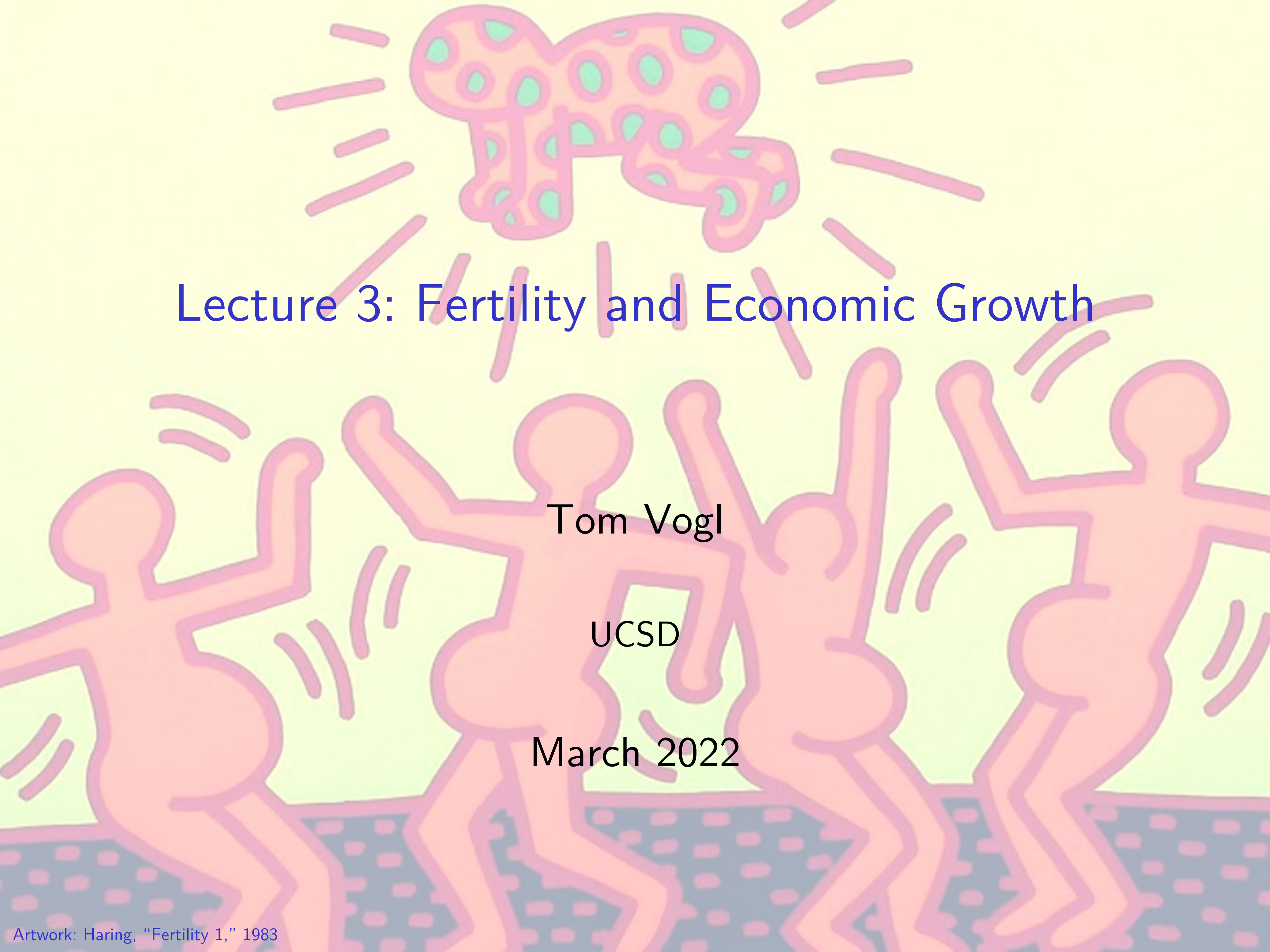


Lecture 3: Fertility and Economic Growth

Tom Vogl

UCSD

March 2022

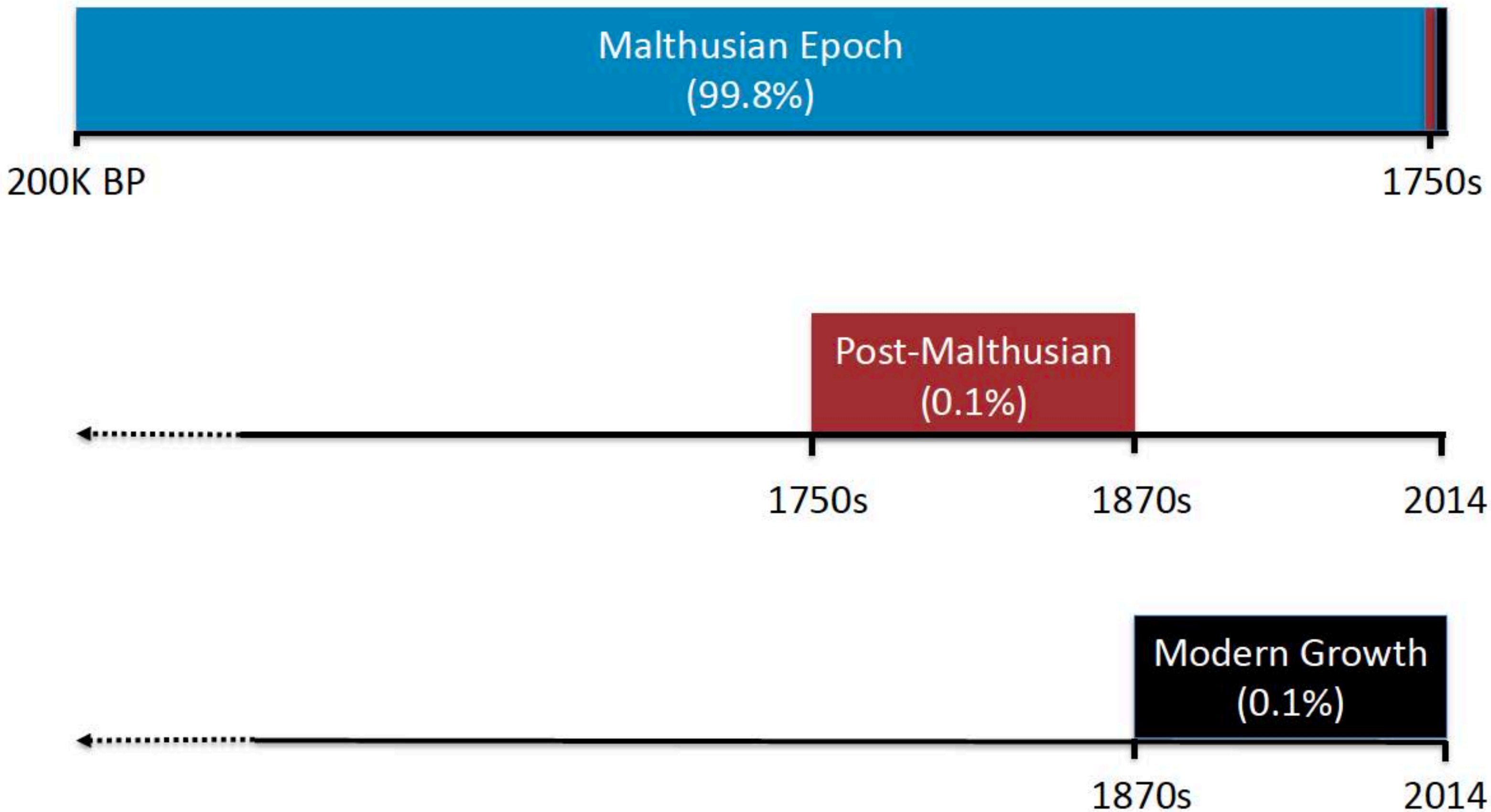
Artwork: Haring, "Fertility 1," 1983

A Timeline of Development over the Long Run

Per Galor (2005), three broad eras:

1. Malthusian Epoch: living standards stagnant, population growth slow.
2. Post-Malthusian Regime: living standards and population both grow.
3. Modern Growth Regime: living standards grow, population slows.

A Timeline of Development over the Long Run



The Malthusian "Epoch"

Central features:

- Positive effects of income on population growth.
- Fixed factor of production (land) → diminishing returns to labor.

Technological progress...

- increases income per capita in short run.
- increases population as long as income remains above "subsistence level."
- leaves income per capita unchanged in the long run.

Technologically advanced and land-rich economies have...

- higher population density.
- similar levels of income per capita in long run.

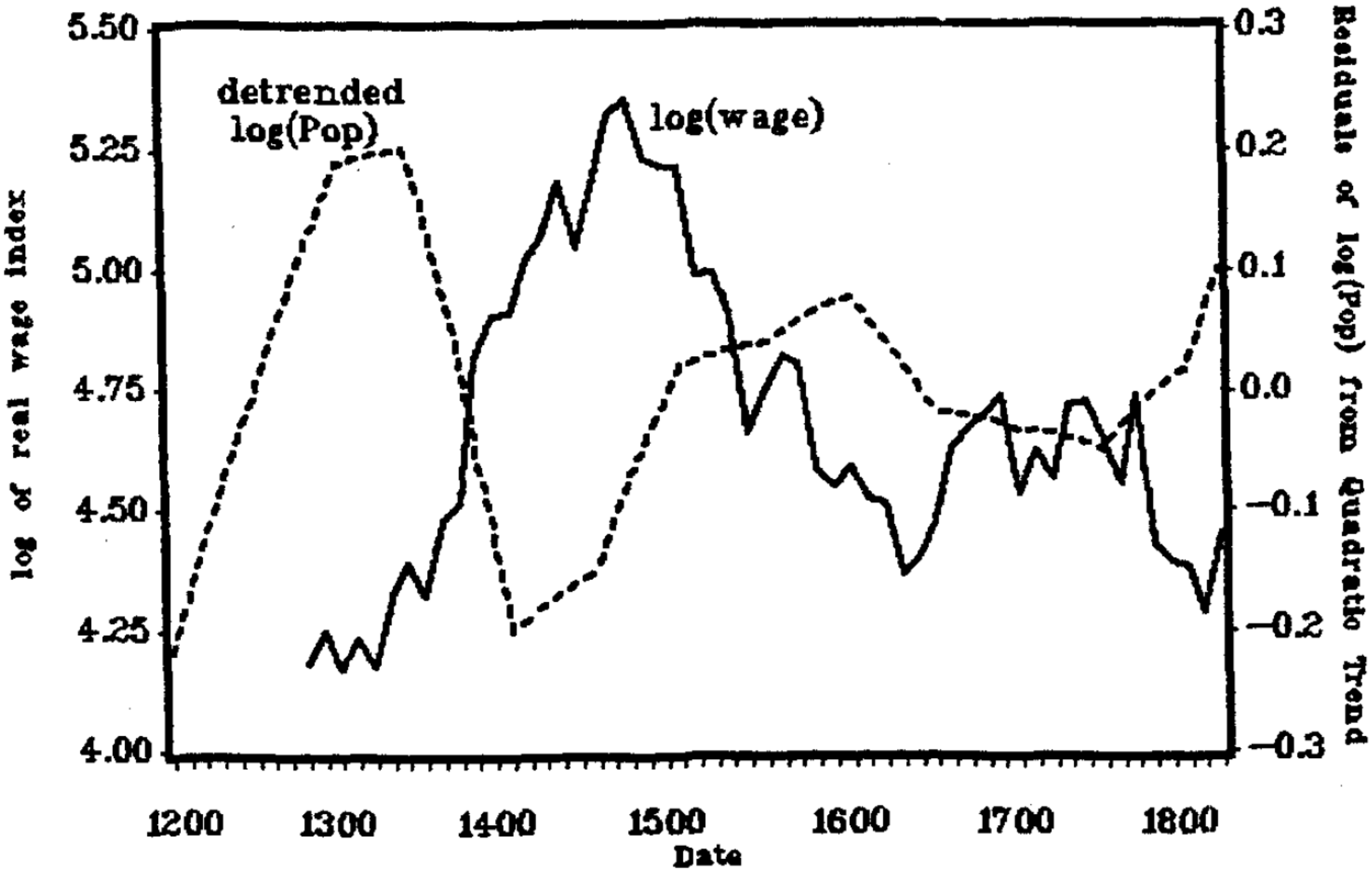


Fig. 2. Population and real wages in Europe, 1200 to 1830. Real wages and population size are based on data from England, France, Italy, Germany, Spain, Austria and Poland. Demographic data come from McEvedy and Jones (1978) modified after 1500 based on DeVries (1984), with details on the timing of turning points derived from country-specific sources. Wage data are for unskilled workers, deflated by grain prices. For English wages, the Phelps-Brown and Hopkins series as modified by Wrigley and Schofield (1981) was used, and as the longest series it served as the template in forming the European average. For some countries, multiple wage series were combined.

Lee (1997)

Table 1
Cumulative elasticities of fertility and mortality with respect to real incomes: median values for sets of studies for four regions[a]

	Fertility	Mortality
Preindustrial Europe (14)	+0.12	–0.15
Asia (7)	+0.26	–0.19
Latin America (9)	+0.31	–0.20
Sub-Saharan Africa (7)	+0.32	–0.30

[a]The number of populations studied is given in parentheses. For Europe and Asia, most of the elasticities are for the negative of food prices. For Latin America and sub-Saharan Africa, most of the elasticities are with respect to per capita GNP. For Africa, retrospective individual demographic data are used; for other regions, aggregate rates are used.
Sources: For preindustrial Europe and Asia, see Lee (1990). For mortality in Latin America, see Palloni and Hill (1992); for fertility in Latin America, see Reher and Ortega-Osona (1992). For sub-Saharan Africa, see National Research Council (1993).

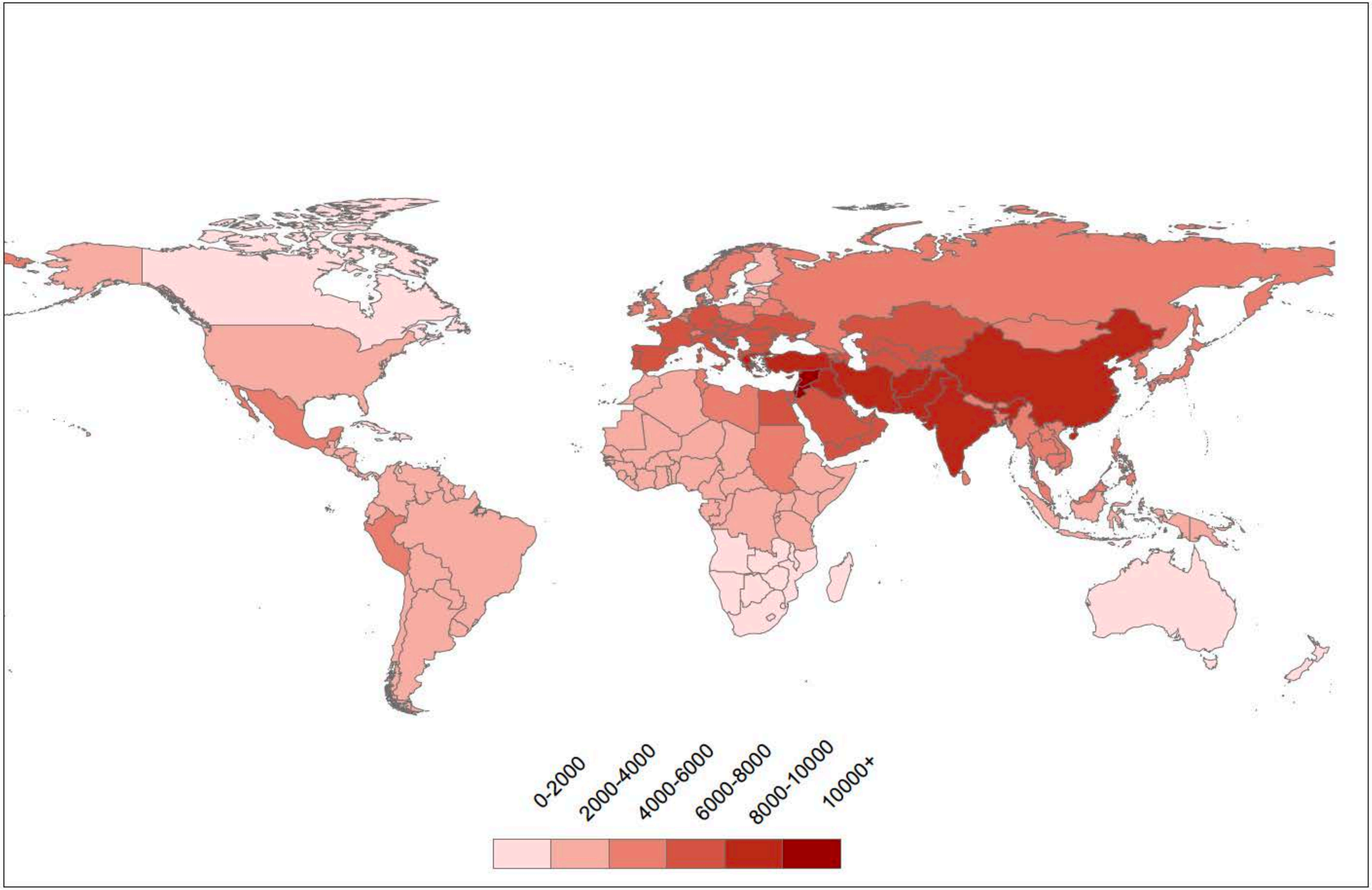
Lee (1997)

Dynamics and Stagnation in the Malthusian Epoch†

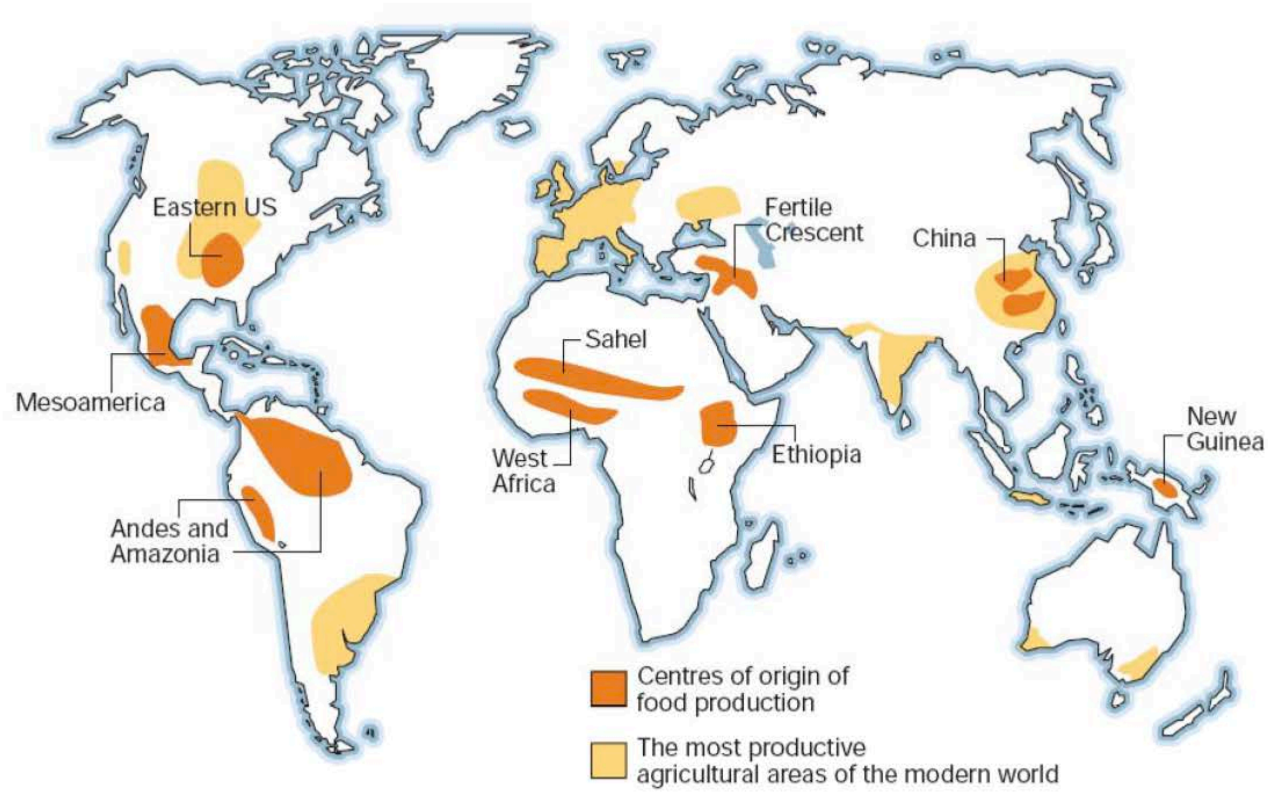
By Quamrul Ashraf and Oded Galor*

This paper examines the central hypothesis of the influential Malthusian theory, according to which improvements in the technological environment during the preindustrial era had generated only temporary gains in income per capita, eventually leading to a larger, but not significantly richer, population. Exploiting exogenous sources of cross-country variations in land productivity and the level of technological advancement, the analysis demonstrates that, in accordance with the theory, technological superiority and higher land productivity had significant positive effects on population density but insignificant effects on the standard of living, during the time period 1–1500 CE. (*JEL* N10, N30, N50, O10, O40, O50)

Ashraf/Galor: Onset of Neolithic Revolution

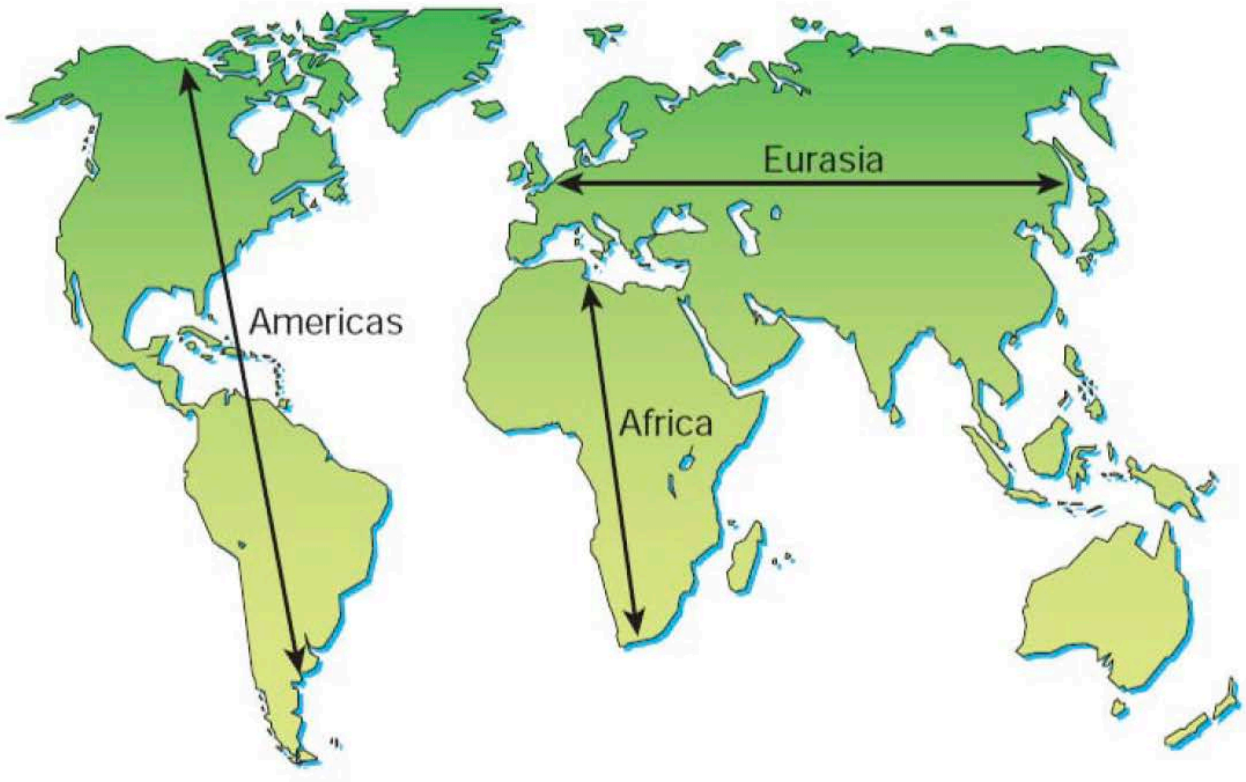


Ashraf/Galor: Onset of Neolithic Revolution



Source: Diamond (Nature 2002)

Ashraf/Galor: Onset of Neolithic Revolution



Source: Diamond (Nature 2002)

TABLE 5—EFFECTS ON INCOME PER CAPITA VERSUS POPULATION DENSITY

Dependent variable is:	Log income per capita in:			Log population density in:		
	1500 CE	1000 CE	1 CE	1500 CE	1000 CE	1 CE
	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Log years since Neolithic transition	0.159	0.073	0.109	1.337**	0.832**	1.006**
	(0.136)	(0.045)	(0.072)	(0.594)	(0.363)	(0.481)
Log land productivity	0.041	−0.021	−0.001	0.584***	0.364***	0.681**
	(0.025)	(0.025)	(0.027)	(0.159)	(0.110)	(0.255)
Log absolute latitude	−0.041	0.060	−0.175	0.050	−2.140**	−2.163**
	(0.073)	(0.147)	(0.175)	(0.463)	(0.801)	(0.979)
Mean distance to nearest coast or river	0.215	−0.111	0.043	−0.429	−0.237	0.118
	(0.198)	(0.138)	(0.159)	(1.237)	(0.751)	(0.883)
Percentage of land within 100 km of coast or river	0.124	−0.150	0.042	1.855**	1.326**	0.228
	(0.145)	(0.121)	(0.127)	(0.820)	(0.615)	(0.919)
Continent dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	31	26	29	31	26	29
R^2	0.66	0.68	0.33	0.88	0.95	0.89

Notes: This table establishes, consistently with Malthusian predictions, the relatively small effects of land productivity and the level of technological advancement, as proxied by the timing of the Neolithic Revolution, on income per capita in the years 1500 CE, 1000 CE, and 1 CE, but their significantly larger effects on population density in the same time periods, while controlling for access to navigable waterways, absolute latitude, and unobserved continental fixed effects. Log land productivity is the first principal component of the log of the percentage of arable land and the log of an agricultural suitability index. A single continent dummy is used to represent the Americas, which is natural given the historical period examined. Regressions (2)–(3) and (5)–(6) do not employ the Oceania dummy due to a single observation for this continent in the corresponding regression samples, restricted by the availability of income per capita data. Robust standard error estimates are reported in parentheses.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Unified Growth Theory

Literature attempts to build a coherent framework capturing the Malthusian regime, the modern growth regime, and the transition between the two.

- Most prominent author is Oded Galor (author of *Unified Growth Theory*).
- Most papers use a similar Q-Q model embedded in an overlapping generations framework.

Some important papers:

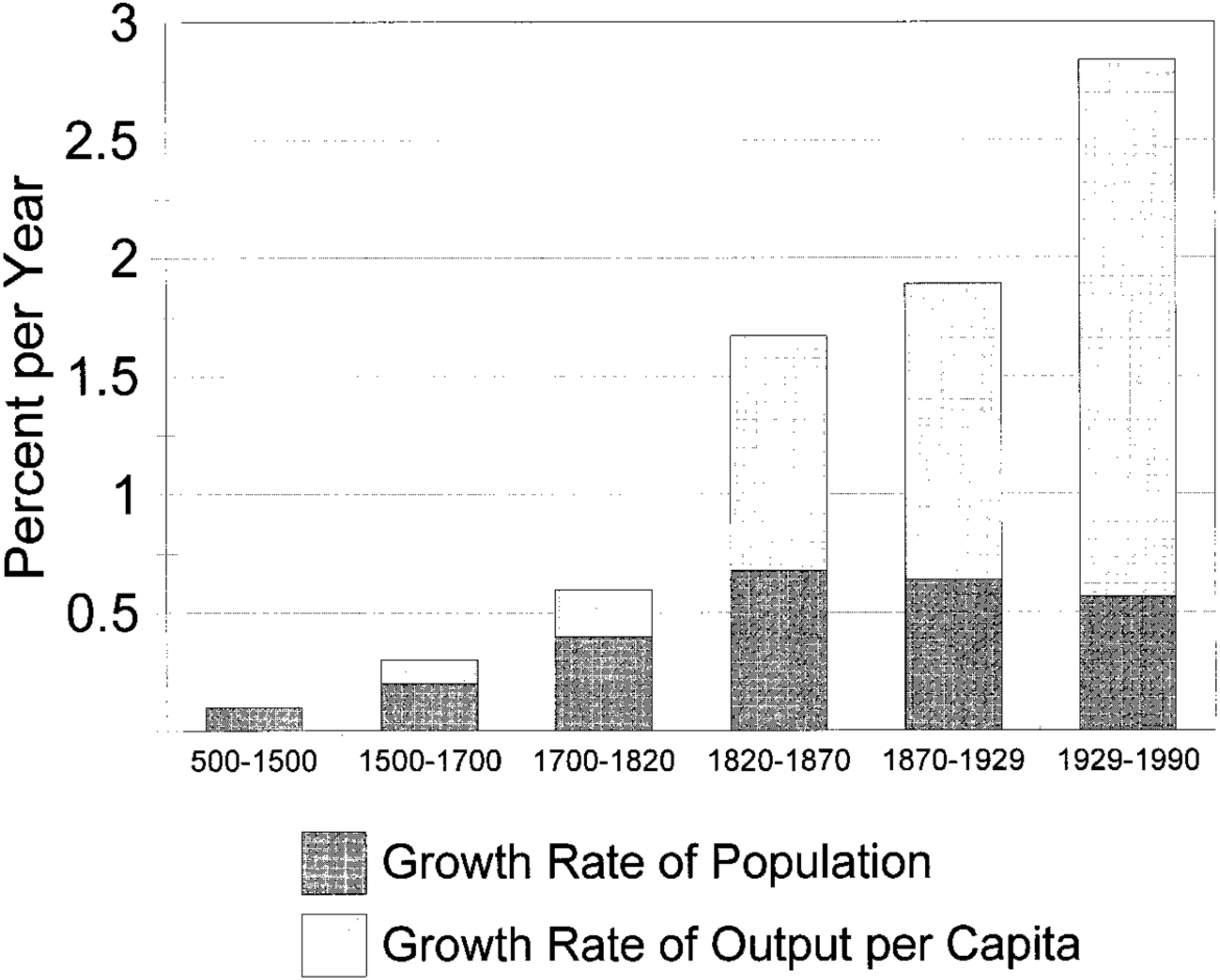
- Becker et al. (1990): human capital externalities.
- Galor & Weil (1996): capital accumulation (w/ exogenous technological progress) and women's work.
- Galor & Weil (2000): scale effects & subsistence consumption.
- Galor & Moav (2002): preference heterogeneity, human capital externalities and subsistence consumption.
- Hansen & Prescott (2002): Malthus and Solow sectors with exogenous productivity growth. No microfoundation for population.

Population, Technology, and Growth: From Malthusian Stagnation to the Demographic Transition and Beyond

By ODED GALOR AND DAVID N. WEIL*

This paper develops a unified growth model that captures the historical evolution of population, technology, and output. It encompasses the endogenous transition between three regimes that have characterized economic development. The economy evolves from a Malthusian regime, where technological progress is slow and population growth prevents any sustained rise in income per capita, into a Post-Malthusian regime, where technological progress rises and population growth absorbs only part of output growth. Ultimately, a demographic transition reverses the positive relationship between income and population growth, and the economy enters a Modern Growth regime with reduced population growth and sustained income growth. (*JEL* J13, O11, O33, O40)

Growth in Western Europe



Main Transitions in Model

Transition from Malthusian to Post-Malthusian Regime:

- Faster rates of technological progress.
- Faster rate of population growth.
- Insignificant investment in human capital.
- Growth of income per capita.

Transition from the Post-Malthusian to Modern Growth Regime:

- Faster rate of technological progress.
- Faster rate of human capital accumulation.
- Decline in population growth.
- Faster growth of income per capita.

Underlying forces governing these transitions:

- Changes in the technological environment → population size and quality.
- Changes in the size and quality of the population → technological progress.

Goods Production

Overlapping-generations economy: $t = 0,\ 1,\ 2,\ 3...$

Two factors of production:

- Land: X.
  - Fixed.
- Labor: H.
  - Measured in efficiency units.
  - Determined by HH decision about number, human capital of children.

One homogeneous good produced by Cobb-Douglas technology:

$$Y_t = H_t^{\alpha}(A_t X)^{1-\alpha}$$

So output per worker is:

$$y_t = h_t^{\alpha} x_t^{1-\alpha}$$

- $h = H/L =$ efficiency units per worker
- $x = AX/L =$ effective resources per worker

Technological Progress

Technology growth depends on size and quality of population:

$$g_{t+1} \equiv \frac{A_{t+1} - A_t}{A_t} = g(e_t, L_t)$$

Education has a positive and diminishing effect on tech. progress:

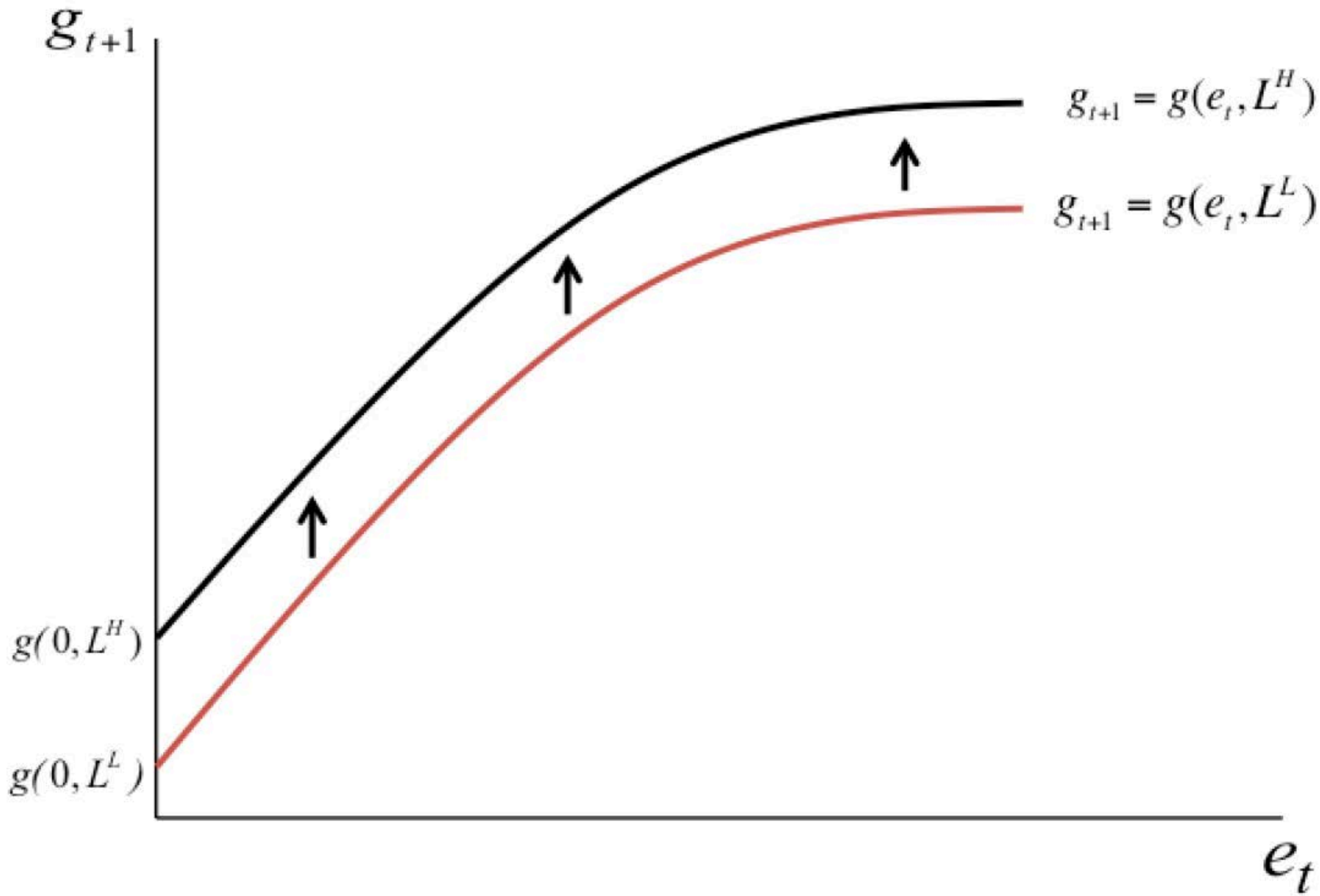
$$g_e(e_t, L_t) > 0 \text{ and } g_{ee}(e_t, L_t) < 0$$

Scale of the economy also has a positive and diminishing effect:

$$g_L(e_t, L_t) > 0 \text{ and } g_{LL}(e_t, L_t) < 0$$

Technological progress is positive at the outset:

$$g(0, L) > 0 \text{ for } L > 0$$


g_{t+1}
$g_{t+1} = g(e_t, L^H)$
$g_{t+1} = g(e_t, L^L)$
$g(0, L^H)$
$g(0, L^L)$
e_t

Individuals

Live for two periods.

Childhood (1st Period):

- Consume a fraction of parental time endowment.
  - $\tau =$ time required to raise a child, regardless of quality.
  - $\tau + e_{t+1} =$ time to raise a child with education e_{t+1}.

Parenthood (2nd Period):

- Allocate time endowment between childrearing and work.
- Choose the optimal mixture of child quantity and quality.
- Consume.

Utility:

$$u^t = (1-\gamma)\ln(c_t) + \gamma \ln(n_t h_{t+1})$$

where $c =$ parental consumption, $n = \#$ kids, and $h =$ human capital per kid.

Constraints

Budget constraint:

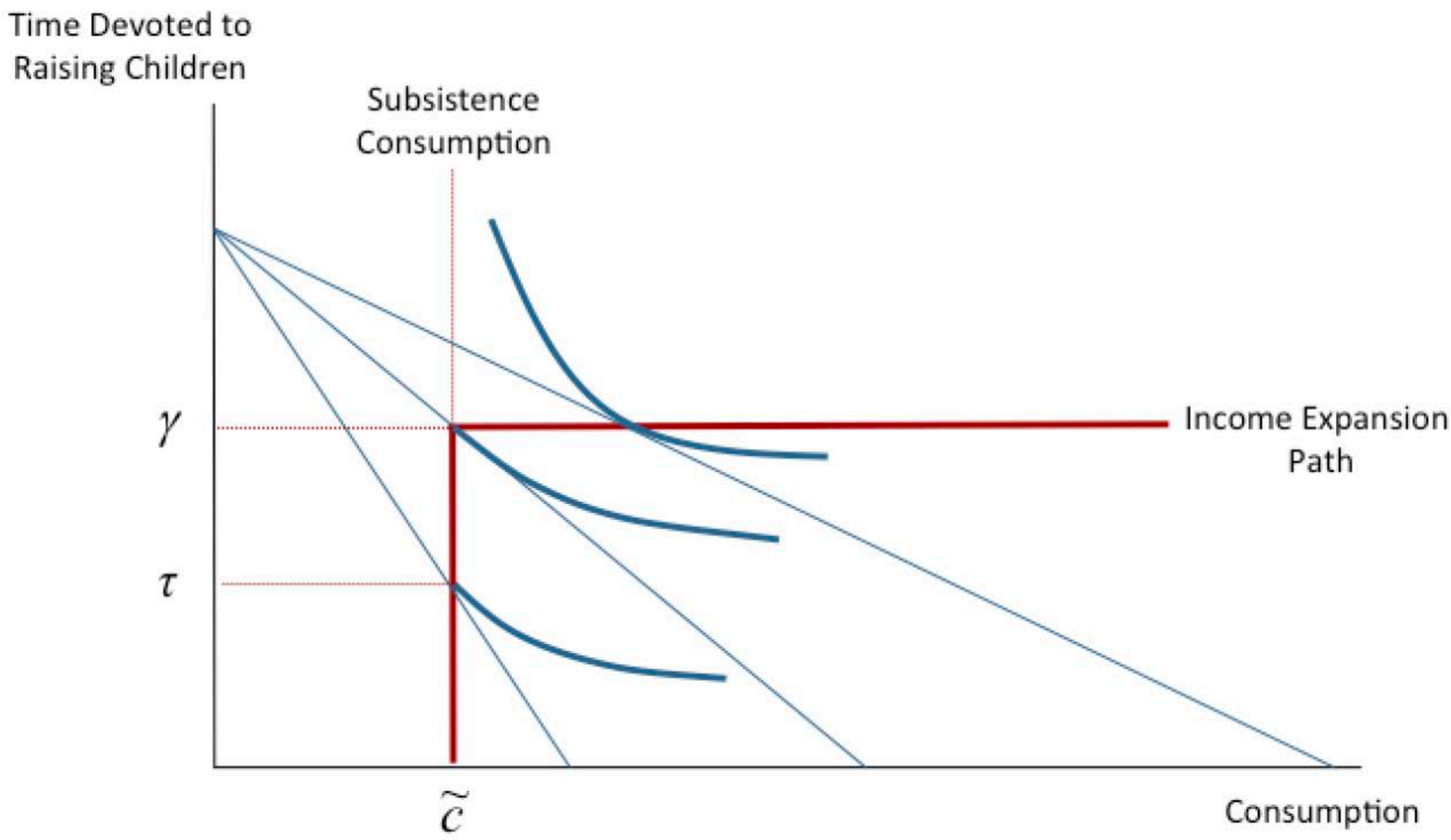
$$z_t n_t(\tau + e_{t+1}) + c_t \leq z_t$$

where z is potential income:

$$z_t \equiv y_t = h_t^{\alpha} x_t^{1-\alpha} = z(e_t, g_t, x_t)$$

Subsistence consumption constraint:

$$c_t \geq \tilde{c}$$


Time Devoted to
Raising Children
Subsistence
Consumption
γ
τ
Income Expansion
Path
c̃
Consumption

Human Capital Production

Production function:

$$h_{t+1} = h(e_{t+1}, g_{t+1})$$

HC is increasing (at decreasing rate) in parental time investment in ed.:

$$h_e(e,g) > 0 \text{ and } h_{ee}(e,g) < 0$$

Obsolescence of HC in a changing technological environment:

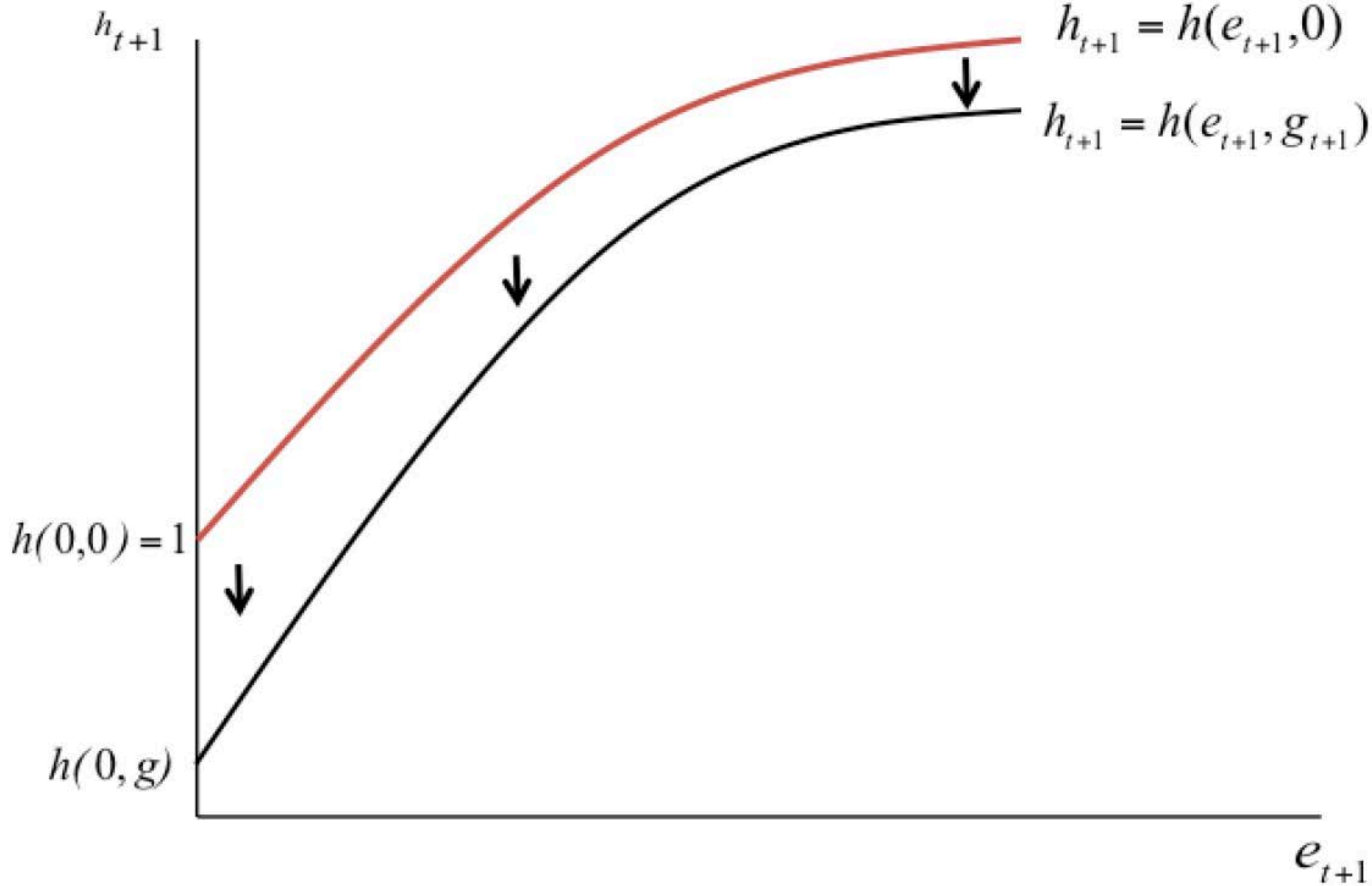
$$h_g(e,g) < 0 \text{ and } h_{gg}(e,g) > 0$$

Education lessens obsolescence of HC in a changing tech. environment:

$$h_{eg}(e,g) > 0$$

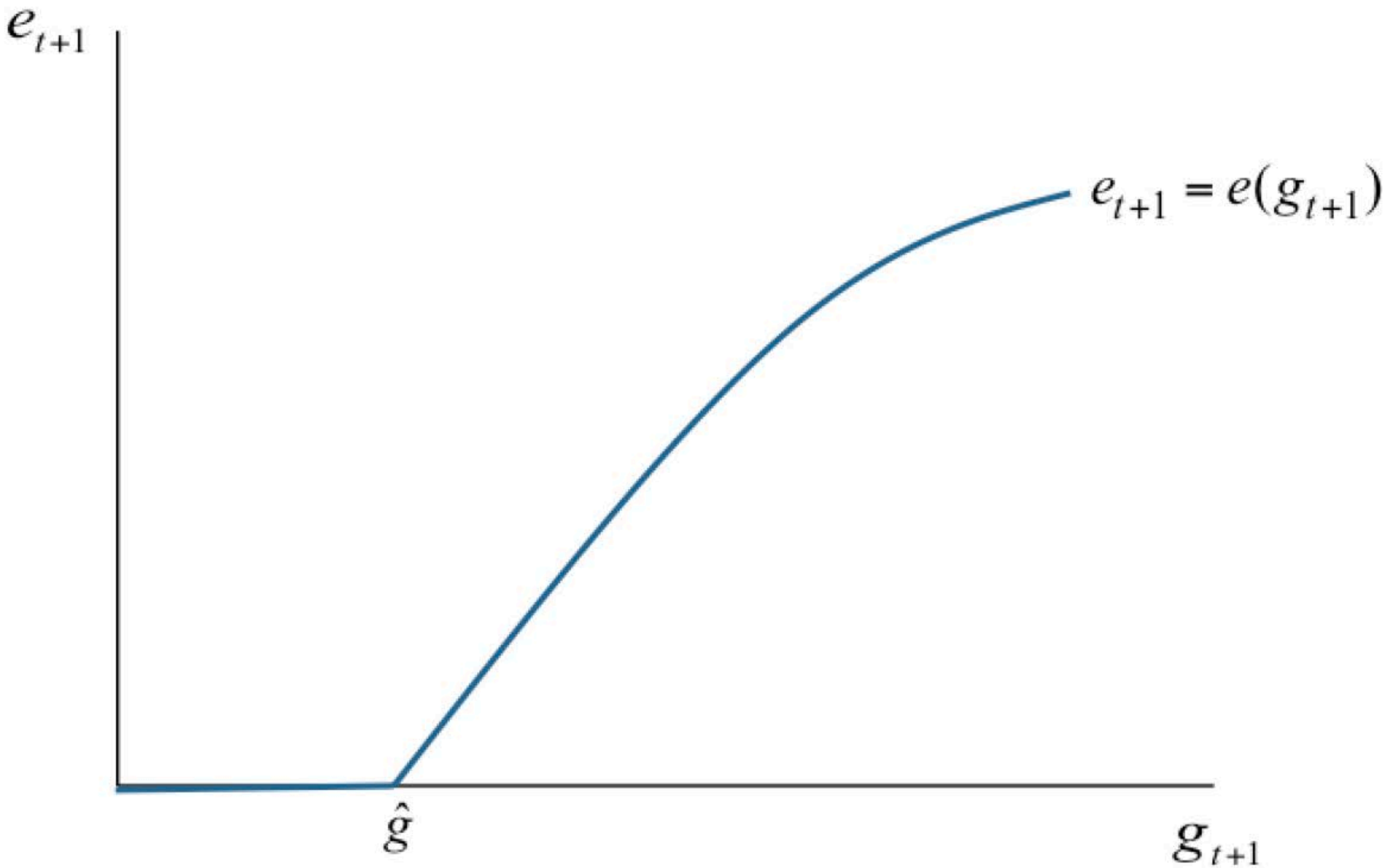
Basic endowment of human capital:

$$h(0,g) > 0$$



h_{t+1}
$h_{t+1} = h(e_{t+1}, 0)$
$h_{t+1} = h(e_{t+1}, g_{t+1})$
$h(0,0) = 1$
$h(0, g)$
e_{t+1}

Optimal Human Capital Investment



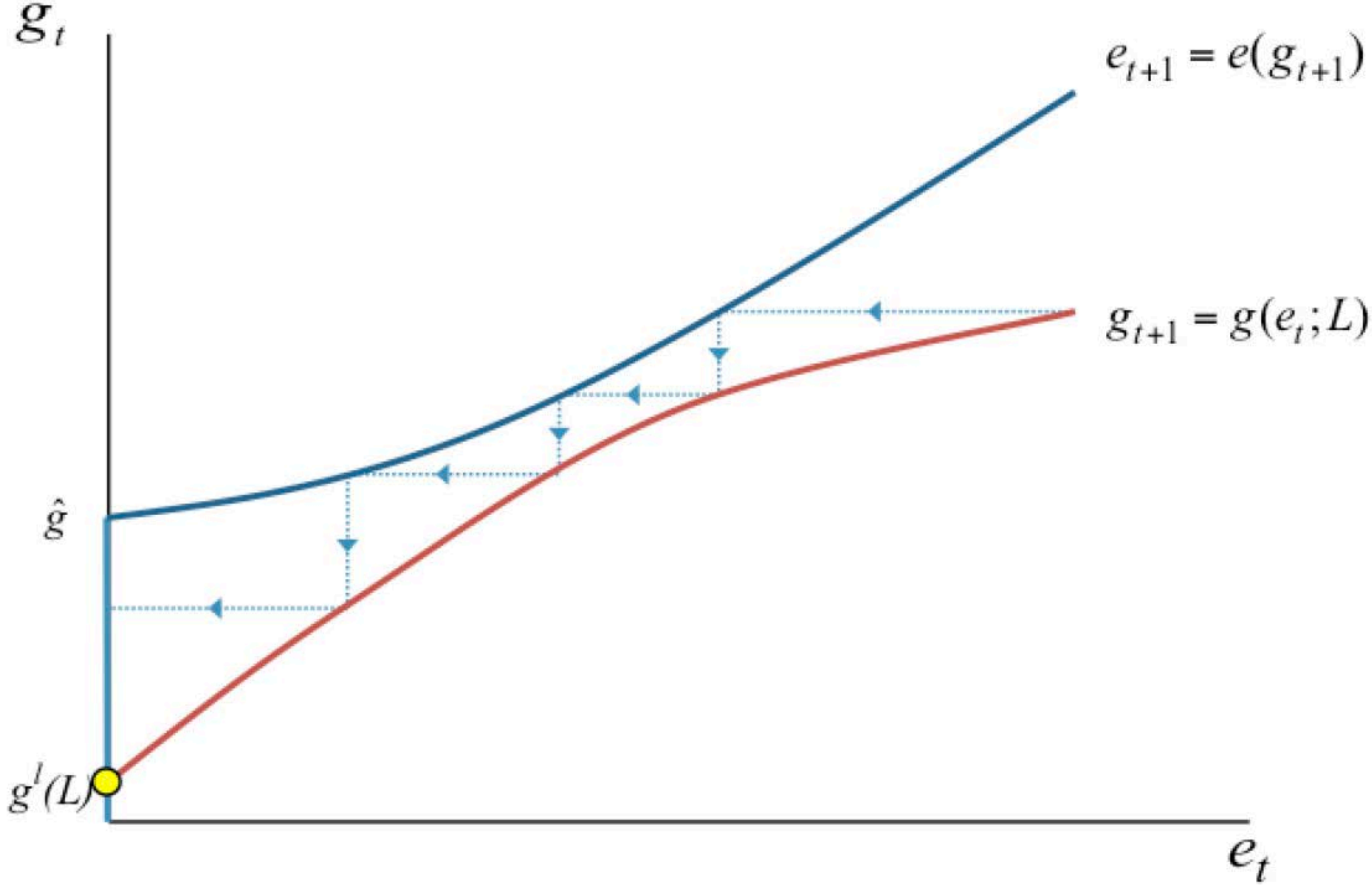
Dynamics

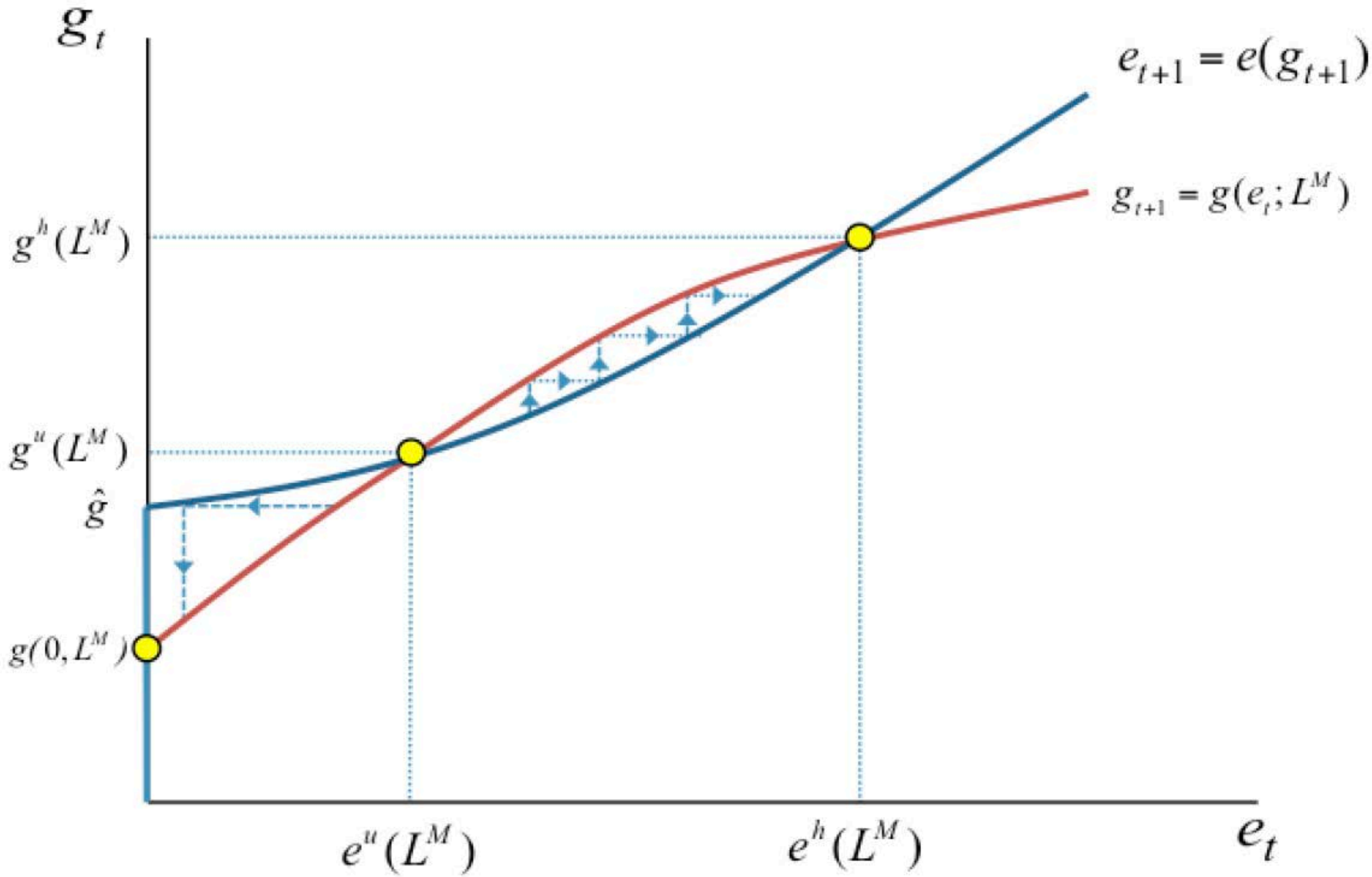
Dynamical system → sequence $\{x_t, e_t, g_t, L_t\}_{t=0}^{\infty}$ s.t.:

$$x_{t+1} = \phi(e_t, g_t, x_t, L_t)x_t$$
$$e_{t+1} = e(g(e_t, L_t))$$
$$g_{t+1} = g(e_t, L_t)$$
$$L_{t+1} = n(e_t, g_t, x_t, L_t)L_t$$

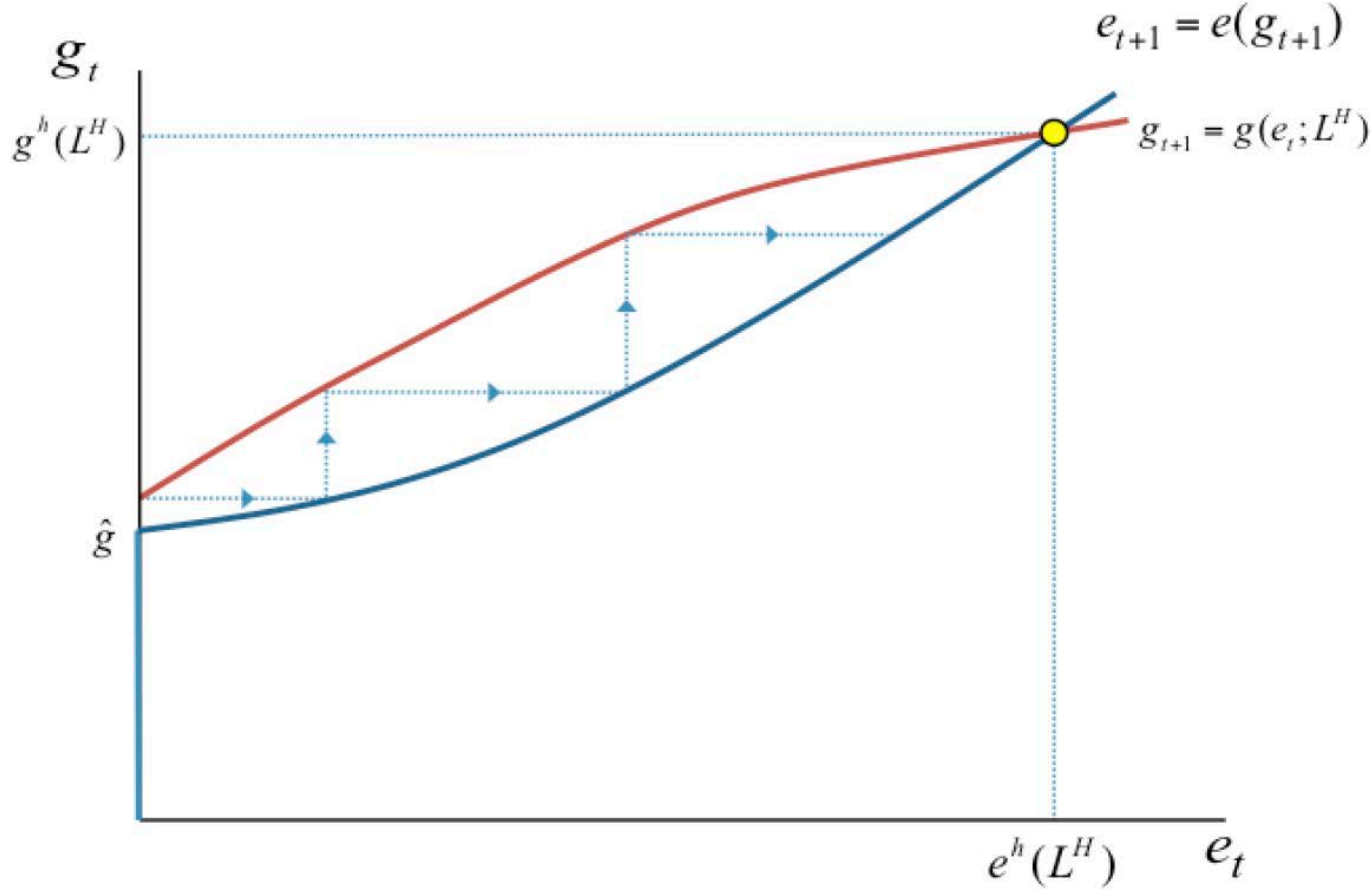
Conditional evolution of ed. & tech. → sequence $\{g_t, e_t; L\}_{t=0}^{\infty}$ s.t.:

$$g_{t+1} = g(e_t; L)$$
$$e_{t+1} = e(g_{t+1})$$


g_t
$e_{t+1} = e(g_{t+1})$
$g_{t+1} = g(e_t; L)$
$\hat{g}$
$g^l(L)$
e_t



g_t
$e_{t+1} = e(g_{t+1})$
$g_{t+1} = g(e_t; L^M)$
$g^h(L^M)$
$g^u(L^M)$
$\hat{g}$
$g(0, L^M)$
$e^u(L^M)$
$e^h(L^M)$
e_t



g_t
$e_{t+1} = e(g_{t+1})$
$g^h(L^H)$
$g_{t+1} = g(e_t; L^H)$
$\hat{g}$
$e^h(L^H)$
e_t

Summary of Model Dynamics

Malthusian interaction between technology and population.

Acceleration in technological progress.
→ Demand for human capital.

Human capital formation.
→ Decline in fertility rates.
→ Further technological progress.

Decline in population growth.
→ Economic growth is freed from counterbalancing effects of population.

Technological progress, human capital and decline in population growth.
→ Sustained economic growth.

Coale's Conditions for Fertility Decline

Ansley Coale's (1973) preconditions for fertility decline:

1. Fertility must be 'within the calculus of conscious choice.'
2. Reduced fertility must seem to confer some advantage to couples.
3. Couples must know some means of birth control, be determined to use it, and communicate sufficiently to be able to use it effectively.

Economists generally think (1) is guaranteed, (3) is usually present but to a varying extent, while (2) is the key to fertility decline. Other social scientists may disagree.

Demand is Important

In a famous paper, Lant Pritchett (1994) compares the actual fertility rate with survey measures of how many children women "want."

Actual fertility is measured as the total fertility rate (TFR).

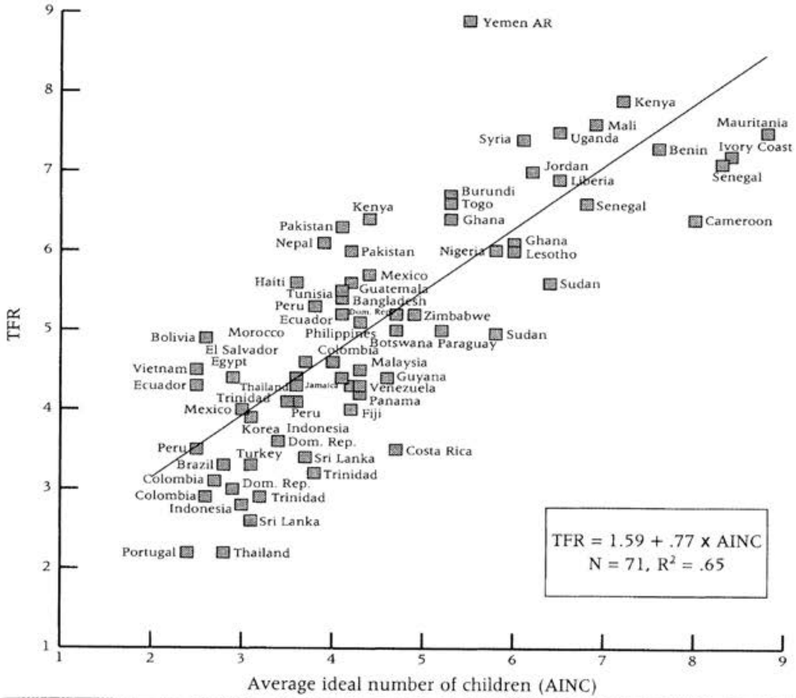
Wanted fertility is measured as...

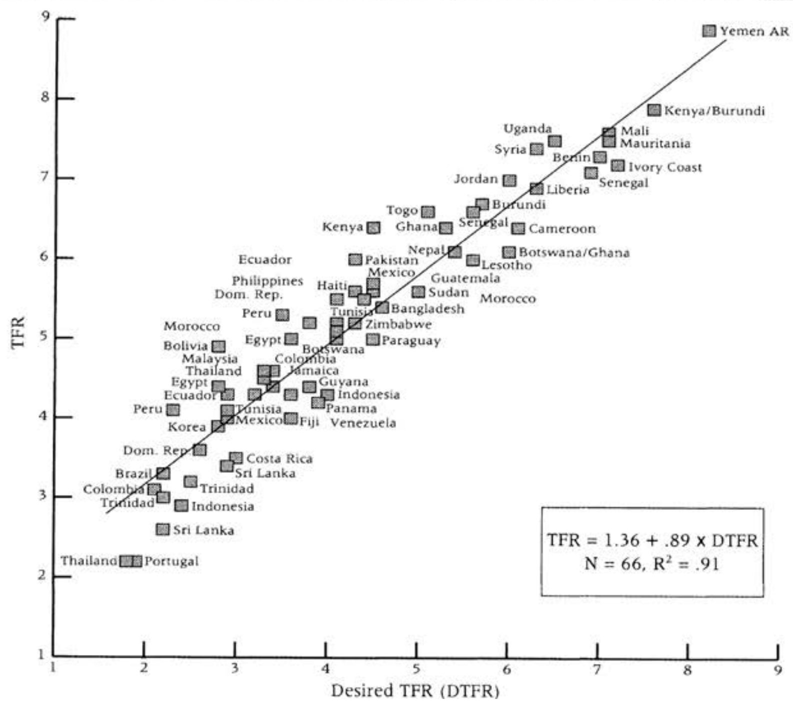
- Average ideal number of children (AINC): average of survey responses to "how many children is ideal?"
- Desired total fertility rate (DTFR): same as the TFR, but omits any births that exceed the woman's stated ideal family size.
- Wanted total fertility rate (WTFR): same as DTFR, but only count births if the woman says she still wants *more* children.

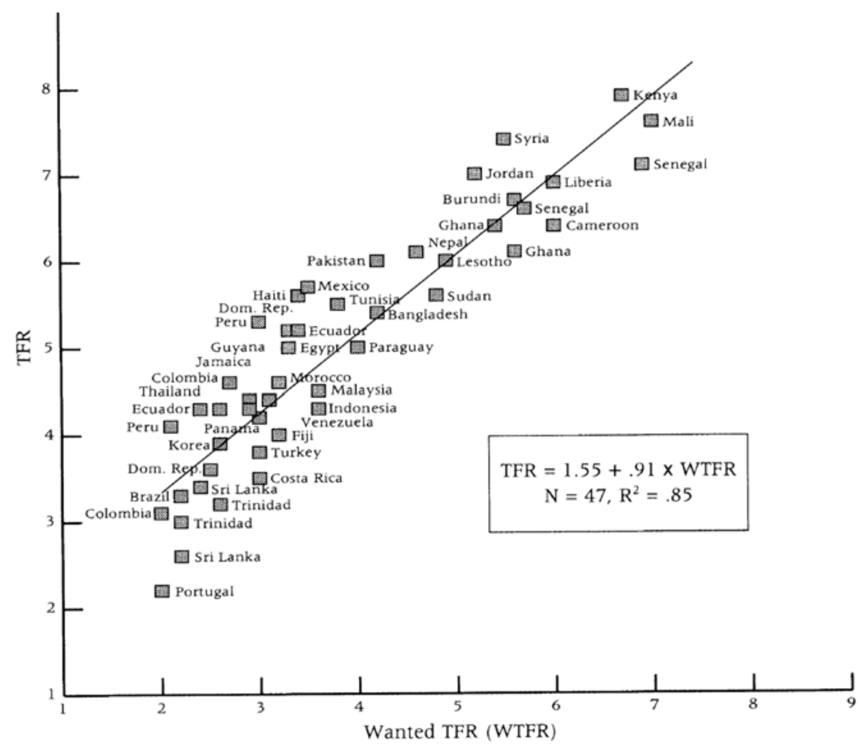
Pritchett was responding to demographers and public health advocates who claimed an "unmet need" for family planning services.

Desired Fertility and the Impact of Population Policies

LANT H. PRITCHETT







Desired Fertility and Number of Children Born Across Time and Space

Isabel Günther[1] **· Kenneth Harttgen**[1]

Published online: 19 January 2016

Abstract Economists have often argued that high fertility rates are mainly driven by women's demand for children (and not by family planning efforts) with low levels of unwanted fertility across countries (and hence with little room for family planning efforts to reduce population growth). We study the relationship between wanted fertility and number of children born in a panel of 200 country-years controlling for country fixed effects and global time trends. In general, we find a close relationship between wanted and actual fertility, with one desired child leading to one additional birth. However, our results also indicate that in the last 20 years, the level of unwanted births has stayed at 2 across African countries but has, on average, decreased from 1 to close to 0 in other developing countries. Hence, women in African countries are less able to translate child preferences into birth outcomes than women in other developing countries, and forces other than fertility demand have been important for previous fertility declines in many developing countries. Family planning efforts only partially explain the observed temporal and spatial differences in achieving desired fertility levels.

Table 2 Regression results for the total sample: OLS and panel

	Pritchett (1994a) Sample (OLS) (1)	Pritchett (1994a) Sample (OLS) (2)	Total Sample (OLS) (3)	Total Sample (OLS) (4)	Total Sample (OLS) (5)	Total Sample (Panel) (6)	Total Sample (Panel) (7)	Total Sample (Panel) (8)
DTFR	0.882**		1.081**			0.945**		
	(0.0367)		(0.0233)			(0.0527)		
WTFR		0.903**		0.990**			0.734**	
		(0.0646)		(0.0316)			(0.0737)	
wTFR					0.913**			0.717**
					(0.0285)			(0.0598)
1985–1989						1.602**	2.159**	2.332**
						(0.200)	(0.295)	(0.237)
1990–1992						1.364**	1.804**	2.001**
						(0.184)	(0.275)	(0.220)
1992–1997						1.293**	1.731**	1.885**
						(0.164)	(0.242)	(0.195)
1998–2004						1.158**	1.560**	1.709**
						(0.155)	(0.229)	(0.185)
2005–2008						1.100**	1.434**	1.606**
						(0.151)	(0.225)	(0.182)
2009–2012						1.011**	1.336**	1.508**
						(0.155)	(0.229)	(0.187)
Constant	1.372**	1.565**	0.715**	1.004**	1.379**			
	(0.171)	(0.261)	(0.0861)	(0.117)	(0.105)			
Country FE						Yes	Yes	Yes
Observations	66	47	199	202	199	172	172	171
R^2	.900	.813	.916	.831	.839	.999	.998	.998

Long-Run Trends in Fertility: Some Explanations

1. Rising income (Becker, Becker & Lewis).
   - Rising opportunity costs of kids.
   - Higher income elasticity of child quality than child quantity.
2. Rising women's labor force participation (Galor & Weil).
   - Related to rising opportunity costs of kids.
   - Driven by technological progress.
3. Rising return to human capital (Galor & Weil).
   - Driven by technological progress.
4. Declining child labor (Hazan & Berdugo, Galor & Moav, Doepke).
   - Closely related to rising return to HC.

Long-Run Trends in Fertility: Some Explanations

5. Declining mortality (Doepke, Moav, Soares).
   - Need to have fewer births to attain a given surviving number of offspring.
   - Additional precautionary motive?
   - $\Uparrow$ life expectancy, $\Uparrow$ incentive to invest in HC.
6. Expanding alternatives for old-age savings (Boldrin & Jones, Caldwell).
7. Diffusion of norms/ideas (Pton. Fertility Project, Wacziarg & Spolaore).
   - But still need a reason for optimal fertility to change.
8. Preference evolution (Galor & Moav).
   - Natural selection first promotes growth of "quality type" then promotes growth of "quantity type."

Gross vs. Net Fertility

Conventional wisdom: child mortality decline is key for fertility decline.

Most economic models implicitly focus on the demand for surviving children.

A subset of the literature focuses explicitly on how mortality risk shapes fertility (Doepke, Kalemli-Ozcan, Soares).

Two features of childbearing are key:

- Most pre-adult mortality happens right at the beginning of life, before human capital investment is complete.
- Fertility is sequential. Due to $\uparrow$, parents may adjust after a child's death.

Does mortality decline decrease gross fertility? Probably, but with unclear lag.

Does mortality decline decrease net fertility? Probably not.

- In setup without sequential childbearing, need a very high precautionary demand for kids. Otherwise, net fertility rises due to $\downarrow$ child costs.
- With sequential childbearing, even harder.

Skill Returns and Fertility Decline

Many of the remaining theories can be characterized as an increase in the return to skill or investment in children.

- Women's wages rise due to a rising relative return to cognitive skill.
- Child labor falls because it becomes more worthwhile to keep kids in school.
- Increased longevity makes child investment more worthwhile.

Some micro evidence to support this class of theories, but very difficult to isolate particular mechanisms.

For example, does an expansion in free public primary schools...

- Increase the return to human capital investment?
- Increase the human capital endowment of children?
- Decrease the time cost of children?

Also, tough issues re: extensive/intensive margin of fertility (Aaronson et al.).

Escaping Malthus: Economic Growth and Fertility Change in the Developing World[†]

By Shoumitro Chatterjee and Tom Vogl*

Following mid-twentieth century predictions of Malthusian catastrophe, fertility in the developing world more than halved, while living standards more than doubled. We analyze how fertility change related to economic growth during this episode, using data on 2.3 million women from 255 household surveys. We find different responses to fluctuations and long-run growth, both heterogeneous over the life cycle. Fertility was procyclical but declined and delayed with long-run growth; fluctuations late (but not early) in the reproductive period affected lifetime fertility. The results are consistent with models of the escape from the Malthusian trap, extended with a life cycle and liquidity constraints. (*JEL* D15, I12, I15, J13, J16, O15, O47)

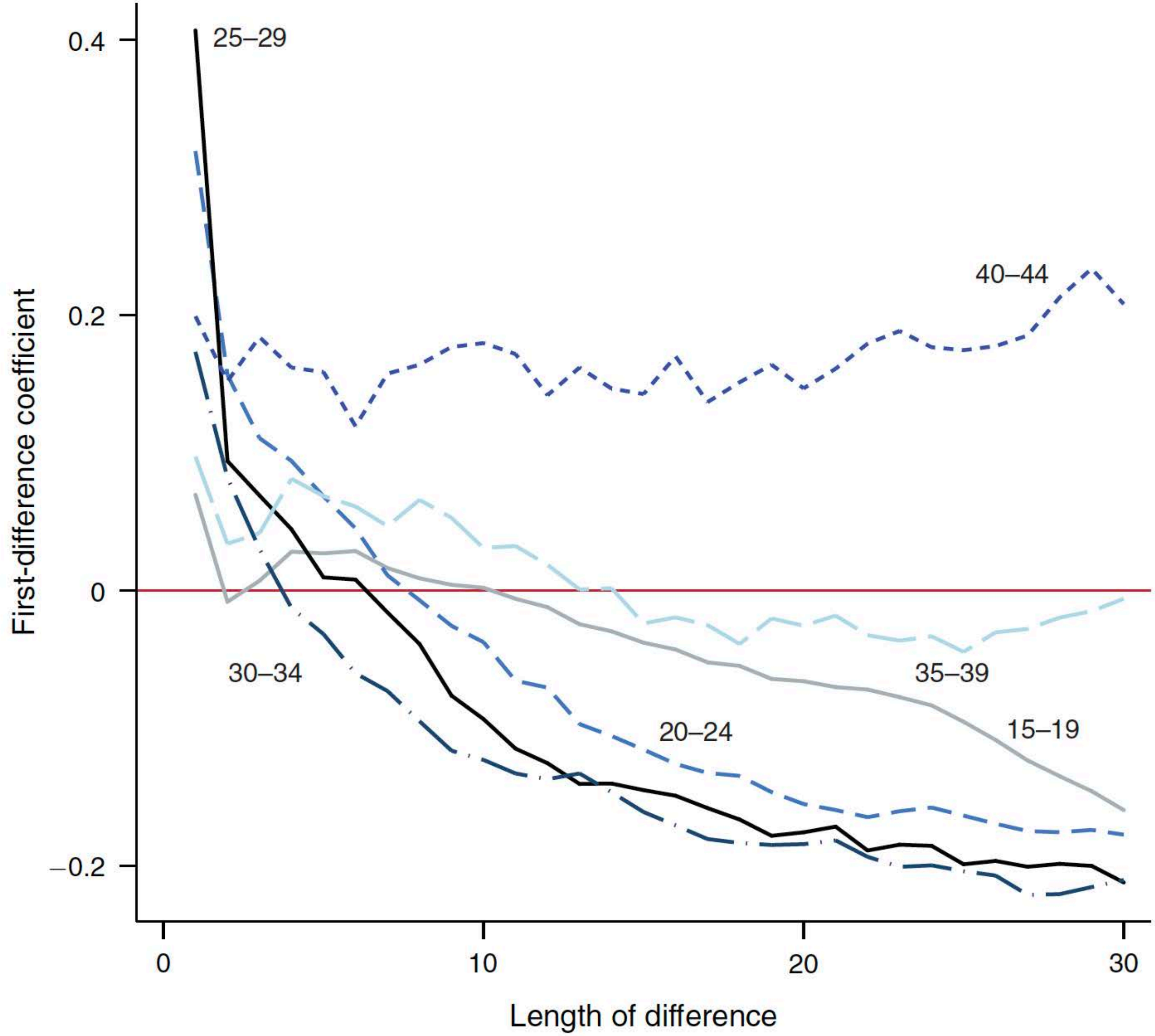


Figure 1. Economic Growth and Fertility Change over Varying Time Horizons

$$CR_{cta} - CR_{c,t-\Delta,a} = \beta^A\left(Y_{ct} - Y_{c,t-\Delta}\right) + \alpha_a^A + \varepsilon_{cta}^A$$

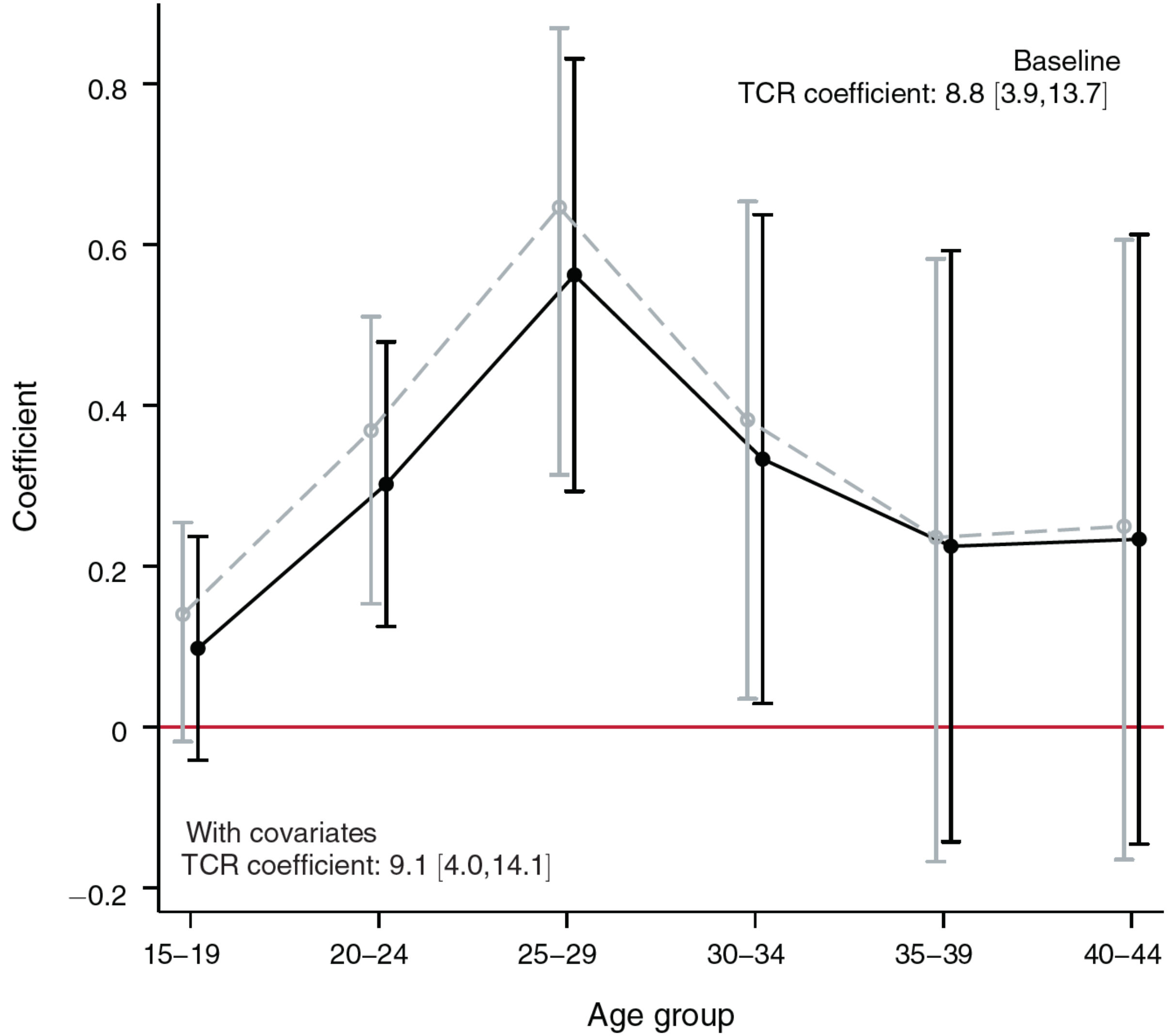


FIGURE 3. SHORT-RUN ESTIMATES

$$\Delta CR_{cta} = \beta^A g_{ct} + \lambda_c^A + \tau_t^A + \alpha_a^A + \varepsilon_{cta}^A$$

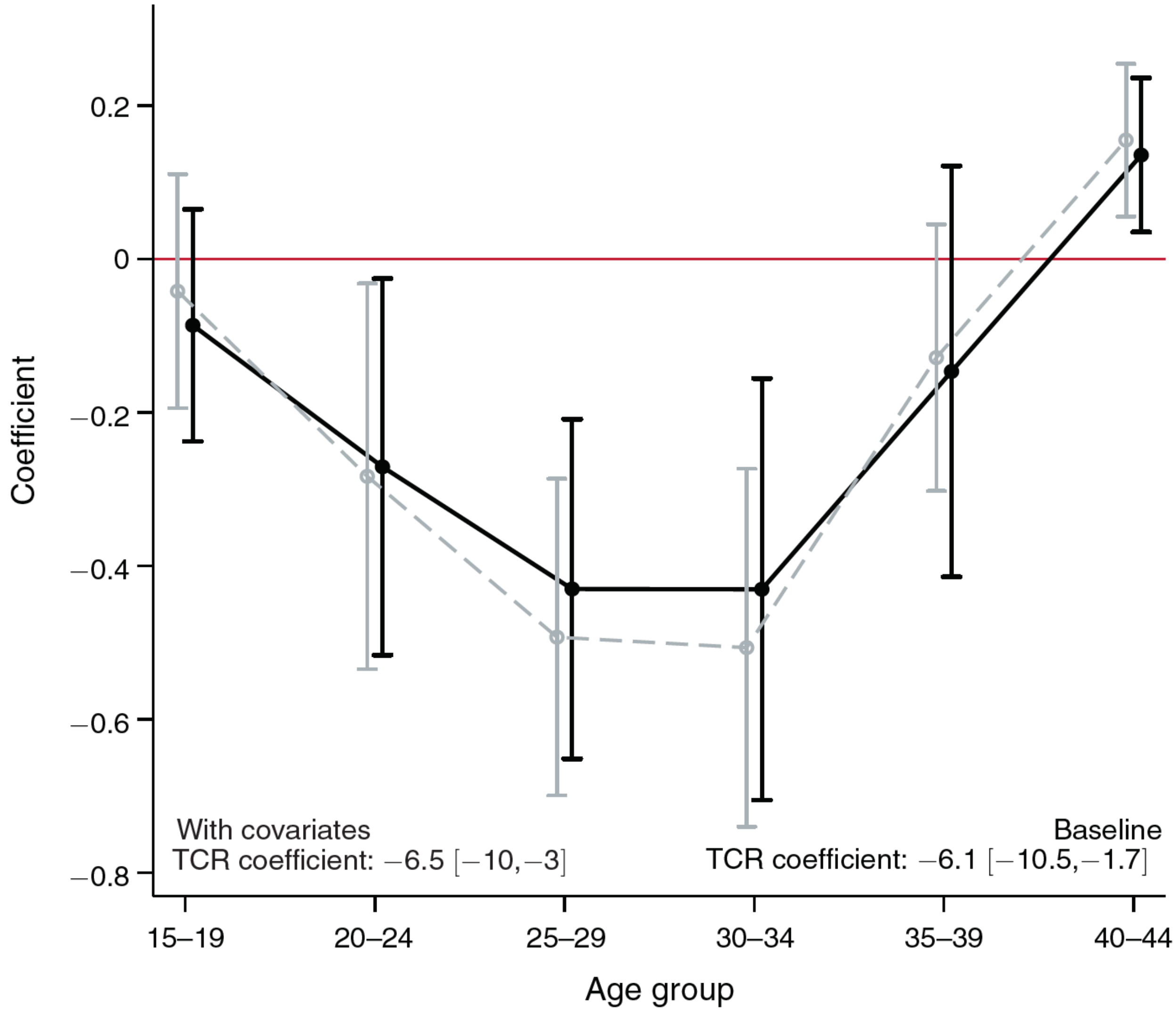


Figure 4. Long-Run Estimates

$$\overline{\Delta CR}_{ca} = \beta^A \bar{g}_{ca} + \alpha_a^A + \varepsilon_{ca}^A$$

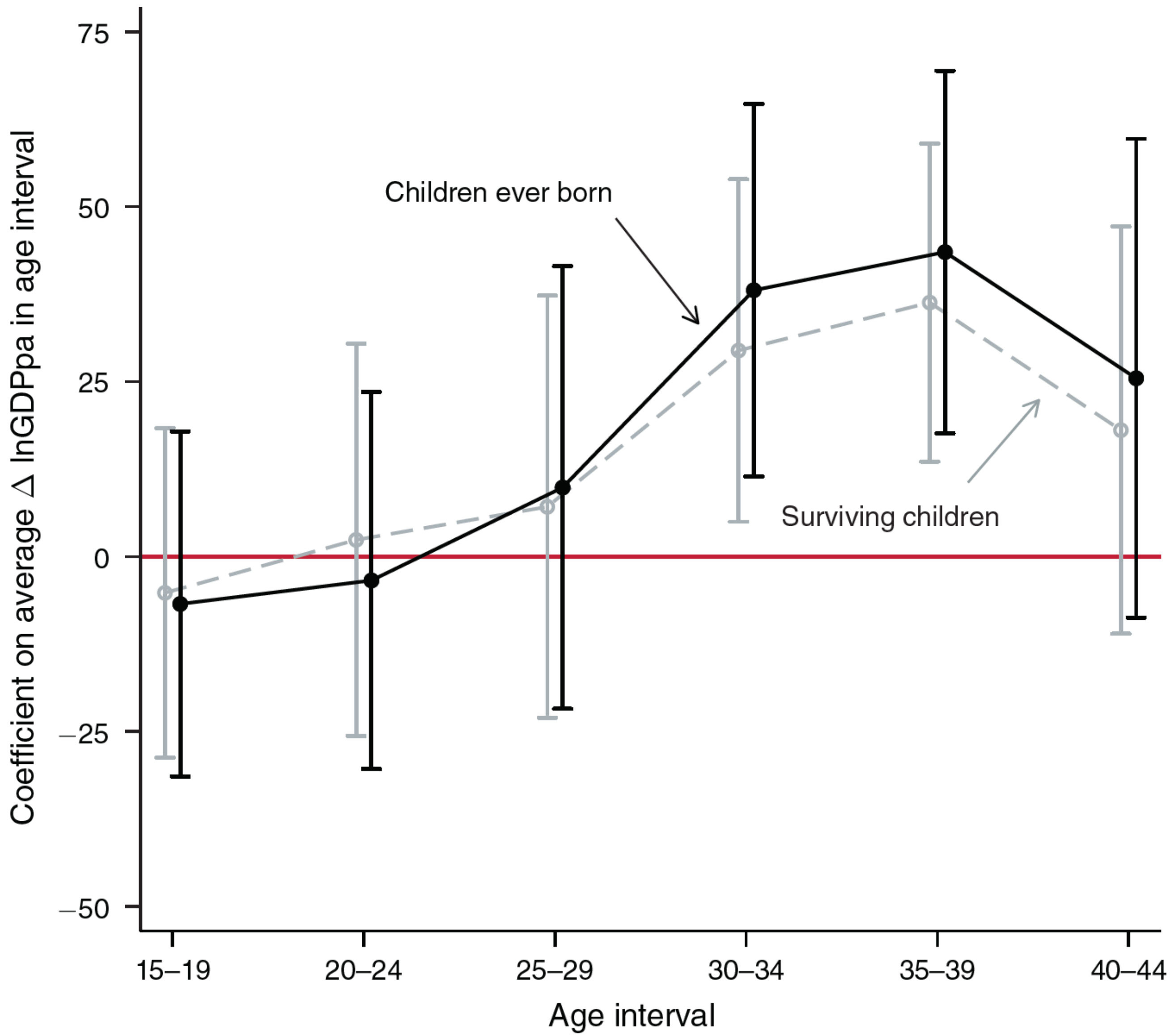


Figure 8. Economic Growth over the Life-cycle and Completed Fertility

$$CFR_{cj} = \sum_{A} \beta^{A} \bar{g}_{cj}^{A} + \lambda_c + \delta_j + \varepsilon_{cj}$$