choice; second, I use the Quantity-Quality model to calibrate the parameters and solve for the household decision variables after tracing the consumption, fertility, transfers to elderly, schooling and child labor behavior from 1967 to 2007 and finally I test effects of CCT's, midday meal programs and fertility reduction subsidies on behavioral outcomes.

Reliance on one's offspring for contributing to household income via child labor earnings and expectation of financial support after retiring in the absence of social security are major motivations for greater child bearing; so policy reforms and interventions affecting fertility alone will be ineffective without provision of appropriate social safety nets. Findings indicate that provision of old age benefits and financial security may allow people to become independent and rely less on economic gifts from their offspring, hence young parents will have fewer children as they are not their sole source of income after they grow old and retire from employment. Also the revenue earned from child labor crucially contributes to household income, so it is not that parents do not care about their children's wellbeing, rather it is dire poverty and survival needs that forces a parent to send their child to work.

Policy instruments can range from financial incentives to targeted socio-cultural development and though such interventions may be ambitious and expensive, if sustained they should yield favorable results in the long run. Monetary benefits and incentive schemes used in conjunction with family planning programs encourage families to modify their fertility downwards and this must be kept in mind during policy making and budget allocation. Using the Q-Q tradeoff entails improving child quality levels in terms of health and education, which will directly raise children's wellbeing and as a byproduct reduce the demand for quantity; higher quality raises income-earning potential and survival probability and at the same time could generate a stable population with replacement rate fertility.

3.10 Limitations & Concerns

The results of the study are confined by the data limitations; estimates are used at 20 year intervals to represent generations and the calibration of the parameters can be fine-tuned further to increase accuracy of the models predictive power. Psychological attachments or tendency to rank other's wellbeing higher than one's own are relative concepts and vary across people so the measures of altruism and preferential parameters are difficult to quantify. The policy experiments show that the amount of financial transfers required to induce parents to lower child labor or raise schooling are very high and may even make such programs prohibitively costly for developing country administrating agencies. Also governments trying to encourage smaller family sizes by positive reinforcement will find that alternative motivations like economic gains from higher childbearing pose significant challenges hindering their progress.

3.11 Future Extensions

This paper aims to see impact of child labor and old age dependency on household decision making, specifically fertility behavior. Birth order and gender preferences are also not specifically addressed in this model but can be incorporated in extended frameworks of the OLG structure. Also the current model aggregates child labor over all age groups but the impact can be separated out over specific age intervals to test effectiveness of policies targeting a certain range. The model can be extended to see the impact of other policy instruments like child labor bans, presence of social security benefits or alternative cash bonuses to delay childbearing. Sensitivity analysis for different parameters requires further investigation and alternative scenarios ($\alpha > \theta$) can be explored by adjusting the parameters and making minor alterations to the model.

Appendix I

First order conditions from the optimization exercise are:

Eqn(1): $C_{2t} = (\lambda_t)^{1/\sigma-1}$

Eqn(2): $g_t = (\frac{\lambda_t}{\phi n_{t-1}^{\sigma}})^{1/\sigma-1}$

Eqn(3): $k_t(1-l_t)^{\gamma-1} = \frac{\lambda_t w_t^c}{\lambda_{t+1}(1+R_{t+1})\gamma}$

Eqn(4): $(1-l_t)^{\gamma} = \frac{\lambda_t}{\lambda_{t+1}(1+R_{t+1})}$

Eqn(5): $\theta n_t^{\sigma-1} g_{t+1}^{\sigma} + \frac{\alpha(1-\varepsilon)}{\sigma} n_t^{-\varepsilon} C_{2t+1}^{\sigma} + \lambda_t(w_t^c l_t - \beta - k_t) + \lambda_{t+1}(e + (1+R_{t+1})(1-l_t)^{\gamma} k_t$

$+ n_{t+1} w_{t+1}^c l_{t+1} - C_{2t+1} - n_{t+1}\beta - g_{t+1} - n_{t+1} k_{t+1}) = 0$

Eqn(6): $e + (1+R_t)(1-l_{t-1})^{\gamma} k_{t-1} + n_t w_t^c l_t - C_{2t} - n_t\beta - g_t - n_t k_t = 0$

Eqn(7): $e + (1+R_{t+1})(1-l_t)^{\gamma} k_t + n_{t+1} w_{t+1}^c l_{t+1} - C_{2t+1} - n_{t+1}\beta - g_{t+1} - n_{t+1} k_{t+1} = 0$

Appendix II

	Period (t-2)			Period (t-1)			**Period (t)**			Period (t+1)			Period (t+2)			
	Start of pd (t-2)			Start of pd (t-1)			**Start of pd (t)**			Start of pd (t+1)			Start of pd (t+2)			Start of pd (t+3)
	x yr	x+2yr	x+7yr	x+20yr	x+22yr	x+27yr	x+40yr	x+42yr	x+47yr	x+60yr	x+62yr	x+67yr	x+80yr	x+82yr	x+87yr	x+100yr
	1967			**1987**			**2007**			**2027**			**2047**			**2067**
Gen (t-3)	Y-Ad = 38	Y-Ad = 40	Y-Ad = 45	Y-Ad = 58	O-Ad = 60	Die = 65	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gen (t-2)	Y-Ad = 18	Y-Ad = 20	Y-Ad = 25	Y-Ad = 38	Y-Ad = 40	Y-Ad = 45	Y-Ad = 58	O-Ad = 60	Die = 65	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gen (t-1)	N/A	Born = 0	Child = 5	Y-Ad = 18	Y-Ad = 20	Y-Ad = 25	Y-Ad = 38	Y-Ad = 40	Y-Ad = 45	Y-Ad = 58	O-Ad = 60	Die = 65	N/A	N/A	N/A	N/A
Gen (t)	N/A	N/A	N/A	N/A	**Born = 0**	**Child = 5**	**Y-Ad = 18**	**Y-Ad = 20**	**Y-Ad = 25**	**Y-Ad = 38**	**Y-Ad = 40**	**Y-Ad = 45**	**Y-Ad = 58**	**O-Ad = 60**	**Die = 65**	N/A
Gen (t+1)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Born = 0	Child = 5	Y-Ad = 18	Y-Ad = 20	Y-Ad = 25	Y-Ad = 38	Y-Ad = 40	Y-Ad = 45	Y-Ad = 58
Gen (t+2)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Born = 0	Child = 5	Y-Ad = 18	Y-Ad = 20	Y-Ad = 25	Y-Ad = 38
Gen (t+3)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Born = 0	Child = 5	Y-Ad = 18
Gen (t+4)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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Chapter 4

RAISING QUALITY MAY REDUCE QUANTITY: TESTING THE TRADEOFF WITH EVIDENCE FROM INDIA

Abstract

India is the second most populous country in the world and is currently undergoing its demographic transition with the average number of children per woman gradually declining. However the birth rate is still above replacement level and the current study uses an extension of the traditional Quantity-Quality model of fertility to understand childbearing behavior in the subcontinent. Earlier empirical studies on the Q-Q tradeoff just explore how greater number of children is usually associated with lower levels of child quality but this econometric analysis examines the reverse direction of causality using the nationally representative Demographic Health Survey (NFHS-3) for 2005-06. With number of children ever born as an indicator of fertility preference, I use ordered responses to examine the most important predictors of the target variable and find that parental quality is one of the crucial determinants of child quantity within a household. This indicates that greater investment in quality for a certain generation affects their childbearing choices once they become parental decision makers, so the Q-Q hypothesis can be augmented beyond a single generational perspective which in the long run may lead to smaller family sizes.

4.1 Introduction

The current world population is over 7 billion and a major part of this populace are residents of the developing world which is yet to complete the demographic transition. Of these countries, India currently ranks second in terms of national population size with a base of 1.2 billion as per Census 2011, and it is still growing with an above replacement fertility rate[18]. Escalating pollution levels, natural resource depletion and degradation, rising food prices are just some of the major problems associated with increasing population pressure and one of the possible solution approaches could involve encouraging smaller family sizes to slow down the rapid population expansion. Such alternative policies could help developing nations speed up their demographic transition and move to a sustainable fertility time-path, which in turn should help reduce the stress and strain on our scarce resources.

[18] Above replacement fertility rates implies TFR>2.1.

Since each developing country is unique with respect to its problems and policy needs, this paper focuses on the Indian scenario and proposes to identify the background factors that filter into the proximate determinants of fertility. By investigating the role of individual and aggregate characteristics in the household decision process regarding children (in terms of both quantity and quality), I can separate out the most influential factors that operate with regards to reproductive preferences. Once we understand the forces behind fertility behavior in India, we should be able to propose feasible and effective policy instruments which may incentivize a stable population growth rate. With this ideology in mind, the paper will attempt to examine the relationship between household and community level factors in determining childbearing and these could potentially be used to influence or inform policy choices.

The paper is organized as follows: Section 4.2 describes the background and motivation; Section 4.3 provides an outline of the main research question; Section 4.4 defines the broad methodological framework; Section 4.5 illustrates the specific estimation strategy followed by Section 4.6 which includes the detailed empirical analyses; finally Sections 4.7, 4.8, 4.9 and 4.10 discuss the policy recommendations, conclusions, limiting concerns and plans for future extensions respectively.

4.2 Background & Motivation

By the Demographic Balancing Equation, fertility, mortality and migration are the main components of population change; since increasing mortality or promoting migration are unacceptable or impractical options, fertility reduction is the only available alternative to motivate population growth deceleration. In the Indian context, population management has been a long standing goal and there has been a significant transformation over the years as evident from the population pyramids depicted in Figure 4.1. The broad based triangular age profile implies a high proportion of younger individuals. Over time there has been a gradual transition towards a mature structure but divergence in numbers between the middle and young age groups denotes a persistence of non-replacement level fertility.

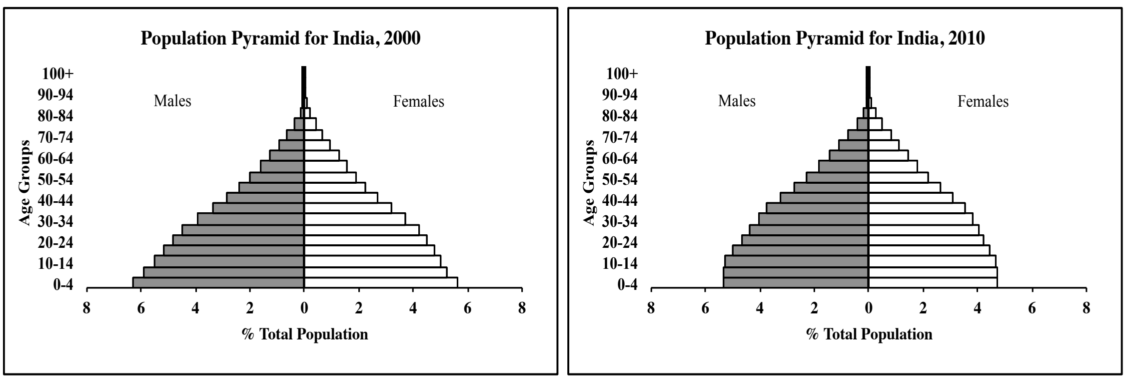


Figure 4.1: Age-Sex Structure of the population of India in 2000 and 2010

The demographic indicators shown in Table 4.1 provide an overview of the social and economic factors prevailing in India and they may all possibly influence reproductive behavior. On the positive side, annual population growth rate has consistently declined from 1991 till 2011 and urbanization is also on the rise. However with a population which is more than one billion strong, a positive growth rate of 1.36% means that the total population size is still on the rise and given the fixed land area, this implies that population density is rising as well. In spite of a booming economy the per capita GDP is quite low compared to other middle income countries and this gives an idea of the magnitude of the country's population pressure.

A steady decline in TFR and improvements in child survival and life expectancy have occurred over the three decades. Parental education represented by literacy, acts as an indirect determinant of fertility and can filter into the system either via increases in income earning potential and greater opportunity cost of time (higher wage rate commanded means that the income forgone while raising children is also greater) or by changing parental preference for children (educated parents may have fewer number of children but make more investments in each child). So both the educational and health indices filter into the traditional Quantity-Quality (Q-Q) hypothesis for fertility whereby higher quality level of children raises the value of each child hence parents are satisfied with fewer units of children and the extended premise that higher quality level of parents allows them to choose higher quality and lower quantity of children.

Indicator	**Unit**	**Year**		
		1991	**2001**	**2011**
Population	millions	891.9	1071.3	1241.4
Population Growth Rate	% annual	2.053	1.644	1.368
Population Density	people per km^2 of land area	229.9	360.3	417.5
Urban Population	% of total	25.75	27.98	31.29
GDP per capita	US $	308.1	459.5	1058.5
Adult Literacy Rate	% of people aged 15+	48.22	61.04	74.04
- Female only	% of females aged 15+	33.72	47.84	65.46
Under 5 Mortality Rate	per 1000 live births	111.5	85.0	61.3
Life Expectancy at Birth	years	58.61	61.96	65.47
Total Fertility Rate	births per woman	3.838	3.054	2.589
Labor Force Participation Rate	% of people aged 15+	60.9	59.7	55.5
Source: Compiled from World Bank Development Indicators and Census of India.				

Table 4.1: Comparative view of Demographic Indicators in India over time

Given that most of the present growth in population is a direct result of fertility behavior, I investigate the determinants of the fertility status and demographic composition in a developing country context with specific emphasis on India.

It is evident that a lot of work is already in progress but most of this research is done in the context of the traditional Q-Q model where it is hypothesized that an increase in child quantity leads to a reduction in qualitative investments in children for resource constrained scenarios (economies where either money or time or both are scarce and must be allocated to maximize the household's welfare). The alternative ideology is that the tradeoff also operates in the reverse direction; so a greater investment in child quality in terms of schooling or healthcare should allow the more educated and healthier children to have a greater chance of success and survival as adults hence reducing parent's precautionary demand for children eventually reducing excessive childbearing.

Now there are several studies that attempt to identify the chief determinants of fertility under different circumstances but there is a significant gap in the literature to understand the impact of parental attributes within the premises of the Q-Q model. The contribution of the current research is that it tries to address this void by extending the traditional Q-Q model to examine the predictors of household's fertility behavior for India using the most recent Demographic Health Survey data from 2005-2006.

4.3 Research Question

The rationale behind the study is that childbearing in developing countries is determined by several socio-cultural components and they need to be better understood in order to find feasible and effective policy instruments that may help to reduce high fertility behavior. The main objective is to identify the primary determinants of child quantity within an household; specifically how can the Quantity-Quality model of fertility be extended to incorporate individual and community level features which could help explain why certain households are satisfied with fewer number of children while others end up choosing much larger family sizes?

By the traditional Q-Q tradeoff notion, unanticipated increases in child quantity is usually associated with lower levels of child quality. The reverse ideology is that if the quality level of children were to improve so that each child was endowed with greater investments in terms of health and education, then these children would grow up to be more successful and have a higher probability of surviving to adulthood, this would reduce the parent's uncertainty of child outcomes like success and survival hence allowing preferences to be re-adjusted towards smaller family sizes.

An extension of the same Q-Q hypothesis is that parents who have themselves achieved a superior degree of education for instance, end up self-selecting higher levels of quality for their children and are satisfied with fewer number of them; this implies that preferences are not exogenous because better educated parents are more inclined to invest in quality of each child which triggers the tradeoff leading to smaller number of offspring. This leads to the aim of exploring the motivations for attitudes of family formation in developing countries like India.

4.4 Methodology

Becker's (1960) household production model forms the economic basis from which we generate the childbearing decisions. Parental demand for number of children is governed by their opportunity cost of time (especially as childbearing is more time-intensive for the mother), their labor and non-wage income, relative market prices and the institutional setting among other things. So if prior to decision making, households can assess the uncertainty about the child's future and properly balance out the cost and benefits then they may voluntarily choose lower quantity in favor of higher quality. The hypothesis here is that parental attributes are crucial to fertility choice and higher quality parents do invest more in child quality which eventually leads to a lower value of child quantity. This can be demonstrated by using the example of India and constructing a discrete response model to evaluate childbearing behavior in the backdrop of the Q-Q tradeoff.

4.4.1 Framework for Fertility Choice

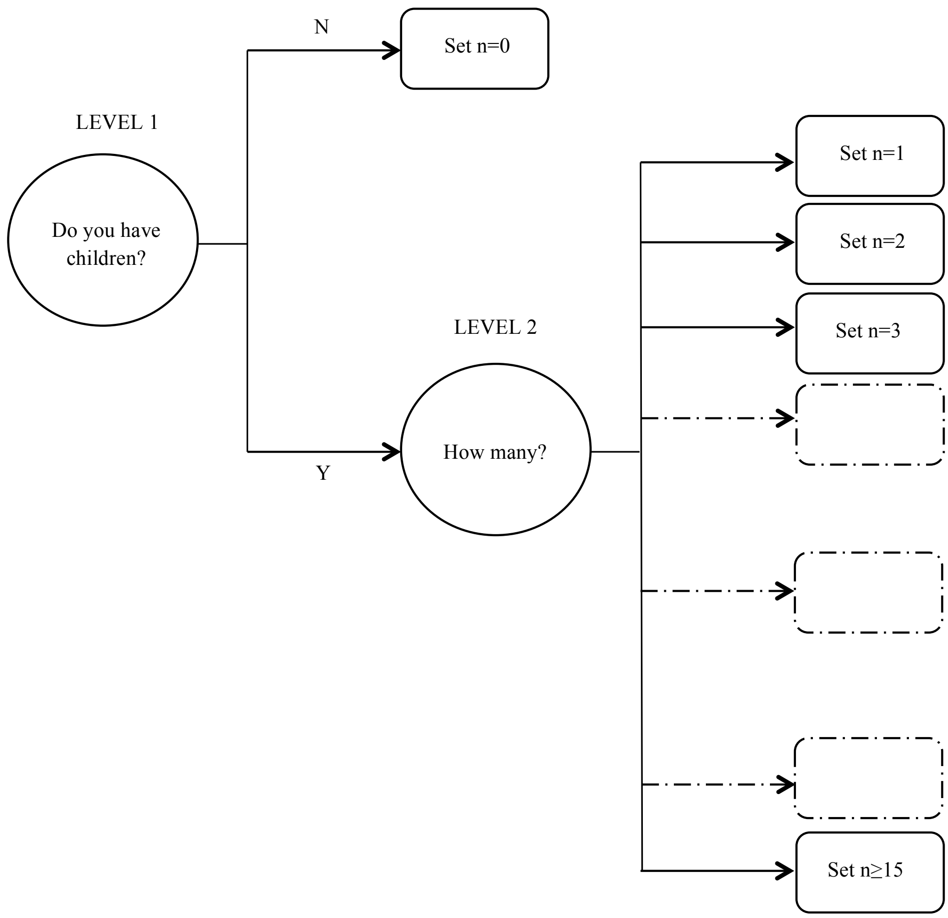


Figure 4.2: 2-step Fertility Decision Making

Reproductive choice at the household level can be viewed as a two step process as depicted in Figure 4.2. I keep respondents with no children in the pool initially as it reflects the initial stage of decision making where parents select whether to have or not have children; in the next stage I then concentrate only on those who have children and further investigate their desire to have a specified number of children. This resembles a Double Hurdle model with a discrete choice in Level 1 as respondents make a binary decision (Y/N) and for those selecting to move to Level 2, a continuous choice is required from the set of positive nonzero integer outcomes.

Typically in the first level, some individuals may self-select out of childbearing or be medically unable to reproduce and at first glance it may appear that sample selection bias could arise. However the emphasis here is on the Q-Q model which is applicable only for parents who have decided to have children because the tradeoff is not relevant for childless households. The assertions and inferences are restricted to the subset of respondents who enter the second level and results are not being generalized for the entire population.

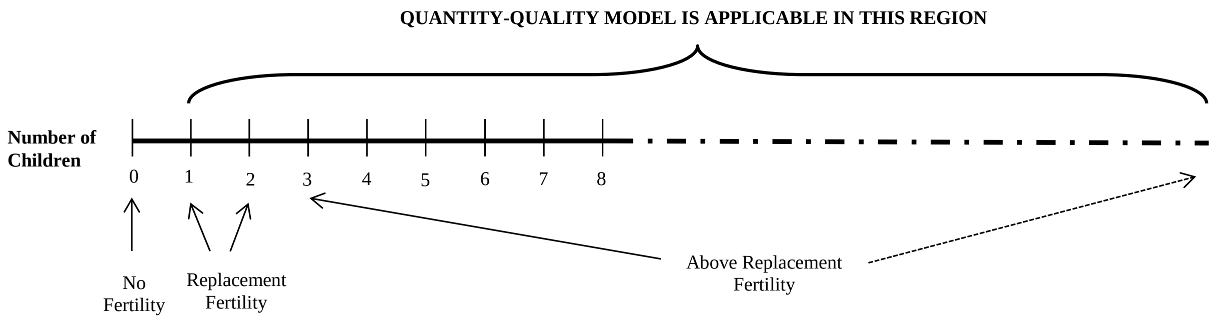


Figure 4.3: Q-Q tradeoff is valid for households with positive (non-zero) quantities of children

The focus is only on attempting to understand the fertility behavior in cases where the Q-Q tradeoff is valid as indicated in Figure 4.3; so in spite of the two-step decision making involved, the analysis is restricted to the set of parents having children and the treatment remains random and free from Heckman selection bias. All the findings and resulting conclusions are applicable only to the population of interest, i.e. households with children present.

4.4.2 Data

I use the DHS 2005-06 cross-sectional database for India which is constructed from the NFHS-3 survey conducted by the Government of India. The Demographic and Health Surveys (DHS) Program was established by the United States Agency for International Development (USAID) in 1984. The project has been implemented in overlapping five-year phases and surveys are designed to collect data on marriage, fertility, family planning, reproductive health, child health and HIV/AIDS.

Due to the subject matter of the survey, women of reproductive age (15–49) are the focus of the survey and all eligible women in the sample of selected households were individually interviewed. All DHS surveys utilize at least two questionnaires, one for the Household (lists all the usual members and visitors in the selected households and collects basic information on their age, sex, education, relationship to the head of the household etc.; further information is collected about the dwelling like the source of water, type of toilet facilities, housing materials, ownership of consumer goods, use of iodized salt etc.) and one for Women (background characteristics like age, education, religion; reproductive history; use of contraceptive methods; antenatal care, delivery care and postnatal care; breastfeeding and infant feeding practices; immunization, child health, and nutrition; marriage and recent sexual activity; fertility preferences; knowledge about HIV/AIDS and other sexually transmitted diseases; husband's background and respondent's work) separately.

For India, the National Family Health Survey (NFHS) is a series of national surveys conducted under the stewardship of the Ministry of Health and Family Welfare at the Government of India with the International Institute for Population Sciences in Mumbai serving as the nodal agency. The NFHS-3 was carried out in 2005-06 where 18 research organizations conducted almost 199,000 interviews with 124,385 women aged 15-49 and 74,369 men aged 15-54 throughout India with the fieldwork running in two phases from November 2005 to August 2006. The NFHS-3 provides information on population, health and nutrition in India and each of its 29 states with the survey being based on a sample of households which is representative at the national and state levels. The DHS processes the wealth of information collected by the NFHS survey and distributes the sample domains into separate files for Births, Children under five, Household, Women, Men, and Couples but it is possible to match and combine the data files for analysis.

Ideally we should only consider women who have completed their reproductive careers so we have records of the entire birth history. Other wise the measure may not accurately represent the total number of children born because the respondents to the survey may not be able to report their choices from later life at the time of data collection. After comparing different age thresholds, I find that few women have any further children between the ages of 45 and 49 so I select cutoff age$\geq$45.

4.4.3 Descriptive Statistics

India being a large country, the data displays a broad range of fertility behavior. There are differences with respect to the family size, the number of births, the age of marriage, the childbearing preferences within and outside of marital unions and several other features.

Regarding the number of children ever born to women within the ages of 15-49, Table 4.2 shows that almost 32% have had no children. If we discount the women who have reported no births (could be too young or unmarried or self-selected to have zero fertility), then we see the next highest group is at about 20% who have reported having 2 children, this is followed by women who report 3 children at 15% while the women who only had one child are at 12%. For values further up, the distribution tapers off with regards to very large values of children ever born. We must bear in mind that 36% of respondents from this sample reported having 3 or more children and considering the total population base of the country, this reflects a large number of households who are contributing to the fertility rate being above the replacement level.

Distribution of Children Ever Born			
Number of Children Ever Born	**Frequency**	**Percentage**	**Cumulative Frequency**
0	39776	31.98	31.98
1	15144	12.18	44.15
2	24554	19.74	63.89
3	18608	14.96	78.85
4	11542	9.28	88.13
5	6638	5.34	93.47
6	3778	3.04	96.51
7	2046	1.64	98.15
8	1161	0.93	99.09
9	627	0.50	99.59
10	297	0.24	99.83
11	136	0.11	99.94
12	62	0.05	99.99
13	10	0.01	100.00
14	4	0.00	100.00
15	1	0.00	100.00
16	1	0.00	100.00
NOTES: Data is from Women's data-file from DHS 2005-06. Statistics for Children Ever Born from entire sample is Mean: 2.0644; Standard Deviation: 2.0461; Minimum: 0, Maximum: 16.			

Table 4.2: Distribution of number of children ever born from DHS 2005-06

Based on the observed frequencies for fertility of women by age and marital status as reported in Table 4.3, we can see the pattern of age specific marital fertility rates. The column for the 45-49 years category provides a synopsis of the distribution of childbearing for women in the latter parts of their reproductive career. Those women between 15-44 may still have more children after they responded to this survey, hence these values do not reflect their final decision regarding number of children.

There are several points of interest here, majority of the women in the older age sample are married and most of the women who have positive number of children born tend to be married and older. Since childbearing out of marriage is not as common in India as in many parts of the Western world, the statistics exhibit this phenomenon that most unmarried women fall under the category reporting no children ever born. From here we can conclude that in certain societies the marital status is intertwined with the resultant fertility level so there are several rungs in the decision making ladder; women must first undergo the decision to marry or not and then move on to the decision that involves whether or not to have children. Given that childbearing is contingent on the marital status, the data shows that most of the women surveyed who reported having positive number of children were involved in some form of marital union or partnership.

Percentage Distribution of Women by Age and Marital Status for Number of Children Ever Born				
Number of Children Ever Born	**Marital Status**	**Women by Age**		
		All (15-49)	Less than 45 (15-44)	45 or more (45-49)
0	%Unmarried	76.90	77.32	30.64
	%Evermarried	23.10	22.68	69.36
	Total	39776	39417	359
1	%Unmarried	0.40	0.40	0.39
	%Evermarried	99.60	99.60	99.61
	Total	15144	14633	511
2	%Unmarried	0.02	0.03	0.00
	%Evermarried	99.98	99.97	100.00
	Total	24554	22803	1751
3	%Unmarried	0.02	0.02	0.00
	%Evermarried	99.98	99.98	100.00
	Total	18608	16441	2167
4	%Unmarried	0.02	0.01	0.06
	%Evermarried	99.98	99.99	99.94
	Total	11542	9730	1812
5	%Unmarried	0.02	0.00	0.08
	%Evermarried	99.98	100.00	99.92
	Total	6638	5439	1199
6	%Unmarried	0.00	0.00	0.00
	%Evermarried	100.00	100.00	100.00
	Total	3778	2962	816
7	%Unmarried	0.00	0.00	0.00
	%Evermarried	100.00	100.00	100.00
	Total	2064	1550	496
8	%Unmarried	0.00	0.00	0.00
	%Evermarried	100.00	100.00	100.00
	Total	1161	849	312
9	%Unmarried	0.00	0.00	0.00
	%Evermarried	100.00	100.00	100.00
	Total	627	439	188
10 or more	%Unmarried	0.00	0.00	0.00
	%Evermarried	100.00	100.00	100.00
	Total	511	315	196

Table 4.3: Percentage distribution of women by number of children ever born from DHS 2005-06

4.5 Estimation Strategy

The traditional Q-Q tradeoff model looks at the relationship between child quantity or fertility and child quality, i.e. health and education. An extension of the hypothesis is that parents who possess higher quality endowments are more likely to choose greater levels of quality for their children as well and are satisfied with fewer number of offspring. So the objective is to analyze how individual and community level attributes affect child bearing and family formation decisions at the household level.

4.5.1 Specification of Model

I employ qualitative response models to describe the fertility behavior for India. The distribution of children organized by birth order shows that the proportion of births at each order is larger than the proportion at the next higher order. Since my outcome variable is fertility or number of children, I can use Limited Dependent Variable models where the random dependent variable has a limited range as there are a finite number of outcomes possible. The explanatory variables may themselves be continuous or discrete and the response probability can be calculated by constructing a Probit model[19] where the error structure has a Standard Normal distribution and we can estimate the partial effects and relative impacts of the regressors.

Multinomial Probit Model

The probit model for binary outcomes can be adapted to the case when unordered responses has more than two outcomes. This is advantageous in comparing the three groups of households, those who choose to have no children, those who have one or two children and those who opt for more than two children.

Let (y) denote the individual's utility maximizing choice of fertility level which can grouped into 3 possible outcomes $(y = 0, 1, 2)$. A random draw from the underlying population should yield a utility level from choosing the j^{th} alternative as $y^*_{ij} = X_{ij}\beta + a_{ij}$ where a_{ij} are unobservables that affect individuals tastes. If a_i has a multivariate normal distribution with arbitrary correlations between a_{ij} and a_{ih} for $j \neq h$ then this multinomial or conditional probit model can be used to evaluate response probabilities using maximum likelihood and partial effects.

Ordered Probit Model

Since parents of a household can be arranged according to increments in number of children, this constitutes a multinomial ordered response where the predictors could be used to explain this difference in individual fertility decision.

Let (y) be the ordered response indicating fertility with integer values $(y = 1, 2, 3....J)$ representing the number of children; (y^*) be the latent demand which is unobserved but continuous and (X) be the vector of explanatory variables. Then $y^* = X\beta + e; e \mid X \sim Normal(0, 1)$. If $\alpha_1 < \alpha_2 < ...... < \alpha_J$ are the unknown cut-points or thresholds for the latent variables then

$y = 1$ if $y^* \leq \alpha_1$

$y = 2$ if $\alpha_1 < y^* \leq \alpha_2$

$\vdots$

$y = J$ if $y^* > \alpha_J$

[19]The Ordinary Least Square will assume that fertility is continuous and unlimited with errors that are symmetric and have constant variance hence the OLS is not appropriate for such an estimation. The Probit model is more realistic and frequently used in literature to analyze fertility behavior hence the current technique adopted here is a generally acceptable standard approach.

Conditional distribution for y given X is equivalent to response probability which is derived as:

$P(y = 1 \mid X) = P(y^* \leq \alpha_1 \mid X) = P(X\beta + e \leq \alpha_1 \mid X) = F(\alpha_1 - X\beta)$

$P(y = 2 \mid X) = P(\alpha_1 < y^* \leq \alpha_2 \mid X) = F(\alpha_2 - X\beta) - F(\alpha_1 - X\beta)$

$\vdots$

$P(y = J - 1 \mid X) = P(\alpha_{J-1} < y^* \leq \alpha_J \mid X) = F(\alpha_J - X\beta) - F(\alpha_{J-1} - X\beta)$

$P(y = J \mid X) = P(y^* > \alpha_J \mid X) = 1 - F(\alpha_J - X\beta)$

For the error term, a standard normal distribution implies $F = \Phi$ yielding a Ordered Probit. The parameters of α and β can be estimated by Maximum Likelihood method. Since y^* is an abstract construct, the β itself holds less meaning from $E(y^* \mid X) = X\beta$ so the goal is to examine response probabilities $P(y = j \mid X)$ using partial effects. Births are discrete events so the model rescales the distance between births in terms of the latent fertility function. The respondent is observed to report their number of births and is accordingly assigned to one of (J) categories if she has $1, 2, 3....J$ births.

4.5.2 Fertility Choice within Q-Q configuration

The choice of child quantity can be portrayed in various ways. The current study endeavors to narrow down the chief determinants of fertility in India using the following structures:

Below, At and Above Replacement Fertility choice

Before looking at the Q-Q tradeoff which applies only to childbearing households, it is useful to examine how individuals decide their fertility behavior in general. Looking at the set of older women (keep age≥45) I divide the respondents into three separate categories and try to compare the different socio-economic and demographic factors that may lead to a wide range of reproductive choices.

The levels of fertility can be arranged as:

No Fertility: $n = 0$

Replacement Fertility: $0 < n \leqslant 2 \Rightarrow n = 1 or 2$

Above Replacement Fertility: $n > 2 \Rightarrow n = 3, 4, 5, 6........$

Using a Multinomial Probit model as described earlier, I try to understand why some households choose to have very large number of children while some choose none or at least within replacement levels of fertility.

Incremental Childbearing decisions

Now concentrating on the population of interest i.e. parents who have positive number of children, I evaluate the extended Q-Q model of fertility. For the women I focus on older respondents (keep age≥45) who have almost completed their reproductive histories and drop those households who report the number of children to be zero (keep n≥1).

The households can be organized with increasing number of children reported as: $n = 1, 2, 3, 4, 5, 6$........ and I use an Ordered Probit model similar to the structure derived previously.

4.5.3 Variable Definitions

The exogenous and endogenous variables of interest are selected and short listed as follows:

Dependent Outcome Variable:

Indicator of Child Quantity

FERTILITY: Total number of children ever born.

Indicator of Child Quality[20]

CHILD HEALTH: Height measures standardized by age.

Independent Predictor Variables:

LOCATION: Spatial aspects are captured by state of residence and degree of urbanization. I aggregate the geographic regions to North, South, East, West and Central India.

WEALTH: A graded wealth index is used as a proxy for income[21] which stratifies the households by weighted average of several indictor variables using quintiles (Range=1-5).

PARENTAL EDUCATION: The husband and wife's own educational attainment is an important precursor to investments in child quality. I consider individuals with at least some secondary schooling to be in the higher education category.

RELIGION: Different religious beliefs may hinder responsiveness to family planning initiatives and currently I am targeting the two largest religious groups of Hindus and Muslims.

AGE: Respondent's own age and partners age and time of marriage indicates the spacing of major life events.

[20] Child Education represented by educational level or highest year of schooling of the child could not be used as quality outcome because of limitations of the current dataset which did not allow the model to be computed due to insufficient number of observations.

[21] Income from labor sources is reflected by market wages but affected by labor force participation which may depend on the number of children and could be endogenous so I use the wealth index instead.

OCCUPATION: The labor force participation and type of job of the parents could impact fertility and I examine the impact of mother's involvement in agriculture as the primary source of employment.

FAMILY PLANNING: Specifies effectiveness of targeted family planning programs (GOI promotes pill, IUD and condoms) which is represented here by respondents knowledge of contraception.

Table 4.4 provides the summary statistics for the variables used in the analysis. Several dependent variables are categorical and have been constructed as binary indicators. The predictors represent regional characteristics, household features and parental qualities.

	Variables^	MEAN	STANDARD DEVIATION	MINIMUM	MAXIMUM
Dependent	**ChEverBorn**	**3.9159**	**2.1874**	**0**	**15**
	ChHealth	**-2.0309**	**3.928**	**-9.2102**	**8.5171**
	Ht/Age Percentile	**24.0516**	**32.3480**	**0**	**99.98**
Independent	**North**	**0.2424**	**0.4286**	**0**	**1**
	East	**0.2492**	**.04326**	**0**	**1**
	West	**0.1344**	**0.3411**	**0**	**1**
	Central	**0.1412**	**0.3483**	**0**	**1**
	Urban	**0.4646**	**0.4987**	**0**	**1**
	HouseOwn	**0.8626**	**0.3442**	**0**	**1**
	Hindu	**0.7487**	**0.4337**	**0**	**1**
	Muslim	**0.1077**	**0.3101**	**0**	**1**
	WealthIndex	**3.6599**	**1.3413**	**1**	**5**
	MoAge	**46.6319**	**1.4067**	**45**	**49**
	MoAgeMarriage1	**18.1375**	**4.2358**	**5**	**43**
	FaAge	**52.1968**	**4.8176**	**30**	**93**
	Literacy	**0.4107**	**0.4920**	**0**	**1**
	MoEduHi	**0.3416**	**0.4742**	**0**	**1**
	FaEduHi	**0.5635**	**0.4959**	**0**	**1**
	MoOccupAg	**0.2236**	**0.4167**	**0**	**1**
	ContraKnowl	**0.8980**	**0.1086**	**0**	**1**

NOTES:
^ Statistics for older women (age>45) who are primary respondents from Women's data-file from DHS 2005-06.

Table 4.4: Summary Statistics for DHS 2005-06

Design of Regression Equations:

The explanatory power of the predictor variables can be seen from the following regressions:

ChildQuantity = f(LOCATION, WEALTH, PARENTAL EDUCATION, RELIGION, AGE, OCCUPATION, FAMILY PLANNING, Interactions)

ChildQuality = f(LOCATION, WEALTH, PARENTAL EDUCATION, RELIGION, AGE, OCCUPATION, Interactions)

I am controlling for individual attributes like parents age and education, household traits like religion and wealth as well as community level parameters like location and contraceptive prevalence. Often one independent variable either adds or detracts from the impact of another and there are several potential interactions that can be considered. I am primarily interested in the underlying maternal influence on childbearing outcomes and so I direct the spotlight on Mother's Education and its interaction with Wealth and Occupation to see whether the variables reinforce each other. Previous literature also suggests that these are important joint effects that could affect the fertility outcomes.

4.6 Empirical Analysis

I run various regression models in order to assess how child quantity and quality is determined. Several individual and aggregate level variables are considered but many of these are totally exogenous to the system or not significant so I only report the relevant attributes that are included in the regression as independent variables. After controlling for these pertinent features, the different models yield coefficients or marginal effects that can be interpreted to get a better idea about how the extended Q-Q model applies to India.

Prior to the regression analysis I run some preliminary diagnostics like ensuring that there is no multicollinearity issues between the independent variables. The possibility of mother's labor force participation influencing fertility choice could lead to potential endogeneity issues. However in the analysis I just use class of occupation (agricultural worker or otherwise) and the women have mostly completed their childbearing prior to the survey; hence their occupation and work status should not be adversely affected by fertility and one could argue that this prevents reverse causality.

The data also needs to be manipulated before it can be used to substantiate the extended Q-Q model. The woman's age is used as a control to restrict my sample to respondents who have either completed or are towards the end of their reproductive careers as this ensures an accurate birth history for the household. Further I create dummies for categorical variables that could affect number of children or child health. Amongst the locational variables, the southern states act as the reference region because they have experienced the maximum fertility decline, so South acts as a base for comparison.

Finally for the interaction terms, I am currently focussing on the joint effects related to how parental quality (reflected by mother's education) may eventually affect quantity of children. The Log Likelihood Ratios indicate that the models with interactions are a better fit and the Log Likelihood Ratio Tests show that the coefficients of the interaction terms are significantly different from zero. Comparing the models with and without interactions, it is found that the joint impacts of the variables improve the explanatory power of the model and I calculate the net marginal effect[22] for the individual factors to understand the contribution of each of the component terms. This is evident as I run each model with and without interaction effects for the whole sample and then separately for the rural and urban subsamples using the appropriate datasets[23].

4.6.1 Multinomial Probit Analysis: Child Quantity choice relative to Replacement Fertility

Using replacement level fertility as the base outcome, the multinomial probit analysis can be conducted as per the following regression function:

FERT=f(North, East, West, Central, Urban, HouseOwn, Hindu, Muslim, WealthIndex, MoAge, MoAgeMarriage1, FaAge, Literacy, MoEduHi, FaEduHi, MoOccupAg, ContraKnowl)

Comparing across individuals who choose to have no fertility versus those who have within replacement or above replacement levels of fertility, there is a great degree of variation caused by the regressors.

Results for the whole of India are reported in Table 4.5. For regional features the southern states are the reference point, hence in comparison all the other areas show higher fertility behavior as they are lagging behind in terms of reduction in childbearing; so all residential regions barring the south correspond to above replacement fertility as opposed to replacement level childbearing. Also above replacement fertility is less common in urban India as opposed to the rural interiors. Within the two major religious groups, Hindu's are found to have children within the replacement range while their Muslim counterparts report higher levels of fertility. By the wealth stratification, richer families have a tendency to have around 1 or 2 children and have lower chances of having no children or extremely large number of them. For the assorted age levels, it is found that as a mother's age increases she has a higher chance of moving toward above replacement fertility but as the age of first marriage rises, these women actually fall into the lower fertility brackets. Moving on to the educational attainment of parents, mothers' who

[22]For the regression $y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_{12} x_1 x_2 + \beta_{13} x_1 x_3 + ...$ we can set up the net partial effects as $\frac{\partial y}{\partial x_1} = \beta_1 + \beta_{12}\bar{x_2} + \beta_{13}\bar{x_3}$; $\frac{\partial y}{\partial x_2} = \beta_2 + \beta_{12}\bar{x_1}$; $\frac{\partial y}{\partial x_3} = \beta_3 + \beta_{13}\bar{x_1}$.

[23]Regression is primarily based on Women and Births data-files. The Children datafile only reports cases of births within the last 5 years hence it is a restrictive subsample; the Male datafile is not of interest as women are main respondents in the surveys; the Couple and Household data-files are constructed by matching the men and women but do not add any additional information; so a combination of Women and Births datasets are used for the study.

are more educated tend have 2 or fewer children and are less predisposed towards above replacement fertility levels, father's education also shows a corresponding response. Finally women who are engaged in agriculture prefer to have greater number of offspring, probably because these children can help with farming activities.

WHOLE SAMPLE§		MODELS WITHOUT INTERACTION (Log Likelihood=-4373.85)			MODELS WITH INTERACTION^ (Log Likelihood=-4347.14)		
Variables		No Fertility	Replacement Fertility	Above Replacement Fertility	No Fertility	Replacement Fertility	Above Replacement Fertility
Regional Characteristics	North	-0.0040	-0.1172*	0.1213*	-0.0041	-0.1241*	0.1282*
	East	-0.0042	-0.1012*	0.1054*	-0.0040	-0.1005*	0.1046*
	West	0.0054	-0.0923*	0.0869*	0.0053	-0.0970*	0.0917*
	Central	0.0002	-0.0999*	0.0996*	0.0002	-0.1072*	0.1070*
	Urban	0.0047	0.0015	-0.0063*	0.0047	-0.0052	0.0004
Household Characteristics	HouseOwn	-0.0021	0.0041	-0.0019	-0.0021	0.0037	-0.0015
	Hindu	0.0077	0.0406*	-0.0483*	0.0075	0.0389*	-0.0465*
	Muslim	0.0104	-0.0661*	0.0556*	0.0103	-0.0629*	0.0525*
	WealthIndex	-0.0046*	0.0155*	-0.0108*	-0.0046*	0.0035*	0.0010
Parental Characteristics	MoAge	-0.0026*	-0.0136*	0.0162*	-0.0026*	-0.0133*	0.0160*
	MoAgeMarriage1	0.0032*	0.0185*	-0.0217*	0.0032*	0.0179*	-0.0212*
	FaAge	0.0007*	0.0040*	-0.0048*	0.0007*	0.0036*	-0.0043*
	Literacy	0.0048	0.0232	-0.2814	0.0048	0.0342*	-0.0391*
	MoEduHi	-0.0028	0.1239*	-0.1210*	-0.0085	-0.1731*	0.1817*
	FaEduHi	-0.0018	0.0217*	-0.0198*	-0.0017	0.0239*	-0.0221*
	MoOccupAg	0.0013	-0.0267*	0.0254*	0.0012	-0.0204	0.0191
	ContraKnowl	0.0116	0.0142	-0.0258	0.0117	0.0221	-0.0339
Inter-actions	MoEduHi*WealthIndex	–	–	–	0.0012	0.0662*	-0.0674*
	MoEduHi*MoOccupAg	–	–	–	-0.0003	-0.0657	0.0660*
Net Effects	WealthIndex^	–	–	–	-0.0041*	0.0263*	-0.0221
	MoEduHi^	–	–	–	-0.0039	0.0544*	-0.0504*
	MoOccupAg^	–	–	–	0.0011	-0.0430	0.0419

NOTES:
§ Log-Likelihood Ratio Tests show that coefficients of interaction terms are significantly different from zero.
^ Reports net effect for terms involved in interactions.
* Indicates marginal effect for multinomial-probit estimates is significant at 10% level.

Table 4.5: Results of regression for whole sample (mprobit)

RURAL SUBSAMPLE§		MODELS WITHOUT INTERACTION (Log Likelihood=-2139.41)			MODELS WITH INTERACTION^ (Log Likelihood=-2133.21)		
Variables		No Fertility	Replacement Fertility	Above Replacement Fertility	No Fertility	Replacement Fertility	Above Replacement Fertility
Regional Characteristics	North	0.0002	-0.1429*	0.1427*	0.0003	-0.1432*	0.1429*
	East	-0.0104*	-0.1379*	0.1484*	-0.0104*	-0.1365*	0.1469*
	West	0.0049	-0.1055*	0.1006*	0.0051	-0.1056*	0.1004*
	Central	-0.0016	-0.0955*	0.0972*	-0.0016	-0.0992*	0.1008*
	Urban	–	–	–	–	–	–
Household Characteristics	HouseOwn	0.0036	0.0004	-0.0040	0.0036	0.0027	-0.0064
	Hindu	-0.0057	0.0072	-0.0015	-0.0059	0.0049	0.0010
	Muslim	-0.0025	-0.0652*	0.0677*	-0.0026	-0.0665*	0.0692*
	WealthIndex	-0.0049*	0.0127*	-0.0077	-0.0047*	0.0069	-0.0021
Parental Characteristics	MoAge	-0.0034*	-0.0134*	0.0168*	-0.0034*	-0.0134*	0.0168*
	MoAgeMarriage1	0.0024*	0.0125*	-0.0150*	0.0024*	0.0122*	-0.0147*
	FaAge	0.0007*	0.0026*	-0.0033*	0.0007*	0.0024*	-0.0032*
	Literacy	0.0001	0.0365*	-0.0366*	-0.0000	0.0432*	-0.0431*
	MoEduHi	-0.0005	0.0768*	-0.0762*	0.0073	-0.0428	0.0354
	FaEduHi	0.0015	0.0071	-0.0087	0.0016	0.0087	-0.0104
	MoOccupAg	-0.0008	-0.0291*	0.0299*	-0.0001	-0.0201	0.0202
	ContraKnowl	0.0112	0.0516	-0.0628	0.0114	0.0552	-0.0667
Inter-actions	MoEduHi*WealthIndex	–	–	–	-0.0016	0.0308*	-0.0291*
	MoEduHi*MoOccupAg	–	–	–	-0.0092	-0.0627*	0.0720*
Net Effects	WealthIndex^	–	–	–	-0.0050*	0.0126	-0.0076
	MoEduHi^	–	–	–	-0.0009	0.0251	-0.0241
	MoOccupAg^	–	–	–	-0.0018	-0.0318	0.0337

NOTES:
§ Log-Likelihood Ratio Tests show that coefficients of interaction terms are significantly different from zero.
^ Reports net effect for terms involved in interactions.
* Indicates marginal effect for multinomial-probit estimates is significant at 10% level.

Table 4.6: Results of regression for rural subsample (mprobit)

The base model and the model incorporating joint effects seem to respond in the same manner to the independent variables for the marginal effect coefficients that have statistical significance. For the model with interactions, literacy becomes a significant determinant of fertility and greater literacy levels are found to encourage lower fertility. It is interesting to note that wealth discourages both very low and very high fertility but promotes replacement level childbearing. Wealth together with mother's education consolidates the impact and has positive influence on

URBAN SUBSAMPLE§		MODELS WITHOUT INTERACTION (Log Likelihood=-2182.98)			MODELS WITH INTERACTION^ (Log Likelihood=-2163.42)		
Variables		No Fertility	Replacement Fertility	Above Replacement Fertility	No Fertility	Replacement Fertility	Above Replacement Fertility
Regional Characteristics	North	-0.0116*	-0.0956*	0.1073*	-0.0121*	-0.1040*	0.1161*
	East	0.0014	-0.0573*	0.0559*	0.0011	-0.0549*	0.0538*
	West	0.0039	-0.0832*	0.0792*	0.0033	-0.0868	0.0835*
	Central	0.0013	-0.1129*	0.1115*	0.0008	-0.1168*	0.1159*
	Urban	–	–	–	–	–	–
Household Characteristics	HouseOwn	-0.0046	0.0016	0.0030	-0.0042	0.0008	0.0033
	Hindu	0.0238*	0.0603*	-0.0841	0.0236*	0.0603*	-0.0840*
	Muslim	0.0286*	-0.0707*	0.0420	0.0282*	-0.0656*	0.0374
	WealthIndex	-0.0028	0.0296*	-0.0267*	-0.0022	-0.0058	0.0080
Parental Characteristics	MoAge	-0.0017	-0.0151*	0.0168*	-0.0017	-0.0146*	0.0164*
	MoAgeMarriage1	0.0040*	0.0257*	-0.0297*	0.0040*	0.0253*	-0.0294*
	FaAge	0.0009*	0.0063*	-0.0072*	0.0009*	0.0058*	-0.0068*
	Literacy	0.0131	-0.0005	-0.0125	0.0122	0.0141	-0.0264
	MoEduHi	-0.0112	0.1564*	-0.1452*	-0.0200	-0.4573*	0.4774*
	FaEduHi	-0.0084	0.0471*	-0.0387*	-0.0081	0.0478*	-0.0397*
	MoOccupAg	-0.0011	-0.0886*	0.0898*	-0.0196	-0.0626	0.0822*
	ContraKnowl[1]	–	–	–	–	–	–
Inter-actions	MoEduHi*WealthIndex	–	–	–	0.0016	0.1295*	-0.1311*
	MoEduHi*MoOccupAg	–	–	–	0.0400	-0.0362	-0.0037
Net Effects	WealthIndex^	–	–	–	-0.0013	0.0621	-0.0607
	MoEduHi^	–	–	–	-0.0111	0.1144*	-0.1033*
	MoOccupAg^	–	–	–	0.0013	-0.0816	0.0803*

NOTES:
§ Log-Likelihood Ratio Tests show that coefficients of interaction terms are significantly different from zero.
^ Reports net effect for terms involved in interactions.
* Indicates marginal effect for multinomial-probit estimates is significant at 10% level.
1 Most urban residents have contraceptive-knowledge so variable is dropped from regression function.

Table 4.7: Results of regression for urban subsample (mprobit)

replacement fertility behavior. Mother's education and agricultural participation on the other hand jointly work to raise child bearing to above replacement levels, hence occupational effect dominates and diminishes the gains from parental quality.

The evidence for the rural and urban zones as reported in Tables 4.6 and 4.7 are found to be consistent with the findings for the entire country. The statistically significant results of the subsamples do share the same signs with the whole of India so the explanations remain valid for varying degrees of urbanization.

4.6.2 Ordered Probit Analysis: Child Quantity decision for Incremental Levels

After arranging the respondents by increasing levels of childbearing, I estimate the relationship between fertility and its determinants as per the following regression:

ChEverBorn=f(North, East, West, Central, Urban, HouseOwn, Hindu, Muslim, WealthIndex, MoAge, MoAgeMarriage1, FaAge, Literacy, MoEduHi, FaEduHi, MoOccupAg, ContraKnowl)

For incremental levels of childbearing within the ordered probit model, I attempt to understand the impact for $n = 2, 3, 4, 5$ because they occur with the maximum frequency within the distribution of births in the age restricted subsample. The actual range of number of children ever born is between 1 to 15.

Within the whole sample as per Table 4.8, we can compare why some women may choose fewer children while others have a larger number of births. The north, east, west and central parts of the country have a lower propensity to have 2 or 3 children but display a leaning towards having 4 or 5 children. Since the states of southern India have the lowest fertility levels in the country, the rest of the regions relatively experience much greater childbearing. Across religious beliefs, the Hindu's continue to show a preference for 2 or 3 children and are less likely to have 4 or more offspring while the Muslim respondents appear to have a preference for larger family sizes.

Wealthier households tend to have positive number of children due to wealth effect but definitely restrict their childbearing to lower levels. The variation in age is also crucial, as older women report that they have more children but as the age of marriage increases or fathers age rises, then there is a downturn in the number of children; this could be a result of delayed childbearing or a shift in the birth cycle where parents start having children later in life which shortens their reproductive window and as a result are found to have fewer number of them.

In terms of parental education, literacy as well as greater schooling for mother and father yield lower fertility levels and seem to deter households from having 4 or 5 children. For the magnitudes within parental quality, it is found that greater literacy is the most important predictor of lower child quantity. Awareness of contraceptives also encourages planned parenting and restricts number of children to 2 or 3. The models with and without interaction effect respond similarly to the variation in the regressors as evident from the coefficient signs. Further the joint effect of wealth and mother's education together yield positive impact on 2 or 3 children hence effectively repressing 4 or 5 births; but the agricultural occupation for the mother dampens the gains from education and together they lead to greater number of children.

WHOLE SAMPLE§		**MODELS WITHOUT INTERACTION** (Log Likelihood=-15103.52)				**MODELS WITH INTERACTION^** (Log Likelihood=-15080.92)			
	Variables	**No. of Children n=2**	**No. of Children n=3**	**No. of Children n=4**	**No. of Children n=5**	**No. of Children n=2**	**No. of Children n=3**	**No. of Children n=4**	**No. of Children n=5**
Regional Characteristics	**North**	**-0.0841***	**-0.0350***	**0.0171***	**0.0346***	**-0.0856***	**-0.0370***	**0.0168***	**0.0355***
	East	**-0.0726***	**-0.0280***	**0.0167***	**0.0305**	**-0.0712***	**-0.0280***	**0.0163***	**0.0304***
	West	**-0.0580***	**-0.0201***	**0.0152***	**0.0250**	**-0.0587***	**-0.0212***	**0.0151***	**0.0256***
	Central	**-0.0802***	**-0.0325***	**0.0171***	**0.0332**	**-0.0818***	**-0.0345***	**0.0168***	**0.0342***
	Urban	**-0.0011**	**-0.0005**	**0.0001**	**0.0004**	**-0.0035**	**-0.0017**	**0.0004**	**0.0013**
Household Characteristics	**HouseOwn**	**-0.0073**	**-0.0036**	**0.0009**	**0.0027**	**-0.0073**	**-0.0037**	**0.0008**	**0.0028**
	Hindu	**0.0508***	**0.0252***	**-0.0064***	**-0.0194***	**0.0489***	**0.0250***	**-0.0057***	**-0.0187***
	Muslim	**-0.0510***	**-0.0253***	**0.0064***	**0.0194***	**-0.0501***	**-0.0255***	**0.0058***	**0.0192***
	WealthIndex	**0.0260***	**0.1293***	**-0.0032***	**-0.0099***	**0.0228***	**0.0116***	**-0.0026***	**-0.0087***
Parental Characteristics	**MoAge**	**-0.0084***	**-0.0041***	**0.0010***	**0.0032***	**-0.0082***	**-0.0042***	**0.0009***	**0.0031***
	MoAgeMarriage1	**0.0118***	**0.0059***	**-0.0015***	**-0.0045***	**0.0115***	**0.0059***	**-0.0013***	**-0.0044***
	FaAge	**0.0025***	**0.0012***	**-0.0003***	**-0.0009***	**0.0024***	**0.0012***	**-0.0002***	**-0.0009***
	Literacy	**0.0274***	**0.0136***	**-0.0034***	**-0.0104***	**0.0302***	**0.0154***	**-0.0035***	**-0.0116**
	MoEduHi	**0.0505***	**0.0251***	**-0.0063***	**-0.0192***	**-0.0558***	**-0.0285***	**0.0065***	**0.0214***
	FaEduHi	**0.0177***	**0.0088***	**-0.0022***	**-0.0067***	**0.0186***	**0.0095***	**-0.0021***	**-0.0071***
	MoOccupAg	**-0.0049**	**-0.0024**	**0.0006**	**0.0018**	**-0.0007**	**-0.0003**	**0.0000**	**0.0002**
	ContraKnowl	**0.0301***	**0.0150***	**-0.0038**	**-0.0115***	**0.0330***	**0.0169***	**-0.0038***	**-0.0126***
Inter-actions	**MoEduHi*WealthIndex**	–	–	–	–	**0.0241***	**0.0123***	**-0.0028***	**-0.0092***
	MoEduHi*MoOccupAg	–	–	–	–	**-0.0466***	**-0.0238**	**0.0054***	**0.0178***
Net Effects	**WealthIndex^**	–	–	–	–	**0.0310***	**0.0158***	**-0.0036***	**-0.0118***
	MoEduHi^	–	–	–	–	**0.0219***	**0.0111***	**-0.0025***	**-0.0084***
	MoOccupAg^	–	–	–	–	**-0.0167**	**-0.0085**	**0.0019**	**0.0064**

NOTES:
§ Log-Likelihood Ratio Tests show that coefficients of interaction terms are significantly different from zero.
^ Reports net effect for terms involved in interactions.
* Indicates marginal effect for ordered-probit estimates is significant at 10% level.

Table 4.8: Results of regression for whole sample (oprobit)

RURAL SUBSAMPLE§		MODELS WITHOUT INTERACTION (Log Likelihood=-8636.68)				MODELS WITH INTERACTION^ (Log Likelihood=-8633.11)			
Variables		No. of Children n=2	No. of Children n=3	No. of Children n=4	No. of Children n=5	No. of Children n=2	No. of Children n=3	No. of Children n=4	No. of Children n=5
Regional Characteristics	North	-0.1058*	-0.0667*	0.0066*	0.0414*	-0.1053*	-0.0670*	0.0063*	0.0412*
	East	-0.1013*	-0.0623*	0.0078*	0.0402*	-0.1005*	-0.0623*	0.0076*	0.0400*
	West	-0.0804*	-0.0442*	0.0113*	0.0337*	-0.0794*	-0.0439*	0.0111*	0.0334*
	Central	-0.0956	-0.0571*	0.0091*	0.0386*	-0.0958*	-0.0579*	0.0087*	0.0387*
	Urban	–	–	–	–	–	–	–	–
Household Characteristics	HouseOwn	-0.0133	-0.0102	-0.0012	0.0042	-0.0129	-0.0100	-0.0012	0.0041
	Hindu	0.0445*	0.0340*	0.0042*	-0.0142*	0.0427*	0.0329*	0.0042*	-0.0137*
	Muslim	-0.0386*	-0.0296*	-0.0036*	0.0123*	-0.0397*	-0.0306*	-0.0039*	0.0127*
	WealthIndex	0.0240*	0.0184*	0.0022*	-0.0077*	0.0236*	0.0181*	0.0023*	-0.0075*
Parental Characteristics	MoAge	-0.0073*	-0.0056*	-0.0006*	0.0023*	-0.0072*	-0.0056*	-0.0007*	0.0023*
	MoAgeMarriage1	0.0086*	0.0066*	0.0008*	-0.0027*	0.0085*	0.0065*	0.0008*	-0.0027*
	FaAge	0.0019*	0.0014*	0.0001*	-0.0006*	0.0019*	0.0015*	0.0001*	-0.0006*
	Literacy	0.0218*	0.0166*	0.0020*	-0.0069*	0.0226*	0.0174*	0.0022*	-0.0072*
	MoEduHi	0.0263*	0.0201*	0.0024*	-0.0084*	0.0254	0.0196	0.0024	-0.0081
	FaEduHi	0.0135*	0.0103*	0.0012*	-0.0043*	0.0139*	0.0107*	0.0013*	-0.0044*
	MoOccupAg	-0.0072	-0.0055	-0.0006	0.0023	-0.0030	-0.0023	-0.0002	0.0009
	ContraKnowl	0.0361*	0.0276*	0.0034*	-0.0115*	0.0372*	0.0287*	0.0036*	-0.0119*
Inter-actions	MoEduHi*WealthIndex	–	–	–	–	0.0018	0.0014	0.0001	-0.0005
	MoEduHi*MoOccupAg	–	–	–	–	-0.0409*	-0.0315	-0.0040*	0.0131*
Net Effects	WealthIndex^	–	–	–	–	0.0239*	0.0184*	0.0023*	-0.0076*
	MoEduHi^	–	–	–	–	0.0153	0.0118	0.0015	-0.0049
	MoOccupAg^	–	–	–	–	-0.0106	-0.0081	-0.0010	0.0034

NOTES:
§ Log-Likelihood Ratio Tests show that coefficients of interaction terms are significantly different from zero.
^ Reports net effect for terms involved in interactions.
* Indicates marginal effect for ordered-probit estimates is significant at 10% level.

Table 4.9: Results of regression for rural subsample (oprobit)

Tables 4.9 and 4.10 record regression results for rural and urban areas and most of the variables elicit a similar response from the dependent fertility measure as in the main sample. However the nationally estimated parameters do differ from those of the rural areas for cases when number of children is set at 4 and these results are statistically significant (contrasting Tables 4.8 and 4.9). For the base model without interactions, factors like practice of Hinduism, greater wealth, higher age at marriage or father's age and more parental education all lead to lower chances of families having 4 children in the whole sample but these same variables operate differently in

URBAN SUBSAMPLE§		MODELS WITHOUT INTERACTION (Log Likelihood=-6385.82)				MODELS WITH INTERACTION^ (Log Likelihood=-6368.27)			
	Variables	No. of Children n=2	No. of Children n=3	No. of Children n=4	No. of Children n=5	No. of Children n=2	No. of Children n=3	No. of Children n=4	No. of Children n=5
Regional Characteristics	North	-0.0648*	-0.0108*	0.0242*	0.0285*	-0.0682*	-0.0125*	0.0249*	0.0303*
	East	-0.0369*	-0.0035*	0.0155*	0.0166*	-0.0347*	-0.0033*	0.0147*	0.0159*
	West	-0.0395*	-0.0040*	0.0164*	0.0177*	-0.0407*	-0.0046*	0.0168*	0.0186*
	Central	-0.0696*	-0.0125*	0.0255*	0.0305*	-0.0716*	-0.0137*	0.0257*	0.0317*
	Urban	–	–	–	–	–	–	–	–
Household Characteristics	HouseOwn	-0.0073	-0.0015	0.0025	0.0031	-0.0073	-0.0016	0.0024	0.0032
	Hindu	0.0492*	0.0105*	-0.0169*	-0.0214*	0.0482*	0.0108*	-0.0163*	-0.0211*
	Muslim	-0.0673*	-0.0144*	0.0232*	0.0293*	-0.0653*	-0.0146*	0.0220*	0.0286*
	WealthIndex	0.0319*	0.0068*	-0.0110*	-0.0139*	0.0211*	0.0047*	-0.0071*	-0.0092*
Parental Characteristics	MoAge	-0.0101*	-0.0021*	0.0035*	0.0044*	-0.0099*	-0.0022*	0.0033*	0.0043*
	MoAgeMarriage1	0.0161*	0.0034*	-0.0055*	-0.0070*	0.0158*	0.0035*	-0.0053*	-0.0069*
	FaAge	0.0036*	0.0007*	-0.0012*	-0.0015*	0.0033*	0.0007*	-0.0011*	-0.0014*
	Literacy	0.0339*	0.0072*	-0.0117*	-0.0148*	0.0382*	0.0086*	-0.0129*	-0.0167*
	MoEduHi	0.0605*	0.0129*	-0.0208*	-0.0263*	-0.1945*	-0.0437*	0.0657*	0.0853*
	FaEduHi	0.0257*	0.0055*	-0.0088*	-0.0112*	0.0262*	0.0058*	-0.0068*	-0.0125*
	MoOccupAg	-0.0221	-0.0047	0.0076	0.0096	-0.0156	-0.0035	0.0052	0.0068
	ContraKnowl	-0.0416	-0.0089	0.0143	0.0181	-0.0402	-0.0090	0.0136	0.0176
Inter-actions	MoEduHi*WealthIndex	–	–	–	–	0.0537*	0.0120*	-0.0181*	-0.0235*
	MoEduHi*MoOccupAg	–	–	–	–	-0.0203	-0.0045	0.0068	0.0089
Net Effects	WealthIndex^	–	–	–	–	0.0490*	0.0110*	-0.0165*	-0.0215*
	MoEduHi^	–	–	–	–	0.0426*	0.0095*	-0.0144*	-0.0187*
	MoOccupAg^	–	–	–	–	-0.0260	-0.0058	0.0088	0.0115

NOTES:
§ Log-Likelihood Ratio Tests show that coefficients of interaction terms are significantly different from zero.
^ Reports net effect for terms involved in interactions.
* Indicates marginal effect for ordered-probit estimates is significant at 10% level.

Table 4.10: Results of regression for urban subsample (oprobit)

rural areas and encourage families to have more children. In addition to same coefficient signs for models with interaction effects, knowledge of contraceptives reduces the propensity to have 4 children in the whole sample unlike its effect in rural areas. Joint effect of mother's education and her participation in agriculture has a positive impact on having 4 births in the whole of India while it leads to more than 4 births for the rural subsample. The switch here indicates that certain factors, which encourage parents within the entire sample to have 2 or 3 children but discourage 4 or 5, do not have the identical effect for rural regions, rather the same predictors lead to 2, 3 or 4 children in rural parts and negatively impact choice of 5 or more offspring.

4.6.3 OLS Regression Analysis: Child Quality preference in terms of Health[24]

With child health as an indicator of quality, the following regression analysis shows how different factors contribute to determination of qualitative investment in children:

ChHealth=f(North, East, West, Central, Urban, HouseOwn, Hindu, Muslim, WealthIndex, MoAge, MoAgeMarriage1, FaAge, Literacy, MoEduHi, FaEduHi, MoOccupAg)

Child quality[25] here is represented by an age standardized measure of height and this serves as a continuous indicator of long term nutritional status for children. As the quality measure is already standardized, there is no risk of bias between younger and older children so no age cutoff need be applied, further it is a continuous variable hence regular least square methods can be utilized first for the whole sample and then separately for the rural and urban areas.

The results listed in Table 4.11 show how child quality in terms of health or nutritional status is determined. We can infer that northern, western and central regions of India need to improve their investments in child health because the regional indicators here have a negative impact on the health indicator. The degree of urbanization has low significance so this means rural and urban areas behave in the same way and other factors explain the changes better rather than where the respondent lives. House ownership does not improve children's wellbeing but wealthier households do show higher measures of child quality. There is a strong negative relationship between both the religious groups and child health, which may indicate that the other religions fare better in terms of this quality measure.

Increase in mother's age appears to have a consistent negative impact on child health across all regions but raising the marriageable age for women leads to a significant improvement in child quality. An increase in father's age adversely affects child health in rural India but is beneficial for children in urban settings. Also higher levels of education for both mothers and fathers could result in better health for children even though literacy alone does not seem to greatly benefit nutritional indicators for the child. One surprising result that is difficult to explain is the negative impact of mother's education on health in the urban subsample with interactions;

[24] Child Quality preference in terms of education could not be used due to data limitations. One of the drawbacks of the DHS 2005-06 survey is that there is insufficient information on children's schooling.

[25] The rescaled variable is constructed from percentiles of the Height/Age ratio by setting $ChHealth = ln\left\{\frac{y}{1-y}\right\}$ where $y = \frac{Height/Age}{100}$; the respective ranges are $0<\text{Height/Age}<100$, $0<y<1$ and $-\infty<\text{ChHealth}<+\infty$.

Variables[1]		WHOLE SAMPLE		RURAL SUBSAMPLE		URBAN SUBSAMPLE	
		Without Interaction	With Interaction^	Without Interaction	With Interaction^	Without Interaction	With Interaction^
Regional Characteristics	North	-0.5584*	-0.5515*	-0.6857*	-0.6623*	-0.4408*	-0.4585*
	East	0.0855	0.1059*	-0.0759	-0.0486	0.2191*	0.2325*
	West	-0.2029*	-0.2004*	-0.1847*	-0.1584	-0.3087*	-0.3051*
	Central	-0.2891*	-0.3188*	-0.4725*	-0.4782*	-0.1261*	-0.1741*
	Urban	0.0059	-0.0188	–	–	–	–
Household Characteristics	HouseOwn	-0.1818*	-0.1905*	-0.3196*	-0.3167*	-0.0664	-0.0759
	Hindu	-0.3705*	-0.3805*	-0.4862*	-0.4989*	-0.2463*	-0.2583*
	Muslim	-0.2565*	-0.2444*	-0.3199*	-0.3163*	-0.1508	-0.1430
	WealthIndex	0.2582*	0.1509*	0.2022*	0.1229*	0.3705*	0.1893*
Parental Characteristics	MoAge	-0.0303*	-0.0310*	-0.0211*	-0.0218*	-0.0519*	-0.0520*
	MoAgeMarriage1	0.0739*	0.0693*	0.0619*	0.0596*	0.0855*	0.0803*
	FaAge	-0.0007	-0.0019	-0.0116*	-0.0123*	0.0222*	0.0203*
	Literacy	-0.2231*	-0.1520*	-0.2101*	-0.1579	-0.1877*	-0.1075
	MoEduHi^	0.3480*	-0.4923*	0.3212*	-0.1335	0.3131*	-1.3214*
	FaEduHi	0.0224	0.0407	-0.0394	-0.0251	0.1669*	0.1732*
	MoOccupAg^	-0.0757	-0.0118	-0.1381*	-0.0262	0.1704	0.0565
Inter-actions	MoEduHi*WealthIndex	–	0.2493*	–	0.1759*	–	0.3969*
	MoEduHi*MoOccupAg	–	-0.2839*	–	-0.4051*	–	0.2616
Net Effects	WealthIndex^	–	0.2335*	–	0.1621*	–	0.3856*
	MoEduHi^	–	0.2311*	–	0.1584	–	-0.3199*
	MoOccupAg^	–	-0.1058	–	-0.1164	–	0.1858

NOTES:
^ Reports net effect for terms involved in interactions.
* Indicates coefficient estimate is significant at 10% level.
1 ContraKnowl does not significantly affect child health so variable is dropped from regression function.

Table 4.11: Results of regression for whole sample and rural/urban subsamples (OLS)

however the effect is not present in the model without interaction nor is it present in the model for the entire sample. While mother's involvement in agriculture negatively affects child health in rural areas, the interaction of mother's education and wealth promotes child quality while the joint effect of mother's education and agricultural occupation detracts from accumulation of health for the child. Both mother's education and wealth seem to have positive impact on child quality but the joint effect is even greater; if mother is more educated then we find that increases in wealth lead to greater rise in child health. Also for a household that is wealthy, if the mother is educated then it provides an extra boost towards the health and nutrition of children. However the interaction between mother's education and her occupation shows that if the woman is engaged in agriculture then this dominates the effects of education and finally results in lower health levels for the child.

4.6.4 Implication of Findings

The three different regression models described above all convey the same message: parental quality affects both child quantity and quality. Analyzing the replacement fertility behavior, incremental levels of children ever born and the indicators of child health help to provide empirical support to the extended Q-Q hypothesis. As quality or education level of parent increases they have greater wage earning potential (which is often translated into higher income levels), with this rise in their opportunity cost of time the parents may wish to allocate less time to child care hence leading to a reduction in childbearing. Further as parent's quality improves, they learn to value the benefits of education and may imbibe their own children with greater endowments in quality whereby there is less demand for child quantity via the tradeoff.

Most of the variables included in the regressions are significant and have a high explanatory power in the models. Education and wealth seem to be the most important factors influencing child quantity and quality within the communities that were surveyed in India and the interactions contribute to understanding differences in household choices. High level of mother's education seems to have the greatest effect at replacement level fertility and this is followed by father's education, literacy, wealth and religion in terms of importance. If mother's education is low then the increases in wealth are found to not have a statistically significant impact on fertility. For the child quantity measures, wealth by itself has a smaller effect on fertility and its contribution depends more on the effect via education. In terms of child quality, wealth always has a positive and significant effect so richer households usually have better health of children and adding the influence of mother's education further improves the child's health status. So from the specific regression relations, parental quality and socio-economic status (SES) are crucial factors that help determine fertility choice among a host of other demographic catalysts.

The traditional Q-Q model posits that a rise in child quantity is accompanied by a decline in child quality. The reverse Q-Q ideology implies that as child quality (health and education) improves, there will be a concurrent reduction in number of children or child quantity. These lead to the extended form of the Q-Q tradeoff in the current paper as illustrated in Figure 4.4, which postulates that as parental quality rises it may have two effects: a direct effect where parents with greater levels of quality prefer fewer number of children and an indirect effect where higher quality parents would value more qualitative investments in their own children thereby leading to a decline in the number of children. So the empirical findings verify the main hypothesis that an increase in parental education could encourage households to choose smaller family sizes as there is a reduction in number of children born.

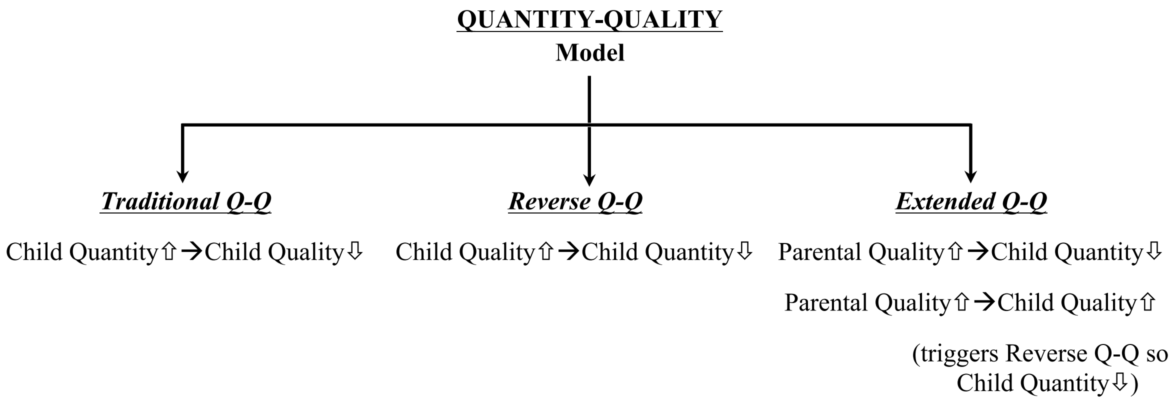


Figure 4.4: Versions of the Quantity-Quality model

4.7 Policy Recommendations

A spectrum of factors may potentially affect fertility of individuals and policies to induce desired fertility behavior range from direct financial incentives to targeted socio-cultural development mechanisms. The findings from this paper supplemented by arguments from past literature implies that better educated, healthy and financially secure individuals tend to have fewer children as predicted by the Quantity-Quality tradeoff models for fertility. Hence Education, Health and Economic Well-being should all be important areas of focus and policy makers should incorporate this into their decision making process during incentive design and budget allocation.

The notion is that investing in quality in terms of child health and education could yield two part benefits: in the first round the children of the present generation receive greater qualitative investments and their parents choose lower levels of fertility as a fall out from the Q-Q tradeoff; in the second round these children grow up with better endowment of education and health so they learn to value quality and they too may prefer the Q-Q swap for the following generation. Hence the effects from benefits of quality leading to voluntary selection of lower quantity could trickle down from one generation to the next eventually leading to a replacement level fertility rate and stable population size in the long run.

4.8 Conclusion

Population size and growth rate are crucial components of long term development for a country. Since mortality rates have already declined as per demographic transition theory, a better understanding of the determinants of fertility will help in the design of effective and efficient policies. In spite of all the research that has already been undertaken, there are several controversies and debates about the most acceptable way to approach the issue of population growth and reproductive behavior. The Indian total fertility rate has dramatically declined, but given a large population base, any above replacement rate of fertility implies that the net population size is steadily expanding.

Parental quality levels are found to be important determinants of fertility behavior. Better educated parents are found to choose smaller family sizes and this could be due to several background mechanisms: the parents may learn to value the benefits of education and endow their children with greater qualitative investments hence triggering the tradeoff; parents become more receptive towards family planing programs and contraceptive awareness increases; educated parents command more market wages and this potential for better earnings implies a greater opportunity cost of time and parents may substitute away from child quantity and move towards greater child quality so higher income is associated with lower child bearing.

Using the Q-Q tradeoff entails improving child quality levels in terms of health and education, which will directly raise children's wellbeing and as a byproduct reduce the demand for quantity; higher quality raises income-earning potential and survival probability and at the same time could generate a stable population with replacement rate fertility. The different models tested for India reveal that there is evidence of the extended version of the Q-Q model in the current cross-sectional study. This implies that raising quality of children could help reduce quantity; raising quality of parents could lead to reduction in child quantity with an increase in child quality and finally we can infer that when higher quality children themselves grow up to be parents with greater quality endowment, they may self select lower levels of childbearing, hence allowing benefits from the tradeoff to cascade across generations.

4.9 Limitations & Concerns

Because I am using a cross-sectional survey to support the extension of the Q-Q model, some of the study findings are confined by the data limitations. For instance the DHS 2005-06 data does not have enough observations on child schooling so it is difficult to use educational attainment as a indicator of child quality while evaluating the tradeoff. Also the Q-Q model assumes all children to be homogeneous so it means that identical investments must be made in all children; hence the framework cannot incorporate gender bias (usually preference towards sons) or birth-order differences (younger and older siblings may be treated differently) in regression analysis.

4.10 Future Extensions

This paper examines the impact of parental quality on household reproductive choices using cross-sectional data but the analysis can be extended to a panel data set where by it will be possible to trace the child health and educational outcomes that could provide stronger evidence for the reverse causality of the Quantity-Quality hypothesis with regards to fertility. Birth order differences and gender preferences are also not specifically addressed in this framework but can be incorporated with additional data.

Appendix I

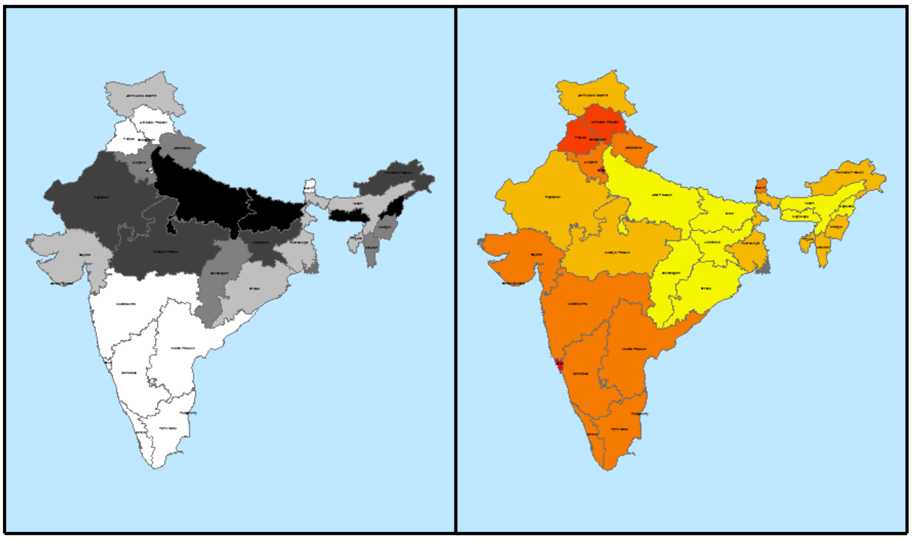
RESULTS from REGRESSION			Number of Observations	Goodness of Fit^ (R^2/Pseudo-R^2)	Log Likelihood
Child Quantity choice relative to Replacement Fertility (*mprobit*)	**WHOLE**	**Without Interaction**	**8293**	**0.790**	**-4373.852**
		With Interaction	**8293**	**0.794**	**-4347.146**
	RURAL	**Without Interaction**	**4461**	**0.827**	**-2139.411**
		With Interaction	**4461**	**0.828**	**-2133.213**
	URBAN	**Without Interaction**	**3832**	**0.755**	**-2182.986**
		With Interaction	**3832**	**0.764**	**-2163.423**
Child Quantity decisions for incremental levels (*oprobit*)	**WHOLE**	**Without Interaction**	**8124**	**0.090**	**-15103.529**
		With Interaction	**8124**	**0.091**	**-15080.928**
	RURAL	**Without Interaction**	**4377**	**0.064**	**-8636.684**
		With Interaction	**4377**	**0.065**	**-8633.117**
	URBAN	**Without Interaction**	**3747**	**0.110**	**-6385.826**
		With Interaction	**3747**	**0.112**	**-6368.274**
Child Quality preference in terms of Health (*OLS*)	**WHOLE**	**Without Interaction**	**39876**	**0.031**	**-**
		With Interaction	**39876**	**0.033**	**-**
	RURAL	**Without Interaction**	**24873**	**0.024**	**-**
		With Interaction	**24873**	**0.025**	**-**
	URBAN	**Without Interaction**	**15003**	**0.034**	**-**
		With Interaction	**15003**	**0.036**	**-**

NOTES:
^ Reports Count-R^2 for Multinomial Probit models and McFadden's-R^2 for Ordered Probit models.

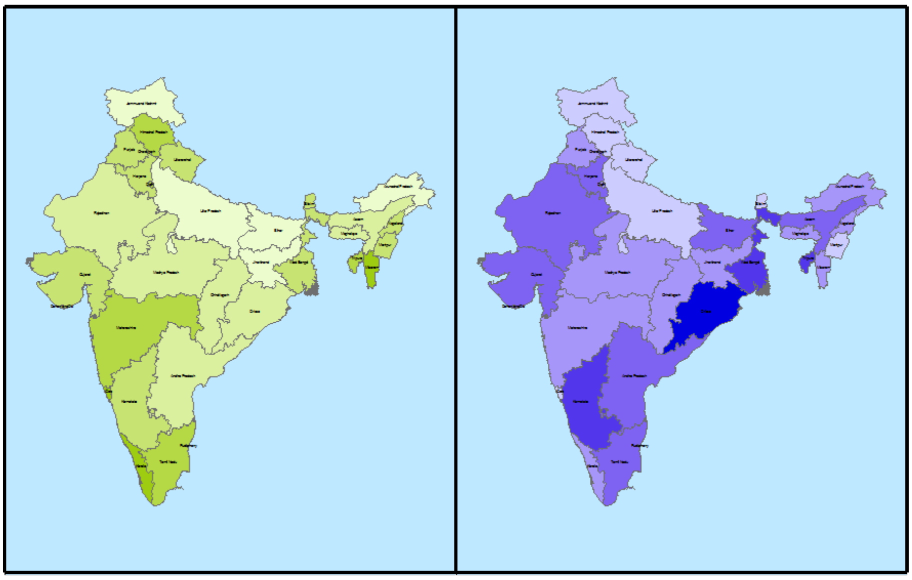
End-notes:

- The pseudo-R^2 values are usually low for models using micro-data.
- The models with interaction effects are an improvement over the original models with the individual predictors.
- The rural and urban categorization helps to understand which subsample contributes more to the whole sample results and eventually defines the national averages.

Appendix II



Panel 1: Fertility Map of India(2001) Panel 2: Income Map of India(2001)



Panel 3: Literacy Map of India(2001) Panel 4: Health Map of India(2001)

Legend: Darker shades indicate higher values of variable by quintiles. Education, income and health determine fertility and inverse relationship between TFR and these socioeconomic factors is evident from the representative maps of India above. Graphs indicate large spatial variation for the basic demographic features where patterns show that states with high TFR are concentrated to the north while lower fertility rates are observed mostly in southern India. Lighter areas in Panel 1 indicate low TFR and this corresponds to darker shades in Panel 2 and Panel 3 representing higher income (proportion of population owning television, phone or car with 1/3 weight to each asset) and education (literacy) respectively. Panel 4 uses access to clean drinking water as predictor of health measure; this does not correlate too highly with TFR.

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Chapter 5

SUMMARY

5.1 Contribution

The three essays discussed here explore the various aspects of the Quantity-Quality model of fertility and try to extend the previous literature in this area. A lot of research has already been undertaken to better understand ways to curb high population growth by reducing fertility, and my study contributes to the existing field in several important ways. Most of the studies in the past has focused on how a higher number of children may lead to lower investments in child quality, but I look at the reverse direction of causality and investigate how increasing child quality may in the long run reduce the demand for quantity as income-earning potential and the probability of survival to adulthood for children increases.

For Essay 1, I first solve the Q-Q model for different forms of the utility function and run simulations to show how changes in prices and income affect the household's decision to invest in number of offspring and their schooling levels. All functional forms tested represent simple systems of choice and has significant weaknesses; the Cobb Douglas stringently assumes the elasticities to behave in a predetermined manner (income elasticity=+1, own price elasticity=-1, cross price elasticity=0) while the Leontief requires goods to be consumed in fixed proportions so quantity and quality of children must maintain a fixed ratio. Given the range of variation in the elasticities for the various functional forms, the Stone Geary seems to be the nearest replica of reality among the 3 alternatives used here especially since it does not suffer from the drawbacks and restrictions of the other two functions. The Linear Expenditure system allows income and price elasticities to be flexible and can accommodate substitutability between child quality and quantity, hence it may be considered as the better of the 3 options being currently compared. Secondly I investigate the impacts of different policy experiments and test the hypothesis that policy initiatives may not always give the anticipated results as simply subsidizing qualitative improvements in children will not necessarily curtail fertility rates; the reduction in parent's out-of-pocket childcare costs to increase quality in terms of health and education may trigger greater childbearing as children are now cheaper to raise.

Essay 2 looks at the incidence of child labor as well as old age dependency on monetary transfers from one's children and finds that revenue earned from child labor and lack of social security for the elderly are important determinants of fertility behavior. The dynamic structural model with OLG examines dynastic household decision making units and extends the earlier literature where the life-cycle analysis only considers two time periods with altruism as the parent's prime goal for investing in child quality. This study is particularly important for three reasons: first, old age dependence and child labor are highly prevalent in most developing economy family structures but previous studies do not at look at the simultaneous presence of both factors in fertility choice; second, I use the Quantity-Quality model to calibrate the parameters and solve for the household decision variables after tracing the consumption, fertility, transfers to elderly, schooling and child labor behavior from 1967 to 2007 and finally I test effects of CCT's, mid-day meal programs and fertility reduction subsidies on behavioral outcomes.

Essay 3 verifies that parental quality levels are important determinants of fertility behavior. Better educated parents are found to choose smaller family sizes and this could be due to several background mechanisms: the parents may learn to value the benefits of education and endow their children with greater qualitative investments hence triggering the tradeoff; parents become more receptive towards family planing programs and contraceptive awareness increases; educated parents command more market wages and this potential for better earnings implies a greater opportunity cost of time and parents may substitute away from child quantity and move towards greater child quality so higher income is associated with lower child bearing. Models with interactions are a better fit as the LLR improves and the interaction terms do highlight some interesting findings. Mother's education and impact on fertility responds differently to varying amounts of wealth and occupational choice. The most striking result is that women's involvement in agriculture dampens their gains from education with respect to lowering of fertility. So the interaction of agricultural sector occupation and mother's education shows that the choice of employment actually moderates the benefits of better education and those women working in agriculture are hurt in terms of educational gains that could lower fertility.

Using the Q-Q tradeoff entails improving child quality levels in terms of health and education, which will directly raise children's wellbeing and as a byproduct reduce the demand for quantity; higher quality raises income-earning potential and survival probability and at the same time could generate a stable population with replacement rate fertility. The different models tested for India reveal that there is evidence of the extended version of the Q-Q model in the current cross-sectional study. This implies that raising quality of children could help reduce quantity; raising quality of parents could lead to reduction in child quantity with an increase in child quality and finally we can infer that when higher quality children themselves grow up to be parents with greater quality endowment, they may self select lower levels of childbearing, hence allowing benefits from the tradeoff to cascade across generations.

5.2 Policy Relevance

The purpose of the study is to find feasible and effective instruments that may be used in policy planning to induce desired fertility behavior. Any coercive and non-voluntary policy that infringes upon individual freedoms with regard to reproductive rights would be considered repressive and unacceptable. A spectrum of factors may potentially affect the fertility of individuals and policies range from direct financial incentives to sociocultural development mechanisms that ensure ethical justice and at the same time help to manage the population pressure.

Assuming that undistorted behavior is optimal for the household but has certain related externalities, this makes the choice socially suboptimal. However every financial instrument will have some associated costs and depending on the type of policy, dead weight losses are incurred by either the household or the administrating body. Any scheme that induces the household to internalize the cost will alter their choice of quantity or quality and result in a dead weight loss for the family as their first best option is now distorted; also any subsidy payment or enforcement cost will result in additional expenditure from the government budget and cause dead weight loss in terms of public finance.

Socio-cultural factors play an indispensable role in curtailing population growth and for a more time efficient response rate we should include an incentive or disincentive mechanism where desired fertility behavior is rewarded and the converse is met with negative sanctions. Though incentives or disincentives have different structures, they should essentially aim for the same goal. Monetary or equivalent benefits and penalties or financial disincentives may encourage families to modify their fertility downwards.

Essay 1 examines two of the commonest policy instruments which include either a penalty disincentive scheme or a subsidy incentive program. The use of financial incentive or disincentive will affect the price $(P_n, P_{nq}, \pi_n, \pi_q)$ and income (R, I) structure of the economy and the empirical analysis is an attempt to replicate such scenarios to explain the variation in demand (n, q) as it reacts to such changes. At first glance, the results may show that an incentive or a disincentive scheme will have a symmetric effect on fertility but closer observation indicates otherwise. The price effect of a policy intervention is identical if income is held constant, however any financial instrument will change the income levels. A penalty on high fertility will create a loss in income while a subsidy for lower child bearing will result in income gain, hence different schemes will not have similar effects and the public responsiveness to potential policies must be tested in advance.

Disincentive schemes may be more effective but a penalty may change the marginal cost for each child and cause loss of income from paying the fines, fees or bribes if one were to exceed the limit. Behavioral studies show that positive incentives are politically more popular than negative reinforcements; so social programs that make smaller families more appealing could encourage a decrease in fertility over a smaller time horizon. Some other possible micro-level policies deterring fertility involve making child schooling mandatory (perhaps with costs of education to be privately borne by parents) or subsiding women's education (so their opportunity cost of time and wages rise). Commonly used incentives are tax exemptions or direct cash payments which may be one time or deferred schemes. Studies claim that direct payments are part of the program costs for family planning programs while indirect tax exemptions or pension plans are costs borne by society as a whole in order to attain fertility reduction and this must be kept in mind during policy making and budget allocation.

Policies may range from incentives to disincentives and there is some degree of asymmetry in terms of efficiency of policy. Disincentives may have quicker response rates but are not looked upon favorably because they do not better the quality of life for people. Generally incentives are preferred as they do not increase the relative deprivation of the people and for a democratically elected government who need to attract votes for the next election cycle, the disincentive mechanisms may not really be very popular or politically palatable. This rationale may be verified by constructing a social welfare function with deadweight losses to show that though theoretically disincentives seem to elicit the desired result faster, in the long run incentive mechanisms are usually implemented in real world public policy scenarios. Another issue that must be considered is the length of the planning horizon since this may affect policy choice (tax or subsidy etc.) as per time efficiency; enforcement of policy depends on comparing the relative effectiveness of the instruments given turnover time of the government in power and responsiveness of potential parents who are the target audience.

From Essay 2, the presence of inter-generational transfers implies that revenue earned from child labor and lack of social security for the elderly are important determinants of fertility behavior. With respect to elderly transfers since the current model does not allow for savings, so in the absence of social security or alternative source of earnings the contributions from children must be non-zero as accommodating corner solutions would not allow any consumption for the old adults. Findings indicate that provision of old age benefits and financial security net may allow people to become more independent and rely less on some form of economic gifts from their offspring, hence young parents will have fewer children as they are not their sole source of income after they grow old and retire from employment.

The policy experiments tested in light of the dynamic Q-Q model are predominantly social programs with positive incentives to make smaller families more appealing and could encourage a decrease in fertility over a shorter time horizon. Most of the families under consideration are already financially constrained so additional negative sanctions may not be socially optimal. The commonest policy instruments include providing subsidies to households who restrict their fertility behavior within acceptable bounds, establishing conditional cash transfers to regulate labor force participation by children and implementation of mid-day meal schemes to encourage school enrollment and attendance. Even though these instruments have different objectives, they all play a role in reducing above replacement fertility so it is possible to harness the skills or resources of various sectors and programs to leverage the Q-Q tradeoff.

Essay 3 expounds the notion that investing in quality in terms of child health and education could yield two part benefits: in the first round the children of the present generation receive greater qualitative investments and their parents choose lower levels of fertility as a fall out from the Q-Q tradeoff; in the second round these children grow up with better endowment of education and health so they learn to value quality and they too may prefer the Q-Q swap for the following generation. Hence the effects from benefits of quality leading to voluntary selection of lower quantity could trickle down from one generation to the next eventually leading to a replacement level fertility rate and stable population size in the long run.

Policy implications do change if we consider the variation within gender preferences and birth order effect. Allowing parents to make differential investments in their children relaxes the homogenous quality assumption of the Q-Q model. For the Indian context, gender bias in favor of the boy child is still prevalent in many parts of the country so female children often suffer. Parents may consider the male heir to continue the lineage and earn higher wages to support the family where as girls are considered to be a burden as they often must be married off with dowry to another family and are not considered worth the investment in terms of human capital accumulation. Further birth order differences are also crucial when we examine large size families where the lower birth order children are often withdrawn from school early in order to care for their younger siblings or perhaps to engage in child labor to supplement the household income. So the qualitative investments discussed in the papers must incorporate these additional setbacks that girls and older siblings face and policies must be directed to rectify these social biases in order to level the playing field for all members of the next generation as each child deserves a fair opportunity and every young person's potential must be fulfilled.

The findings from these papers supplemented by arguments from past literature implies that better educated, healthy and financially secure individuals tend to have fewer children as predicted by the Quantity-Quality tradeoff models for fertility. Hence Education, Health and Economic Well-being should all be important areas of focus and policy makers should incorporate this into their decision making process during incentive design and budget allocation. Specifically population regulation via education subsidies alone is inefficient as parents will find children cheaper to raise and may increase childbearing; to reduce fertility via the Q-Q tradeoff we must improve child quality in conjunction with other family planning initiatives.

5.3 Caveats

Within the framework of the Q-Q tradeoff, the essays do not test the relative merits of the model but rather expand on the existing theories. Also investing in child quality does not simply mean academic pursuits; the definition of education must be broadened beyond conventional schooling and could include vocational training or acquiring other skill sets that will enhance a person's marketable human capital. This expanded qualitative investment may improve employment prospects, increase earning potential and better the way of life for individuals.

In the first essay, the expression for Roy's Identity uses internally determined shadow prices to estimate Marshallian demand and this may seem unconventional. However given that the same parents are the demanders and suppliers of children, for the current purpose we can use the shadow prices as regular prices even though they are endogenous. Also for the estimation of the 6 unknowns, I directly solve the 6 simultaneous equations hence the use of shadow prices in Roy's Identity does not affect the derivation of the results for the individual functional forms. Also the findings of the study are bound by data restrictions; since the entire set of 2011 estimates from the recent Indian Census are not available as yet, they are being substituted by 2001 indicators. At the policy implementation level, most of the public funding is diverted to critical areas that need immediate attention and very little is left over for family planning policies. Moreover no matter what plan is employed there will be a significant time lag before we see results because fertility decline is a slow process; this may hamper long term planning and policy execution as every five years a newly elected government may come to power and have a different agenda and outlook.

The results of the second essay also suffer from limited data; estimates are used at 20 year intervals to represent generations and the calibration of the parameters can be fine-tuned further to increase accuracy of the models predictive power. Intergenerational mobility can be observed by comparing the consumption levels across different generations as earnings may improve for the future descendants; also children may migrate from rural to urban areas in search of a better life but this spatial relocation is not included in the dynamic model. Psychological attachments or tendency to rank other's wellbeing higher than one's own are relative concepts and vary across people so the measures of altruism and preferential parameters are difficult to quantify. Child labor can be interpreted differently depending on the degree and time intensity of the activity that the child is involved in. Certain schools of thought claim that some amount of work at low levels may not be detrimental and could actually be beneficial for the child as it raises their human capital and productivity. Children may learn responsibility, punctuality, time management and they may pick up skills that could actually help them in their later lives provided the work does not encroach upon their physical, mental and emotional development. However for the purpose of this study, I specifically consider labor force participation by children that detracts from their human capital leading to lower future earning potential and wellbeing. The revenue earned from children contributes to household income, but the way I have modeled child labor ensures that it does not begin to adversely affect human capital accumulation to a great extent until we get to the point when significantly high levels of time is being devoted to market employment. Also the study assumes that all young adults are employed but several developing countries face the problem of widespread youth unemployment and this may change the effectiveness of any policy. If young adult parents are unable to earn the minimum wage then their budget constraint may be affected; impoverished households may respond quite differently to the same set of polices and the reaction to subsidies or CCT's may vary depending on the family's survival threshold and childbearing propensities. These relative response rates and attractiveness of policies should not vary too much because I use nationally representative data to calculate the returns to employment and wages earned, which should account for all forms of unemployment and under-employment.

For the third and final essay, because I am using a cross-sectional survey to support the extension of the Q-Q model, some of the study findings are confined by the data limitations. For instance the DHS 2005-06 data does not have enough observations on child schooling so it is difficult to use educational attainment as a indicator of child quality while evaluating the tradeoff. Also the Q-Q model assumes children to be homogeneous so it means that identical investments must be made in all children; hence the framework cannot incorporate gender bias (usually preference towards sons) or birth order differences (younger and older siblings may be treated differently) in regression analysis. The spatial variation in India also indicates that regionally directed policies may provide better results. The inter-regional differences suggest that policies may need to be specifically tailor made to the states and such targeting will be more beneficial as it will account for the fact that southern India fares better in terms of literacy and fertility decline while other parts lag far behind. Northern parts of India are more reliant on agriculture as primary occupation which is more labor intensive and this could also encourage higher fertility. The results of the Q-Q model only focus on families who have children so the models do not try to explain the behavior of childless couples. Also since only older women are being considered, most of them have either above or below replacement childbearing; as the coefficients of regression must add to zero and the no fertility category is not significant for most variables, the remaining two cases are mutually exclusive hence the coefficients appear to be mirror images of each other.

5.4 Future Directions

Essay 1 aims to find cost-effective and time efficient policy interventions that have an impact on the determinants of fertility so we can incentivize smaller family sizes for countries suffering from unsustainably high population growth rates due to high fertility. Once we identify appropriate target variables and effective instruments, the counterpart of the model could be applied to below replacement countries to see how parallel policy instruments may be applied to boost birth rates when fertility is viewed as too low. The current findings may also be extended to other developing nations that are facing similar problems after we account for their geographic location and position in the time path of demographic transition. The policy experiments can further be tested for more advanced forms or specifications of the utility function.

Essay 2 tries to see the impact of child labor and old age dependency on household decision making, specifically with reference to fertility behavior. Birth order and gender preferences are also not considered in this model but can be incorporated in extended frameworks of the OLG structure. The current case aggregates child labor over all age groups but the impact can be separated out over specific age intervals to test effectiveness of policies targeting a certain range. The model can be extended to see the impact of other policy instruments like child labor bans, presence of social security benefits or alternative cash bonuses to delay childbearing. Further, the study findings can be used to look at similar scenarios in both developed and developing countries by adjusting the parameters and making minor alterations to the model.

Essay 3 examines the impact of parental quality on household reproductive choices using cross-sectional data but the analysis can be extended to a panel data set whereby it will be possible to trace the child health and educational outcomes that could provide stronger evidence for the reverse causality of the Quantity-Quality hypothesis with regards to fertility. Birth order differences and gender preferences are also not specifically addressed in this framework but can be incorporated with additional data. I could also change the preferential parameters so parents care more about children's wellbeing ($\alpha > \theta$) and trace the household choices under these new circumstances.

So the agenda for future work includes extending the analyses as well as addressing some of the limitations and concerns associated with the current research.

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Master of Arts in Economics (Gold Medalist 1st Division with 1st Rank),
Jadavpur University, India, 2006-2008. [GPA of 9.45 on 10]

Bachelor of Arts in Economics (Honors 1st Division),
Jadavpur University, India, 2003-2006. [GPA of 9.29 on 10]

FIELDS of CONCENTRATION: **Primary:-** Development & Regional Economics; Demography; Public Policy.
Secondary:- Health & Behavioral Economics; Environmental Economics.

COMPUTER SKILLS: Stata, Matlab, SPSS, ArcGIS, Geoda, UCINET, C++, MS Office.

TEACHING EXPERIENCE:

Fall 2012, Fall 2011: Teaching Assistant, PSU for Agribusiness Management and Community, Environment & Development, AGBM 338: Agribusiness in Global Economy; CED 450: International Development, Renewable Resources & Environment.

Spring 2011: Teaching Assistant, PSU for Agribusiness Management, AGBM 102: Economic Food Systems & AGBM 338: Agribusiness in the Global Economy.

Summer 2009: Teaching Assistant, UMN for Economics, ECON 1102: Principles of Macroeconomics.

RESEARCH EXPERIENCE:

Spring 2013, Spring 2012, Fall 2010: Research Assistant at PSU for AEREC; Supervisor: Prof. D. Abler, Ph.D.

Summer 2012: Research Assistant at Temple University; Supervisor: Prof. K. Das, Ph.D.

Summer 2011, Summer 2010: Research Associate and Intern at Global Change Program, JU; Supervisor: Prof. J. Roy, Ph.D.

PROFESSIONAL MEMBERSHIPS: PAA; AAEA; AEA; PRI; AIARD; NAREA; Gamma Sigma Delta – Honor Society.

HONORS & AWARDS:

Gold Medal from Jadavpur University for 1st position distinction in Master of Arts in Economics, 2008.

S. K. Mitra Memorial Gold Medal for securing highest aggregate marks in Master of Arts in Economics, 2008.

Sandor Fellowship in Environmental Economics 2008-2009 from Department of Economics, University of Minnesota.

Graduate Fellowship 2009-2010 from University Graduate School, The Pennsylvania State University.

Graduate Assistantship 2010-2013 from Department of Agricultural Economics, The Pennsylvania State University.

2012 Future Leaders Forum Fellowship from the Association for International Agriculture and Rural Development.

Graduate Student Travel Grants from College of Agricultural Sciences (CAS), Agricultural Economics, Sociology and Education (AESE) Program and Population Research Institute (PRI), The Pennsylvania State University, 2012-2013.

Population Reference Bureau (PRB) Policy Communications Fellowship, 2012-2013.

2013 Conference Scholarship Award from Northeast Agricultural and Resource Economics Association (NAREA).

President and founding member of the Penn State Graduate Economics Association 2012-2013.