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A Computable OLG Model for Gender and Growth Policy Analysis

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Abstract

This paper develops a computable Overlapping Generations (OLG) model for gender and growth policy analysis that brings to the fore the role of access to public infrastructure. The model accounts for human and physical capital accumulation, intra- and inter-generational health persistence, fertility choices, and women's time allocation between market work, child rearing, and home production. Bargaining between spouses and gender bias, in the form of discrimination in the work place and mothers' time allocation between daughters and sons, are also accounted for. The model is calibrated for a low-income country and various experiments are conducted, including improved access to infrastructure, an increase in subsidies to child care, a reduction in gender bias, and a composite gender-based reform program to assess the role of policy complementarities. The results illustrate the importance of accounting for changes in women's time allocation in assessing the impact of public policy on economic growth.

JEL Classification Numbers: I15, I25, J16, O41

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1 Introduction

The role of women in promoting growth in developing countries remains a critical issue on the international agenda. Much of the debate has focused on women's differential access to education, formal sector employment, assets, production technology, health care, and social institutions, as well as on how the relationship between gender and growth is mediated by women's labor force participation, productivity, and earnings (see Morrison et al. (2007)). What has emerged from recent studies is a picture of slow progress, if not setbacks, in many of these areas. A case in point is education. On the one hand, the gender gap in educational attainment has gradually narrowed or moved in favor of women in some regions; and in many individual countries the gender gap in *primary* school enrollment has almost disappeared. On the other, however, more than half of girls in Sub-Saharan Africa still do not complete even a primary school education. In addition, progress towards gender equality in secondary schooling has been slower, and in some regions gaps are widening, especially in the aftermath of the global financial crisis (see World Bank (2011*a*)). Related in part to gender bias in education, in today's low- and middle-income countries the labor force participation rate for women is significantly lower than the rate for men; in South Asia for instance, in 2009 the participation rate was 82.6 percent for men but only 39.6 for women (International Labour Office (2011)). For Latin America and the Caribbean, the comparable numbers were 79.9 and 52 percent, respectively. Moreover, women's share in formal sector employment remains low and has even fallen in some cases in recent years. In such conditions, understanding analytically and measuring quantitatively how general and gender-specific public policies affect women's access to education, health, employment, and income, as well as the economy's overall growth rate, has taken on new urgency.

Much of the recent analytical research on gender and growth has taken place in the context of overlapping generations (OLG) models of endogenous growth. Indeed, since a seminal contribution by Galor and Weil (1996), gender-based OLG models of economic growth have been developed by, among others, Momota (2000), Zhang et al. (1999), Lagerlöf (2003), Andreassen (2004), Greenwood et al. (2005), Greenwood and Seshadri (2005), de la Croix and Vander Donckt (2010), Du and Wei (2010), Cavalcanti and Tavares (2011), Guner et al. (2012), Agénor and Agénor (2014), and Agénor et al. (2014). However, much of this literature has focused on long-term development issues—most importantly the demographic transition and its implications for changes in men and women labor force participation rates, and the conditions under which multiple development regimes may emerge. Moreover, many contributions dwell on small, illustrative models. Although parsimonious models may be well suited for academic exploration, they may not be adequate for policy analysis if important channels are "shut down" to enhance analytical tractability—by imposing for instance exogenous wages in some models, or by limiting the set of choices that women face in allocating their time.

By contrast, this paper presents a gender-based, *computable* OLG model that is rich enough to provide a serious starting point for the analysis of a range of policies that today's policymakers may be contemplating, in terms of their impact on gender and growth. In that respect, the paper goes beyond existing contributions to the extent that its ultimate goal is a quantitative approach to gender and growth analysis, with a particular emphasis on the impact of access to infrastructure—or lack thereof—on women's time allocation and the role of inter- and intra-generational (or vertical and horizontal) health externalities, namely, how mothers affect their children's health, and how health in childhood affects health in adulthood.[1] Moreover, because some of the gender-based policies considered in the paper have not been implemented systematically in developing countries, it can be viewed as being also a normative contribution to the existing debate on gender inequality.

More specifically, the approach proposed here is to calibrate the steady-state solution of the model and focus therefore on the long-run effects of public policy, in the context of a balanced budget constraint for the government—a natural benchmark for this type of experiments. The underlying view is that gender-based policies, just like a variety of other structural adjustment policies (such as an increase in spending on tertiary education or higher public investment in the energy sector) are unlikely to produce tangible economic results in the short run—often not even in the medium run; what matters therefore is a good understanding of the *long-run* effects. The fact that the model is based on rigorous microfoundations implies that these effects (on the economy's growth rate, in particular) are calculated on the basis of precise expressions and formulas, which can be computed, given their static nature, relatively easily. This is critical of course because in many applied dynamic models used for development policy analysis (for instance, computable general equilibrium models) the steady-state properties are not always well understood and cannot usually be explicitly established, implying that an exact expression for the economy's equilibrium growth rate, in particular, cannot be written out. Thus, by focusing on steady-state effects, based on an explicit analytical characterization of the long-run equilibrium, the model provides a rigorous yet practical tool that may help to integrate more systematically interactions between structural policies, gender and growth in the design of development programs.[2]

[1] The analysis dwells in part on Agénor and Agénor (2014). However, they ignore intrahousehold bargaining and do not provide numerical experiments.

[2] Of course, the transitional dynamics of the model could be studied with a full calibration of the dynamic equations from which the steady-state solution is calculated. However, this would be difficult to implement in simple software and would limit its operational usefulness. Moreover, the theoretical model presented here is based on only three generations; to study realistically the dynamics of an applied OLG model one would need to consider a much higher number of cohorts (perhaps up to 6 or

The paper is organized as follows. Section 2 describes the model and Section 3 characterizes the balanced growth equilibrium. Section 4 presents a benchmark calibration for a low-income country (Benin) and provides a brief discussion of its solution procedure. Section 5 presents several policy experiments designed to illustrate the properties of the model—higher investment in infrastructure, improved efficiency of government spending, and several gender-related experiments: an increase in subsidies to child care (which translates into a reduction in family spending on child rearing), a reduction in gender bias in the market place, an improvement in women's bargaining power, and an increase in mothers' time allocated to their daughters. A composite gender-based reform program is also studied, in order to assess the extent to which policy complementarities may generate externalities in terms of growth and women's health. Section 6 provides a summary of the main results and provides some concluding remarks.

To preview our results, they suggest that promoting women's participation to market activity and strengthening their contribution to economic growth in Benin may depend in important ways on providing them with better access to infrastructure. Such access allows women to reallocate their time away from household chores and may help to improve educational and health outcomes as well. Moreover, these benefits could be magnified by the judicious implementation of a composite pro-growth, pro-gender reform program, rather than by piecemeal reforms. Because the role of women in the development process remains a critical issue on the agenda of a number of countries, these results have broader implications as well. Indeed, what the results of this paper suggest, beyond their direct relevance for Benin, is that promoting gender equality and women's participation in the labor force is not only desirable from a social equity point of view—a desirable goal in itself—it is also good economics. At the same time, to achieve these goals policymakers should not think only in terms of microeconomic, gender-focused interventions; macroeconomic factors also do matter. This perspective should not be lost in the current debate about the need to promote public infrastructure investment in low-income countries, in Sub-Saharan Africa and elsewhere (see for instance Foster and Briceño-Garmendia (2010)). Investing more in infrastructure is not only about increasing the efficiency of private inputs in production and the functioning of markets, it is also about alleviating structural constraints on women's ability to engage in market work and strengthening their contribution to economic growth.

8), which means that data requirements would increase significantly.

2 The Model

Consider an economy where two goods are produced, a marketed commodity and a home good, and individuals live for (at most) three periods: childhood, adulthood (or middle age) and retirement. The marketed commodity can be either consumed in the period it is produced or stored to yield capital at the beginning of the following period. Each individual is either male or female, and is endowed with one unit of time in each period of life. Schooling is mandatory, so children devote all their time to education.[3] They depend on their parents for consumption and any spending associated with schooling and health care. In old age, time is allocated entirely to leisure. All individuals, males and females, work in middle age; the only source of income is therefore wages in the second period of life. Savings can be held only in the form of physical capital. Agents have no other endowments, except for an initial stock of physical capital at $t = 0$, which is the endowment of an initial old generation.

In adulthood, individuals match randomly into couples with someone of the opposite sex to form a family. In line with the collective household model, although fathers and mothers have different preferences, all income is pooled and couples therefore are joint decision makers.[4] Once married, individuals do not divorce; couples retire together (if they survive to old age) and die together.[5] Boys and girls have the same innate abilities and thus the same intrinsic capacity to acquire human capital.

The cost of rearing children involves the cost of schooling and the cost of keeping them healthy. In turn, these costs involve both parental time and spending on marketed commodities (school supplies, medicines, etc.). As a result of biological differences (women are the ones who actually bear children and are capable of breast feeding) or social norms, mothers incur the whole time cost involved in rearing children. Thus, women "specialize" in that activity within the family. Male spouses are not involved in child rearing and allocate inelastically all their time to market work; by contrast, female spouses must consider three alternatives: market work, raising children, and home production.

[3] The model therefore abstracts from child labor. As long as total time in childhood is fixed, and that children must spend a given fraction of it in school, accounting explicitly for the fact that children (especially girls) are involved in household chores does not make any qualitative difference to the analysis.

[4] See Haddad et al. (1994), Vermeulen (2002), and Xu (2007).

[5] This assumption, which was dubbed the "sorrow" argument in Agénor and Agénor (2014), has some basis in reality: spouses often die within a few years of its other. One reason may be what is clinically known as *stress cardiomyopathy*, according to which sudden emotional stress related to the loss of a close family member can trigger acute heart failure. At a more formal level, this assumption simplifies matters considerably by allowing one to keep the gender composition of the population constant. Indeed, in gender-based models where survival into old age is uncertain, and marriage is between a man and a woman, single survivors would imply an unbalanced gender distribution in the steady state.

The health status of children and adults are determined in different ways. The former depends on the time mothers allocate to rearing their brood, access to publicly-provided health services, and on mother's health. Health status in adulthood depends on health status in childhood. There is therefore "state dependence" in health outcomes, as in Agénor (2012, Chapter 3; 2015) and de la Croix and Licandro (2013).

At the beginning of the first period of life and the end of the second, there is a non-zero probability of dying. Survival rates from childhood to adulthood, as well as from adulthood to old age, are treated as distinct. Although the survival probabilities for boys and girls are the same in childhood, in adulthood the survival probability of women is higher than that of men, as suggested by the evidence.

In addition to individuals, the economy is populated by firms and an infinitely-lived government. Firms produce marketed commodities using public capital in infrastructure as an input, in addition to male and female labor and private capital. Home production (which affects positively the family's utility) combines women's time and infrastructure services. The government invests in infrastructure and spends on education, health, and some unproductive items. It taxes the wage income of adults (males and females), but not the interest income of retirees. It cannot borrow and therefore must run a balanced budget in each period. Finally, all markets clear.

2.1 Utility and Income

At the beginning of adulthood in $t+1$, all men and women are randomly matched into married couples. Each couple, or family, produces n_{t+1} children. Parents raising a child faces two types of costs. First, the child's mother must spend $\varepsilon_{t+1}^{f,R} \in (0,1)$ units of time on each of them, because she provides tutoring or "home schooling" and takes care of the child's health (going to the hospital for checkups and vaccination, etc.). Second, raising children involves costs in terms of marketed commodities. Specifically, it entails a cost per child (regardless of gender) equal to a fraction $\theta^R \in (0,1)$ of the family's net income. This cost is related to sending children to school and educating them at home (which involves buying school supplies, etc.), and to taking care of their health needs (buying medicines).[6] Thus, although access to "out of home" schooling and health services *per se* is free, families face a cost in terms of foregone wage income and foregone consumption.

In addition to raising children, mothers allocate time to market activity (in proportion $\varepsilon_{t+1}^{f,W}$). Let $\varepsilon_{t+1}^{f,P}$ denote the time women allocate to home production (which includes time spent collecting water and firewood, for instance); the time constraint

[6] These two types of costs could be separated by introducing different spending shares for the schooling and health components. This, however, would mainly add notational clutter and produce little value added to the analysis. Note also that the provision of child care could be specified as a production process, involving maternal time and market goods; see Olivetti (2006) for instance.

that women face is thus

$$\varepsilon_{t+1}^{f,W} = 1 - \varepsilon_{t+1}^{f,P} - p_C n_{t+1} \varepsilon_{t+1}^{f,R}. \tag{1}$$

The probability of survival from childhood to adulthood (at the beginning of period $t+1$) is denoted by $p_C \in (0,1)$, whereas the probability of survival from adulthood to old age is denoted by $p_A^j \in (0,1)$, $j = m, f$, and $p_A^f > p_A^m$. Given the deterministic nature of the model, the actual number of survivors in each age group is simply given by the expected number of survivors. To avoid convergence of population size toward zero, it is also assumed that $p_C n_{t+1} \geq 2$ in the steady state.[7]

The family's (collective) utility takes the composite form

$$U_t = \varkappa_t U_t^f + (1 - \varkappa_t) U_t^m, \tag{2}$$

where U^j is partner j's utility function and $\varkappa_t \in (0,1)$ is a weight that measures the wife's bargaining power in the household decision process. As shown by Doepke and Tertilt (2014), maximizing (2) subject to appropriate constraints and for $\varkappa_t$ given yields an outcome that is similar to the solution of a Nash bargaining problem in which the couple maximizes the weighted product of the two partners' marital surpluses and the outside option is given by the utility achieved upon divorce.[8]

Assuming that consumption of children is subsumed in the family's consumption, the sub-utility functions are given by, with $j = f, m$,

$$U_t^j = \eta_C^j \ln c_{t+1}^t + \eta_Q \ln q_{t+1} \tag{3}$$

$$+\eta_N \ln p_C n_{t+1} + \eta_H^j (\ln h_{t+1}^{C,f} + \ln h_{t+1}^{C,m}) + \frac{p_A^j}{1+\rho} \ln c_{t+2}^t,$$

where c_{t+1}^t (c_{t+2}^t), is the family's total consumption in adulthood (old age), q_{t+1} consumption (and production) of home goods, $h_{t+1}^{C,j}$ health status of a child of gender j,

[7]It could be argued that because parents choose n_{t+1} live births, but with no replacements, the number of surviving children is a random variable, with mean $p_C n_{t+1}$. By implication, it is only if c_{t+1}^t is chosen *after* the number of surviving children has been revealed that each family's realized level of consumption will be non-random. Otherwise, families will differ *ex post*, and there will be n_{t+1} types of them. However, treating the actual number of surviving children as a random variable would require a full stochastic analysis, as in Kalemli-Ozcan (2003, 2008) for instance. This would entail, in particular, a specific assumption regarding the probability distribution of survivors and the resulting first-order condition would end up being highly nonlinear. The treatment adopted here, which essentially equates the actual number of survivors to the expected number of survivors, $p_C n_{t+1}$, is a reasonable approximation given that ultimately the goal is to obtain a closed-form solution that can be used for standard numerical experiments. Boucekkine et al. (2009), among others, adopt a similar simplification.

[8]Doepke and Tertilt also develop a noncooperative model of household bargaining that has similar implications to the type of cooperative bargaining framework used here.

and $\rho > 0$ the discount rate. Actual family size is $p_C n_{t+1}$, which differs from fertility, n_{t+1}, because the child survival rate is less than unity.[9] Thus, parents care about all of their surviving children, and equally about their health. For simplicity, the utility function is assumed to be separable in health status and the number of children.

Coefficients η_C^j measure relative preference for today's consumption, η_N relative preference for surviving children, η_Q the family's relative preference for the home-produced good, and η_H^j relative preference for children's health (with no distinction between boys or girls). The restrictions $\eta_C^f < \eta_C^m$ and $\eta_H^f > \eta_H^m$ are also imposed. Thus, both parents benefit equally from consumption of the home good, and care equally about the number of (surviving) children; neither η_Q nor η_N depends on j. But women are less concerned than men about current consumption ($\eta_C^f < \eta_C^m$) and care more about the health of their children ($\eta_H^f > \eta_H^m$). These facts are well documented in a number of studies, including Smith et al. (2003), UNICEF (2007), World Bank (2011*b*), and Doepke and Tertilt (2014). As noted earlier, they also have longer longevity than men ($p_A^f > p_A^m$), implying a higher weight on consumption in old age.

For simplicity, only the marketed commodity is consumed in old age. It is also assumed that parents' preferences over boys and girls are the same, and that they do not have control over the gender composition of their family, so that half of their children are daughters and half of them sons.[10] I therefore abstract from unwanted births. Parents do not care directly about the human capital of their children, only their health.[11]

A male (female) adult in period $t+1$ is endowed with e_{t+1}^m (e_{t+1}^f) units of human capital. Each unit of (human capital-, productivity-adjusted) time earns an *effective* market wage, w_{t+1}^m for men and w_{t+1}^f for women, per unit of time worked. Child mortality occurs only at the beginning of the period; parents therefore incur rearing costs only on their children who survive into adulthood.[12] Giving birth involves no

[9] The distinction between actual and expected family size is discussed further later on.

[10] This assumption can actually be formally derived by replacing the term $\eta_N \ln p_C n_{t+1}$ in (3) by the composite term $\eta_N^B \ln p_C n_{t+1}^B + \eta_N^G \ln p_C n_{t+1}^G$ where n_{t+1}^B (n_{t+1}^G) is the number of boys (girls). With $\eta_N^B = \eta_N^G$, the solution would then yield $n_{t+1}^B = n_{t+1}^G$. A preference for boys would imply $\eta_N^B > \eta_N^G$. However, in such conditions the population would become unbalanced in its composition and defining an equilibrium would be complicated. "Market" forces would eventually force a return to an equilibrium characterized by gender parity.

[11] If they were, it could further be assumed that mothers care relatively more about the human capital of their daughters—therefore introducing another channel through which gender preferences may matter for growth. A mother's rearing time allocation between sons and daughters would then be chosen endogenously and her bargaining power would matter as well. At the same time, however, there is much evidence to suggest that social norms play an important role in that context, as implicitly assumed in the sequential approach adopted here. This issue is thus best left for future analysis.

[12] If rearing costs are incurred for all births, the term $\theta^R p_m^C n_{t+1}$ in (4) should be replaced by $\theta^R n_{t+1}$. However, the assumption in the text is more natural, given that infant mortality in poor countries tends to occur very early in life. Indeed, in these countries newborn mortality accounts for about 40

time cost.

The family's budget constraints for period $t+1$ and $t+2$ are given by[13]

$$c_{t+1}^t + s_{t+1} = (1 - \theta^R p_C n_{t+1})(1-\tau)w_{t+1}^T, \tag{4}$$

$$c_{t+2}^t = [(1+r_{t+2})s_{t+1}]/p_A, \tag{5}$$

where $\tau \in (0,1)$ is the tax rate, p_A the weighted survival rate (defined later), s_{t+1} saving, r_{t+2} the net rental rate of private capital, and w_{t+1}^T total *gross* wage income, defined as

$$w_{t+1}^T = e_{t+1}^m a_{t+1}^m w_{t+1}^m + e_{t+1}^f \varepsilon_{t+1}^{f,W} a_{t+1}^f w_{t+1}^f. \tag{6}$$

In this expression, a_{t+1}^i is productivity of labor i. As noted earlier, husbands supply their unit of time inelastically to market work. Thus, $e_{t+1}^m a_{t+1}^m$ (respectively, $e_{t+1}^f \varepsilon_{t+1}^{f,W} a_{t+1}^f$) measures male (respectively, female) labor supply in efficiency units.

Combining (4) and (5), the family's consolidated budget constraint is thus

$$c_{t+1}^t + \frac{p_A c_{t+2}^t}{1+r_{t+2}} = (1 - \theta^R p_C n_{t+1})(1-\tau)w_{t+1}^T. \tag{7}$$

Thus, families maximize (2) subject to (1), (3), and (7), as well as (8) and (13) below, with respect to c_{t+1}^t, c_{t+2}^t, $\varepsilon_{t+1}^{f,P}$, $\varepsilon_{t+1}^{f,R}$, and n_{t+1}; $\varepsilon_{t+1}^{f,W}$ is then solved residually from (1).

2.2 Home Production

Home production (which includes cooking dinner, doing laundry, cleaning the house, etc.) involves combining women's time allocated to that activity with infrastructure services. For simplicity, these factors are assumed to be perfect substitutes and production is subject to decreasing returns to scale:

$$q_t = [\varepsilon_t^{f,P} + \zeta^P (\frac{K_t^I}{\bar{K}_t^P})]^{\pi^Q}, \tag{8}$$

where K_t^I is the stock of public capital in infrastructure, $\bar{K}_t^P$ the aggregate stock of private capital, $\pi^Q \in (0,1)$, and $\zeta^P \in (0,1)$ is a coefficient that helps to parameterize the degree of substitutability between women's time and infrastructure services, with $\zeta^P = 0$, $\zeta^P = 1$, and $\zeta^P < 1$ corresponding to from zero, perfect, and imperfect

percent of the mortality of children under five years of age, and more than half of infant mortality (World Health Organization (2005, p. 9))

[13] To abstract from unintended bequests, the savings left by agents who do not survive to old age are assumed to be confiscated by the government, which transfers them in lump-sum fashion to surviving members of the same cohort. The rate of return to saving is thus $(1+r_{t+2})/p_A$, as shown in (5). See Agénor (2012, p. 73) for a derivation.

substitutability, respectively. Improved access to clean water through public wells in the vicinity of the village, for instance, reduces directly the amount of time that women must spend to fetch water from other sources. Access to infrastructure is assumed subject to congestion, as discussed next.[14]

2.3 Human Capital Accumulation

As noted earlier, schooling is mandatory so children allocate all of their time to education. Boys and girls have identical innate abilities and have access to the same "out of home" learning technology. However, each group's education outcomes depend also on the amount of time that parents devote to tutoring them at home.

Let $e_{t+1}^{t,j}$, $j = m, f$ be the human capital of men and women born in period t and used in period $t+1$. The production of either type of human capital requires several inputs, in addition to children's time. First, it depends on the time that mothers allocate to tutoring their children. A sequential process is considered, whereby parents determine first the total amount of mothers' time allocated to child rearing, $\varepsilon_t^{f,R}$, and then subdivide that time into a fraction $\chi^R \in (0,1)$ allocated to sons and $1-\chi^R$ allocated to daughters. A bias in parental preferences toward boys can therefore be captured by assuming that $\chi^R > 0.5$. This bias is consistent with the evidence for a number of developing countries (see Bongaarts (2013)).

Second, the production of human capital depends on the stock of public infrastructure, taking into account a congestion effect measured again by the (aggregate) private capital stock. This effect captures the importance of infrastructure for education outcomes (see Agénor (2011; 2012, Chapter 2)).

Third, knowledge accumulation depends on average government spending on education per (surviving) child, $\varphi_E G_t^E / p_C n_t 0.5 N_t$, where $\varphi_E \in (0,1)$ is an indicator of efficiency of spending and N_t is the number of adults alive in period t, itself given by

$$N_t = p_C n_{t-1} 0.5 N_{t-1}, \tag{9}$$

that is, the number of surviving children per family born in period $t-1$, $p_C n_{t-1}$, times the number of families formed in $t-1$, $0.5N_{t-1}$.

Finally, in line with the empirical evidence (see Blackden et al. (2006)), human capital accumulation depends on a mother's human capital. Because individuals are identical within a generation, a mother's human capital at t is equal to the average human capital of the previous generation.

[14] In principle, the production of the home good may also require (durable and nondurable) marketed goods. However, in practice such inputs represent only a relatively small component of home production costs.

Thus, abstracting from gender-based discrimination in the public education system itself, and assuming no depreciation for simplicity, the human capital that men and women have in the second period of life is

$$e_{t+1}^{j} = (\frac{\varphi_E G_t^E}{p_C n_t 0.5 N_t})^{\nu_1} (E_t^f)^{1-\nu_1} (k_t^I)^{\nu_2} (\chi^{R,j} \varepsilon_t^{f,R})^{\nu_3}, \tag{10}$$

where $\nu_1 \in (0,1)$, $\nu_2, \nu_3 > 0$, and

$$\chi^{R,j} = \begin{cases} \chi^R & \text{for } j = m \\ 1 - \chi^R & \text{for } j = f \end{cases}. \tag{11}$$

For tractability, the human capital technology is taken to exhibit constant returns to scale in government spending and the average human capital of mothers.

Combining equations (10) and using (11) yields

$$\frac{e_{t+1}^m}{e_{t+1}^f} = (\frac{\chi^R}{1 - \chi^R})^{\nu_3}, \tag{12}$$

which implies that, if $\chi^R > 0.5$, a boy's human capital will exceed systematically a girl's human capital—as a result solely of the greater time allocated by mothers to rearing their sons.[15]

2.4 Health Status and Productivity

Health status in childhood, h_t^C, depends on the mother's health, on the effective amount of time allocated by the child's mother to child rearing, and the provision of (congested) health services by the government, H_t^G,

$$h_t^{C,j} = (h_t^{A,f})^{\kappa_1} (\chi^{R,j} \varepsilon_t^{f,R})^{\kappa_2} (\frac{H_t^G}{K_t^P})^{\kappa_3}, \tag{13}$$

where $\kappa_1 \in (0,1)$ and $\kappa_i > 0$, for $i = 2, 3$.[16] The congestion effect on health services can be justified by assuming that taking children to health facilities is hampered by a more

[15] A possible way to endogenize the human capital ratio (and, by implication from the discussion below, bargaining power) is to account for gender bias in government-provided learning materials (namely, textbooks) used in schools; see UNESCO (2008). This could be captured by assuming that ν_1 in (10) is smaller for girls, and would get the term $\varphi_E G_t^E / p_C n_t 0.5 N_t$ to appear in (12), with a positive effect. Alternatively, it could be assumed that girls are more "productive" than boys in studying. If girls are involved in household chores, their effort level in schooling could be positively related with the family's access to infrastructure, just like mothers' time devoted to home production varies inversely with such access. This could be captured by making girls' human capital inversely related to $\varepsilon_t^{f,P}$, which would lead to k_t^I appearing in (12) with a negative effect. I intend to explore both options in detail in future work.

[16] This specification could be extended to account for the possibility that the productivity of time allocated to child rearing by a mother depends on her level of education. A simple way to do so would be to replace "raw" time in (13) by "effective" time, $\varepsilon_t^{f,R} e_t^f$.

intensive use of roads associated with private sector activity, which is proxied directly by K_t^P. Put differently, the *delivery* of health services is hampered by excessive private sector use of existing public capital.

Alternatively, it could be assumed that the congestion factor in access to public health services is measured in terms of the number of children in period t, $n0.5N_t$, but that the *efficiency* with which these services are delivered depends positively again on access to (congested) and on the number of families in the population, $0.5N_t$, because of scale economies in delivery. It is easy to verify then that the results would be qualitatively unchanged, as long as an appropriate restriction is imposed on the degree of congestion induced by private capital.[17] To ease the exposition, the specification in (13) is therefore retained.

Health status of both males and females in adulthood, $h_{t+1}^{A,j}$, is determined by health status in childhood and by the relative level of women's human capital:

$$h_{t+1}^{A,j} = h_t^{C,j}(\frac{E_t^f}{E_t^m})^{\nu_A}, \tag{14}$$

where $\nu_A > 0$.

The first effect, the dependence of health status at t on health status at $t-1$, is consistent with the evidence suggesting that early childhood health affects cognitive and physical development, which in turn affects health outcomes later in life (see Behrman (2009)). The second effect indicates that when women are relatively more educated, it benefits not only their own health but also the health of their husbands. In addition, if more educated women are healthier (by (14)), they also end up taking better care of their children (by (13)). Put differently, when women are relatively more educated—at least up to a certain point—they are better informed about the nutritional and health risks that their children and husbands face.[18] In line with the empirical evidence, there are therefore important *health externalities* associated with women's education—which themselves depend on mothers' time allocation between their sons and daughters. However, an apparent drawback of (14), as it stands, is that fathers' health has a negative effect on their chidren's health. Appendix 1 discusses

[17]Suppose indeed that the last term in (13) is replaced by $(e_t H_t^G/n0.5N_t)^{1-\nu_C}$, where e_t is an efficiency factor defined as $e_t = 0.5N_t[K_t^I/(K_t^P)^{\phi_H}]^{\alpha_H}$, where $\alpha_H, \phi_H > 0$. Rewriting the term $e_t H_t^G$ as $(e_t K_t^P)(H_t^G/K_t^P)$, and noting from the results in Appendix 2 that K_t^I/K_t^P and H_t^G/K_t^P are constant in the steady state, implies that to ensure stationarity in health status requires imposing the restriction $\phi_H = 1 + 1/\alpha_H$.

[18]See Agénor (2012, Chapter 3) and Agénor et al. (2014) for a review of the evidence. Sianesi and Reenen (2003) and McMahon (2004) discussed externalities in terms of husbands' health. Of course, it is possible that these externalities exist only up to a certain level of education; beyond that, they may disappear. However, in the case of low-income countries, where women tend to be poorly educated, it is quite likely that they play an important (marginal) role.

alternative specifications, including the case where $\nu_A = 0$, and shows that the health externality has (given the calibration) only a limited impact on the results.[19]

Adult productivity, a^j_{t+1}, is positively related to health status, with decreasing marginal returns:

$$a^j_{t+1} = (h^{A,j}_{t+1})^{\nu_P}, \tag{15}$$

where $\nu_P \in (0,1)$. Substituting (13) and (14) in (15) yields

$$a^j_{t+1} = (h^{A,f}_t)^{\kappa_1 \nu_P} (\chi^{R,j} \varepsilon^{f,R}_t)^{\kappa_2 \nu_P} (\frac{H^G_t}{K^P_t})^{\kappa_3 \nu_P} (\frac{E^f_t}{E^m_t})^{\nu_A \nu_P}. \tag{16}$$

From equations (13) and (14), the male-female health status ratio is given by $h^{A,m}_t / h^{A,f}_t = \chi^R/(1-\chi^R)$, which implies that changes in male health status are directly proportional to female health status. Using (11) and (16) yields

$$\frac{a^m_{t+1}}{a^f_{t+1}} = (\frac{\chi^R}{1-\chi^R})^{\kappa_2 \nu_P}. \tag{17}$$

This result implies again that, if $\chi^R > 0.5$, a boy's health in childhood, and productivity in adulthood, will exceed systematically a girl's health and productivity in mid-life—again solely as a consequence of bias toward boys in mothers' time allocation.

2.5 Bargaining Power

The relative bargaining power of women is assumed to evolve as a function of the relative levels of human capital of husband and wife:[20]

$$\varkappa_t = \bar{\varkappa}^{1-\gamma_B} [(\frac{e^f_t}{e^m_t})^{\mu_B}]^{\gamma_B}, \tag{18}$$

where $\bar{\varkappa} \in (0,1)$ measures the autonomous component of women's bargaining power and $\gamma_B \in (0,1)$ the relative importance of the endogenous component of bargaining

[19]Specification (14) could be extended to account for the possibility that consumption of public health services in adulthood affects health, and that more educated individuals tend to take better care of their own health. In the latter case, this would take the form of e^j_t also affecting $h^{A,j}_{t+1}$ positively.

[20]In a study of Nepal, Koolwal and Ranjan (2002) found that an increase in a wife's educational attainment leads to a rise in her bargaining power. In addition, they also found a nonmonotonic relationship between a woman's bargaining power and the household's expenditure outcomes. In other studies, women's bargaining power is alternatively related to, or measured by, the male-female ratio of earned incomes, the share of assets that they hold within the household or patterns of decision-making within the household (as revealed by surveys), and women's access to financial services. See for instance Doss (1996, 2013), Frankenberg and Thomas (2003), Anderson and Eswaran (2009), Angel-Urdinola and Wodon (2010), and Quisumbing (2010). However, it can be argued that some of these measures are likely to be correlated with relative educational outcomes.

power between spouses. The parameter $\mu_B \geq 0$ measures the sensitivity of the endogenous component of bargaining power to relative stocks of human capital. The larger it is, the stronger is the effect of a relative increase in women's human capital stock on their bargaining power. When $\gamma_B = 0$, bargaining power is exogenous and equal to $\bar{\varkappa}$.[21]

Substituting (12) in (18) yields

$$\varkappa = \bar{\varkappa}^{1-\gamma_B}(\frac{\chi^R}{1-\chi^R})^{-\nu_3\mu_B\gamma_B}, \tag{19}$$

Thus, in equilibrium women's bargaining power depends fundamentally on a key structural parameter: the allocation of mothers' time to their sons and daughters, as measured by χ^R.[22] The stronger the bias toward boys in childhood (the higher χ^R is), the lower the human capital women eventually accumulate, and the weaker their bargaining position. In that sense, inequality in the family (in terms of bargaining power) is the consequence of social norms.

2.6 Market Production

Firms engaged in market production are identical and their number is normalized to unity. Each firm $i \in (0,1)$ produces a single nonstorable commodity, using male *effective* labor, $A_t^m L_t^{m,i}$, where A_t^m is average male labor productivity in the economy, and female *effective* labor, defined as $A_t^f \varepsilon_t^{f,W} L_t^{f,i}$, where A_t^f is economy-wide female labor productivity, and $L_t^{i,j} = E_t^j N_t^{i,j}$ (where E_t^j is average human capital for $j = m, f$), private capital, $K_t^{P,i}$, and public infrastructure. Although public capital is nonexcludable, it is partially rival because of congestion effects; for simplicity, congestion is taken to be proportional to the aggregate private capital stock, $\bar{K}_t^P = \int_0^1 K_t^{P,i} di$.[23]

The production function of individual firm i takes the form

$$Y_t^i = (\frac{K_t^I}{\bar{K}_t^P})^{\alpha}(A_t^m L_t^{m,i})^{\beta}(A_t^f \varepsilon_t^{f,W} L_t^{f,i})^{\beta}(K_t^{P,i})^{1-2\beta}, \tag{20}$$

where $\alpha, \beta \in (0,1)$. Equation (20) assumes therefore that the two categories of labor are imperfect substitutes, in line with the evidence. In the terminology of Galor and Weil (1996), one could think of men providing *raw physical strength* and women *mental*

[21] De la Croix and Vander Donckt (2010) propose a slightly more general linear specification.

[22] If the bargaining power parameter was assumed to depend also on the family's choice variables, it would need to be determined (as in Basu (2006) for instance) as part of the family's optimization process. It would therefore not be constant, as assumed here. This could provide a useful extension of the analysis.

[23] Given the linearity of aggregate output in K_t^P, as shown later, using the former as the congestion factor in (20) and elsewhere would not alter the results in any fundamental way.

input. In addition, the elasticity of output with respect to each labor input is taken to be the same for simplicity.

With the price of the marketed good normalized to unity and assuming full depreciation of private capital, profits of firm i in the final sector, Π_t^i, are given by

$$\Pi_t^i = Y_t^i - (w_t^m A_t^m L_t^{m,i} + w_t^f A_t^f \varepsilon_t^{f,W} L_t^{f,i}) - (1+r_t) K_t^{P,i},$$

where r_t is the rental rate of private capital (which is also, as noted earlier, the rate of return on savings).

Profit maximization with respect to private inputs, labor and capital, taking factor prices as given, and with $L_t^{i,j} = E_t^j N_t^{i,j}$, $j = m, f$, yields

$$\frac{\partial \Pi_t^i}{\partial N_t^{m,i}} = 0 \Rightarrow \frac{\beta Y_t^i}{N_t^{m,i}} - w_t^m A_t^m E_t^m = 0,$$

$$\frac{\partial \Pi_t^i}{\partial N_t^{f,i}} = 0 \Rightarrow \frac{\beta Y_t^i}{N_t^{f,i}} - w_t^f A_t^f \varepsilon_t^{f,W} E_t^f = 0,$$

$$\frac{\partial \Pi_t^i}{\partial K_t^{P,i}} = 0 \Rightarrow \frac{(1-2\beta) Y_t^i}{K_t^{P,i}} - (1+r_t) = 0.$$

Due to direct discrimination in the workplace, women only earn a fraction $b \in (0,1)$ of their marginal product.[24] Thus, these equations can be rearranged to give[25]

$$w_t^m = \frac{\beta Y_t^i}{A_t^m E_t^m N_t^{m,i}}, \quad w_t^f = b \frac{\beta Y_t^i}{A_t^f \varepsilon_t^{f,W} E_t^f N_t^{f,i}}, \quad r_t = (1-2\beta) \frac{Y_t^i}{K_t^{P,i}} - 1. \tag{21}$$

In equilibrium, the superscript i can be dropped. And given that men and women are in equal numbers in the adult population ($N_t^m = N_t^f$),

$$w_t^m = b^{-1} (\frac{A_t^f \varepsilon_t^{f,W} E_t^f}{A_t^m E_t^m}) w_t^f. \tag{22}$$

Thus, all else equal, the smaller b is, the larger will be the effective wage differential between men and women in the workplace.

Given that all firms are identical, and that their number is normalized to 1, $\bar{K}_t^P = K_t^{P,i}$ $\forall i$, and aggregate output is, from (20),

$$Y_t = \int_0^1 Y_t^i di = (k_t^I)^\alpha (\frac{A_t^m L_t^m}{K_t^P})^\beta (\frac{A_t^f \varepsilon_t^{f,W} L_t^f}{K_t^P})^\beta K_t^P,$$

[24] In Galor and Weil (1996), a gender wage gap emerges as a result of differences in physical strength between men and women.

[25] The loss in income that women suffer as a result of $b < 1$ could be assumed to accrue to capital owners, who use it to finance current consumption. However, to capture the adverse economic effects of gender discrimination, I assume instead that it is a pure deadweight loss.

where $k_t^I = K_t^I / K_t^P$ is the public-private capital ratio.

Using $L_t^j = E_t^j N_t^j$, this expression can be rewritten as

$$Y_t = (k_t^I)^{\alpha}(\frac{E_t^m N_t^m}{K_t^P})^{\beta}(\frac{E_t^f N_t^f}{K_t^P})^{\beta}(\varepsilon_t^{f,W})^{\beta}(A_t^m)^{\beta}(A_t^f)^{\beta} K_t^P. \tag{23}$$

Thus, in the steady state, if k_t^I, $E_t^m N_t^m / K_t^P$, $E_t^f N_t^f / K_t^P$, $\varepsilon_t^{f,W}$, A_t^m, and A_t^f are all constant, as turns out to be the case, output will grow at the same rate as the private capital stock; there is endogenous growth.

2.7 Government

As noted earlier, the government taxes only the wage income of adults. It spends a total of G_t^I on infrastructure investment, G_t^E on education, G_t^H on health, and G_t^U on unproductive items. All its services are provided free of charge. It cannot issue bonds and must therefore run a balanced budget:

$$G_t = \sum G_t^h = \tau(w_t^m A_t^m L_t^m + w_t^f A_t^f \varepsilon_t^{f,W} L_t^f). \tag{24}$$

Shares of spending are all assumed to be constant fractions of government revenues:

$$G_t^h = \upsilon_h \tau(w_t^m A_t^m L_t^m + w_t^f A_t^f \varepsilon_t^{f,W} L_t^f), \qquad h = E, H, I, U \tag{25}$$

Combining (24) and (25) therefore yields

$$\sum \upsilon_h = 1. \tag{26}$$

Assuming again full depreciation for simplicity, public capital in infrastructure evolves according to

$$K_{t+1}^I = (\varphi_I G_t^I)^{\mu_I}(K_t^I)^{1-\mu_I}, \tag{27}$$

where $\mu_I \in (0,1)$ and $\varphi_I \in (0,1)$ is an indicator of efficiency of spending on infrastructure (see Agénor (2010)). This specification indicates that the production of public capital requires combining the flow of spending on infrastructure and the existing stock of public capital (see Agénor (2012, Chapter 1)).

The production of health services by the government is assumed to exhibit constant returns to scale with respect to the stock of public capital in infrastructure, K_t^I, and government spending on health services, G_t^H:

$$H_t^G = (\varphi_H G_t^H)^{\mu_H}(K_t^I)^{1-\mu_H}, \tag{28}$$

where $\mu_H \in (0,1)$ and $\varphi_H \in (0,1)$ is an indicator of efficiency of spending on health. This specification captures the fact that access to infrastructure is essential to the production of health services (See Agénor (2008; 2012, Chapter 3)). Through (13) and (28), access to sanitation infrastructure, in particular, may thus have a significant impact on early childhood health, as suggested by the evidence (see Andres et al. (2014)).

2.8 Market-Clearing Conditions

The asset-market clearing condition requires tomorrow's private capital stock to be equal to savings in period t by individuals born in $t-1$. Given that s_t is savings per family, that the number of families is $(N_t^m + N_t^f)/2$, and that $N_t^f = N_t^m$,

$$K_{t+1}^P = 0.5(N_t^m + N_t^f)s_t = N_t^f s_t. \tag{29}$$

The labor-market clearing condition is $N_t = N_t^m + N_t^f$. Using equations (21) and (22), this condition yields the equilibrium female wage $w_t^f = 2b\beta Y_t/A_t^f \varepsilon_t^{f,W} E_t^f N_t$, which is simply (given the assumption of perfect wage flexibility) the marginal product condition for female labor, adjusted for the loss due to gender discrimination. A similar condition (without a loss factor) holds for the male equilibrium wage.

3 Balanced Growth Equilibrium

A *competitive equilibrium* in this model is a sequence of prices $\{w_{t+1}^m, w_{t+1}^f, r_{t+2}\}_{t=0}^{\infty}$, allocations $\{c_{t+1}^t, c_{t+2}^t, s_{t+1}, \varepsilon_{t+1}^{f,P}, \varepsilon_{t+1}^{f,R}\}_{t=0}^{\infty}$, physical capital stocks $\{K_{t+1}^P, K_{t+1}^I\}_{t=0}^{\infty}$, human capital stocks $\{E_{t+1}^m, E_{t+1}^f\}_{t=0}^{\infty}$, a constant tax rate, and constant spending shares such that, given initial stocks $K_0^P, K_0^I > 0$ and $E_0^m, E_0^f > 0$, initial health statuses $h_0^{C,j}, h_0^{A,j} > 0$, families maximize utility, firms maximize profits, markets clear, and the government budget is balanced. In equilibrium, it must also be that $e_t^j = E_t^j$, and $a_t^j = A_t^j$, for $j = m, f$. A *balanced growth equilibrium* is a competitive equilibrium in which c_{t+1}^t, c_{t+2}^t, K_{t+1}^P, K_{t+1}^I, E_{t+1}^m, E_{t+1}^f grow at the constant, endogenous rate $\boldsymbol{\gamma}$, the rate of return on private capital r_t is constant, women's time allocation is constant, and health status of both children, $h_t^{C,f}$ and $h_t^{C,m}$, and adults, $h_t^{A,f}$ and $h_t^{A,m}$, are constant.[26]

As shown in Appendix 2, the solution of the model yields women's time allocation and the total fertility rate as[27]

$$\varepsilon_t^{f,P} = \left\{1 + \frac{\Lambda_1}{\Lambda_2}\right\}^{-1} \left\{\frac{\Lambda_1}{\Lambda_2} - \zeta^P k_t^I\right\}. \tag{30}$$

$$\varepsilon_t^{f,W} = 1 - \varepsilon_t^{f,P} - p_C n_t \varepsilon_t^{f,R}, \tag{31}$$

$$\varepsilon_t^{f,R} = \frac{\Lambda_3 \theta^R \eta_H \kappa_2 (1-\sigma)}{\eta_C (1 - \eta_H \kappa_2/\eta_N)} (\frac{1 - \varepsilon_t^{f,P}}{\Lambda_2}). \tag{32}$$

$$n = \frac{(1 - \eta_H \kappa_2/\eta_N)}{\Lambda_3 \theta^R p_C}, \tag{33}$$

[26] The constancy of health status in equilibrium is discussed in detail in Agénor (2012, Chapter 3; 2015).

[27] To ensure that $n > 0$ requires imposing $1 - \eta_H \nu_C/\eta_N > 0$, which is a sufficient (although not necessary) condition to ensure that $\Lambda_3 > 0$.

where

$$\sigma = \frac{p_A}{(1+\rho)\eta_C + p_A} < 1, \tag{34}$$

$$p_A = \omega p_A^m + (1-\omega) p_A^f, \tag{35}$$

$$\eta_h = \varkappa \eta_h^f + (1-\varkappa)\eta_h^m = \eta_h^m + (\eta_h^f - \eta_h^m)\varkappa, \quad h = C, H \tag{36}$$

where $\omega \in (0,1)$ is a relative weight, defined later, and

$$\Lambda_1 = \eta_Q \pi^Q (1-\sigma)\eta_C^{-1} > 0,$$

$$\Lambda_2 = 1 + \eta_H \kappa_2 (1-\sigma)\eta_C^{-1} > 1,$$

$$\Lambda_3 = 1 - \frac{\eta_H \kappa_2}{\eta_N} + \frac{\eta_C}{\eta_N(1-\sigma)}.$$

Given the restrictions imposed earlier, $\eta_C^f < \eta_C^m$, $\eta_H^f > \eta_H^m$, and $p_A^f > p_A^m$, equations (35) and (36) imply that

$$\frac{d\eta_C}{d\varkappa} < 0, \quad \frac{d\eta_H}{d\varkappa} > 0, \quad \frac{dp_A}{d\varkappa} > 0. \tag{37}$$

The result $d\eta_H/d\varkappa > 0$ is consistent with the evidence showing that a woman's control over household resources has a significant effect on her family's child health care usage (see Maitra (2004) for instance).

Equation (30) holds as long as $\varepsilon_t^{f,P} > \varepsilon_L^{f,P}$, where $\varepsilon_L^{f,P} \geq 0$ is the minimum amount of time that women must allocate to household chores in the family. It captures the main channel through which access to public infrastructure affects women's time allocation choices.

Equation (33) shows that the total fertility rate is inversely proportional to the childhood survival rate. Put differently, *net* fertility (or the optimal number of surviving children) is independent of the survival probability.[28] It also depends on the bargaining parameter, through both η_H and η_C. However, given the results in (37), the net effect of an increase in $\varkappa$ on fertility is in general ambiguous ($dn/\varkappa \lesseqgtr 0$).[29]

[28] This neutrality effect results directly from the absence of specific birth costs (parents spend only on surviving children) and from the fact that survival is not random. As shown by Sah (1991) and Kalemli-Ozcan (2003), under stochastic survival rates a precautionary demand for children (a "hoarding effect") is likely to arise, thereby also affecting net fertility. However, Doepke (2005) has shown that once the sequential nature of fertility decisions is taken into account (that is, parents conditioning their fertility decisions on the observed survival of offspring born previously), the triggered "replacement effect" may be large enough to offset the "hoarding effect."

[29] Note also that the fertility rate is constant over time; the model therefore does not explain changes in that rate in the course of development. To do so would require, in particular, the use of a more complicated (nonseparable) utility function or an alternative model of fertility choice such as the Barro-Becker model (see Jones and Schoonbroodt (2010)). However, this would imply that we would no longer be able to derive exact solutions for the steady state, thereby forcing complete reliance on the computer to generate the long-run solution numerically. More fundamentally, and as noted in the introduction, the purpose of the paper is on the long-run effects of policies, not transitional dynamics.

Equation (34) defines the family's propensity to save, σ. Thus, through η_C and p_A, σ is also a function of bargaining power. However, given the results in (37), the net effect of an increase in $\varkappa$ on savings is also ambiguous in general ($d\sigma/d\varkappa \lesseqgtr 0$).

Let $x_t^f = K_t^P/E_t^f N_t^f$ denote the private capital-effective labor j ratio; as also shown in Appendix 2, the model can be condensed into a dynamic system in three equations:

$$k_{t+1}^I = \Gamma_2 (k_t^I)^{(1-\mu_I)(1-\alpha)} (\varepsilon_t^{f,W})^{-\beta(1-\mu_I)} [\frac{(h_t^{A,f})^{\nu_P}}{x_t^f}]^{-2\beta(1-\mu_I)}, \tag{38}$$

$$h_{t+1}^{A,f} = \Gamma_4 (\varepsilon_t^{f,R})^{\kappa_2} (k_t^I)^{\Omega_1} (\varepsilon_t^{f,W})^{\Omega_2} \frac{(h_t^{A,f})^{\kappa_1+\nu_P 2\Omega_2}}{(x_t^f)^{2\Omega_2}}, \tag{39}$$

$$x_{t+1}^f = \Gamma_6 (k_t^I)^{-\nu_2+\alpha(1-\nu_1)} (h_t^{A,f})^{\nu_P 2\beta(1-\nu_1)} (x_t^f)^{(1-2\beta)(1-\nu_1)} (\varepsilon_t^{f,R})^{-\nu_3} (\varepsilon_t^{f,W})^{\beta(1-\nu_1)}, \tag{40}$$

where

$$\Gamma_1 = (\frac{\chi^R}{1-\chi^R})^{\beta(\nu_3+\kappa_2\nu_P)},$$

$$\Gamma_2 = \frac{[\varphi_I \upsilon_I \tau(1+b)\beta]^{\mu_I}}{b\beta\Phi\sigma(1-\theta^R p_C n_t)\Gamma_1^{1-\mu_I}},$$

$$\Phi = (1-\tau)(b^{-1}+1),$$

$$\Gamma_3 = [\varphi_H \upsilon_H \tau(1+b)\beta]^{\mu_H} \Gamma_1^{\mu_H},$$

$$\Gamma_4 = (1-\chi^R)^{\kappa_2} \Gamma_3^{\kappa_3} (\frac{\chi^R}{1-\chi^R})^{-\nu_3\nu_A},$$

$$\Omega_1 = \kappa_3[1-\mu_H(1-\alpha)] > 0,$$

$$\Omega_2 = \kappa_3 \beta \mu_H \in (0,1),$$

$$\Gamma_5 = [\frac{b\beta\Phi\sigma(1-\theta^R p_C n_t)}{(1-\chi^R)^{\nu_3}(p_C n_t)^{1-\nu_1} 0.5}][\varphi_E \upsilon_E \tau(1+b)\beta]^{-\nu_1},$$

$$\Gamma_6 = \Gamma_5 \Gamma_1^{1-\nu_1}.$$

These equations form a first-order linear difference equation system in $\hat{k}_t^I = \ln k_t^I$, $\hat{h}_t^{A,f} = \ln h_t^{A,f}$, and $\hat{x}_t^f = \ln x_t^f$. In the general case where $\mu_I < 1$, stability conditions are too complex to be studied analytically. However, with $\mu_I = 1$, as imposed in the calibration, the public-private capital ratio remains constant over time; as shown by Agénor and Canuto (2015), stability requires then that $1 - \kappa_1 - \nu_P 2\Omega_2 > 0$. This condition is satisfied for the parameter values discussed later.

As also shown in Appendix 2, the steady-state growth rate of output is given by

$$1+\gamma_Y = \Gamma_1 (\tilde{k}^I)^{\alpha} (\tilde{\varepsilon}^{f,W})^{\beta} \frac{\beta\sigma(1-\theta^R p_C \tilde{n})}{[(1-\tau)(1+b)]^{-1}} (\tilde{h}^{A,f})^{\nu_P 2\beta} (\tilde{x}^f)^{-2\beta}, \tag{41}$$

where $\tilde{k}^I$, $\tilde{h}^{A,f}$ and $\tilde{x}^f$ are the steady-state solutions obtained by setting $\Delta k^I_{t+1} = \Delta h^{A,f}_{t+1} = \Delta x^f_{t+1} = 0$ in (38), (39), and (40):

$$\tilde{k}^I = \left\{ \Gamma_2 (\tilde{\varepsilon}^{f,W})^{-\beta(1-\mu_I)} [\frac{(\tilde{h}^{A,f})^{\nu_P}}{\tilde{x}^f}]^{-2\beta(1-\mu_I)} \right\}^{1/\Pi_1}, \tag{42}$$

$$\tilde{h}^{A,f} = \left\{ \Gamma_4 (\tilde{\varepsilon}^{f,R})^{\kappa_2} (\tilde{k}^I)^{\Omega_1} (\tilde{\varepsilon}^{f,W})^{\Omega_2} (\tilde{x}^f)^{-2\Omega_2} \right\}^{1/\Pi_2} \tag{43}$$

$$\tilde{x}^f = \left\{ \Gamma_6 (\tilde{k}^I)^{-\nu_2+\alpha(1-\nu_1)} (\tilde{h}^{A,f})^{2\nu_P\beta(1-\nu_1)} (\tilde{\varepsilon}^{f,R})^{-\nu_3} (\tilde{\varepsilon}^{f,W})^{\beta(1-\nu_1)} \right\}^{1/\Pi_3}, \tag{44}$$

where

$$\Pi_1 = 1 - (1-\mu_I)(1-\alpha),$$

$$\Pi_2 = 1 - \kappa_1 - \nu_P 2\Omega_2,$$

$$\Pi_3 = 1 - (1-2\beta)(1-\nu_1) > 0.$$

Note also that, using (22), (12), and (17),

$$\frac{w^m_t}{\varepsilon^{f,W}_t w^f_t} = b^{-1}(\frac{A^f_t E^f_t}{A^m_t E^m_t}) = b^{-1}(\frac{\chi^R}{1-\chi^R})^{-(\kappa_2\nu_P+\nu_3)},$$

which shows that in equilibrium wage inequality between genders depends on two key structural parameters: gender bias in the workplace, as measured by b, and the allocation of mothers' time to their sons and daughters, as measured by χ^R. The lower b is, or the higher χ^R is, the larger the wage differential is.

Before proceeding to calibration and policy experiments, it is worth stressing that in the model presented earlier, the subutility functions U^f and U^m were both assumed to have a log-linear form. This simplifies significantly the analysis—by permitting an explicit solution to the first-order conditions for household optimization, by leading to a savings function that depends linearly on wages only (and not on the interest rate), and thus by allowing an explicit derivation of the steady-state growth rate. In addition, it implies that neither the wage nor the interest rate matter in fertility and women's labor allocation decisions; that is, it neutralizes the effect of prices on optimal decisions. In general, higher wages normally induce two opposite effects: a positive income effect, which raises both consumption and leisure (and thus reduces women's time allocated to market work), and a substitution effect, which stems from the increase in the opportunity cost of leisure (and therefore raises women's time allocated to market work). These two effects exactly offset each other with logarithmic utility. By implication, the parameter measuring gender bias in the workplace, b, has no effect either on women's labor supply to the market. Because time allocated to market work does not change, the overall constraint on women's time implies that the fertility rate does not change either.

Similarly, there are normally two opposite effects when the interest rate goes up: an intertemporal substitution effect, triggered by the fall in the relative price of future consumption (in old age) with respect to present consumption (in adulthood), which induces an increase in women's time allocated to market work, and a positive income effect, which results here from the relaxation of the family's intertemporal budget constraint and leads to lower savings and lower participation in the labor force for women. Again, both effects exactly offset each other under logarithmic preferences for consumption.

By contrast, with a more general isoelastic utility function for instance, an increase in the wage rate or the interest rate would have ambiguous effects on women's time allocated to market work and the fertility rate. As can be inferred from the results in Boucekkine et al. (2009) in particular, if the intertemporal elasticity of consumption is less than unity, an increase in the market wage would raise women's labor force participation rate and reduce the total fertility rate.

For the issue at hand, the fact that a change in the market wage has an ambiguous effect on women's market work with more general utility preferences is potentially important. The reason is that the stock of public capital, through its effect on the marginal productivity of labor, has a positive effect on wages. So when that stock increases, there are now two effects on women's labor supplied to the market: a direct (negative) effect on time allocated to home production, as identified earlier, and an indirect effect through an increase in wages. If the effect on labor supply associated with a change in wages is positive (because the substitution effect dominates the income effect), then the reallocation of time toward market work is magnified. But if it is negative, the net, general equilibrium impact on women's time allocated to market work may be negligible or even negative. However, the income effect would have to be fairly large relative to the substitution effect and the time reallocation effect for this case to occur; there is no strong empirical evidence to suggest that this is actually the case for women in poor countries.

This ambiguity may explain why microeconomic studies of women's labor supply response to changes in access to infrastructure have often found conflicting results. For instance, Dinkelman (2011) found that in South Africa women's time allocated to market work increases in response to improved access to electricity. By contrast, Koolwal and van de Walle (2013), in a study of eight developing countries, found that improved access to safe water increases women's leisure and higher school enrollment rates—possibly through more time allocated by mothers to their children, a productive activity in the present setting—rather than off-farm labor market participation for women.[30] However, identification and causality remain difficult econometric issues in this literature.

The impact on women's labor supply may also depend on the *type* of infrastructure that they have access to. In addition, indivisibility in labor supply decisions, and the lack of market employment opportunities for women (as argued by Bhalotra and Umana-Aponte (2010)) may explain a muted response. In particular, if labor supply decisions are indivisible (or equivalently, part-time work is not feasible), changes in the amount of time saved as a result of greater access to infrastructure would need to be very large to have a detectable effect. Whatever the reason, a muted impact of infrastructure on women's labor supply can be captured indirectly by adjusting the value of the parameter π^Q (the curvature of the home production function) in the model's calibration.

4 Calibration and Solution

To illustrate possible outcomes, and examine the impact of public policy, the model is calibrated for a low-income country, Benin. In selecting a country for application, the goal was to choose a "typical," non-oil, low-income country in Sub-Saharan Africa, with a reasonably long period of economic and political stability to approximate a steady state, without a predominant Muslim population (to avoid issues specific to the role of women in that context), where data availability is average (in order to demonstrate the feasibility of the calibration approach even in such environments), and gender issues are potentially an important consideration in designing a growth strategy in the years ahead. Benin fits all these characteristics fairly well.[31] Main sources of the data used for that purpose are the *World Development Indicators* (WDI) database of the World Bank, the International Monetary Fund, and the United Nations (UN). Various other sources, including published papers, are used as well.

On the *household side*, the annual discount rate is set at 0.04, a fairly conventional choice. This implies that the discount factor is equal to 0.96 on a yearly basis. Interpreting a period as 20 years in this framework yields an intergenerational discount rate of $[1/(1 + 0.04)]^{20} = 0.456$.

[30] Another explanation for the improved schooling outcomes, as noted by Koolwal and van de Walle (2013), may be related to the fact that water collection was the main responsibility of children. This is tantamount to child labor, which is not considered explicitly in the model.

[31] A more detailed discussion of gender issues in that country is provided in Appendix 3. An alternative approach would have been to calibrate the model for a larger group of low-income countries, but an illustration based on a specific country is better suited to demonstrate the overall applicability and usefulness of the model for policy analysis.

As defined in equation (19), women's bargaining power is given by

$$\varkappa = \bar{\varkappa}^{1-\gamma_B}(\frac{\chi^R}{1-\chi^R})^{-\nu_3\mu_B\gamma_B}. \tag{45}$$

To calibrate $\varkappa$ requires setting five parameters: γ_B, $\bar{\varkappa}$, χ^R, ν_3, and μ_B. The coefficient ν_3 is set equal to 0.1, as discussed below. The parameter μ_B is set to a "neutral" value of $\mu_B = 1$ and γ_B is set at 0.5, to capture the fact that endogenous "macro" factors play only a limited role in determining women's bargaining power. It is also assumed that there is some initial bias in mothers' rearing time allocation toward boys and therefore χ^R is set at 0.6. The initial bargaining power of women is set at $\varkappa = 0.344$. This corresponds to the relative literacy rate of adult females (ages 15 and above) for Benin in 2008, as given in WDI, divided by the sum of literacy rates of adult males and females, that is, $28.1/(28.1 + 53.5)$. Expression (45) can therefore be solved for the parameter $\bar{\varkappa}$, so that

$$\bar{\varkappa} = [0.344(\frac{0.6}{1-0.6})^{0.1\cdot 1\cdot 0.5}]^2 = 0.123.$$

To calibrate the survival rates p^m, p^f, and p, I start with estimates of the probability of death. According to WHO data, in 2011 in Benin the probability of dying between ages 15 and 60 was 0.326 for men and 0.27 for women, with an average value of 0.298.[32] The implicit weight used in the average measure is thus $0.326\omega + (1-\omega)0.27 = 0.298$, or $\omega = (0.298 - 0.27)/(0.326 - 0.27) = 0.5$. The survival rates for men and women can therefore be measured as $p^m = 1 - 0.326 = 0.674$ and $p^f = 1 - 0.27 = 0.73$, with an average rate given by

$$p_A = 0.5 \cdot 0.674 + (1 - 0.5)0.73 = 0.702. \tag{46}$$

The family savings rate for Benin is set at 0.082, corresponding to the private savings rate estimated for 2009 by the International Monetary Fund. This gives

$$\sigma = \frac{p_A}{(1+\rho)\eta_C + p_A} = 0.082,$$

or equivalently

$$\eta_C = (\frac{1}{1+\rho})[(\frac{1}{0.082}) - 1]p_A. \tag{47}$$

Thus, with the intergenerational discount factor actually equal to 0.456, and using (46), equation (47) can be calibrated to obtain η_C:

$$\eta_C = 0.456[(0.082)^{-1} - 1] \cdot 0.702 = 3.587. \tag{48}$$

[32] See http://apps.who.int/gho/data/node.main.11?lang=en. To match the model's definition of the survival rate, what one would normally want to use is the probability that a young adult in period t dies before reaching the third phase of life, that is, given the generational structure, the probability of dying before age 40, conditional on surviving until age 20. This measure is not available.

The survival rate for children p_C is estimated by taking one minus the under-five mortality rate (the number of deaths of children under five per 1,000 live births), which is estimated at 146/1000 for Benin according to UN data. Thus, $p_C = 1-0.146 = 0.854$.

UN data give a gross fertility rate (number of births per woman) for Benin for the period 2008-10 of $\tilde{n} = 5.0$. According to data from the 2005-07 round of Multiple Indicator Cluster Survey (MICS) by the United Nations, consumption by children aged between 0 and 14, in proportion to total household consumption, is about 45 percent in West and Central Africa.[33] In terms of the model, this can be taken as an approximation of the share of total family income devoted to spending on children, which corresponds to $p_C\tilde{n}\theta^R$. As noted earlier, $\tilde{n} = 5$ and $p_C = 0.854$; thus, θ^R (the share of family spending on *each* surviving child) can be estimated as $0.45/(5 \cdot 0.854)$, that is, $\theta^R = 0.105$.

In the *home good production sector*, the parameter ζ^P is set to unity initially to capture perfect substitutability between women's time and infrastructure services and the curvature of the home production function initially at $\pi^Q = 0.7$, to capture rapidly decreasing marginal returns in terms of both inputs. In the experiments reported in the next section, a smaller value of $\pi^Q = 0.12$, corresponding to the value used by Kimura and Yasui (2010, Table 4) for a production function with labor only, will also be used to capture smaller decreases in marginal returns initially. A smaller value of $\zeta^P = 0.5$ is also used later.

Based on household survey data, the time spent in home production (including household chores) by mothers is estimated to be 4.5 hours a day, that is, with total daily time of 10 hours, $\tilde{\varepsilon}^{f,P} = 0.45$.[34] The same data also indicate that time allocated to market work is $\tilde{\varepsilon}^{f,W} = 0.428$.

The model does not account explicitly for women's time spent in education. That time is estimated by using UN data on School Life Expectancy (SLE), which is 6 years for women.[35] There are no specific data on tertiary education for women Benin (as least not in WDI); this fraction is assumed to be small at the national level, and therefore all those six years in education are assumed spent in primary and secondary education—that is, in the first period of life. Thus, in adult life, no time is spent in education, as assumed in the model.

[33] See http://www.unicef.org/statistics/index_24302.html for the list of countries and associated reports. Note that leisure is not explicitly accounted for in the model. In practice, it represents only a small fraction of women's time.

[34] From the results in Blackden and Wodon (2006, Table 3.7), time allocated by women in Benin to fetching water and collecting wood only is estimated at 45 minutes a day. However, the model's measure of $\tilde{\varepsilon}^{f,P}$ includes all household chores and therefore a broader estimate is used.

[35] School life expectancy (SLE), or the expected number of years of schooling, is defined as the total number of years of schooling which a child can expect to receive, assuming that the probability of his or her being enrolled in school at any particular future age is equal to the current enrolment ratio at that age. See http://unstats.un.org/unsd/demographic/products/socind/education.htm

Given p_C and $\tilde{n}$, the time constraint (equation (1)) can be used to calculate $\tilde{\varepsilon}^{f,R}$ residually, that is,

$$\tilde{\varepsilon}^{f,R} = (1 - \tilde{\varepsilon}^{f,P} - \tilde{\varepsilon}^{f,W})/p_C\tilde{n},$$

which gives $\tilde{\varepsilon}^{f,R} = 0.029$, and thus $p_C\tilde{n}\tilde{\varepsilon}^{f,R} = 0.122$. Thus, initially, women allocate 45 percent of their time to household chores, about 43 percent to market work, and about 3 percent to each (surviving) child.[36]

Using these data on women's time allocation ($\tilde{\varepsilon}^{f,P}$, $\tilde{\varepsilon}^{f,W}$, and $p_C\tilde{n}\tilde{\varepsilon}^{f,R}$), the estimate of $\tilde{n}$, the calibrated values for σ, θ^R, and η_C derived earlier, $\nu_4 = 0.1$, $\kappa_2 = 0.15$, $\tilde{k}^I = 0.135$ (all discussed below), the definitions of Λ_1, Λ_2, and Λ_3 provided earlier, equations (30), (32), and (33) can be solved backward and jointly for the preference parameters η_H , η_N, and η_Q.[37] This gives $\eta_H = 7.425$, $\eta_N = 4.289$, and $\eta_Q = 7.634$.[38] Thus, the family preference parameter for the home good is more than twice as high as the preference parameter for marketed goods.

Having determined η_C and η_H, the values η_C^m, η_C^f and η_H^m, η_H^f must be determined. Given that $\varkappa = 0.344$, and setting $\eta_C^m = 4.5$ and $\eta_H^m = 6.0$, the last two values can be determined residually using (36), (48) and the solution for η_H:

$$\eta_C^f = \frac{\eta_C - \eta_C^m(1-\varkappa)}{\varkappa} = 1.845, \quad \eta_H^f = \frac{\eta_H - \eta_H^m(1-\varkappa)}{\varkappa} = 10.142,$$

so that by construction $\eta_C^f < \eta_C^m$ and $\eta_H^f > \eta_H^m$.[39]

In the *marketed good production sector*, the elasticities of production of final goods with respect to public capital and each type of labor, α and β, are set equal to 0.15 and 0.35, respectively. Both values are taken from Agénor (2011), with the first being also consistent with the long-run value of 0.14 estimated by Bom and Ligthart (2011, Table 4) for core public capital at the national level. This yields a value of the elasticity of output with respect to private capital equal to $1 - 2\beta = 0.3$, again in line with the empirical evidence. The parameter b, which captures the degree of gender bias in the workplace, is set at 0.6. This value is consistent with the average value of male-female earning gaps for the group of Sub-Saharan African countries reported in Nopo et al. (2012).

[36] By comparison, Lagerlöf (2003) sets $\tilde{\varepsilon}^{f,R} = 0.05$. Data from WDI on the labor force participation rate for adult women (ages 15 to 64) in Benin is about 68 percent for the period 2004-08. However, the concept of labor supply used in the model is not the same as the one captured by the data. Percentage changes (following an experiment) can nevertheless be used to link the two concepts.

[37] The solution involves an iterative procedure, given that the system is nonlinear. Note that equation (31) is used to calibrate $\tilde{\varepsilon}^{f,R}$ residually and is therefore left out of the system.

[38] The calibrated value of η_Q is quite sensitive to the value of π^Q; for instance, with $\pi^Q = 0.9$ instead, η_Q drops to 5.938, with no change in any other calibrated preference parameter.

[39] The results are not highly sensitive to this particular choice of η_C^m and η_H^m because it is the *average* values that matter, and these are constant for all shocks—except for those involving changes in $\varkappa$, or more precisely, changes in mothers' time allocated to sons and daughters.

In the *human capital sector*, the parameter measuring the intergenerational externality associated with the transmission of human capital through mothers, $1 - \nu_1$, is set equal to 0.6, close to the value used by de la Croix and Vander Donckt (2010). This implies an elasticity with respect to government spending on education, ν_1, equal to 0.4. The elasticity with respect to the public-private capital ratio, ν_2, is set equal to 0.15, as in Agénor (2011); it is also consistent with some of the micro evidence reviewed in Brenneman and Kerf (2002). There is not much evidence regarding the elasticity with respect to time allocated by mothers, ν_3; one estimate is the elasticity of child human capital with respect to "time spent developing the human capital of children" by adults, used by Moe (1998), 0.66. However, this is an estimate based for a middle-income country, where average human capital (in the family) tends to be higher than in poorer ones, and may therefore be on the high side. Accordingly, ν_3 is set initially equal to a relatively low value, 0.1, and sensitivity analysis is conducted later on.

Regarding *health status and productivity*, the degree of intergenerational persistence κ_1 is set equal to 0.5, a value that is relatively close to the implicit value used by Osang and Sarkar (2008), 0.45. The elasticity of child health status with respect to mothers' rearing time, κ_2, is set equal to 0.15, whereas the elasticity with respect to public health services, κ_3, is set equal to 0.2. There are no good benchmarks in the literature to guide the choice of the elasticity of health status in adulthood with respect to the ratio of human capital stocks, ν_A, so it is set initially at a relatively low value, 0.2, to avoid biasing the results in terms of health outcomes.[40] The elasticity of both male and female productivity with respect to health status is set at $\nu_P = 0.8$, which is consistent with some of the cross-country econometric estimates reported in Cole and Neumeyer (2006). It is also consistent with the evidence provided by some of the micro-level studies reviewed in McNamara et al. (2010), which suggests that health improvements can have a very large impact on labor productivity in developing countries.

Regarding the *government*, the effective tax rate on output, τ, is calculated by multiplying the average ratio of tax revenues to GDP given in WDI for the years 2004-07, 16.3 percent, divided (to match the model's definition) by the average share of labor income for developing countries estimated by Guerriero (2012, Appendix E), 0.68.[41] Thus, $\tau = 23.9$ percent.

The initial share of government spending on health, υ_H, is based on the average estimate from WDI for the period 2004-07 and is set at 0.115. The initial share of government spending on education, υ_E, is based on the average estimate from WDI

[40] Higher values of ν_A were also tried but did not affect the results. The reason is that, as can be inferred from (39), changes in that parameter only has level effects on health; and health status is recalibrated to unity for each experiment.

[41] The estimate used is the corrected measure LS4 proposed by Guerriero, which accounts for the self employed.

for the years 2004, 2006, and 2007 and is set at 0.171. The initial share of government *investment* on infrastructure, υ_I, is set at 0.05. These numbers imply from the budget constraint (26) that the share of spending on other items, υ_U, is 0.664.

Dabla-Norris et al. (2012, Table 1) estimate the efficiency parameter for public investment in Benin, φ_I, at 0.39.[42] Thus, according to these numbers, in Benin more than 60 percent of public spending on infrastructure investment is "wasted," in the sense that it does not turn into public capital. In the absence of data specific to the education and health sectors, the efficiency parameters for spending on education and health, φ_E and φ_H, respectively, are also set at the same value.

It is assumed initially that public capital is not an essential input for the production of new public capital, so that $\mu_I = 1$. This is a reasonable assumption for a country where the stock of public physical assets is low to begin with. From the model's solution (42), under that assumption, $\Pi_1 = 1 - (1-\mu_I)(1-\alpha) = 1$; given the definition of Γ_2, and the fact that $b\Phi = (1-\tau)(1+b)$,

$$\tilde{k}^I = \frac{\varphi_I \upsilon_I \tau}{\sigma(1-\tau)(1-\theta^R p_C \tilde{n})}, \tag{49}$$

which can be computed to give an equilibrium public-private capital ratio $\tilde{k}^I = 0.135$. Public capital is thus a relatively scarce factor; this is consistent with the view that lack of public infrastructure remains a major impediment to private capital accumulation and growth in low-income countries.

Finally, the elasticity of output of health services with respect to public spending on health is set at $\mu_H = 0.8$. There are no good benchmarks in the literature but this value appears to be a reasonable starting point, given that most of these services are measured based on salaries paid to medical workers, and the correspondence between elasticities and shares in the Cobb-Douglas function with constant returns to scale. By implication, the elasticity with respect to public capital in infrastructure is 0.2, which again is consistent with some of the micro evidence reported in Brenneman and Kerf (2002).

The benchmark parameter values are summarized in Table 1. Based on these parameter and initial values, the model is first solved for the steady-state solutions of $\tilde{k}^I$, $\tilde{h}^{A,f}$, and $\tilde{x}^f$. These solutions are then inserted in the growth rate equation, together with the solutions for $\tilde{\varepsilon}^{f,W}$ and $\tilde{n}$, to determine the steady-state growth rate of output. A multiplicative constant is also introduced, in order to yield an annual growth rate of marketed output per worker equal to 4.5 percent, the average rate of growth of real GDP for Benin over the period 1990-2009.

[42] Dabla-Norris et al. (2012) define their metric on a range of 1 to 4, with a value of 1.56 for Benin; this value was simply divided by 4 to obtain an indicator bounded by unity.

5 Policy Experiments

To illustrate the role of public policy in the model, two types of experiments are considered: those related to general policies and those focusing on gender. The analysis is conducted throughout under the assumption that $\mu_I = 1$ and that $\varepsilon_t^{f,P} > \varepsilon_L^{f,P}$, which implies from equation (30) that women's time allocated to home production is sensitive to changes in access to infrastructure. For each experiment, steady-state changes in some key variables are reported; these variables include women's time allocation, women's bargaining power, the adult survival rate, the family's savings rate, the public-private capital ratio, female health status, and the growth rate of marketed output.

5.1 General Public Policies

The general policies considered here consist of changes in the level and efficiency of various components of public spending. Specifically, the following experiments are conducted: an increase in the share of public expenditure on infrastructure, and an across-the-board increase in the efficiency of spending on infrastructure and education.[43]

5.1.1 Increase in Share of Public Spending on Infrastructure

Consider the case of a public policy aimed at promoting access to infrastructure, by investing in rural roads, power grids, etc. This can be captured by considering an increase in υ_I. Specifically, an increase in υ_I from an initial value of 0.05 to 0.08 is considered. The case where the increase in investment in infrastructure is financed by a cut in unproductive spending ($d\upsilon_I + d\upsilon_U = 0$) is considered first. The case of potential trade-offs that arises if financing occurs through a cut in other components of (productive) spending, either health or education outlays, is discussed next.

The impact of this experiment is shown in Table 2 for the benchmark set of parameters and alternative values for some of them. Consider first the benchmark case. The direct effect of the shock is of course an increase in the public-private capital ratio $\tilde{k}^I$ (which rises from an initial value of 0.135 to 0.216), thereby promoting growth directly through standard productivity effects. In addition, an increase in the share of government spending on infrastructure lowers mothers' time allocated to home production. This, in turn, raises time allocated to market work and time spent on child rearing. Indeed, time allocated to home production drops from a share of 0.45 initially to about

[43]The model can be used to conduct a variety of other general experiments, including changes in spending on health or education, taxation, and in demographic variables (adult life expectancy, child survival rate, etc.).

0.41, whereas time spent in market work increases from 0.43 to 0.46. At the same time, total time allocated to child rearing increases from 0.122 to 0.131.[44] The increase in rearing time leads to improved health in both childhood and adulthood, thereby increasing effective labor supply. Thus, time allocation effects also help to promote growth and health outcomes.

Because survival rates are constant in this experiment, the change in female time allocation has no direct effect on the fertility rate. And because the increase in income also raises the level of private savings and investment, the higher stock of private capital exerts a direct, positive effect on the growth rate of output per worker. At the same time, female health in adulthood also improves—partly as a result of more rearing time (as noted earlier) but also because of higher government spending on health (due to higher tax revenues induced by the increase in wages and time allocated to market work). This "health effect" compounds the "savings effect" (through higher family income) on growth. The long-run effect is improved female health status and higher steady-state growth, which increases by about 0.7 percentage point in the benchmark case.

Table 2 also shows results for a lower value of $\pi^Q = 0.12$ (to capture smaller decreases in marginal returns initially between women's time and infrastructure services), a lower value of ζ^P (which measures the degree of substitutability between women's time and access to infrastructure services), a lower value of $\eta_N = 2.5$ (the family preference parameter for the number of children), as well as a higher value of $\eta_C^m = 5.5$ (the male preference parameter for current consumption). A lower π^Q magnifies the shift in women's time allocation away from home production and toward productive uses (child rearing and market work) but has no discernible effect on growth. The reason is that a higher private capital stock tends to increase the capital-effective female labor ratio by more than in the base case, and this tends to lower output as well as (through lower tax revenues and a reduction in the supply of health services) female health status. These adverse effects tend to offset the benefits associated with more time being devoted by women to child rearing and market work. A lower degree of substitutability between women's time and infrastructure services (lower ζ^P) mitigates the drop in the amount of time that they allocate to household chores and thus the increase in labor force participation; this, in turn, tends to hamper economic growth. A higher male preference parameter for current consumption (higher η_C^m) magnifies the drop in female time devoted to home production, because it lowers the family savings rate and therefore reduces private investment. At the same time, by lowering the private cap-

[44] In all the experiments reported here, the implicit assumption is that labor supply decisions are divisible, or equivalently that part-time work is feasible. Otherwise, changes in women's time allocation would be either negligible (as noted earlier) or subject to thresholds. Lack of divisibility may explain why studies, such as Koolwal and Van de Waal (2013) for instance, did not find any significant effects of improved access to water on women's paid labor.

ital stock, the congestion effect on public infrastructure is weakened; as a result, the increase in the public-private capital ratio is larger than in the benchmark case. However, although health outcomes are slightly better, the larger increase in women's time allocated to market work does not translate into a higher growth effect because of the reduction in private investment. Finally, a reduced preference for children (lower η_N) tends to mitigate the shift away from household chores, and to dampen the increase in women's time devoted to child rearing and market work. The benefits of increased public investment in terms of growth and health outcomes are thus weaker.

To illustrate the possible trade-offs that may arise when the increase in infrastructure investment is financed by a cut in another productive component of spending, Table 2 also presents simulation results when the increase in υ_I is matched by a drop in spending on education ($d\upsilon_I + d\upsilon_E = 0$). By and large the results are qualitatively similar to those discussed earlier, but clearly the impact on growth is significantly smaller, given that there are now offsetting effects between productive components of public spending. With the benchmark set of parameters, for instance, the increase in the steady-state growth rate drops from 0.7 to 0.3 percentage points. Qualitatively, similar results would obtain by considering an offsetting decrease in the share of spending on health services ($d\upsilon_I + d\upsilon_H = 0$); the net effect on female health status would now be ambiguous, given that the direct, negative effect related to health spending is offset by higher spending on infrastructure.

5.1.2 Improved Efficiency of Public Spending

Consider an increase in efficiency of productive public spending, from an initial, uniform value of 0.39, to 0.6, first for each component separately (infrastructure, education, and health) and then for all components simultaneously. In broad terms, this policy experiment can be viewed as capturing the benefits of an ambitious program of governance reform.

The steady-state effects of this policy are displayed in Table 3. With the benchmark set of parameters, the public-private capital ratio rises significantly, from 0.135 to 0.208. As a result, time spent by women in home production drops from 0.45 to 0.415, whereas time allocated to market work increases from 0.428 to 0.456. Total time allocated to rearing children increases slightly, from 0.122 to 0.13. Of course, with $\pi^Q = 0.12$, these time allocation effects are magnified, as with the previous experiment. Overall, growth increases by about 0.6 percentage points. Health status of adult females (and, by implication, children's health) also improves, both because of the time reallocation effect, and because of the effect of the higher public capital stock and higher effective health spending on the supply of health services.

The increase in efficiency of education generates a larger increase in the steady-state growth rate of output (of the order of 0.8 percentage points), whereas the increase in the growth rate associated with improved efficiency of spending on health is significantly lower (an increase of about 0.2 percentage points). These two policies have no discernible impact on women's time allocation, as can be expected; but the increase in efficiency of health (and, to a lesser extent, education) spending does have a substantial positive impact on health outcomes. When the improvement in spending efficiency occurs across the board, the impact on growth is magnified—the long-run growth rate in output increases by 1.8 percentage points, whereas the sum of the direct effects is $0.62 + 0.79 + 0.19 = 1.6$ percentage points. The difference between these two numbers, 0.2 percentage points, can be viewed as a rough measure of the positive externality associated with the simultaneous implementation of a combination of reforms aimed at improving spending efficiency.

5.2 Gender-Related Experiments

Four types of gender-related experiments are analyzed in what follows: a reduction in the cost of child rearing, a reduction in gender bias in the market place, an increase in mothers' time allocated to their daughters, and an autonomous increase in women's bargaining power.[45]

5.2.1 Reduction in the Cost of Child Rearing

Suppose that the government implements measures (free medical supplies, etc.) that lead to a drop in the unit cost of child rearing for the family, θ^R. These measures are assumed to result from a reallocation within unproductive components of spending, G_t^U, so that shares of all spending components remain constant. Thus, the shift in θ^R is budget neutral (from the perspective of the government) and can be considered in isolation from other changes.[46] Specifically, a drop in θ^R from an initial value of 0.105 to 0.085 is considered for illustrative purposes.

The effects of this experiment are displayed in Table 4. As can be inferred from the solution for the fertility rate in equation (33), a drop in θ^R raises the gross fertility rate in the exact same proportion; in the benchmark case, it increases from 5.0 initially to 6.2. However, these two effects offset each other, and as a result the total cost of rearing surviving children, $\theta^R p_C \tilde{n}$, does not change. By implication, the public-private capital ratio $\tilde{k}^I$ does not change, and neither does the savings *rate*. In addition, the amount of

[45] See Buvinic et al. (2010) for a broader discussion of gender-related policies, in relation with recent demographic trends.

[46] Household-specific subsidies to child rearing can be introduced directly in the family and government budget constraints. Doing so would allow also an analysis of possible trade-offs between subsidies and other productive components of public spending.

time spent by women in home production and in market work are not affected. Given the time constraint, time allocated to rearing each (surviving) child, $\tilde{\varepsilon}^{f,R}$, must fall, to ensure that total rearing time, $p_C\tilde{n}\tilde{\varepsilon}^{f,R}$, remains constant as well. In the benchmark case, time allocated to each child drops indeed from an initial value of 0.029 to about 0.024. There is therefore a substitution of "quantity" for "quality," the latter measured in terms of the proportion of time that mothers devote to each of their children.

Although the reduction in θ^R tends to promote growth (by raising the *level* of private savings and investment) the fall in $\tilde{\varepsilon}^{f,R}$ tends to hamper it, because it has an adverse effect on children's health, which eventually affects their health and productivity in adulthood. Whether the latter effect dominates the former depends in particular on the magnitude of the parameter κ_2, which measures the impact of rearing time on children's health. In the benchmark case, where $\kappa_2 = 0.15$, growth increases by about 0.4 percentage points, despite the fact that female health status deteriorates.

Table 4 assesses the sensitivity of the benchmark results in response to changes in four parameter values: a lower degree of persistence in health, κ_1 (from 0.5 to 0.45), a higher κ_2 (from 0.15 to 0.25), a higher male preference for current consumption, η_C^m (from 4.5 to 5.5), and a lower preference for children, η (from 4.289 to 2.5). As κ_2 goes up for instance, the adverse effect of the drop in time allocated to each child on growth is magnified; growth increases by only 0.3 percentage points. A higher η_C^m mitigates the increase in the fertility rate but has no discernible effect on female health status or growth. Similar results obtain with a lower preference for children.[47] By contrast, with less persistence in health, the adverse effect of the drop in rearing time on health is mitigated, and the impact on steady-state growth is slightly higher.

5.2.2 Reduction in Gender Bias in the Market Place

Suppose now that the government implements anti-discrimination laws that lead to a permanent reduction in gender bias against women in the work place; analytically, this can be captured by considering an *increase* in b. Specifically, increases in b from an initial value of 0.6 to either 0.8 or 1.0 (complete elimination of gender bias) are considered.

The effects of this policy are summarized in Table 5. The direct effect of a higher b (at the initial level of wages) is to raise family income. In turn, higher income leads to a higher level of private savings and private capital stock, which has a direct positive impact on growth, as well as higher tax revenues. Because changes in b affect tax

[47] Note that the initial time allocation changes with η_N ($\tilde{n}$ falls, whereas $\tilde{\varepsilon}^{f,R}$ increases). As a result, the *absolute* change in rearing time associated with a lower η_N is larger, and the change in the fertility rate smaller, than in the benchmark case. However, in *relative* terms the changes in $\tilde{n}$ and $\tilde{\varepsilon}^{f,R}$ are the same in both cases. These changes also offset each other, in such a way that total rearing time remains constant, that is, $d(p_C\tilde{n}\tilde{\varepsilon}^{f,R})/d\theta^R = 0$.

revenues and private savings in exactly the same way, the public-private capital ratio is not affected. Thus, women's time allocation, and the fertility and savings rates, are not affected either. But higher tax revenues also lead to higher public spending on health, which has a positive effect on health in childhood and female health in adulthood. In the long run, a reduction in gender bias leads therefore to an improvement in women's health status and an increase in the growth rate of output. With the benchmark set of parameters, an increase in b from 0.6 to 0.8 (respectively, to 1.0) raises the steady-state growth rate by about 0.3 (respectively, 0.6) percentage points.[48]

Table 5 also provides simulation results when an increase in b (from 0.6 to 0.8) is combined either with a higher ν_1 (the elasticity of human capital with respect to government spending on education, from 0.4 to 0.45), a lower χ^R (the parameter that measures the fraction of women's time allocated to boys), and a higher government spending share on education, υ_E, by 2 percentage points. All three experiments lead to higher growth and improved health outcomes compared to the benchmark case. In addition, the more equal distribution of mothers' time between their sons and daughters leads to higher female bargaining power, which leads to more weight attached by the family to children's health. As a result, time allocated by mothers to child rearing increases. But because the higher levels of private investment and private capital stock tend to lower the public-private capital ratio (which in turn tends to increase women's time spent on household chores), the increase in time allocated to child rearing is offset by a reduction in women's time allocated to market work.

5.2.3 Autonomous Increase in Women's Bargaining Power

Suppose that changes in cultural values and social norms regarding the role of women lead to an increase in the autonomous component of women's bargaining power, that is, an increase in $\bar{\varkappa}$, from an initial value of 0.123 to a value of 0.24. In the benchmark case this changes the initial value of $\varkappa$ from 0.344 to 0.48, thereby (almost) achieving gender parity in bargaining power between husbands and wives.

The steady-state effects associated with this experiment are displayed in Table 6. In the model, there are two main channels through which the change in $\bar{\varkappa}$ affects growth. First, because women's preference for current consumption is *lower* than that of men ($\eta_C^f < \eta_C^m$), it reduces the average family preference parameter for today's consumption, η_C. As a result, the family's savings rate σ, defined in (34), increases, from an initial value of 0.082 to 0.0904 in the benchmark case. At the aggregate level, the increase in savings translates into a higher private capital stock. Second, because women's

[48] Note that the model does not capture the possibility that gender gaps in access to managerial positions and employment may distort the allocation of talent and the production and productivity of human capital. Had these effects been accounted for, the benefits of an increase in b on economic growth would be magnified.

preference for children's health is *higher* than that of men ($\eta_H^f > \eta_H^m$), it increases the average family preference parameter for children's health, η_H. However, because children are a normal good, the drop in the preference for current consumption leads also to an *increase* in the fertility rate, which translates into an increase in women's time allocated to child rearing, both at the individual and aggregate levels.[49] This is offset by a reduction in time devoted to market work.

Both of these channels have important effects on growth outcomes. The increase in the private capital stock has a direct, beneficial impact on market production. At the same time, however, it tends to reduce both the public-private capital stock and the female labor-private capital ratio; both of these effects have a direct, negative impact on long-run growth.[50] The first effect, essentially, reflects the congestion of public capital generated by higher savings and a higher private capital stock. As a result, women's time allocated to household chores increases, thereby compounding the drop in time allocated to market work resulting from more time being devoted to child rearing. In addition, the drop in the public-private capital stock has an adverse effect on human capital accumulation, as well as health status in childhood and adulthood, through the supply of health services, which tends to fall. The magnitude of this "human capital effect" depends in particular on the parameters ν_2 (the elasticity of human capital with respect to the public-private capital ratio), whereas the magnitude of the "health effect" depends on the parameters κ_1 (the degree of persistence in health) and κ_2 (the elasticity of child health status with respect to women's rearing time).

The impact of an increase in $\bar{\varkappa}$ on women's time allocation is worth stressing. Higher family preference for children's health means that mothers end up allocating more time to child rearing; this reallocation is *productive*, because it helps to improve children's health (to an extent that depends on κ_2) and education outcomes (to an extent that depends on parameter ν_3), and thus their productivity in adulthood. This is beneficial for growth. However, this reallocation occurs to a large extent to the detriment of women's time allocated to market work; this tends to have an adverse effect on growth. In sum, there is a negative congestion effect, a negative female labor-private capital effect, an ambiguous human capital effect (a negative effect of the public-private capital ratio, and a positive effect of higher rearing time), and an ambiguous health effect (a negative effect of the supply of health services induced by a lower public-private capital ratio, and a positive effect of higher rearing time); because these various effects work in opposite directions, the net impact on growth is generally ambiguous.

[49] If η_C were to remain constant, the fertility rate would fall whereas time allocated to child rearing would again increase; there would be a substitution of quality for quantity. This result was verified numerically.

[50] The reduction in the public-private capital ratio also tends to *increase* time allocated to household chores, but as shown in Table 6 the net effect is still negative.

As shown in Table 6, in the benchmark case, the general equilibrium effect of the increase in $\bar{\varkappa}$ comes out slightly positive. The same result obtains with a higher μ_B (from 1.0 to 1.5), the parameter that measures the sensitivity of the endogenous component of bargaining power to relative stocks of human capital, or a higher ν_2 (from 0.15 to 0.2). However, with a higher value of γ_B (the relative importance of the endogenous component of bargaining power between spouses) the effect is zero whereas with a higher κ_2 (from 0.15 to 0.25), the net effect on growth is slightly negative. In particular, a higher ν_2 magnifies the negative effect of the public-private capital ratio on education outcomes. With a higher κ_2, the marginal benefit of women's time allocated to child rearing rises, and as a result women spend more time with each of them; this helps to mitigate the adverse effect on health outcomes, compared to the benchmark case. At the same time, however, women's time reallocation toward child rearing occurs at the expense of time spent in market work, which has an adverse effect on growth.

The lessons from this experiment are quite important. When trying to assess the growth effects of an increase in women's bargaining power, it is essential to distinguish the benefits at the microeconomic (or family) level, and macroeconomic (aggregate) level. At the microeconomic level, the increase in women's bargaining power benefits children, because it implies that the family's overall preference parameter tends to increase and this induces a reallocation of time toward rearing children—which benefits both their education and their health. At the same time, the lower family preference for present consumption leads to higher savings and a higher demand for children. At the aggregate level, however, the increased investment associated with higher savings has conflicting effects on the economy's production capacity—a direct effect, which is positive, and an indirect effect, related to congestion of public capital, which is negative—whereas more time spent taking care of children may mean less time in market work if access to infrastructure services becomes more congested. Unless the benefits of mothers spending more time with their children are large (as a result of improved health and education outcomes in childhood, and greater productivity in adulthood), the net effect on growth of shifting the balance of power in the family toward women may not be very significant.[51]

5.2.4 Increase in Mothers' Time Allocated to Daughters

Suppose that changes in perceptions about the role of women in society induce families to reduce the fraction of rearing time that mothers allocate to sons, χ^R, and thus increase the time devoted to their daughters, from an initial value of 0.6 to parity, at 0.5.

[51] It should be kept in mind, however, that the foregoing discussion focuses only on an *autonomous* change in women's bargaining power; as discussed in the next experiment, *endogenous* changes could be more important, depending on parameter values.

The effects of this experiment are summarized in Table 7. In the model, mothers allocating relatively less time to their sons means that their human capital and productivity in adulthood (given that rearing time affects both schooling and health outcomes in childhood) will also be relatively lower compared to their daughters. By implication, effective male labor will tend to fall relatively to women's effective labor. However, at the same time, the increase in the relative female human capital stock induced by the reduction in time allocated to sons also improves women's bargaining power, which translates into a higher savings rate per household (due to the fact that the family preference parameter for current consumption, η_C, falls) and a higher stock of private capital. Although this positive effect on growth is mitigated by congestion effects, with the benchmark set of parameters both female health status and the the rate of growth of marketed output increase, in the latter case by about 0.1 percentage points. Because the reduction in family preference for current consumption raises also the demand for children, both the fertility rate and time devoted to child rearing increase, as in the previous simulation. This is offset, just like the increase in women's time spent in household chores (resulting from the lower public-private capital ratio), by a drop in time allocated to market work. Nevertheless, female health status improves substantially.

The increase in women's bargaining power in this experiment depends positively on the value of γ_B, which measures the relative weight attached to the endogenous component of bargaining power, and μ_B, which measures the sensitivity of that component to women's relative stock of human capital. This is in contrast with the previous experiment, where the focus was on a change in the *autonomous* component of women's bargaining power. A higher value of μ_B for instance magnifies the impact of the reduction in χ^R on women's bargaining power. As a result, the increase in the family savings rate is more substantial, thereby amplifying (despite the congestion effect) the positive effect of χ^R on the rate of economic growth. The extent to which reduced gender bias in mothers' time allocation increases women's bargaining power also depends on the parameter κ_2, which measures the response of child health status with respect to changes in women's rearing time.

More formally, Table 7 provides sensitivity analysis for a higher γ_B (from 0.5 to 0.8), a higher μ_B (from 1.0 to 1.5), and a higher κ_2 (from 0.15 to 0.25); it also considers a lower female preference parameter for child health, η_H^f (from 10.142 to 5.0). In the first two cases the increase in female bargaining power is magnified, but there are no significant differences in the effect on female health status and growth, compared to the benchmark case. With a higher κ_2, the benefit of spending more time with children is amplified, and as a result more time is devoted to that activity. Consequently, the impact on female health status is also larger. Nevertheless, because the increase in rearing time is offset by a drop in time spent in market work, the impact on growth is only slightly higher. By contrast, with a lower female preference for children's health, time spent by mothers in child rear and engaging in market activities both fall; the impact on health status in adulthood and growth are slightly lower than in the benchmark case.

Finally, to illustrate the benefits of policy complementarities, consider a composite reform program involving three of the experiments previously considered: an increase in the share of spending on infrastructure, from $\upsilon_I = 0.05$ to 0.08, financed by a cut in unproductive spending; a drop in θ^R from an initial value of 0.105 to 0.085; and an increase in b from an initial value of 0.6 to 0.8. From the data reported in Tables 2, 4, and 5, the sum of the direct effects is $0.68 + 0.37 + 0.29 = 1.3$ percentage points. By contrast, with all three policies implemented simultaneously, the growth effect is 1.5 percentage points. A similar result obtains in terms of women's health status. Thus, the simultaneous implementation of a combination of structural and gender-oriented policies may generate substantial positive externalities in terms of growth and women's health, compared to a "piecemeal" approach.

6 Concluding Remarks

The purpose of this paper was to present a computable overlapping-generations model for gender and growth analysis. Despite its relatively small scale, the model is detailed enough to provide a serious starting point for studying the impact of public policies. As noted in the introduction, and in line with much of the literature on applied general equilibrium models, the approach proposed here is to calibrate the steady-state solution of the model and focus on the long-run effects of public policies, on the ground that many of these policies are structural in nature and likely to produce tangible economic results only over a period of several years.

After describing the model and characterizing its long-run properties, an illustrative calibration was provided for a low-income country. Several policy experiments were then discussed—improved access to, and efficiency in the use of, public infrastructure, and a number of gender-related experiments, including an increase in subsidies to child care, a reduction in gender bias in the market place, an increase in women's bargaining power over family resources, and a shift in mothers' time allocated between sons and daughters. The results illustrate the importance of accounting for gender effects, most importantly women's time allocation decisions and bargaining power, in assessing the impact of public policy (whether gender-specific or not) on economic growth. They also show that the simultaneous implementation of a combination of structural and gender-based policies, as opposed to a "piecemeal" approach, may generate substantial additional benefits in terms of growth and women's health. This is an important lesson for policymakers.

The analysis presented in this paper can be extended in at least three directions. First, the survival probability from childhood to adulthood, and from adulthood to old age, could both be endogenized by relating them to health status in childhood and adulthood, respectively. In addition, the former could also account for an externality associated with women's education. Several studies have found indeed in countries where mothers are better educated (and presumably more aware of health risks to their children), infant mortality rates are lower, and attendance rates in school are higher. Better-educated women tend, on average, to have more knowledge about health risks. Early evidence on this effect was provided by Cleland and van Ginneken (1988). Subsequent studies include Summers (1994), Smith and Haddad (2000), Maitra (2004), and McGuire (2006), among others. Summers (1994) found that five additional years of education for women could reduce infant mortality rates by up to 40 percent in Sub-Saharan Africa. In Niger alone, researchers have found that infant mortality rates are lower by 30 percent when mothers have a primary education level, and by 50 percent when they have completed secondary education. In a study of India, Maitra (2004), provided evidence that a woman's level education has a stronger effect on child health care usage compared to that of her husband. Smith and Haddad (2000) estimated that improvements in female secondary school enrollment rates are responsible for 43 percent of the 15.5-percentage-point reduction in the child underweight rate recorded during the period 1970-95 in developing countries. Similarly, in more recent cross-section regressions for developing countries, McGuire (2006) found that average years of female schooling have a statistically significant impact on under-five mortality rates.

Second, the model could be extended to account for child labor—both by boys (outside the home) and by girls, in household chores. This issue is discussed analytically in a contribution by Agénor and Alpaslan (2013). In their model, improved access to infrastructure reduces the amount of time parents find optimal for their daughters to spend on household chores, thereby allowing them to allocate more time to studying at home. Their analysis shows that poor access by families to infrastructure may provide an endogenous explanation, complementary to those focusing solely on social norms and cultural values, for the persistence of child labor at home and gender inequality. Finally, rather than assuming that women's bargaining power is determined only by social norms and relative human capital stocks, as is done here, it could also be related to the time that they allocate to human capital accumulation—which would therefore be indirectly related to access to infrastructure, given its impact on time devoted to home production. As discussed in Agénor and Canuto (2015), this creates an additional channel through which public policy can affect gender equality and economic growth.

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Table 1
Calibration: Benchmark Case

Parameter	Value	Description
Households		
ρ	0.04	Annual discount rate
$\varkappa$	0.344	Women's bargaining power in the family
μ_B	1.0	Sensitivity of bargaining power to human capital stocks
γ_B	0.5	Weight of endogenous component of bargaining power
χ^R	0.6	Proportion of mothers' rearing time allocated to boys
p_A, p_C	$0.702, 0.854$	Average adult, child survival probability
σ	0.082	Family's savings rate
η_C^m, η_C^f	$4.5, 1.845$	Preference parameters for current consumption
n	5.0	Gross fertility rate
θ^R	0.105	Share of family income allocated to child rearing
η_N	4.289	Family preference parameter for number of children
η_H^m, η_H^f	$6.0, 10.142$	Preference parameters for children's health
η_Q	7.634	Family preference parameter for the home good
Home production		
ζ^P	1.0	Substitution parameter
π^Q	0.7	Curvature of production function
Market production		
α	0.15	Elasticity wrt public-private capital ratio
β	0.35	Elasticity wrt male labor and female labor
b	0.6	Gender bias in the workplace
Human capital		
ν_1	0.4	Elasticity wrt public spending in education
ν_2	0.15	Elasticity wrt public-private capital ratio
ν_3	0.1	Elasticity wrt mothers' rearing time
Health		
κ_1	0.5	Degree of persistence in health status
κ_2	0.15	Elasticity of child health status wrt rearing time
κ_3	0.2	Elasticity of child health status wrt health services
ν_A	0.2	Elasticity of health status wrt human capital ratio
ν_P	0.8	Elasticity of productivity wrt health status
Government		
τ	0.239	Tax rate on marketed output (adjusted for labor share)
υ_I	0.05	Share of spending on infrastructure investment
υ_E	0.171	Share of spending on education
υ_H	0.115	Share of spending on health
μ_I	1.0	Elasticity of public capital wrt investment
μ_H	0.8	Elasticity of public health services wrt health spending
φ_h	0.39	Spending efficiency parameters, $h = I, E, H$

Table 2

Increase in Share of Spending on Infrastructure 1/

Financed by Cut in Unproductive Spending, υ_U		Absolute deviations from baseline				
	Baseline	Benchmark	$\pi^{Q} = 0.12$	$\zeta^{P} = 0.5$	$\eta_C^{m} = 5.5$	$\eta_N = 2.5$
Time allocated by mothers to						
Household chores	0.450	-0.0393	-0.0687	-0.0197	-0.0457	-0.0294
Child rearing	0.029	0.0020	0.0036	0.0010	0.0023	0.0026
Child rearing (total)	0.122	0.0087	0.0152	0.0044	0.0090	0.0065
Market work	0.428	0.0306	0.0535	0.0153	0.0367	0.0229
Women's bargaining power	0.344	0.0000	0.0000	0.0000	0.0000	0.0000
Fertility rate	5.000	0.0000	0.0000	0.0000	0.0000	0.0000
Family's savings rate	0.082	0.0000	0.0000	0.0000	0.0000	0.0000
Public-private capital ratio	0.135	0.0812	0.0812	0.0812	0.0888	0.0607
Female health status	1.000	0.1088	0.1088	0.0942	0.1113	0.1017
Growth rate of final output	0.045	0.0068	0.0068	0.0062	0.0069	0.0065

Financed by Cut in Education Spending, υ_E		Absolute deviations from baseline				
	Baseline	Benchmark	$\pi^{Q} = 0.12$	$\zeta^{P} = 0.5$	$\eta_C^{m} = 5.5$	$\eta_N = 2.5$
Time allocated by mothers to						
Household chores	0.450	-0.0393	-0.0687	-0.0197	-0.0457	-0.0294
Child rearing	0.029	0.0020	0.0036	0.0010	0.0023	0.0026
Child rearing (total)	0.122	0.0087	0.0152	0.0044	0.0090	0.0065
Market work	0.428	0.0306	0.0535	0.0153	0.0367	0.0229
Women's bargaining power	0.344	0.0000	0.0000	0.0000	0.0000	0.0000
Fertility rate	5.000	0.0000	0.0000	0.0000	0.0000	0.0000
Family's savings rate	0.082	0.0000	0.0000	0.0000	0.0000	0.0000
Public-private capital ratio	0.135	0.0812	0.0812	0.0812	0.0888	0.0607
Female health status	1.000	0.0835	0.0835	0.0692	0.0859	0.0765
Growth rate of final output	0.045	0.0032	0.0032	0.0026	0.0033	0.0029

1/ Increase in υ_I from 0.05 to 0.08. Initial values of π^{Q}, ζ^{P}, η_C^{m}, and η_N are equal to 0.7, 1.0, 4.5, and 4.289, respectively.

Source: Author's calculations.

Table 3
Increase in Efficiency of Government Spending 1/

	Baseline	Absolute devations from baseline $\varphi_I = 0.6$	$\varphi_I = 0.6$ and $\pi^Q = 0.12$	$\varphi_E = 0.6$	$\varphi_H = 0.6$	$\varphi_{I,E,H} = 0.6$
Time allocated by mothers to						
Household chores	0.450	-0.0353	-0.0617	0.0000	0.0000	-0.0353
Child rearing	0.029	0.0018	0.0032	0.0000	0.0000	0.0018
Child rearing (total)	0.122	0.0078	0.0137	0.0000	0.0000	0.0078
Market work	0.428	0.0275	0.0480	0.0000	0.0000	0.0275
Women's bargaining power	0.344	0.0000	0.0000	0.0000	0.0000	0.0000
Fertility rate	5.000	0.0000	0.0000	0.0000	0.0000	0.0000
Family's savings rate	0.082	0.0000	0.0000	0.0000	0.0000	0.0000
Public-private capital ratio	0.135	0.0729	0.0729	0.0000	0.0000	0.0729
Female health status	1.000	0.0988	0.0988	0.0529	0.1631	0.3456
Growth rate of final output	0.045	0.0062	0.0062	0.0079	0.0019	0.0176

1/ Increase in φ_I from 0.39 to 0.6. The Initial value of π^Q is equal to 0.7 whereas initial values of both φ_E and φ_H are also equal to 0.39.

Source: Author's calculations.

Table 4
Reduction in the Cost of Child Rearing 1/

		Absolute devations from baseline				
	Baseline	Benchmark	$\kappa_1 = 0.45$	$\kappa_2 = 0.25$	$\eta_C^m = 5.5$	$\eta_N = 2.5$
Time allocated by mothers to						
Household chores	0.450	0.0000	0.0000	0.0000	0.0000	0.0000
Child rearing	0.029	-0.0054	-0.0054	-0.0098	-0.0057	-0.0090
Child rearing (total)	0.122	0.0000	0.0000	0.0000	0.0000	0.0000
Market work	0.428	0.0000	0.0000	0.0000	0.0000	0.0000
Women's bargaining power	0.344	0.0000	0.0000	0.0000	0.0000	0.0000
Fertility rate	5.000	1.1765	1.1765	1.0070	1.0767	0.6872
Family's savings rate	0.082	0.0000	0.0000	0.0000	0.0000	0.0000
Public-private capital ratio	0.135	0.0000	0.0000	0.0000	0.0000	0.0000
Female health status	1.000	-0.0371	-0.0335	-0.0807	-0.0371	-0.0371
Growth rate of final output	0.045	0.0037	0.0038	0.0031	0.0037	0.0037

1/ Drop in Θ^R from 0.105 to 0.085 (or equivalently a 24 percent reduction in each household spending on their children). Initial values of κ_1, κ_2, η_C^m, and η_N are equal to 0.50, 0.15, 4.5, and 4.289, respectively.

Source: Author's calculations.

Table 5
Reduction in Gender Bias in the Market Place 1/

		Absolute devations from baseline				
	Baseline	b = 0.8	b = 1	b = 0.8 and ν_1 = 0.45	b = 0.8 and χ^R = 0.5	b = 0.8 and υ_E = 0.191
Time allocated by mothers to						
Household chores	0.450	0.0000	0.0000	0.0000	0.0010	0.0000
Child rearing	0.029	0.0000	0.0000	0.0000	0.0001	0.0000
Child rearing (total)	0.122	0.0000	0.0000	0.0000	0.0006	0.0000
Market work	0.428	0.0000	0.0000	0.0000	-0.0016	0.0000
Women's bargaining power	0.344	0.0000	0.0000	0.0000	0.0070	0.0000
Fertility rate	5.000	0.0000	0.0000	0.0000	0.0094	0.0000
Family's savings rate	0.082	0.0000	0.0000	0.0000	0.0004	0.0000
Public-private capital ratio	0.135	0.0000	0.0000	0.0000	-0.0004	0.0000
Female health status	1.000	0.0204	0.0389	0.0227	0.1189	0.0340
Growth rate of final output	0.045	0.0029	0.0057	0.0033	0.0044	0.0049

1/Initial values of both b and χ^R are equal to 0.6, whereas initial values of ν_1 and υ_E are equal to 0.4 and 0.171, respectively.

Source: Author's calculations.

Table 6

Autonomous Increase in Women's Bargaining Power 1/

	Baseline	Absolute devations from baseline				
		Benchmark	$\gamma_B = 0.8$	$\nu_2 = 0.2$	$\mu_B = 1.5$	$\kappa_2 = 0.25$
Time allocated by mothers to						
Household chores	0.450	0.0201	0.0143	0.0201	0.0198	0.0158
Child rearing	0.029	0.0016	0.0008	0.0016	0.0016	0.0033
Child rearing (total)	0.122	0.0118	0.0086	0.0118	0.0117	0.0165
Market work	0.428	-0.0319	-0.0229	-0.0319	-0.0316	-0.0323
Women's bargaining power	0.344	0.1361	0.0908	0.1361	0.1347	0.1361
Fertility rate	5.000	0.1938	0.1705	0.1938	0.1911	0.0990
Family's savings rate	0.082	0.0084	0.0085	0.0084	0.0082	0.0084
Public-private capital ratio	0.135	-0.0085	-0.0057	-0.0085	-0.0084	-0.0096
Female health status	1.000	-0.0079	-0.0119	-0.0089	-0.0077	-0.0031
Growth rate of final output	0.045	0.0002	0.0000	0.0001	0.0002	-0.0001

1/ Increase in ӣ from 0.123 to 0.24. Initial values of γ_B and μ_B are equal to 0.5 and 1, respectively, whereas initial values of both ν_2 and κ_2 are equal to 0.15.

Source: Author's calculations.

Table 7
Increase in Mothers' Time Allocated to their Daughters 1/

	Baseline	Absolute devations from baseline Benchmark	$\gamma_B = 0.8$	$\mu_B = 1.5$	$\kappa_2 = 0.25$	$\eta_H^f = 5.0$
Time allocated by mothers to						
Household chores	0.450	0.0010	0.0033	0.0015	0.0008	0.0013
Child rearing	0.029	0.0001	0.0002	0.0001	0.0002	0.0000
Child rearing (total)	0.122	0.0006	0.0020	0.0009	0.0008	0.0000
Market work	0.428	-0.0016	-0.0052	-0.0024	-0.0017	-0.0014
Women's bargaining power	0.344	0.0070	0.0210	0.0105	0.0070	0.0070
Fertility rate	5.000	0.0094	0.0379	0.0141	0.0047	0.0142
Family's savings rate	0.082	0.0004	0.0019	0.0006	0.0004	0.0004
Public-private capital ratio	0.135	-0.0004	-0.0013	-0.0007	-0.0005	-0.0003
Female health status	1.000	0.0966	0.0941	0.0964	0.1497	0.0951
Growth rate of final output	0.045	0.0013	0.0013	0.0013	0.0017	0.0013

1/ Reduction in χ^R from 0.6 to 0.5. Initial values of γ_B, η_H^f, and κ_2 are equal to 0.5, 10.142 and 0.15, respectively, whereas μ_B is equal to unity.

Source: Author's calculations.