The Inequality Process As An Evolutionary Process

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ABSTRACT

The Inequality Process (IP) is a competition process that models the dynamics of personal income and wealth at the micro (individual person) and macro (distribution) levels. At the micro level, it is a particle system. It has a macro model in terms of the parameters of the micro model, a gamma pdf that approximates the stationary distribution of the micro model. Randomly paired particles compete for each other's wealth with an equal chance to win. The loser gives up a fraction of its wealth to the winner. That fraction is its parameter. By hypothesis and empirical analogue, that fraction scales inversely with the particle's productivity of wealth. Long term, wealth flows to particles that lose less when they lose, robust losers, nourishing their further production of wealth. Given a survival function that is an increasing function of wealth, the more robust loser is more losses away from death (Gambler's Ruin) at any given amount of wealth than others. As the level of productivity rises among particles, holding the global mean of wealth constant, expected particle wealth in each productivity equivalence class decreases relative to global mean wealth and the variance of wealth in each equivalence class decreases, i.e., the transfer of wealth from the less to the more productive occurs more efficiently making wealth a better indicator of productivity. The IP operates with no information about how wealth is produced and consequently adapts fluidly to higher productivity, change in constraints on wealth production and over time variation in global mean wealth. The IP is a dynamic attractor for a population, maximizing wealth production, minimizing extinction risk. It is an evolutionary process in an interdependent population, a colony of organisms, in which each organism depends on the product of the whole population. As an evolutionary process it focuses on selection rather than search. The IP might be adapted as a method to allocate computing resources to a population of parallel processors. In nature, the IP operates in parallel without central direction.

Keywords
competition, evolutionary process, Inequality Process, particle system, wealth.

1. INTRODUCTION: THE INEQUALITY PROCESS, A PARTICLE SYSTEM

The Inequality Process (IP) was inferred in the early 1980's from a social theory explaining the smaller Gini concentration ratio of income from more skilled labor [1-23]. The theory identifies the cause as the greater bargaining power of more skilled labor in keeping a larger share of the wealth it creates.

Despite the nitty-grittiness of the origin of the IP in a particular social theory of a particular statistical pattern in personal income from labor, the IP is a general evolutionary process. Think of a population as a set of solutions to the problem of generating wealth. Nothing is known about each solution except its current wealth and its history of wealth, from which its parameter, the fraction of wealth it loses when it loses a competitive encounter with another particle, can be calculated. Each solution is a particle. The optimization problem the IP solves is how to allocate wealth to particles to maximize aggregate wealth production and minimize extinction risk without knowing anything except particles' current and past wealth. The IP infers that a particle that loses less wealth in a loss, a robust loser, is more productive than other particles. Robust losers may be more productive because they rebound faster from a loss, are treated more gently, or have more bargaining leverage. Given a survival function that is an increasing function of wealth, the more robust loser is more losses away from death (Gambler's Ruin) at any given amount of wealth than others. The IP is a competition process in a population of particles that transfers wealth (a positive quantity) via randomly decided competitions between randomly paired particles. While short term, wealth goes to winners of these encounters, since the chance of winning is 50%, long term, wealth flows to the robust losers.

As the level of productivity rises in the population of particles, holding the global mean of wealth constant, expected particle wealth in each productivity equivalence class decreases relative to global mean wealth as the variance of wealth in each equivalence class decreases, i.e., the transfer of wealth from the less to the more productive occurs more efficiently making wealth a better indicator of productivity. The IP operates with no information about how wealth is produced and consequently adapts fluidly to higher productivity, change in constraints on wealth production and over time variation in global mean wealth. The IP is a dynamic attractor for a population, maximizing wealth production and minimizing extinction risk. It is an evolutionary process in an interdependent population, a colony of organisms, in which each organism depends on the product of the whole population. As an evolutionary process, the IP focuses on selection rather than search. The IP might be adapted as a method to allocate computing resources to a population of parallel processors.

In the IP, wealth is distributed to particles via zero-sum transfers. These do not change the amount of wealth summed over all particles. Particles are randomly paired; a winner is chosen via a discrete 0,1 uniform random variable; the loser gives up a fixed proportion of its wealth to the winner. In words, the process is:

> Randomly pair particles. One pair is particle i and particle j. A fair coin is tossed and called. If i wins, it receives an ω_θ of j's wealth. If j wins, it receives an ω_ψ of i's wealth. Repeat.

The transition equations of the transfer of wealth between two IP particles are:

$$x_{it} = x_{i(t-1)} + \omega_\theta d_{it} x_{j(t-1)} - \omega_\psi (1-d_{it}) x_{i(t-1)}$$
$$x_{jt} = x_{j(t-1)} - \omega_\theta d_{it} x_{j(t-1)} + \omega_\psi (1-d_{it}) x_{i(t-1)} \qquad (1a,b)$$

where $x_{i(t-1)}$ is particle i's wealth at time t-1 and:

ω_ψ = proportion of wealth lost by particle i when it loses

ω_θ = proportion of wealth lost by particle j when it loses.

and,

$$d_{it} = \begin{cases} 1 & \text{with probability .5 at time t} \\ 0 & \text{otherwise} \end{cases}$$

The IP has an asymmetry of gain and loss, which is apparent in figure 1, the graph of forward differences, $x_{it}-x_{i(t-1)}$, against wealth, $x_{i(t-1)}$ in the IP (1a,b).

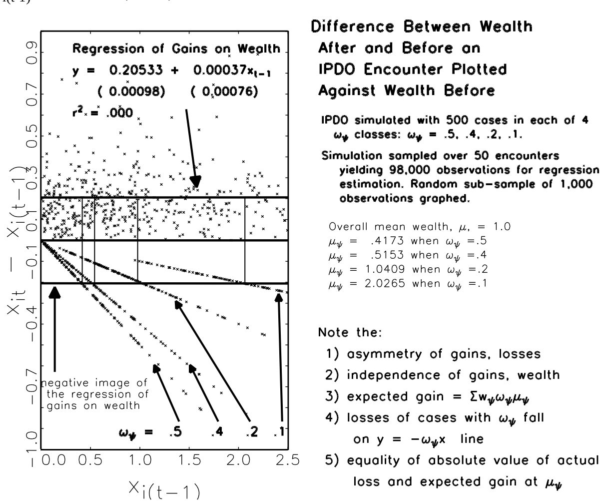

Figure 1

When particle i, in the ω_ψ equivalence class loses, its loss in absolute value is:

$$\omega_\psi x_{i(t-1)} \qquad (2)$$

Losses of particles in the ω_ψ equivalence class fall on the line $y = -\omega_\psi x_{i(t-1)}$. When particle i whose parameter is ω_ψ wins an encounter with particle j whose parameter is ω_θ, its gain is:

$$\omega_\theta x_{j(t-1)} \qquad (3)$$

The expected gain of all particles in the IP (1a,b) is:

$$\overline{\omega\mu} \equiv \sum_{\psi=1}^{\Psi} w_\psi \omega_\psi \mu_\psi \qquad (4)$$

where there are Ψ distinct ω_ψ equivalence classes, and w_ψ is the proportion of the population of particles in the ω_ψ equivalence class

$$w_i > 0$$
$$w_1 + \ldots + w_\psi + \ldots + w_\Psi = 1.0$$
$$w_\psi = \frac{n_\psi}{n} \qquad (5)$$

$$n = n_1 + n_2 + \ldots + n_\psi + \ldots + n_\Psi \qquad (6)$$

The expectation of gain of particle i is independent of the amount of its wealth, $x_{i(t-1)}$, resulting in a regression line with near zero slope fitted to all gains, regardless of ω_ψ equivalence class, for particles with a gain in figure 1.

2. The Gamma PDF Approximation to the IP's Stationary Distribution in the ω_ψ Equivalence Class

The stationary distribution of (1a,b) is given by its solution. (1a,b) is solved by backward substitution:

$$\begin{aligned} x_{it} = \; & \omega_{\theta j} x_{j(t-1)} d_{it} \\ & + \omega_{\phi k} x_{k(t-2)} d_{i(t-1)} \left[1-\omega_\psi(1-d_{it})\right] \\ & + \omega_{\xi l} x_{l(t-3)} d_{i(t-2)} \left[1-\omega_\psi(1-d_{it})\right] \left[1-\omega_\psi(1-d_{i(t-1)})\right] \\ & + \ldots \ldots \ldots \end{aligned} \qquad (7)$$

Particle i's wealth is the sum of its gains from competitors, each gain weighted by $(1-\omega_\psi)$ raised to the power of the number of later losses. The RHS of eq (7), after the realization of d_{it}'s as 0's or 1's, equals:

$$\begin{aligned} & \omega_{\theta j} x_{j(t-1)} d_{it} \\ & + \omega_{\phi k} x_{k(t-2)} d_{i(t-1)} (1-\omega_\psi)^{1-d_{it}} \\ & + \omega_{\xi l} x_{l(t-3)} d_{i(t-2)} (1-\omega_\psi)^{2-d_{it}-d_{i(t-1)}} \\ & + \ldots \ldots \ldots \end{aligned} \qquad (8)$$

(8) is the sum of "bites" taken out of competitors multiplied by $(1-\omega_\psi)$ raised to the power of the number of later losses, i.e., particle i's current wealth, x_{it}, is what it has won from competitors and did not lose at a later time. When $(1-\omega_\psi)$ is small, x_{it} is determined by

the length of a consecutive run of wins backward in time. Where $(1-\omega_\psi)$ is large, losing is less catastrophic and x_{it} can be considered a run of wins backward in time tolerating some intervening losses.

When the harmonic mean, $\tilde{\omega}$, of the ω parameters, ω_θ, ω_ϕ, ω_ζ,...., ω_Ψ is sufficiently small, and particle i's parameter, ω_ψ, is also sufficiently small, the "bites" taken out of competitor particles become smaller and there are more of them. In this situation the Central Limit Theorem results in their mean, $\overline{\omega\mu}$, being a better approximation to them. It can be shown numerically that (9) approximates (8):

$$x_{it} \approx \overline{\omega\,\mu}\left[\begin{array}{c} d_{it} \\ + \; d_{i(t-1)}(1-\omega_\psi)^{1-d_{it}} \\ + \; d_{i(t-2)}(1-\omega_\psi)^{2-d_{it}-d_{i(t-1)}} \\ + \; d_{i(t-3)}(1-\omega_\psi)^{3-\sum_{\tau=0}^{2} d_{i(t-\tau)}} \\ + \; .... \end{array}\right] \tag{9}$$

The infinite series of weighted Bernoulli variables in the brackets on the RHS of (9) can be approximated by summing a finite sequence of unweighted Bernoulli variables running from the present, t, back to t - τ in the past where τ is the number of previous competitive encounters that make a difference in particle i's wealth at time t, the time horizon of the process in the past for particle i:

$$d_t + d_{t-1} + d_{(t-2)} + \;......\; + d_{(t-\tau)} \tag{10}$$

The number of wins of particle i, k, must be the same in (10) as (9). However, the number of losses, N_ψ, N_ψ = 1, 2, ..., that terminates (10)'s run back into the past varies with $(1-\omega_\psi)$. The larger $(1-\omega_\psi)$, the larger the N_ψ must be so that $(1-\omega_\psi)^N$ is negligibly different from zero. [22] shows that (9) requires $N_\psi+1$ losses to approximately erase wealth from past wins. So,

$$N_\psi + 1 \approx \sum_\tau (1-\omega_\psi)^\tau$$
$$N_\psi \approx \left(\frac{1-\omega_\psi}{\omega_\psi}\right) \tag{11a,b}$$

N_ψ, like ω_ψ, is a parameter.

The random variable, k wins before N losses, is distributed as a negative binomial probability function, NB(N,p), where p = ½:

$$P(X=k) = \binom{k+N-1}{N-1} p^N (1-p)^k$$
$$E[k] = N-1 \approx \frac{1}{\omega_\psi} \tag{12}$$

The expectation is N−1 because of the constraint on the number of losses and the fact that the sum of losses and wins has to add to τ. The gamma pdf that approximates NB(N,p) has a shape parameter, α_ψ, equal to N_ψ:

$$\alpha_\psi \approx \frac{1-\omega_\psi}{\omega_\psi} \tag{13}$$

where the gamma pdf is defined by:

$$f(x) \equiv \frac{\lambda_\psi^{\alpha_\psi}}{\Gamma(\alpha_\psi)} x^{\alpha_\psi - 1} e^{-\lambda_\psi x} \tag{14}$$

and :

$$\begin{array}{lcl} x & > & 0 \\ \alpha_\psi & > & 0 \\ \lambda_\psi & > & 0 \\ \alpha_\psi & \equiv & \text{the shape parameter, } \omega_\psi \text{ equivalence class} \\ \lambda_\psi & \equiv & \text{the scale parameter, } \omega_\psi \text{ equivalence class} \end{array}$$

If the ω_θ, ω_ϕ, ω_ζ,...., 's are all equal to a single value, ω, then the expression in brackets on the RHS of (9) has an expectation equal to 1/ω. Since $\overline{\omega\mu}$ is a constant, the expected value of mean of wealth in the ω_ψ equivalence class, μ_ψ, is on the RHS of (9):

$$\mu_\psi \approx \frac{\overline{\omega\mu}}{\omega_\psi} \tag{15}$$

Given (15) and the fact that the mean of the approximating gamma pdf, μ_ψ, is α_ψ/λ_ψ:

$$\mu_\psi \approx \frac{\overline{\omega\mu}}{\omega_\psi} \approx \left(\frac{1-\omega_\psi}{\omega_\psi}\right)\frac{1}{\lambda_\psi} \tag{16}$$

which implies:

$$\lambda_\psi \approx \frac{1-\omega_\psi}{\overline{\omega\mu}} \tag{17}$$

(4) defines $\overline{\omega\mu}$ in terms of w_ψ's and ω_ψ's which are known and μ_ψ's which are not. λ_ψ can be solved for in terms of knowns, ω_ψ, w_ψ, and the grand mean, μ, also known, in the following way:

$$\mu = w_1\mu_1 + w_2\mu_2 + \ldots + w_\Psi\mu_\Psi \tag{18}$$

and from (15):

$$\mu \approx \left(\frac{w_1}{\omega_1}\right)\overline{\omega\mu} + \left(\frac{w_2}{\omega_2}\right)\overline{\omega\mu} + \ldots + \left(\frac{w_\Psi}{\omega_\Psi}\right)\overline{\omega\mu} \quad (19)$$

which implies that:

$$\overline{\omega\mu} \approx \frac{\mu}{\left(\frac{w_1}{\omega_1} + \frac{w_2}{\omega_2} + \ldots + \frac{w_\Psi}{\omega_\Psi}\right)} \quad (20)$$

so the RHS of (17) can be expressed in terms of known quantities:

$$\lambda_\psi \approx \frac{1 - \omega_\psi}{\overline{\omega\mu}} \approx \frac{(1-\omega_\psi)\left(\frac{w_1}{\omega_1} + \frac{w_2}{\omega_2} + \ldots + \frac{w_\Psi}{\omega_\Psi}\right)}{\mu} = \frac{1 - \omega_\psi}{\tilde{\omega}\mu} \quad (21)$$

where $\tilde{\omega}$ is the harmonic mean of the ω_ψ's.

Given (15):

$$\overline{\omega\mu} \approx \omega_\psi \mu_\psi$$

a loss occurring to an ω_ψ class particle at the conditional mean, the μ_ψ, approximately equals expected gain, $\overline{\omega}\overline{\mu}$. See the vertical lines in figure 1 at the conditional means, μ_ψ. The length of the vertical line segment above the x-axis, $\overline{\omega}\overline{\mu}$, approximately equals the length of the vertical line segment below the x-axis, $\omega_\psi\mu_\psi$. $\overline{\omega}\overline{\mu}$ can be estimated over any range of income sizes, in particular close to the income size that the definitions and collection practices of large-scale household surveys are optimized for: the median. Estimating $\overline{\omega}\overline{\mu}$ from gains does not require the identification of the ω_ψ of particles. $\overline{\omega}\overline{\mu}$ can be estimated either as the intercept of the linear regression of gains on wealth or as the mean gain of particles with a gain. If the ω_ψ' s are known, $\overline{\omega}\overline{\mu}$ can be estimated as the mean loss (in absolute value) of cases in the ω_ψ equivalence class or as the actual loss at the conditional mean, μ_ψ . Given ω_ψ, an estimate of $\overline{\omega}\overline{\mu}$ can be used to estimate μ_ψ, or given μ_ψ, $\overline{\omega}\overline{\mu}$ can be used to estimate ω_ψ.

3. THE IP AS AN EVOLUTIONARY PROCESS

The expectation of particle x_{it}'s wealth in the ω_ψ equivalence class when the unconditional mean of wealth, μ_t, can change, as well as the proportion of the population of particles in any given ω_ψ equivalence class, is:

$$E[x_{it}] \approx \frac{\alpha_\psi}{\lambda_{\psi t}} = \mu_{\psi t} \approx \frac{1 - \omega_\psi}{\omega_\psi} \cdot \frac{\tilde{\omega}_t \mu_t}{(1 - \omega_\psi)} = \frac{\tilde{\omega}_t \mu_t}{\omega_\psi} \quad (22)$$

i.e., the ratio of the current harmonic mean of particle productivity in the population to particle productivity in the ω_ψ equivalence class multiplied the current unconditional mean of wealth. Keep in mind that smaller $\tilde{\omega}_t$ and ω_ψ indicates greater productivity. (22) presumes that the distribution of particle productivity in the population may change, as may the unconditional mean of wealth, μ_t.

Assuming that wealth is an input into its own production, the IP differentially nourishes the production of wealth by the more productive, maximizing the aggregate production of wealth. Assuming that survival is a positive function of wealth, the IP protects the survival of the more productive with any given amount of wealth since they require more losses to be reduced to a given lower, riskier amount of wealth. The IP also minimizes extinction risk of the whole population via wealth maximization. The distribution of wealth of the whole population is stretched to the right, over larger wealth amounts, as μ_t increases. Increasing μ_t decreases $\lambda_{\psi t}$. See by comparing figure 3 to figure 2 how smaller $\lambda_{\psi t}$ stretches a gamma pdf to the right over larger x values. In figure 2, the gamma scale parameter, $\lambda = 2.0$:

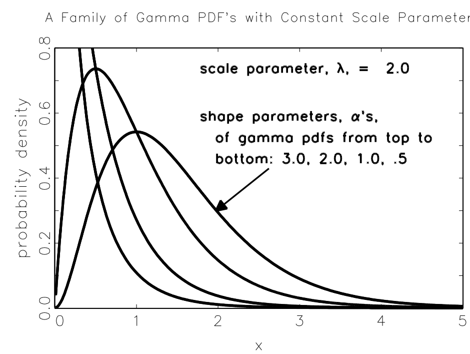

Figure 2: Gamma pdfs with common scale parameter, $\lambda = 2.0$, and different shape parameters

but in figure 3, $\lambda = 0.5$. See in figure 3 how the gamma pdf's with the smaller λ are stretched to the righ, putting more of the probabiity mass of the pdf over larger x's (wealth amounts)t:

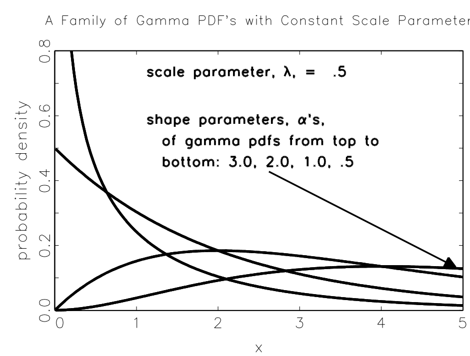

Figure 3: Gamma pdfs with common scale parameter, $\lambda = 0.5$, and different shape parameters

So the whole population shares in the increase in aggregate wealth due to the IP's transferring resources to the more productive, and given survival as an increasing function of wealth, the consequent decrease in extinction risk.

Given fixed ω_ψ's, $\mu_{\psi t}$ becomes a smaller fraction of μ_t in every ω_ψ equivalence class as $\tilde{\omega}_t$ falls. With fixed ω_ψ's, $\tilde{\omega}_t$ falls as the proportion of particles in equivalence class ω_θ grows at the expense of the proportion of particles in equivalence class ω_ψ where $\omega_\psi > \omega_\theta$. Following (21), $\lambda_{\psi t}$, the gamma scale parameter of wealth in the ω_ψ equivalence class where $\tilde{\omega}_t$ and μ_t can change is:

$$\lambda_{\psi t} \approx \frac{1 - \omega_\psi}{\tilde{\omega}_t \, \mu_t} \tag{23}$$

If the proportional decrease in $\tilde{\omega}_t$ is greater than the proportional increase in μ_t, the product $(\tilde{\omega}_t \, \mu_t)$ decreases and the distribution of wealth in all ω_ψ equivalence classes is compressed left over smaller wealth amounts, as in the comparison of figure 3 to figure 2 since $\lambda_{\psi t}$ is larger. The variance of wealth in the ω_ψ equivalence class decreases rapidly as $(\tilde{\omega}_t \, \mu_t)$ decreases since the variance of the gamma pdf approximation to the stationary distribution of wealth in the ω_ψ equivalence class is:

$$var(x_{\psi t}) = \frac{\alpha_\psi}{\lambda_{\psi t}^{\,2}} \approx \left(\frac{1 - \omega_\psi}{\omega_\psi} \right) \cdot \left(\frac{(\tilde{\omega}_t \, \mu_t)^2}{(1-\omega_\psi)^2} \right) = \frac{(\tilde{\omega}_t \, \mu_t)^2}{\omega_\psi \, (1-\omega_\psi)} \tag{23}$$

So luck in winning IP encounters advances the wealth of the lucky less than when $(\tilde{\omega}_t \, \mu_t)$ was larger. If particle i were able to decrease ω_ψ (increase its productivity) in order to maintain its expected wealth, it would, in a finite population of particles, lower $\tilde{\omega}_t$, further increasing particle i's need to lower ω_ψ to maintain its expected wealth. Smaller $\tilde{\omega}_t$ means that the wealth of particle i is more closely tied to ω_ψ at any given level of μ_t. Thus, not only does the IP cause μ_t to drift upward (something the IP, however, does not explicitly model), the IP creates an incentive for particle i to lower ω_ψ (to become more productive) to maintain its wealth whenever μ_t decreases or fails to increase proportionally as fast or faster than any decrease in $\tilde{\omega}_t$. Thus, the IP acts as a dynamic attractor for a population by decreasing its extinction risk via wealth maximization by the transfer of wealth to the more productive and incentivizing increasing productivity throughout the population. An evolutionary process is a dynamic attractor through time, a way of creating more time for a population.

4. THE EMPIRICAL EVIDENCE ON THE INEQUALITY PROCESS (IP) AS A WEALTH MAXIMIZING PROCESS

The empirical evidence that the Inequality Process is a wealth maximizing process is multi-faceted. There is the evidence that it implies a number of well accepted propositions from economics about labor income:

Labor Economics Proposition	IP Implication
1) All distributions of labor income are right skewed with tapering right tails [24]; hence the impossibility of radical egalitarianism.	The IP generates right skewed distributions shaped like empirical distributions of labor income [22].
2) Differences of wealth and income arise easily, naturally, and inevitably via an ubiquitous stochastic process; cf. Gibrat's law of proportional effect [25]; hence the impossibility of radical egalitarianism.	In the IP, differences of wealth arise easily, naturally, and inevitably, via an ubiquitous stochastic process [1, 2, 15, 22].
3) Each worker's earnings are closely tied to each worker's productivity;	In the gamma pdf macro model of the IP's stationary distribution, a particle's expected wealth is the product of the ratio of its productivity to the harmonic mean of particle productivity multiplied by the unconditional mean of wealth [22].
4) The ratio of mean wages in two occupations remains constant, given no change in the productivity of labor in either occupation, despite fluctuation in the mean wage in the labor force as a whole.	In the gamma pdf macro model of the IP, the ratio of the expected wealth of two particles remains constant despite changes in the unconditional mean of wealth [22].
5) Labor incomes small and large benefit from a business expansion strong enough to increase mean labor income; "A rising tide lifts all boats"; there is a community of interest between rich and poor in prosperity; in radical egalitarianism these interests are opposed.	In the macro model of the IP, an increase in unconditional wealth increases all percentiles of the stationary distribution of wealth by an equal factor [22].
6) Competition in the market creates wealth and transfers wealth to the more productive of wealth via market transactions; cf. Adam Smith's "invisible hand".	In the IP, competition between particles causes wealth to flow via transactions from particles that are by hypothesis and empirical analogue less productive of wealth to those that are more productive, nourishing wealth production, and explaining the upward drift in mean wealth without a) requiring knowledge of how wealth is produced or b) central direction, i.e., with extreme information efficiency [22]. This process can operate homogeneously over the entire course of techno-cultural evolution.

The IP's empirical explanandum includes:

the decrease of the Gini concentration ratio and the increasing dispersion of wealth and income over the course of technocultural evolution [1, 2, 22] ; a decrease in the Gini concentration ratio of the stationary distribution of the IP with smaller ω_ψ is a logical requirement of the model; see (24);

$$G_\psi = \frac{\Gamma\left(\alpha_\psi + \frac{1}{2}\right)}{\sqrt{\pi}\;\Gamma(\alpha_\psi + 1)} \qquad (24)$$

G_ψ is the Gini concentration ratio of a gamma pdf [26]. Given (13), G_ψ is an increasing function of ω_ψ as stipulated in the social theory from which the IP was abstracted.

the sequence of shapes of the distribution of wage incomes of workers by level of education and why this sequence of shapes changes little over decades [22] ; see figures 4 and 5:

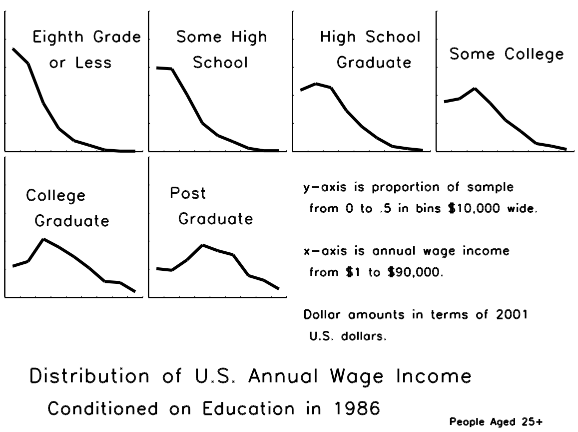

Figure 4
Source: Author's estimates from the March CPS.

Note that sequence of shapes of wage income with education level in figures 4 and 5 is as expected under the theory from which the IP was derived, i.e., smaller ω_ψ is associated with a higher level of education since that distribution is fitted by a gamma pdf with a larger shape parameter α_ψ. See (13).

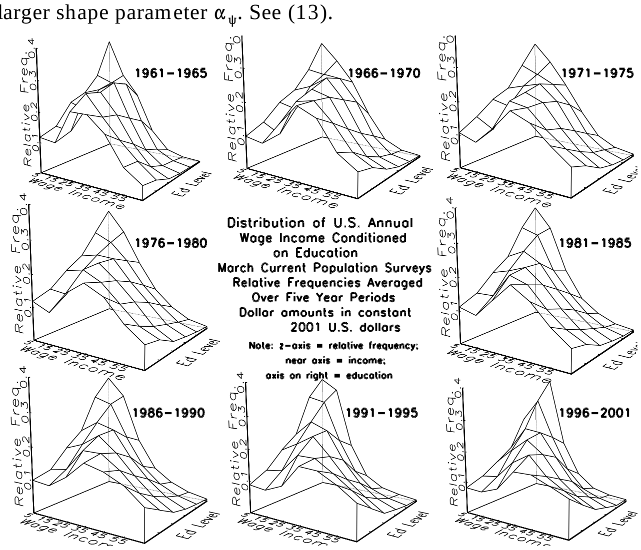

Figure 5
Source: Author's estimates from the March CPS.

the dynamics of the distribution of wage income conditioned on education as a function of the unconditional mean of wage income and the distribution of education in the labor force [16-18];

why a gamma pdf is a useful model of the left tails and central masses of wage income distributions and why their far right tails are approximately Pareto pdfs [22];

why the IP's parameters estimated from certain statistics of the wage incomes of individual workers in longitudinal data on annual wage incomes are ordered as predicted by the IP's meta-theory [15] and approximate estimates of the same parameters from fitting the gamma pdf model of the IP's stationary distribution to the distribution of wage income conditioned on education;

the difference in shape between the distribution of income from labor and the distribution of income from tangible assets [9];

the sequence of shapes of the distribution of personal wealth and income over the course of technocultural evolution [1, 2];

the universality of the transformation of hunter/gatherer society into the chiefdom, society of the god-king, with the appearance of storable food surpluses [1,2].

If one allows a coalition of particles to have a greater probability than 50% of winning, then the Inequality Process so modified reproduces features of the joint distribution of income to African-Americans and other Americans such as:

the % minority effect on discrimination (the larger the minority, the more severe discrimination on a per capita basis) [7];

the relationships among variables as specific as a) % of a U.S. state's population that is non-white; b) median white male earnings in a U.S. state; c) the Gini concentration of white male earnings in a U.S. state; and d) the ratio of black male to white male median earnings in a U.S. state [7].

5. CONCLUSIONS

The mechanism that the IP uses to transfer wealth to the more productive is the asymmetry of gain and loss. If the more productive lose less when they lose - because they rebound faster, or are treated more gently, or have more leverage - then an IP-like empirical process of competition will transfer wealth to the more productive, nourishing their more efficient production, and causing upward drift in aggregate wealth production. The IP implies faster upward drift in aggregate wealth production, the higher the level of productivity in a labor force, since its mechanism of wealth transfer to the more productive works more efficiently in a more productive labor force, i.e., an IP-like empirical process becomes an "attractor" for a population over time [22], i.e., an evolutionary process, a process by which an interdependent population of organisms (processors), a colony, maintains itself and expands over time by more efficiently producing what it needs and differentially preserving the more productive organisms (processors).

Zero-sum competition is the perturbing mechanism that transfers wealth from the less productive to the more productive in the IP via the asymmetry of loss and gain of wealth. Zero-sum competition is how the IP learns about particle productivity. Zero-sum competition between particles is thus the IP's explanation of aggregate wealth production. The only information required to make the IP work is knowledge of current wealth and past wealth back to the process' time horizon. In nature the process operates in parallel without central direction. If nature chose extreme parsimony for its algorithm to maximize wealth production, it may have chosen zero-sum competition as in the IP.

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