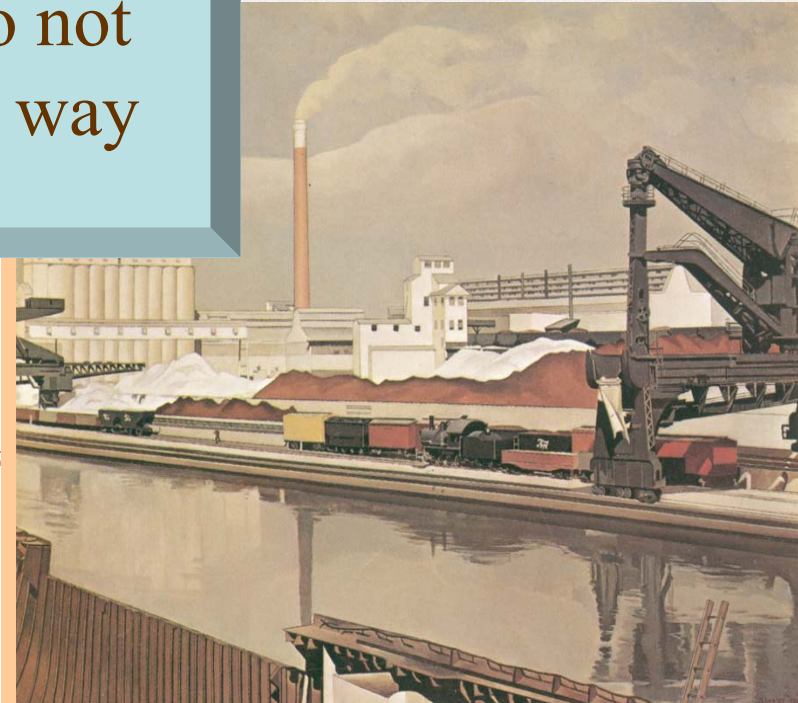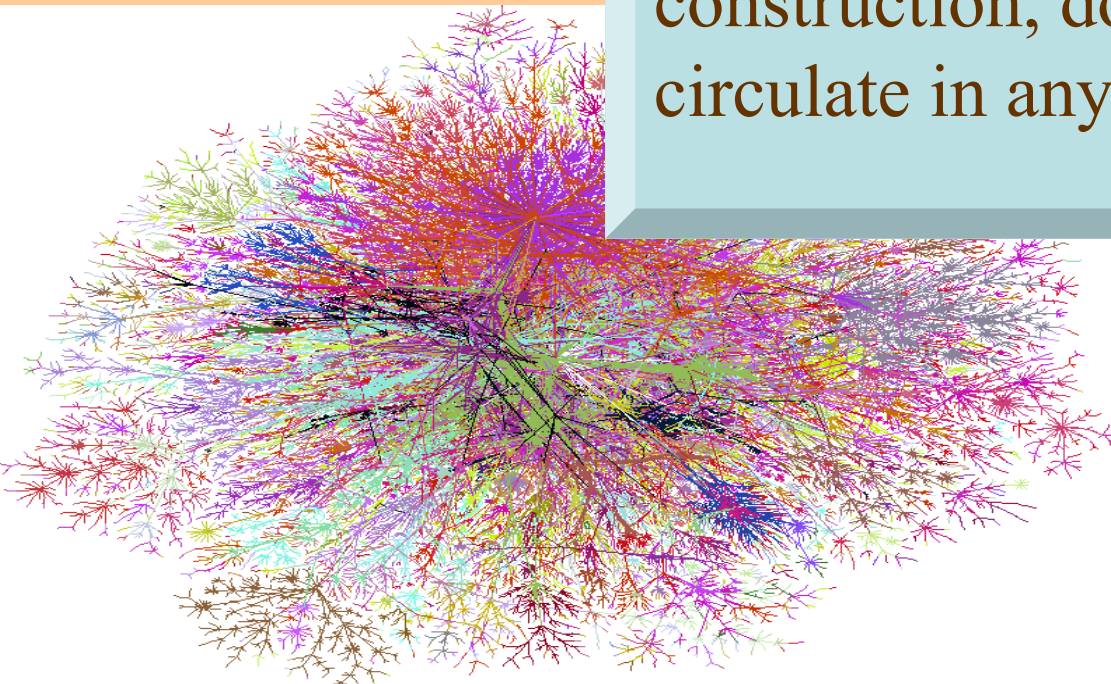# The nature of wealth and the dynamics of inequality

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Warning: paper under construction, do not circulate in any way

Thanks!

..to my o authors: Monique Borgerhoff Mulder[1] Tom Hertz[2] Adrian Bell[3] Jan Beise[4] Greg Clark[5] Ila Fazzio[6] Michael Gurven[7] Kim Hill[8] Paul Hooper[9] Hillard Kaplan[10] Donna Leonetti[11] Bobbi Low[12] Frank Marlowe[13] Suresh Naidu[14] David Nolin[15] Patrizio Piraino[16] Rob Quinlan[17] Rebecca Sear[18] Mary Shenk[19] Eric Alden Smith[20] Polly Wiessner[21]

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Background: A reverse Kuznets curve?

- Did the anti-K curve happen?

- If so, what explains it?

- Two transitions to explain

- From a hierarchic ape to an egalitarian forager

- From egalitarian foragers to agrarian (and later) societies with concentrated wealth

- A general model/ Speculations re future

- Kuznets curve redux?

Reproductive skew

Wealth inequality

time

2 million ybp to 200kybp

12 kybp
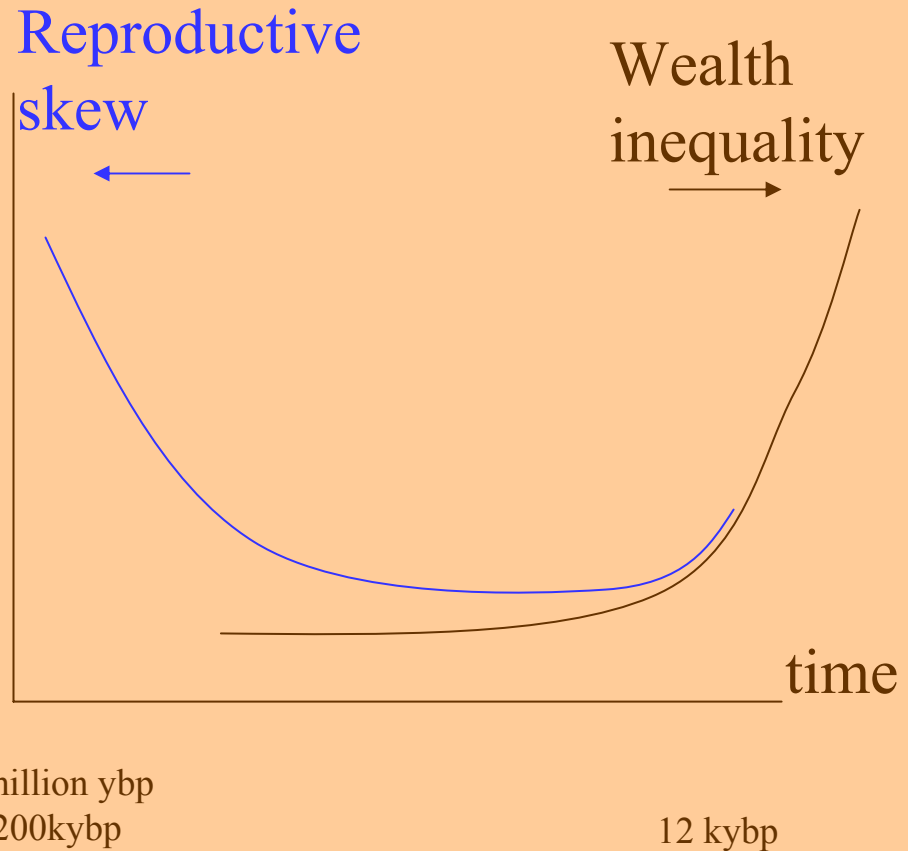
Explaining the emergence of persistent inequality during the Holocene (10kyp to present): a menu of models

- Property rights. Holocene climate change allowed agriculture and individual possession based property rights to co-evolve; the increase in productivity of land and animals made the defense of property feasible, while the property rights made agriculture individually advantageous.

- Network structure: star-like network structures with unequal degree distributions and betweenness supported substantial inequality; but for plausible equilibrium concepts (a modification of Aumann's strong equilibrium) these only became equilibrium networks during the Holocene.

- The new forms of wealth that facilitated the transmission of inequality over generations: this project.

A model of income dynamics

- Income-generating assets (wealth, skills) are acquired from parents (considered as a single individual) and from randomly selected others in the population (equal access to common resources, knowledge, public education and such).

- The expected wealth of individual i $\beta w_{ip} + (1-\beta)\underline{w}$, where income is measured in natural logarithms, $\beta \in (0,1)$, and w_{ip} is the income level of individual i's parent and $\underline{w}$ is the average income level (constant across generations).

- $(1-\beta)$: regression to the mean (Francis Galton, 1889).

- β is a reduced form parameter

An ergodic (stationary) distribution of wealth

- In each generation, the realized wealth (measured by its ln) of an individual, w_i, is his expected wealth plus a disturbance term, λ, that over time is independent of past values of wealth with mean zero and variance σ_λ^2:

$$w_i = \beta w_{ip} + (1-\beta)\underline{w} + \lambda_i$$

- This stochastic process is a first-order auto regression with a steady state expected (ln) wealth of $\underline{w}$.

- Variance of ln w (a unit-free measure of inequality)
$$\mu_t = \text{var}(w_{it}) = \beta^2 \text{var}(w_{it-1}) + \sigma_\lambda^2$$

- So the steady state variance of ln w is: $\mu = \sigma_\lambda^2 / (1 - \beta^2)$.

- The stationary distribution is thus the result of both 'chance' (the numerator) and social structure (the denominator).

Ergodic distribution, cont.

μ_t

$\mu_t = \mu_{t-1}$

$\mu_t = \beta^2 \mu_{t-1} + \sigma_\lambda^2$

σ_λ^2

μ_{t-1}

- Steady state inequality
  $\mu = \sigma_\lambda^2 / (1 - \beta^2)$
  the result of stochastic shocks, blown up by the inter-generational transmission multiplier $(1 - \beta^2)^{-1}$
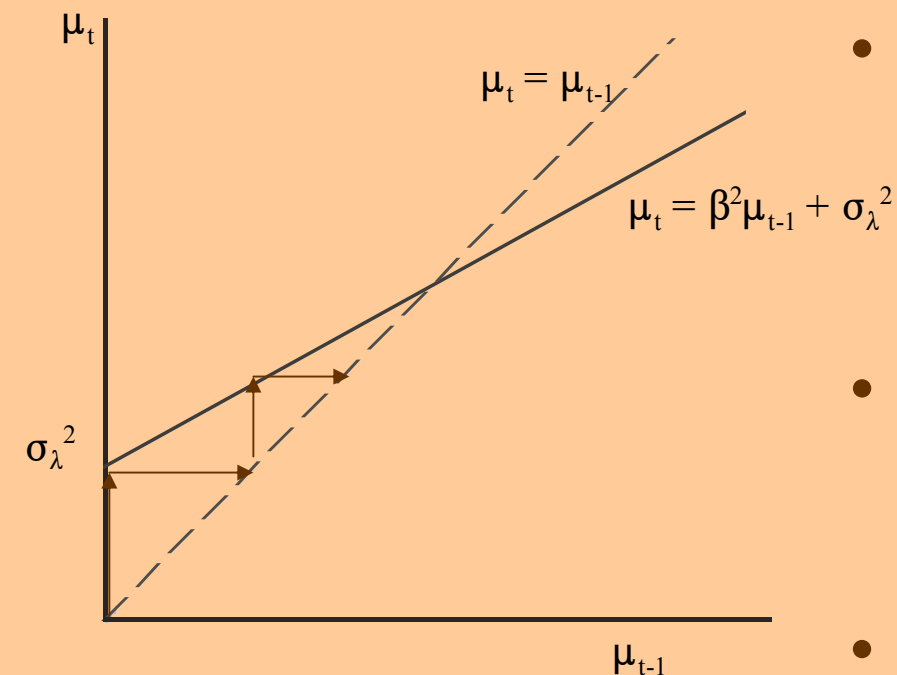
- The stationary distribution is thus the result of both 'chance' (the numerator) and social structure (the denominator).

- For β exceeding one there is no steady state and the inequality will increase from year to year.

- Leveling enters in two ways: reducing both β and σ_λ^2

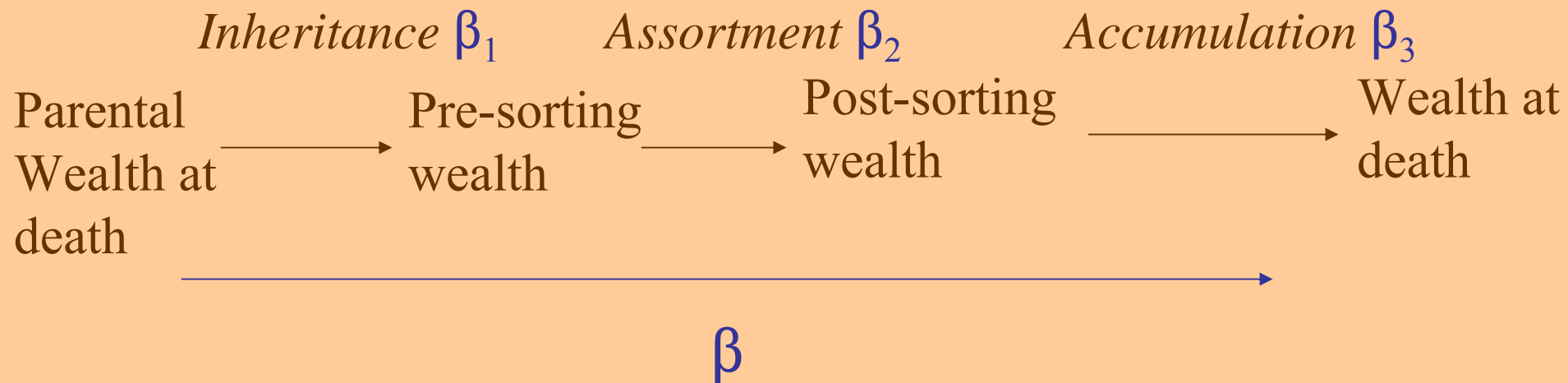# Runaway inequality: $\beta > 1$

- The correlation between parental and offspring wealth, $\rho \leq 1$ but $\beta = \rho\sigma/\sigma_p$ where σ and σ_p are the standard deviation of ln w in the current and parental generation, respectively.

- Thus $\beta > 1$ implies $\sigma > \sigma_p$

- For β exceeding one there is no steady state and the inequality will increase from year to year.

A possible decomposition of the transmission process

- *Inheritance* from parents to offspring
- *Assortment* in marriage or production
- *Accumulation* or dis-accumulation
- $\beta = \beta_1 \, \beta_2 \, \beta_3 > 1$ must derive from the last process, i.e. $\beta_3 > 1$
- *Accumulation* may represent a process of *development* (e.g. expression of a genotype in an adult phenotype) placing it prior to assortment

Inheritance β_1	*Assortment* β_2	*Accumulation* β_3

Parental Wealth at death $\longrightarrow$ Pre-sorting wealth $\longrightarrow$ Post-sorting wealth $\longrightarrow$ Wealth at death

$\longrightarrow$

β

Can the accumulation process entail β > 1? Increasing returns, credit market exclusion, wealth constraints

- a minimum project size (or other sources of increasing returns)
- wealth effects on the rate of time preference
- credit market exclusion or wealth constraints on borrowing

Accumulation and dis-accumulation

(Ln) Wealth after investment, w'

$\beta = 1$

w'(w)

$\beta = 1$

(Ln) Wealth prior to investment, w

δ

$w_m(m)$

m^- m^+
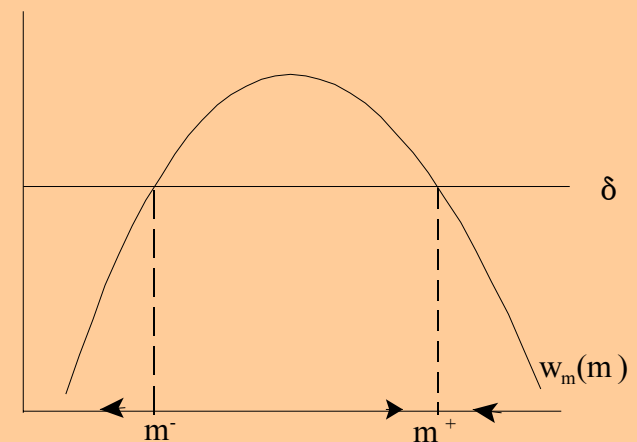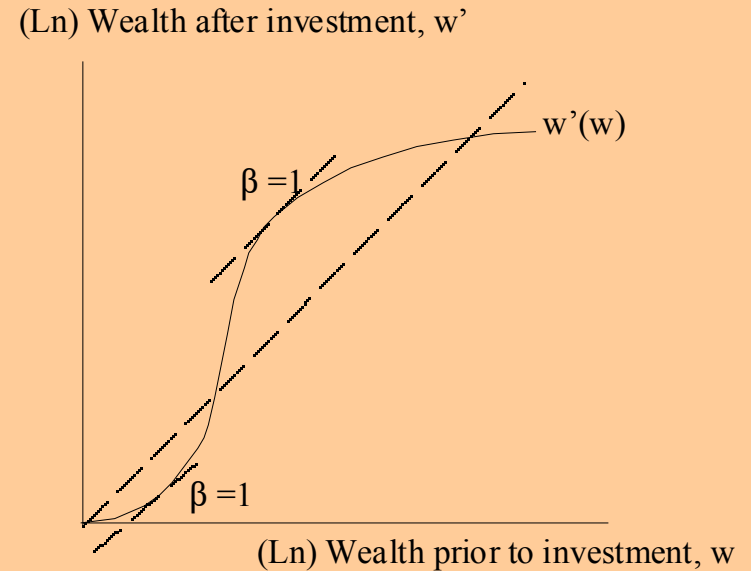
State-dependent transmission and polarization

- Due to increasing returns to assets (etc) the value of β may depend on the level of assets inherited and hence on parental income:

$$w_i = \beta(w_{ip})w_{ip} + (1-\beta(w_{ip}))\underline{w} + \lambda_i$$

- This model exhibits runaway inequality for middling levels of inheritance and convergence of expected income to two distinct levels at the extremes and may produce a bimodal steady state distribution of income with substantial polarization.

(Ln) Wealth after investment, w'

w'(w)

β =1

β =1

(Ln) Wealth prior to investment, w

β

1.0

β(y_{ip})

y_{ip}

%

y
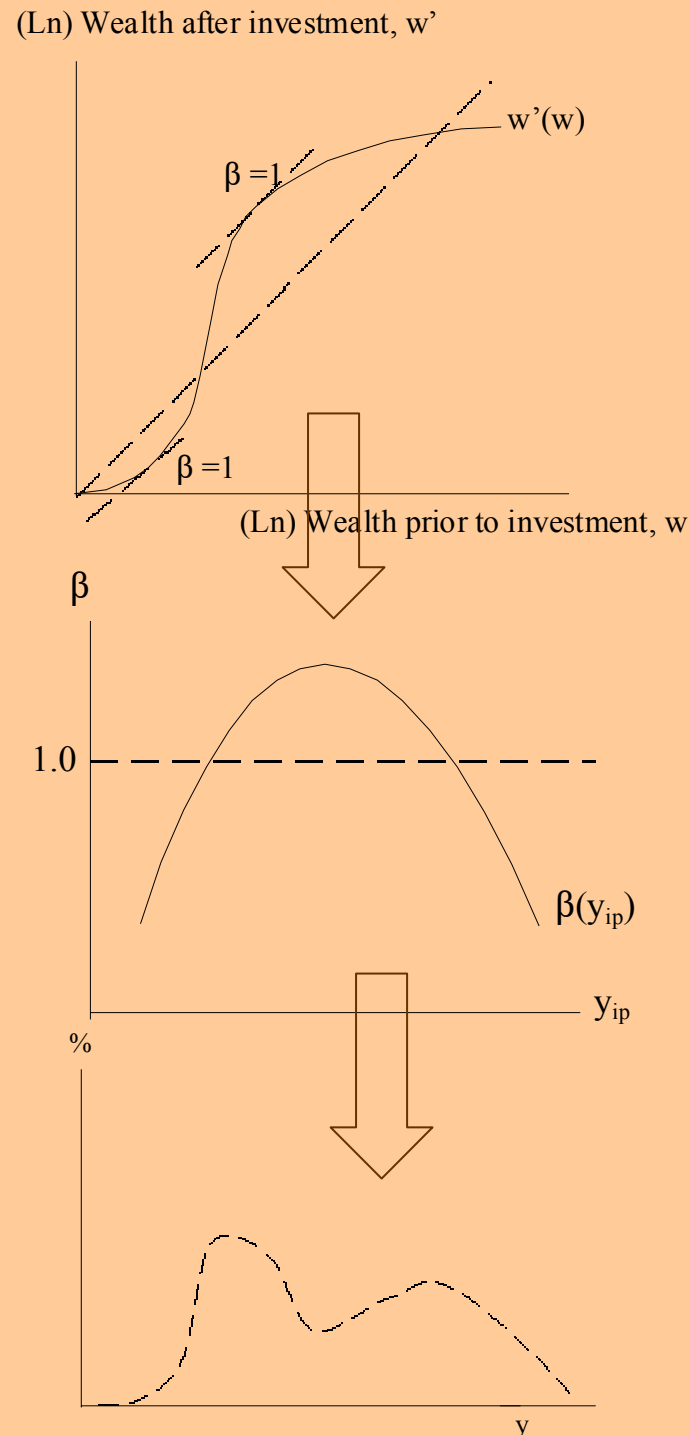
The nature of wealth and its intergenerational transmission by type of wealth

- *Material*: tools, land
- *Somatic* : health status, physical and cognitive capacities
- *Knowledge/network*
- In each case the transmission of wealth across generations faces serious impediments due to the nature of the inheritance process

Three inheritance processes:
- Bequest
- Genetic: genetic similarity of parent-offspring phenotype expression
- Cultural: learning from parents (vertical transmission)

Genetic transmission: parent offspring similarity + phenotypic expression of the genotype

- Genotype (G) and phenotype (P) are normalized, ' = parental

- Phenotypic expression of the genotype, $h = dP/dG$ ($h^2 = $ 'heritability')

- Degree of marital assortment (correlation of reproducting genotypes) = m

- $\beta_G = h^2(1+m)/2$

- E.g. h^2 for IQ may be about 0.5, so if $m = 0$, $\beta_G = 0.25$ and the intergen. transmission multiplier $(1- \beta^2)^{-1} = 1.07$

- Even strong genetic transmission does not add much to stationary inequality.

$$G' \xrightarrow{\;h\;} P'$$
$$\downarrow (1+m)/2 \qquad\qquad \downarrow \beta_G$$
$$G \xrightarrow{\;h\;} P$$
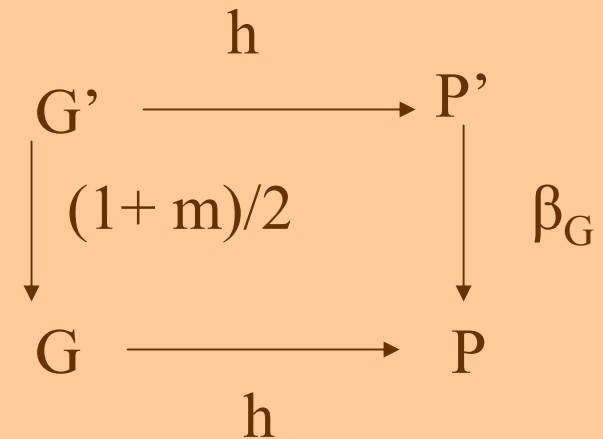
Bequest: 'mechanical transmission' offset by fitness effects of wealth

- Suppose $w = w'/s$ where s = number of offspring (or male offspring) and $s = s(w')$ with $s' >$ prior to the demographic transition.

- Then if wealth is transmitted solely to offspring and without loss $\beta = d\ln w/d\ln w' = 1 - d\ln s/d\ln w'$ which need not even be positive.

- Empirically $d\ln s/d\ln w'$ is positive in many premodern societies (e.g. polygamous) but not close to one.

Cultural transmission: easily transmitted wealth (knowledge) is difficult to own; embodied knowledge (personality) is difficult to transmit.

- Culturally transmitted forms of wealth (information, personality) may be transmitted from both parents between whom the level of assortment may be substantial (unlike genetic sorting).

- For the forms that are most easily transmitted (information) the sole use by the offspring may be difficult (exclusion of others may be impossible).

- Where the wealth form is embodied (personality) the degree of intergenerational transmission is probably very limited ($\beta < 0.2$)

Wealth in a foraging economy: knowledge, personality networks, and somatic capital

- Stature and health
- Personality, linguistic skills, etc
- Consumption smoothing networks
- The cognitive demands of foraging: Ache (Paraguay) adult men hunted in nearly 12,000 square kn of territory during their lives, almost all use more than 200 km^2 in a single year; they survive on 78 mammal species, at least 21 species of reptiles and amphibians, at least 150 species of birds and 14 species of fish.
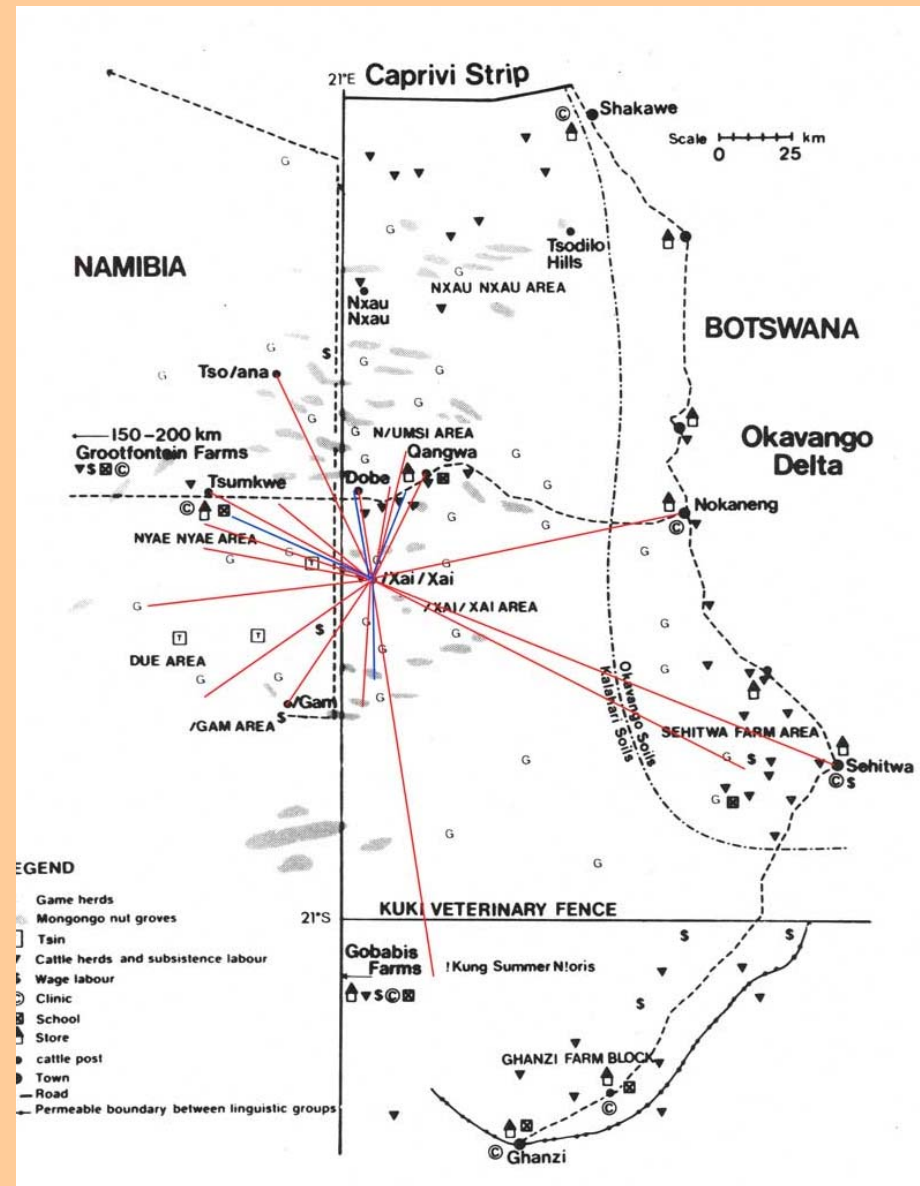
Intergenerational transmission of forager wealth (Borgerhoff Mulder, Bowles, et al. 2008, estimates currently under revision)
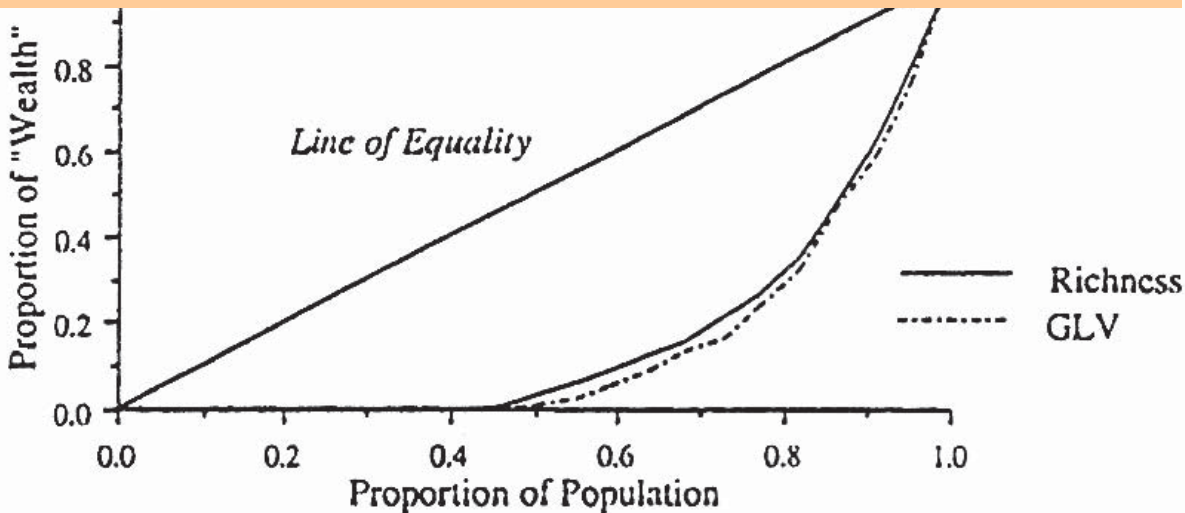

Wealth	β	Population (Hunter/Gatherer)
Hunting ability	0.081	Ache (Paraguay)
Social networks	0.208	Kung (Southern Africa)
Social networks	0.251	Lamalera (Indonesia)
Reproductive Success	0.088	Meriam (Torres Strait, Aus)
Reproductive Success	0.163	Lamalera (Indonesia)
Grip strength	-0.055*	Hadza (Tanzania)

Rich resources such as fishing sites could be monopolized and defended; here political hierarchy and inequality (even slavery) existed among hunters and gatherers.

The native American fishers of Keatley Creek (Canada) :"Ownership of key … areas [and] the social and economic groups that possessed these rights had persisted for ..a period of over 1,400 years."
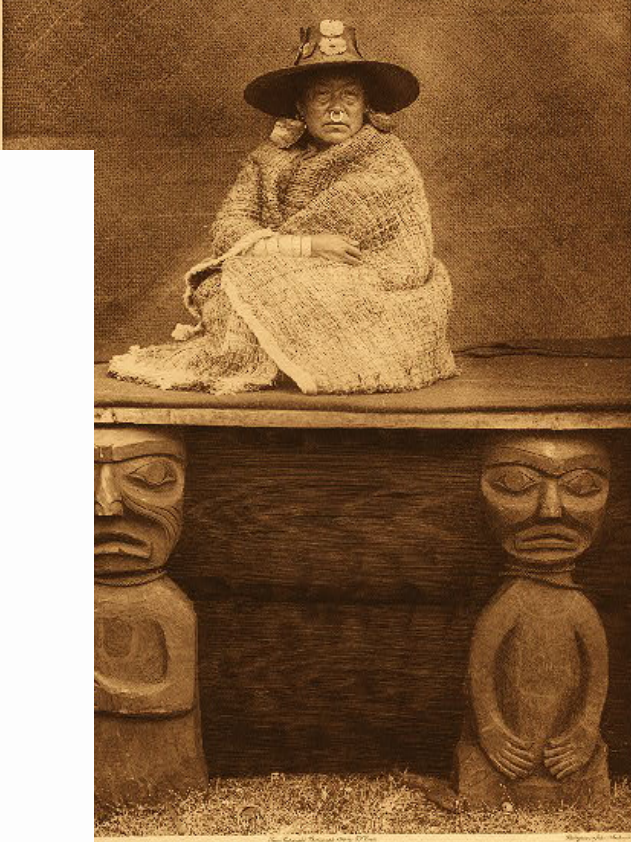

Salmon fishing sites

Daughter of a chief of the Nokoaktocs

Wealth inequality among Canadian Indians (from grave goods)
Gini = 0.70

Material wealth (valuable defensible resources, estimates currently under revision)

Wealth	β	Population (Agricultural/Pastoral)
Livestock	0.545	Chad Arabs
Livestock	0.564	Charwar Turkman
Livestock	0.678	Datoga (Tanzania)
Livestock	0.451	Kipsigis (Tanzania)
Livestock	0.957	Ukwaheri
Land	0.642	England (18th century)
Land	0.362	Kipsigis

Material, somatic and knowledge capital

Power as a source of income: Cumulative advantage + limited transmission
Network capital: little cumulative advantage, limited transmission

	Material	Somatic	Knowledge
Cumulative advantage	Yes	No	Yes
Privately appropriable and transmissible	Yes	Somewhat	Effectively no

Characteristics of Three Types of Wealth
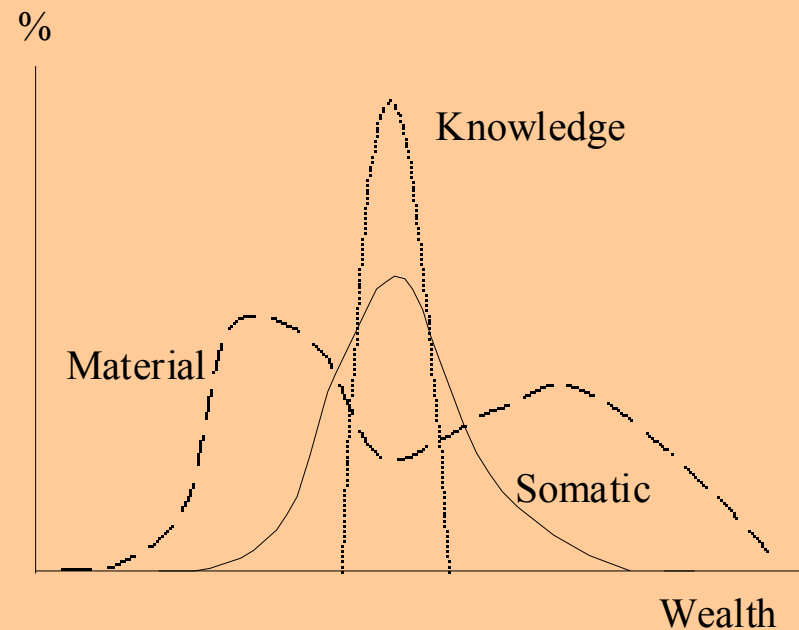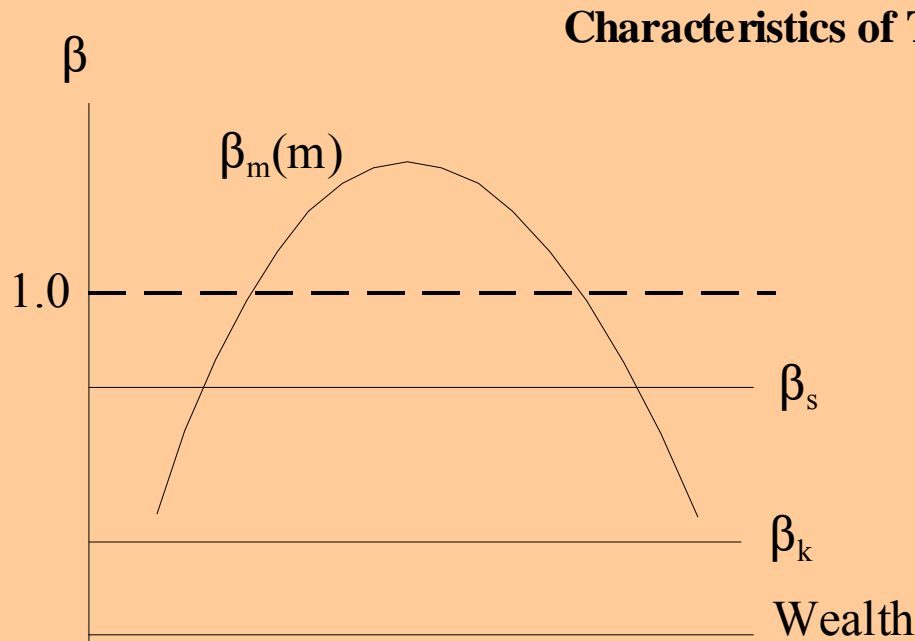
Summary: Intergenerational wealth transmission $\beta = d\ln w/d\ln w'$ estimates currently under revision

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The aggregate technology of an economy

- Suppose income is generated, and hence wealth is determined by the following production function: $w = Ak_m{}^{\alpha m}k_s{}^{\alpha s}k_k{}^{\alpha k}$

- Foraging bands: **a**

- Agrarian/industrial economies: **b**

Somatic

α_k

α_m

α_s
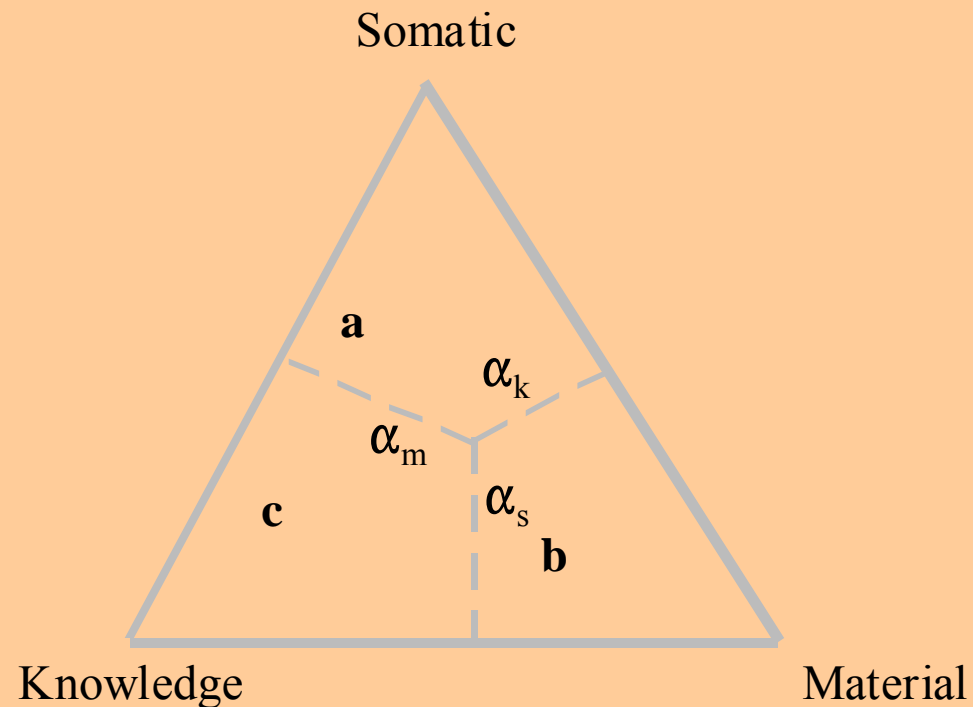
a

b

Knowledge

Material
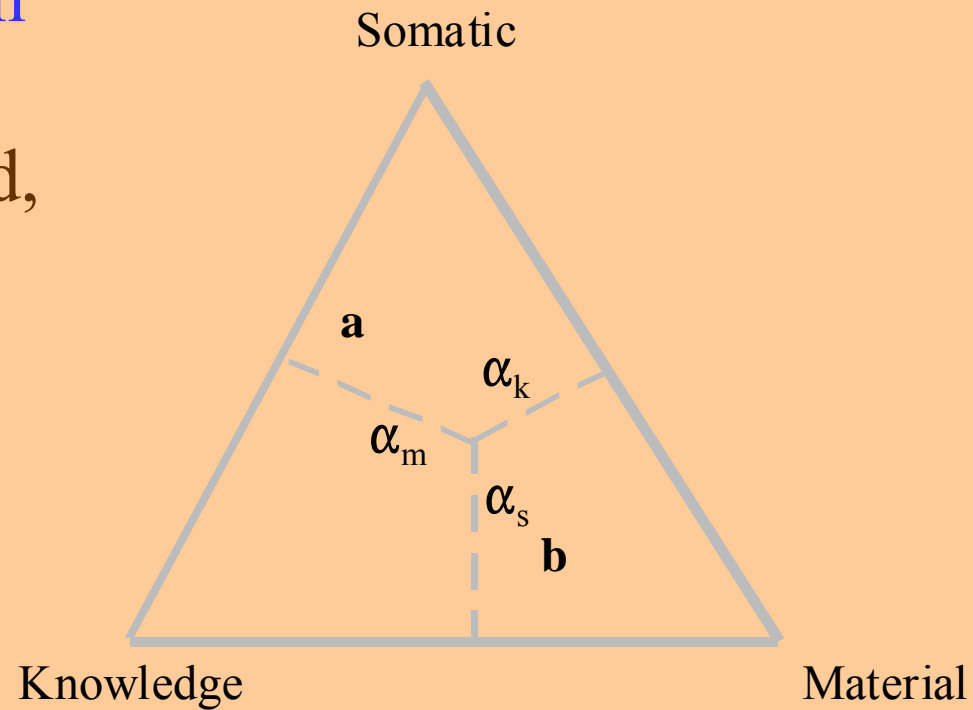
Each point in the simplex is a technology; the distance from the side opposite a vertex indicates the importance of the kind of wealth at the vertex.

The weightless economy: A long run Kuznets curve?
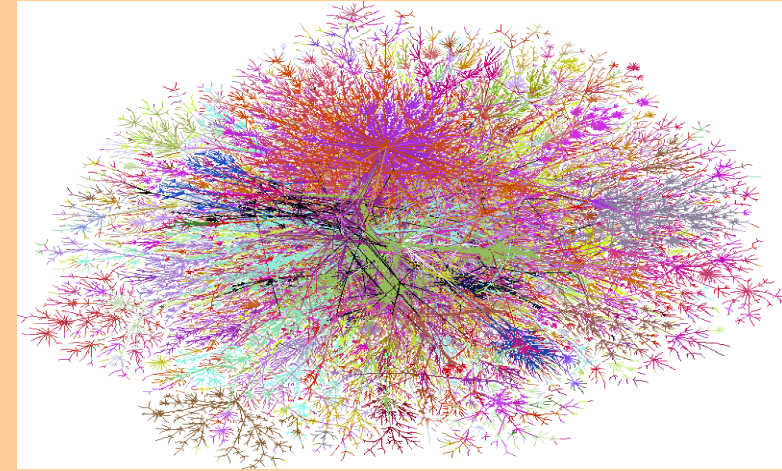
- Foraging bands: **a**

- Agrarian/industrial economies: **b**

- Human capital/information intensive economies: **c**

Somatic

a

α_k

α_m

α_s

c

b

Knowledge   Material

Kudus or cows?

- Kudus, antelopes, zebras, and the vast majority of species constituting the meat-based late Pleistocene economy could not be domesticated and owned privately, remaining more valuable in the wild, un-owned.

- Some – horses and cows, for example– became more valuable when domesticated.

- Is a song or a new software application more like an antelope or a cow?

- Will the attempt to domesticate the modern day antelopes prove costly and as ineffective as the attempt to domesticate the zebra?

- What are the are the best governance structures for the production and distribution of information? Firms? Communities?

"Knowledge hunters" vs intellectual property rights

- Because they sometimes grant exclusive monopoly over a productive input with few close substitutes, intellectual property rights (if enforced) may be more transmissible across generations than those to material wealth.

- E.g. access to tools may be accomplished through saving, but well protected intellectual property may not be accessible by any means.

- The take home message: β is not uniquely determined by technology

Modifications, extensions: Agrarian and capitalist inequality

- The causally decisive inequalities in pre-modern (pre-capitalist) societies may have concerned power, and other inequalities (reproductive, wealth, etc) were consequences.

- Inherited political position may have permitted high levels of wealth persistence (in part due to limited incentives to save and invest for those without power).

- Wealth accumulation is more central in capitalist societies, with other inequalities (i.e. power) its consequences.

Is inequality determined by technology? ... political processes?

- Forms of wealth that are readily transmissible across generations, increasing returns, minimum project size etc may increase β, but β depends also on marital and economic assortment, inheritance practices etc.

- Challenges:
  - Significant evidence of social inequality emerges pre-Holocene (e.g. by 20kypb Hayden 2001, Aitkens 1981, Arnold 1993, Soffer, 1989))
  - In many areas there is a long lag between sedentism, intensification and/or agriculture on the one hand and the emergence of substantial inequality on the other (PNG) and in some places it did not occur (Australia, California)
  - Institutional regime shifts induce substantial changes in inequality with a given technology (end of Communism, social democracy, feminism, end of apartheid).
  - Technically feasible storage not used (Hawkes (Hadza))

Inequality before agriculture

- The best evidence that storage was related to the emergence of hierarchical social structures prior to the advent of agriculture comes from sites in the Dnepr-Desna watershed where permanent storage economies existed by 20 kybp (Soffer 1989)

- At one of the earlier sites, a large storage pit was located centrally among the dwellings, suggesting common use.

- At a later site smaller pits of similar size were distributed around each dwelling, suggesting the control by individual households of particular stores without stratification among the households.

- At another later site, six of the eight pits were adjacent to the largest dwelling, which contained exotic jewelry, art, and fossil marine shells brought from 800km to the south

- The causal connection is unclear.

Substantial inequality among non human primates also suggests an important role for politics (e.g. leveling coalitions)

Politics	*Wealth* Transmissible inter-gen. (Material capital: Defendable and heritable)	Not easily trans (Somatic- or knowledge- capital)
Hierarchical	Archaic agrarian states, some sedentary hg (NW coast Indians)	Gorilla, some macaques Australian hg (Tiwi?)
Leveling coalitions	Some hort. & sed. hg (Pre-contact Cal. & highland PNG)	Foragers; chimps, some baboons as precursors?
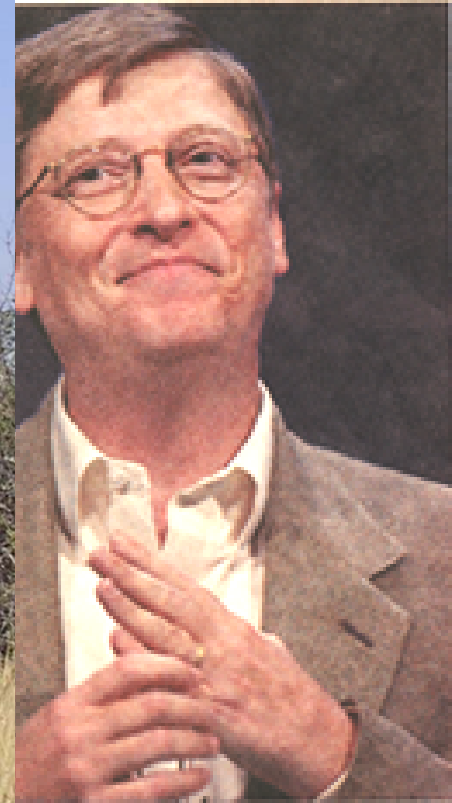
knows how best to
ize the weightless
my?

Equality's Fate

Samuel Bowles

Forthcoming sometime this century

Justice, from Lorenzetti's *Aspects of Good Government,* 1347 (Siena)