Family Planning and Development: Aggregate Effects of Contraceptive Use

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Gary Becker (1960)

"Each family tries to come as close as possible to its desired number of children... Families with excess children consume less of other goods, especially of goods that are close substitutes for the quantity of children. Because quality seems like a relatively close substitute for quantity, families with excess children would spend less on each child than other families with equal income and tastes. Accordingly, an increase in contraceptive knowledge would raise the quality of children as well as reduce their quantity."

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- **Fertility is stochastic**
  - Unwanted Fertility
  - Contraception use and abortions
  - 39 percent of annual developing-world pregnancies are unplanned and roughly half of these end in induced abortions

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- Income and output may also be lower; Inequality might be more persistent
- How important are these effects?

Unwanted Fertility and Contraception Use

	Dependent variable: Unwanted fertility (fertility gap)			
	(1)	(2)	(3)	(4)
Ever use of modern contr. methods (% of women)	-0.0100^{***}	-0.0052^{***}	-0.0135^{***}	-0.0091^{***}
	(0.0033)	(0.0032)	(0.0030)	(0.0033)
Log of per capita GDP	-0.0101	-0.0447	0.0010	0.1027
	(0.1562)	(0.1454)	(0.1387)	(0.1413)
Wanted fertility			-0.1122^{*}	-0.2160^{***}
			(0.0651)	(0.0688)
Country fixed effects	Yes	Yes	Yes	Yes
Decade fixed effects	No	Yes	No	Yes
Number of observations	200	200	200	200
Number of countries	80	80	80	80
R-squared	0.8565	0.8632	0.8601	0.8740

Fertility and Education

More Facts

	Dependent variable: Human capital attainment		
	(1)	(2)	(3)
Unwanted fertility	-0.1470^{**}	-0.0938^{*}	-0.1179^{***}
	(0.0735)	(0.0556)	(0.0279)
Wanted fertility		-0.2147^{***}	-0.0854^{***}
		(0.0180)	(0.0187)
Log of per capita GDP			0.0604
			(0.0395)
Country fixed effects	No	No	Yes
Decade fixed effects	No	No	Yes
Number of observations	188	188	188
Number of countries	64	64	64
R-squared	0.0210	0.4462	0.9858

What We Do

- Build equilibrium OLG model
  - Endogenous and stochastic fertility (pregnancy shock)
  - Human and physical capital accumulation
- Fit the model to Kenyan data
- Perform counterfactuals

What We Do

- Build equilibrium OLG model
  - Endogenous and stochastic fertility (pregnancy shock)
  - Human and physical capital accumulation
- Fit the model to Kenyan data
- Perform counterfactuals
- Preview of the results
  - Benchmark to perfect fertility choice: GDP per capita $\uparrow$ 13%
  - Targeted family planning policy are very effective to increase Output (For small budget it is more cost effective than investing in human capital!)
  - Variety of counterfactual interventions/decomposition

Related Literature

- Economics and fertility
  - Becker (1960), Becker and Lewis (1973, JPE), Galor and Weil (2000, AER)
- Fertility and development
  - Barro and Becker (1989, Econometrica), Pritchett (1994), de la Croix and Doepke (2003, AER), Vogl (2016, REStud), Baudin, de la Croix and Gobbi (2016)
- Experiments/applied micro:
  - Bloom et al (2009, JOEG), Schultz (2008, HDev), Joshi and Schultz (2013), Ashraf, Field and Lee (2014, AER), Miller (2010, EJ)
- Contraception use and economics
  - Goldin and Katz (2002, JPE), Edlund and Machado (2015, EER), Kocharkov (2012), Hotz and Miller (1988, Econometrica)

Fixing Ideas

- To clarify ideas, we first develop a toy model
- Simplified model:
  - Representative agent
  - No uncertainty in fertility
  - Costly contraception (but no abortion)

Toy Model

- OLG model: three periods of life
  - Childhood (no decisions)
  - Young adults
  - Old adults
- Young adults
  - Fertility/Costly contraception
  - Children's education decision
  - Save for old age
- Old adults
  - Consume savings

Toy Model - Technology

- Representative firm
- Standard CRS technology:

$$Y = AK^{\alpha}L^{1-\alpha}$$

Toy Model - Households

- Fertility:

$$n = N - \theta q, \ \theta > 0$$

- Education:

$$h' = h(e) = e^{\zeta}$$

- Preferences:

$$U(c_y, c'_o, n, h') = \log(c_y) + \beta \log(c'_o) + \gamma \log(n) + \xi \log(h')$$

- Budget:

$$c_y + s + \phi_q q + en = wh(1 - \chi n)$$
$$c'_o = R's$$

Toy Model - HH Fertility

- Optimal fertility:

$$n = \frac{(\gamma - \xi\zeta)}{(1+\beta+\gamma)}\left(\frac{wh - \frac{\phi_q}{\theta}N}{wh\chi - \frac{\phi_q}{\theta}}\right)$$

- $\phi_q = 0 \Rightarrow$ fertility does not depend on income
- $\phi_q > 0 \Rightarrow$ fertility decreases with income

Toy Model - HH Fertility

Proposition

Define $\varepsilon_{z,\chi}$ *and* ε_{z,ϕ_q} *as the elasticity of variable* $z \in \{n, e\}$ *with respect to* χ *and* ϕ_q*, respectively. Then whenever* $q > 0$*, we have that:*

(i) $\frac{\partial e}{\partial \chi} > 0$, $\frac{\partial n}{\partial \chi} < 0$ *and* $\frac{\partial s}{\partial \chi} = 0$. *Moreover,* $r_\chi = \frac{|\varepsilon_{n,\chi}|}{\varepsilon_{e,\chi}} = 1$.

(ii) $\frac{\partial e}{\partial \phi_q} < 0$, $\frac{\partial n}{\partial \phi_q} > 0$ *and* $\frac{\partial s}{\partial \phi_q} < 0$. *Moreover,*

$$r_{\phi_q} = \frac{\varepsilon_{n,\phi_q}}{|\varepsilon_{e,\phi_q}|} = \frac{wh(1-N\chi)}{wh - \frac{\phi_q}{\theta} N} \text{ and } \frac{\partial r_{\phi_q}}{\partial (wh)} < 0.$$

Point: Family planning interventions ($\downarrow \phi_q$) have strong effects on the quantity and quality of children when income levels are low.

Toy Model - Fertility

Proposition

It can be shown that $n(k) \in \left(\frac{(\gamma - \xi\zeta)}{(1+\beta+\gamma)\chi}, N \right]$ *and*

- *(i) there exists a* $\underline{k}(\phi_q) > 0$ *such that if* $k \leq \underline{k}(\phi_q)$*, then* $n(k) = N$*; and if* $k > \underline{k}(\phi_q)$*, then* $n(k) < N$*; in addition,* $\underline{k}'(\phi_q) > 0$*. Moreover,*
- *(ii) for* $k > \underline{k}(\phi_q)$ *fertility is decreasing with capital accumulation, i.e.,* $n'(k) < 0$*.*

Toy Model - Equilibrium

Proposition

(Existence and uniqueness of equilibrium path) *For a given initial capital stock k_0, the dynamic system has a unique trajectory (solution).*

Toy Model - Steady State

Proposition

Let ϕ_q be sufficiently small, then there exists at least one locally stable steady-state equilibrium for capital per young household, $k^*(\phi_q)$, such that:
i) in the neighbourhood of $k^*(\phi_q)$ fertility decreases with capital accumulation;
ii) family interventions which reduce the price of modern contraceptive methods increase the steady-state level of capital, i.e. $k^{*\prime}(\phi_q) < 0$.

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i) in the neighbourhood of $k^*(\phi_q)$ fertility decreases with capital accumulation;
ii) family interventions which reduce the price of modern contraceptive methods increase the steady-state level of capital, i.e. $k^{*\prime}(\phi_q) < 0$.

Corollary

Human capital increases with physical capital accumulation. If ϕ_q is sufficiently small, then family interventions which reduce the price of modern contraceptive methods increase the steady-state level of human capital.

Models

- Toy model
  - No heterogeneity
  - No pregnancy shocks
- Full model:
  - Richer model for quantitative analysis

Quantitative Model Overview

- OLG model: three periods of life
  - Childhood (no decisions)
  - Young adults
  - Old adults
- Young adults
  - Fertility, contraception and abortion decisions
  - Children's education decision
  - Save for old age
- Old adults
  - Consume savings

Technology

- Representative firm
- Standard CRS technology:

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Preferences

- Utility function: $E[U(c_y, c'_o, n, h')]$

$$U(c_y, c'_o, n, h') = \log(c_y) + \beta \log(c'_o) + \gamma \log(n) + \xi \log(h')$$

c_y and c_o: consumption when young and old
n: number of children
h': children's human capital

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- Also:
  - Disutility of contraception use: Ψ_q
  - Disutility of abortion: Ψ_a

Fertility

- Number of pregnancies:

$$p = \tilde{n} + \max\{\eta - \theta q, 0\}$$

$\tilde{n}$: chosen number of pregnancies
η: fertility shock (random variable)
q: contraception use

Fertility

- Number of pregnancies:

$$p = \tilde{n} + \max\{\eta - \theta q, 0\}$$

  $\tilde{n}$: chosen number of pregnancies
  η: fertility shock (random variable)
  q: contraception use

- Number of births:

$$n = p - a$$

  a: abortions

Education

- Child's human capital:

$$h' = \varepsilon \tilde{h}(e)$$

e: education

- With:

$$\tilde{h}(e) = h_0 + h_1 e^{\zeta}$$

and

$$\ln \varepsilon \sim N(0, \sigma_\varepsilon^2)$$

Decision Making

Before realization of pregnancies:

$$V(h) = \max_{\tilde{n},q\geq 0}\{E_\eta[\tilde{V}(h,p,q) - \Psi_q \mathscr{I}_{q>0}]\},$$

subject to:

$$p = \tilde{n} + \max\{\eta - \theta q, 0\}$$

Decision Making

After realization of pregnancies:

$$\tilde{V}(h,p,q) = \max_{c_y,c_o',a,s,e\geq 0} \{U(c_y,c_o',n,h') - \Psi_a \mathscr{I}_{a>0}\},$$

subject to:

$$\begin{aligned} c_y + s + \phi_q q + \phi_a a + \phi_e en &= wh(1-\chi n) \\ c_o' &= R's \\ n &= p-a \\ h' &= h_0 + h_1 e^{\zeta} \end{aligned}$$

Equilibrium

Definition: (Stationary Competitive Equilibrium) *A stationary competitive equilibrium for this economy consists of allocations for firms* $\{K, L\}$*, a collection of policy functions for young couples* $\{c_y(x), c_o'(x), s(x), q(h), a(x), e(x), \tilde{n}(h)\}$*, a stationary distribution* Υ*, a vector of prices* $\{w, R\}$*, and a population growth rate* g *such that:*

- *i. Given the vector of prices* $\{w, R\}$*, the vector* $\{K, L\}$ *solves the firm's problem.*
- *ii. Policy functions* $q(h)$ *and* $\tilde{n}(h)$ *solve value function* $V(h)$ *and*

$$p - \tilde{n}(h) = \max\{\eta - \theta q(h), 0\}.$$

- *iii. Policy functions* $\{c_y(x), c_o'(x), s(x), a(x), e(x)\}$ *solve value function* $\tilde{V}(h, b, q)$*.*

Equilibrium (cont)

- *iv. Market clearing conditions, such that:*

$$\int_{\mathscr{X}} [c_y(x) + s(x) + \phi_q q(x) + \phi_a a(x) + \phi_e e(x) n(x)] d\Upsilon(h) d\Gamma(\eta) \tag{1}$$

$$+ \frac{1}{1+g} \int_{\mathscr{X}} c_o(x) d\Upsilon(h) d\Gamma(\eta) = A K^{\alpha} L^{1-\alpha},$$

$$L = \int_{\mathscr{X}} h(1 - n(x)\chi) d\Upsilon(h) d\Gamma(\eta). \tag{2}$$

and

$$K' = \int_{\mathscr{X}} s(x) d\Upsilon(h) d\Gamma(\eta). \tag{3}$$

- *v. The (normalized) distribution of human capital* Υ *is stationary.* ▸ More
- *vi. The population growth rate* g *is given by* $1 + g = \int_{\mathscr{X}} n(x) d\Upsilon(h) d\Gamma(\eta)$.

Calibration and Estimation: Kenya Data in 2008

Internal estimation:

$$\hat{\Theta} = \min_{\Theta} \mathbf{R}(\Theta)' \mathbf{W} \mathbf{R}(\Theta),$$

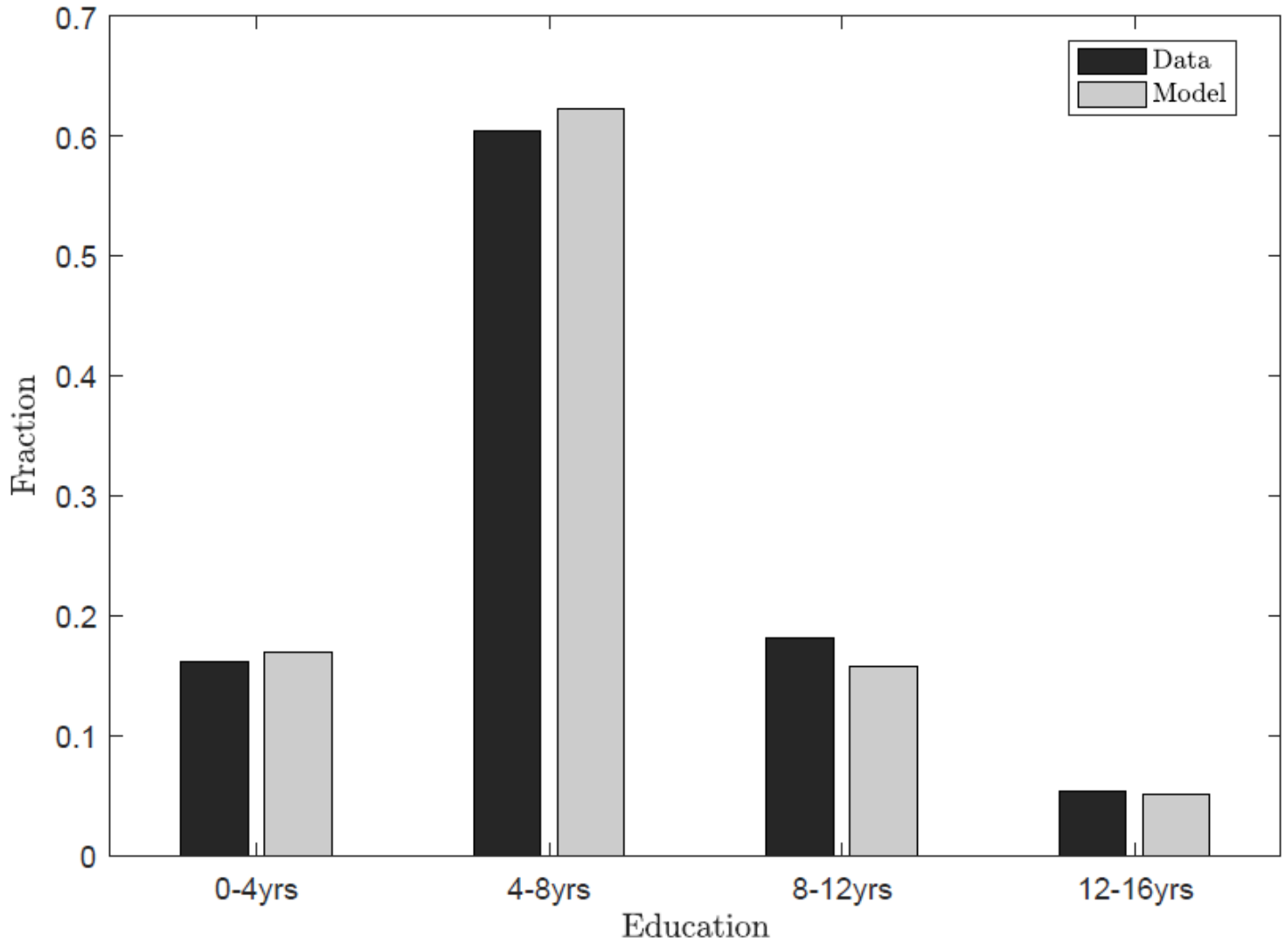
1. Fraction of people in each education category (4 levels).
2. Realized fertility rate and unwanted fertility rate by levels of education.
3. Abortion rates and the fraction of women using modern contraception by levels of education.
4. Capital-ouput and consumption-ouput ratios.
5. Gini coefficient of household labor income.

Fitting the Model to the Data

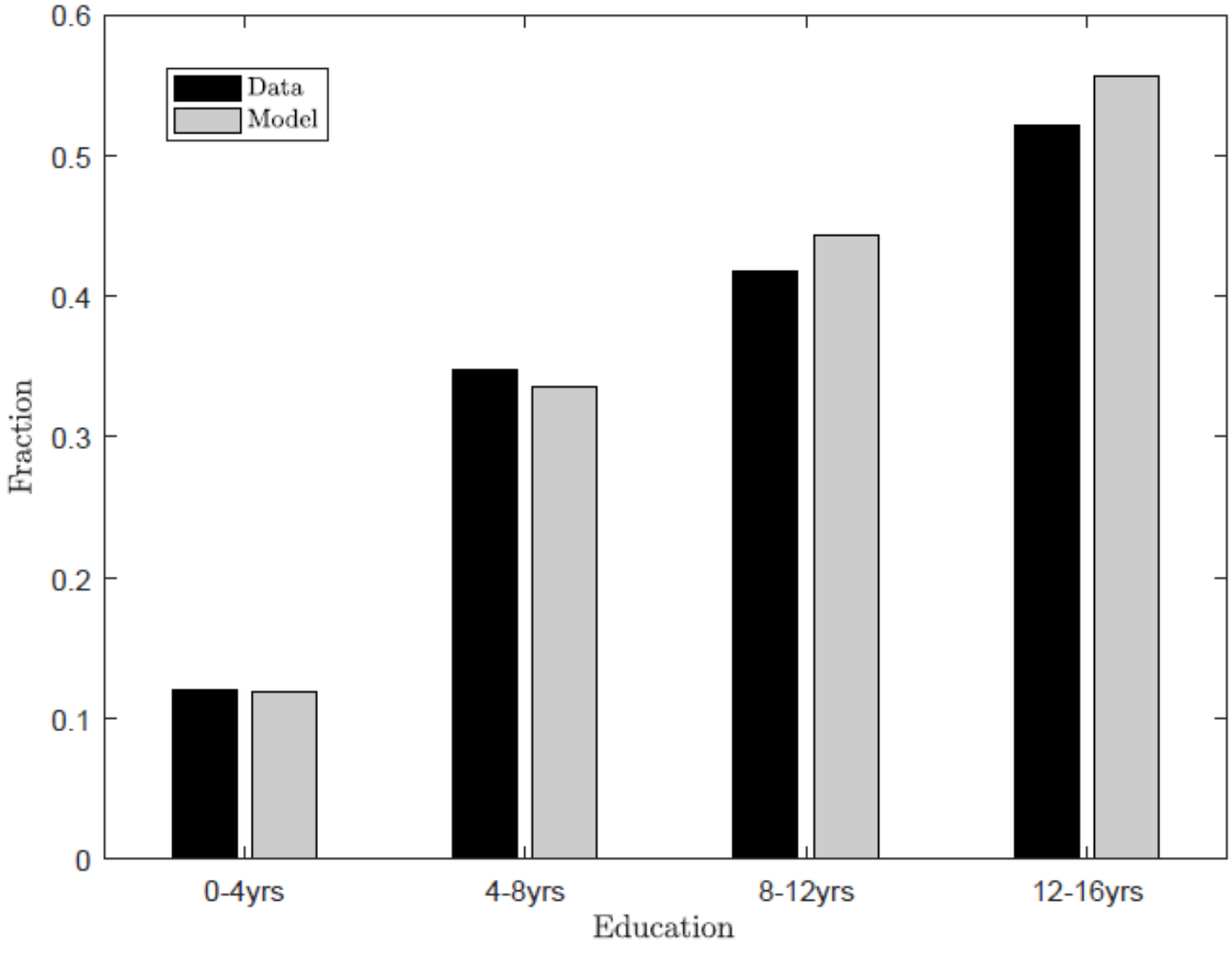
Table 3: Calibrated and estimated parameters

Parameter	Description	Value	Comment
Calibrated parameters (3 parameters)			
α	Capital share in income	0.36	Feenstra et al (2015)
N	Max. number of unwanted pregnancies	10	Normalized
ϕ_q	Price of modern contraceptives	1	Normalized
Estimated parameters (18 parameters)			
A	TFP parameter	0.6602	Moments (i)-(v)
β	Discount factor	0.5952	Moments (i)-(v)
γ	Utility weight on fertility	0.8819	Moments (i)-(v)
ξ	Utility weight on human capital	1.9252	Moments (i)-(v)
Ψ_q	Utility cost of contraception	0.0024	Moments (i)-(v)
Ψ_a	Utility cost of abortion	0.0804	Moments (i)-(v)
h_0	Human capital - fixed	4.6612	Moments (i)-(v)
h_1	Human capital - marginal	0.0349	Moments (i)-(v)
ζ	Human capital - curvature	2.1145	Moments (i)-(v)
χ	Time cost per child	0.0353	Moments (i)-(v)
σ_ϵ	Std of ability shock	0.5992	Moments (i)-(v)
κ	Fertility uncertainty	0.2830	Moments (i)-(v)
θ	Efficiency of contraception	347.5306	Moments (i)-(v)
ϕ_a	Abortion cost	0.0033	Moments (i)-(v)
λ_1	Education cost: 4 years of schooling	0.0047	Moments (i)-(v)
λ_2	Education cost: 8 years of schooling	0.0093	Moments (i)-(v)
λ_3	Education cost: 12 years of schooling	0.0646	Moments (i)-(v)
λ_4	Education cost: 16 years of schooling	0.2392	Moments (i)-(v)

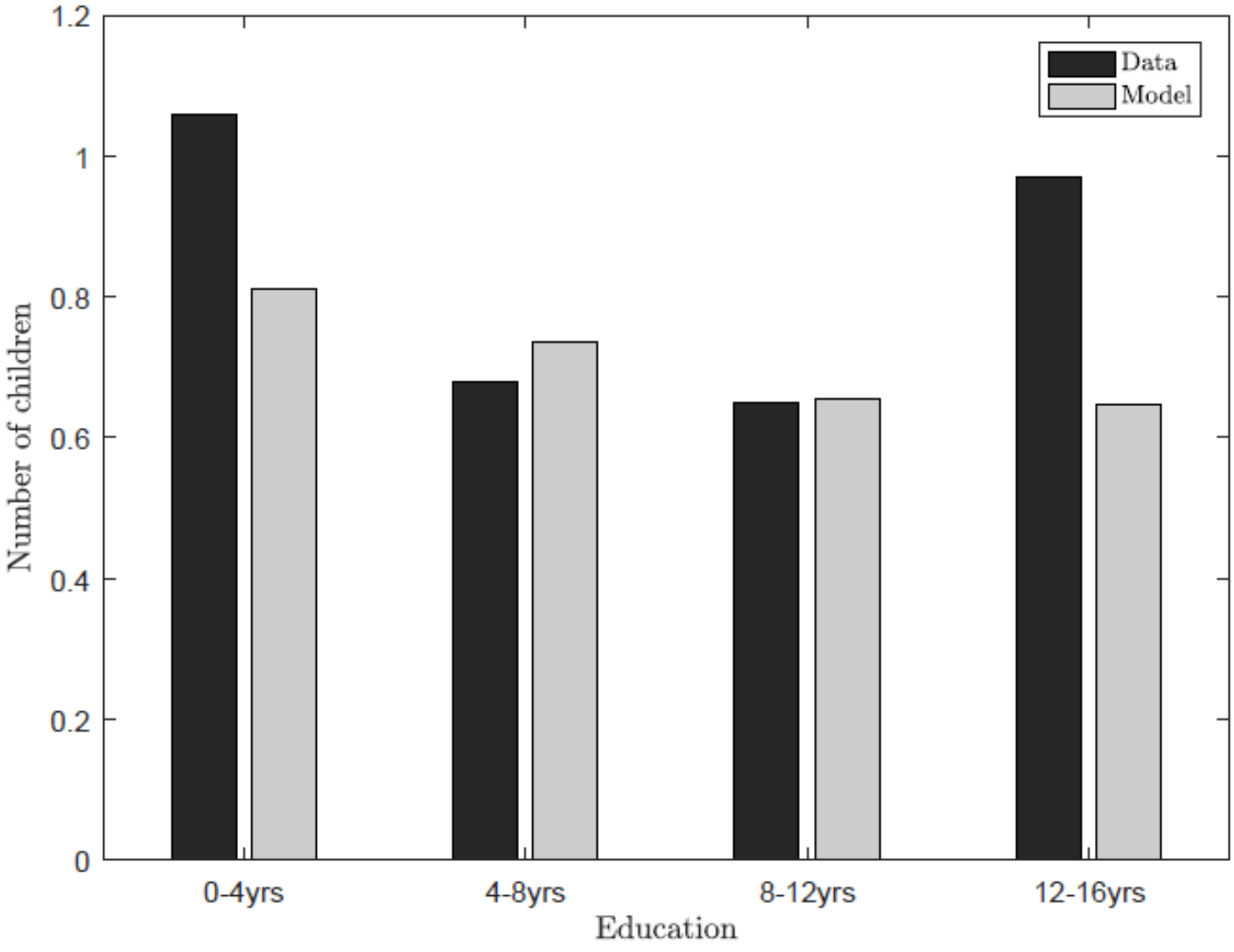
Model Fit - Education



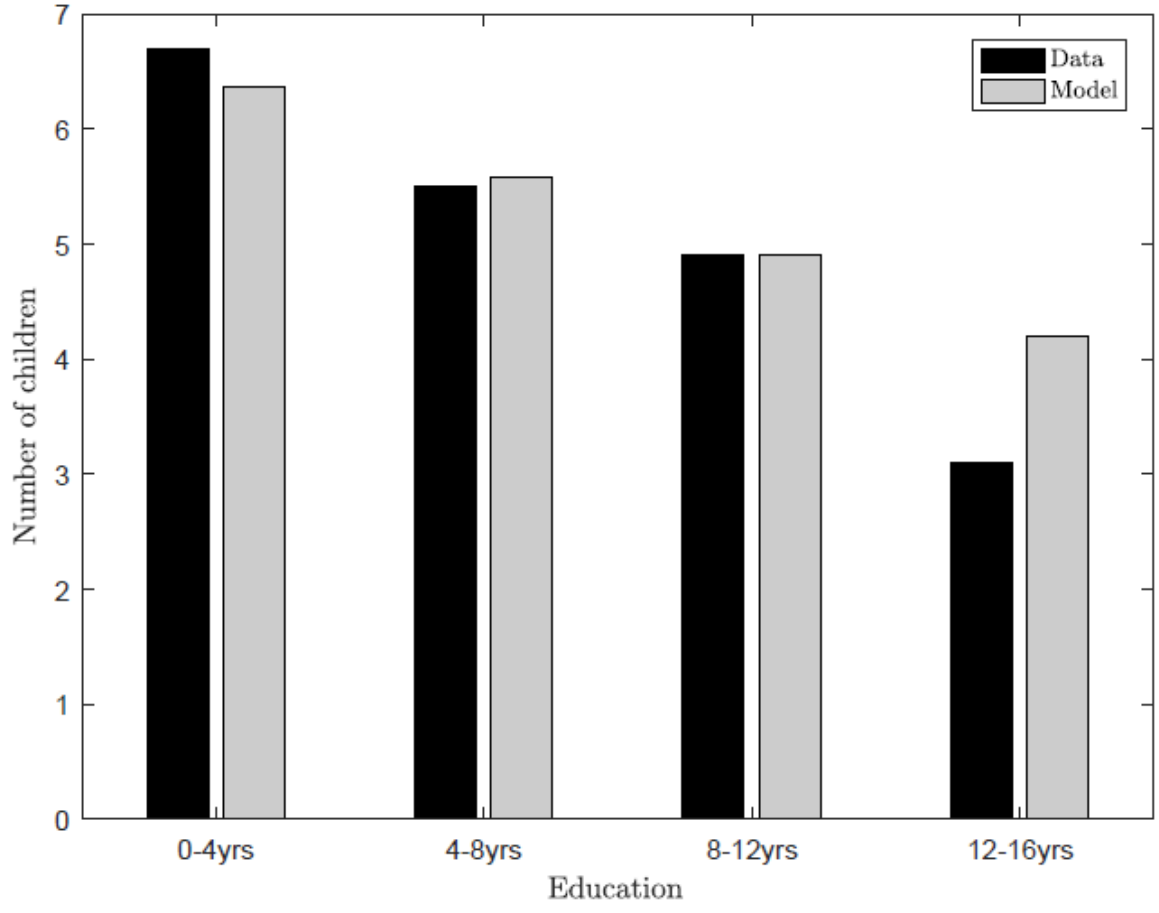
Model Fit - Contraception Use



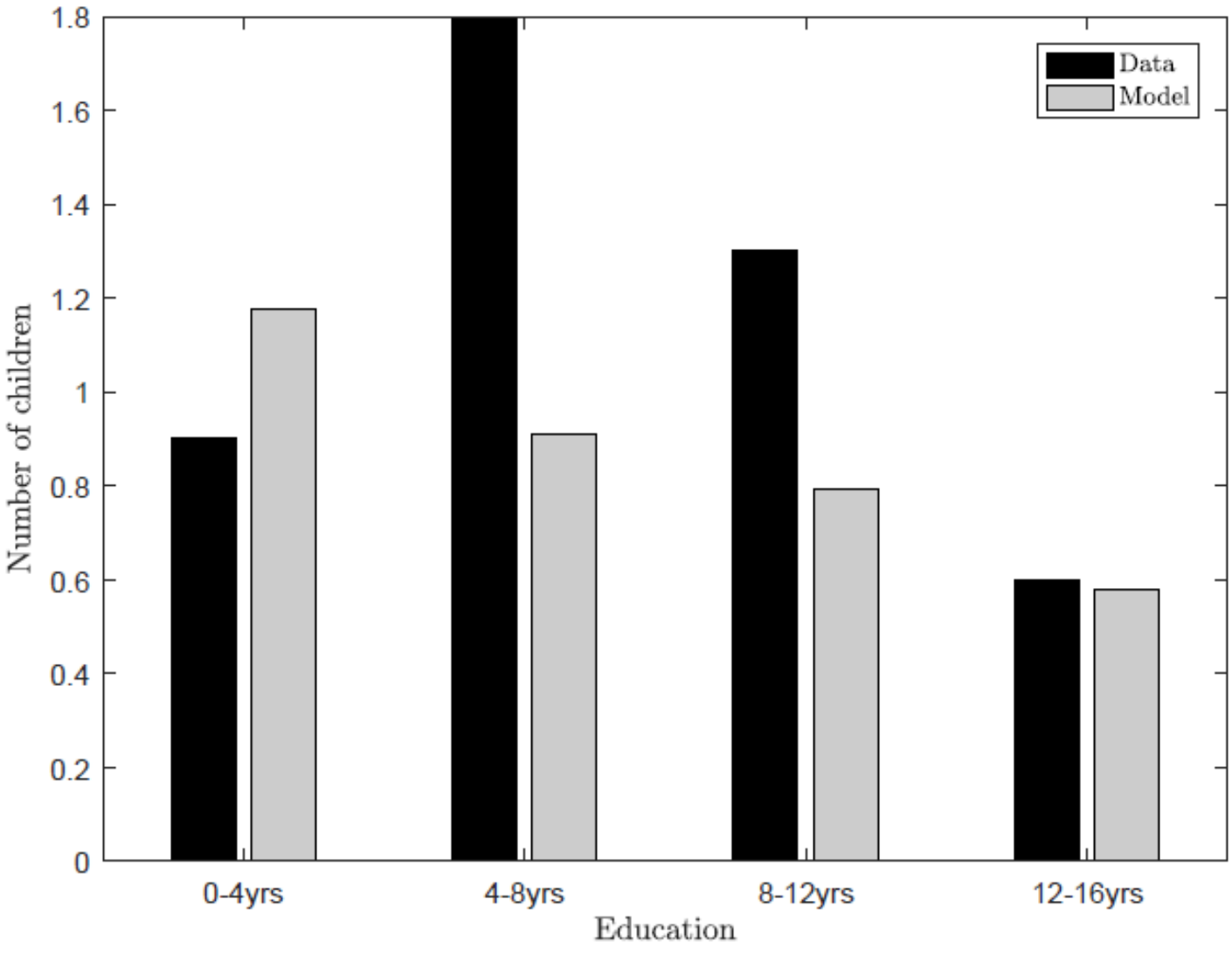
Model Fit - Abortions



Model Fit - Fertility



Model Fit - Unwanted Fertility



Model Fit - Aggregates

	Data	Model
Targeted moments		
Gini	0.49	0.48
K/Y	0.08	0.07
Non-targeted moments		
Years of Educ	6.1	7.7
Total unwanted fertility	1.2	0.9187
Unit abortion cost, % of GDP per capita	0.15-5	0.32
Contraception expenditure, % of GDP per capita	0.68	0.36

Free Contraception

		Free Contraception			
	Benchmark	Full exp.	Partial eq.	Exog. fert.	Exog. educ.
Y^i_{pc}/Y^{basel}_{pc}	**1.00**	**1.13**	1.12	1.31	1.13
K^i/K^{basel}	1.00	1.21	1.18	1.68	1.21
Schooling (years)	7.68	8.78	8.75	9.07	8.78
Av. fertility	**5.54**	**5.16**	5.08	4.50	5.16
Av. unw. fert.	**0.92**	**0**	0	0	0
Contrac. use (% HHs)	0.33	1	1	1	1
Pregn. aborted (%)	0.12	0	0	0	0
Gini index	0.48	0.47	0.47	0.47	0.47
Labor Inc 90/10	**12.57**	**10.89**	10.88	10.63	10.89
Cost/Y (Y^1), (%)	0	**2.43**	2.45	2.08	2.43
Cost/Y (Y^0), (%)	0	**2.74**	2.74	2.71	2.74
Welfare	3.86	4.11	4.07	4.25	4.11

Free Abortion

		Free Abortion			
	Benchmark	Full exp.	Partial eq.	Exog. fert.	Exog. educ.
Y^i_{pc}/Y^{basel}_{pc}	**1.00**	**1.09**	1.07	1.13	1.01
K^i/K^{basel}	1.00	1.15	1.11	1.24	1.01
Schooling (years)	7.68	8.46	8.46	8.58	7.75
Av. fertility	**5.54**	**5.25**	5.24	5.11	5.57
Av. unw. fert.	**0.92**	**0.42**	0.37	0.57	0.62
Contrac. use (% HHs)	0.33	0.12	0.17	0.17	0.15
Pregn. aborted (%)	0.12	0.22	0.22	0.20	0.19
Gini index	0.48	0.47	0.47	0.47	0.48
Labor Inc 90/10	**12.57**	**10.29**	10.30	10.96	12.05
Cost/Y (Y^1), (%)	0	**0.43**	0.44	0.36	0.40
Cost/Y (Y^0), (%)	0	**0.47**	0.48	0.40	0.41
Welfare	3.86	4.02	3.99	4.06	3.89

Counterfactual Policies

Table 6: Counterfactual experiments: Supply and demand policies, Kenya 2008

Statistics	Baseline	Supply Policies		Demand Policies	
		Free contrac.	Free abortion	No disutil. of contrac.	No disutil. of abortion
Output, input and prices					
Ypc relat. to the baseline	1	1.13	1.09	0.99	1.05
K relat. to the baseline	1	1.21	1.15	0.98	1.09
Av. years of schooling	7.68	8.78	8.46	7.65	8.09
w relat. to the baseline	1	1.04	1.03	0.99	1.02
r relat. to the baseline	1	0.93	0.95	1.01	0.97
Fertility and family planning					
Av. fertility	5.54	5.16	5.25	5.58	5.35
Av. unwanted fert.	0.92	0	0.42	0.91	0.51
% of HHs who use contrac.	0.33	1	0.12	0.34	0
% of pregn. aborted	0.12	0	0.22	0.12	0.23
Exp. on contrac./Ypc (%)	0.28	0	0.08	0.28	0
Inequality and welfare					
Gini index	0.48	0.47	0.47	0.48	0.48
Labor Income 90/50	3.83	3.89	4	3.83	3.95
Labor Income 90/10	12.57	10.89	10.29	12.57	12.16
Welfare	3.86	4.11	4.02	3.85	3.96
Cost of the policy					
Cost/Y (current Y), (%)	0	2.43	0.43	-	-
Cost/Y (original Y), (%)	0	2.74	0.47	-	-

Universal Policies

Statistics	Baseline	Universal Policies: Subsid. contrac.	Universal Policies: Subsid. abortion	Universal Policies: Subsid. education (0-4 yrs)
Y^i_{pc}/Y^{basel}_{pc}	**1**	1.027	**1.091**	**0.977**
K^i/K^{basel}	1	1.04	1.15	0.95
Schooling (years)	**7.68**	8.78	**8.46**	**7.84**
Av. fertility	**5.54**	5.44	**5.25**	**5.73**
Av. unw. fert.	0.92	0.58	0.42	0.92
Contrac. use (% HHs)	33	84	12	26
Pregn. aborted (%)	12	5	22	12
Gini index	0.48	0.48	0.47	0.48
Labor Inc 90/10	**12.57**	12.21	**10.29**	**12.03**
Cost/Y (Y^1), (%)	0	0.50	0.43	0.50
Cost/Y (Y^0), (%)	0	0.51	0.47	0.49
Welfare	3.86	3.91	4.02	3.89

Targeted Policies

Statistics	Baseline	Targeted Policies *Parents with up to 8 years of schooling* Subsid. contrac.	Subsid. abortion	Subsid. education (0-4 yrs)
Y^i_{pc}/Y^{basel}_{pc}	**1**	1.025	**1.087**	**1.033**
K^i/K^{basel}	1	1.04	1.14	1.04
Schooling (years)	**7.68**	1.04	**1.14**	**1.04**
Av. fertility	**5.54**	5.45	**5.25**	**5.52**
Av. unw. fert.	0.92	0.63	0.50	0.90
Contrac. use (% HHs)	33	73	17	28
Pregn. aborted (%)	12	5	20	12
Gini index	0.48	0.48	0.48	0.47
Labor Inc 90/10	**12.57**	12.21	**10.73**	**12.10**
Cost/Y (Y^1), (%)	0	0.50	0.35	0.50
Cost/Y (Y^0), (%)	0	0.51	0.38	0.52
Welfare	3.86	3.90	4.01	3.98

Conclusions

- What's the impact of family interventions on development?
  - Role for contraception and abortion
- Really the first model to assess this question
- Results suggest that: quantitative effect may be significant
  - Differences in average fertility rate are indeed driven by the quantity-quality trade-off (not much on unmet need, or contraceptive prevalence)
  - But access to modern contraceptives has an important **composition effect**
  - This composition effect might be important
  - Family planning interventions might have sizeable effects and might be preferred to educational policies.

Distribution

- Transition:

$$P(h'|x) = \int \mathbf{1}(x, \varepsilon, h') dF(\varepsilon),$$

with

$$\mathbf{1}(x, \varepsilon, h') = \begin{cases} 1 & \text{if } \log(h') = \varepsilon \tilde{h}(e(x)) \\ 0 & \text{otherwise} \end{cases}.$$

- Number of children:

$$n(x) = \tilde{n}(h) + \max\{\eta - \theta q(h), 0\} - a(x).$$

- Distribution:

$$\Upsilon(h') = \frac{\int_{\mathscr{X}} n(x) P(h'|x) d\Upsilon(h) d\Gamma(\eta)}{\int_{\mathscr{X}} n(x) d\Upsilon(h) d\Gamma(\eta)}.$$

◂ Return

Quantity-Quality Trade-off

Table 10: Relationship between realized fertility and wanted fertility versus human capital. Data source: see data appendix for description and source of the variables used.

	Dependent variable					
	Realized	Wanted	Realized	Wanted	Realized	Wanted
	(1)	(2)	(3)	(4)	(5)	(6)
Human capital	−2.1589***	−2.0158***	−3.1947***	−2.3523**	−2.1653***	−1.3219***
	(0.1807)	(0.1675)	(0.1951)	(0.1954)	(0.3809)	(0.3833)
Test (χ^2)		2.99*		29.16***		9.89***
Country fixed effects	No	No	Yes	Yes	Yes	Yes
Decade fixed effects	No	No	No	No	Yes	Yes
Number of observations	188	188	188	188	188	118
Number of countries	64	64	64	64	64	64
R-squared	0.434	0.437	0.966	0.961	0.969	0.964

Note: Standard erros are in parentheses. Symbols *, ** and *** imply that coefficients are statistically different from zero at 90, 95 and 99 percent confidence levels, respectively.

◂ Return