Development Policies when Accounting for the Extensive Margin of Fertility

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February 9, 2016

Intensive and Extensive Margins of Fertility

Most studies look at fertility without distinguishing its two margins:

extensive: decision on having children or not (childlessness)

intensive: decision on number of children $|_{\text{having children}}$

Childlessness is large in developing countries.

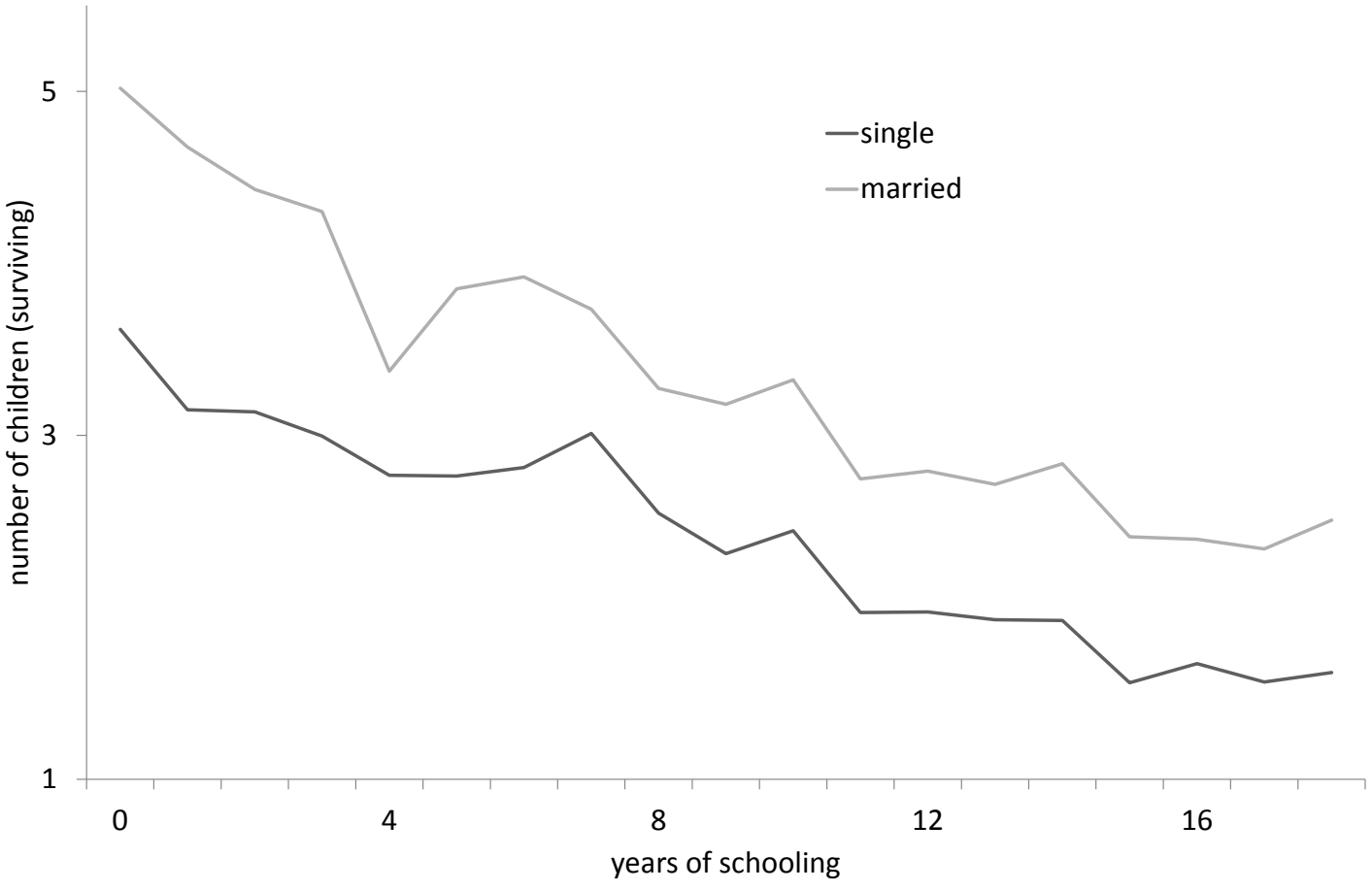
Is there anything special with the extensive margin (childlessness) we should care about ?

Does it affect the effectiveness development policies / trends in reducing total fertility

The intensive margin

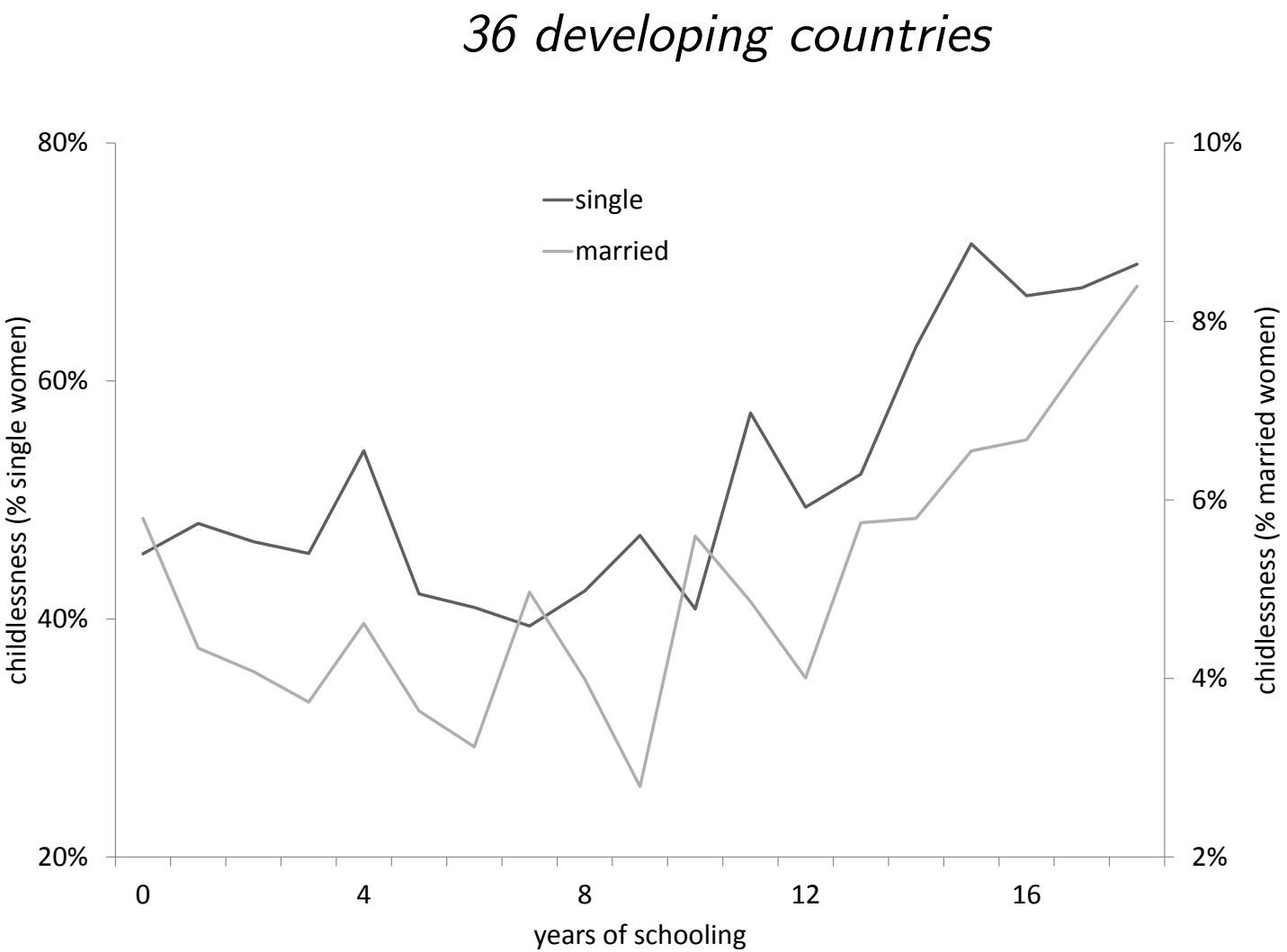
Completed fertility drops as mother's education increases

36 developing countries (women aged 40-54)



The extensive margin

Childlessness and education are U or J-shaped related



Questions

Q1: Why do childlessness & fertility relate to women's education differently ?

Q2: Macro implication: Does childlessness depend on development?

Q3: How does including this margin affect development policies?

- Compulsory Education
- Family Planning
- Fight against Child Mortality
- Women empowerment

Answers

Q1: A theory with endogenous marriage and fertility modelling different reasons why women are childless:

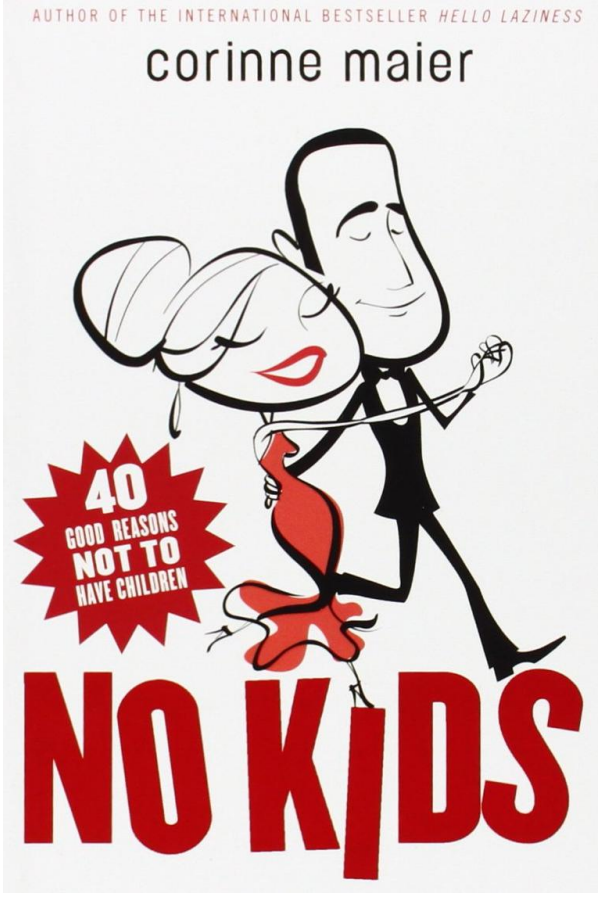
N: Natural sterility (1.9%)

P: Poverty-driven childlessness (3.8%)

Nutrition, pollution, diseases ($\searrow$ with education)

M: Mortality driven childlessness (0.6%)

O: Opportunity cost driven childlessness (2.1%)



$\approx$ voluntary. ($\nearrow$ with education)

$\Longleftarrow$ Includes cases of not finding right partner

Answers – Effect of policies on total fertility

Q2: Types of childlessness depend on development

Q3: Neglecting the endogeneity of marriage and the extensive margin leads to

... believe that imposing **primary education** to all will reduce fertility, while it will not.

... under-estimate the effect of **female empowerment**, in particular when voluntary childlessness is high.

... over-estimate the effect of **family planning**.

... over-estimate the effect of a reduction in **child mortality**.

Literature on childlessness

On childlessness in economics

On voluntary childlessness: Gobbi (JPop, 2013), Aaronson, Lange & Mazumder (AER, 2014)

On different types of childlessness in the US: Baudin, de la Croix & Gobbi (AER, 2015)

On childlessness in demography

Poston and Trent (JFI, 1982), + many other papers

Sample

For each census, take all women aged 40-54.

For married women, find their husbands

Compute age range to get 90% of husbands. Take all men from census in this age range

Drop divorced, separated, widowed, polygynous

Keep Single (never married) and Married/in union. 4.5 millions women

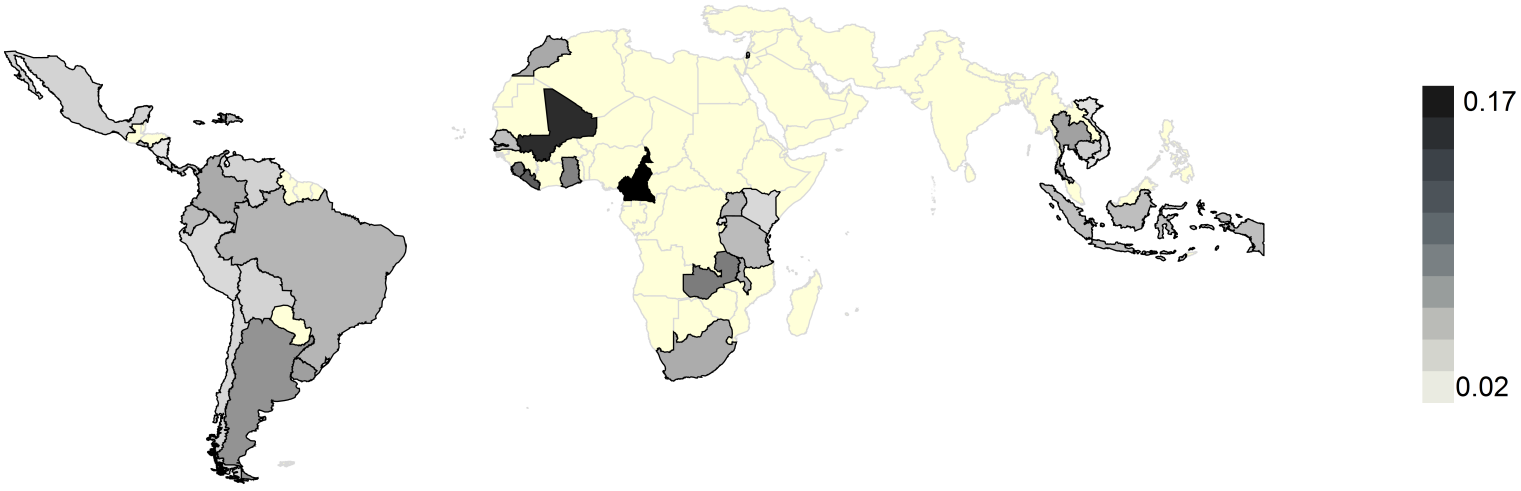
Years of schooling, children ever born, children surviving

Ex: Brazil, 7.2% single, 71.6% married, 0% polygynous, 15.2% divorced/separated, 6% widowed. Age range for men: 37-63.

Census Data

Country	Year	Obs.	Country	Year	Obs.
Argentina	1991	285621	Kenya	1999	42051
Bolivia	2001	42659	Liberia	2008	12995
Brazil	2000	621313	Morocco	2004	97332
Chile	2002	118660	Mali	2009	20940
Colombia	2005	248780	Malawi	2008	40906
Costa Rica	2000	23608	Rwanda	2002	23877
Dominican Republic	2010	50491	Senegal	2002	19475
Ecuador	2010	86974	Sierra Leone	2004	13647
Haiti	2003	41598	Tanzania	2002	136317
Jamaica	2001	8639	Uganda	2002	54428
Mexico	2010	764469	South Africa	2001	189722
Nicaragua	2005	23886	Zambia	2010	38106
Panama	2010	22376	Indonesia	1995	40068
Peru	2007	176570	Cambodia	2008	89137
El Salvador	2007	34473	Thailand	2000	46798
Uruguay	1996	20313	Vietnam	2009	788013
Venezuela	2001	137955	Palestine	1997	9548
Cameroon	2005	50876			
Ghana	2010	116990	**All**		**4539611**

Childlessness across countries – married women



Moments

We compute:

- childlessness rate for single and married women wrt schooling
- fertility of mothers for single and married women wrt schooling (children surviving)
- marriage rates (male and female) wrt schooling

Regularity 1: Fertility of mothers is decreasing with education for both singles and married

Regularity 2: U or J-shaped relationship between childlessness rates and education

Regularity 3: Highly educated women marry less often

Theory

Heterogeneous agents characterized by:

- gender $i = \{m, f\}$
- education e
- non-labor income a
- some women can control their fertility, others cannot (not known a priori)
- some women are naturally sterile (not known a priori)

Marriage is an intra-country 2 stage game:

- Stage 1: random match (opposite sex, same country) and marriage decision knowing e & a
- Stage 2: consumption and fertility decision, after having learned natural fertility status and ability to control fertility
- Mortality shocks realize

Preferences

The utility of an individual of sex i is

$$u\left(c_i, n\right) = \ln\left(c_i\right) + \ln\left(n + \nu\right)$$

n: "net" fertility (discrete variable)

Married – collective decision model:

$$W(c_f, c_m, n) = \theta u(c_f, n) + (1 - \theta) u(c_m, n)$$

where

$$\theta \equiv \frac{1}{2}\,\underline{\theta} + (1 - \underline{\theta})\frac{w_f}{w_f + w_m}$$

and $w_f = \gamma \exp\{\rho e_f\}$, $w_m = \exp\{\rho e_m\}$.

Fertility

Infant mortality: Each child has a country specific probability $q(e_f)$ to survive to adulthood with $q'(e_f) > 0$

n follows a binomial distribution (Kalemli-Ozcan (2002) and Baudin (2012)):

$$P(n|N) = \binom{N}{n} [q(e_f)]^n [1 - q(e_f)]^{N-n}$$

N: the total number of births

ADVANTAGE: allows to understand childlessness driven mortality

Expected Utility

$$\mathbb{E}_n\left[u(c_f, n)|N\right] = \sum_{n=0}^{N} P(n|N)u(c_f, n).$$

$$\mathbb{E}_n\left[W(c_f, c_m, n)|N\right] = \sum_{n=0}^{N} P(n|N)W(c_f, c_m, n).$$

Fertility constraints

Ability to control births number:
A proportion $\kappa(e_f) \in \{0, 1\}$ controls fertility perfectly, while $1 - \kappa(e_f)$ have the max number of children
Only applies to married women (singles can always walk away)

Natural sterility:
Fraction sterile is $\chi_i \in [0, 1]$, uniformly distributed over education categories and across countries

Social sterility:
to be able to give birth, any woman has to consume at least $\hat{c}$

$$c_f < \hat{c} \rightarrow N = 0$$

Budget constraints

Single men:

$$c_m = (1 - \delta_m) w_m + a_m - \mu$$

Single women:

$$c_f + \phi n w_f = (1 - \delta_f) w_f + a_f - \mu$$

Couples:

$$c_f + c_m + \phi n \left(\alpha w_f + (1 - \alpha) w_m\right) = w_m + w_f + a_f + a_m - \mu$$

Time constraints → maximum fertility

Single woman:

$$\underline{N}_{\mathrm{M}} = \left\lfloor \frac{1-\delta_f}{\phi} \right\rfloor$$

Married woman:

$$\bar{N}_{\mathrm{M}} = \left\lfloor \frac{1}{\alpha\phi} \right\rfloor$$

After marriage: possible situations

Let us solve backward. In the end, we observe:

- Sterile persons $\rightarrow \tilde{V}_f,\ V_m,\ \tilde{U}_f,\ \tilde{U}_m$
- Fecund single women controlling fertility $\rightarrow V_f$
- Fecund couple controlling fertility $\rightarrow U_f,\ U_m$
- Fecund couple not controlling fertility $\rightarrow \widehat{U}_f,\ \widehat{U}_m$

▶ Fecund single women controlling fertility

1. Social sterility: $N^* = 0$

2. Constrained fertility:

$$\overline{N}_s = \left\lfloor \frac{(1-\delta^f)w_f + a_f - \mu - \hat{c}}{\phi w_f} \right\rfloor$$

$$N^* = \underset{N \in [0, \overline{N}_s]}{\text{argmax}} \; \mathbb{E}_n \left[u(c_f, n) | N \right]$$

3. Unconstrained fertility:

$$N^* = \underset{N \in [0, \underline{N}_M]}{\text{argmax}} \; \mathbb{E}_n \left[u(c_f, n) | N \right]$$

Fecund couple controlling fertility

1. Social sterility: $N^* = 0$

2. Constrained fertility:

$$\overline{N} = \left\lfloor \frac{w_f + w_m + a - \hat{c}}{\phi(\alpha w_f + (1-\alpha) w_m)} \right\rfloor$$

$$N^* = \underset{N \in [0, \overline{N}]}{\text{argmax}} \, \mathbb{E}_n \left[W(c_f, c_m, n) | N \right]$$

3. Unconstrained fertility:

$$N^* = \underset{N \in [0, \bar{N}_M]}{\text{argmax}} \, \mathbb{E}_n \left[W(c_f, c_m, n) | N \right]$$

Fecund couple not controlling fertility

$$\widehat{N} = \begin{cases} \overline{N} & \text{if } \theta\mathcal{B}(\bar{N}_{\mathrm{M}}) < \hat{c} \\ \bar{N}_{\mathrm{M}} & \text{otherwise.} \end{cases}$$

where

$$\mathcal{B}(n) = (1 - \alpha\phi n)w_f + (1 - (1 - \alpha)\phi n)w_m + a_f + a_m - \mu$$

Marriage decision

Expected values of accepting a marriage offer:

$$\mathcal{M}_f(e_f, a_f, e_m, a_m) = (\chi_f + (1-\chi_f)\chi_m)\,\tilde{U}_f + (1-\chi_f-(1-\chi_f)\chi_m)\left(\kappa U_f + (1-\kappa)\widehat{U}_f\right)$$

$$\mathcal{M}_m(e_m, a_m, e_f, a_f) = (\chi_m + (1-\chi_m)\chi_f)\,\tilde{U}_m + (1-\chi_m-(1-\chi_m)\chi_f)\left(\kappa U_m + (1-\kappa)\widehat{U}_m\right)$$

Value of being single:

$$\begin{aligned}\mathcal{S}(e_f, a_f) &= \chi_f \tilde{V}_f + (1-\chi_f)V_f \\ \mathcal{S}(e_m, a_m) &= V_m.\end{aligned}$$

Step 1: marriage decision

A match will end up in a marriage iff:

$$\mathcal{M}_f(e_m, a_m, e_f, a_f) > \mathcal{S}(e_f, a_f)$$

$$\mathcal{M}_m(e_f, a_f, e_m, a_m) > \mathcal{S}(e_m, a_m)$$

Estimation – Parameters fixed *a priori*

Natural sterility: $\chi_f = \chi_m = 0.01$

Mincerian determination of wages:

$$\begin{aligned} w_f &= \gamma \exp\{\rho e_f\} \\ w_m &= \exp\{\rho e_m\} \end{aligned}$$

$\rho = 5\%$ (Oyelere, 2008) for all countries
γ is country specific from the Global Gender Gap Report (Hausmann et al. 2013)

Parameters taken from data

Child Mortality (IPUMS)

Country and education specific survival probabilities from census (ratio children surviving/children ever born)
Assumption: same for single and married women (negl. husband)

Fertility control probabilities (DHS)

Fertility control probabilities built from DHS - married women
Assumption: a woman does not control her fertility if:

(completed fertility $-$ ideal fertility) ≥ 2

she believes her partner did not want more children than herself

Estimation – SMM

Remaining parameters p are estimated using SMM:

$$\min_{p} \quad f(p) = [d - s(p)]\,[W]\,[d - s(p)]'$$

W: diagonal weighting matrix with $1/d^2$ as elements

d: fertility of mothers (single and married), childlessness (single and married), marriage rates of men and women

$s(p)$: theoretical moments

Estimation – theoretical moments s

For each country we draw 100,000 hypothetical women for each category of education with:

- a non-labor income (a_f) from an exponential distribution with mean β

- a potential husband with (e_m and a_m)

- a probability that her children die

- a probability to control her fertility

$\Rightarrow$ for each education we obtain 100,000 decisions about marriage and fertility, we can average and calculate the simulated moments

Value of parameters

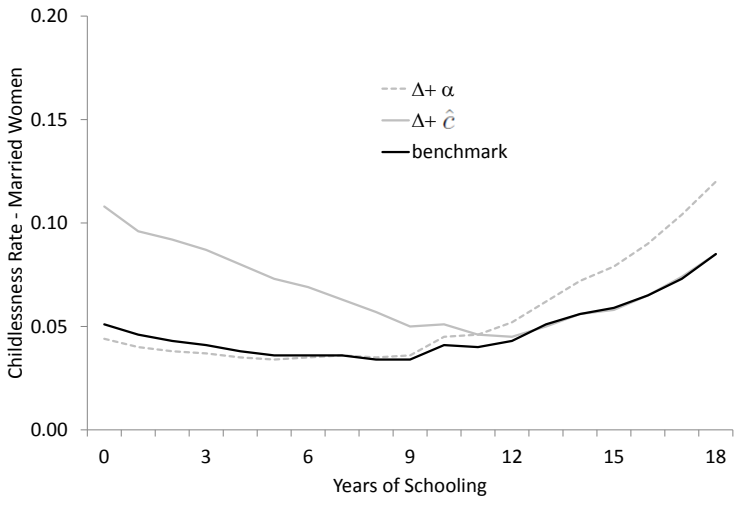
Two alternatives:

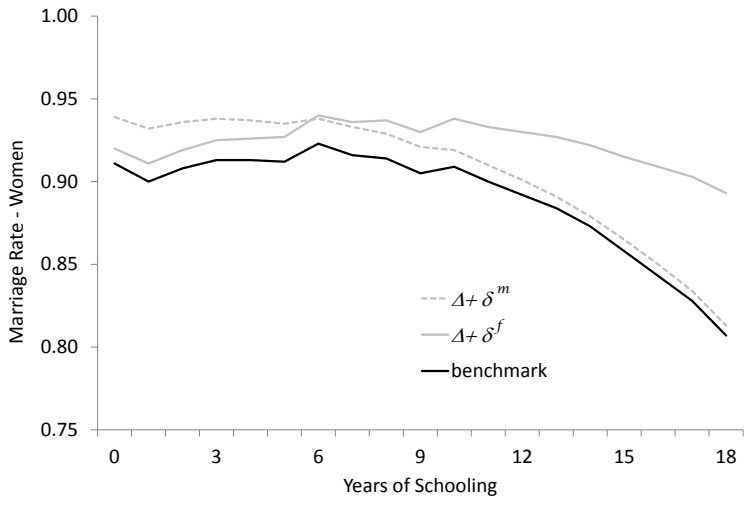
Same parameters in all countries,

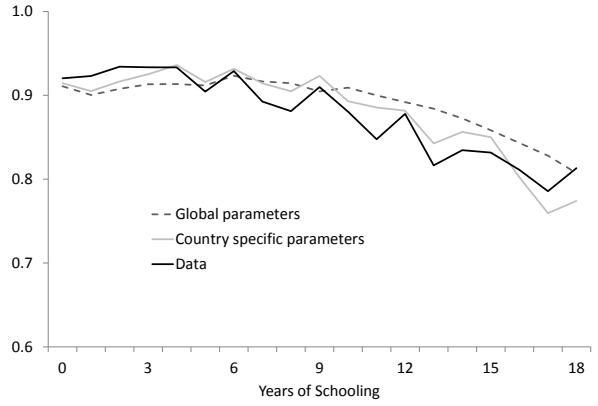
Country Specific parameters

		Global	Country specific		
Description	p	Value	Min	Mean	Max
Mean of the exponential distribution	β	0.278	0.152	0.372	0.807
Preference parameter	ν	6.773	5.119	7.029	9.249
Minimum consumption to procreate	$\hat{c}$	0.345	0.081	0.306	0.538
Good cost supported by a household	μ	0.230	0.045	0.293	0.565
% of childrearing supported by women	α	0.797	0.663	0.871	0.999
Time cost for one child	ϕ	0.207	0.131	0.184	0.230
Time cost of being single (men)	δ^m	0.262	-0.028	0.194	0.439
Time cost of being single (women)	δ^f	0.080	-0.131	0.124	0.429
Bargaining parameter	$\underline{\theta}$	0.722	0.010	0.632	0.948

Value of parameters - Identification



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Years of Schooling
Global parameters
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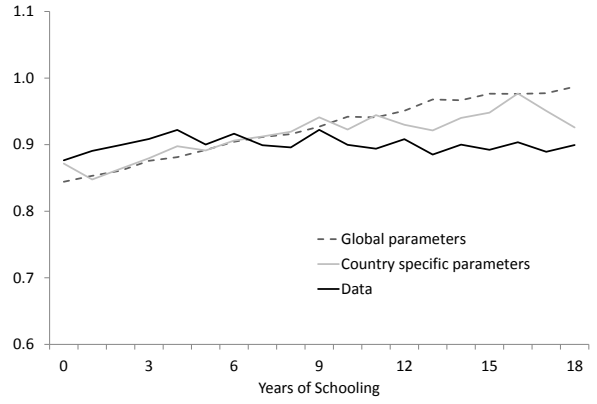
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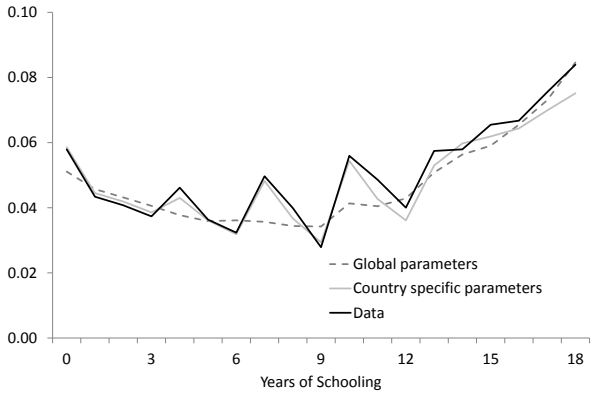
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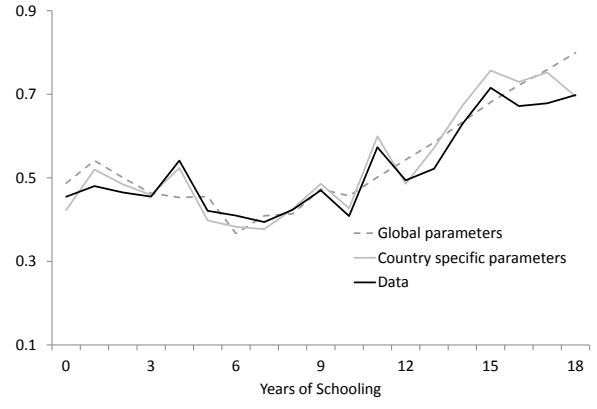
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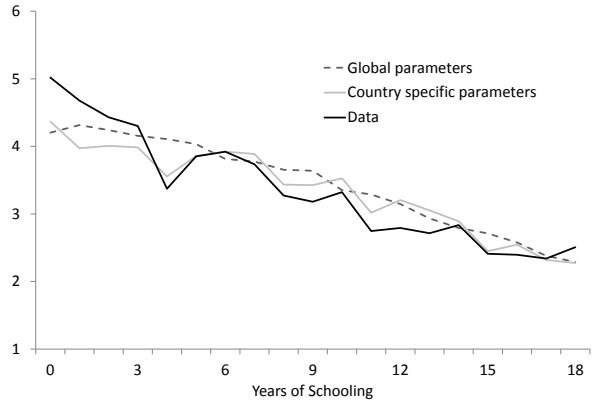
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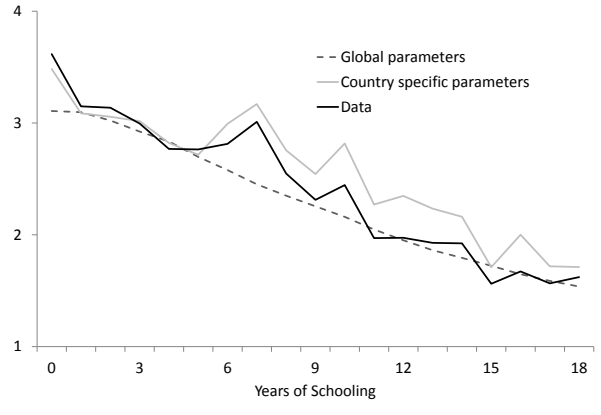
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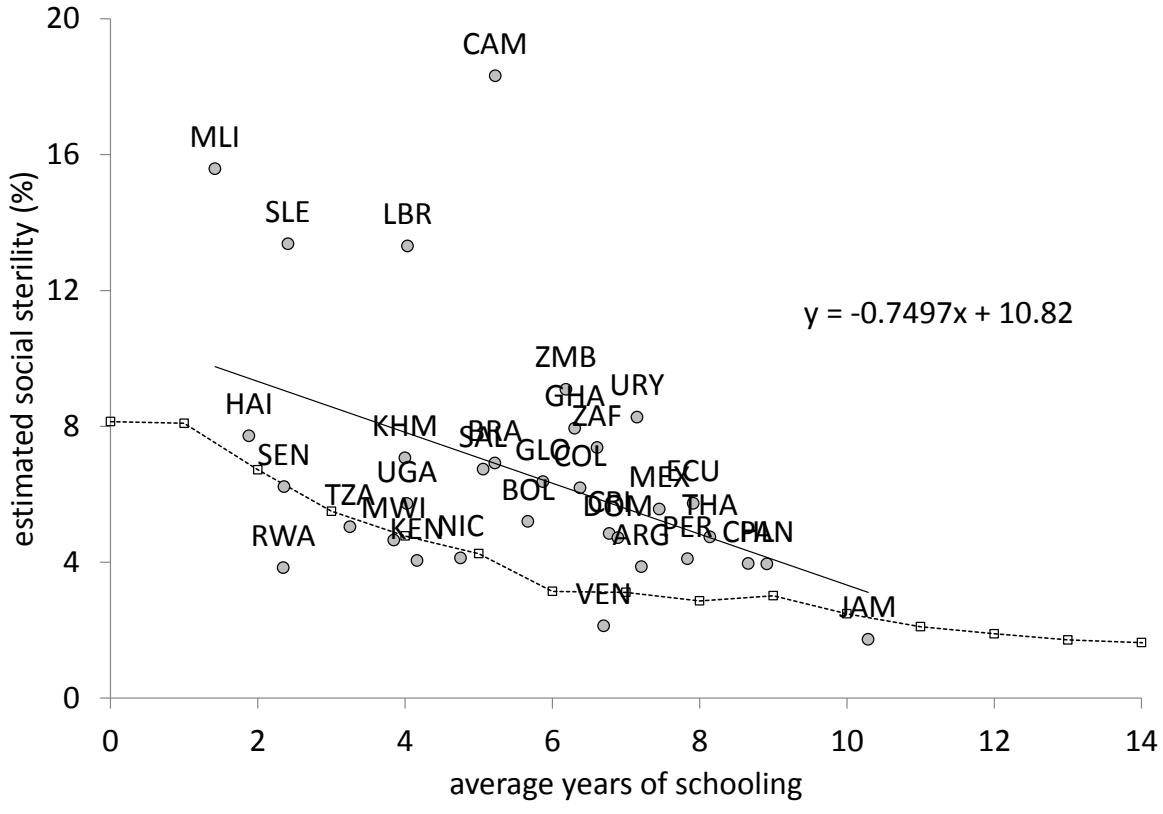
Global parameters
Country specific parameters
Data

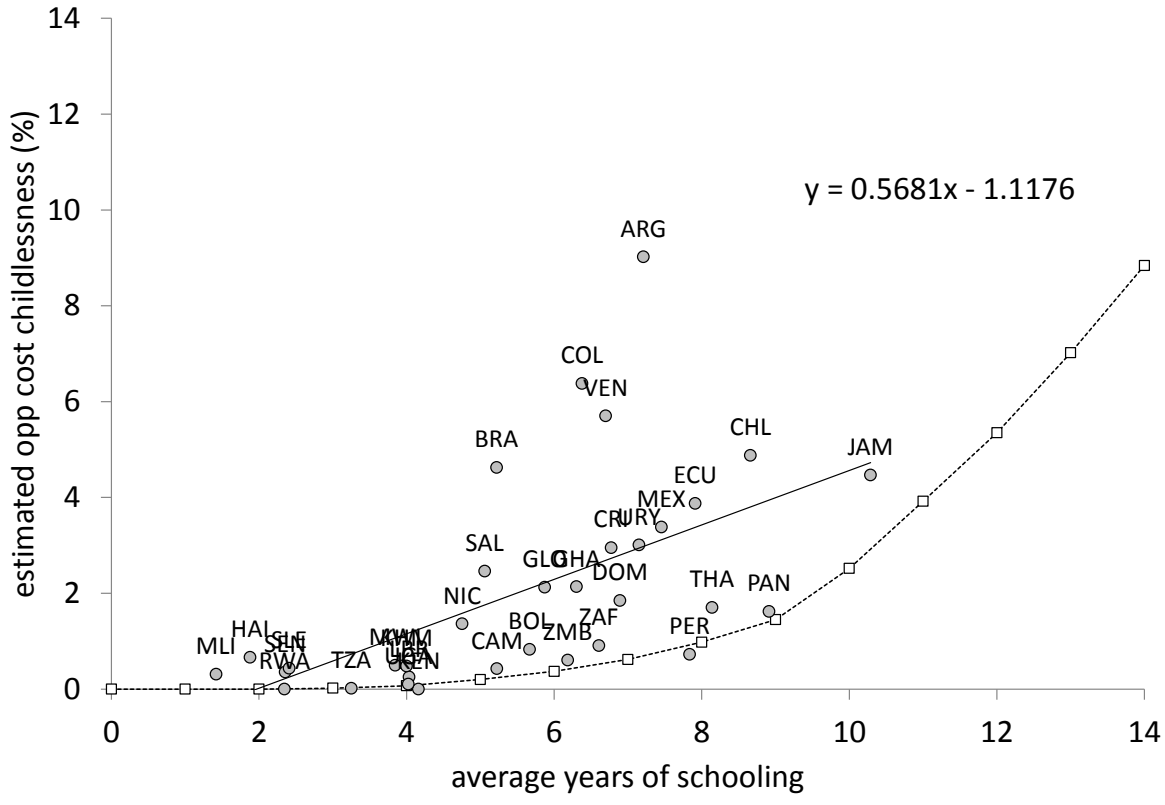
Decomposition of childlessness

Country	Data	Theory	Voluntary	Poverty	Mort.	Natural
ARG	13.9	12.9	9.0	1.3	0.7	1.9
BOL	6.1	6.0	0.8	2.8	0.6	1.9
BRA	11.9	11.5	4.6	4.3	0.8	1.9
CHL	8.9	8.8	4.9	1.7	0.4	1.8
COL	12.8	12.6	6.4	4.0	0.4	1.8
MEX	8.9	8.9	3.4	3.4	0.3	1.9
CAM	17.8	18.7	0.4	16.2	0.4	1.8
GHA	9.8	10.1	2.1	5.1	0.9	1.9
LBR	12.9	13.6	0.3	11.0	0.4	1.9
MLI	16.3	15.9	0.3	13.0	0.7	1.9
SLE	13.5	13.8	0.4	10.4	1.1	1.9
ZMB	10.3	9.7	0.6	5.8	1.3	2.0
VNM	7.2	6.4	1.7	2.6	0.2	1.9
ALL	9.0	8.5	2.1	3.8	0.6	1.9

Poverty Driven Childlessness



Opportunity Cost Driven Childlessness (Voluntary)



Confirms intuitions of Poston and Trent (1982).
Composition of childlessness changes with development.

Robustness

	Benchmark	higher ρ	machist marriage	assortative matching
Parameters - Global value				
ρ	0.050	0.111	0.050	0.050
λ	0	0	0	0.15
Fit				
$f(p)$ global	0.929	1.472	17.709	0.992
R^2	0.967	0.967	0.578	0.955
Development and Childlessness				
∂ voluntary$/\partial$ schooling	0.57	0.56	-0.02	0.55
∂ pov. driven$/\partial$ schooling	-0.75	-0.71	-0.65	-0.77
Decomposition of Childlessness				
Voluntary	2.13	1.75	2.96	1.79
Poverty driven	3.83	4.65	4.93	4.26
Mortality driven	0.66	0.33	0.12	0.66
Natural sterility	1.90	1.90	1.88	1.90

Policies

Universal education ($e_i \geq 7$)

Female empowerment ($\gamma = 1$)

Family planning ($\kappa(e_f) = 1,\ \forall e_f$)

No child mortality ($q(e_f) = 1,\ \forall e_f$)

$$F = m\,(1 - C_{married})\,n_{married} + (1 - m)\,(1 - C_{single})\,n_{single}$$

Partial change in fertility $\Delta F_{partial}$: effect of the intensive margin only

Total change in fertility ΔF : includes the effect on marriage and childlessness

Policies

Universal education ($e_i \geq 7$)

Female empowerment ($\gamma = 1$)

Family planning ($\kappa(e_f) = 1,\ \forall e_f$)

No child mortality ($q(e_f) = 1,\ \forall e_f$)

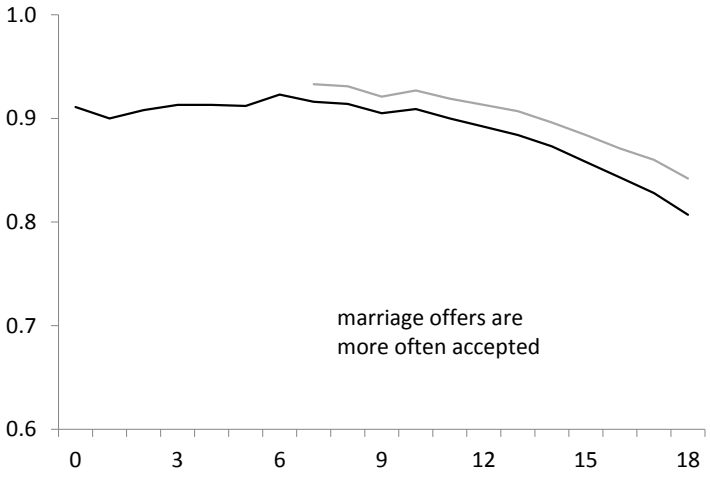
$$\mathrm{F} = \mathrm{m}\,(1 - \mathrm{C}_{\mathrm{married}})\,n_{\mathrm{married}} + (1 - \mathrm{m})\,(1 - \mathrm{C}_{\mathrm{single}})\,n_{\mathrm{single}}$$

Partial change in fertility $\Delta \mathrm{F}_{\mathrm{partial}}$: effect of the intensive margin only

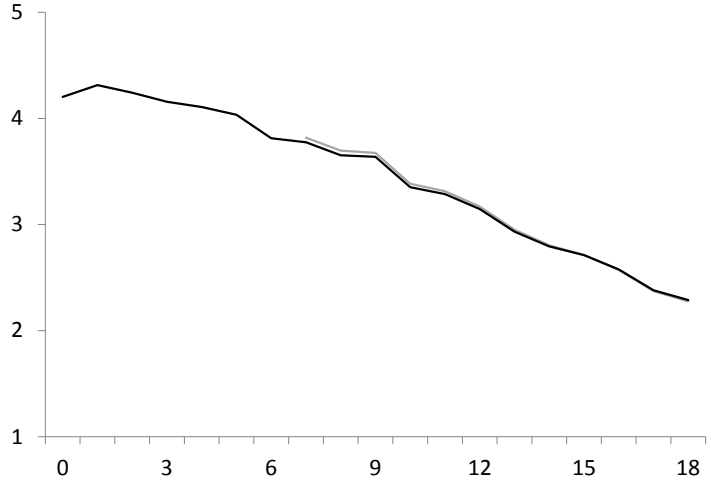
Total change in fertility $\Delta \mathrm{F}$: includes the effect on marriage and childlessness

Universal Education

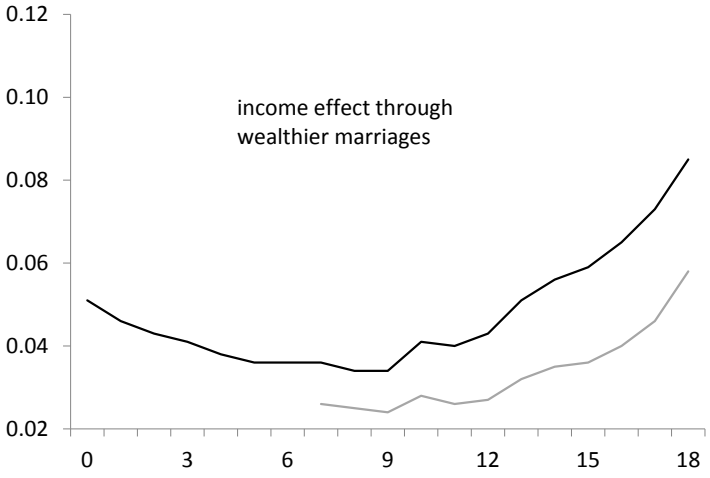
Marriage rate of women



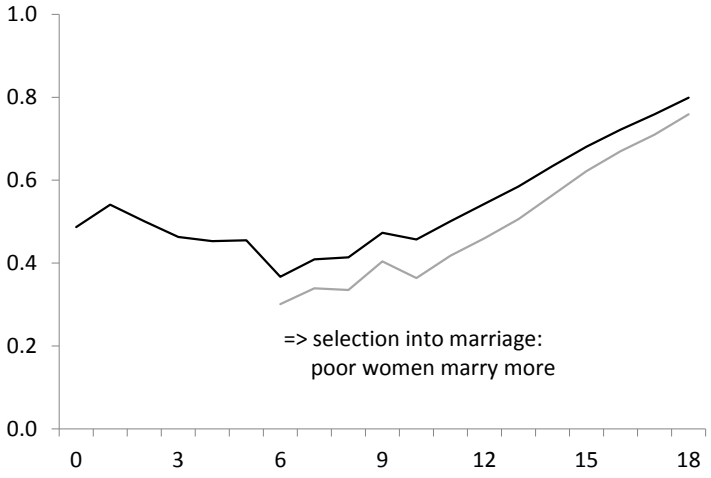
Fertility of married mothers



Childlessness rate (married)



Childlessness rate (single)

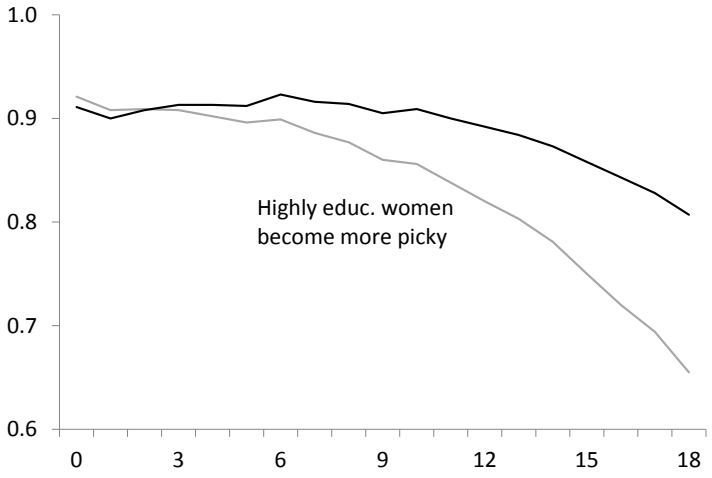


Importance of endogenous marriage and childlessness

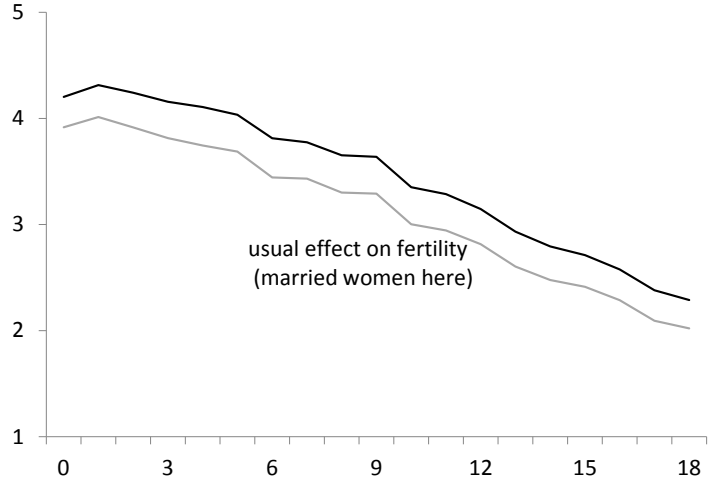
		Universal Education	
	F	$\Delta F/F$	$\Delta F_p/F$
BOL	3.4	8.0	5.0
BRA	2.8	2.4	-4.5
COL	3.1	2.3	-1.8
GHA	4.0	-1.9	-6.1
KEN	5.3	3.9	2.5
MLW	5.2	-1.5	-3.6
RWA	4.9	8.5	7.0
ZAF	3.7	2.5	-0.2
VNM	3.0	1.5	-1.1
All	3.5	0.1	-3.6

Female Empowerment

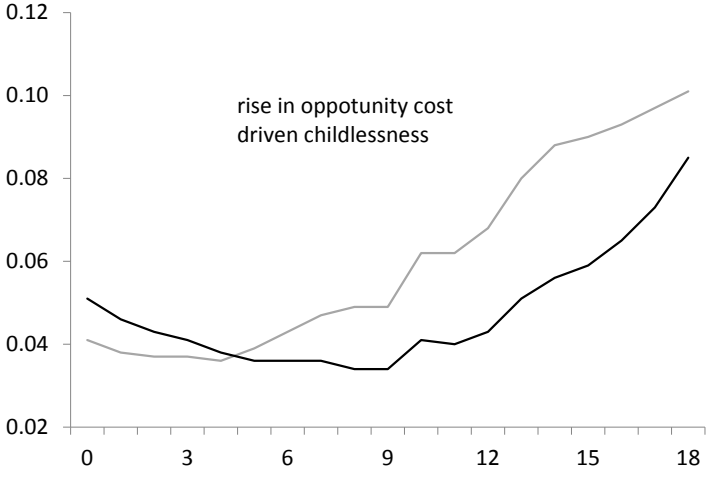
Marriage rate of women



Fertility of married mothers



Childlessness rate (married)



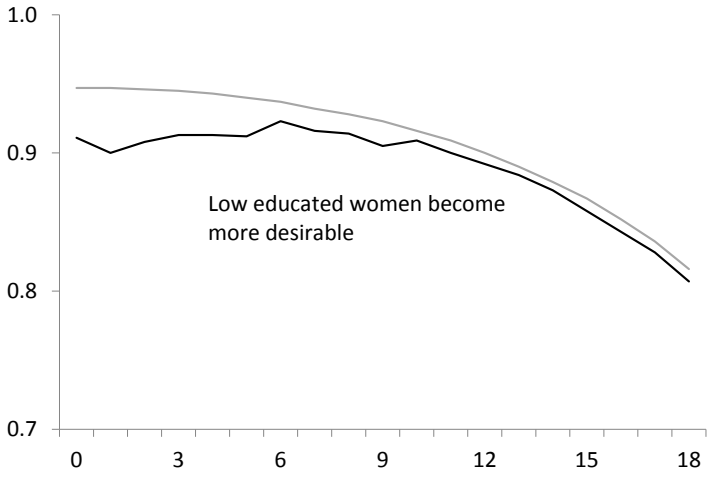
Childlessness rate (single)

Importance of endogenous marriage and childlessness

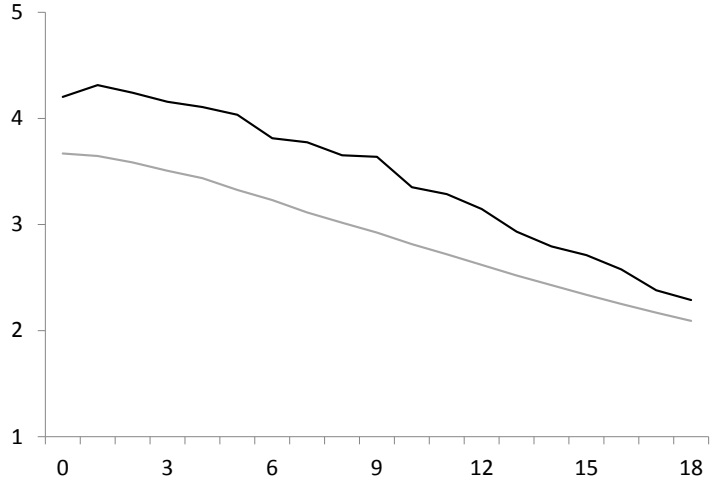
		Female empowerment	
	F	$\Delta F/F$	$\Delta F_p/F$
BOL	3.4	-5.0	-4.0
BRA	2.8	-14.0	-7.2
COL	3.1	-12.6	-7.2
GHA	4.0	-9.2	-8.0
KEN	5.3	-1.9	-3.2
MLW	5.2	-2.7	-3.5
RWA	4.9	0.3	-1.3
ZAF	3.7	-4.8	-3.4
VNM	3.0	-10.2	-8.4
All	3.5	-11.9	-8.5

Family planning

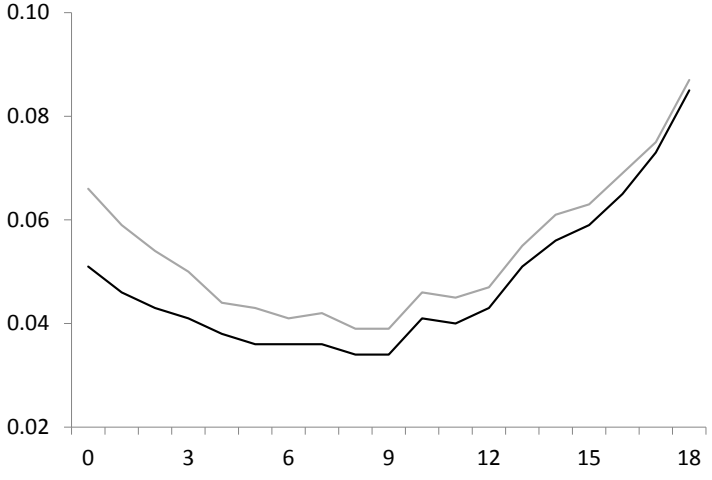
Marriage rate of women



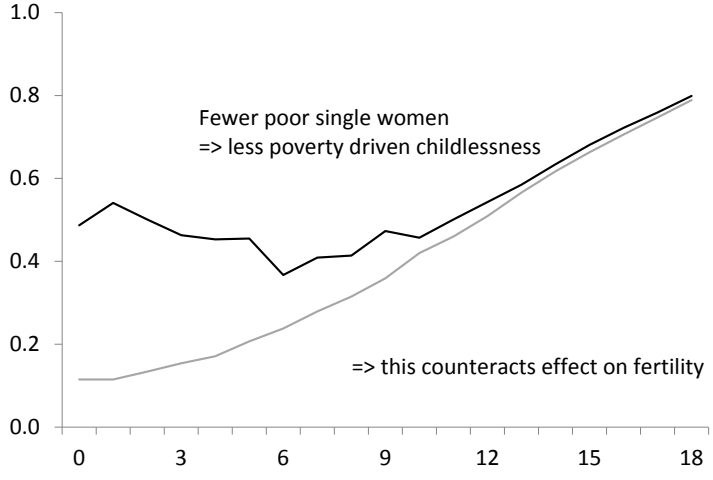
Fertility of married mothers



Childlessness rate (married)



Childlessness rate (single)

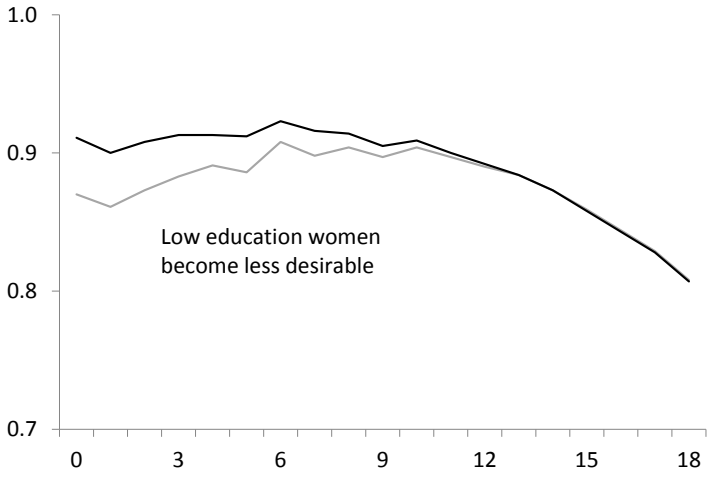


Importance of endogenous marriage and childlessness

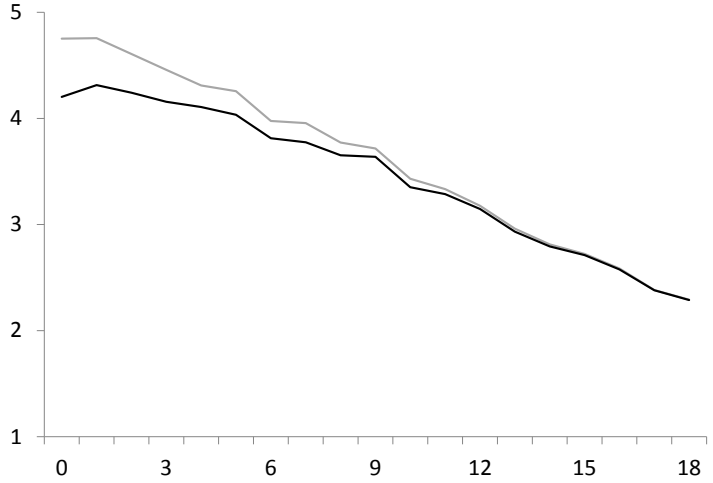
		No child mortality	
	F	$\Delta F/F$	$\Delta F_p/F$
BOL	3.4	20.5	21.1
BRA	2.8	2.9	4.9
COL	3.1	3.3	3.5
GHA	4.0	7.7	7.9
KEN	5.3	12.2	13.6
MLW	5.2	13.6	18.1
RWA	4.9	26.0	31.7
ZAF	3.7	6.6	5.9
VNM	3.0	0.8	1.4
All	3.5	4.1	5.7

No mortality

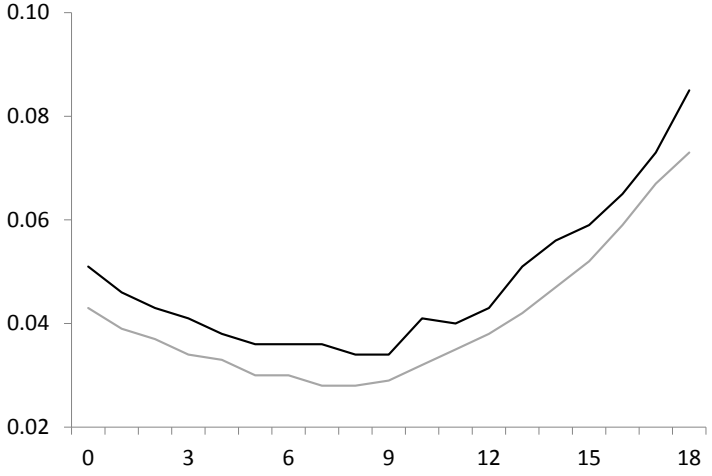
Marriage rate of women



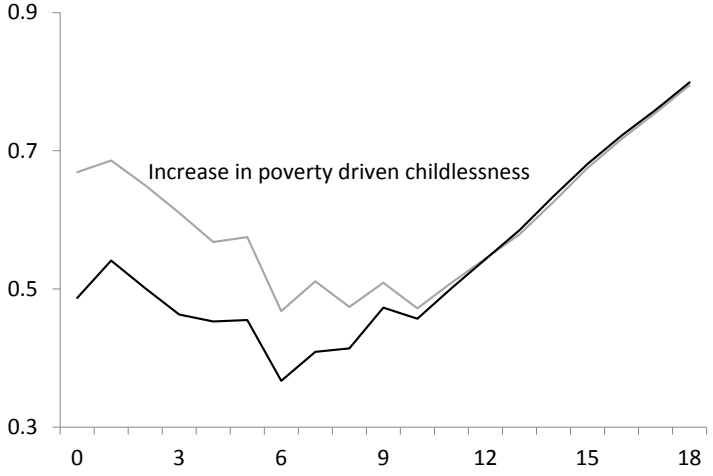
Fertility of married mothers



Childlessness rate (married)



Childlessness rate (single)



Importance of endogenous marriage and childlessness

		Family planning	
	F	$\Delta F/F$	$\Delta F_p/F$
BOL	3.4	-3.2	-4.0
BRA	2.8	-18.3	-20.3
COL	3.1	-9.6	-9.4
GHA	4.0	-13.3	-12.3
KEN	5.3	-2.6	-3.9
MLW	5.2	-17.4	-16.7
RWA	4.9	-3.3	-4.7
ZAF	3.7	-2.9	-2.4
VNM	3.0	-26.6	-28.8
All	3.5	-13.6	-15.0

Conclusion

Decomposition of childlessness rates into its main components allows to understand better how childlessness reacts to development.

Poverty part of childlessness decreases with development: one more year of schooling decreases social sterility by 0.75 percentage points.

One more year of schooling increases the opportunity cost part of childlessness by 0.57 percentage points from the 9th year of schooling onwards.

Eluding adjustments of childlessness and marriage can lead to incorrect conclusions in term of economic policies.