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Title: Family size and Education Inequalities: Trends and Patterns Over three Generations

Introduction

The relationship between family size and education is largely studied. Literature clearly showed a negative effect, explaining that as trade-off or dilution effect, fewer children leads to more education investment (Becker and Lewis, 1973; Blake, 1989; Downey, 2001; Eloundou-Enyegue and Williams, 2006; Kuepie *et al.*, 2011). Nevertheless, whereas most of the studies assessed it in transversal or comparative perspective, several researches mentioned that relationship is a socioeconomic contextual linkage, and would change over time (Maralani, 2008; Mueller, 1984). These studies explained that both education values, importance of children and family size desired are defined according the socioeconomic context. Therefore, this relation would be changing over time, thus through generations.

In spite of the great consideration for the impact of fertility decline on the educational investment from demographers and family economists, very few tried to understand the potential consequences on the education inequalities over time. Hausmann and Székely (2001) and Bloom et al. (Bloom *et al.*, 2012) show that fertility decline should reinforce inequality between families over time, at least at the first phase of the demographic transition because richer and educated families are the first one in declining their family size. Other researches such as Lloyd (1994), Allendorf (2012), and Eloundou-Enyegue and Williams (2006) advocate that it should lead in contrarily to a reduction of intrafamily educational inequality between boys and girls due to the loosen of family budget which forced family to choose among children who are to be

schooled. However, in both cases, there are few empirical evidences, and even less considering family in generational and dynamic perspective(Lachaud, LeGrand and Jean-François, 2013).

Our study aims to describe and analyze the patterns of family size, education, and inequality over time, considering three generations, and to measure the impact of family size on education inequalities from a generation to another. We first presented a mathematical conceptualization of this impact considering a dynamic perspective. Then, we discussed our data and estimation methods. After a briefly presentation of our empirical findings, we discussed our results in their historical and institutional settings.

Conceptualization of the effect of family size decline on education inequalities

Suppose that family has a long-term view over time, so actual family decisions would also affect future generations. The hypothesis that fewer children lead to more education investment could be written as follows:

$$\text{if} \qquad S_{i(t-1)} > S_{it} \rightarrow Y_{i(t+1)} > Y_{it}$$

where S is the family size or the sibship and Y is the average education level of family *i* and *t* generation.

We could write the effect of the generation variation of family size of education variation as a first-differences (FD) model considering the education level of generation *t+1* depends on education level of generation *t*.

$$Y_{i(t+1)} - Y_{it} = \beta_0 + \alpha_1(S_{it} - S_{i(t-1)}) + X\beta + \Delta\varepsilon_{it} \qquad (1)$$

$$\text{with } \Delta\varepsilon_{it} = \varepsilon_{it+1} - \varepsilon_{it}$$

where X is all control variables, $\boldsymbol{\beta}_0$, includes the time effect, α_i, the effect of the reduction of family size, $\boldsymbol{\beta}$ are the parameters of control variables, and ε the idiosyncratic error.

The expected value of the ΔY_t, conditional on the ΔS_t and the other independent variables is:

$$E(\Delta Y_t | \Delta S_t, X) = \beta_0 + \alpha_1(S_t - S_{t-1}) + X\beta_{i=1,n}$$

if $E(\Delta\varepsilon_{it}\Delta S_{it}) = 0$, and $E(\Delta\varepsilon_{it}) = 0$ using a Ordinary Linear Square (OLS), we can estimate consistently α_1.

Now, we introduce a *g-group* factor as the socioeconomic status of generation *t-1* observed prior to the variation of family size, so exogenous to this variation process and would affect this process in such way that we have:

$$(S_t - S_{t-1})_g > (S_t - S_{t-1})_{g'} \qquad \text{if } g > g'.$$

Thus, our model has a full set of group-generation effects:

$$Y_{ig(t+1)} - Y_{igt} = \beta_0 + \alpha_0 g + \alpha_1(S_{it} - S_{i(t-1)}) + \alpha_2\tau_{ig} + X\beta_{i=1,n} + \mu_{igt} \qquad (2)$$

with α_0 is the group effect g, α_2 the effect of τ, which is an interaction variable between family size variation, $(S_{it} - S_{i(t-1)})$, and the group factor *g*, socioeconomic status, for *i* family, and μ_{it}, family-specific error.

Finally, suppose that education is gendered distributed inside family. That means:

$$(\hat{Y}_{bi} - \hat{Y}_{gi})_t > 0$$

with boys (b) of family *i* have systematically in average more education than girls (*g*) of *i* in generation *t*.

Consider the last two generations, *t* and *t+1*, a reduction of the gender education discrepancies decrease could be expressed as a double difference:

$$(\hat{Y}_{bi} - \hat{Y}_{gi})_{t+1} - (\hat{Y}_{bi} - \hat{Y}_{gi})_t \leq 0$$

and if the reduction of family size affects the reduction of intrafamilial inequality over generations, we have:

$$(Y_{bi} - Y_{gi})_{t+1} - (Y_{bi} - Y_{gi})_t = \beta_0 + \alpha_1(S_t - S_{t-1}) + X\beta_{i=1,n} + \Theta_{it} \quad (3)$$

With $E(\Theta_{it}) = 0$

Data and Estimation Methods

We used data from the Demtrend survey collected on a subsample of the follow-up population by Ouaga-HDSS since 2008. To analyze the causal effect of family size on education investment, this survey, undertaken in 2012, was focused on women who are at their last life reproductive cycle, 35-59 and with at least one child, and their family based on blood or union relation. Therefore, retrospective data on their biological parents, more precisely on their mothers, and on their biological children have been gathered. In total, 2952 women were interviewed. Considerable data were gathered on life reproduction, education, socioeconomic status, and family composition and size for grandmothers, mothers and children. To limit memory biases, retrospective data were collected for women whose mother survived until at least their 15th birthday, 2821 women. Thus, for the analysis we considered only women with children from 15 and over - 2531 women representing about 90.3% -. For the analysis of gender intrafamily inequality, only 52.07% (1469) have both girls and boys over 15. That is mostly an age effect because a great part of women are 35-44 years old (table 1).

Variables

We noted Y as education variable of this study, which is defined on one hand as literacy, ability to read or write, and on other hand the years of schooling that is a measure of accumulation of education investment. The last one is considered to estimate the models presented here. Family size is defined as the total number of children born to a woman, the sibship, and it is computed for grandmothers and mothers.

The *g-factor* is defined as the socioeconomic status of grandmothers that should be exogenous to the family size decline. It was included in the Demtrend survey as subjective evaluation by

asking the women to compare the economic situation of their parents' household when they were 15 years old with respect to other family households living in the same area (better, similar or worse). The validity of this variable was tested by comparing it to other characteristics of grandparents as education level, literacy, and residence area which are theoretically correlated with the living standard – refer to Kobiané (2013). In addition, to control the effect of the reproductive life cycle of family size of mother, mother's age is included as a categorical variable. Table 1 presents summary statistics for variables used for our analysis.

Table 1: Summary statistics for variables used in the analysis

Variables	N	Mean	Standard Deviation	Min	Max
Literacy					
Grandmother	2531	0.07	0.248	0	1
Mother	2418	0.28	0.450	0	1
Children	2531	0.87	0.339	0	1
Years of schooling					
Grandmother	2485	0.22	1.253	0	13
Mother	2418	1.97	3.771	0	18
Children	2529	7.48	3.473	0	17
Average year of schooling (mother Sibship)					
Girls	2354	2.00	2.854	0	15.9
Boys	2491	2.83	3.445	0	15.5
Average year of schooling (children sibship)*					
Girls	1468	7.34	3.901	0	17
Boys	1465	7.48	3.842	0	18
Family size					
Grandmother	2530	6.85	2.617	1	19
Mother	2530	4.60	1.728	0	10
SES of grandparents					
Poorer	2531	0.23	0.422	0	1
Poor	2531	0.57	0.495	0	1
Better off	2531	0.19	0.395	0	1
Mother generation					

34-44	2531	0.62	0.486	0	1
45-59	2531	0.38	0.486	0	1

Sources: Calculated with Data from Ouaga-HDSS 2011 and Demtrend 2012

*Computed only for families who have both boys and girls over 15

Comparing the three generations, the literacy rate increased from 7% to 28% from grandmothers to mothers, and reach 87% for children. Subsequently, the years of schooling increased significantly from 0.22 to 1.97 years before reaching 7.48 years for the last generation. In counterpart, family size had reduced more than 2.2 children: in average from 6.85 to 4.60 children.

Estimation methods

We used first-difference models. First, we computed the differential variables for years of schooling and sibship size as a first difference as defined in models (1). For the model (2), we also computed the interaction variable between sibship size and thesocio-economic status after transformed into three dummy variables: g (better off), g' and g" (poorer). For the intrafamilial family inequality, model (3), we computed the differential variable between boys and girls for generations *t* and *t+1*, and then we made the double difference. After computing our variables, we used OLS to estimate the parameters, and to test the exogeneity of the size variation and the consistency of our estimations, we computed the error term. Finally, we tested if the perturbations null and non-correlated between distinct families.

Results

Fertility decline differential

Results in table 2 shows the average number of children was high for the oldest generation, around 6.85 children per women, independently of their SES. However, the fertility decline from

grandmothers to mothers in average in all families but it is slightly more important for better-off families compare to poor and poorer families. Indeed, better-off families have 0.41 and 0.33 children less than respectively poor and poor, and theses discrepancies are statistically significant at 1%.

Table 2: Education and Fertility: Evolution over two generations

	Grandmothers	Mothers		
		Total	35-44 years	45-59 years
Average number of children				
Poorer	6.82	4.73	4.54	5.10
Poor	6.85	4.65	4.39	5.05
Better off	6.87	4.31	4.12	4.61
Diff (Better off-Poor)	0.03	-0.33***	-0.27***	-0.44***
Diff (Better off-Poorer)	0.05	-0.41***	-0.42***	-0.49***

Data are from the 2011 Ouaga-HDSS and the 2012 Demtrend survey.

Significance: *** 0.01 **0.05 *0.10.

Evolution of Education inequalities

Our findings presented in table 3 about the evolution of education inequalities are interesting. Although education increases over time from a generation to another, the socioeconomic inequalities persist, mostly for years schooling. As regards to literacy, from grandmothers to mothers, we observed a substantial increasing of these inequalities. The difference between better-off and poorer family passed from 9.5% to 22.7%, and between better-off and poor from 8.9% to 15.5%. Nonetheless, for the third generation, that difference reduced to only 6.78% between better-off and poorer, and statistically non-significantly between better-off and poor. The same pattern is observed for years of schooling. That being said, the inequalities still persist significantly.

Table 3: Education inequalities: Evolution and transmission over two generations

	Grandmothers	Mothers			Children
		Total	35-44 years	45-59 years	15 +
Literacy					
Poorer	4.43	19.61	19.84	19.15	82.79
Poor	5.02	26.84	28.3	24.59	87.35
Better off	13.91	42.34	40.93	44.44	89.57
Diff (Better off-Poor)	8.9***	15.5***	12.6***	19.9***	2.22
Diff (Better off-Poorer)	9.5***	22.7***	21.1***	25.3***	6.78**
Average years of schooling					
Poorer	0.14	1.2	1.3	1.1	5.44
Poor	0.18	1.8	1.8	1.7	6.23
Better off	0.53	3.4	3.4	3.5	7.29
Diff (Better off-Poor)	0.18***	1.78***	1.85***	1.67***	1.06**
Diff (Better off-Poorer)	0.39***	2.26***	2.18***	2.41***	1.85***

Data are from the 2011 Ouaga-HDSS and the 2012 Demtrend survey.

Significance: *** 0.01 **0.05 *0.10.

Contrarily to socioeconomic educational inequalities, the table 4 shows that gender inequalities within family tend to disappear over generation. By comparing mother and children' sibships, we noted that boys had significantly (at 1%) 0.81% years schooling more than girls in mother's sibship, while in children' sibship the difference is 0.14 years and not significantly.

Table 4: Education inequalities within family: Evolution and

transmission over two generations

	Mothers			Children
	Total	35-44 years	45-59 years	15 +
Average years of schooling				
Male	2.47	2.51	2.42	7.48
Female	1.66	1.59	1.75	7.35
Difference	0.81***	0.93***	0.68***	0.14

Data are from the 2011 Ouaga-HDSS and the 2012 Demtrend survey.

Significance: *** 0.01 **0.05 *0.10.

Multivariate analysis

Table 5 presents the coefficients estimated for the first-difference regression of years of schooling on sibship size reduction. Results show an important and significant at 1% time effect measured partially through the constant $\boldsymbol{\beta}_0$=3.66, which depicts the increases of education over time independently of family's characteristics. Secondly, we found a significant at 5% coefficient 0.26 of the variation of sibship size. In other words, if the gap between grandmothers and mothers sibship size - which results from sibship decline of mothers - increased by 1%, the variation of years of schooling will increase by 0.26 years. Nonetheless, by adjusting the model by mother' group age, the effect disappears for older mother of 45-59 years old. For the model consistency, we found that the mean absolute error is statistically not different from zero and independent variables are strictly exogenous.

Tables 5: Coefficient of the first-difference model

		Age affect	
	All	35-44	45-59
Dependent variable⁺			
Variation of sibship size‡	0.26(0.137)**	0.48(0.188)**	0.05(0.193)
Mother age (ref. 35-44)			
45-59	1.70(0.2490***		
Constant	3.66(0.135)***	3.7(0.135)***	5.35(0.202)
Error analysis			
E(absolute error)	0.02(0.099)	0.06(0.126)	-0.06(0.157)

Regression error on independent variables	NS	NS	NS
N	2410	1491	919

Sources: data are from the 2011 Ouaga-HDSS and the 2012 Demtrend survey.

Coefficient (robust Standard Deviation)

Significant level, *** 0.01 **0.05 *0.10

+ =years of children of children-years of schooling of mothers

‡((mother family size-grandmother family size)/grandmother family size))

NS: none of independent variable is significant

Table 6 displays coefficient of the first-difference models considering two at a time g-factor and SES of grandmothers. Comparing better-off families to poorer, and then to poor ones, results show a substantial multiplier effect of SES through sibship size reduction on the increases of education level over generations. In the model "better-off vs. poorer", a variation by 1% of the sibship result in 0.89 years of schooling for children for richer families and 0.53 for poorer. For model "better-off vs. poor", the same variation of sibship increased the variation of years of schooling by 0.86 for better-off families and by 0.79 for poor ones. The interaction effect is statistically significant respectively those models at 1% and 5%. For our last estimation "poor vs. poorer", neither sibship variation nor interaction variable are significant statistically. The error analyses demonstrate our fitted models are consistent.

Tables 6: Coefficient of the first-difference models considering g-factor, socioeconomic status

	Better off (0) vs. poorer (1)	Better off (0) vs. poor (1)	Poor (0) vs. poorer (1)
Dependent variable			
Variation of Sibship size+	0.89 (0.290)***	0.86(0.287)***	0.11(0.165)
SES	0.52(0.342)	0.68(0.320)**	-0.12(0.250)
Sibship size*SES	-0.88(0.431)***	-0.75 (0.330)**	-0.12(0.364)
Mother age (ref. 35-44)			
45-59	1.46(0.363)***	1.84(0.290)***	1.78(0.257)***
Constant	3.24(0.298)***	3.09 (0.295)***	3.79(0.165)***
Error analysis			
E(absolute error)	0.05(0.154)	0.03(0.116)	-0.01(0.105)
Regression error on independent variables	NS	NS	NS
N	1026	1851	1944
Estimation of effect of sibship size variation			

Poorer	0.53		0.11
Poor		0.79	-0.13
Better off	0.89	0.86	

Sources: data are from the 2011 Ouaga-HDSS and the 2012 Demtrend survey.

Coefficient (robust Standard Deviation)

Significant level, *** 0.01 **0.05 *0.10

+ =years of children of children-years of schooling of mothers

‡((mother family size-grandmother family size)/grandmother family size))

NS: none of independent variable is significant

Regarding reduction of inequality intra-familial, table 7 present the coefficient of model 3 where the dependent variable is measured as the variation of education intrafamilial inequality between children's sibship and parents' sibship, and the education intrafamilial inequality is computed as the difference in average years schooling between boys and girls. We observed a downward trend of education intrafamilial inequality over generations (-1.07). However, the trend is statistically significant at 1% in poorer and poor families (-1.12 and -1.02). Concerning the family size variation, whether the negative sign indicates the reduction of family size tend to decrease the education intrafamilial inequality; the effect (-0.56) is only significant in poorer families at 10%. This suggests that family size facilitates the reduction of education intrafamilial inequality over generations in poorer families.

Table7. Coefficient of the first-difference models of education intrafamilial inequality

	All	Poorer	Poor	Better off
Dependant variable				
Variation of Sibship size*	-0.14(0.174)	-0.56(0.332)*	-0.11(0.210)	0.27(0.386)
Poorer (ref.)				
Poor	0.14(0.311)			
Better off	0.66(0.380)*			
Mother age (ref. 35-44)				
45-59	0.22(0.264)	0.31(0.536)	0.42(0.360)	-0.46(0.555)
Constant	-1.07(0.277)	-1.12(0.327)***	-1.02(0.219)***	-0.03(0.389)
Error analysis				
E(absolute error)	0.10(0.113)	0.00(0.233)	0.17(0.147)	-0.02(0.268)*
Regression error on independent variables	NS	NS	NS	NS
N	1340	307	781	252

Coefficient (robust Standard Deviation)

Significant level, *** 0.01 **0.05 *0.10

[+] =(years of children of boys-years of schooling of girls in children's sibship)- (years of children of boys-years of schooling of girls in mother's sibship)

‡((mother family size-grandmother family size)/grandmother family size))

NS: none of independent variable is significant

Discussions

This study aimed to analyze the patterns of family size and education inequalities over three generations and to measure the impact of family size on education inequalities from a generation to another. We estimated a first-difference models considering family in a generational and dynamic perspective. Our results are relevant to understand the reproduction of education inequalities in family reduction size context, to develop and adapt public policies and programs for education for all in the fight against social inequalities.

Democratization of schooling Access at Ouagadougou

Our findings point to a democratization of schooling access over time and generations. In fact, the evolution of literacy shows a large change in schooling access from grandmothers who were 7% literate to more than 87% of children (the third generation) at least literate. Independently of socioeconomic level of family, schooling became largely accessible to all families, even though some little disparities still remained between poorer and better-off families (89.6% vs. 82.8%). This growing trend should be resulted from the evolution of the socioeconomic context, which facilitates the improvement of schooling system at Ouagadougou, mostly schooling access. Specifically, considering the age of women in this study, 35-59, their parents were growing largely before the independence of Upper Volta (1960, named Burkina Faso in 1984), in a colonialism context. Schooling was not assessable for almost of all them. That explained why only 7% were literate (the national level in 1961 was 6%) and had about 0.22 years of schooling. After the Addis-Ababa conference (1961) in which Burkina Faso had taken part, several programs and policies have been implemented to overlook the situation. There were the reviewing schedules of primary education in 1962, the ruralisation school in 1967 (generally named as reform Mr. Crespin), the1979-reform, revolutionary school of 1986 and more recent programs - Education for all (2000), Education for girls, Ten-Year Plan for the

Development of Basic Education (2001), Community schools, Bilingual schooling, considering maternal language of children, etc. (Coulidiati-Kielem, 2007; Kobiané and Bougma, 2009) -. Generally, schooling statistics shown poor results at the national level (2007) but in urban area, especially in Ouagadougou, the quantity of public and private schools has increased considerably and schooling rates indicate at least a large access to school (Coulidiati-Kielem, 2007; Pilon *et al.*, 2002).

Education aspirations changing

Alongside, our results reveal changing in education aspirations of family. Indeed, analyzing the schooling attendance and the education over time, we noticed that even better-off families from oldest generation did not have a lot of interest in educating their children. Less than 14% are literate and in average had less than 0.6 years of schooling. This suggests, beside of schooling access, the education aspiration was also low. Education was neither a need nor rentable during the period in which the older generation evolved, even for better-off families. It was not an indicator of living standard. Nevertheless, the rapid growth of education, mostly for poorer families, indicates family aspiration toward education increased. They aspire to at least a better schooling access for their children. This evolution could be explained by the changing role of education, becoming a greater factor of social mobility, to get a decent job, mostly for those who are from poorer families with a poor social network.

Family size effect and Educational inequalities

Our study showed a decline of family size from 6.8 to 4.6 children - 33%- slightly more importantly in better-off families than poorer ones, 37% vs. 31%. In addition, our results indicated the years of schooling from mother to children increased with the decline of family size from grandmothers to mothers. This suggests that fertility decline of their families contributes to improving educational investment over generations. However, better-off, beside of a larger family size decline compare to poorer ones, the effect is greater. Two explanations are put forward: on one hand better-off families are the forerunners of the fertility transition (Bloom *et al.*, 2012; Hausmann and Székely, 2001; Livi-Bacci, 1986); on the another each kid never-born has a greater effect for children in better-off families than ones in poorer families because more financial resource to this never-born kid in better-off families compare to poorer ones. This

suggests reinforcement of educational inequalities over generations, unless external contributions as family or institutional supports mitigate or eliminate this lever effect. Our results reveal the potential external support effect, mostly in terms of schooling access, for the third generation. In fact, socioeconomic inequalities for schooling access increased substantially from grandmothers to mothers but in the third generation, it tends to disappear. In spite of this, socioeconomic inequalities in terms of number of years increased and remained. That would be a result, as mentioned previously, from education programs and policies primarily focused on schooling access for all instead of staying at school.

Relatively to intrafamily gender inequalities, our study indicates that they decreased over time: rather than family size decline, it could likely result from other factors as socioeconomic context and institutional evolution. Despite all of this, the effect of family size decline is significant for poorer families, and tend to confirm the gendered discrimination in education investment was, at least partially, explained by budget constraints which pushed family to choose among children, as argued by Lloyd (1994).

Our analysis leads toward some levers that could facilitate the fight against education inequalities, interfamily and intrafamily. Although they have a great positive impact on education level improvement, policies and programs targeting fertility alone may not enough to fight it against education inequalities. Looking forward, we highlight the importance of the contribution of democratization of schooling access. As other studies carried out, the schooling supply, most public or community, played a great role in this democratization process (Kobiané, 2006; Lloyd, 2005; Lloyd, 1994; Pilon, 2007). Schooling becomes widely accessible to all children, better-off, poor or poorer, independently of the family size. Further, priority should be shifted to determinant factors for staying at school, mostly for poorer families, as they are unfortunately the most disadvantaged in years of schooling.

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