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Gender Equality, Economic Growth and Poverty in Côte d'Ivoire: A Quantitative Analysis

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Keywords

Three-period gender-based OLG model, life expectancy, poverty, Côte d'Ivoire

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Gender Equality, Economic Growth and Poverty in Côte d'Ivoire: A Quantitative Analysis*

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In this paper, we develop a three-period gender-based Overlapping Generations (OLG) model of economic growth for Côte d'Ivoire by endogenizing life expectancy and linking growth and poverty. We then calibrate the model using the country-specific data to illustrate the role of public policies in the model, and its implications for long-term growth, gender equality, and poverty in Côte d'Ivoire. To this end, we discuss three sets of quantitative experiments: broad-based development policies (increase in education spending and infrastructure investment, and governance reform), gender-based policies (reduction in gender bias in the market place, increase in women's bargaining power, and reduction in family bias against girls' education), and a composite reform program (combination of pro-growth, pro-gender policies). Overall, our findings suggest that Côte d'Ivoire could achieve better growth and poverty outcomes if the country could implement a composite reform program that includes comprehensive development and gender-based policies.

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*We are grateful to Pierre-Richard Agénor for providing us with some guidance on developing the theoretical model. However, any errors that remain are our sole responsibility. The appendix is available upon request.

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1 Introduction

According to the World Bank's latest estimates, Côte d'Ivoire is the 3^{rd} biggest economy among the ECOWAS and has the 9^{th} biggest economy of the Sub-Saharan Africa. As for GDP per capita, the country ranks 3^{rd} and 12^{th} among the ECOWAS and the Sub-Saharan African countries, respectively. Despite its strong economic performance over the last years, the country has, however, experienced gender disparities in many aspects, including access to education and healthcare. Indeed, opportunities to attend school at any level are particularly limited for girls. For instance, according to the estimates based on data from the 2018-19 EHCVM household survey, while the probability of completing lower education is 13.1 percent for boys, it is only 8.7 percent for girls. In fact, this probability is even lower in rural areas for girls; the probability of completing lower secondary school is 6.7 percent in comparison with a completion rate of 12.5 percent in urban areas. However, the probability of attending school is lower for children of parents with no educational attainment. For example, the probability of children who cannot complete the primary school is 72 percent if their father did not complete the primary school either, and this becomes more significant for girls; the probability of girls with less than primary education ranges from 51.7 percent to 76.4 percent. Besides, the fertility rate remains high among women with no formal education and living in urban areas: it ranges from 5.9 to 6.6. According to data from the 2011-12 DHS, pregnancy-related deaths are very high in the country due to a number of reasons, including lack of financial means and distance to the nearest health centre. Women are also more vulnerable than men to other diseases, such as anemia and HIV infection. Not only do women face constraints in terms of access to education and healthcare, but they also experience gender-based discrimination in different dimensions, such as decision-making power, domestic violence, and child marriage among others. Based on the same data source, while only 35 percent of women take part in health decisions, 42 percent of women

do not even have any say in household decisions. Although the country has made a significant progress in closing the gender gap in labor force participation, women's labor force participation rate still remains low in urban areas. Besides, employment opportunities are not large enough to respond to the labor force for men and women alike but, according to data from the 2018-19 EHCVM household survey, in 2018 the unemployment rate for females was higher at 7.2 percent in comparison to an unemployment rate of 5 percent for males. While 35.8 percent and 52.2 percent of women are self-employed in agriculture and non-agricultural sectors, respectively, only 12.1 percent of women in employment are wage workers. However, these gaps in employment between men and women are also reflected in the gender wage gap in the country. Such that, according to the estimates by the World Bank, using data from the 2018-19 EHCVM household survey, it ranges from 33.9 percent to 47.9 percent.

In summary, all these figures clearly suggest that there are gender disparities in many aspects in Côte d'Ivoire and this has important implications for long-term growth, gender equality, and poverty. For example, if women are less educated, they will have less say not only in health decisions but also in the allocation of family resources within the household, especially towards children. Due to gender-based social norms, girls are, however, the ones who are mostly affected by a mother's intra-household bargaining power, which depends on their relative level of human capital. In other words, a mother's bargaining power has important consequences for girls' ability to accumulate human capital in childhood, their productivity and capacity to generate income, and therefore their bargaining power in adulthood. Besides, women with a lower level of education will tend to have more children, which, however, poses health risks, such as pregnancy-related deaths for mothers and their children and also creates a hidden barrier to their own human capital formation. Less-educated women will also be at risk of being less informed about the health issues they may face at any stages of life. Indeed, as noted earlier, in Côte

d'Ivoire, women are more vulnerable than men to other diseases, such as anemia and HIV infection. However, all these factors are important to explain persistence in gender inequality.

To address some of these issues, we develop a three-period gender-based Overlapping Generations (OLG) model of economic growth for Côte d'Ivoire. The model we present in this paper dwells on a series of contributions by Agénor (2012, 2017, 2020), Agénor and Canuto (2015), Agénor et al. (2014, 2021), and Agénor and Agénor (2020). However, we extend these contributions by endogenizing life expectancy and linking growth and poverty. We then calibrate the model using the country-specific data to illustrate the role of public policies in the model, and its implications for long-term growth, gender equality, and poverty in Côte d'Ivoire. To this end, we discuss three sets of quantitative experiments: broad-based development policies, gender-based policies, and a composite reform program (combination of pro-growth and pro-gender policies), as further discussed later. The paper has been organised in the following way. While Section 2 presents the model, Section 3 provides a detailed discussion of the model calibration. Section 4 discusses public policies in detail. Finally, Section 5 concludes.

2 The Model

In this section, we present a three-period, childhood (period $t-1$), adulthood (period t) and old age (period $t+1$), gender-based OLG model of economic growth for Côte d'Ivoire. In what follows family preferences, home production, market production, human capital accumulation, government activities, bargaining power and gender bias in the family, the savings-investment balance, the adult survival rate, the link between growth and poverty, and balanced growth equilibrium are discussed in detail.

2.1 Family Preferences

A mother's time allocated to market activity, $\varepsilon_t^{f,W}$, is

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

where $\varepsilon_t^{f,P}$ time allocated by women to home production, $\varepsilon_t^{f,E}$ time allocated to human capital accumulation, $\varepsilon_t^{f,R} \in (0,1)$ units of child rearing time so $n_t \varepsilon_t^{f,R}$ is the total amount of time allocated to child rearing given that n_t is the number of children each couple produces; it is, however, assumed that half of them are sons and the other half are daughters so that the gender balance can hold.

It is assumed in what follows that $\varepsilon_t^{f,W} \geq 1 - \varepsilon_m^{f,P}$, where $\varepsilon_m^{f,P} \geq 0$ is the minimum amount of time that women must allocate to household chores in the family.

Using a similar notation, men's time allocation is constant over time and is given by

$$\varepsilon^{m,W} = 1 - \varepsilon^{m,P} - \varepsilon^{m,E}. \tag{2}$$

The family's utility can be written as follows:

$$U_t = \varkappa_t U_t^f + (1 - \varkappa_t) U_t^m, \tag{3}$$

where U^j is partner j's utility function and $\varkappa_t \in (0,1)$ is a weight parameter that helps measure the wife's bargaining power in the household decision process.

The sub-utility functions are given by, with $j = f, m$,[1]

$$U_t^j = \eta_C^j \ln c_t^{t-1} + \eta_Q \ln Q_t + \eta_N^j \ln n_t \tag{4}$$

$$+\eta_G(\chi_t \ln e_t^{f,C} + \ln e_t^{m,C}) + \eta_E^j \ln e_t^{f,A} + \frac{p_t}{1+\rho} \ln c_{t+1}^{t-1},$$

where $c_t^{t-1} = c_t^{f,t-1} + c_t^{m,t-1}$ ($c_{t+1}^{t-1} = c_{t+1}^{f,t-1} + c_{t+1}^{m,t-1}$) is the family's total consumption in adulthood (old age), Q_t consumption of the home good, $e_t^{j,C}$ is child j's human

[1] It is assumed that children's consumption is included in the family's consumption and that the home good is not consumed in old age.

capital, $e_t^{f,A}$ unit of human capital for females, $\rho > 0$ the discount rate, and $p_t \in (0,1)$ the probability of survival from adulthood to old age. Coefficient η_C^j measures the relative preference for today's consumption, η_E^j the relative preference for women's education, η_N^j the relative preference for the number of children, and η_Q the family's relative preference for the home-produced good. We also have the following the restrictions: $\eta_C^f < \eta_C^m$, $\eta_E^f > \eta_E^m$, and $\eta_N^f < \eta_N^m$, which imply that men attach more importance than women to current consumption, and prefer higher children than women, but they are less concerned about women's education[2]. In addition, both men and women attach equal importance to the consumption of the home good (measured by η_Q) and to the education of their children (measured by η_G, the altruism parameter). However, as in Agénor (2020), there is a gender bias in parental preferences for the human capital of girls, which can be captured by the parameter χ_t, and this parameter is therefore assumed to be less than 1.

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

$$c_t^{t-1} + m_t + s_t = (1 - \theta^R n_t)(1 - \tau)w_t, \tag{5}$$

$$c_{t+1}^{t-1} = [(1 + r_{t+1})s_t]/p_t, \tag{6}$$

where $\tau \in (0,1)$ is the tax rate on wages, m_t spending on the market good used to produce the home good, s_t family savings, θ^R the share of family income allocated to each child, r_{t+1} the rental rate of private capital, and w_t gross wage income of the family, defined as

$$w_t = \varepsilon_t^{f,W} e_t^{f,A} w_t^f + \varepsilon^{m,W} e_t^{m,A} w_t^m, \tag{7}$$

where $e_t^{f,A}$ ($e_t^{m,A}$) unit of human capital for females (males) and w_t^f (w_t^m) effective market wage per unit of time worked for females (males).

[2]These assumptions are well documented in the literature; see, for instance, UNICEF (2007), World Bank (2011), and Doepke and Tertilt (2019).

Combining (5) and (6), the family's consolidated budget constraint is thus

$$c_t^{t-1} + m_t + \frac{p_t c_{t+1}^{t-1}}{1 + r_{t+1}} = (1 - \theta^R n_t)(1 - \tau) w_t. \tag{8}$$

Families maximize (3) subject to (1), (2), (4), and (8), as well as (9), (14), and (15) below, with respect to c_t^{t-1}, c_{t+1}^{t-1}, $\varepsilon_t^{f,P}$, $\varepsilon_t^{f,R}$, $\varepsilon_t^{f,E}$, m_t, and n_t; $\varepsilon_t^{f,W}$ is then solved residually from (1).

2.2 Home Production

Home production, Q_t, involves combining both men's and women's time allocated to household chores with infrastructure services and market goods. For tractability, use of the market good enters linearly in the home production technology:

$$Q_t = [\varepsilon_t^{f,P} + \zeta_Q (\frac{K_t^I}{K_t^P})]^{\pi^Q} (\varepsilon^{m,P})^{1-\pi^Q} m_t, \tag{9}$$

where K_t^I is the stock of public capital in infrastructure, K_t^P the aggregate stock of private capital, $\pi^Q \in (0,1)$, and $\zeta_Q > 0$ is a coefficient that measures the degree of efficiency in the use of infrastructure services.

2.3 Market Production

Each firm i produces a single nonstorable good, using male effective labor, $L_t^{m,i}$, and female effective labor, $L_t^{f,i}$, where $L_t^{i,j} = \varepsilon_t^{j,W} E_t^{j,A} N_t^{i,j}$ (with $E_t^{j,A}$ denoting *average* human capital in adulthood for $j = f, m$), private capital, $K_t^{P,i}$, and public infrastructure. Public capital is subject to congestion and it is assumed to be proportional to the aggregate private capital stock, $K_t^P = \int_0^1 K_t^{P,i} di$[3].

Assuming a constant returns to scale in private inputs, the production function of individual firm i takes the form

$$Y_t^i = (\frac{K_t^I}{K_t^P})^{\alpha} (L_t^{f,i})^{\beta^f} (L_t^{m,i})^{\beta^m} (K_t^{P,i})^{1-\beta^f-\beta^m}, \tag{10}$$

[3]See Agénor (2012) for further discussion.

where $\beta^f, \beta^m \in (0,1)$ and $\alpha > 0$.

As in Agénor (2020), female workers are assumed to be subject to discrimination from all employers due to the entrenched gender stereotypes and norms. But doing so involves a cost, because discrimination is illegal. This cost is, however, assumed to be proportional, at the rate $\phi^i \in (0,1)$, to the female wage bill for simplicity purposes.

Assuming full depreciation of physical capital, firm i's profits are thus defined as

$$\Pi_{i,t}^Y = Y_t^i - (1+\phi_t^i) w_t^f L_t^{f,i} - w_t^m L_t^{m,i} - (1+r_t^i) K_t^{P,i}.$$

Using (10), and the definition of $L_t^{j,i}$, profit maximization with respect to $N_t^{f,i}$, $N_t^{m,i}$ and $K_t^{P,i}$ gives

$$\varepsilon_t^{f,W} E_t^{f,A} w_t^f = b^i \frac{\beta^f Y_t^i}{N_t^{f,i}}, \quad \varepsilon^{m,W} E_t^{m,A} w_t^m = \frac{\beta^m Y_t^i}{N_t^{m,i}}, \quad r_t = (1-\beta^f-\beta^m)\frac{Y_t^i}{K_t^{P,i}} - 1, \tag{11}$$

where $b^i = 1/(1+\phi^i) \in (0,1)$, the parameter to capture gender discrimination.

In a symmetric equilibrium, and given that men and women are in equal numbers in the adult population ($N_t^m = N_t^f$), the first two equations in (11) give the wage ratio as

$$\frac{\varepsilon_t^{f,W} E_t^{f,A} w_t^f}{\varepsilon^{m,W} E_t^{m,A} w_t^m} = b(\frac{\beta^f}{\beta^m}), \tag{12}$$

which implies that, other things being equal, the wage difference between males and females will be larger as the parameter b becomes smaller.

Given that all firms are identical, and that their number is normalized to 1, $K_t^P = K_t^{P,i}\ \forall i$, and from (10) and the definition of $L_t^j = \varepsilon_t^{j,W} E_t^{j,A} N_t^j$, aggregate output is

$$Y_t = \int_0^1 Y_t^i di = (k_t^I)^\alpha (\frac{\varepsilon_t^{f,W} E_t^{f,A} N_t^f}{K_t^P})^{\beta^f} (\frac{\varepsilon^{m,W} E_t^{m,A} N_t^m}{K_t^P})^{\beta^m} K_t^P, \tag{13}$$

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

2.4 Human Capital Formation

Human capital in childhood depends on a mother's human capital, $E_t^{f,A}$, government spending on education per child, $\varphi_E G_t^E / n_t 0.5 N_t$, where $0.5N_t$ measures the number of families and $\varphi_E \in (0,1)$ is an efficiency indicator, public-private capital ratio[4], the amount of time mothers allocate to child rearing; however, they allocate a smaller fraction, $0.5\chi_t$, of their rearing time to their daughters due to gender-related social norms, where χ_t is the gender bias parameter in parental preferences and $\chi_t < 1$, as noted earlier. As a result, human capital in childhood is as follows:

$$e_t^{m,C} = (E_t^{f,A})^{1-\nu_1} (\frac{\varphi_E G_t^E}{n_t 0.5 N_t})^{\nu_1} [(1 - 0.5\chi_t)\varepsilon_t^{f,R}]^{\nu_2} (k_t^I)^{\nu_3}, \tag{14}$$

$$e_t^{f,C} = (E_t^{f,A})^{1-\nu_1} (\frac{\varphi_E G_t^E}{n_t 0.5 N_t})^{\nu_1} (0.5\chi_t \varepsilon_t^{f,R})^{\nu_2} (k_t^I)^{\nu_3}, \tag{15}$$

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

Human capital in adulthood of an individual born at t is determined by human capital in childhood and the amount of time that they choose to invest in the acquisition of skills:

$$e_{t+1}^{j,A} = e_t^{j,C} (\varepsilon_{t+1}^{j,E})^{\nu_4}, \tag{16}$$

where $\nu_4 > 0$.

Dividing (15) by (14) yields

$$\frac{e_t^{f,C}}{e_t^{m,C}} = (\frac{0.5\chi_t}{1 - 0.5\chi_t})^{\nu_2}, \tag{17}$$

which can be substituted in (16) to give

$$\frac{e_{t+1}^{f,A}}{e_{t+1}^{m,A}} = (\frac{0.5\chi_t}{1 - 0.5\chi_t})^{\nu_2} (\frac{\varepsilon_{t+1}^{f,E}}{\varepsilon^{m,E}})^{\nu_4}. \tag{18}$$

Equation (18) has important implications for a reduction in gender bias; an increase in χ_t or in women's time allocated to own education raises a girl's human capital later in life relative to a boy's human capital.

[4] See Agénor (2011, 2012, Chapter 2).

2.5 Government

It is assumed that the government spends on education (G_t^E) and infrastructure investment (G_t^I), which are both productive types of public spending, as well as on unproductive items (G_t^U) and that it finances its expenditures by taxing the wage income of adults. Its services are provided at no charge. Besides, the government cannot issue debt, and therefore there is a balanced budget:

$$G_t = \sum G_t^h = \tau(w_t^f L_t^f + w_t^m L_t^m). \tag{19}$$

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

$$G_t^h = \upsilon_h \tau(w_t^f L_t^f + w_t^m L_t^m), \tag{20}$$

where $h = E, I, U$.

Combination of equations (19) and (20) therefore yields

$$\sum \upsilon_h = 1. \tag{21}$$

The stock of public capital in infrastructure is

$$K_{t+1}^I = \varphi_I G_t^I, \tag{22}$$

where $\varphi_I \in (0,1)$ is an indicator of efficiency of spending on infrastructure[5], and full depreciation is assumed for simplicity.

2.6 Bargaining Power and Family Gender Bias

The relative bargaining power of women is assumed to be a function of the relative wages of husbands and wives[6]:

$$\varkappa_t = \varkappa_m \left(\frac{\varepsilon_t^{f,W} E_t^{f,A} w_t^f}{\varepsilon^{m,W} E_t^{m,A} w_t^m}\right)^{\mu_B}, \tag{23}$$

[5] See Agénor (2012, Chapter 2) for a discussion.

[6] See Quisumbing (2010) and Doss (2013) for a discussion of the evidence on the determinants of women's bargaining power. Note that because it is *average* values that matter, bargaining power is taken as given in solving the family's optimization problem.

where $\varkappa_m > 0$ measures the autonomous component of women's bargaining power and $\mu_B \geq 0$ a parameter that measures the sensitivity of that variable to relative wages.

Substituting (12) in (23) yields

$$\varkappa_t = \varkappa_m [b(\frac{\beta^f}{\beta^m})]^{\mu_B}, \tag{24}$$

which indicates that gender discrimination in the labor market (a low value of b) has a direct impact on bargaining dynamics in the family; it benefits men, in the sense that it mitigates the influence of their wives on family decisions.

While gender bias in the market place is taken as given, gender bias in the family against girls' education is endogenously related, as in Agénor (2020), to women's bargaining power:

$$\chi_t = \min \left\{ \chi_m \varkappa_t^{\mu_G}, 1 \right\}, \tag{25}$$

where $\chi_m > 0$ and $\mu_G \geq 0$.

As noted earlier, women are more concerned than men about the education of their daughters so women with a stronger bargaining power play an important role in girls' educational outcomes. Besides, mothers allocate more rearing time to their daughters, which in turn improves their human capital in adulthood, thereby mitigating the gender gap in education. Indeed, this specification corroborates the findings of earlier studies, such as Doss (2013).

2.7 Savings-Investment Balance

Let us define N_t as the number of adults alive in period t;

$$N_t = n_{t-1} 0.5 N_{t-1}, \tag{26}$$

where n_{t-1} is the number of children per family born in the previous period and $0.5N_{t-1}$ is the number of families in $t-1$.

The savings-investment balance requires that tomorrow's private capital stock is equal to today's savings in period t by adult workers born in $t-1$. Given that s_t is savings per family, that the number of families at t is $0.5N_t$, and that $N_t^f = N_t^m$,

$$K_{t+1}^P = 0.5N_t s_t = 0.5(N_t^m + N_t^f)s_t = N_t^f s_t. \tag{27}$$

2.8 Adult Survival Rate

The survival rate from adulthood to old age, p_t, is taken to depend on the public-private capital ratio:

$$p_t = p_m + \bar{p}(\frac{k_t^I}{1+k_t^I})^{\nu_S}, \tag{28}$$

with $\nu_S > 0$. The underlying view is that greater access to infrastructure allows individuals (both men and women) to have better access to health services, as documented in the literature (see Agénor (2012, Chapter 3)). With better roads, for instance, it is easier to get to medical facilities. Thus, public capital also generates an externality in terms of health outcomes[7]. The relationship between the survival rate and the public-private capital ratio is concave, with, in addition, $p_0 = p_m$, and $\lim_{k_t^I \to \infty} p_t = p_m + \bar{p} \leq 1$[8].

2.9 Link with Poverty

To assess in a simple manner the impact of the policy experiments reported below on poverty in Côte d'Ivoire, the formula estimated by Ravallion (2004) for a large group of developing countries is used. Formally, the rate of change of the poverty rate, γ_{POV}, is linked to the growth rate of output per capita, through the formula

$$\gamma_t^{POV} = -9.33(1-GINI)^3(\frac{1+\gamma_t^Y}{1+\gamma_t^P}) - 1, \tag{29}$$

[7]It could also be assumed that it is average human capital, $(E_t^{f,A})^{\varkappa_t}(E_t^{m,A})^{1-\varkappa_t}$, weighted by bargaining power, that affects the survival rate. See Agénor (2012, Chapter 3) for a discussion of alternative functional forms.

[8]Note also that because it is *average* female human capital that matters in (28), the survival probability is taken as given in solving the family's optimization problem, as noted earlier.

where γ_t^Y is the growth rate of output, γ_t^P the growth rate of the population, and $GINI \in (0,1)$ the Gini coefficient. Therefore, the term $-9.33(1-GINI)^3$ measures the growth elasticity of poverty. From that formula, the *level* of poverty can be derived, for a given initial level.

2.10 Balanced Growth Equilibrium

As in Agénor (2017, 2020), a competitive equilibrium in this economy is: prices $\{w_t^m, w_t^f, r_{t+1}\}_{t=0}^{\infty}$, family consumption and spending on market goods for home production, $\{c_t^{t-1}, c_{t+1}^{t-1}, m_t\}_{t=0}^{\infty}$, female time allocation $\{\varepsilon_t^{f,E}, \varepsilon_t^{f,P}, \varepsilon_t^{f,R}\}_{t=0}^{\infty}$, physical capital stocks $\{K_{t+1}^P, K_{t+1}^I\}_{t=0}^{\infty}$, female and male human capital stocks $\{E_{t+1}^{f,A}, E_{t+1}^{m,A}\}_{t=0}^{\infty}$, a constant tax rate, and constant spending shares such that, given initial physical and human capital stocks $K_0^P, K_0^I > 0$ and $E_0^{f,A}, E_0^{m,A} > 0$, families maximize utility subject to their time and budget constraints, firms producing the market good maximize profits, markets clear, and the government budget is balanced. Also, in equilibrium, $e_t^j = E_t^j$, for $j = f, m$. A balanced growth equilibrium is a competitive equilibrium in which c_{t+1}^{t-1}, c_{t+1}^{t-1}, m_t , Q_t, K_{t+1}^P, K_{t+1}^I, $E_{t+1}^{f,A}$, $E_{t+1}^{m,A}$ grow at the constant, endogenous rate $1 + \boldsymbol{\gamma}$, the rate of return on private capital r_{t+1} is constant, and women's time allocation and bargaining power, and the survival rate, are all constant.

As can be seen from the Appendix, once the model is solved analytically, the public-private capital ratio is given by

$$k_{t+1}^I = \frac{\varphi_I \upsilon_I \tau}{(1-\tau)\sigma_t(1-\theta^R n_t)}, \tag{30}$$

where σ_t is the family's propensity to save, defined as

$$\sigma_t = \frac{p_t/(1+\rho)\eta_t^C}{\eta_t + p_t/(1+\rho)\eta_t^C} < 1, \tag{31}$$

with

$$\eta_t = 1 + \frac{\eta_Q}{\eta_t^C} > 1. \tag{32}$$

Women's time allocation to home production, child rearing, own education, and market work, as well as the fertility rate are given by, as long as $k_t^I \leq k_t^{I,C}$,[9]

$$\varepsilon_t^{f,P} = \left\{1 + \frac{\eta_Q \pi^Q \Lambda_t^1}{\Lambda_t^2}\right\}^{-1} \left\{\frac{\eta_Q \pi^Q \Lambda_t^1}{\Lambda_t^2} - \zeta_Q k_t^I\right\}, \tag{33}$$

$$\varepsilon_t^{f,R} = \eta_G \nu_2 (\frac{\chi_t + 1}{n_t}) \Lambda_t^1 (\frac{1 - \varepsilon_t^{f,P}}{\Lambda_t^2}), \tag{34}$$

$$\varepsilon_t^{f,E} = \eta_t^E \nu_4 \Lambda_t^1 (\frac{1 - \varepsilon_t^{f,P}}{\Lambda_t^2}), \tag{35}$$

$$\varepsilon_t^{f,W} = 1 - \varepsilon_t^{f,P} - \varepsilon_t^{f,E} - n_t \varepsilon_t^{f,R}, \tag{36}$$

$$n_t = \frac{1}{\theta^R} \frac{\Lambda_t^3 - 1 - (b\beta^{fm})^{-1}}{\Lambda_t^3}, \tag{37}$$

where $k_t^{I,C}$ is a threshold level given by

$$k_t^{I,C} = \frac{1}{\zeta_Q} \left\{\frac{\eta_Q \pi^Q \Lambda_t^1}{\Lambda_t^2} - (1 + \frac{\eta_Q \pi^Q \Lambda_t^1}{\Lambda_t^2}) \varepsilon_m^{f,P}\right\},$$

and

$$\eta_t^h = \varkappa_t \eta_h^f + (1 - \varkappa_t) \eta_h^m = \eta_h^m + \varkappa (\eta_h^f - \eta_h^m), \quad h = C, E, N \tag{38}$$

together with

$$\Lambda_t^1 = \frac{1}{\eta_t \eta_t^C} (1 - \sigma_t)[1 + (b\beta^{fm})^{-1}] > 0,$$

$$\Lambda_t^2 = 1 + \Lambda_t^1 [\eta_t^E \nu_4 + \eta_G \nu_2 (\chi_t + 1)] > 1,$$

$$\Lambda_t^3 = 1 + (b\beta^{fm})^{-1} + [\eta_t^N - \eta_G \nu_2 (\chi_t + 1)] \Lambda_t^1.$$

Equation (33) holds as long as $\varepsilon_t^{f,P} > \varepsilon_m^{f,P}$. Through η_t^C, η_t^E and η_t^N, the bargaining parameter $\varkappa_t$ affects the fertility rate, women's time allocation, and the savings rate.

Note that, given the restrictions discussed earlier, $\eta_C^f < \eta_C^m$, and $\eta_N^f < \eta_N^m$, $d\eta_t^h / d\varkappa_t < 0$, $h = C, N$. Similarly, with $\eta_E^f > \eta_E^m$, $d\eta_t^h / d\varkappa_t > 0$.

[9] In the steady-state, the condition $n \geq 2$ is also assumed; population size converges to zero otherwise.

Let $x_t^f = K_t^P/E_t^f N_t^f$ denote the private capital-female effective labor ratio, which can be expressed in the following way:

$$x_{t+1}^f = \Lambda_t^5 (k_t^I)^{-\nu_3+\alpha(1-\nu_1)} (\varepsilon_t^{f,W})^{\beta^f(1-\nu_1)} (x_t^f)^{(1-\beta)(1-\nu_1)} (\frac{0.5\chi_{t-1}}{1-0.5\chi_{t-1}})^{-\beta^m\nu_2(1-\nu_1)}, \quad (39)$$

$$\times (\frac{\varepsilon_t^{f,E}}{\varepsilon^{m,E}})^{-\beta^m\nu_4(1-\nu_1)} (0.5\chi_t \varepsilon_t^{f,R})^{-\nu_2} (\varepsilon_{t+1}^{f,E})^{-\nu_4},$$

where $\beta = \beta^f + \beta^m$, and

$$\Lambda_t^4 = [\frac{(1-\tau)\sigma_t(1-\theta^R n_t)[b+(\beta^{fm})^{-1}]\beta^f}{n_t^{1-\nu_1}0.5}][\varphi_E \upsilon_E \tau(b+\frac{1}{\beta^{fm}})\beta^f]^{-\nu_1},$$

$$\Lambda_t^5 = \Lambda_t^4 (\varepsilon^{m,W})^{\beta^m(1-\nu_1)},$$

with $\beta^{fm} = \beta^f/\beta^m$.

As can also be seen from the Appendix, the steady-state growth rate of output is given by

$$1+\boldsymbol{\gamma} = \tilde{\Lambda}^6 (\tilde{k}^I)^{\alpha} (\tilde{\varepsilon}^{f,W})^{\beta^f} (\tilde{x}^f)^{-\beta} (\frac{0.5\tilde{\chi}}{1-0.5\tilde{\chi}})^{-\beta^m\nu_2} (\frac{\tilde{\varepsilon}^{f,E}}{\varepsilon^{m,E}})^{-\beta^m\nu_4}, \quad (40)$$

where, from (23) and (25),

$$\tilde{\varkappa} = \varkappa_m [b(\frac{\beta^f}{\beta^m})]^{\mu_B}, \qquad \tilde{\chi} = \chi_m \tilde{\varkappa}^{\mu_G}, \quad (41)$$

$$\tilde{\Lambda}^6 = (\varepsilon^{m,W})^{\beta^m} (1-\tau)\tilde{\sigma}(1-\theta^R\tilde{n})(b+\frac{1}{\beta^{fm}})\beta^f,$$

from (30),

$$\tilde{k}^I = \frac{\varphi_I \upsilon_I \tau}{(1-\tau)\tilde{\sigma}(1-\theta^R\tilde{n})}, \quad (42)$$

and $\tilde{x}^f$ is the steady-state solution obtained by setting $\Delta x_{t+1}^f = 0$ in (39):

$$\tilde{x}^f = \left\{ \tilde{\Lambda}^5 (\tilde{k}^I)^{-\nu_3+\alpha(1-\nu_1)} (\tilde{\varepsilon}^{f,W})^{\beta^f(1-\nu_1)} (\frac{0.5\tilde{\chi}}{1-0.5\tilde{\chi}})^{-\beta^m\nu_2(1-\nu_1)} \right. , \quad (43)$$

$$\left. \times (\frac{\tilde{\varepsilon}^{f,E}}{\varepsilon^{m,E}})^{-\beta^m\nu_4(1-\nu_1)} (0.5\tilde{\chi}\tilde{\varepsilon}^{f,R})^{-\nu_2} (\tilde{\varepsilon}^{f,E})^{-\nu_4} \right\}^{1/\Pi},$$

with

$$\Pi = 0 < [1 - (1 - \beta)(1 - \nu_1)] < 1,$$

which is a necessary condition for the transition equation (39) to be stable, together with $\beta < 1$ and $\nu_1 \in (0, 1)$, as noted earlier.

As can be inferred from the first equation in (41), because the degree of gender bias (as measured by b) is constant, women's bargaining power is also constant; as a result, as implied by the second equation in (41), gender bias in the family against girls' education is also constant.

3 Calibration

We use a number of data sources in calibrating the model for Côte d'Ivoire: the *World Development Indicators* (WDI) database of the World Bank, data from the 2018-19 EHCVM household survey, data from the 2019 Country Report by the International Monetary Fund (IMF), as well as both theoretical and empirical papers where necessary.

For households, the annual discount rate is set at 0.03, which implies that the discount factor is equal to 0.97 on a yearly basis. A 20-year period in an OLG framework yields an intergenerational discount rate of $0.97^{20} = 0.544$.

The family savings rate for Côte d'Ivoire, σ , can be proxied by gross domestic saving for the nongovernment sector as a share of GDP over the period 2016-19, as defined in the IMF Country Report No. 19/366 (Table 1); this gives 19.4 percent.

The gross fertility rate (number of births per woman) is multiplied by the child survival probability so that the (effective) fertility rate, n, can be obtained. According to WDI data, the gross fertility rate over the period 2011-18 is 4.8. The child survival probability is $1 - 0.092 = 0.908$, where 0.092 is the number of deaths of children under five per 1,000 live births over the same period according to WDI data. Therefore, the (effective) fertility rate is $4.8 \cdot 0.908 = 4.4$.

To calibrate the adult survival rate, p, we first estimate the probability of death. According to WHO's latest estimates, in 2016 in Côte d'Ivoire the probability of dying between ages 15 and 60 was an average of 0.398[10]. The survival rate can therefore be measured as $p = 1 - 0.398 = 0.602$.

Based on data from the 2018-19 EHCVM household survey for Côte d'Ivoire, the proportion of total household income spent on children (aged between 0 and 18) is estimated to be 40.6 percent, which corresponds to $n\theta^R$ in our model. As noted earlier, $n = 4.4$; thus, θ^R (the share of family spending on each child) can be estimated as 0.406/4.4, that is, $\theta^R = 0.092$.

To estimate women's time allocation, we rely on Blackden and Wodon (2006), Agénor et al. (2014), and Charmes (2015). Time spent by women in household chores, market work, and education is estimated at 40 hours, 35 hours, and 12 hours per week, respectively. However, in calculating total time available in a week, we also consider time spent sleeping and time spent on personal care and leisure, which are both subtracted from raw time. As a result, weekly time available is $168(7 \cdot 24$ hours a day$) - 56(7 \cdot 8$ hours a day$) - 14(7 \cdot 2$ hours a day$) = 98$ hours. The proportion of total time spent by women in home production, market work, and education can be then estimated as follows: $\varepsilon^{f,P} = 40/98 = 0.408$, $\varepsilon^{f,W} = 35/98 = 0.357$, and $\varepsilon^{f,E} = 12/98 = 0.122$. Given these estimates, the total proportion of time devoted to rearing time can be estimated as $n\varepsilon^{f,R} = 1 - 0.408 - 0.357 - 0.122 = 0.113$, implying that (given that $n = 4.4$, as noted earlier) the proportion of time spent on each child is $\varepsilon^{f,R} = 0.026$.

Men's time allocation is calibrated so that they spend three-fourths of their available time in market work (in line with the data for Sub-Saharan Africa reported by Blackden and Wodon (2006, Table 3.13)) and allocate the rest to household chores and education. Men are also assumed to allocate the same amount of time as women

[10] See http://apps.who.int/gho/data/node.main.11?lang=en.

to education. This gives $\varepsilon^{m,W} = 0.75$ and $\varepsilon^{m,E} = 0.122$. The share of time allocated to home production is thus $\varepsilon^{m,P} = 1 - 0.75 - 0.122 = 0.128$. By implication, the female-to-male ratio of time allocated to home production, $\varepsilon^{f,P}/\varepsilon^{m,P}$, is equal to 3.188, to market work, $\varepsilon^{f,W}/\varepsilon^{m,W}$, to 0.476, and to education, $\varepsilon^{f,E}/\varepsilon^{m,E}$, to 1.

In calibrating the initial bargaining power of women, $\varkappa$, we follow the same methodology as in Agénor (2017). In other words, we divide the relative literacy rate of adult females (aged 15 and above) by the sum of the literacy rates of adult males and females. Using WDI data for 2018, this gives $\varkappa = 40.5/(40.5 + 53.7) = 0.43$[11]. As shown below, $b = 0.5$, $\beta^f = 0.226$ and $\beta^m = 0.474$, whereas the parameter μ_B is set initially to 0.3 to ensure decreasing marginal gains to increases in the female-male ratio. Given these values, the first equation in (41) can therefore be solved backward for the scale parameter $\varkappa_m = 0.661$.

It is also assumed that there is initial bias in mothers' rearing time allocation toward boys and that this reflects directly women's bargaining power in the value; thus $\chi = 0.43$. The parameter μ_G, which captures the response of the family gender bias parameter with respect to women's bargaining power, is set equal to 0.9, as in Agénor (2020). Given μ_G, and the calibrated values of both χ and $\varkappa$ provided earlier, the second equation in (41) can be solved backward for the scale parameter χ_m; this gives 0.919.

Using the above data on women's and men's time allocation, the calibrated values of n, σ, θ^R, and $\varkappa$ provided earlier, and the definitions of Λ^1, Λ^2 and Λ^3 also provided earlier, the first-order conditions of the family's optimization problem (33), (34), (35), and (37), the definition of the savings rate (31)—after substituting for the composite parameter η_t given in (32)—can be solved together to obtain the values of the following preference parameters: η^C, η^E, η_G, η^N, and η_Q. This gives $\eta^C = 0.767$,

[11] Alternatively, $\varkappa$ can be calibrated by using the relative secondary enrollment rate for females, divided by the sum of the secondary enrollment rates of males and females. The result, using again WDI data for 2018, gives $35.1/(35.1 + 45.3) = 0.44$, which is very similar.

$\eta^E = 1.130$, $\eta_G = 0.111$, $\eta^N = 1.273$, and $\eta^Q = 0.618$.

Having determined η^C, η^N, and η^E, the values (η^m_C, η^f_C), (η^m_N, η^f_N), and (η^m_E, η^f_E) can now be determined. In line with Agénor (2020), the gap between the female-specific values and the family average is taken to be of the order of 20 percent. Thus, $\eta^f_C/\eta^C = \eta^f_N/\eta^N = 0.8$, and $\eta^f_E/\eta^E = 1.2$. In turn, given the estimates of η^h reported earlier, $\eta^f_C = 0.614$, $\eta^f_N = 1.019$, and $\eta^f_E = 1.356$. The values of η^m_N, η^m_C and η^m_E can thus be determined residually using (38), so that $\eta^m_C = 0.883$, $\eta^m_N = 1.465$, and $\eta^m_E = 0.960$. Thus, by construction, $\eta^f_C < \eta^m_C$, $\eta^f_N < \eta^m_N$, and $\eta^f_E > \eta^m_E$, as discussed earlier.

In the home good production sector, the parameter ζ_Q is set to 0.8 to capture some degree of inefficiency in access to infrastructure services. The parameter characterizing the curvature of the home production function is set initially at $\pi^Q = 0.7$, which is significantly higher than what was used in Kimura and Yasui (2010, Table 4) but more convenient for a developing economy where access to energy, water, and transportation is limited.

In the market good production sector, the elasticity of production of the market good, α, is set equal to 0.17, and this value is consistent with the value in Bom and Ligthart (2014, Table 4). The elasticity of output with respect to private capital is set equal to 0.3, a fairly standard value. This implies, given that the production function in (10) exhibits constant returns to scale, that the calibrated share of labor is $\beta = \beta^f + \beta^m = 0.7$, which is close to the average share of labor income for Côte d'Ivoire estimated by Guerriero (2012, Appendix E), 0.67[12]. Now, to calculate the elasticity of output with respect to female labor, we first calculate women's relative participation rate, which is defined as the average labor force participation rate of the female population aged 15 and over, divided by the sum of the average labor force participation rates of both females and males population aged 15 and over.

[12]The estimate used is the average of the three measures defined as LS2, LS3, and LS4 (with the latter accounting for the self employed) proposed by Guerriero (2012).

Based on WDI data for the period 2011-17), the results are 0.323 for females and 0.677 for males. These numbers must be rescaled in order to obtain a sum equal to 0.7; thus, $\beta^f = 0.323 \cdot 0.7 = 0.226$, and $\beta^m = 0.677 \cdot 0.7 = 0.474$. The value of β^f is very close to the average value of the output elasticity with respect to female employment estimated by the International Labour Organization for Africa over the period 1991-2017 (2019, Figure 1.2). The parameter b, which captures the degree of gender bias in the workplace, is set at 0.5, consistent with estimates of the gender wage gap in the labor market in Côte d'Ivoire (World Bank (2017, p. 11))[13].

In the human capital sector, the elasticity with respect to government spending on education, ν_1, is set equal to 0.2 as in Chen (2005) and Agénor (2011). In reviewing the literature, there is no evidence on the elasticity with respect to time allocated by mothers to child rearing, ν_2; we use a value of 0.66, as in Agénor and Canuto (2015). The elasticity with respect to the public-private capital ratio, ν_3, is set equal to 0.1, as in Agénor (2011). Thus, all inputs are subject to diminishing marginal returns in terms of their impact on human capital formation in childhood. There is not much evidence either for ν_4; a low initial value of 0.1 is used, as in Agénor and Canuto (2015), and experiments with an alternative, higher value are reported later on.

The effective tax rate on output, τ, is calculated as follows. We first obtain the average ratio of tax revenues to GDP. According to WDI data for the years 2011-17, it is equal to 14.5 percent. However, to make it compatible with our model definition, we then divide this value by the average share of labor income, 0.7[14]. Thus, $\tau = 20.7$ percent. Government spending on education, as a share of noninterest government expenditure, υ_E, is given by dividing government spending on education

[13]By way of comparison, the average unadjusted gender pay gap in Sub-Saharan Africa is estimated at 30 percent by the United Nations (2016, p. 62) and UN Women (based on 2016 data), whereas the average value of male-female earning gaps for professionals and technicians in Sub-Saharan Africa is estimated at 40 percent by Nopo et al. (2012).

[14]The estimate used is the average of the three measures defined as LS2, LS3, and LS4 (with the latter accounting for the self employed) proposed by Guerriero.

as a share of GDP by noninterest government expenditure as a share of GDP. The first value, based on the average estimate from WDI for the period 2017-18, is 4.76 percent. The second value, based on data in the IMF 2019 Country Report No. 19/366 (Table 3b), again for the period 2017-18, gives 22.7 percent. Thus, the share of government spending on education in total noninterest public expenditure is given by $0.0476/0.227 = 20.9$ percent.

There are no recent data on public investment on infrastructure for Côte d'Ivoire. Based on estimates compiled by (Foster and Pushak (2010, Figure 15, p. 34)), the share of government investment on infrastructure is estimated at 1.8 percent of GDP. Given again that noninterest government expenditure as a share of GDP is 22.7 percent, the share of public investment in infrastructure in total noninterest public expenditure, υ_I, is given by $0.018/0.227 = 7.9$ percent. These numbers imply from the budget constraint that the share of spending on other items, υ_U, is $1 - (0.209 + 0.079) = 71.2$ percent. Dabla-Norris et al. (2012, Table 1) estimate the efficiency parameter for public investment in Côte d'Ivoire, φ_I, at 0.47. Given that there is no evidence on the education sector, the efficiency parameter for spending on education, φ_E, is also set at the same value.

The curvature parameter of the survival rate function (28) with respect to the public-private capital ratio, ν_S, is set at 0.3. Based on data from the 2018-19 EHCVM household survey, the Gini coefficient for Côte d'Ivoire, $GINI$, is set at 0.351, whereas the poverty headcount ratio is set at 39.5 percent. This implies that the growth elasticity of poverty is $-9.33(1 - 0.351)^3 = -2.55$[15]. The growth rate of the population, γ_t^P (which enters in equation (29) and is used to calculate income growth per capita), is estimated at 2.5 percent during the period 2011-18, according to WDI data. To solve endogenously for γ_t^P, the fertility rate (measured in percent) is adjusted downward, this adjustment (equivalent to 1.9 percent) can be used to rep-

[15] By way of comparison, the World Bank estimates that the growth elasticity of poverty in Côte d'Ivoire was only -0.8 for the period 2015-18.

resent the replacement rate. Finally, based on WDI data, the average rate of growth of real GDP for Côte d'Ivoire is set equal to 5.4 percent over the period 2007-18, to which the steady-state growth rate of output is calibrated[16]. While the benchmark parameter values are summarized in Table 1, numerical solutions of simultaneous equations for some parameters are reported in Table 2.

4 Public Policies

To illustrate the role of public policy in the model, and its implications for long-term growth, gender equality, and poverty in Côte d'Ivoire, three types of experiments are considered: broad-based development policies, gender-based policies (that is, policies aimed at mitigating discrimination against women), and a composite reform program involving both types of policies. Gender-based policies are important because Côte d'Ivoire is considered to be lagging in that area, even with respect to other countries in Sub-Saharan Africa (World Bank (2017)).

The analysis is conducted throughout in the case where $k^I < k^{I,C}$ at all times, or equivalently $\varepsilon^{f,P} > \varepsilon_m^{f,P}$, which implies from equation (33) that women's time allocated to home production is sensitive to changes in access to infrastructure[17]. In discussing the simulation results, we report the following variables: women's time allocation, family-wide variables (relative time allocated by spouses to home production and market work, fertility, the survival rate, and the savings rate), gender bias towards girls and women's bargaining power, as well as the public-private capital ratio, the growth rate of market output, and the poverty rate.

[16] However, a multiplicative constant is introduced into the growth equation to obtain this value.

[17] The analysis also assumes that, at the aggregate level, there are no threshold effects associated with the impact of infrastructure on time allocation.

4.1 Broad-Based Development Policies

Three types of development policies are considered: an increase in spending on education, an increase in public investment in infrastructure, and governance reform, which leads to an improvement in the efficiency of government spending on education and infrastructure.

4.1.1 Increase in Education Spending

Consider the case of a policy aimed at promoting access to primary and secondary education, which takes the form of a one-percentage point increase in spending on education as a share of GDP, from 4.76 percent to 5.76 percent. Equivalently, as a share of noninterest government expenditure, spending on education, υ_E, increases from 20.9 percent to $0.0576/0.227 = 25.4$ percent. The policy is assumed to be budget-neutral and to be financed by a cut in unproductive spending ($d\upsilon_E + d\upsilon_U = 0$)[18].

The results are reported in Table 3 for the benchmark set of parameters shown in Table 1, as well as for four alternative parameter values: a value of the elasticity of human capital accumulation with respect to public spending in education, ν_1, equal to 0.3 instead of 0.2, a value of the elasticity of human capital accumulation with respect to women's time allocated to education, ν_4, equal to 0.4 instead of 0.1, a value of the elasticity of bargaining power to relative wages, μ_B, equal to 0.5 instead of 0.3, and finally a value of the elasticity of final output with respect to the public-private capital ratio, α, equal to 0.25, in line with the estimates of Agénor and Neanidis (2015), instead of 0.17.

By construction, changes in public spending on education are gender neutral; thus, the policy has no effect on women's time allocation, family-wide variables,

[18] Alternatively, as in Agénor (2012), we could also analyze the case where a higher share of government spending on education is financed by a concomitant cut in infrastructure investment, another productive type of government spending in which case we could discuss trade-offs.

or women's bargaining power. Indeed, the only effect is on market output, which increases by 0.2 percentage points per annum; the poverty rate falls by a similar margin. The results are not very sensitive to the alternative values of the parameters stated above.

4.1.2 Increase in Infrastructure Investment

Consider now an increase in the share of government spending on infrastructure investment, υ_I, from an initial value of 1.8 to 2.8 percent of GDP or, equivalently, from 7.9 percent to $2.8/0.227 = 12.3$ percent of total government spending. Again, the increase in expenditure is assumed to be matched by a cut in unproductive spending ($d\upsilon_I + d\upsilon_U = 0$).

The impact of this experiment is shown in Table 4, again for the benchmark set of parameters, and alternative values for ν_4, μ_B, and α, as explained earlier, as well as value of the elasticity of human capital accumulation with respect to the public-private capital, ν_3, equal to 0.5 instead of 0.1.

In the benchmark case, on the one hand, an increase in the public-private capital ratio affects growth in a direct way. On the other hand, better access to infrastructure reduces the amount of time mothers allocate to home production, and therefore increases the time they allocate to market work, their own human capital accummulation, and child rearing (which contributes to human capital in both childhood and adulthood for both genders). Therefore, there is a further positive effect on growth.

At the same time, there is a substitution of quantity for quality—as women devote more time to each child, the fertility rate falls. In addition, the increase in the public-private capital ratio raises the adult survival rate, which in turn leads to an increase in the savings rate, private savings and the private capital stock accordingly. As a result, despite the congestion effect associated with the public-private capital ratio, there is a further positive effect on the growth rate of output.

As noted earlier, because the degree of gender bias (as measured by b) is con-

stant, women's bargaining power is constant, and thus so is gender bias in the family against girls' education (see (41)). In addition, the fact that women's bargaining power is constant implies that there are no changes in the other family preference parameters—namely, the family preference parameters for current consumption, mothers' education, and the number of children.

Overall, with the benchmark set of parameters, as well as in the cases of higher ν_4, μ_B, and α, the steady-state growth rate increases by about 0.5 percentage points and the poverty rate falls. With a higher elasticity of human capital accumulation with respect to the public-private capital ratio, ν_3, the effect on growth in magnified – the increase in the growth rate is now of the order of 1.5 percentage points. Thus, the externality associated with infrastructure for education has a highly significant effect on growth, even if it has no impact on the other variables reported in the table.

4.1.3 Governance Reform

Consider now increases in the efficiency of public spending on infrastructure and education, φ_E and φ_I, both separately and jointly. First, an increase in φ_E from 0.47 to 0.6; second, an increase in φ_I also from 0.47 to 0.6; third, an increase in both φ_E and φ_I from 0.47 to 0.6; fourth, φ_E and φ_I from 0.47 to 0.7, and finally φ_E and φ_I from 0.47 to 0.8. Broadly speaking, these policy experiments can therefore be considered as a way of capturing the benefits of a governance reform program that becomes progressively more ambitious.

The steady-state effects of these experiments are displayed in Table 5. When only φ_E is increased, the policy has no effect on any variable except output and poverty – just as was the case with an increase in the share of spending on education, as discussed earlier. When only φ_I is increased, and with the benchmark set of parameters, the public-private capital ratio rises by 2.2 percentage points. The resulting effects are similar to those discussed earlier, in the case of an increase in the share of investment in infrastructure. Time spent by women in home production

falls (by about 1 percentage point), whereas time allocated to own education, child rearing, and market work all increase – all of which contribute to promote human capital and labor supply to the market. At the same time, greater access to public infrastructure generates a benefit in terms of higher life expectancy and this leads to a higher family savings rate. Overall, growth increases by about 0.25 percentage points, whereas poverty falls by 0.27 points. When both φ_E and φ_I increase, to 0.6, 0.7, and 0.8, these effects are naturally magnified; in the latter case, for instance, the growth rate of output increases by 1.2 percentage points, whereas the poverty rate drops by 1.3 points.

4.2 Gender-Based Policies

Three types of gender-based policies are considered: a reduction in gender bias in the market place, an autonomous increase in women's bargaining power, and a reduction in bias in the family toward girls' education (promoted by educational campaigns). A composite program involving all three policies is also examined.

4.2.1 Reduction in Gender Bias in the Market Place

Consider a policy that would help reduce gender bias in the market place and such a policy corresponds to an increase in parameter b from an initial value of 0.5 to 0.8. Indeed, this policy has important implications not only for closing gender gaps in the market place at the microeconomic level but also for achieving the 2030 Sustainable Development Goals at the macroeconomic level; in particular, Goal 1 (No Poverty), Goal 5 (Gender Equality), as well as Goal 8 (Decent Work and Economic Growth).

The results are shown in the second column of Table 6. In the model, there are two direct effects. The first effect is that family income increases, which in turn leads to a higher *level* of private savings and private capital stock, and that this has a direct positive effect on growth. The second effect (as can be inferred from

(41)) is to increase women's bargaining power, which in turn mitigates the degree of gender bias in the family against girls' education (that is, χ increases). Further, the increase in women's bargaining power lowers the family preference parameter for current consumption, η^C (as implied by (38), and given that $\eta_C^f < \eta_C^m$), which leads from (31) to an increase in the savings *rate*. The result is a reduction in the public-private capital ratio (as can be inferred from (42)), which would tend to increase time allocated by women to home production[19]. However, the increase in the market wage (an increase in the opportunity cost of staying home) leads to a significant increase in women's time allocated to market work); to achieve this, all other components of women's time are reduced. The reduction in rearing time (due to a reduction in both the unit rearing time and the fertility rate) is consistent with the fact that the increase in women's bargaining power also leads to a lower fertility rate (given that $\eta_N^f < \eta_N^m$, as noted earlier) but not with the fact that, by itself, such an increase would normally induce women to allocate more time to their own education (given that $\eta_E^f > \eta_E^m$). Indeed, women's time allocated to their own education also falls.

Overall, the benefits of a policy aimed at mitigating discrimination in the market place, mainly through their impact on savings and women's time allocation, are fairly substantial; the growth rate of market output increases by 0.19 percentage points per annum, whereas the poverty rate falls by 0.25 points.

4.2.2 Increase in Women's Bargaining Power

Consider a 10 percent increase in the autonomous component of women's bargaining power $\varkappa_m$, which implies that $\varkappa$ increases from 0.43 to 0.473. The effects of this experiment are shown in the third column of Table 6. In the model, there are three main channels through which growth can be affected by the change in $\varkappa_m$.

[19] As shown in the table, the reduction in the public-private capital ratio also lowers the survival rate, which tends to reduce the savings rate. However, the positive effect of a lower family preference for current consumption dominates.

First, as noted earlier, women's preference for current consumption is assumed to be *lower* than that of men ($\eta_C^f < \eta_C^m$). Therefore, an increase in women's bargaining power indicates a reduction in the average family preference parameter for today's consumption, η^C, and an increase in the family's savings rate accordingly, which translates into a higher private capital stock. As a result, the public-private capital ratio falls and so does the adult survival rate. This is the same effect as discussed earlier, where the increase in women's bargaining power is due to a reduction in gender bias in the market place (an increase in b).

Second, the increase in women's bargaining power raises the family's preference parameter for mothers' education (given that $\eta_E^f > \eta_E^m$) and for girls' education (parameter χ). Women therefore invest more in education, and this eventually benefits their children, through the intergenerational externality alluded to earlier (see (14) and (15)). Again, this effect, which benefits growth, is similar to the effect discussed earlier.

Third, because women prefer fewer children ($\eta_N^f < \eta_N^m$), the increase in their bargaining power leads to a lower fertility rate, and there is a substitution of quantity for quality – the amount of time allocated to each child increases. The net effect on total rearing is positive, as indicated in the table. The increase in time devoted to own education and child rearing is accompanied by a reduction in time devoted to household chores and market work.

Overall, even though the public-private capital ratio falls, the steady-state growth rate increases by about 0.3 percentage points, whereas the poverty rate falls by 0.4 points. However, these benefits are mitigated by the fact that women's time reallocation toward human capital formation and child rearing, occurs only to a small extent through a reduction in their time devoted to home production, but mainly through a fall in the time that they allocate to market work, which tends to have an adverse effect on growth.

4.2.3 Reduction in Family Bias against Girls' Education

Consider an increase in the autonomous component of the family's preference parameter for girls' education, that is, an increase in χ_m, which may, for instance, result from changes in cultural norms. Specifically, suppose that χ_m increases by 10 percent, again from 0.43 to 0.473.

The effects of this experiment are displayed in the fourth column of Table 6. Essentially, the increase in the family's preference parameter for girls' education induces women to devote more time to child rearing, but now this increase is brought about by a larger reduction in women's time devoted to household chores and women's time allocated to their own education, rather than market work, in contrast to the previous experiment. Thus, despite the fact that this policy has no impact on savings, the benefits in terms of higher growth and reduced poverty are of the same order.

The fifth column of Table 6 shows the results of combining increases in $\varkappa_m$ and χ_m by the same magnitudes as before, whereas the last column of the table shows the results of a composite gender-based program which combines the three experiments reported individually in the second to fourth column. The transmission channel obviously combines the description described earlier. The net benefit in terms of growth is now of the order of 0.91 percentage points, whereas the poverty rate drops by 1.1 points. Importantly, the results indicate that the combination of policies generates slightly better outcomes than the sum of the individual policies; adding the growth rates in output from columns 2, 3 and 4 gives 0.85 percentage points, whereas adding the changes in the poverty rate gives 1.0 percentage point. Thus, the complementarity between the gender-based policies considered here is a source of additional gains if they are implemented jointly.

4.3 Composite Reform Program

Finally, consider what can be called a pro-growth, pro-gender program, which involves combining all the development and gender-based policies considered earlier:

a) a 1 percentage point increase in spending on education as a share of GDP, financed by a cut in unproductive spending;

b) a 1 percentage point increase in investment in infrastructure as a share of GDP, financed by a cut in unproductive spending;

c) An across-the-board increase in the degree of efficiency of public spending on infrastructure and education, φ_E and φ_I, from 0.47 to 0.6;

d) A reduction of gender bias in the market place, which translates into an increase in b from 0.5 to 0.8;

e) An autonomous increase in women's bargaining power, by 10 percent;

f) An autonomous reduction in family bias against girls' education, by 10 percent.

Table 7 shows the results, for the benchmark set of parameters and for alternative values of ν_1, ν_4, μ_B, and α, as in Table 3. The transmission process is similar to what was discussed earlier for the individual policies. In the benchmark case, the impact on the growth rate is substantial; it increases by 2.4 percentage points per year. The poverty rate also drops significantly, by 2.7 points. At the same time, women's time allocated to home production falls, whereas time devoted to child rearing (both unit time and total time) and market work increase. However, given the calibration, time allocated to human capital accumulation falls, albeit the effect is small. The results are essentially unchanged for the alternative parameter values considered in the table. In particular, with higher values of ν_1 (the elasticity of human capital with respect to public spending in education) and μ_B (the sensitivity of bargaining power to relative wages) the growth rate increases by 2.8 percentage points and the poverty rate falls by 3.1 points.

To illustrate the benefits of policy complementarities, one can compare growth

and poverty outcomes under the composite reform program with those obtained by adding up the results of each policy when implemented individually. From Tables 3 to 6, the sum of individual effects gives 2.0 percentage points (compared to 2.4 points) for the growth rate, and -2.2 points (compared to -2.7 points) for the poverty rate[20]. The difference is significant and shows the potential benefits of joint implementation of pro-growth and pro-gender policies for Côte d'Ivoire.

5 Concluding Remarks

In this paper, we developed a three-period gender-based OLG model of economic growth by endogenizing life expectancy and linking growth and poverty. We then calibrated the model using the country-specific data to illustrate the role of public policies in the model, and its implications for long-term growth, gender equality, and poverty in Côte d'Ivoire. To this end, we discussed three sets of quantitative experiments: broad-based development policies (increase in education spending and infrastructure investment, and governance reform), gender-based policies (reduction in gender bias in the market place, increase in women's bargaining power, and reduction in family bias against girls' education) and a composite reform program (combination of pro-growth, pro-gender policies). Overall, our findings suggest that Côte d'Ivoire could achieve better growth and poverty outcomes if the country could implement a composite reform program that includes comprehensive development and gender-based policies.

[20] For the growth rate, the figure corresponds to the sum of 0.002 (Table 3, second column), 0.0047 (Table 4, second column), 0.0051 (Table 5, fourth column), 0.0019 (Table 6, second column), 0.0031 (Table 6, third column), and 0.0035 (Table 6, fourth column). The same calculations for the poverty rate give indeed -0.0021-0.0051-0.0055-0.0025-0.0031-0.0038 = -2,2 points.

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Table 1: Benchmark Calibration

Parameter	Value	Description
Households		
ρ	0.03	Annual discount rate
θ^R	0.092	Share of family income allocated to each child
σ	0.194	Family's savings rate
n	4.4	Effective fertility rate
Time Allocation		
$\varepsilon^{f,P}, \varepsilon^{m,P}$	$0.408, 0.128$	Time allocated by females/males to home production
$\varepsilon^{f,R}$	0.026	Time allocated by females to each child
$\varepsilon^{f,E}, \varepsilon^{m,E}$	$0.122, 0.122$	Time allocated by females/males to own education
$\varepsilon^{f,W}, \varepsilon^{m,W}$	$0.357, 0.750$	Time allocated by females/males to market work
Home Production		
ζ_Q	0.8	Efficiency parameter
π^Q	0.7	Curvature of production function
Market Production		
α	0.17	Elasticity w.r.t public-private capital ratio
β^f, β^m	$0.226, 0.474$	Elasticity w.r.t female/male labor
Human Capital		
ν_1	0.2	Elasticity w.r.t public spending in education
ν_2	0.66	Elasticity w.r.t mothers' rearing time
ν_3	0.1	Elasticity w.r.t public-private capital ratio
ν_4	0.1	Elasticity w.r.t women's time allocated to education
Bargaining Power/Gender Bias		
$\varkappa$	0.43	Women's intra-family bargaining power
μ_B	0.3	Sensitivity of bargaining power to relative wages
b	0.5	Gender bias in the workplace
χ	0.43	Gender bias in family preferences toward girls
μ_G	0.9	Elasticity w.r.t bargaining power
Adult Survival Rate		
p	0.602	Average survival probability
ν_S	0.3	The curvature parameter of the survival rate function
Government		
τ	0.207	Tax rate on marketed output (adjusted for labor share)
υ_I, υ_E	$0.079, 0.209$	Share of spending on infrastructure investment/education
φ_I, φ_E	0.47	Spending efficiency parameters, infrastructure/education
Inequality and Poverty		
$GINI$, pov_rate	$0.351, 0.395$	Gini coefficient, poverty headcount ratio

Table 2: Numerical Solutions of Simultaneous Equations

Parameter	**Value**	**Description**
Preference Parameters		
η^C	0.767	Family preference parameter for current consumption
η^f_C, η^m_C	$0.614, 0.883$	Preference parameter, female/male, for current consumption
η^N	1.273	Family preference parameter for number of children
η^f_N, η^m_N	$1.019, 1.465$	Preference parameter, female/male, for number of children
η_G	0.111	Family preference parameter for children's education
η^E	1.130	Family preference parameter for women's education
η^f_E, η^m_E	$1.356, 0.960$	Preference parameter, female/male, for women's education
η_Q	0.618	Family preference parameter for home good
Scale Parameters		
$\varkappa_m$	0.661	Autonomous component of women's bargaining power
χ_m	0.919	Gender bias in the family against girls' education

Table 3
Côte d'Ivoire: Increase in Share of Public Expenditure on Education

		Absolute Deviations from Baseline				
	Baseline	Benchmark	$\nu_1 = 0.3$	$\nu_4 = 0.4$	$\mu_B = 0.5$	$\alpha = 0.25$
Women's time allocation						
Home production	0.408	0.0000	0.0000	0.0000	0.0000	0.0000
Child rearing (unit time)	0.026	0.0000	0.0000	0.0000	0.0000	0.0000
Child rearing (total time)	0.113	0.0000	0.0000	0.0000	0.0000	0.0000
Education	0.122	0.0000	0.0000	0.0000	0.0000	0.0000
Market work	0.357	0.0000	0.0000	0.0000	0.0000	0.0000
Family-wide variables						
Female-male home production time ratio	3.188	0.0000	0.0000	0.0000	0.0000	0.0000
Female-male market work time ratio	0.476	0.0000	0.0000	0.0000	0.0000	0.0000
Fertility rate	4.400	0.0000	0.0000	0.0000	0.0000	0.0000
Adult survival rate	0.602	0.0000	0.0000	0.0000	0.0000	0.0000
Family's savings rate	0.194	0.0000	0.0000	0.0000	0.0000	0.0000
Gender bias and bargaining power						
Gender bias in family preferences [1]	0.430	0.0000	0.0000	0.0000	0.0000	0.0000
Women's bargaining power	0.430	0.0000	0.0000	0.0000	0.0000	0.0000
Capital ratio, growth and poverty						
Public-private capital ratio	0.084	0.0000	0.0000	0.0000	0.0000	0.0000
Growth rate of final output	0.054	0.0020	0.0029	0.0020	0.0020	0.0020
Poverty rate (headcount index)	0.401	-0.0021	-0.0031	-0.0021	-0.0021	-0.0021

Note: The increase in υ_E is from 0.209 to 0.254, or equivalently 1 percent of final output.

[1] An increase indicates a reduction in gender bias.

Table 4
Côte d'Ivoire: Increase in Share of Public investment in Infrastructure

		Absolute Deviations from Baseline				
	Baseline	Benchmark	$\nu_3 = 0.5$	$\nu_4 = 0.4$	$\mu_B = 0.5$	$\alpha = 0.25$
Women's time allocation						
Home production	0.408	-0.0208	-0.0208	-0.0245	-0.0211	-0.0208
Child rearing (unit time)	0.026	0.0009	0.0009	0.0007	0.0009	0.0009
Child rearing (total time)	0.113	0.0037	0.0037	0.0028	0.0036	0.0037
Education	0.122	0.0040	0.0040	0.0119	0.0040	0.0040
Market work	0.357	0.0131	0.0131	0.0098	0.0136	0.0131
Family-wide variables						
Female-male home production time ratio	3.188	-0.1622	-0.1622	-0.1916	-0.1651	-0.1622
Female-male market work time ratio	0.476	0.0175	0.0175	0.0131	0.0181	0.0175
Fertility rate	4.400	-0.0105	-0.0105	-0.0105	-0.0105	-0.0105
Adult survival rate	0.602	0.0125	0.0125	0.0125	0.0125	0.0125
Family's savings rate	0.194	0.0032	0.0032	0.0032	0.0032	0.0032
Gender bias and bargaining power						
Gender bias in family preferences [1]	0.430	0.0000	0.0000	0.0000	0.0000	0.0000
Women's bargaining power	0.430	0.0000	0.0000	0.0000	0.0000	0.0000
Capital ratio, growth and poverty						
Public-private capital ratio	0.084	0.0444	0.0444	0.0444	0.0454	0.0444
Growth rate of final output	0.054	0.0047	0.0146	0.0052	0.0047	0.0052
Poverty rate (headcount index)	0.401	-0.0051	-0.0158	-0.0056	-0.0052	-0.0057

Note: The increase in υ_I is from 0.079 to 0.123, or equivalently 1 percent of final output.

[1] An increase indicates a reduction in gender bias.

Table 5
Côte d'Ivoire: Increase in Efficiency of Public Expenditure on Education and Infrastructure

		Absolute Deviations from Baseline				
	Baseline	$\varphi_E = 0.6$	$\varphi_I = 0.6$	$\varphi_E = \varphi_I = 0.6$	$\varphi_E = \varphi_I = 0.7$	$\varphi_E = \varphi_I = 0.8$
Women's time allocation						
Home production	0.408	0.0000	-0.0104	-0.0104	-0.0183	-0.0261
Child rearing (unit time)	0.026	0.0000	0.0004	0.0004	0.0008	0.0011
Child rearing (total time)	0.113	0.0000	0.0018	0.0018	0.0032	0.0046
Education	0.122	0.0000	0.0020	0.0020	0.0035	0.0050
Market work	0.357	0.0000	0.0066	0.0066	0.0115	0.0164
Family-wide variables						
Female-male home production time ratio	3.188	0.0000	-0.0811	-0.0811	-0.1427	-0.2038
Female-male market work time ratio	0.476	0.0000	0.0088	0.0088	0.0154	0.0219
Fertility rate	4.400	0.0000	-0.0057	-0.0057	-0.0094	-0.0127
Adult survival rate	0.602	0.0000	0.0068	0.0068	0.0112	0.0151
Family's savings rate	0.194	0.0000	0.0018	0.0018	0.0029	0.0039
Gender bias and bargaining power						
Gender bias in family preferences [1]	0.430	0.0000	0.0000	0.0000	0.0000	0.0000
Women's bargaining power	0.430	0.0000	0.0000	0.0000	0.0000	0.0000
Capital ratio, growth and poverty						
Public-private capital ratio	0.084	0.0000	0.0222	0.0222	0.0391	0.0558
Growth rate of final output	0.054	0.0025	0.0025	0.0051	0.0086	0.0119
Poverty rate (headcount index)	0.401	-0.0027	-0.0027	-0.0055	-0.0093	-0.0129

[1] An increase indicates a reduction in gender bias.

Table 6
Côte d'Ivoire: Gender-based Policies

	Baseline	Absolute Deviations from Baseline				
		b = 0.8	$\varkappa_m$ by 10%	χ_m by 10%	$\varkappa_m$, χ_m 10%	Composite[2]
Women's time allocation						
Home production	0.408	-0.0608	-0.0007	-0.0015	-0.0023	-0.0621
Child rearing (unit time)	0.026	-0.0021	0.0008	0.0007	0.0016	-0.0005
Child rearing (total time)	0.113	-0.0105	0.0027	0.0030	0.0060	-0.0045
Education	0.122	-0.0133	0.0015	-0.0004	0.0010	-0.0120
Market work	0.357	0.0846	-0.0035	-0.0012	-0.0047	0.0786
Family-wide variables						
Female-male home production time ratio	3.188	-0.4750	-0.0052	-0.0116	-0.0178	-0.4855
Female-male market work time ratio	0.476	0.1128	-0.0047	-0.0015	-0.0063	0.1048
Fertility rate	4.400	-0.0485	-0.0318	-0.0070	-0.0396	-0.0955
Adult survival rate	0.602	-0.0005	-0.0003	0.0000	-0.0003	-0.0009
Family's savings rate	0.194	0.0019	0.0012	0.0000	0.0012	0.0033
Gender bias and bargaining power						
Gender bias in family preferences [1]	0.430	0.0582	0.0385	0.0430	0.0854	0.1551
Women's bargaining power	0.430	0.0651	0.0430	0.0000	0.0430	0.1146
Capital ratio, growth and poverty						
Public-private capital ratio	0.084	-0.0014	-0.0009	0.0000	-0.0010	-0.0026
Growth rate of final output	0.054	0.0019	0.0031	0.0035	0.0069	0.0091
Poverty rate (headcount index)	0.401	-0.0025	-0.0037	-0.0038	-0.0078	-0.0109

[1] An increase indicates a reduction in gender bias.

[2] "Composite" refers to the combination of changes in b, $\varkappa_m$ and χ_m defined in the previous columns.

Table 7
Côte d'Ivoire: Composite Reform Program

		Absolute Deviations from Baseline				
	Baseline	Benchmark	$\nu_1 = 0.3$	$\nu_4 = 0.4$	$\mu_B = 0.5$	$\alpha = 0.25$
Women's time allocation						
Home production	0.408	-0.1012	-0.1012	-0.0819	-0.1037	-0.1012
Child rearing (unit time)	0.026	0.0010	0.0010	0.0013	0.0012	0.0010
Child rearing (total time)	0.113	0.0015	0.0015	0.0033	0.0024	0.0015
Education	0.122	-0.0060	-0.0060	-0.0090	-0.0053	-0.0060
Market work	0.357	0.1056	0.1056	0.0875	0.1067	0.1056
Family-wide variables						
Female-male home production time ratio	3.188	-0.7907	-0.7907	-0.6395	-0.8101	-0.7907
Female-male market work time ratio	0.476	0.1409	0.1409	0.1167	0.1422	0.1409
Fertility rate	4.400	-0.1122	-0.1122	-0.1122	-0.1146	-0.1122
Adult survival rate	0.602	0.0187	0.0187	0.0187	0.0187	0.0187
Family's savings rate	0.194	0.0085	0.0085	0.0085	0.0086	0.0085
Gender bias and bargaining power						
Gender bias in family preferences [1]	0.430	0.1551	0.1551	0.1551	0.1597	0.1551
Women's bargaining power	0.430	0.1146	0.1146	0.1146	0.1263	0.1146
Capital ratio, growth and poverty						
Public-private capital ratio	0.084	0.0732	0.0732	0.0732	0.0749	0.0732
Growth rate of final output	0.054	0.0242	0.0280	0.0252	0.0282	0.0252
Poverty rate (headcount index)	0.401	-0.0271	-0.0313	-0.0282	-0.0313	-0.0282

[1] An increase indicates a reduction in gender bias.