Galor and Zhang (1998): Fertility, income distribution and economic growth

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Model framework

$$g_t = G_n n + G_Q Q + G_{y_t} y_t + G_e e + G_h h + u_t$$

Predicted partial effects:

$$G_n < 0; G_Q < 0; G_e > 0; G_h < 0; G_{y_t} ?$$

where n is the family size, y_t family income in period t, Q the degree of income inequality, e the average stock of human capital and h the cost for education.

Regressions: per worker output growth rate

Regressions for per-worker output growth rate 1960–1988 (1)

Reg. no.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
Intercept	3.2038	0.1371	3.4815	0.4970	2.6116	−1.1356	2.3107	−1.8019	
	(3.190)	(0.118)	(3.253)	(0.399)	(2.736)	(−1.261)	(2.561)	(−2.028)	
NETFERT	−0.2547	−0.2497	—	—	—	—	—	—	*family size*
	(−2.182)	(−2.124)							
DEPEND	—	—	−1.9071	−1.8720	—	—	—	—	
			(−2.341)	(−2.284)					
GP6088	—	—	—	—	−0.1783	−0.1765	—	—	*population / labor force growth*
					(−1.112)	(−1.099)			
GPW6088	—	—	—	—	—	—	−0.0255	−0.0216	
							(−0.148)	(−0.125)	
GINI	−3.9620	—	−3.8522	—	−4.8819	—	−5.3559	—	*inequality*
	(−2.211)		(−2.145)		(−2.833)		(−3.088)		
BOT60	—	0.0503	—	0.0488		−0.0620	—	0.0679	
		(2.267)		(2.200)		(2.914)		(3.171)	
GDPW60	−0.2011	−0.2004	−0.2028	−0.2022	−0.1883	−0.1881	−0.1796	−0.1793	*initial GDP*
	(−6.056)	(−6.056)	(−5.992)	(−5.994)	(−5.314)	(−5.332)	(−5.413)	(−5.431)	
SCHOOL	0.0293	0.0294	0.0282	0.0283	0.0299	0.0299	0.0320	0.0320	*effective labor units per worker*
	(4.806)	(4.837)	(4.516)	(4.546)	(4.769)	(4.799)	(5.067)	(5.098)	
PUBEDU	0.1785	0.1718	0.1811	0.1745	0.1889	0.1806	0.1801	0.1707	*public education expenditure*
	(1.820)	(1.748)	(1.857)	(1.787)	(1.850)	(1.761)	(1.679)	(1.581)	
R^2	0.3923	0.3929	0.3969	0.3973	0.3747	0.3764	0.3680	0.3698	
$\hat{\sigma}$	1.1801	1.1795	1.1757	1.1753	1.1971	1.1955	1.2035	1.2018	
No. obs.	73	73	73	73	73	73	73	73	

Note: *T*-ratios appear in parentheses. The values are based on the White (1980) heteroskedasticity-consistent covariance matrix.

predicted partial effects: $G_n < 0$; $G_Q < 0$; $G_e > 0$; $G_h < 0$

Things to notice

- predicted signs match empirical observations
- lowering school attendance cost or fertility rates has positive effect on output growth.
- population and labor force growth are insignificant while family size is significant
- lowering the observed population growth from 28 to 20 years decreases the partial effect on per capita output growth
- effect of schooling is really low

Population growth and economic growth

- mortality/ fertility rate is unaffected by population structure
- birth/ death rate is affected by population structure

$\rightarrow$ if demographics change, pop. growth rates change because birth and death rates change.
Population has a weaker effect on economic growth than birth rates because the death rates offset the effect.

- fertility rates affect labor force growth with a lag

(baby boom and then baby bust -> family size might decrease but labor force still grows because of the lag)
$\longrightarrow$ labor force rate and population growth rate in the data have a different effect on economic growth than family size in the context of demographics!

Regressions: per capita growth rate

Table 2
Regressions for per-capita output growth rate 1960–1988 (1)

Reg. no.	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Intercept	2.8598	−0.6834	3.1524	−0.3593	2.3539	−1.6763	2.1227	−3.2203
	(2.571)	(−0.505)	(2.623)	(−0.240)	(2.202)	(−1.653)	(2.027)	(−3.016)
NETFERT	−0.2904	−0.2844	—	—	—	—	—	—
	(−2.060)	(−2.002)						
DEPEND	—	—	−2.1267	−2.0815	—	—	—	—
			(−2.124)	(−2.064)				
GP6088		—	—	—	−0.3039	−0.3026	—	—
					(−1.583)	(−1.574)		
GP6080	—	—	—	—	—	—	−0.1974	—
							(−0.981)	
GPW6088	—	—	—	—	—	—	—	+0.1278
								(0.571)
GINI	−4.5654	—	−4.5176	—	−5.2391	—	−5.5385	—
	(−2.227)		(−2.163)		(−2.668)		(−2.809)	
BOT60	—	0.0582	—	0.0575	—	0.0668	—	0.0800
		(2.299)		(2.232)		(2.775)		(3.300)
GDP60	−0.4897	−0.4888	−0.4981	−0.4969	−0.4616	−0.4630	−0.4412	−0.3820
	(−5.321)	(−5.331)	(−5.246)	(−5.255)	(−4.731)	(−4.767)	(−4.565)	(−4.286)
SCHOOL	0.0367	0.0368	0.0357	0.0359	0.0367	0.0361	0.0377	0.0395
	(5.324)	(5.363)	(5.102)	(5.139)	(5.191)	(5.078)	(5.282)	(5.654)
PUBEDU	0.2289	0.2216	0.2342	0.2269	0.2377	0.2372	0.2346	0.1854
	(2.101)	(2.027)	(2.171)	(2.097)	(2.134)	(2.131)	(2.076)	(1.463)
R^2	0.4239	0.4248	0.4263	0.4269	0.4166	0.4184	0.4094	0.4084
$\hat{\sigma}$	1.3419	1.3409	1.3392	1.3385	1.3505	1.3484	1.3588	1.3599
No. obs.	73	73	73	73	73	73	73	73

Note: T-ratios appear in parentheses. The values are based on the White (1980) heteroskedasticity-consistent covariance matrix.

Reverse causation?

- fertility rate is a better proxy for children the closer we are at the initial point in time
- theory: reverse causation would imply that the population growth coefficient increases over time
- the further away from the initial point in time, the stronger the negative effect gets (GP6080 vs. GP6088)

$\rightarrow$ reverse causation: economic growth affects population growth

Schooling

- schooling impact is not discussed by Galor and Zhang
- schooling: share of primary school attenders of total population for the respective age
- observed values in data set: between 5 and 144
- some children are in other classes than their age would predict

$\rightarrow$ Is this a good indicator? Galor and Zhang show that if there are measurement errors, true results will always be higher than the ones provided. Attenuation bias?
If we falsely measure human capital because the primary schooling attendance rate is an imperfect estimator, the estimator is biased towards zero.
$\rightarrow$ Use a different human capital endowment estimator?

Summary: What do we learn from the study?

- Research question: How to explain cross-country differences in per capita / per worker output growth rates?
- given income distribution, population growth/ labor force growth does not sufficiently explain growth rates across countries while family size does
- given family size, labor force growth does has a **positive** effect!
- larger family size (given income distribution) or larger income distribution (given family size) increases per-capita/ worker output growth.
- combined income inequality and family size together has more explanatory power than each of them separately

$\rightarrow$ Familiy size and income inequality affect the explanatory power of population and labor force growth on per capita / per worker output growth.

Thank you for your attention!

Figures taken from Galor and Zhang (1997)

Appendix: model description

- efficiency units in second period: e for basic education, θe for advanced education. e and $\theta > 1$.
- e is postively related to the average aggregate level of education and country-specific $\rightarrow$ human capital of one generation has an effect on the level of human capital of the next generation. Countries with high human capital will have higher productivity and therefore wages.

Appendix: Family and labor force growth

Table 5
Regressions for per-worker output growth rate 1960–1988 (4);

Reg. no.	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)
Intercept	4.3999	1.1858	3.9739	3.5762	2.7747	−1.3436	3.0350	1.9662
	(3.935)	(4.738)	(3.622)	(3.861)	(2.885)	(−1.491)	(2.830)	(2.262)
NETFERT	−0.7988	—	−0.7196	−0.9076	−0.2168	—	—	—
	(−2.897)		(−2.605)	(−3.836)	(−1.986)			
DEPEND	—	−6.9038	—	—	—	—	−1.6552	—
		(−4.299)					(−2.028)	
GP6088	—	—	—	—	—	−0.1465	—	—
						(−0.915)		
GPW6088	+0.7366	+0.9581	+0.6667	+0.7956	—	—	—	−0.0166
	(2.189)	(3.514)	(1.988)	(2.710)				(−0.102)
INV6088	—	—	0.0264	0.0273	0.0362	0.0398	0.0357	0.0415
			(0.779)	(0.861)	(1.108)	(1.222)	(1.094)	(1.269)
GINI	−3.0698	−2.6389	−3.1084	—	−3.8987	—	−3.7825	−5.0596
	(−1.815)	(−1.594)	(−1.901)		(−2.290)		(−2.236)	(−3.045)
BOT60	—	—	—	—	—	0.0591	—	—
						(2.925)		
GDPW60	−0.2260	−0.2364	−0.2211	−0.2126	−0.1976	−0.1864	−0.1996	−0.1792
	(−7.148)	(−7.017)	(−6.763)	(−6.756)	(−5.891)	(−5.244)	(−5.754)	(−5.330)
SCHOOL	0.0276	0.0235	0.0245	0.0233	0.0248	0.0248	0.0238	0.0263
	(4.680)	(3.851)	(2.866)	(2.711)	(2.908)	(2.956)	(2.864)	(3.030)
PUBEDU	0.0950	0.0790	0.0778	—	0.1440	0.1413	0.1467	0.1397
	(0.843)	(0.768)	(0.671)		(1.421)	(1.328)	(1.456)	(1.273)
R^2	0.4391	0.4658	0.4495	0.4277	0.4126	0.4014	0.4167	0.3954
$\hat{\sigma}$	1.1423	1.1148	1.1404	1.1452	1.1690	1.1800	1.1649	1.1860
No. obs.	73	73	73	73	73	73	73	73

Note: *T*-ratios appear in parentheses. The values are based on the White (1980) heteroskedasticity-consistent covariance matrix.

including GPW and NETFERT: GPW has positive impact, contrast to neoclassical models! Investment impact is not robust.
When family size is controlled for, labor force growth positively affects per worker output growth.

Appendix: high quality data set

Regressions for per-worker output growth rate 1960–1988 (5); using country data of quality ratings C– or above

Reg. no.	(47)	(48)	(49)	(50)	(51)	(52)	(53)	(54)
Intercept	6.1296	1.6341	6.3879	1.9161	6.6630	1.8141	6.8003	2.0396
	(4.352)	(1.178)	(5.000)	(1.296)	(4.893)	(1.355)	(4.575)	(1.391)
NETFERT	−0.3359	−0.3311	—	—	−0.4176	−0.4098	—	—
	(−2.824)	(−2.751)			(−3.710)	(−3.630)		
DEPEND	—	—	−2.3543	−2.3204	—	—	−2.8778	−2.8188
			(−2.792)	(−2.726)			(−3.595)	(−3.520)
GINI	−5.8637	—	−5.8286	—	−6.2088	—	−6.0886	—
	(−2.869)		(−2.880)		(−3.029)		(−2.944)	
BOT60	—	0.0725	—	0.0720	—	0.0793	—	0.0774
		(2.857)		(2.880)		(3.037)		(2.949)
GDPW60	−0.1974	−0.1963	−0.1988	−0.1977	−0.2058	−0.2061	−0.2075	−0.2076
	(−5.998)	(−5.980)	(−5.818)	(−5.815)	(−6.465)	(−6.496)	(−6.141)	(−6.167)
SCHOOL	0.0130	0.0133	0.0119	0.0122	0.0162	0.0167	0.0160	0.0166
	(1.808)	(1.839)	(1.558)	(1.589)	(2.215)	(2.274)	(2.051)	(2.111)
PUBEDU	0.1140	0.1047	0.1201	0.1110	0.0448	0.0345	0.0526	0.0426
	(1.347)	(1.228)	(1.407)	(1.290)	(0.555)	(0.423)	(0.664)	(0.533)
R^2	0.4099	0.4080	0.4129	0.4108	0.5350	0.5359	0.5430	0.5428
$\hat{\sigma}$	1.0363	1.0378	1.0337	1.0355	0.9575	0.9565	0.9491	0.9494
No. obs.	58	58	58	58	45	45	45	45

Note: T-ratios appear in parentheses. The values are based on the White (1980) heteroskedasticity-consistent covariance matrix. Regressions (47)–(50) are from a sample of 58 countries whose data are rated as C– or above by Summers and Heston (1991). Regressions (51)–(54) are from a sample of 45 countries whose data are rated as C or above by Summers and Heston (1991).

Excluding countries with low schooling weakens explanatory power of SCHOOL.

NETFERT gets stronger and stronger the smaller the sample size

$\rightarrow$ is the effect weaker for bigger sample size?

Appendix: Trivia

- investment: low significance in all regressions
- reverse causation: values too high because per worker output growth affects investment ratio $\rightarrow$ in reality, values might be even lower