Can increasing population density and urbanization foster the African demographic transition?

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Motivation

Main challenge of the 21st century: population growth.

In particularly for Africa.

Other continents

s Vorld



How do population density and urbanization affect the demographic transitions in South African countries?

Research question

- Why doesn't fertility in Africa drop as fast as expected? population density remains low
 - Africa: 87 inhabitants/km²
 - Asia: 246 inhabitants/km²
- How do population density and urbanization affect the demographic transitions in South African countries?
 - Age at marriage
 - Age at first birth

Results

- Moving from the 5th to the 95th percentile of population density:
 - age at first birth increases by 2.17 years.
 - age at marriage increases by 3.3 years.
- Channels:
 - better health in denser places
 - higher living standards due to agglomeration forces

Literature & Mechanisms: biological and ecological

Many mechanisms: competition, cooperation, parasitism or predation.

Fowler and Ruxton 2002: two classes of mechanisms going in opposite direction:

- negative relationship: competition effects (biologists)
- positive relationship: inbreeding reduces the fitness of a population as its size decreases ("Allee effect")

Lotka-Volterra model: oscillatory population dynamics.

Samuelson (1971), de la Croix and Dottori (2008)

Literature & Mechanisms: demographics

Idea that fertility should adjust to population density.

Montesquieu (1749):

"In a small and flourishing territory, the number of citizens must soon augment, so as to become a burden. [...] Plato limits the number of citizens to five thousand and forty, and recommends, according as the case may require: either the prohibition or encouragement of propagation, by motives of honor or ignominy, and by the reasonable admonitions of the elders. He advises also a regulation of the number of marriages. [...] Every parent should be limited to a certain number says Aristotle. And when the children are more numerous than the laws permit, he advises the women to procure abortion before the foetus be endowed with life."

Literature & Mechanisms: demographics

Malthus (1807) description of too high density on fertility:

"The ultimate check to population appears then to be a want of food arising necessarily from the different ratios according to which population and food increase. The preventive checks, as far as it is voluntary, is peculiar to man, and arises from that distinctive superiority in his reasoning faculties, which enables him to calculate distant consequences. [...] Of the preventive checks, the restraint from marriage which is not followed by irregular gratifications may properly be termed moral restraint. Promiscuous intercourse, unnatural passions, violations of the marriage bed, and improper arts to conceal the consequences of irregular connections, are preventive checks that clearly come under the head of vice."

Literature & Mechanisms: demographics Sadler (1830):

The prolificness of human beings, otherwise similarly circumstanced, varies inversely as their numbers."

Opposite mechanism than Malthus: Denser places are richer + Fertility decreases with income \Rightarrow Denser places have lower fertility.

Country	Inhabitants on	children to
	a square mile	a marriage
Cape of Good Hope	1	5.48
North America	4	5.22
Russia in Europe	23	4.94
Denmark	73	4.89
Prussia	100	4.70
France	140	4.22
England	160	3.66

Source: Sadler, 1830. The Law of Population - in disproof of the superfecundity of human beings, and developing the real principle of their increase. Second volume.

Literature & Mechanisms: economics

Becker (1993)

- housing market: Sato (2007), Murphy, Simon and Tamura (2008), de la Croix and Gosseries (2012)
- provision of education: Boucekkine, de la Croix and Peeters (2007), Becker, Cinnirella, and Woessmann (2010)
- endogenous technology: Galor and Weil (2000)

1. Introduction

2. Data

3. Empirical analysis

4. Conclusion

Data sources

- Individual data: Demographic and Health Survey (DHS) data.
 - All Sub-Saharan surveys that are geolocalized.
 - 34 countries, 126 surveys (between phase II and VII), 37285 clusters, 947191 individuals
- Population density in 1990: CIESIN et al. (2011) gridded population data at 30 arc-seconds.
- Land productivity: caloric suitability index from Galor and Özak (2014).

GDP per capita:

- Light-night satellite data from Ghosh et al. (2010)
- Henderson, Storeygard and Weil (2012): strong proxy for GDP

Clusters and population density



Descriptive statistics

	N. obs.	Mean	St. Dev.	Min	Max
From the Individual Recode					
Age (in completed years)	947,191	28.387	9.469	15	49
Education (in single years)	947,191	4.734	4.514	0	26
Partner's Education	637,604	5.090	5.054	0	25
Children's mortality rate	947,191	0.089	0.187	0	1
Motherhood rate	947,191	0.729	0.445	0	1
Marriage rate	947,191	0.738	0.440	0	1
Islamic (%)	914,920	0.322	0.467	0	1
Christian (%)	914,851	0.587	0.492	0	1
Age at first birth (in years)	690,406	19.086	3.775	8	48
Age at first birth (in months)	690,406	234.400	45.191	98	586
Age at first marriage (in years)	699,107	18.025	4.216	8	49
Age at first marriage (in months)	699,107	221.582	50.561	96	599
Moved from place of residence after 14 (%)	947,191	0.258	0.438	0	1
Ethnicities	947,164		269 catego	rical variables	5
From the Household Recode					
Has electricity (percent)	936,401	0.301	0.459	0.000	1.000
Has a refrigerator (percent)	907,958	0.138	0.345	0.000	1.000
From CIESIN et al. (2011)					
Population density in 1990 (pop. per km ²)	947,191	747.977	1,981.006	0.012	32,860.830
From Galor and Özak (2014)					
Caloric suitability index post 1500 (/10000)	947,191	10.006	2.816	0.000	17.684
From Ghosh et al. (2010)					
GDP per capita	947,191	0.002	0.010	0.00001	0.427

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Unconditional probabilities: birth and marriage

by population density quartiles



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Proportional hazard model

$$\lambda_j(a) = \lambda_0(a) \exp\left\{ \tau_1 \ln(1 + \text{density}_j) + \sum_{i=2}^N \tau_i X_{ij} \right\}$$

► λ_j(a) probability that individual j exits childlessness or singlehood at age a

Dependent variable: Probability of becoming a mother					
In(1+density)	-0.099***	-0.024***	-0.014***		
,	(0.001)	(0.001)	(0.001)		
married		1.271***	1.268***		
		(0.007)	(0.007)		
infant mortality		0.627***	0.584***		
		(0.007)	(0.007)		
education		0.046***	0.052***		
_		(0.001)	(0.001)		
$(education)^2$		-0.008***	-0.008***		
		(0.000)	(0.000)		
calories			0.014^{***}		
			(0.001)		
mean mortality			0.579***		
			(0.036)		
GDP per capita			0.549***		
			(0.160)		
mean education			-0.012***		
			(0.001)		
Observations	947,191	947,191	947,191		
Notes: *p<0.1; *	**p<0.05; ***p<	0.01. Standard	errors clustered		

 $\it Notes: ~^{*}p{<}0.1; ~^{**}p{<}0.05; ~^{***}p{<}0.01.$ Standard errors clustered at the cluster level. All specifications include survey fixed effects.

Interpretation: unconditional effect



Difference in the age at first birth between the 5th and 95th percentiles of population density: 2.17 years (26 months).

Interpretation: conditional effect

The effect is very much driven by other factors that also change with population density (at both the individual and the cluster level).

Difference in the age at first birth between the 5th and 95th percentiles of population density: 4 months.

Dependen	Dependent variable: Probability of becoming a wife					
In(1+density)	-0.136***	-0.057***	-0.019***			
	(0.001)	(0.001)	(0.002)			
infant mortality	. ,	0.537***	0.441***			
		(0.008)	(0.008)			
education		-0.057***	-0.036***			
		(0.001)	(0.001)			
(education) ²		-0.003***	-0.003***			
		(0.000)	(0.000)			
calories			0.007***			
			(0.001)			
mean mortality			1.258***			
			(0.049)			
GDP per capita			1.990***			
			(0.249)			
mean education			-0.052***			
			(0.001)			
Observations	947,191	947,191	947,191			
Notes: $*n < 0.1$	**n<0.05 [.] ***n<	0.01 Standard	errors clustered			

at the cluster level. All specifications include survey fixed effects.

Difference in the age at marriage birth between the 5^{th} and 95^{th} percentiles of population density:

- Unconditional effect: 40 months (3.3 years)
- Conditional effect: 5 months

Might explain the stalls of demographic transitions: population density only plays a role after some point.

	Dependent variable: Probability of first birth					
	Benchmark	(1)	Benchmark	(2)		
In(1+density)	-0.099***		-0.014***			
	(0.001)		(0.001)			
Decile 2		0.014	· · · ·	0.003		
		(0.009)		(0.008)		
Decile 3		-0.015*		-0.004		
		(0.009)		(0.008)		
Decile 4		-0.036***		0.003		
		(0.009)		(0.008)		
Decile 5		-0.046***		0.018**		
		(0.009)		(0.008)		
Decile 6		-0.117***		0.002		
		(0.010)		(0.008)		
Decile 7		-0.170***		-0.007		
		(0.009)		(0.008)		
Decile 8		-0.308***		-0.043***		
		(0.009)		(0.008)		
Decile 9		-0.460***		-0.060***		
		(0.010)		(0.009)		
Decile 10		-0.610***		-0.096***		
		(0.010)		(0.009)		
Controls	NO	NO	YES	YES		
Observations	947,191	947,191	947,191	947,191		

Notes: *p<0.1; **p<0.05; ***p<0.01. Standard errors clustered at the cluster level. All specifications include survey fixed effects.

	Depe	ndent variable: F	Probability of mari	rying
	Benchmark	(1)	Benchmark	(2)
In(1+density)	-0.136***		-0.019***	
	(0.001)		(0.002)	
Decile 2		0.027**	()	0.029***
		(0.011)		(0.011)
Decile 3		-0.047***		-0.007
		(0.011)		(0.010)
Decile 4		-0.092***		-0.006
		(0.012)		(0.011)
Decile 5		-0.118***		-0.003
		(0.012)		(0.011)
Decile 6		-0.207***		-0.020*
		(0.013)		(0.011)
Decile 7		-0.291***		-0.039***
		(0.012)		(0.011)
Decile 8		-0.459***		-0.063***
		(0.012)		(0.011)
Decile 9		-0.647***		-0.065***
		(0.012)		(0.011)
Decile 10		-0.826***		-0.111***
		(0.012)		(0.012)
Controls	NO	NO	YES	YES
Observations	947,191	947,191	947,191	947,191

Notes: *p<0.1; **p<0.05; ***p<0.01. Standard errors clustered at the cluster level. All specifications include survey fixed effects.

Robustness

Ethnicities

- Religion
- Refrigerator / electricity
- Education of spouse / mean education of spouses in cluster
- Mean contraception knowledge

	Dependent variable:					
		Pro	bability of be	coming a mo	ther	
	Bench.	(1)	(2)	(3)	(4)	(5)
$\overline{\ln(1+\text{density})}$	-0.014*** (0.001)	-0.015*** (0.001)	-0.013*** (0.001)	-0.008*** (0.001)	-0.011*** (0.001)	-0.015*** (0.001)
Controls	YES	YES	YES	YES	YES	YES
islam			0.009 (0.008)			
christian			-0.023* ^{***} (0.007)			
refrigerator			. ,	-0.073*** (0.005)		
electricity				-0.056*** (0.005)		
educ. sp.					-0.000 (0.000)	
mean contr.						0.182*** (0.014)
Observations Ethnicity FE	947,191 NO	947,191 YES	914,851 NO	907,071 NO	635,722 NO	947,191 NO

Notes: p<0.1; p<0.05; p<0.05; p<0.01. Standard errors clustered at the cluster level. All specifications include survey fixed effects. Column (3) includes married women only.

	Dependent variable:						
			Probability	of marrying			
	Bench.	(1)	(2)	(3)	(4)	(5)	
In(1+density)	-0.019*** (0.002)	-0.027*** (0.001)	-0.022*** (0.002)	-0.015*** (0.002)	-0.019*** (0.002)	-0.019*** (0.002)	
Controls	YES	YES	YES	YES	YES	`YES ´	
islam			0.126*** (0.009)				
christian			-0.042*** (0.008)				
refrigerator			. ,	-0.063*** (0.006)			
electricity				-0.023*** (0.006)			
mean educ.sp.					0.016*** (0.002)		
mean contr.						0.009 (0.019)	
Observations Ethnicity FE	947,191 NO	947,191 YES	914,851 NO	907,071 NO	931,154 NO	947,191 NO	

Notes: *p<0.1; **p<0.05; ***p<0.01. Standard errors clustered at the cluster level. All specifications include survey fixed effects.

Women with lower desire for marriage/children might migrate from areas with low to high population density.

We remove:

- (1) those we know have moved (keeping NAs)
- (2) everyone but those we know for sure did not migrate (we remove also NAs)

	Dependent variable:					
	Probabili	Probability of becoming a mother				
	Benchmark	(1)	(2)			
In(1+density)	-0.014***	-0.012***	-0.013***			
	(0.001)	(0.001)	(0.002)			
married	1.268***	1.308***	1.370***			
	(0.007)	(0.008)	(0.011)			
infant mortality	0.584***	0.595***	0.584***			
	(0.007)	(0.009)	(0.012)			
education	0.052***	0.052***	0.054***			
	(0.001)	(0.001)	(0.002)			
(education) ²	-0.008***	-0.008***	-0.008***			
	(0.000)	(0.000)	(0.000)			
calories	0.014***	0.016***	0.014***			
	(0.001)	(0.001)	(0.001)			
mean mortality	0.579***	0.702***	0.585***			
	(0.036)	(0.042)	(0.058)			
GDP per capita	0.549***	0.801***	1.186***			
	(0.160)	(0.189)	(0.217)			
mean education	-0.012***	-0.011***	-0.006***			
	(0.001)	(0.001)	(0.002)			
Ethnicity FE	NO	NO	NO			
Observations	947,191	702,626	327,632			

Notes: *p<0.1; **p<0.05; ***p<0.01. Standard errors clustered at the cluster level. All specifications include survey fixed effects.

	D	Dependent variable:				
	Pro	Probability of marrying				
	Benchmark	(1)	(2)			
In(1+density)	-0.019***	-0.015***	-0.019***			
	(0.002)	(0.002)	(0.003)			
infant mortality	0.441***	0.515***	0.594***			
	(0.008)	(0.009)	(0.013)			
education	-0.036* ^{**}	-0.046***	-0.049* ^{**} *			
	(0.001)	(0.001)	(0.002)			
(education) ²	-0.003***	-0.003* ^{**} *	-0.003***			
,	(0.000)	(0.000)	(0.000)			
calories	0.007***	0.010***	0.005***			
	(0.001)	(0.001)	(0.002)			
mean mortality	1.258***	1.408***	1.247***			
	(0.049)	(0.055)	(0.078)			
GDP per capita	1.990***	1.940***	2.598***			
	(0.249)	(0.288)	(0.310)			
mean education	-0.052***	-0.053***	-0.053***			
	(0.001)	(0.002)	(0.003)			
Ethnicity FE	NO	NO	NO			
Observations	947,191	702,626	327,632			

Notes: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$. Standard errors clustered at the cluster level. All specifications include survey fixed effects.

Quality of the data

Common source of error in birth history data: misreporting dates/events

Can affect age at birth in 3 ways:

- "Potter effect": the woman reports that an earlier birth occurred later than it actually did
 - increase the age at first birth for older women
- adjustment of birth date by interviewers or respondents in order to avoid completing the health section of the DHS questionnaire (for children younger than 5 or 3)
 - reduction in the average age at first birth for younger women
- omission of earlier births
 - likely to increase the average age at first for older women

Remove from the sample the countries classified as having data of "poor quality" in Schoumaker 2014.

Countries removed from the sample: Burkina Faso, Benin, Cameroon, Chad, Ethiopia, Guinea, Madagascar, Mali, Mozambique, Nigeria, Niger, Uganda, Central African Republic, Liberia, Sierra Leone.

	Dependent variable:					
	Probability o	of first birth	Probability of marrying			
	Benchmark	(1)	Benchmark	. (2)		
In(1+density)	-0.014***	-0.022***	-0.019***	-0.036***		
	(0.001)	(0.002)	(0.002)	(0.002)		
married	1.268***	1.109***		· · ·		
	(0.007)	(0.008)				
infant mortality	0.584***	0.523***	0.441***	0.430***		
	(0.007)	(0.011)	(0.008)	(0.012)		
education	0.052***	0.064***	-0.036* ^{**}	-0.009* ^{**} *		
	(0.001)	(0.001)	(0.001)	(0.002)		
(education) ²	-0.008***	-0.009***	-0.003***	-0.005***		
	(0.000)	(0.000)	(0.000)	(0.000)		
calories	0.014***	0.013***	0.007***	0.008***		
	(0.001)	(0.001)	(0.001)	(0.001)		
mean mortality	0.579***	0.660***	1.258***	1.125***		
	(0.036)	(0.056)	(0.049)	(0.068)		
GDP per capita	0.549***	0.672***	1.990***	2.046***		
	(0.160)	(0.178)	(0.249)	(0.263)		
mean education	-0.012***	-0.004***	-0.052***	-0.033***		
	(0.001)	(0.001)	(0.001)	(0.002)		
Ethnicity FE	NO	NO	NO	NO		
Observations	947,191	487,581	947,191	487,581		

Notes: *p<0.1; **p<0.05; ***p<0.01. Standard errors clustered at the cluster level. All specifications include survey fixed effects.

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Conclusion

- Population density delays the timing of both marriage and first child.
- The effect is large and robust (migration, religion, ethnicity).
- Mediated by both individual and cluster-level variables.
- Nonlinear effects of population density might be one of the reasons of stalling demographic transitions?

Europe: Total Population

Asia: Total Population



back

World: Total Population



