



# Share the love: Parental bias, women empowerment and intergenerational mobility<sup>☆</sup>

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## ABSTRACT

This study provides empirical evidence and develops a model that captures the complex intra-household bargaining interactions and gender-based intergenerational occupational mobility. Using panel data from Nigeria, our estimates show that greater intra-household female bargaining power leads to greater intergenerational occupational mobility for sons more than daughters. Similarly, the median age at first marriage has a positive impact on occupational mobility for both daughters and sons. However, benefit is larger for sons. In the model, parental gender bias is modeled as non-pecuniary (psychic) cost – a representation of parents' pessimistic attitude towards their children's adulthood outcomes – which negatively affects the marginal benefit of investing in children's human capital. The decision of parents is critical in determining children's mobility and becomes the basis of gender-based differences in human capital investment and intergenerational persistence.

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## 1. Introduction

The interest in intergenerational persistence is often not merely based on the question of its existence but, more importantly, on whether it is a result of unequal opportunity. Inequality in opportunity often relates to intergenerational persistence, however, it may be one of many reasons behind differences in individual success. When social mobility varies by class, gender or race, it may be an indication of the existence of differential access to opportunities. Intergenerational per-

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sistence becomes more of a policy concern if it is an outcome of inequality of opportunity rather than differences in ability and preferences that are often transmitted from parent to child.

Inequality of opportunity starts at home. Although many parents claim the same degree of love for their children, regardless of their gender or age, it is also evident that there exists some form of parental bias in families. Several studies report that in India boys fare better than girls (e.g., [Barcellos et al., 2014](#); [Aurino, 2016](#)). Boys receive more childcare, are breastfed longer and get more dietary supplements. For example, [Jayachandran and Rohini \(2017\)](#) show that birth order in India is marked by favoritism towards eldest sons, and this affects parents' fertility decisions and the allocation of resources within the family. The authors also show that this gradient is more pronounced for the eldest-son preferences and also varies with sibling gender. This phenomenon is quite common in developing countries where the mortality rates are substantially higher for girls than for boys (e.g., [Arnold and Minja Kim Choe, 1998](#); [Amartya, 1990](#)).<sup>1</sup>

Why are families' gender biased? Some answers are provided in the debate over gender inequality in human capital investment. [Lagerlof \(2003\)](#), [Iyigun and Walsh \(2007\)](#) and [de la Croix and Donckt \(2010\)](#) put biological differences between women and men at the centre of gender inequality in human capital accumulation. Restricted time allocation by women in the labour market (due to their biological time commitment to childcare during pregnancy, childbirth and breast-feeding) leads to systematic gender differences in human capital investment. When women devote less time in the labor market, it negatively impacts their returns to education relative to men. This, in turn, lowers parental investment in daughters education. However, such an explanation could be at odds with the reversal of the gender education gap that has been observed more recently in many advanced countries. The gender education gap has changed the course recently in these economies that the educational attainment of females now often exceeds that of males. In [Lagerlof \(2003\)](#), gender inequality in human capital arises through a coordination process. Families play a coordination game against one another, not only caring about the income of their daughters but also the income of their future sons-in-law. In this case, it may be optimal for an atomistic parent to discriminate when all other families discriminate against their daughters.

In this article, we provide alternative theories that are particularly helpful in understanding parental gender bias and gender inequality in human capital and intergenerational occupational mobility (hereafter IG mobility) in developing countries. Firstly, we argue parental gender bias is a result of the non-pecuniary (psychic cost) associated with parental children's investment. We, in particular, treat gender bias as differences in parents' psychic cost – a reflection of their pessimism on their children's adulthood outcomes– of children's education investment, which leads to different human capital accumulation and IG mobility for daughters and sons.<sup>2</sup> Secondly, we argue intra-household bargaining power has an effect on IG mobility. Thus, we construct a collective household decision model that allows for a dynamic interaction between parental gender bias, IG mobility and intra-household bargaining power.

Before developing these theories, we start with a careful empirical assessment of the determinant of gender-based intergenerational occupational persistence across different sectors using a representative survey data from Africa's largest economy – the Nigerian General Household Survey (NGHS). NGHS collect the occupation and the highest level of education of parents, regardless of whether parents are alive or if alive, reside in the same household with their children. In line with the literature in developing countries, we study exit from traditional to modern sector. We estimate panel probit models.

Our main empirical findings are threefold: First, we find strong intergenerational persistence in the modern sector along gender line (mother-daughter and father-son) – daughters (sons) whose parents (both mothers and fathers) work in the modern sector are more likely to work in the same sector. The intergenerational occupational correlations are robust to controlling for parental education and children characteristics such as age, marital status and religion. Second, median age at first marriage, our proxy for psychic cost (we expound on this in [Section 2.2](#)) has a positive impact on IG mobility of both sons and daughters. However, the effect of late marriage on daughters' engagement in the modern sector is smaller in terms of numerical magnitude compared to sons suggesting gender norms could be another important factors in explaining differences in IG mobility between men and women. Finally, women intra-household bargaining power (measured by greater relative mothers human capital) leads to greater upward mobility for both sons and daughters, however, it is more beneficial to sons than daughters. This suggest that parental gender bias could be a driving force behind gender-based intergenerational occupation persistence.

An important contribution of this paper is that to the best of our knowledge, it is the first study to incorporate women intra-household bargaining power and gender bias (psychic cost) in the intergenerational mobility literature.<sup>3</sup> In general, intergenerational mobility studies in developing countries and, to a lesser extent, in advanced economies focus out of necessity on sons and their fathers.<sup>4</sup> Research on the implications of mothers' occupation in the occupational outcomes of their

<sup>1</sup> In China, institutional factors explain explicit preferences for boys (sex-selective abortion and differential mortality).

<sup>2</sup> In a society where child marriage is commonly practiced, for instance, parents may fear that their investment in their daughters is little rewarding, and hence may attach a relatively larger psychic cost to their daughter human capital investment. Similarly, parents who fear that their boys are more likely to become combatants during a civil war, for instance, may rather prefer to invest more on their daughters schooling than their sons.

<sup>3</sup> Existing work in intergenerational aspects of women's empowerment focus mainly on fertility issues (e.g., [Entwisle and Chen, 2002](#); [de la Croix and Donckt, 2010](#)) or welfare of young children ([Desai and Jain, 1994](#)), with little attention to the effects of women bargaining power on gender-based IG mobility.

<sup>4</sup> [Alesina et al. \(2021\)](#), [Azomahou, Yitbarek, 2021](#), [Emran and Shilpi \(2015\)](#) and [Currie and Moretti \(2003\)](#) study intergenerational education mobility from gender perspective in developing countries.

adult children is in particular quite limited in developing countries. This is at odds with the ample evidence that suggests the importance of maternal background (such as mothers educational attainment, occupation, and income) on children's adulthood socioeconomic outcomes (see [Azomahou, Yitbarek, 2021](#) and [Alesina et al., 2021](#) for detail discussion on gender based intergenerational education persistence in Africa). Few exceptions are work by [Lambert et al. \(2014\)](#) and [Emran and Shilpi \(2011\)](#) that examine the gender effects of IG mobility in developing countries.<sup>5</sup>

The framework for our theoretical analysis is a gender-based overlapping generation's model in which married/partnered couples face a trade-off between quality and quantity of their children, their consumption and labor force participation. The theory builds on models of altruistic parents that face a warm glow utility and human capital investment threshold (e.g., [Banerjee and Newman, 1993](#); [Galar and Zeira, 1993](#); [Moav, 2002](#); [Galar and Moav, 2004](#); [Galar and Mountford, 2008](#)), which defines individual intergenerational occupational mobility. Following [Chiappori \(1988\)](#) and [Chiappori \(1992\)](#), we introduce a collective household decision-making process that considers intra-household bargaining power between couples, which is determined according to the human capital of the couples (as in [de la Croix and Donckt, 2010](#)).<sup>6</sup> Another important motivation comes from the work of [Ben-Porath and Welch \(1976\)](#) and [Davies and Zhang \(1995\)](#) who treat gender inequality as a result of parental sex preference, which is a feature of parental utility function.

A novel feature of our model comes with our specification of parental attitude towards different sex siblings that determines their children's relative human capital development and hence IG mobility. In particular, we treat parental gender bias as part of the parental psychic cost, which negatively impacts the parents' marginal benefit of investing in their children's human capital. This could be a reflection of their pessimistic view of the world, which in turn could be a result of intrinsic values placed by the society in gender roles or gender stereotypes. Parents need to overcome their psychic cost before they can invest in their children's human capital. Thus, this parental gender bias ends up playing a critical role in determining their children's occupational mobility. Parents who fear that their boys are more likely to become combatants during a civil conflict, for instance, may rather prefer to send their daughters to schools ([Stewart et al., 2001](#); [de Walque, 2006](#); [Akresh and de Walque, 2008](#)). On the contrary, if parents fear that their daughters are at greater risk of being sexually assaulted and harassed, they may stop sending them to school ([Shemyakina, 2011](#)). Parental bias against a certain gender group is associated with a relatively larger psychic cost attached to the specific gender. Differences in psychic cost thus lead to differences in the human capital investment threshold of girls and boys. This, in turn, determines the IG mobility threshold for women and men in the economy.

In the model we argue that high parental psychic cost amount to parental gender bias, which becomes the basis of gender-based differences in human capital investment and IG mobility. Second, due to differences in parental altruism, intra-household bargaining power determines an individual's IG mobility. Such effect emanates from the collective decision-making process of the household where children's education investment depends on the weighted parental altruism. Increased bargaining power of a parent that attach a relatively high weight to the welfare of its children implies a reduced psychic cost. Third, individuals benefit from their opposite-sex sibling misfortunes. When parents are biased against a particular gender, then they tend to compensate for it by investing more in the opposite sex. However, the total household education investment tends to be lower than what it would have been without a presence of psychic cost or gender bias, implying that parental gender bias could be a basis for aggregate inefficiency. Fourth, higher psychic cost associates to higher fertility as parents face quality–quantity trade-off in child-rearing and child education investment. When the cost of education is higher, parents tend to shift resources from education to child-rearing. Fifth, when comparing the relative IG mobility between individuals, both family income (occupation) and intra-household bargaining power are important. This could imply children from well-to-do family may not be necessarily more mobile than those from un-affluent family. This is especially the case if gender bias in the society implies that those parents who display more willingness to allocate household resources to children (in many cultures women) are relatively less empowered in more affluent families.

The rest of the paper is organized as follows. [Section 2](#) establishes some empirical facts: [Section 2.1](#) describes the data. [Section 2.5](#) presents the econometric framework and estimation strategy. [Section 2.6](#) discusses the estimation results. [Section 3](#) develops the theoretical model and provides the analytical results. [Section 4](#) concludes the study. Proof of propositions and further details are provided in the Appendix.

## 2. Empirical evidence

In this section, we assess intergenerational mobility out of traditional sector to modern sector using the Nigerian General Household Survey (NGHS).

<sup>5</sup> [Emran and Shilpi \(2011\)](#) study IG mobility from agriculture to the non-farm sectors in Nepal and Vietnam. [Lambert et al. \(2014\)](#) explore IG mobility from a gender point of view in Senegal and they found higher maternal intergenerational occupational persistence.

<sup>6</sup> Early work in modeling of the intra-household decision-making process as a bargaining problem goes back to [Manser and Brown \(1980\)](#) and [McElroy and Horney \(1981\)](#).

## 2.1. Construction of the sample

NGHS is a panel of 5000 households with about 14,000 individuals in each wave.<sup>7</sup> It is a nationally representative survey that collects detailed information on demographic characteristics, education, health, employment, time use, and migration of household head and household members. It is one of the few national representative panel surveys available in developing countries that collect information on adults' parental backgrounds. For this study, we use three waves of NGHS 2010/11, 2012/13, and 2015/16.

We consider individuals between the ages of 15 and 65 years who have been active in the labor market in the last 12 months at the time of data collection and for whom we observe the parents' education and occupation status regardless of whether parents are alive or if alive reside in the same household. In our analysis, we do not use co-residence to construct children and parents pairs. Our approach has two advantages. First, co-residence may lead to a sample selection problem that biases the intergenerational persistence coefficient downward (Emran et al., 2018). Second, co-residence over-represents younger adults who are still living with their parents, which in turn restricts the analysis to unrepresentative young population (Hnatkovska et al., 2013; Emran et al., 2018).

In all waves, we observe the main industry of occupation and the highest level of education for both children and their parents. For children, it is the sector of the most recent job; for parents, it is the industry of occupation they got engaged into most of their adulthood. We classify the economy into two sectors: traditional (agriculture, forestry, and fishing), modern (manufacturing, construction, and service). For parents, we create four dummies: both father and mother work in the modern sector, only mothers in the modern sector, only fathers in the modern sector, and both parents work in the traditional sector.

Our dependent variable is the children's occupation sector, explaining the probability of engaging in the modern sector. Our main variables of interest are parental industry, psychic cost, and women's bargaining power. We include several control variables in all estimations, including parent's education, unearned income (local and international remittance), age, gender, marital status, and regional and time dummies. Parents' years of schooling is used as a proxy for human capital in the household when a child was growing up. We include the age and age square of children representing children experience in the labour market, this also captures cohort effect. Unearned income (remittance) and marital status of children are used to control for taste, preference, and lifecycle-related heterogeneity between children. Social and economic networks often run along with religion. This is especially important in a country like Nigeria, where religion is of integral importance. We thus include a set of dummies that reflects the religion of children.<sup>8</sup> We note that the coefficients for intergenerational persistence may become spurious if parents and children have different labor market opportunities in their respective generations. For instance, the coefficient for IG mobility can be overestimated if there are more jobs available in the modern sector now than it used to be, then occupational persistence may be an artifact of not adequately controlling for heterogeneity in the availability of jobs in the modern sector. We include time dummies in our regressions to account for unobserved location, generation-specific heterogeneity, and structural change. These may also help to control for peer and cohort effects.

## 2.2. Gender Norms, Psychic Cost and Education Investment

Parents' investment in their children education could involve both pecuniary and non-pecuniary costs. We refer to the latter a parental psychic cost – a reflection of parents' pessimism on their children's adulthood outcomes – which is a result of intrinsic values placed by the society in gender roles or gender stereotypes.

Marital customs are central cultural features of societies. The timing for marriage and, in particular, the marriage age of women compared to their men peers can lead to significant implications for investments in education and human capital accumulation of the different genders (Adams and Andrew, 2019; Bergstrom and Schoeni, 1996). Early marriages are found particularly problematic for girls in both developing and developed countries. Early female marriage affects female education more negatively than male education (Stimpfle and Stadelmann, 2016; Sabbah-Karkaby and Stier, 2017; Klepinger et al., 1999).

Investments in children education are often rationalised by their associated labour market returns (Ortiz-Gervasi, 2020; Cunha et al., 2013). This motive is likely be gender biased in patriarchal values of a traditional society. In such society women get married early and very few women work for pay and, in any event, women's wages accrue to her future family and her husband rather than to her own parents, creating a disincentive for parent to invest on education of girls. Differences in education and human capital accumulation by gender in turn affect occupation mobility of men and women differently. Thus, we argue if median age at first marriage affects occupation mobility of daughters and sons differently it reflects the non-pecuniary costs of education in a society. In a society where early marriage is declining, parents will have incentive to invest on children (both boys and girls) education equally and hence we expect more intergenerational occupation mobility for both genders.

<sup>7</sup> The data is collected by the National Bureau of Statistics of Nigeria in collaboration with the Bill and Melinda Gates Foundation and the World Bank. More statistical addendum of NGHS is available on the Living Standards Measurement Study (LSMS) website of the World Bank. See <http://go.worldbank.org/IFS9WVG7E00>.

<sup>8</sup> Ethnicity may also capture differences in network and social capital.

**Table 1**  
Median age at the first marriage and educational attainment by gender and region.

Characteristics	North Central		North East		North West		South East		South South		South West	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Median age at the first marriage	18.4	26.54	16.21	25.46	15.52	24.83	22.83	29.09	21.54	27.64	22.16	29.41
Education level (percent)												
No schooling	52.93	27.23	65.99	41.01	77.82	52.08	22.98	10.85	17.83	8.70	20.80	9.64
Primary schooling	23.03	29.62	18.16	24.60	13.75	22.79	38.14	43.58	34.93	32.75	33.11	33.67
Secondary schooling	15.71	24.98	12.49	23.37	6.19	16.60	27.79	32.26	33.63	40.55	30.70	40.14
Tertiary schooling	8.34	18.18	3.36	11.01	2.24	8.53	11.08	13.32	13.61	18.00	15.39	16.55
Correlations in years of schooling and age at first marriage	0.277***		0.234***		0.240***		0.121***		0.171***		0.158***	

Note: Data on Median age at the first marriage is from Demographic and Health Survey. Data on Educational attainment is from Nigerian General Household Survey.

We determine the role of age at first marriage on children's engagement in the modern sector by combining the NGHS data with data from the Demographic and Health Survey (DHS). DHS data provides age at first marriage by five years age group and region, for both men and women. We expect late marriages to affect modern sector employment positively through human capital accumulation (Foreman-Peck and Zhou, 2018). We hypothesize that in the absence of parental psychic cost, late marriage is expected to incentivize parental investment in education (human capital accumulation) and improve the probability of engaging in the modern sector of boys and girls equally.

As expected, NGHS and DHS data suggest parents' education investment on women is negatively affected by the presence of child marriage. Table 1 compares and contrasts median age at first marriage with different educational attainments by gender and regions. It shows that in the Northern regions of Nigeria, median age at first marriage for women ranges between 15 and 18 years while it is above 21 years in the rest of the regions. In the North West and North East regions of Nigeria where early marriage is more prevalent and the median age at first marriage is significantly lower among girls, daughters have a significantly lower educational attainment.<sup>9</sup> Less than 4 and 3 percents of women complete tertiary education in the North East and North West regions, respectively (Table 1).

### 2.3. Women Intra-household Bargaining Power

We define women's intra-household bargaining power based on individual human capital endowments. The literature has used various women's bargaining power such as relative education, employment, and asset ownership, among others, depending on data availability (see Doss, 2013 and Deere et al., 2013 for detailed discussions). It is generally found that education better explains the distribution of women's bargaining power in household decision-making. Further, there exists empirical evidence that shows a woman's education is positively related to her fertility decision, which lowers fertility (e.g. Samarakoon and Parinduri, 2015), improves children's nutritional outcomes (Samarakoon and Parinduri, 2015), and lowers her tolerance for practices that negatively affect her wellbeing (Mocan and Cannonier, 2012). Therefore, we construct women's intra-household bargaining power measures based on mothers' education relative to their partners (fathers). Our women empowerment variable, mother more schooling, is a dummy variable that takes a value of 1 if mothers have more years of schooling than their partners and zero otherwise. Thus, we expect women's bargaining power to reduce parental psychic cost and hence improve the probability of children engaging in the modern sector.

### 2.4. Descriptive statistics

Table 2 gives summary statistics.<sup>10</sup> As mentioned earlier, the data covers a panel sample of 5000 households and about 14,000 individuals in 2010/11, 2012/13, and 2015/16 that spread over six zones in rural and urban areas. The majority of children (about 70%) are engaged in the modern sector, about 51% of them are female, and 60% are married. About 24% of mothers have more years of schooling than fathers, and about 23% of fathers and mothers are engaged in the modern sector.

Table 3 presents the probability of children participating in the modern sector conditional on the parents' sector, for sons and daughters separately. Participation in the modern sector is persistent across generations. We find that 68% of daughters in the modern sector had a mother working in the same sector. Similarly, 71% percent of sons had a mother working in the modern sector. Overall, the probability of being employed in the modern sector is much higher for children if their parents were employed in the same sector. We also note a higher intergenerational persistence between mothers and daughters in the modern sector. Sons that have farmer mothers are relatively more mobile; they have a higher chance (about 43%) of joining the modern sector than daughters whose mothers are farmers (about 17%).

<sup>9</sup> The Chibok schoolgirls kidnapping by Boko Haram Militia also exemplifies another challenges that parents in Nigeria face in sending their daughters to schools.

<sup>10</sup> Tables A.6 in the Appendix report the list and definition of all variables used in the empirical analysis.

**Table 2**  
Descriptive statistics.

Variables	Mean	Std. Dev. <sup>e</sup>	Min. <sup>a</sup>	Max. <sup>b</sup>
<b>Dependent variable:</b> Children sector				
Traditional (proportion)	0.305			
Modern (proportion)	0.695			
<b>Parents characteristics:</b>				
Both parents in modern sector (proportion)	0.231			
Mother only in modern sector (proportion)	0.343			
Father only in modern sector (proportion)	0.052			
Both parents in traditional sector (proportion)	0.374			
Parents years schooling <sup>c</sup>	2.511	3.981	0	18
Mother more schooling	0.242			
<b>Children characteristics:</b>				
Unearned income (remittance in log)	0.232	1.608	0	16.811
Age of children	35.381	14.220	15	65
Female	0.514			
Married <sup>d</sup>	0.606			
Median age at the first marriage	21.769	4.723	14.6	33.2
<b>Median age at the first marriage by region</b>				
North-Central Zone	21.495	3.750	17.800	28.400
North-East Zone	19.549	4.604	15.300	28.600
North-West Zone	19.006	4.531	14.600	26.100
South-East Zone	24.507	3.697	19.300	32.800
South-South Zone	23.969	3.783	18.300	30.100
South-West Zone	24.954	3.805	20.400	33.200
Year 2011	0.293			
Year 2013	0.308			
Year 2016	0.399			
Christian	0.783			
Muslim	0.212			
Traditional	0.005			

Note: Number of observations: 10,701 in each wave. <sup>a,b,e</sup> Min., Max. and standard deviation (Std) are not reported for binary variables as per 0 and 1, respectively. Std. can be retrieved from the Bernoulli distribution. <sup>c</sup> Parental years schooling is the average of the years of schooling of the mothers and fathers. <sup>d</sup> Polygamous unions are also common. About 17% of married individuals are engaged in this type of relationship.

**Table 3**  
Movements in sectors.

Panel A. Children's modern sector participation conditional on parents' sector				
	Mother		Father	
	Daughters	Sons	Daughters	Sons
Traditional sector	0.173	0.429	0.113	0.114
Modern sector	0.676	0.713	0.332	0.397

Panel B. All sectors			
	Gross mobility	Minimum share of movers	Net mobility
Daughters	0.601	0.306	0.303
Sons	0.614	0.283	0.331

Note: The table reads as follows. In Panel A, 17% of daughters whose mothers were engaged in the traditional sector are engaged in the modern sector, against 68% of children whose mothers were in the modern sector. In Panel B, 60% of the daughters have a different sector than their parents. If all daughters whose mothers work in the modern sector would have stayed in the same sector (no downward mobility to the traditional sector) and only daughters who have a farmer mother transit to the modern sectors due to economic structural change, the movement rate would be 30%, pointing out 30% mobility unexplained by structural change.

Individuals may change occupations for various reasons. They may face either upward mobility (when joining the modern sectors while their parents are/were engaged in the traditional (farm sector) or downward mobility (when joining the traditional sector while their parents are/were engaged in the modern sector). Following [Bossuroy and Cogneau \(2013\)](#), we call such mobility as *gross mobility* across generations, capturing both up and downward intergenerational occupation mobility. Thus, gross mobility captures the likelihood of children having a different occupation than that of their parents. Intergenerational occupational mobility relates to the overall shifts in occupational structure in the country. In Nigeria, there is a fall in

**Table 4**  
Probit estimates: average partial effects.

Dependent variable:	Daughters	Sons	Daughters	Sons
Children in modern sector	(1)	(2)	(3)	(4)
Both modern <sup>a</sup>	0.410***	0.477***	0.305***	0.295***
	-0.009	-0.009	-0.011	-0.014
Mother modern	0.330***	0.203***	0.276***	0.047***
	-0.006	-0.008	-0.007	-0.011
Father modern	0.113***	0.220***	0.099***	0.169***
	-0.013	-0.016	-0.015	-0.02
Parents years of schooling <sup>b</sup>			0.005***	0.014***
			-0.002	-0.002
Unearned income (in log)			0.002	0
			-0.002	-0.003
Age			0.009***	0.028***
			-0.002	-0.002
Age square			-0.000***	-0.000***
			0.000	0.000
Married			0.040***	-0.004
			-0.011	-0.017
Muslim <sup>c</sup>			0.068***	0.023**
			-0.008	-0.01
Traditional			0.015	-0.106**
			-0.037	-0.049
Year 2013 <sup>d</sup>			-0.444***	-0.469***
			-0.005	-0.005
Year 2011			-0.438***	-0.492***
			-0.005	-0.007
Log-likelihood	-7600.38	-9013.63	-3587.82	-3937.13
Prob > $\chi^2$	1803.19	1340.55	674.12	1020.66
P-value	0.000	0.000	0.000	0.000
N = nT	16505	15599	11662	9884

<sup>a</sup> Both parents working in traditional sector is the reference group.  
<sup>b</sup> Parents' year of education refers to the average year of schooling of mothers and fathers.  
<sup>c</sup> Christian is the reference group.  
<sup>d</sup> Year 2016 is the reference year. Standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

employment shares of the agriculture sector and a rise in the employment of modern sectors such as service (Beegle et al., 2016). To separate structural economic shifts, the share of job mobility associated with expansion in non-agricultural employment, we calculate 'minimum share of movers'. *Minimum movement* is a situation where children whose parents are engaged in modern sectors remaining in the same sector (no downward mobility to the traditional sector), and only children who have farmer parents transit to the modern sectors due to economic structural change. We refer to *net mobility*, gross mobility minus the *minimum movement* across sectors due to structural change. By comparing gross and net mobility, we identify the effects of structural change on IG mobility.

Gross mobility for daughters and sons in our sample are 60% and 61%, respectively. Table 3 shows that almost half of IG mobility is left unexplained by structural change in Nigeria. It also reports a significant difference in IG mobility between sons and daughters in our sample. Thus, our objective is to determine whether parental psychic cost and women's empowerment explains net IG mobility. This will be investigated in the next section using panel probit models.

### 2.5. Estimation strategy

The estimation strategy relies on a latent probit model for unbalanced panel data:

$$y_{it} = \mathbf{1}_{[y_{it}^* > 0]} \quad i = 1, \dots, N_{t_i}; \quad t = 2011, 2013, 2016 \tag{2.1}$$

$$y_{it}^* = \mathbf{x}'_{it} \boldsymbol{\beta} + \mu_i + \varepsilon_{it} \tag{2.2}$$

where  $\mathbf{1}_{[\cdot]}$  denotes the indicator function which takes on value 1 if child  $i$  are engaged in the modern sector and zero otherwise,  $\mathbf{x}'_{it}$  is the set of regressors,  $\boldsymbol{\beta}$  is the vector of unknown parameters to be estimated,  $\mu_i$  denotes the individual specific error and  $\varepsilon_{it}$  is the idiosyncratic error term. In this specification, Eq. (2.2) is the latent equation with  $y_{it}^*$  denoting the latent variable. In terms of sample notation,  $t_i$  is the year a person is surveyed and  $N_{t_i}$  is the number of individuals surveyed in year  $t_i$ . We estimate a random effect model which assumes that  $\mathbb{E}(\mu_i | \mathbf{x}'_{it}) = 0$  and  $\mathbb{E}(\varepsilon_{it} | \mathbf{x}'_{it}) = 0$  with normal distribution.

## 2.6. Empirical results

### 2.6.1. Intergenerational occupational persistence

With empirical evidence that suggests intergenerational persistence between parental and children occupational choice along gender lines in Table 3, we turn to a formal econometric analysis in this section. We follow a sequential approach, introducing relevant control variables into two steps. First, we run a panel probit regression of children's occupation on the parental occupation for daughters and sons separately. We create four dummies to capture parents' occupation, namely: both fathers and mothers work in the modern sector, only mothers in the modern sector, only fathers in the modern sector, and both fathers and mothers work in the traditional sector.

Columns 1 and 2 of Table 4 report the estimated partial effects of the parents' sector on daughters' and sons' participation in the modern sector without additional control variables, respectively. The results show that parental background is important for children's engagement in the modern sector. Specifically, having both parents in the modern sector positively impacts children's participation in the same sector than having one, or both parents engaged in the traditional sector, indicating strong intergenerational occupation persistence in the modern sector.

The partial effect of both mothers and fathers participating in the modern sector is estimated to have the highest effect, partial effect of 41% and 48% for daughters and sons, respectively. Interestingly, the mothers' effect is strong on daughters (partial effect of 33% for daughters and 20% for sons); both are significant at 1 percent. Similarly, fathers participation in the modern sector appears to have a higher effect on sons participation in the modern sector: partial effect 22% and 11% for sons and daughters, respectively. These findings are concordant with the empirical evidence in developing countries such as Senegal (Lambert et al., 2014) and Nepal (Emran and Shilpi, 2011).

The results reported in Columns 3 and 4 of Table 4 show that the addition of controls does not affect the estimated intergenerational partial effects in any significant way either for sons or daughters. Although the partial effects of both parents engaged in the modern sector on children's occupation choice decline more for sons (from 48% to 30%) than daughters (from 41% to 31%). We also note the highest persistence in the modern sector for daughters who has both parents working in the same sector, the partial effect of 31%. The effect of parental education, the average of the years of schooling of the mothers and fathers, on the probability of children engaging in the modern sector is small in magnitude (1% for both sons and daughters) but significant. We also find that age and being Muslim makes joining the modern sector more likely for both daughters and sons. Being married increases the likelihood of being engaged in the modern sectors of daughters but not sons. This might reflect the effect of social capital through marriage on modern sector engagement for women (Verbakel and De Graaf, 2009).

To account for unobserved time-specific heterogeneity in the modern sector opportunities, we also included time-level fixed effects in Columns 3 and 4 of Table 4.<sup>11</sup> Results indicate that children in old cohorts have less chance to engage in the modern sector. This is in line with the recent structural transformation in Nigeria that makes more employment opportunities available in the service sector (Beegle et al., 2016).

### 2.6.2. Early marriage (Psychic Cost) and IG mobility

We now examine whether psychic cost, proxied by median age at first marriage, affects IG mobility. As pointed out earlier, if parental psychic cost is nonexistent, then all else equal, late marriage is expected to increase parental investment in education and benefit the participation of both sons and daughters in the modern sector equally. Therefore, we include median age at first marriage in the regressions and report the results in Table 5 in Columns 1 and 2 for daughters and sons, respectively.

The estimated partial effect of median age at first marriage is different for sons and daughters in terms of both magnitude and significance. Specifically, the partial effect is 2.5% for sons and significant at 1 percent, and the coefficient is 0.4% and significant only at 5 percent for daughters.<sup>12</sup> These results suggest that there is a psychic cost in favor of sons. Indeed, the positive and lower effects of the median age at first marriage on daughters' engagement in the modern sector, combined with the higher effect of mothers' engagement in the modern sector in promoting daughters participation in a modern sector, provide support for the role of higher psychic cost on human capital accumulation investment on girls in traditional societies where patriarchal values regarding gender roles and marital behavior prevail.

Most of our previous findings hold. The effect of parental engagement in the modern sector on the probability of children being engaged in the same sector is significant and large in magnitude. As before, both parent's engagement in the modern sector has a more significant effect on daughters' engagement in the modern sector, while fathers' engagement is more important to sons participation in the modern sector. Again, the effect of parental education on the probability of children participating in the modern sectors is small in magnitude but significant for both sons and daughters. The effect of being married on daughters engagement in the modern sector is not significant anymore. The loss of significance of married after controlling for median age at first marriage may highlight the strength of the negative relationship between early marriage and education attainment and lower participation in the modern sector for both daughters and sons. Finally, being Muslim makes joining the modern sector likely for daughters but not sons anymore; this might highlight the strong network (social

<sup>11</sup> Intergenerational correlation in occupation may still be spurious because parents and children may have different labor market opportunities specific to their generations.

<sup>12</sup> The equivalence of the marginal effects is significantly different from zero,  $\chi_2=43.72$  and  $P\text{-Value}=0.000$ .



**Table 5**  
Probit estimates: average partial effects.

Dependent variable: Children in modern sector	Daughters (1)	Sons (2)	Daughters (3)	Sons (4)	Daughters (5)	Sons (6)
Both modern <sup>a</sup>	0.293*** (0.012)	0.233*** (0.020)	0.292*** (0.012)	0.231*** (0.020)	0.293*** (0.012)	0.231*** (0.020)
Mother modern	0.270*** (0.007)	0.074*** (0.014)	0.269*** (0.007)	0.072*** (0.014)	0.269*** (0.007)	0.072*** (0.014)
Father modern	0.115*** (0.018)	0.165*** (0.028)	0.116*** (0.018)	0.163*** (0.028)	0.116*** (0.018)	0.163*** (0.028)
Parents years of schooling <sup>b</sup>	0.006*** (0.002)	0.020*** (0.003)	0.005*** (0.002)	0.018*** (0.003)	0.005*** (0.002)	0.018*** (0.003)
Unearned income (Remittance in log)	-0.001 (0.003)	0.002 (0.005)	-0.001 (0.003)	0.002 (0.005)	-0.001 (0.003)	0.002 (0.005)
Age	0.006 (0.004)	0.017 (0.012)	0.007 (0.004)	0.018 (0.012)	0.007 (0.004)	0.018 (0.012)
Age square	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Married	0.017 (0.015)	-0.018 (0.024)	0.018 (0.015)	-0.017 (0.024)	0.018 (0.015)	-0.018 (0.024)
Muslim <sup>c</sup>	0.058*** (0.009)	0.015 (0.016)	0.059*** (0.009)	0.016 (0.016)	0.059*** (0.009)	0.016 (0.016)
Traditional	0.011 (0.045)	-0.031 (0.066)	0.014 (0.045)	-0.034 (0.066)	0.014 (0.045)	-0.033 (0.066)
Year 2013 <sup>d</sup>	-0.446*** (0.006)	-0.469*** (0.008)	-0.447*** (0.006)	-0.469*** (0.008)	-0.447*** (0.006)	-0.469*** (0.008)
Year 2011	-0.418*** (0.006)	-0.456*** (0.010)	-0.419*** (0.006)	-0.457*** (0.010)	-0.419*** (0.006)	-0.457*** (0.010)
Median age at first marriage (psychic cost) <sup>e</sup>	0.004** (0.002)	0.025*** (0.003)	0.004** (0.002)	0.024*** (0.003)	0.004** (0.002)	0.024*** (0.003)
Mother more schooling <sup>f</sup>			0.030*** (0.010)	0.073*** (0.018)		
Psychic cost # Mother more schooling					0.027*** (0.010)	0.068*** (0.017)
Log-likelihood	-2557.441	-1973.942	-2553.361	-1965.861	-2553.898	-1966.554
Prob > $\chi^2$	461.38	561.34	460.91	560.07	460.78	560.42
P-value	0.000	0.000	0.000	0.000	0.000	0.000
$N = nT$	8687	5057	8687	5057	8687	5057

<sup>a</sup> Both parents working in traditional sector is the reference group.

<sup>b</sup> Parents' year of education is the average year of schooling of mothers and fathers.

<sup>c</sup> Christian is the reference group.

<sup>d</sup> Year 2016 is the reference year.

<sup>e</sup> Data on Median age at the first marriage is from Demographic and Health Survey.

<sup>f</sup> Mother more schooling is women Empowerment variable that takes a value of 1 if mother has more years of schooling compared to her husband (father), zero otherwise. Median age at first marriage is available only for individual ages 19 to 49, this reduces the sample from 16505 to 8687 for daughters and from 11662 to 5057 for sons. However, the qualitative results in Table 4 remain the same using this sub-sample. Results are available from authors. Standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

capital) that runs along the religious line to women compared to men. This finding is also in line with the findings of Adeyem et al. (2016) that religion has a significant positive effect on female labour force participation in Nigeria.

### 2.6.3. Women bargaining power and IG mobility

As discussed earlier, we construct measures of women intra-household bargaining power based on mothers' education relative to their partners (fathers). Table 5 shows that women bargaining power is positively related to IG mobility, mothers empowerment increases the likelihood of daughters and sons being employed in the modern sector by about 3 and 7 percent, respectively (Table 5, in Columns 3 and 4). The gain from late first marriage is weak, significant at 5 percent for daughters. To assess the combined effect of women bargaining power and psychic cost, we interact women empowerment variable with median age at first marriage in Column 5 and 6 of Table 5, for daughters and sons, respectively. Results show that women bargaining power enhances children engagement in the modern sector, for sons and daughters. However, the effect is bigger for sons, 2.7 percent and 6.8 percent for daughters and sons respectively.

In summary, our empirical findings, on the one hand, lead to several important insights on individuals' intergenerational occupational mobility, from traditional to modern sector, which, all in all, show the important role of gender and parental psychic cost play in IG mobility. In particular, we document a strong intergenerational occupational persistence in the modern sector when both parents are employed in the same sector. The intergenerational occupational correlation between mothers and daughters in the modern sector is much stronger than the correlation between mothers and sons or fathers and sons occupation sectors. There is also a positive and higher relationship between a mothers empowerment

and the IG mobility of her sons. The age of the first marriage of children is a weak determinant of daughters' engagement in the modern sector but a strong determinant of sons engagement in the modern sector after controlling for women empowerment. On the other hand, our empirical analysis leads to many unanswered questions: Why is women empowerment (intra-household bargaining) important to IG mobility? Why are parents – who often claim the same degree of love for their children – gender-biased? The model that we develop in the next section delves into the mechanisms that attempt to answer these questions.

### 3. Theoretical model

Suppose an overlapping generation of many individuals identified as male and female. Each individual lives for two periods as a child and an adult. We assume children do not make decision and all economic decisions are made by adults, as in Doepke and Tertilt (2009) and de la Croix and Donckt (2010). Their consumption in both cases is set to nil.<sup>13</sup> Adulthood begins by women and men joining in a partnership. When reaching adulthood, a son and a daughter of a given family simply draw spouses at random from other families and form their own family.<sup>14</sup> At any point in time, each family, indexed by  $i$ , consists of young individuals – the offspring – and two opposite-sex adults – the parents.

During childhood, individuals either go to school and accumulate human capital, if their parents invest in their education, or grow as unskilled (if they do not invest in their education). We suppose, in every period, that the economy has access to both traditional and modern technologies (modern). And, individuals who do not acquire human capital during their childhood work in the traditional sector and earn labor income whereas those who accumulate human capital during their childhood work in the modern sector and receive an additional skill premium during adulthood. Thus, there are two types of heterogeneity in the economy based on gender and occupational status.

Individuals derive utility from their own consumption, the quality and quantity of their children, in the spirit of Becker and Lewis (1973). Couples pool their income and collectively decide in all household matters such as working, child rearing, consumption, the quantity and quality of their children, subject to the household's budget constraints.<sup>15</sup> The weight of their decision on such household matters depends on their relative bargaining power, which in turn, depends on their relative human capital.

#### 3.1. Preferences

The utility function of the  $i$ th household is given by

$$u_{it}(c_{it}, h_{it+1}) = \theta_{it}u^f(c_{it}^f, h_{it+1}) + (1 - \theta_{it})u^m(c_{it}^m, h_{it+1}) \tag{3.1}$$

where  $u^f$  and  $u^m$  represent the utility of the female and male adults, respectively;  $c_{it}$  and  $h_{it+1}$  denote the respective total household consumption and children's human capital.  $\theta_{it}$  represents the bargaining power of the female adult;  $1 - \theta_{it}$ , that of the male adult. Following de la Croix and Donckt (2010), we model  $\theta_{it}$  as a function of the couple's relative human capital:

$$\theta_{it} = (1 - \epsilon)\varpi + \epsilon \frac{h_{it}^f}{h_{it}^f + h_{it}^m} \tag{3.2}$$

where,

$$0 \leq \{\epsilon, \varpi\} \leq 1$$

and  $h_{it}^f$  and  $h_{it}^m$  stand for the human capital of the female and male adults, respectively. The last term captures the effect of relative human capital on the couple's intra-household bargaining power.

$\epsilon$  and  $\varpi$  are parameters important to intra-household bargaining power. The parameter  $\epsilon$  represents the marginal impact of the female's relative human capital in her intra-household bargaining power. The case  $\epsilon = 1$  implies that intra-household bargaining power is solely determined by the relative human capital in the household. In contrast, if  $\epsilon = 0$ , then bargaining power is independent of the couple's relative human capital. In the latter case,  $\theta_{it} = \varpi$ , bargaining power is exogenous, and the model belongs to the unitary household models.<sup>16</sup>  $\varpi$  captures the exogenous institutional and societal factors that affect intra-household bargaining power. Lower  $\varpi$  relates to higher degree of gender norms and stereotypes that intrinsically restricts women's intra-household bargaining power, regardless of their relative human capital advantage. If  $\varpi < 0.5$ , for instance, the bargaining power of women is less than that of men even if  $h_{it}^f = h_{it}^m$ .<sup>17</sup>

Let the utility function of the  $j$ th gender adult of the  $i$ th couple is defined as follows:

$$u^j(c_{it}^j, h_{it+1}) \equiv \ln(c_{it}^j - \bar{c}) + \beta^j \ln(h_{it+1}^j + \gamma^j)^\sigma (h_{it+1}^m + \gamma^m)^{1-\sigma} + \zeta \ln n_{it} \tag{3.3}$$

<sup>13</sup> Alternatively, it could be assumed that their consumption to be included in the consumption of their parents.

<sup>14</sup> For the sake of simplicity, we abstract from the possibility of being divorced or being in a same-sex marriage.

<sup>15</sup> We also assume that households face credit constraints.

<sup>16</sup> See Browning et al. (2006) for a discussion in the relationship between unitary and collective models of the household.

<sup>17</sup> This is easily seen from Eq. (3.2) that if  $h_{it}^f = h_{it}^m$  then  $\theta_{it} = (1 - \epsilon)\varpi + 0.5\epsilon < 0.5$  iff  $\varpi < 0.5$ .

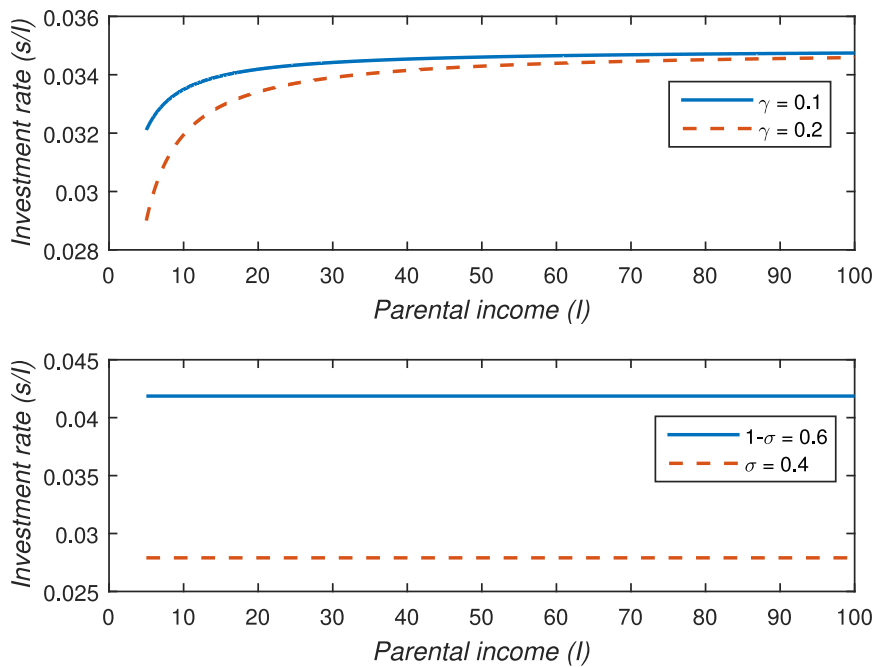


Fig. 1. Effects  $\gamma$  and  $\sigma$  on parental education investment rate.

where

$$0 < \{\beta, \alpha, \sigma\} < 1$$

As in de la Croix and Donckt (2010), singles will not have children. They derive utility solely from their consumption while consuming the whole amount of their income. In contrast, couples have “warm glow” preferences, and they care not only for their own consumption but also for the quality and quantity of their children.  $n_{it}$  is the number of children.  $\zeta$  represents the couples’ preference for family size (number of children).  $\bar{c} \geq 0$  stands for subsistence consumption.  $\beta^j$  is the degree of parental altruism.  $j \in \{f, m\}$  where  $f$  and  $m$  stand for female and male offspring or adult (depending on the context), respectively. We assume gender differences in parental altruism,

$$\beta^j \neq \beta^{-j} \tag{3.4}$$

where  $-j$  represents the opposite sex. Doepke and Tertilt (2009) consider that women attach a relatively higher weight to the human capital of their children,  $\beta^f > \beta^m$ , which is quite plausible. Women are believed to be biologically inclined to do so by many due to their relatively large presence from the earliest moments of their children during pregnancy and breastfeed that creates bonds and gives them a bigger stake. This is also mainly supported empirically. In many cultures, women are primary caregivers of children (Duflo, 2000; Behrman and Skoufias, 2006; Bank, 2011).

The parameter  $\gamma^j > 0$  determines the curvature of the marginal utility to investment in the  $j$ th gender children education, and, is of central interest in this paper. Higher  $\gamma^j$  makes the marginal benefit schedule to shift downward with a steeper curvature at the lower level of education investment (Figure 1). Such a decrease in marginal benefit to education investment is ascribed to a higher non-pecuniary (psychic) cost. The presence of such a psychic cost in the parent’s utility function reduces the total amount of investment in children’s education, through negatively impacting the marginal benefit of investing in children’s education.

While  $\gamma^j$  reflects the parents’ non-pecuniary psychological cost in education investment, parental bias against the  $j$ th gender children is captured by  $\gamma^j > \gamma^{-j}$ . Such bias could be a result of psychological factors such as the parents’ perception of the world that some of their children may face a relatively tougher time to be successful, due to prevailing institutional, political and social factors. For instance, in a society where child marriage is widely practiced, parents may fear that investing in their daughters’ education is little rewarding due to a likely school dropout.<sup>18</sup> This, in turn, may lower their relative marginal benefit of investing in their girls’ education, which could be captured by  $\gamma^f > \gamma^m$ .

The parameter  $\sigma$  is used to reflect the parents’ inherent sex preference. The main difference between  $\sigma \neq \frac{1}{2}$  (that implies parents have favorite children) and  $\gamma^j \neq \gamma^{-j}$  (parents are gender biased) is that the former is independent of the parents’ characteristic or the environment. For instance,  $\sigma < \frac{1}{2}$  implies that parents always favor boys; regardless of their income,

<sup>18</sup> Table 1 shows in Nigerian regions where child marriage is prevalent relative educational attainment of girls is substantially lower.

they invariably invest more in their boys' education. But this is not necessarily true for the case  $\gamma^m < \gamma^f$ . Although parents invest more in their boys' education, the investment rate varies in their income and other external factors (such as aggregate productivity). Particularly, when resources are meager, parents allocate little resources to their daughters relative to their sons; however, such bias gradually declines as their income increases.

This is demonstrated in Fig. 1,<sup>19</sup> which depicts the gender gap in parental education investment rate at different levels of parental income for the two cases:  $\sigma \neq \frac{1}{2}$  and  $\gamma^j \neq \gamma^{-j}$ . As shown in the second panel of the Figure, for the case  $\sigma \neq \frac{1}{2}$ , the gender gap is constant, regardless of changes in parental income. In contrast, for the case  $\gamma^j \neq \gamma^{-j}$  (the first panel of the Figure), the gap is very large at lower income levels but narrows down as income increases.

### 3.2. Technologies and constraints

Suppose  $e_{it}^j$  and  $l_{it}^j$  represent the average good and time spending in the  $j$ th child education of the  $i$ th household. Then, the total human capital of the  $j$ th gender children of this household is given by

$$h_{it+1}^j = (s_{it}^j)^\nu (\bar{h}_t x_{it}^j)^\eta \tag{3.5}$$

where  $s_{it}^j \equiv \frac{1}{2} n_{it} e_{it}^j$  is the couple's total material spending on the  $j$ th gender children schooling (e.g., tuition fee, books, school uniforms); and,  $x_{it}^j \equiv \frac{1}{2} n_{it} l_{it}^j$  is the total time allocated for tutoring of these children (e.g., reading bedtime stories, helping with homework). Thus, the couple cares for the total education (quality) of their children.<sup>20</sup>

The parameters  $\nu$  and  $\eta$  are elasticities for learning, which reflect the productivity of parental education spending in the accumulation of human capital. We assume constant returns to scale:  $\nu + \eta = 1$ .  $\bar{h}_t$  is the average human capital of the parent's generation that captures a positive intergenerational spillover in human capital accumulation in the economy. The budget constraint of the  $i$ th household is given as follows:

$$c_{it}^f + c_{it}^m + s_{it}^f + s_{it}^m = I_{it} \tag{3.6}$$

where  $I_{it}$  is the pooled income of the couple, which is defined below.  $s_{it}^f$  and  $s_{it}^m$  are the total education investment in daughters and sons respectively.

### 3.3. Aggregate technology

Every period, the economy has access to two types of technologies: traditional and modern. In both sectors, the final goods are produced by perfectly competitive firms. Let a firm's production function in the modern sector is given by the following  $Ak$  type production function, in the spirit of Romer (1986) and Lucas, (1988):  $y_t = A(h_t)^\alpha (l_{t,w} \bar{h}_t)^{1-\alpha}$ .  $A$  is a deterministic total factor productivity (TFP).  $h_t$  and  $l_{t,w}$  are human capital and labor, respectively, hired by the firm to produce output  $y_t$ .  $\bar{h}_t \equiv \frac{h_t}{l_{t,w}}$  is the average human capital, which captures the spillover effects of knowledge, and is modelled as in Frankel (1962) to deal with the scale effect from population growth. In perfect competition, factors are paid according to their marginal productivity, ensuring all firms to hire the same amount of capital and labor:  $\bar{h}_t = \frac{h_{st}}{l_{st,w}} = \frac{h_{rt}}{l_{rt,w}} \forall s, r$ . Thus, the wage rate ( $\omega_t$ ) and the price per unit of labor and human capital are  $\omega_t \equiv (1 - \alpha)A\bar{h}_t$  and  $\alpha A$ , respectively. A no-arbitrage condition in the factor markets implies that wage in the traditional sector should also be  $(1 - \alpha)A\bar{h}_t$ . The wage rate depends on aggregate productivity implies that productivity in the traditional sector increases as the economy continues to grow.<sup>21</sup>

### 3.4. Couples' income and occupation

Each adult couple is endowed with a unit of labor.<sup>22</sup> To raise a single child,  $\phi$  amount of time is needed. If the child goes to school, parents allocate an additional  $l_{it}$  amount of time to tutor the child. In a family of  $n_{it}$  number of children who send all their children to school, the time allocated for work is thus  $l_{it,w} = 1 - \phi n_{it} - l_{it} n_{it}$ . Thus, the wage income of the family is given by  $l_{it,w} \omega_t$ . If one or both of the couple have received education during their childhood, they work in the modern sector and receive the additional skill premium  $\alpha A$  per unit of human capital.<sup>23</sup> The pooled income of an adult couple, where only one of them works in the modern sector, for instance, is given by  $l_{it,w} \omega_t + \alpha A h_{it}^j$ .

We suppose that, at time  $t$ , there are four different types of couples, categorized based on the occupational status of each adult in the household, which are defined below:

<sup>19</sup> Illustrative calibration is conducted for Eqs. (3.9) and (3.10):  $A = 1$  (total factor productivity),  $\nu = 0.25$  (education elasticity following de la Croix and Donckt, 2010),  $\psi = 0.3$  (average discount factor following de La Croix and Michel, 2002) and  $\alpha = 0.75$  (considering a 25% agricultural GDP share in Nigeria).

<sup>20</sup> See Jones et al. (2008) for similar setup.

<sup>21</sup> We abstract here from structural change, which is out of the scope of the paper. Structural transformation can be achieved though, by considering differential factor intensity in the supply side, or through income or relative price effects in the demand side. See Acemoglu and Guerrieri (2008) and Herrendorf et al. (2014) for more in this topic.

<sup>22</sup> The qualitative results will not change if we rather assume that each individual is endowed with a unit of labor time.

<sup>23</sup> The outcome will not change if raw labor is assumed to have been upgraded, say, as a result of a universal compulsory primary or secondary education. Then, acquiring human capital could be interpreted as acquiring the special skill required to work in the modern sector.

**Definition 1.** We refer to Type 1 couple, denoted by  $i = 1$ , when both members of the household work in the modern sector. Type 2,  $i = 2$ , is when the female works in the modern sector while the male works in the traditional sector. Type 3,  $i = 3$ , is the opposite of Type 2; the male works in modern while the female works in the traditional sector. Type 4,  $i = 4$ , is when both adults work in the traditional sector.

The pooled income of the  $i$ th couple ( $I_{it}$ ) is given by

$$I_{it} = (1 - \phi n_{it} - x_{it})\omega_t + b_{it} \tag{3.7}$$

where  $x_{it} \equiv l_{it}n_{it}$ . The first term is the wage income of the couple's whereas  $b_{it}$  is the income premium and defined as follows:

$$b_{it} \equiv \begin{cases} \alpha A(h_{it}^f + h_{it}^m) & \text{if } i = 1 \\ \alpha A h_{it}^f & \text{if } i = 2 \\ \alpha A h_{it}^m & \text{if } i = 3 \\ 0 & \text{if } i = 4 \end{cases} \tag{3.8}$$

The first line captures the pooled skill premium of a couple, who both adults work in the modern sector. The second (third) line is the income premium earned by the female (male) adult member of the household. The income premium is nil in the last line since there is no one in this household who works in the modern sector.

### 3.5. Households' optimal decisions

Households maximize Eqs. (3.1) and (3.3) subject to Eqs. (3.5)–(3.7). Solutions for the  $i$ th couple problem consist of optimal education investment in sons and daughters and fertility decision, which are presented in the Lemma below (See Appendix B):

**Lemma 1.**

$$s_{it}^{m*} = \left( \omega_t + b_{it} - 2\bar{c} + \frac{z}{v} \gamma^f \right) \chi_{it} (1 - \sigma) - \delta_{it}^m \gamma^m \tag{3.9}$$

$$s_{it}^{f*} = \left( \omega_t + b_{it} - 2\bar{c} + \frac{z}{v} \gamma^m \right) \chi_{it} \sigma - \delta_{it}^f \gamma^f \tag{3.10}$$

$$\chi_{it}^{j*} = \frac{\eta}{\omega_t v} s_{it}^{j*} \tag{3.11}$$

$$n_{it}^* = \left( \omega_t + b_{it} - 2\bar{c} + \frac{z}{v} \gamma \right) \frac{1}{1 + \psi_{it} + \varsigma} \frac{\varsigma}{\phi \omega_t} \tag{3.12}$$

where

$$\psi_{it} \equiv \theta_{it} \beta^f + (1 - \theta_{it}) \beta^m$$

$$\chi_{it} \equiv \frac{v \psi_{it}}{1 + \psi_{it} + \varsigma}$$

$$\delta_{it}^m \equiv z \frac{1 + \sigma \psi_{it} + \varsigma}{1 + \psi_{it} + \varsigma}$$

$$\delta_{it}^f \equiv z \frac{1 + (1 - \sigma) \psi_{it} + \varsigma}{1 + \psi_{it} + \varsigma}$$

$z$  and  $\gamma$  are defined in the appendix.

Eqs. (3.9)–(3.12) show the  $i$ th couple optimal decisions in terms of children's education investment and fertility.  $s_{it}^{j*}$  and  $\chi_{it}^{j*}$  represent the total optimal education spending on the  $j$ th gender children, in goods and time, respectively.  $n_{it}^*$  is the optimal number of children. The couple's decisions in fertility and children's education depend on their pooled income, their relative bargaining power ( $\theta_{it}$ ), sex preference ( $\sigma$ ), education technologies ( $v$  and  $\eta$ ), productivity parameters ( $A$  and  $\alpha$ ), subsistence consumption ( $\bar{c}$ ), psychic cost related to ones gender ( $\gamma^j$ ) and the opposite sex ( $\gamma^{-j}$ ), taste for family size ( $\varsigma$ ), and the cost of raising children ( $\phi$ ).

The first terms in the big brackets, in Eqs. (3.9) and (3.10), show the couple's pooled income, net of their substance consumption plus the psychic cost related to the opposite sex siblings, which are all positively related to the  $j$ th gender children's education investment. The last term constitutes primarily the psychic cost related to ones gender, and negatively influence education investment. Eq. (3.11) captures the trade off between parental investment in children's education in time and goods. It depends on the wage rate  $\omega_t$  and schooling technologies,  $v$  and  $\eta$ . If wages are higher, parents may prefer to allocate more time to work and compensate their children with more of material resources investment. Eq. (3.12) is the couple's optimal fertility decision. Fertility increases in preference for number of children  $\varsigma$  and non-pecuniary costs associated to children's education  $\gamma$  but decreases in the weighted parental altruism  $\psi_{it}$ .

*Optimal education investment*

According to Lemma 1, couples with income below their subsistence level  $2\bar{c}$  may struggle to invest in the human capital of their children. Furthermore, since the last terms in Eqs. (3.9) and (3.10) are positive, the presence of psychic costs creates additional pressure on parental investment in children’s human capital. Effective investment in children’s education are thus given by, in terms of goods and time spending by the parents, respectively,

$$s_{it}^j = \max(0, s_{it}^{j*}) \tag{3.13a}$$

$$x_{it}^j = \max(0, x_{it}^{j*}) \tag{3.13b}$$

Couples’ optimal education investment has thus a corner solution. To ensure the continuum of the dynasty, one may impose:

$$\bar{h}_0 > 2 \frac{\bar{c}}{(1 - \alpha)A} \tag{3.13c}$$

which is the sufficient condition for a couple to chose having and raising children,  $n_{it} \neq 0$ . That is, the initial level of the economy’s average human capital (productivity) should be sufficiently high for the wage rate to be large enough to cover the minimum consumption requirement of a couple.

Even if parents satisfy the minimum consumption requirement, some parents may still opt not to invest in one or both of their children’s human capital due to the presence of parental gender bias or non-pecuniary costs associated to children’s education investment. Particularly, in the presence of a significant parental gender bias,  $\gamma^j > \gamma^{-j}$ , relatively poor households may find it optimal to invest in only one gender of their children, or not to invest in any of them (in case of higher  $\gamma$ ).

Total household education expenditure,  $s_{it} \equiv s_{it}^f + s_{it}^m$ , is computed by simply adding Eqs. (3.9) to (3.10):

$$s_{it}^* = (\omega_t + b_{it} - 2\bar{c})x_{it} - \frac{1 + \varsigma}{1 + \psi_{it} + \varsigma} z\gamma \tag{3.14}$$

We see from Eq. (3.14) that the total education expenditure in the case where  $\gamma^j \neq 0$  is smaller than that of the case where  $\gamma^j = 0$ . Total household time spending in children’s education,  $x_{it} \equiv x_{it}^m + x_{it}^f$ , is given by,

$$x_{it}^* = \left( (\omega_t + b_{it} - 2\bar{c})x_{it} - \frac{1 + \varsigma}{1 + \psi_{it} + \varsigma} z\gamma \right) \frac{\eta}{v\omega_t} \tag{3.15}$$

which is also lower than the case where there is no psychic cost,  $\gamma^j = \gamma^{-j} = 0$ . Therefore, the presence of a psychic cost could reduce household investment in children’s education and hence can be a basis for aggregate inefficiency. However,  $s_{it}^*$  and  $x_{it}^*$  are independent of  $\sigma$ .

Furthermore, the average education investment in an offspring ( $\frac{s_{it}^*}{n_{it}^*}$ ) could easily be derived from Eqs. (3.12) to (3.14):

$$e_{it}^* = \frac{1}{\varsigma} \phi \omega_t \left( v\psi_{it} - \frac{z\gamma(1 + \psi_{it} + \varsigma)}{\omega_t + b_{it} - 2\bar{c} + \frac{z}{v}\gamma} \right) \tag{3.16}$$

Eq. (3.16) shows the quality–quantity trade-off that parents face in their fertility and education investment choices. Parents invest more in a child’s education, the higher the cost of raising a child ( $\phi$ ) or the lesser  $\varsigma$  is.

The Proposition below summarizes the role of psychic cost and parental gender bias in parents’ optimal choices:

**Proposition 1.** (i) The greater  $\gamma^{-j}$  or the lesser  $\gamma^j$  is, the higher  $s_{it}^{j*}$  and  $x_{it}^{j*}$  become. (ii) Given  $\beta^f > \beta^m$ , an increase in women’s bargaining power increases couples’ investment in children’s education. (iii) The presence of a psychic cost or parental gender bias could reduce the total household investment in education. (iv) Fertility increases in non-pecuniary cost associated to children’s education investment ( $\gamma$ ).

**Proof.** See Appendix B  $\square$

From Proposition 1, it appears that individuals benefit from their opposite-sex sibling misfortunes (higher  $\gamma^{-j}$ ). Not only the non-pecuniary cost related to one’s gender but also to the opposite sex is important to the person’s human capital accumulation. When parents are biased against a particular gender, then they tend to compensate for it by investing more in the opposite sex. However, the net effect is negative. The last proposition of Proposition 1 is another feature of quality–quantity trade-off that parents face in child-rearing and child education investment. When the cost of education is higher, parents shift resources from education to child-rearing.

3.6. Optimal human capital

By substituting Eq. (3.11) into Eq. (3.5), we derive the total optimal human capital of the  $j$ th gender offspring of the  $i$ th household at  $t + 1$ :

$$h_{it+1}^{j*} = z^{-1} s_{it}^{j*} \tag{3.17}$$

It is straightforward to see that Proposition 1 and the related discussions also apply to individuals' optimal human capital accumulation. It follows that from Eqs. (3.13) to (3.17), individuals' human capital at time  $t + 1$  who are born at time  $t$  is given by:

$$h_{it+1}^j = \max(0, h_{it+1}^{j*}) \tag{3.18}$$

The corner solution  $h_{it+1}^j = 0$  represents those individuals who do not possess human capital during their adulthood at  $t + 1$ . Individuals whose parents invest in their education during childhood will have the human capital  $h_{it+1}^{j*} > 0$  during their adulthood.

Given that there are four types of couples at time  $t$ , if all invest in their children's education, there will be eight types of individuals who will acquire human capital at time  $t + 1$ , when categorized based on their gender and family background. These are four types of female offspring and another four types of male offspring. They can be categorized based on their parental background, as having: (i) non-farmer parents, (ii) farmer father and non-farmer mother, (iii) farmer mother and non-farmer father, or (iv) farmer parents.

### 3.7. Mobility threshold

Considering (3.17) and (3.18), the  $j$ th gender offspring human capital who are born at time  $t$  is given by

$$h_{it+1}^j = \begin{cases} z^{-1}s_{it}^{j*} & \text{if } s_{it}^j(\bar{h}_t) > 0 \\ 0 & \text{if } s_{it}^j(\bar{h}_t) \leq 0 \end{cases} \tag{3.19}$$

From (3.19), we derive the average human capital ( $\hat{h}_{it}^j$ ) below which Type  $i$  households do not invest in the  $j$ th offspring's human capital.<sup>24</sup> In particular,

$$h_{it+1}^j = \begin{cases} h_{it+1}^{j*} & \text{if } \bar{h}_t > \hat{h}_{it}^j \\ 0 & \text{if } \bar{h}_t \leq \hat{h}_{it}^j \end{cases} \tag{3.20}$$

We refer to  $\hat{h}_{it}^j$  as IG mobility threshold, associated to the  $j$ th gender offspring of the  $i$ th couples, given  $h_{it+1}^j = 0$  is the break-even point for working in the traditional sector.<sup>25</sup>

**Lemma 2.** The threshold levels of average human capital below which parents do not invest in their daughters' and sons' education, respectively are given by:

$$\hat{h}_{it}^f = ((1 - \alpha)A)^{-1} \left( \frac{Z}{V} \varrho_{it}^f + 2\bar{c} - b_{it} \right) \tag{3.21}$$

and

$$\hat{h}_{it}^m = ((1 - \alpha)A)^{-1} \left( \frac{Z}{V} \varrho_{it}^m + 2\bar{c} - b_{it} \right) \tag{3.22}$$

where

$$\varrho_{it}^f \equiv \gamma^f \left( \frac{1}{\sigma} \frac{1 + \psi_{it} + \varsigma}{\psi_{it}} - 1 \right) - \gamma^m \tag{3.23}$$

$$\varrho_{it}^m \equiv \gamma^m \left( \frac{1}{1 - \sigma} \frac{1 + \psi_{it} + \varsigma}{\psi_{it}} - 1 \right) - \gamma^f \tag{3.24}$$

**Proof.** See Appendix B □

The higher  $\hat{h}_{it}^j$  becomes the less mobile the individual becomes. The mobility of two individuals can thus be compared and contrasted using their associated threshold levels. For instance, if  $\hat{h}_{2t}^m < \hat{h}_{3t}^f$ , then sons from Type 2 families (where only the mothers work in the modern sector) are more likely to show upward mobility than daughters from Type 3 families (where only the fathers work in the modern sector).

According to Lemma 2, the mobility threshold of an individual is determined mainly by parental income (or occupational background), and non-pecuniary costs. The latter is captured in the composite variable  $\varrho_{it}^j$ . Given that parents are able to meet their basic consumption needs,<sup>26</sup> as long as  $\varrho_{it}^j > 0$ , there will be some parents that fall short of investing in their children's education, particularly, at the early stage of the economy when the initial level of average human capital ( $\bar{h}_0$ )

<sup>24</sup> See Appendix B.

<sup>25</sup> Similar threshold analysis are often applied in inequality and growth literature with multiple equilibria (e.g., Galor and Zeira, 1993; Moav, 2002; Galor and Moav, 2004)

<sup>26</sup> The restriction in Eq. (3.13c) ensures that wage income is always higher than minimum consumption,  $\omega_t > 2\bar{c} \forall t$ .

is too small. On the contrary, if  $\varrho_{it}^j = 0$ , then all parents invest in their children’s human capital, regardless of their initial endowment or family occupation composition, leading to a complete IG mobility.<sup>27</sup>

We refer to the composite parameter  $\varrho_{it}^j$  as *effective parental gender bias* against the  $j$ th gender children because it is mainly a result of differences in psychic cost ( $\gamma^j \neq \gamma^{-j}$ ). The higher  $\varrho_{it}^j$  becomes, the less mobile the  $j$ th gender offspring are. The first term of  $\varrho_{it}^j$  captures the *effective* psychic cost related to the  $j$ th gender children’s education investment, where  $\gamma^j$  is weighed by relative bargaining power of the couples, parental sex and family size preferences. The second term is the psychic cost associated to individuals’ opposite-sex siblings education investment.

Since couples are heterogeneous in terms of their human capital composition, intra-household bargaining power ( $\theta_{it}$ ) also varies between couples. The latter constitutes the effective psychic cost that determines IG mobility and thence is an important source of variation in IG mobility among families.

**Proposition 2.** (i) If  $\beta^f > \beta^m$ , then women empowerment will be positively associated to IG mobility, and conversely. (ii) The greater  $\gamma^{-j}$  or the lesser  $\gamma^j$  is, the higher the mobility of the  $j$ th gender offspring. (iii) Higher  $\sigma$  implies higher IG mobility for daughters. (iv) Higher  $\varsigma$  implies lower IG mobility for all children.

**Proof.** See Appendix B □

If there are no differences in parental altruism ( $\beta^f = \beta^m$ ), however, intra-household bargaining power will have no influence in IG mobility. Such relation exists due to the collective decision-making process nature of the household where children’s education investment depends on the weighted parental altruism ( $\psi_{it}$ ). This is intuitive, because when parents put similar weight in the welfare of their children, it doesn’t matter who have more saying in children’s education investment. But if a parent with more willingness to allocate household resources to children has a lower bargaining power within the household decision-making structure, it may imply a forgone investment opportunity to children’s human capital.

The second and third statements of Proposition 2 are the direct results of parental gender bias and sex preference on children’s education investment. When there is parental bias in the family, it would create IG mobility differences among siblings. The parents’ taste for family size is also important for children’s IG mobility, as it influences resource allocation in the household between child rearing and child education.

### 3.8. IG mobility comparison

The IG mobility, in general, is a function of aggregate and individual factors. It depends, for instance, on aggregate productivity parameters ( $A$  and  $\alpha$ ). It also depends on household occupation composition or parental income ( $b_{it}$ ), relative bargaining power of couples (as captured in  $\theta_{it}$ ), the psychic costs related to ones gender ( $\gamma^j$ ) and the opposite sex ( $\gamma^{-j}$ ), parental sex and family size preferences ( $\sigma$  and  $\varsigma$ ), and education technologies ( $\eta$  and  $\nu$ ). But, when comparing relative IG mobility between siblings and individuals, differences in relative family occupation background ( $b_{it}$ ) and intra-household bargaining power ( $\theta_{it}$ ) are the two most important factors to look out for, given household heterogeneity is based on those aspects.

We compare the mobility between and within males and females in the economy based on two scenarios: (i) Parents show no particular sex preference and are not gender biased. (ii) Parents show sex preference and are gender-biased. The latter is a more likely scenario, particularly in Africa. In both cases, similar to Doepke and Tertilt (2009), we assume women attach a relatively higher weight to the human capital of their children,  $\beta^f > \beta^m$ .

In the first case where  $\gamma^m = \gamma^f$  and  $\sigma = 1/2$ , there would be no intrinsic differences between the human capital of men and women, i.e.,  $h^f = h^m$ , thus there is no differences in IG mobility between opposite sex siblings.<sup>28</sup> Initial IG Mobility between different types of households is determined by the degree of intra-household bargaining power ( $\theta_{it}$ ) and parental occupational background ( $b_{it}$ ). In this special case, we have the following proposition:

**Proposition 3.** (i) Children whose two parents work in the modern sector are more likely to work in the same sector than children whose two parents work in traditional sector, (ii) or than children only their fathers work in the modern sector. (iii) Children only their mothers work in the modern sector are more likely to work in the same sector than children only their fathers work in the modern sector, (iv) or than children both two parents work in traditional sector.

**Proof.** See Appendix B □

The bargaining power of the females in Type 1 households (where both parents work in the modern sector) is the same as the females in Type 4 households (where both parents work in traditional sector), since there is no difference in human capital *within* the couples’ in these types of households. But, it is higher than that of the mothers in Type 3 household (where only the fathers work in the modern sector). But, since Type 1 couples have a relatively larger human capital than Type 3 or 4 couples, the IG mobility of children of Type 1 couples is higher than the IG mobility of children of Type 3 or 4

<sup>27</sup> If  $\varrho_{it}^j = 0$ , the threshold becomes  $\widehat{h}_{it}^j = ((1 - \alpha)A)^{-1}(2\bar{c} - b_{it})$ . But, given Eq. (3.13c),  $\bar{h}_0 > \widehat{h}_{it}^j \forall i, j$ .

<sup>28</sup> This can be easily confirmed from Lemma 1. Particularly, if  $\gamma^m = \gamma^f$  and  $\sigma = 1/2$ , then parents invest the same amount of education in their sons and daughters, leading to similarity in human capital between men and women.



4 couples. Furthermore, since the mothers in Type 2 households are more empowered than the mothers in Type 3 and 4 households, given  $h_i^m = h_i^f$ , children of Type 2 couples are more mobile than children of Type 3 or 4 couples.

The relationship between IG mobility of children in Type 1 and 2 households and IG mobility of children in Type 3 and 4 households are ambiguous. For instance, the bargaining power of the mothers in Type 2 households is higher than that of the mothers in Type 1 households, implying a higher IG mobility in the former. But, the fact that all members of Type 1 couples work in the modern sector makes mobility relatively more likely in these households. The same analysis applies when comparing individuals in Type 3 and 4 households. Although the bargaining power of the mothers is relatively higher in Type 4 households, this would be compromised by the fact that both parents in these type of households work in traditional sector.

In the second case, we consider the more plausible condition where  $\gamma^m < \gamma^f$  and  $\sigma < 1/2$ , boys are favored. Thus, not only there are mobility differences among individuals with different family backgrounds but also within families themselves (between opposite sex siblings). In the case,  $\gamma^m < \gamma^f$  and  $\sigma < 1/2$ , we have the following proposition:

**Proposition 4.** (i) Between siblings, sons are relatively more mobile than their sisters. (ii) Sons (daughters) whose mothers work in the modern sector are more likely to work in the modern sector than sons (daughters) whose two parents work in traditional sector. (iii) Sons (daughters) whose two parents work in the modern sector are more likely to work in the same sector than sons (daughters) whose fathers work in the modern sector.

**Proof.** See Appendix B  $\square$

With respect to the relative mobility between individuals of the opposite sex, the corollary below follows from Proposition 4.

**Corollary 1.** (i) Sons only their mothers work in the modern sector are more likely to work in the same sector than daughters whose both parents work in traditional sector. (ii) Sons whose both parents work in the modern sector are more likely to work in the same sector than daughters only their fathers work in the modern sector.

In the case  $\gamma^m > \gamma^f$  and  $\sigma < 1/2$ , parents are biased against their daughters and consequently sons are more likely to receive education and be mobile than their opposite sex siblings. Children's mobility in Type 2 households is relatively higher than in Type 4 households because the females are relatively empowered in the former. Parental occupational background is also relatively better in Type 2 households, since at least one of the parents work in the modern sector. We also see IG mobility in Type 1 households to be relatively higher than IG mobility in Type 3 households, because the former are better both in terms of relative female bargaining power and parental occupational background.

However, relative IG mobility between Type 1 and 2, between Type 2 and 3 and between Type 1 and 4 households are ambiguous. Although the intra-household bargaining power of the mothers is relatively larger in Type 2 households than in Type 1 or 3 households, the human capital of Type 2 couples is relatively smaller compared to the human capital of Type 1 or Type 3 couples. Similarly, mobility in Type 1 households is not necessarily higher than mobility in Type 4 households. Because, even though there is relatively larger human capital in Type 1 households, the bargaining power of the mothers is relatively better in Type 4 households.

Apparently, the (direction of the) results will change if girls are more favoured by their parents in the household and men display more willingness to allocate household resources to children's education, although these are a less likely scenarios in particular to many developing countries. However, the implication that children from well-to-do family may not be necessarily more mobile than those from unaffluent family rather bases on weaker assumptions that there are differences in parental altruism ( $\beta^j \neq \beta^{-j}$ ) and there exists parental gender bias ( $\gamma^j \neq \gamma^{-j}$ ). The latter implies intrinsic differences between the human capital of men and women in the society. If  $\gamma^m < \gamma^f$ , for instance, within the household boys possess more human capital, even when both parents work in the modern sector and hence they are relatively more empowered. If this is followed by  $\beta^f > \beta^m$ , then the parents (in this case the women) who display more willingness to allocate household resources to children's education are less empowered within this family even when both parents work in the modern sector. Therefore, some of the mobility advantage children from this family has over children from less affluent families (where women are more empowered) will be eroded.

In summary, not only individual differences in IG mobility depends on couples' occupational backgrounds but also on relative intra-household bargaining powers. But, the latter is important only if there are differences in altruism within couples. This implies, because, in many cultures, especially in developing countries, women are assumed to be the primary caregivers, the degree of mothers' intra-household bargaining power could be an important determinant of their children's IG mobility.

This result is in line with the broad empirical regularities that women empowerment translates into better child outcomes. When evaluating the effect of pension transfer on children's nutritional status in South Africa, Duflo (2000) find that pension that was received by a woman leads to substantial improvement in health outcome (weight-for-height z-scores and height-for-age z-scores) of children. Similar results are found in Mexico where women social transfer beneficiaries tend to shift a larger share of spending on goods that promote human capital investments (health and education) on children (Behrman and Skoufias, 2006). Women's educational attainment relative to men's is also identified as an important factor for resource control in households. Empowered women, more educated women relative to their husband, are found allocating more resources towards children's human capital allocation (health and education) than their male counterparts

(e.g. Abu-Ghaida and Klasen, 2004; Haddad et al., 1997). On the other hand, Osmani (1997) suggests that lack of women empowerment is an important determinant of malnutrition and stunting in South Asia.

#### 4. Conclusion

The paper developed a model that captures the complex intra-household interactions that affect children's adulthood outcome. Intergenerational occupational mobility of an individual is determined by whether the individual receives education during childhood. Such decisions are made collectively by both parents. Parents have different altruism towards their children's human capital. There exists both pecuniary and non-pecuniary costs (psychic) of children's schooling. The latter is modeled as parental psychic cost – a representation of parents' pessimistic attitude towards their children's adulthood outcomes –, which negatively influences the marginal benefit of investing in children's human capital. Parents need to overcome their psychic cost to invest in their children's human capital, as it may stand as a critical point of their children's mobility. Parents' perception of the world that some of their children may face a relatively tougher time to be successful, due to prevailing institutional, political and social factors, could lead to differential children's education investment. For instance, in a society where child marriage is widely practiced, parents may fear that investing in their daughters' education is little rewarding due to a likely school dropout. On the contrary, parents who fear that their boys are more likely to become combatants during a civil conflict, for instance, may rather prefer to invest in their daughters' education. Such effects are more pronounced when resources are meagre or when parents possess few resources to allocate for all their children. However, it may decline, and eventually disappear, at the later stage of the development process.

In such society, differences in parental psychic cost could amount to parental gender bias, which could become the basis of gender-based differences in human capital investment and intergenerational mobility. Differences in parental altruism means intra-household bargaining power is important to children's mobility. When household matters are decided collectively, children's education investment depends on the weighted parental altruism. Given that, women attach a relatively high weight to the welfare of their children, then the degree of their intra-household bargaining power is important in defining the mobility of their children. The presence of psychic cost or parental gender bias could lead to aggregate inefficiency as the total household education investment becomes lower than what it would have been without the presence of parental gender bias. Because, when comparing the relative IG mobility between individuals, both family income (occupation) and intra-household bargaining power are important, children from affluent family may not necessarily more mobile than those from un-affluent family. This is especially the case if gender bias implies that those parents who show more willingness to allocate household resources to children are relatively less empowered in affluent families.

The theoretical analysis is motivated by empirical findings: Our estimations showed that parental gender bias could be the basis of gender based intergenerational occupational mobility. In particular, median age at first marriage has a positive impact on IG mobility for boys and girls, however, the effect on boys is larger. We also showed that greater intra-household female bargaining power leads to greater upward intergenerational occupational mobility for boys more than girls. Thus overall, our work underlines the importance of conducting further research into the impact of gender bias in social mobility in developing countries, particularly on countries where race bias is prevalent. A better understanding of such biases could help to address the sluggish occupation and education mobility of women.

#### Author agreement statement

We the undersigned declare that this manuscript is original, has not been published before and is not currently being considered for publication elsewhere.

We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed.

We further confirm that the order of authors listed in the manuscript has been approved by all of us.

We understand that the Corresponding Author is the sole contact for the Editorial process. He/she is responsible for communicating with the other authors about progress, submissions of revisions and final approval of proofs.

#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

**Appendix A. Appendix for the Empirics**

**Table A1**  
List and definition of variables.

Variable name	Definition	Nature
Children’s sector	0=traditional (agriculture), 1=Modern,	binary (modern=1)
Age of children	Age of individuals (completed years)	continuous
Father schooling	Fathers number of years of schooling associated with the highest grade completed	continuous
Mother schooling	Mothers number of years of schooling associated with the highest grade completed	continuous
Mother more schooling	Mother has more years of schooling than fathers	binary (yes=1)
Sex of children	Gender of children	binary (female=1)
Father in traditional sector	Father engaged in agriculture, forestry, fishing and mining for most of his life	binary (yes=1)
Father in modern sector	Father engaged in manufacturing and construction sector for most of his life	binary (yes=1)
Mother in traditional sector	Mothers engaged in agriculture, forestry, fishing and mining for most of her life	binary (yes=1)
Mother in modern sector	Mothers engaged in manufacturing and construction sector for most of her life	binary (yes=1)
Marital status of children	Married (Monogamous or polygamous)	binary (yes=1)
Median age at first marriage	Median age at first marriage	continuous
Children’s religion	1=Christian, 2=Muslim, 3=Traditional	discrete
Year	Structural change indicator: Years 2016 (base), 2013, 2011	binary (yes=1)

**Appendix B. Appendix for the Theory**

*B1. Proof for the Lemmas*

*B1.1. Proof for Lemma 1*

The couples solve the following problem, from Eqs. (3.1) to (3.3),

$$\max_{\{c_{it}^m, c_{it}^f, s_{it}^f, s_{it}^m, x_{it}^f, x_{it}^m\}} \left\{ \theta_{it} \ln(c_{it}^f - \bar{c}) + (1 - \theta_{it}) \ln(c_{it}^m - \bar{c}) + \psi_{it} \left[ \ln(h_{it+1}^f + \gamma^f)^\sigma + \ln(h_{it+1}^m + \gamma^m)^{1-\sigma} \right] + \varsigma \ln n_{it} \right\} \tag{B.1}$$

subject to Eqs. (3.5)–(3.7) where,

$$\psi_{it} \equiv \theta_{it} \beta^f + (1 - \theta_{it}) \beta^m \tag{B.2a}$$

$\psi_{it}$  is the weighted average of parental altruism. From the first order conditions of the problem, we have:

$$c_{it}^m : \frac{c_{it}^m - \bar{c}}{c_{it}^f - \bar{c}} = \frac{1 - \theta_{it}}{\theta_{it}} \tag{B.3}$$

$$s_{it}^j : \frac{\theta_{it}}{c_{it}^f - \bar{c}} = \frac{h_{it+1}^f \sigma \nu \psi_{it}}{(h_{it+1}^f + \gamma^f) s_{it}^f} = \frac{h_{it+1}^m (1 - \sigma) \nu \psi_{it}}{(h_{it+1}^m + \gamma^m) s_{it}^m} \tag{B.4}$$

$$x_{it}^j : \frac{\theta_{it}}{c_{it}^f - \bar{c}} \omega_t = \frac{\psi_{it} \eta \sigma}{h_{it+1}^f + \gamma^f} \frac{h_{it+1}^f}{x_{it}^f} = \frac{\psi_{it} (1 - \sigma) \eta}{h_{it+1}^m + \gamma^m} \frac{h_{it+1}^m}{x_{it}^m} \tag{B.5}$$

$$n_{it} : \frac{\theta_{it}}{c_{it}^f - \bar{c}} \phi \omega_t = \frac{\varsigma}{n_{it}} \tag{B.6}$$

From Eq. (B.3), the relative consumption of male and female adult is determined by their relative intra-household bargaining power. Eqs. (B.4) and (B.5) equate the marginal benefits in sons’ and daughters’ education investment, in terms of material resources and time, respectively. Eq. (B.6) captures the tradeoff between an individual’s consumption and the cost of raising children.

Combing Eqs. (B.4) and (B.5) will lead to

$$\frac{s_{it}^f}{x_{it}^f} = \frac{s_{it}^m}{x_{it}^m} = \omega_t \frac{\nu}{\eta} \tag{B.7}$$

which is similar to Eq. (3.11). Thus, the ratio of total parental investment in goods and time is the same for both sons and daughters, which is proportional to the wage rate in the traditional sector. Given the number of daughters and sons are the same, the average investment ratio is also the same.

To derive the couple's optimal education investment and fertility decision, first substitute Eqs. (3.5) and (B.7) into the last two terms of Eq. (B.4) to get:<sup>29</sup>

$$s_{it}^f = \frac{\sigma}{1 - \sigma} s_{it}^m - \bar{\gamma} z \tag{B.8}$$

where,  $z$  and  $\bar{\gamma}$  are defined as follows, considering  $\omega_t = (1 - \alpha)A\bar{h}_t$ ,

$$z \equiv \left( \frac{\omega_t \nu}{\bar{h}_t \eta} \right)^{1-\nu} = \left( \frac{\nu}{\eta} (1 - \alpha)A \right)^{1-\nu}$$

$$\bar{\gamma} \equiv \frac{(1 - \sigma)\gamma^f - \sigma\gamma^m}{1 - \sigma}$$

Then, from Eqs. (3.5), the first and third terms of (B.4) and (B.7), one obtains

$$c_{it}^f - \bar{c} = \frac{\theta_{it}}{(1 - \sigma)\nu\psi_{it}} (s_{it}^m + z\gamma^m) \tag{B.9}$$

But, we can rewrite Eq. (B.3) as

$$c_{it}^m = \frac{1 - \theta_{it}}{\theta_{it}} c_{it}^f + \bar{c} \frac{2\theta_{it} - 1}{\theta_{it}} \tag{B.10}$$

Then substitute Eq. (B.10) into the budget constraint, Eq. (3.6), to get

$$c_{it}^f - \bar{c} + \theta_{it}(s_{it}^f + s_{it}^m) = \theta_{it}I_{it} - 2\bar{c}\theta_{it} \tag{B.11}$$

Substituting Eq. (B.9) into (B.11), and using Eq. (B.8), gives,

$$s_{it}^{m*} = (I_{it} - 2\bar{c} + z\gamma^f)a_{it}(1 - \sigma) - \gamma^m(1 - a_{it}(1 - \sigma))z \tag{B.12}$$

where

$$a_{it} \equiv \frac{\nu\psi_{it}}{1 + \nu\psi_{it}}$$

which is the optimal education investment in sons. In order to get the one for daughters, substitute the above into (B.8):

$$s_{it}^{f*} = (I_{it} - 2\bar{c} + z\gamma^m)a_{it}\sigma - \gamma^f(1 - a_{it}\sigma)z \tag{B.13}$$

Adding Eqs. (B.12) and (B.13), gives the total education expenditure:

$$s_{it}^* = (I_{it} - 2\bar{c} + z\gamma)a_{it} - z\gamma \tag{B.14}$$

Total time spendings in children education is derived from Eqs. (B.7) to (B.14):

$$x_{it}^* = \frac{\eta}{\nu\omega_t} ((I_{it} - 2\bar{c} + z\gamma)a_{it} - z\gamma) \tag{B.15}$$

where

$$\gamma \equiv \gamma^m + \gamma^f$$

With respect to fertility decision, from Eqs. (B.4) to (B.6), we have

$$\phi\omega_t n_{it} = \frac{\zeta}{\sigma\nu\psi_{it}} (s_{it}^f + z\gamma^f)$$

Substituting Eq. (B.13) into the above, we get the couple's optimal fertility decision:

$$n_{it}^* = \frac{\zeta}{\phi\omega_t} (1 - a_{it})(I_{it} - 2\bar{c} + z\gamma) \tag{B.16}$$

The next is to derive the couple's income  $I_{it}$ , which is endogenously defined in Eq. (3.7). By substituting Eqs. (B.15) and (B.16) into Eq. (3.7), we can rewrite the  $i$ th couple income as follows:

$$I_{it} = \frac{(1 + \nu\psi_{it})(\omega_t + b_{it}) + 2\bar{c}(\zeta + \eta\psi_{it}) + (\eta/\nu - \zeta)z\gamma}{1 + \psi_{it} + \zeta} \tag{B.17a}$$

Eq. (B.17a) represents the couple's pooled income that consider their optimal time allocation between, child education, child rearing, and work. Finally substituting Eq. (B.17a) into Eqs. (B.12), (B.13), and (B.16) give Eqs. (3.9), (3.10) and (3.12), respectively.

<sup>29</sup> We consider first degree homogeneity in Eq. (3.5),  $\nu + \eta = 1$ .

B1.2. Proof for Lemma 2

From Eqs. (3.10) to (3.17), the *i*th couples do not invest in their girls' education if

$$h_{it+1}^f = z^{-1}s_{it}^f = 0$$

$$\Leftrightarrow \omega_t = \frac{\delta_{it}^f}{\kappa_{it}\sigma} \gamma^f - \frac{z}{\nu} \gamma^m - b_{it} + 2\bar{c}$$

Using the definitions for  $\delta_{it}^f$  and  $\kappa_{it}$ , and solving for  $\bar{h}_t$  gives (3.21). Do the same for the boys to get (3.22).

B2. Proofs for the Propositions

B2.1. Proposition 1

**Proof.** (i) It is straightforward to see, from the Lemma 1,  $s_{it}^{j*}$  and  $x_{it}^{j*}$  increase in  $\gamma^{-j}$  but decrease in  $\gamma^j$ . (ii) Given  $\beta^f > \beta^m$ , from Eqs. (3.14) to (3.15), we see that  $\partial s_{it}^*/\partial \theta_{it} > 0$  and  $\partial x_{it}^*/\partial \theta_{it} > 0$ . (iii) From Eqs. (3.14) to (3.15), both  $s_{it}^*$  and  $x_{it}^*$  will reach their maximum at the boundary  $\gamma^j = \gamma^{-j} = 0$ . (iv) From Eq. (3.12),  $\partial n_{it}^*/\partial \gamma^j > 0$ . □

B2.2. Proposition 2

**Proof.** Note first that from Lemma 2, the higher  $\hat{h}_i^j$  becomes the less likely the *j*th individual becomes mobile.<sup>30</sup> Then, from Lemma 2, we can show that: (i) If  $\beta^f > \beta^m$ ,  $\hat{h}_i^j$  decreases in  $\theta_i$ . (ii)  $\hat{h}_i^j$  decreases in  $\gamma^{-j}$  but increases in  $\gamma^j$ . (iii)  $\hat{h}_i^f$  decreases in  $\sigma$ . (iv)  $\hat{h}_i^j$  increases in  $\varsigma$ . □

B2.3. Proposition 3

**Proof.** (i) Since, for the case  $\gamma^m = \gamma^f$  and  $\sigma = 1/2$ , there is no difference in human capital investment between siblings, we can drop the superscript *j*. Note also that, from Lemma (2), mobility between different types of households is determined by the effective parental gender bias ( $\varrho_i$ ) and parental occupational background ( $b_i$ ). The former, in turn, is determined by the degree of intra-household bargaining power ( $\theta_i$  as defined in  $\psi_i$ ). (i) When comparing the IG mobility between Type 1 and 4 households, the bargaining power of the females in Type 1 households is the same as that of the females in Type 4 households,  $\theta_1 = \theta_4 \Rightarrow \psi_1 = \psi_4$ .<sup>31</sup> It follows that  $\varrho_1 = \varrho_4$ . But since  $b_1 > b_4$ , from Lemma (2), we have  $\hat{h}_1 < \hat{h}_4$ . (ii) When comparing mobility between Type 1 and 3 couples, we have  $\theta_1 > \theta_3 \Rightarrow \psi_1 > \psi_3$ , which implies that  $\varrho_1 < \varrho_3$ . Also,  $b_1 > b_3$ . Therefore,  $\hat{h}_1 < \hat{h}_3$ . (iii) When comparing between Type 2 and 3 couples, we have  $\theta_2 > \theta_3 \Rightarrow \psi_2 > \psi_3$ , which implies that  $\varrho_2 < \varrho_3$ . Also,  $b_2 = b_3$ . Thus,  $\hat{h}_2 < \hat{h}_3$ . (iv) When comparing IG mobility between Type 2 and 4 couples, we have  $\theta_2 > \theta_4 \Rightarrow \psi_2 > \psi_4$ , which implies that  $\varrho_2 < \varrho_4$ . Since, also,  $b_2 > b_4$ , we have  $\hat{h}_2 < \hat{h}_4$ . □

B2.4. Proposition 4

**Proof.** (i) Given,  $\gamma^m > \gamma^f$  and  $\sigma < 1/2$ , from Lemma (2), it is straightforward to see that within the *i*th household  $\hat{h}_i^m < \hat{h}_i^f$ . (ii) The bargaining power of the females in Type 2 households is higher than the bargaining power of the females in Type 4 households:  $\theta_2 > \theta_4 \Rightarrow \psi_2 > \psi_4$ . It follows that  $\varrho_2^f < \varrho_4^f$  &  $\varrho_2^m < \varrho_4^m$ . Parental occupational background is also relatively better in Type 2 households:  $b_2 > b_4$ . Thus, from Lemma (2), it follows that  $\hat{h}_2^m < \hat{h}_4^m$  &  $\hat{h}_2^f < \hat{h}_4^f$ . (iii) The bargaining power of the females in Type 1 households is higher than the bargaining power of the females in Type 3 households:  $\theta_1 > \theta_3 \Rightarrow \psi_1 > \psi_3$ . It follows that  $\varrho_1^f < \varrho_3^f$  &  $\varrho_1^m < \varrho_3^m$ . Parental occupational background is also relatively better in Type 1 households:  $b_1 > b_3$ . This translates to higher relative mobility,  $\hat{h}_1^m < \hat{h}_3^m$  &  $\hat{h}_1^f < \hat{h}_3^f$ . □

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<sup>30</sup> In the rest of the Proofs, we drop the time subscript for simplicity.

<sup>31</sup> This can be confirmed by applying L'Hôpital's rule in Eq. (3.2). That is, given  $h_1^m = h_1^f$  and  $h_4^m = h_4^f = 0$ , it follows that  $\theta_1 = \theta_4 \Rightarrow \psi_1 = \psi_4$ .

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