MODEL OF CHILD BEARING WITH 2 SIDED ALTRUISM IN DEVELOPING COUNTRIES: A CALIBRATION EXERCISE*

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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, midday 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.

Keywords: quantity-quality tradeoff, intergenerational transfers, child labour, old age security

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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, midday 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.

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 2 describes the background and motivation; Section 3 provides an overview of the surveyed literature while Section 4 is devoted to the main research questions; Section 5 defines the methodology for the Dynamic model by constructing the theoretical framework; Section 6 illustrates the estimation strategy and Section 7 includes the empirical analyses; finally Sections 8, 9, 10 and 11 discuss the policy relevance, conclusions, limiting concerns and future extensions. The detailed derivations for the optimization exercise and inter-generational time line are provided in the Appendix.

2 Background & Motivation

By the standard Demographic Balancing Equation we have fertility, mortality and migration as the main components of population growth, and since increasing mortality or promoting migration are unacceptable or impractical options, fertility reduction seems to be the only available alternative and to motivate it we need government intervention. Singh et al (1986) provide an interesting summary of how we make the transition from high population growth to 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, 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.

Following the seminal article by Becker (1960), children can be interpreted as durable goods that yields some return, and the demand for children is made in the presence of uncertainty 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. the parents, and their decision is affected by income, tastes, knowledge and costs. This continued discrepancy in realized and desired births over the long run leads to the problem of unsustainable population growth rates.

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 in terms 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 an asset 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.

3 Review of Literature

A lot of research is already underway to better understand the nature of the problem of over-population and excessively high fertility and this is reflected in the academic literature. Some of the recurring themes are:

3.1 Demographic Change and 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 as evident from the fundamental work by Becker, Easterlin & Crimmins, Schultz and others; these help to develop the micro foundations for the 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 (from labor and non-human capital), male versus female productivity, altruism or exchange of care and resources all are important factors affecting costs of child bearing. 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.

The nineteenth and early twentieth century fertility decline in Europe and North America was accompanied by long-run economic growth as described in Guinnane (2011). The earlier scenario had women expecting almost eight children each and facing a positive elasticity of fertility with respect to income. 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 have all helped to ensure that the elasticity of fertility with respect to income is now zero or even negative under some situations.

Galor (2011) attempts to consolidate the theoretical basics and testable implications for demographic transition models and asserts that human capital demand in the development process was the main trigger for the transition from stagnation to modern growth. Capital market development was another element that fed into the transformation as it reduced parental dependence on children as sole means of old age security but this was just a supplementary mechanism as it is not the prime motivation for child bearing since there already was some form of social assistance for the elderly available. Other instruments tested empirically include rise in per capita income (led to greater fertility), fall in infant and child mortality (may have indirectly contributed to fertility reduction but did not significantly contribute to decline in population growth), rise in demand for human capital (this occurred as a phase of industrialization whereby investment in education became a dominant force in fertility decline), reinforcing mechanisms (decline in child labor, higher life expectancy, globalization, preference for child quality) and narrowing of the gender gap (rising relative female wages reduced fertility).

Blandy (1974) conducts a welfare analysis of reducing fertility which is largely ignored in most cost benefit studies. Different societies have varying child raising costs and deep rooted psychic satisfactions from children and these factors are often overlooked. 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 children 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. Clear evidence of Pareto improvements from smaller family sizes is hindered by the differences in response rates and income distribution preferences which are specific to each society. 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 and 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.

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. In the initial phases of their physical and mental maturation, they cannot enter into any contract with their caretakers or other agents and 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. The authors also hypothesize a thought experiment where potential children may have contracts[1] with parents which helps to determine optimal family size and optimal population. 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 state interventions 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 for the United States, concludes that extreme poverty and deprivation will feed back into the loop to restore the balance between population and the resource base.

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. But the activity in this area has fluctuated with uninterrupted periods of abundant research punctuated by brief periods where the interest has dwindled. Overall, there has been significant progress over time and there is a current revival as is evident from some of the recent publications in the next subsection. Most of the literature has inter-linkages and overlaps but we can find a more or less steady flow of ideas progressing over time.

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. Using a dynastic utility function, they face a tradeoff between the benefit of an additional child and the cost of providing for it. The paper analyzes the link between fertility and capital accumulation with 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. They concentrate on the western fertility experience and conduct a life cycle analysis for intergenerational consumption. Incorporating intergenerational welfare considerations, the model links consumption, fertility, and total number of descendants over all generations. The

[1]Potential child commits to recompensing the parent in case of being born; the parent already has planned bequests and gifts but this compensation reduces net gift to the child.

dynastic family head implicitly conducts a cost-benefit analysis of each additional descendant given a certain lifetime earnings constraint. The arbitrage condition causes fertility to respond to interest rate changes and degree of altruism. Looking at time preferences, the model suggests that a permanent tax on children imposed at the start of period i will lower fertility for generation i since the current cost of rearing children goes up compared to the relative cost for previous generations. But if interest rates are held constant, fertility for all subsequent generations will remain unaffected. Similarly a permanent reduction in the mortality rate will raise population growth, and a permanent expansion of social security will lower fertility, but if interest rates are unchanged then both impacts will be restricted to that single time period.

For open economies that participate in the international capital market, fertility moves positively with the long-term real interest rate, degree of altruism and probability of child survival. Within such an economy, fertility is negatively correlated to the rate of technological progress and the growth rate of transfer payments. Their simplified model helps to explain the fertility decline observed during the mid-1950's in the Western countries and captures important aspects of fertility, population growth and consumption.

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 change the open economy assumption and look at the determination of interest rates, wage rates, population growth, and income growth in closed economies. They calculate the dynamic time paths of fertility, capital labor ratio, wages, interest rate, per capita consumption and run comparative statics to find the welfare implications. The framework is set in the same way as the earlier model with a more detailed production sector of competitive CRS firms. 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. However if the initial scenario involves fertility declining as income rises then rapid progress may actually raise fertility. As population growth rate is endogenous, temporary changes in the parameters could have permanent effects. Further a permanent rise in cost of child rearing will reduce the steady state interest rate. The positive relation between interest rates and fertility implies that this fall in r will eventually lower the steady state value of population growth and raise the per capita capital steady state. 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.

3.3 Quantity-Quality Tradeoff – Applications

Shifting to some empirical studies, Grawe (2003) investigates the tradeoff between child achievement and fertility in his article on Britain and Germany. The regional nature of socio-cultural norms hinders generalization of theory but using common employment and income definitions, he compares the tradeoff for the these two developed countries. With data from the German Socio-Economic Panel (GSOEP) and the British Household Panel Survey (BHPS), he finds that the link between family size and child quality is similar in both places. However the inverse relationship between family size and son's years of schooling is stronger in Germany than in Britain. Income shows a neutral or small positive effect on family size. Looking at life cycle issues, in Germany young women from smaller families were found to have higher employment rates than women from larger families but this disparity disappeared amongst the middle aged categories. Credit market failure is another approach to explaining the quantity quality tradeoff where, as families grow in size resources are diluted and credit constraints prove to be more disadvantageous for larger families. Parents have limited capacity to self-finance higher education for their children, and subsequently invest less than unconstrained households. Plotting the relationship between family size and log earnings both with and without constraints conditional on mother's education and natural ability of the child generates patterns indicating that in the absence of constraints, child earnings does not depend on family size but in the presence of credit constraints variance in child earnings declines with family size. This acts as an empirical test for credit market failure where if credit constraints are present, then earnings variance will be smaller in large families. That credit constraints alone do not provide an explanation for the trade-off in European nations. Education is highly subsidized and standardized in Europe and so financial constraints should not play a major role in determining school attendance. Comparing Britain and Germany, the paper confirms the hypothesis that fertility and achievement of children are negatively linked but fails to identify any specific economic explanation that causes this phenomenon.

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. Delpiano (2006) and Wahl (1992) both find that Becker's Q-Q tradeoff is consistent with the U.S. data in the nineteenth century and is a better fit than Easterlin's target-bequest model. For American families making life cycle decisions, parents facing an exogenous shift in family size had to reallocate resources which affects child investment and well-being. According to the household production theory, higher order twin births reduce older children's chances of attending private school, make it more likely for mothers to exit the labor force (part-time or full-time) and raise the probability for divorce. The 2SLS estimates differ from OLS due the omitted variable bias in single equation models and for more direct measures of child quality like educational attainment, there is very little negative impact of greater number of children as resource reallocation has a mitigatory effect. Black et al. (2005) use Norwegian data to study effects of family size and birth order on child quality. Initially children's education and

family size seem to be negatively correlated but including birth order or twin births makes the family size effect negligible; further higher birth orders are found to adversely affect education. As family sizes declined average child outcomes improved even though the effect on the first-born child remained unchanged. Birth order is also a crucial factor, especially for women when determining education, earnings, full-time employment and teenage births; later born children have lower earnings; men are not less likely to work less; and women are more likely to have their first birth as a teenager. They wrap up with a recommendation to consider both differences across families and differences within families when analyzing fertility and child production.

Depending on the country and the timeline, different researchers have either verified the Q-Q model or questioned its validity. 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 child quality in terms of health and education may reduce the demand for child quantity.

3.4 Human Capital Investment, Income and Mortality

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. The key implications are: earnings regress to the mean faster in richer than in poorer families, consumption regresses faster for the poorer households and interestingly, fertility is positively related to wealth which dilutes the bequest transferred down to the successive generations.

Becker, Murphy & Tamura (1990) assumes fertility to be endogenous with increasing returns to human capital. 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. There are two stable steady state that emerge; one is a Malthusian equilibrium with large families and low human capital while the other is Development equilibrium of small families with growing human and physical capital. Tamura (2006) has three chief contributions: a general equilibrium model for fertility and human capital accumulation under uncertainty; a structural form of young adult mortality and empirical testing of the assertion that technological

progress raises educational demand; and numerical solutions to the models with cross-country data. Young adult mortality is negatively related to schooling but positively linked to fertility; hence raising human capital may lower mortality, induce the demographic transition and bring about economic development and population stability.

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. For China, Rosenweig & 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 and grades, expectations about college, health indexes due to the 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. Also national fertility studies are usually imperfectly based on surveys at one point in time and use individual level data as a basis for population policies, even though fertility is a collective property and needs macro analytic evaluation. 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 on private tutoring expenditures to test whether large family size influences educational investment in children. The endogeneity problems arising from family size are tackled with instrumental variables and non-parametric bounding methods; the main findings are 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). Philippines implements mandatory primary schooling between ages of 7 and 13 with most elementary schools being public and tuition free; using completed years of education and time spent on school activities the authors find 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.

Fertility is often linked to education and human capital investment as well as mortality and life expectancy. Uncertainty regarding child survival due to high mortality increases the marginal benefit of large families, this precautionary demand guarantees that at least some of the offspring will reach adulthood and reproduce. Both Soares (2005) and Kalemli-Ozcan (2003) investigate how declining mortality at birth was closely followed by fertility reductions and greater human

capital accumulation since the benefits of having an additional child went down. Parents have a tendency to maximize long term number of descendants but after crossing a critical level of life expectancy at birth, society reduces its high fertility and moves from a Malthusian stagnation to a long run growth equilibrium. Cervellati & Sunde (2005) presents a unified model of how economic conditions, life expectancy, skills and population size evolved in the Western world. Health conditions and economic factors interact to generate educational investment which then filters into productivity and wages; the results though are not immediate as the whole system needs time to develop sufficiently until the positive feedback loop has enough momentum to make up for the costs of human capital accumulation.

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.

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 and 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.

3.7 Country specific case 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. 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 she became one of the first countries to start a national government sponsored family planning program; unfortunately though 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. 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. Female education monotonically increases age at marriage and contraceptive use, which in turn decreases fertility and so educational policy should be given

high priority as it will yield substantial returns in the long run but this investment may not be the most cost effective means of reducing fertility over the short term.

3.8 Motives for Fertility - Old Age Security and Child Labour

Old age security is a major factor contributing to the reproductive behavior in less developed countries. Lack 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. 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. The paper presents the conditions under which old age security becomes an important motive for fertility some of which 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. A formal model with intergenerational transfers from children to parents can be found in Fujui (2001) which proves the existence of a dynamically consistent sub-game perfect Nash equilibrium.

Zhang & Nishimura (1992) look at children's altruism for a two overlapping 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. These results are challenged by Lagerlof (1997) which claims that the interior solutions for the utility maximization by Nishimura & Zhang (1992, 1993) are incorrect as corner solutions yield more utility.

Focusing on rural India, 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 this particular motivation for large family sizes.

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. 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. 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.

It is evident that 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.

4 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 the 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 labour, lack of old age security and intergenerational transfers to incentivize smaller family sizes in developing countries with above replacement fertility rates?

5 Methodological Framework

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.

5.1 General Theoretical Model

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 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.

5.2 Framework for Dynamic Model

I use a Buiter-Carmichael-Burbidge[2] 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 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

[2]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.

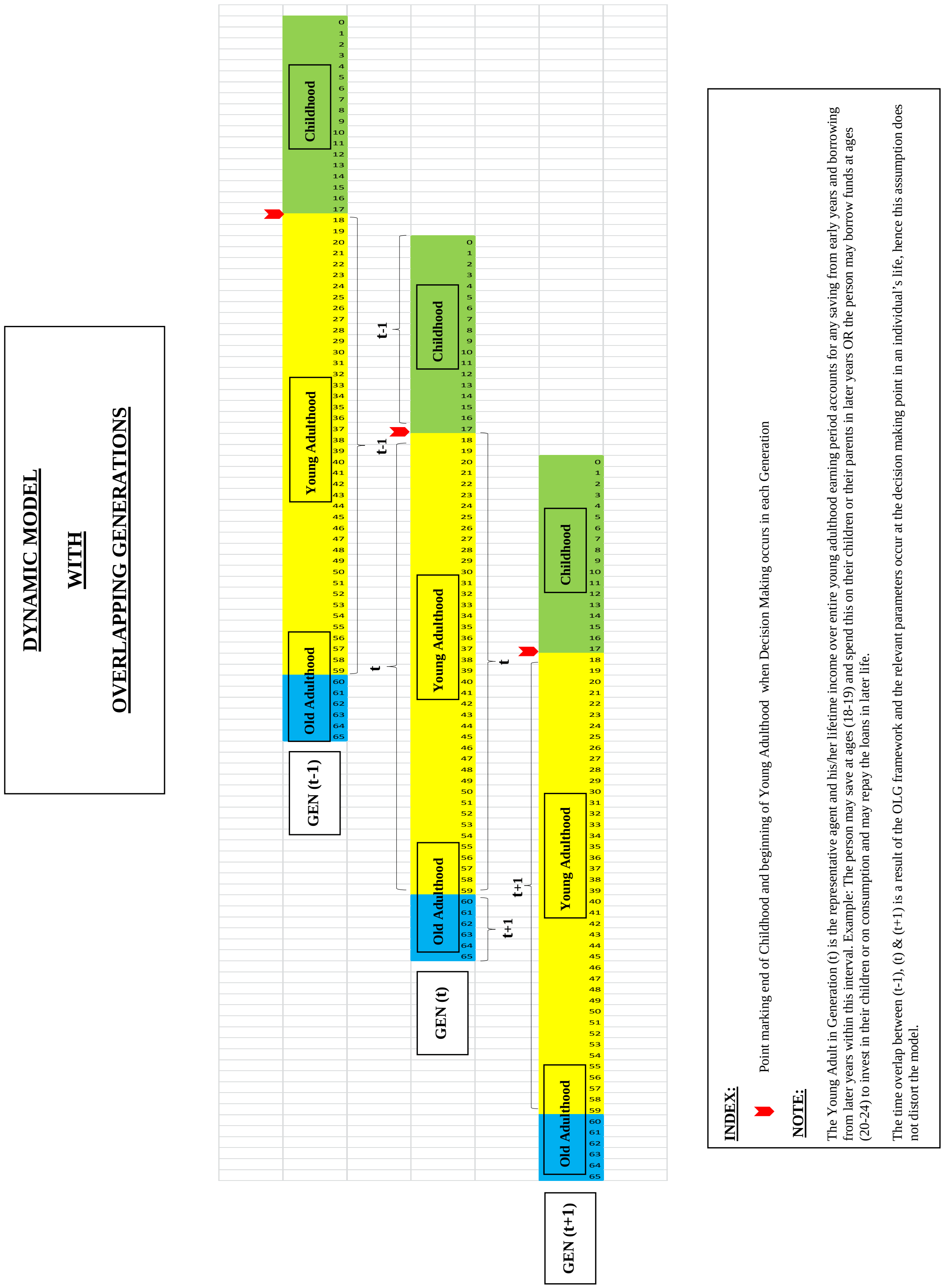

Figure 1: OLG visualization for Dynamic model

descendants. An individual's welfare depends on their consumption at each stage of life but since expenses in their youth[3] 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[4] (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}) a of generation (t) young adult and drop (U_t) since it appears on the left. Also 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.

$$h_{t-1} = f(\underset{(+)}{\beta}, \underset{(-)}{l_{t-2}}, \underset{(+)}{k_{t-2}}) \backsimeq f(l_{t-2}, k_{t-2}) = (1 - \gamma l_{t-2}) k_{t-2}$$

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

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

[4] 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.

$w_t^A = e + (1 + R_t)h_{t-1} = e + (1 + R_t)(1 - \gamma l_{t-2})k_{t-2}$

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.

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

The dynamic model optimization exercise can be set up as:

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

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

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

subject to

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

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

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

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

$\vdots$

$to \rightarrow \infty$

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).

6 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)[5] is same for a young and an old adult across time periods and generations.

6.1 Simplified Framework for Dynamic Model

The Simpler Version of the Model for numerical estimation is:

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

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

subject to

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

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

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

6.2 Specification for Analytical Solution

After truncating the OLG model and excluding distant future generations, the first order conditions[6] 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.

[6] 7 F.O.C. listed in Appendix I.

7 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.

7.1 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 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[7]. 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 $(t) = 2007$.

7.2 Calibration of Model 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^e, 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

[7]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 1 shows the parameters and variables that can be derived directly from the data.

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

Table 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 ($k_t = 3674.6646$). With these variables in place, the system of 7 simultaneous equations listed in Section 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	$\boldsymbol{\theta}$	0.8772
Rate of human capital accumulation	$\boldsymbol{\gamma}$	0.5
Degree of altruism towards children	$\boldsymbol{\alpha}$	0.4881
Degree of altruism towards elderly parents	$\boldsymbol{\phi}$	0.124
Elasticity of number of children	$\boldsymbol{\varepsilon}$	0.2419
Elasticity of consumption	$\boldsymbol{\sigma}$	0.5

Table 2: Results of parameter estimation.

Table 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 it does follow the inequality of $(\theta > \alpha > \phi)$ whereby young adult decision makers care more about their own old age consumption that 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.

7.3 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.

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: 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.

7.4 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[8] 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 $(1 - l_t)^\gamma = \frac{\lambda_t}{\lambda_{t+1}(1+R_{t+1})}$, it is evident that in the absence of child labor $(l_t = 0)$ the intergenerational discount rate equals the market discount rate $(\frac{\lambda_t}{\lambda_{t+1}} = \frac{1}{(1+R_{t+1})})$ but for existence of child labor $(l_t > 0)$ in the system the intergenerational discount rate exceeds the market discount rate $(\frac{\lambda_t}{\lambda_{t+1}} > \frac{1}{(1+R_{t+1})})$. Replacing the solution for the Lagrange multipliers yields the intergenerational discount rate to be 1.052631578 which exceeds the inverse of the market rate of interest at 0.932900218 implying that the inequality 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.

7.5 Results from 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

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

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.

7.5.1 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, the 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 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.[9] If each person reduces fertility by half then the couple together lower their child bearing by one so this shows the economic subsidy 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 value of the income

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

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.

7.5.2 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 raises 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 make 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 hence 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 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 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 the solutions to the comparative static exercise traces the transformation in the young adult parents decision making behavior. The second panel clearly shows that as the amount of conditional transfer rises, 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 into 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.

7.5.3 Mid-day Meal Schemes to Raise School Attendance

The mid-day meal schemes were introduced by the Government of India[10] 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[11] 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:

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

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

[11]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

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

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 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* $\bar{\beta}$ *= 7652.6320*	0.1535	5308.2	1.2878
** Note: C_{2t} and g_t remain unaffected by the transfers.*			

Table 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.

8 Policy Relevance & 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 labour 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 labour 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 labour laws and promote benefits of education that will encourage parents to send the children to school instead of the labour 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.

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 labour 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.

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.

11 Future Extensions

This paper aims to see the impact of child labour and old age dependency on household decision making, specifically with reference to 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 conditional cash transfer schemes. The study findings hence 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.

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**			**<u>2007</u>**			**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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