Does human capital compensate for depopulation?

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WITTGENSTEIN CENTRE CONFERENCE 2021
THE CAUSES AND CONSEQUENCES OF DEPOPULATION,
30 November 2021

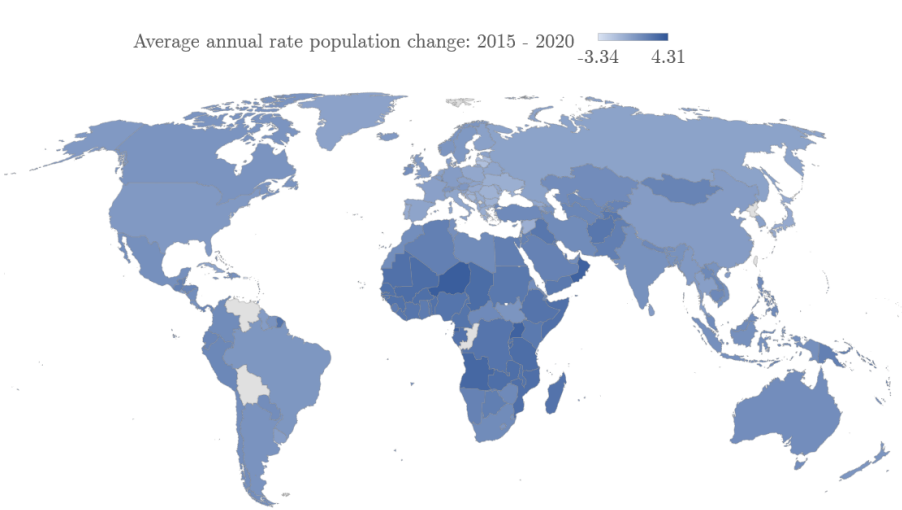
What do we study?

We analyze the degree to which the fertility loss is compensated by human capital gains

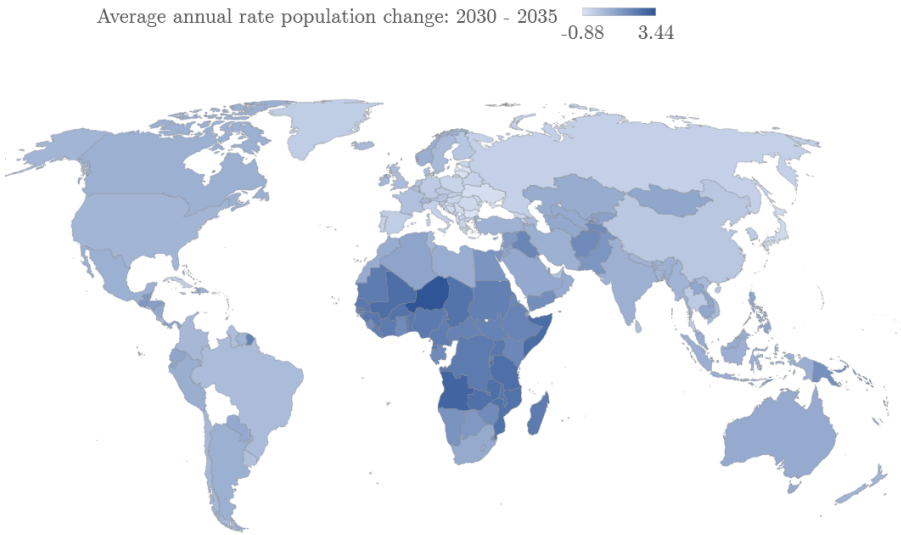
Why focus on depopulation countries?

Long term economic consequences of depopulation

Depopulation predictions

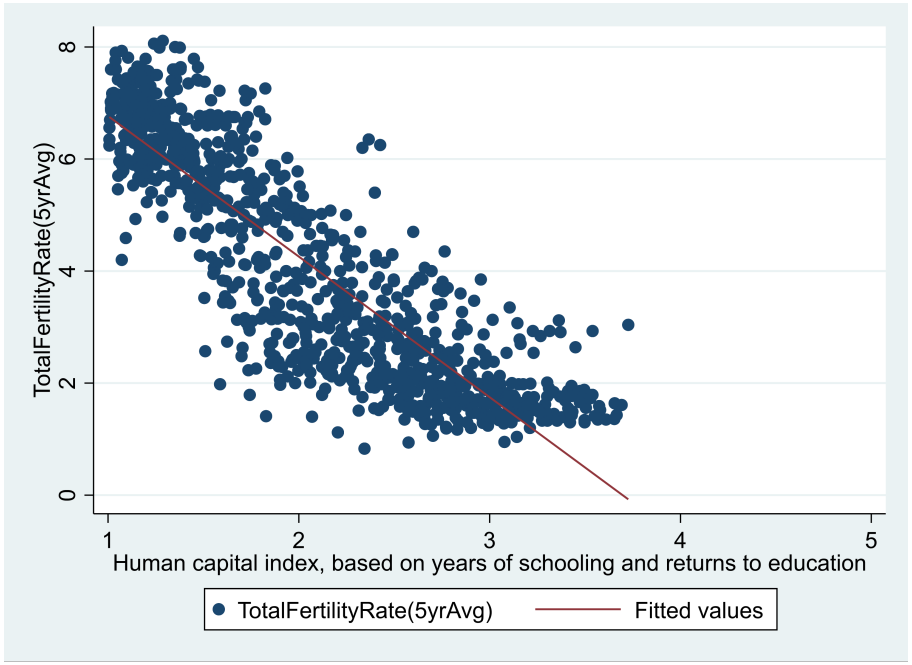


(a) Trends: years 2015-2020

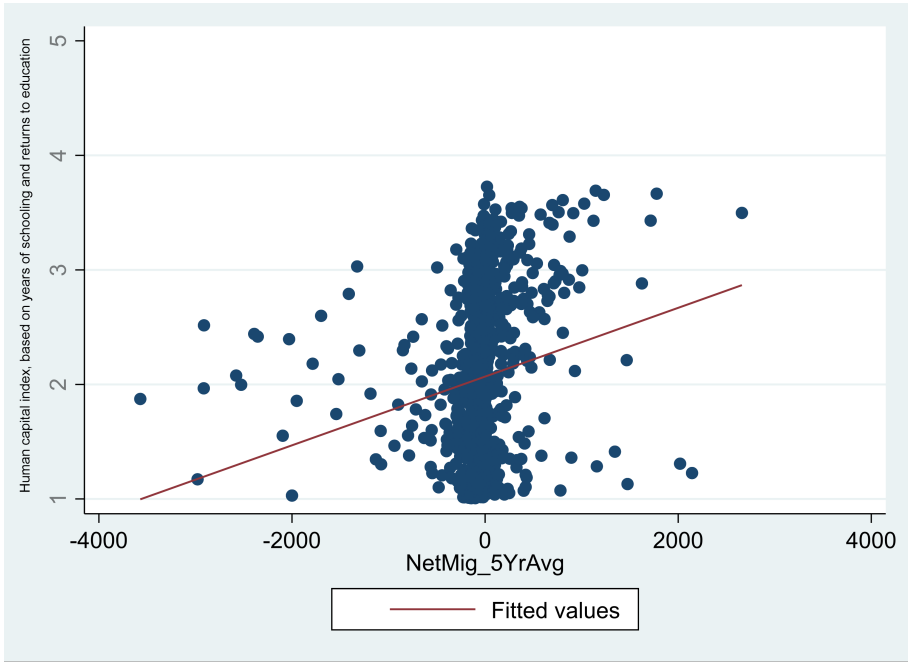


(b) Predictions: years 2030-2035

Figure 1: Average annual rate population change, Source: World Prospects

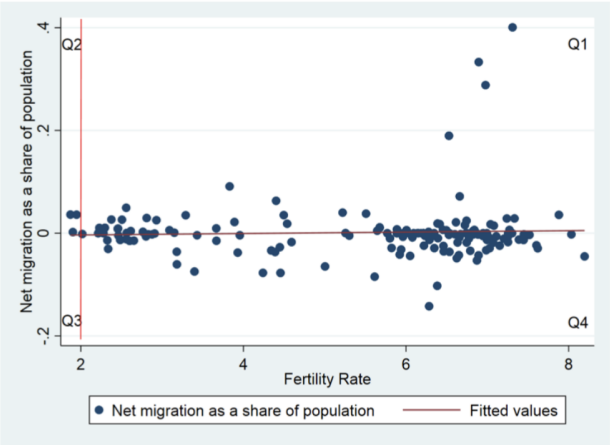


(a) HCI and Fertility

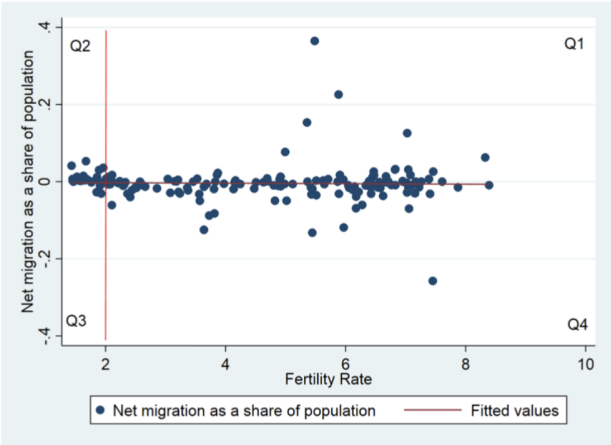


(b) HCI and Net Migration

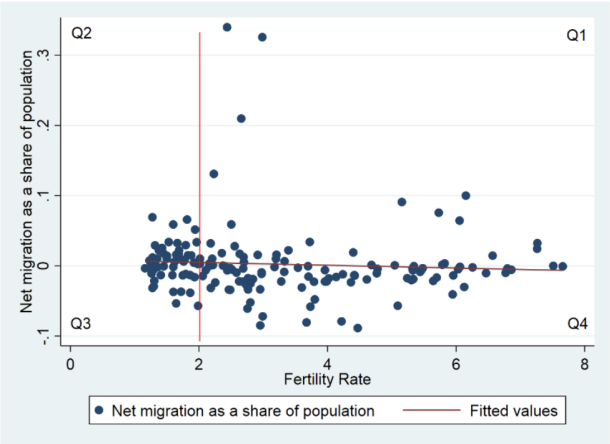
Figure 2: HCI relationship with key explanatory variables



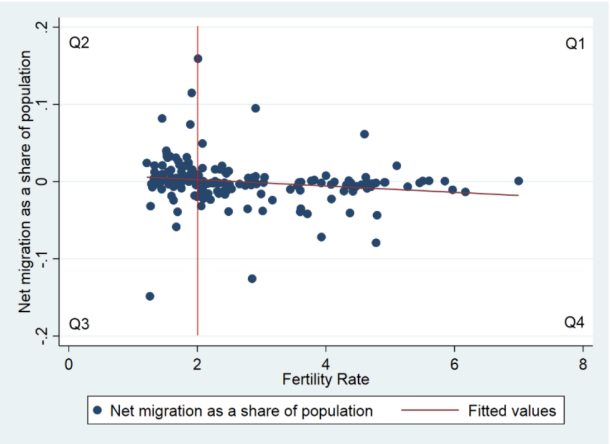
(a) 1960



(b) 1980



(c) 2000



(d) 2015

Figure 3: 5 year averages of fertility rate vs net migration as a share of population from 1960 through 2015, Source: Fertility rate and Population from WB and Net Migration from Wittgenstein Centre Human Capital Data Explorer

Literature review

-Importance of human capital in economics:

- i) human capital vs individual productivity vs output: Lucas (1988),
- ii) human capital vs R&D technological progress and productivity growth: Romer (1990) and Strulik et al. (2013).
- iii) quality-quantity tradeoff between fertility and education: Becker (1960), Barro and Becker (1989) and Becker et al. (2015)
- iv) negative econ consequences of declining fertility should be compensated by the increase in education and health investments: Prettner et al. (2013).

Set up

Consider an economy in which time t evolves discretely, where

$$Y_t = A_t K_t^{\alpha} H_t^{1-\alpha} = A_t K_t^{\alpha} \left(n_t h_t N_{t-1}\right)^{1-\alpha}, \tag{1}$$

- Output (Y_t)
- Physical capital (K_t)
- Aggregate human capital (H_t), where $H_t = n_t h_t N_{t-1}$
- Fertility rate (n_t)
- Individual human capital (h_t)
- Previous generation's size (N_{t-1})
- Technology (A_t)
- Elasticity of Y_t with respect to K_t (α)

The effect of declining fertility depends on the elasticity of human capital with respect to fertility:

$$\frac{\delta h_t}{\delta n_t} \cdot \frac{n_t}{h_t} \begin{cases} \in (-\infty, -1) & \text{overcompensated,} \\ = -1 & \text{exactly compensated,} \\ \in (-1, 0) & \text{partly compensated,} \\ = 0 & \text{not compensated,} \\ \in (0, \infty) & \text{inconsistent with quality-quantity trade-off.} \end{cases} \tag{2}$$

The last scenario would be an oddity, but it may occur if e.g. country's fertility is low due to malnourishment and the economy is also struggling, hence people have few kids and simultaneously their kids' educational levels are also low.

Constructed HCS (I)

$$h_{i,t} = e^{\text{RoH}_{i,t}\, S_{i,t} + ys_{i,t} \cdot \text{RoE}_{i,t}}, \tag{3}$$

- $h_{i,t}$ is average human capital
- country i
- time t
- $\text{RoH}_{i,t}$ return on health as in Bloom et al. (2019).
- $S_{i,t}$ adult survival rate
- $ys_{i,t}$ years of schooling
- $\text{RoE}_{i,t}$ return on education as in Psacharopoulos and Patrinos (2018),

Constructed HCS (II)

$$h_{i,t} = e^{\text{RoH}_{i,t}\, S_{i,t} + ys_{i,t}^{prim} \cdot \text{RoE}_{i,t}^{prim} + ys_{i,t}^{sec} \cdot \text{RoE}_{i,t}^{sec} + ys_{i,t}^{tert} \cdot \text{RoE}_{i,t}^{tert}}, \quad (4)$$

- Educational attainment: primary (*prim*), secondary (*sec*), and tertiary (*tert*). And $ys_{i,t}^{prim}$ represents the number of years in primary schooling. The four HCS created:

Specification	$\text{RoH}_{i,t} = 9,10\%$	$\text{RoH}_{i,t} = 6,70\%$
Equation3	HCS1	HCS3
Equation4	HCS2	HCS4

Table 1: Human capital stock and the data sources for each measure

where $\text{RoH}_{i,t} = 9,10\%$ is from Strulik et al. (2013) and $\text{RoH}_{i,t} = 6,70\%$ is from Weil (2014).

Econometric estimation

$$\log(h_{i,t}) = \beta_0 + \beta_1 \log(\text{Fert}_{i,t-n}) + \beta_2 \log(\text{Mig}_{i,t-n}) + \beta_4 X_{i,t-n} + \varepsilon_{i,t}, \tag{5}$$

- human capital index $h_{i,t}$
- fertility rate $\text{Fert}_{i,t-n}$
- net migration $\text{Mig}_{i,t-n}$
- lag n
- control variables matrix X_{it-n}
- composite error term ε_{it}

Sources of data

Variable	Source
Fertility and adult survival rates	World Bank
Net Migration	Wittgenstein Centre: Human Capital Data Explorer
Years of schooling	Barro-Lee Educational Attainment Dataset Barro and Lee (2013)
Absence of corruption	The Global State of Democracy Indices
GDP, HCI	Penn World Tables
Agriculture VA and GFCF	FAO

Results (I)

Table 2: Results for all countries using HCI as a measure of human capital

VARIABLES	HCI	HCI
Fert[b]	-0.103***	-0.092***
	(0.014)	(0.015)
Mig[c]		-0.159***
		(0.055)
Observations	903	805
R-squared	0.855	0.850
Number of id	113	100
State FE	YES	YES
Year FE	YES	YES
Controls[d]	YES	YES

[a] St. errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

[b] Fert represents a lag of 2 for log(Fertitily)

[c] Mig is the net migration share of population

[d] The controls included the log of GDP, agriculture, absence of corruption, gross fixed capital formation and trade share of GDP. For complete table see Appendix tables A.??-??

Results (II)

Table 3: Results for depopulation countries

VARIABLES	HCI	HCI
Fert[b]	-0.098***	-0.074***
	(0.022)	(0.025)
Mig[c]		-0.477***
		(0.151)
Observations	182	156
R-squared	0.925	0.925
Number of id	26	22
State FE	YES	YES
Year FE	YES	YES
Controls[d]	YES	YES

[a] St. errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

[b] Fert represents a lag of 2 for log(Fertility)

[c] Mig is the net migration share of population

[d] The controls included the log of GDP, agriculture, absence of corruption, gross fixed capital formation and trade share of GDP. For complete table see Appendix tables A.??-??

Table 4: Results for all countries and all measures of human capital - both HCI and HCS

VARIABLES	HCI	HCI	HCS1	HCS1	HCS2	HCS2	HCS3	HCS3	HCS4	HCS4
Fert[b]	-0.103***	-0.092***	-0.109***	-0.096***	-0.119***	-0.102***	-0.108***	-0.102***	-0.119***	-0.107***
	(0.014)	(0.015)	(0.012)	(0.014)	(0.013)	(0.015)	(0.012)	(0.013)	(0.013)	(0.015)
Mig [c]		-0.159***		-0.017		-0.009		0.001		0.009
		(0.055)		(0.045)		(0.050)		(0.045)		(0.049)
Observations	903	805	770	685	770	685	770	685	770	685
R-squared	0.855	0.850	0.874	0.869	0.870	0.865	0.872	0.865	0.868	0.862
Number of id	113	100	109	96	109	96	109	96	109	96
State FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Controls[d]	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

[a] Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

[b] Fert represents a lag of 2 for log(Fertitily)

[c] Mig is the net migration share of population

[d] The controls included the logarithmic transformation of GDP, agriculture, absence of corruption, gross fixed capital formation and trade share of GDP. For complete table see Appendix tables A.**??**-**??**

Summary

- disintangle the impact of fertility on human capital
- more control variables (e.g. corruption & agriculture) and created an extensive database.
- constructed our own measures of human capital stock variables
- fertility is only partly compensated by education and health investments in complete panel even when controlling for net migration
- depopulation countries experience even lower levels of compensation
- immigration negatively impacts human capital

- Further research
  - Quality of education
  - Fertility loss vs GDP

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