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Research Article

The Principle of Social Scaling

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This paper identifies a general class of economic processes capable of generating the first-moment constraints implicit in the observed cross-sectional distributions of a number of economic variables: processes of *social scaling*. Across a variety of settings, the outcomes of economic competition reflect the normalization of individual values of certain economic quantities by average or social measures of themselves. The resulting socioreferential processes establish systematic interdependences among individual values of important economic variables, which under certain conditions take the form of emergent first-moment constraints on their distributions. The paper postulates a principle describing this systemic regulation of *socially scaled* variables and illustrates its empirical purchase by showing how capital- and labor-market competition can give rise to patterns of social scaling that help account for the observed distributions of Tobin's q and wage income. The paper's discussion embodies a distinctive approach to understanding and investigating empirically the relationship between individual agency and structural determinations in complex economic systems and motivates the development of observational foundations for aggregative, macrolevel economic analysis.

1. Introduction

Over the past twenty-five years contributions from Econophysics have established that the frequency distributions for many economic variables are consistently well approximated by known functional forms [1–3]. This includes a number of quantities that are central to the functioning of financial markets and broader capitalist economies: changes in financial asset prices, their correlations over different time horizons, and financial-market trading volumes [4–9]; individual income and wealth [10–14]; corporate rates of growth and profitability [15–19]; the measure of corporate security prices given by Tobin's q [20, 21]; and daily changes in foreign exchange rates [22]. These findings are an interesting development for economic analysis, which confronts complex social systems shaped by evolving patterns of interaction between large numbers of individuals whose own characteristics and behavior are socially conditioned. Functional stability in the frequency distributions of several important economic variables makes it possible to see beyond much of the complex detail of individual economic behavior and interactions to develop observationally grounded insights into the emergent macroscopic functioning of key economic systems. With the aid of an *inverse* application of the Principle of Maximum Entropy (PME), this functioning may be formally characterized by the aggregate moment constraints that define the phase spaces over which the persistently observed distributional forms maximize entropy [23, 24]. (Early *forward* uses of the PME in economic analysis include [25–27].) Those constraints can be taken as the emergent, systemic outcome or expression of the microlevel interactions driving the system in question, over the time domains at which observations are taken. While promising, this development also poses analytical challenges: in most cases it is not readily evident how accepted, mainline theoretical frameworks in Economics can account for the presence of the constraints inferred from observed economic data.

A notable example of this situation is given by the observed cross-sectional distribution of individual annual income in the US and Britain. Physicists have demonstrated that these distributions can be very accurately described by a combination of Pareto Power-Law functions for their top few percentiles and Boltzmann-Gibbs exponential functions for the rest of their support [28]. Those contributions have usefully taken this observation to confirm the existence of two distinct types of income appropriation—a return on capital accumulated by individuals at the top of the distribution and the payment of wages to individual suppliers of labor. While the association of Pareto distributions with returns on capital has been understood by economists since the contributions of Wilfredo Pareto in the early 1900s and that of Gibrat [29] a few decades later, the persistent observation of Boltzmann-Gibbs distributions for the vast majority of income ranges poses a theoretical puzzle. There are no widely acknowledged economic processes capable of enforcing the first-moment constraints implicit in those distributions.

Drawing an analogy to the connection between the conservation of energy and Boltzmann-Gibbs distributions for energy levels in the microcanonical ensemble of statistical mechanics, the physicists who drew attention to these distributions of income have suggested they reflect the "conservation of money" in economic systems. This is not an argument most economists accept, since it is not plausible to consider either gross money stocks or total income flows as given over annual frequencies. In fact, much economic analysis concerns itself precisely with variations in those quantities. As a result, the remarkable discovery by those physicists of a persistent functional form across a large portion of the distribution of individual income—for which there is no accepted explanation in Economics—is yet to make a general impact in economic thought, with two important exceptions [30, 31].

This paper makes an innovative contribution on this account by identifying a distinctive class of economic processes capable of imposing first-moment constraints on the distribution of a broad range of economic variables shaped by competitive interactions. It shows how patterns of economic competition can result in what it terms *social scaling*—outcomes that reflect the competitive normalization of individual values of certain economic quantities by average or social measures of themselves. Individual values for the *socially scaled* quantities resulting from this type of competitive normalization are fundamentally interdependent. Under fairly general conditions these interdependences take the form of emergent first-moment constraints bearing upon their distributions. Those constraints reflect not the presence of conservation principles, but the irreducibly socioreferential character of economic competition. Section 2 of this paper formally develops these points and postulates a general *Principle of Social Scaling* describing this pattern of systemic regulation of the individual values taken by some quantities conditioned by economic competition.

Sections 3 and 4 illustrate the empirical relevance of the principle by developing formal accounts of how competitive social scaling can help explain not only the observed distributions of individual wage income in the US, Britain, and Brazil, but also the distributions of Tobin's q observed in US capital markets over fifty years. Those accounts motivate two concluding points, discussed in Section 5. First, they motivate further observational inquiry into the frequencies for other quantities that may be shaped by competitive processes of social scaling. Second, the accounts of labor- and capital-market competition developed by the paper underscore the pervasive, nonprice social interdependences shaping individual economic outcomes, highlighting the analytical shortcomings of the methodologically individualistic approaches that dominate today's mainline Economics. As an alternative, the paper motivates its own application of the PME to support the development of observationally grounded, macroscopic approaches to analysis of complex economic systems.

2. First-Moment Constraints and Social Scaling

It is in the essence of Economics to confront situations of scarcity, where members of a community would like to appropriate total quantities of certain goods that exceed existing supplies at their collective disposal. Across many analytical settings, this can be represented by a first-moment constraint on the distribution of individual appropriations of any such good, along similar lines to the representation of energy conservation in an isolated, multiparticle physical system.

But economic systems exhibit further structural and behavioral characteristics that can impose first-moment constraints on the distributions of certain variables. Economic life imposes important structural interdependences between individuals, like the aggregate identity between all expenditure and all revenues. This identity ensures that changes to individual *net* monetary positions, which are given by the difference between individuals' monetary revenues and outlays, *always* add up to zero across any economic system. As a result, the distribution of such changes across all individuals in an economy is consistently subject to a constraint on its mean, irrespective of all further influences on the distributions of income and expenditures.

This paper points to a further and hitherto unrecognized feature of competitive economic behavior that can also impose this kind of constraint. Across a variety of settings, economic competition relates individual measures of certain quantities to average or social measures of themselves. These relationships may arise as explicit or effective features of individual economic behavior. For instance, individuals in a finite-sized community may explicitly define their welfare by their attempts to "keep up with the Joneses." That is, they may evaluate their well-being not in proportion to their absolute level of consumption, but by their consumption relative to some average measure of consumption across the entire community.

Such evaluations ensure that individual welfare levels x_i are socially scaled measures of individual consumption levels. In the simplest possible cases, these valuations could follow from simple multiplicative or additive scaling of levels of consumption y_i by their average measure $\langle y \rangle$,

$$x_i^m \equiv \frac{y_i}{\langle y \rangle} \quad \text{or} \quad x_i^a \equiv y_i - \langle y \rangle . \tag{1}$$

It is trivial to see how such evaluations would ensure that individual welfare is effectively a zero-sum game, defining a first-moment aggregate constraint on its distribution across individuals in the community. Formally, $\langle x^m \rangle = 1$ and $\langle x^a \rangle = 0$, *irrespective of the distribution of* y. For any distribution of individual consumption levels, we know that the distribution of individual welfare would be subject to a first-moment constraint.

While this abstract, simple example is an expositional convenience, the basic mechanism it illustrates has broad applicability across a variety of competitive settings. Economic competition ensures a number of important economic variables are effectively determined by processes of the form

$$x_i \equiv f\left[y_i, \langle wy \rangle\right] + o_i, \quad (2)$$

where f is a scaling function of y by a weighted average $\langle wy \rangle$ of itself and o_i reflects other influences in the determination of x_i. Clearly individual values for any such socially scaled variable are interdependent, as each y_i shapes not only x_i directly through the first term of f, but also all x_j indirectly, by shaping $\langle wy \rangle$. In any setting where the scaling function is stable, in the sense that its parameters and the weights w_i ensure that $\langle f \rangle$ is constant and where o is systemically uninformative, in the sense that $\langle o \rangle = 0$, these interdependences take the form of an aggregate constraint on the mean of the distribution of x across all individuals in the relevant economic system.

This systemic regulation bearing on variables defined by stable patterns of competitive social scaling may be postulated as a Principle of Social Scaling. It reflects neither a conservation principle nor a monetary accounting identity. It reflects the sociореferential content of many forms of economic competition. Social scaling defined by competition in capital, labor, and product markets can ensure important economic quantities like Tobin's q and wage income are socially scaled variables, accounting for the first-moment constraints implicit in their observed distributions. As shown in the next two sections, those accounts also distinctively point economic inquiry to the emergent social content and macroscopic consequences of economic competition.

3. Tobin's q and Explicit Competitive Scaling

Scharfernaker and dos Santos [20] offered the first examination of frequency distributions of Tobin's q, which measures the ratio of market valuations of a corporation's liabilities, M_i, to measures of the value of its assets, A_i. Since 1962, the end-of-year distribution of $z_i \equiv \ln q_i$ for US-listed private, nonfinancial corporations has consistently conformed to asymmetric Laplace functions, as evident in the semilog plots in Figure 1.

The asymmetric Laplace distribution is the maximum-entropy distribution for a variable subject to two moment constraints, $\langle z \rangle = c_1$ and $\langle |z| \rangle = c_2$ [32]. Given the persistence of this functional form over 50 years, it is reasonable to contend that the complex microlevel behavior of all agents competing in capital markets consistently gives rise to these two simple emergent macroscopic regulations bearing on all values of Tobin's q. As that paper made clear, this means successful theories of Tobin's q must be mathematically equivalent to these two constraints, whatever their conceptual and explanatory premisses.

Social scaling can account for the presence of a first-moment constraint on z. Competition among corporations and investors can ensure Tobin's q embodies a scaling of the rate of total return that investors expect on a corporation's assets. To see this, it is necessary to understand that Tobin's q is in fact a forward-looking ratio of two expected rates of return [21]. At any point in time the valuation of a corporation's liabilities effectively reflects the consensus among competitive investors concerning the total returns or benefits T_i they expect the corporation's assets to generate in the next period. Total returns include cash flows, capital gains, risk-management services, and all possible gains to liability holders the corporation may generate. The expected flow of total returns can be expressed as two behaviorally relevant rates of return: an expected total rate of return on the corporation's assets, ρ_i, and an expected rate of return r_i available to all investors buying the corporation's liabilities at their present valuations. Formally and by accounting identity, $T_i = \rho_i A_i = r_i M_i$, which implies

$$q_i \equiv \frac{\rho_i}{r_i}. \quad (3)$$

In competitive markets with no significant obstacles to trading, investors trade and quickly move security prices until their expected rate of *total* returns on all security investments is the same $r_i = r$. Competition also ensures that this general rate of return is conditioned by what investors deem to be the "typical" rate of total return available across all possible investments they may undertake. In an economy where corporations account for large and representative portions of such investment opportunities, it is reasonable to suppose that r will reflect some average measure of the rates of total return on assets investors expect across all corporations. In this sense, Tobin's q can be understood to embody a form of social scaling, analogous to the multiplicative welfare measure in (1). This scaling ensures that q is a systemic measure of excess returns expected by investors. As such, the moments of its distribution contain information about the macroscopic performance of capital markets as a competitive system tasked with allocating capital to the highest-expected-yield uses.

More pertinently, there are plausible, general conditions under which this scaling imposes a first-moment constraint on the distribution of z. A simple possibility congruent with observation is that r is given by a weighted geometric average across all n corporations in the system (other forms of averaging for r yield the same economic content of what follows, in considerably less elegant mathematical form),

$$r = \prod_{k=1}^{n} \rho_k^{g_k/n}, \quad (4)$$

where $\langle g \rangle = 1$. Letting $a_j = \ln \rho_j$, it is trivial to show that $z_i = a_i - \langle ga \rangle$ is a socially scaled quantity and that

$$\langle z \rangle = -\langle g, a \rangle. \quad (5)$$

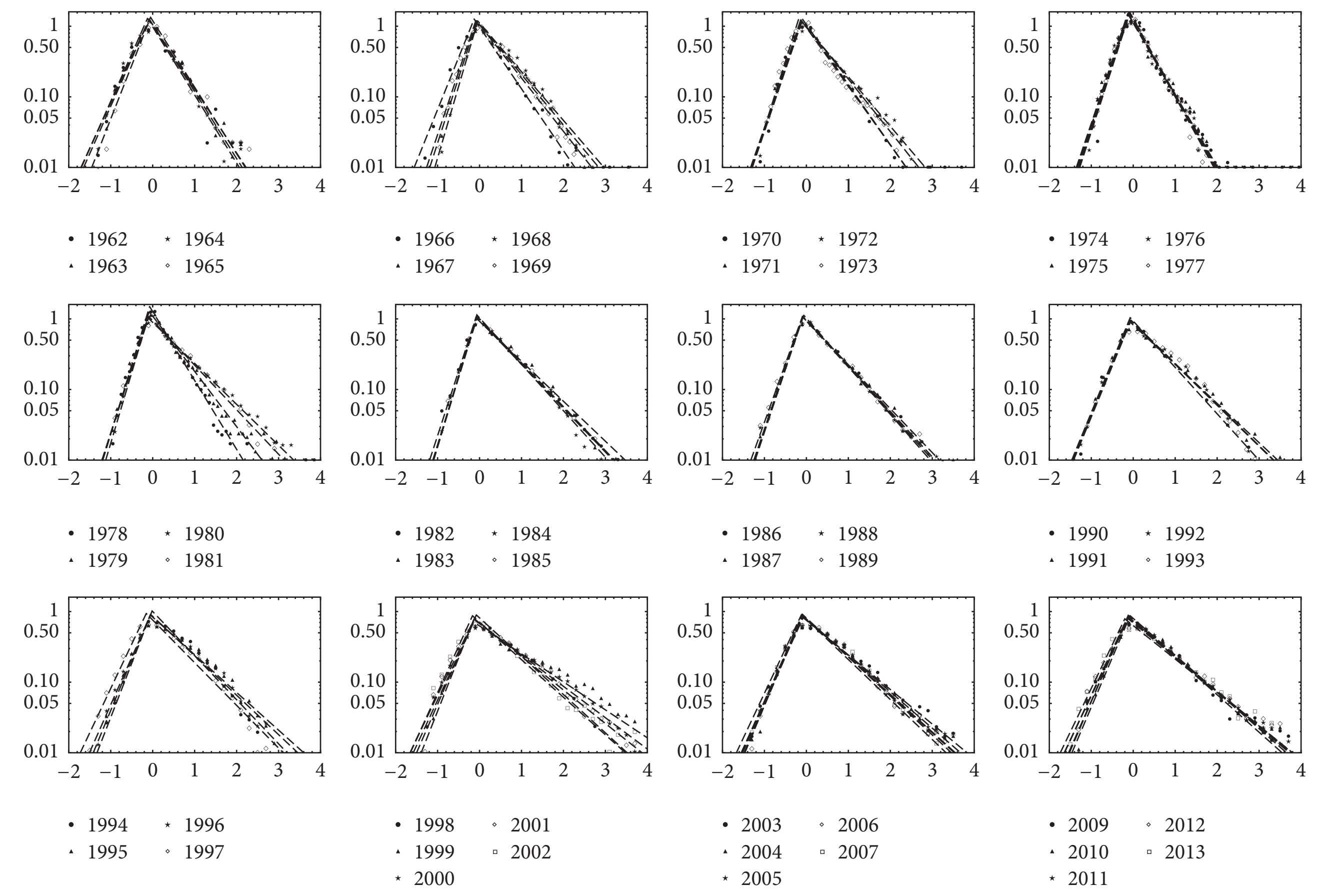

Figure 1: Stacked empirical densities of centered z on a log probability scale, 1962–2014, with maximum likelihood fitted asymmetric Laplace distributions (dashed lines). Source: Scharfernaker and dos Santos [20].

In this setting, stability in $-\langle g, a\rangle$ would account for the inferred mean constraint bearing on the distribution of z. This covariance can be understood as a negative, systemic measure of investor "bullishness." It reflects the extent to which investors regard high rates of return they expect on the assets of some corporations as less representative of typical or average returns than low expected rates of return. Stable measures of this bullish inconsistency in investors' expectations would ensure that the social scaling embodied by q results in a stable value of $\langle z\rangle$ over certain time horizons. In addition to helping account for observation, this systemic account suggests observed values of $\langle z\rangle$ offer a basis for innovative systemic diagnostics for the presence of speculative bubbles in security markets. Those observed values display a strong positive association with measures of the spread in the distribution of z. Settings where security prices reflect high measures of bullishness are also settings where managers are less willing to invest in line with prices (which would tend to increase the measure of organization in the distribution of z). This is possibly a reflection of the fact that managers do not agree with the bullish valuations they face, suggesting the presence of speculative behavior by investors [21].

4. Scaling and a Classical Approach to Wage Income

A number of studies have established that almost the entire ranges of the distributions of individual income in the US and Britain are extremely well represented by Boltzmann-Gibbs exponential functions [11–14]. This finding is easily corroborated by more recent observation, as shown in Figures 2 and 3, which use data from the US Census Bureau Current Population Survey to corroborate earlier findings made with IRS income data.

Along parallel lines, Soares et al. [33] have established that cross-sectional data for individual incomes in Brazil supports the contention that their distribution persistently conforms to q-exponential functions, which are the maximum-Tsallis-entropy distributions for a variable subject to a first-moment constraint (and confined to a support bounded on one side).

Two recent contributions have offered accounts of processes capable of generating equilibrium Boltzmann-Gibbs distributions for wage income [30, 31]. In line with the contention by Keynes [34] that workers may value their wages relative to the average measure of wages, those contributions offered microkinetic models where changes in individual

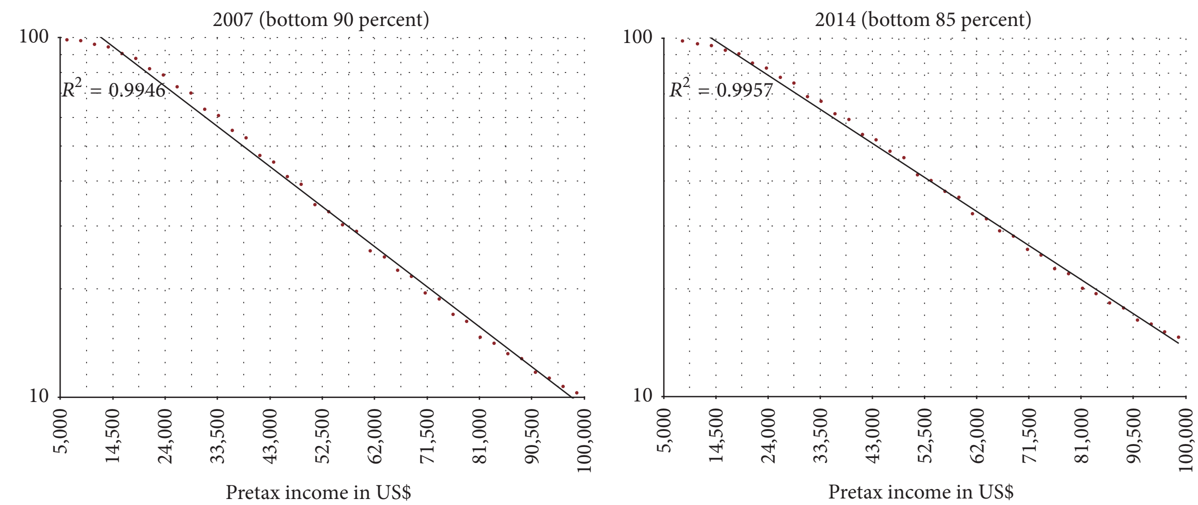

Figure 2: Semilog inverse or counter-cumulative distributions of income in US, exponential fits (linear in this space), and their R^2. Bottom 90 percent of surveyed households for 2007 and bottom 85 percent for 2014. Calculated from US Census Bureau data.

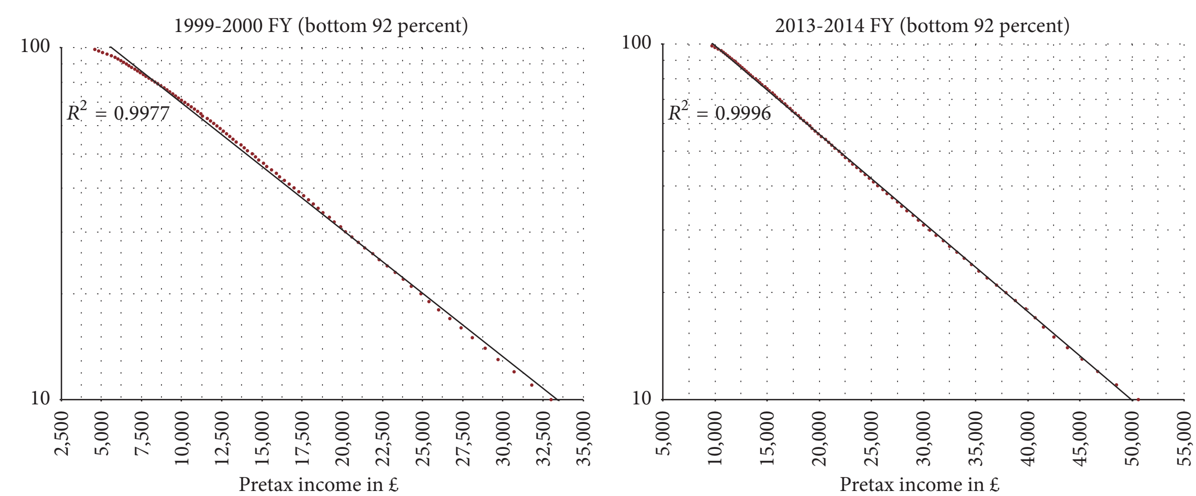

Figure 3: Semilog inverse or counter-cumulative distributions of income in Britain, exponential fits (linear in this space), and their R^2. Selected years, bottom 92 percent of taxpayers. Calculated from HM Revenue and Customs data.

wage income relative to average are driven by Gaussian "shocks." While those models effectively rely on a form of social scaling, they interpret the observed distributions as a result of indeterminate "shocks" and not of competitive interactions.

Yet competition in labor, capital, and product markets may result in patterns of social scaling that effectively impose first-moment constraints on the distribution of wage income implicit in *all* of these observations. These patterns are defined most generally by the contrast between the mobility of capital and the segmentation of labor markets, which ensures wage income reflects the social scaling of the effective bargaining power of individual workers or groups of workers over their wage. The mechanism involved may be simply stated: consider a *ceteris paribus* increase in the bargaining capacity of a worker or group of workers in a labor-market segment, resulting in an increase in their distributional share. Competition in capital markets ensures that in the first instance this increase erodes the distributional share of *all* enterprises. Inasmuch as this erosion increases the drive by all enterprises to push back on the evolution of all wages, workers who have not experienced improvements in their bargaining capacity will suffer a reduction in their distributional share as a result. This mechanism creates patterns of systemic interdependence and competition *among* wage earners that have been largely ignored by economic analysis.

A simple, illustrative formalization can show how this mechanism can sustain accounts of observed patters of wage income distribution.

Broadly following the Classical approach taken by Shaikh [31], consider the wage w_i paid on an individual job as determined by the *trend* measure of the job's money value added, δ_i, and by the share β_i of that value added appropriated by workers. Formally,

$$w_i = \delta_i \beta_i. \quad (6)$$

Competition ensures neither workers nor employers have direct control over measures of money value added per worker: product-market competition ensures that individual measures of money value added per worker reflect comparative measures of physical productivity and of success in establishing market shares of individual producers. More broadly, the mobility of capital tends to ensure the values of δ_i established by product-market competition are in line with the equalization of profitability across all possible areas of investment. Finally, the average measure of money value added per worker can be understood as conditioned by measures of aggregate demand for consumption and investment goods per employed worker. While it is possible to offer explicit characterizations of these processes (which may embody processes of social scaling of measures of physical productivity and of efforts to develop market shares), it is sufficient for present purposes to consider that all δ_i, and thus $\langle\delta\rangle$, are effectively given to labor-market competitors, whose wage bargaining consequently boils down to conflict over the measure of β_i.

Bargaining over the measure of β_i takes place within labor-market microsegments defined by heterogeneity in economic and broader social characteristics of wage earners. While capital value is generally capable of moving across different allocations in search of the best possible yield, the mobility of labor across jobs and across levels of pay within jobs is limited by differences in skills, training, and experience, as well as by broader social realities of gender, race, immigration status, and so forth. The wage outcomes in a labor-market microsegment can be understood to reflect the bargaining capacities of workers and employers in that segment. Those capacities reflect a variety of factors conditioning the ability of workers and enterprises to move the measure of β_i in their favor, like the size of potential labor supply relative to demand, as well as a broader range of institutional, social, and political factors—including the extent and effectiveness of trade union organization, the confidence and broader social standing of wage earners in that segment, the political and regulatory climate, and so forth.

Consider that bargaining over individual or microsegmental wage shares involves the confrontation of two opposing "forces" defined by the efforts of market participants to change the measure of β_i. Suppose that wage earners value their wages in line with socially conditioned consumption standards that evolve in line with average measures of productivity, so that they bargain according to $v_i = w_i/\langle\delta\rangle$. Suppose further that within each microsegment wage earners enjoy a given measure of net bargaining power, α_i. Formally, let $f[v_i;\alpha_i]$ denote that the effective "force" workers in a microsegment can apply on the evolution of β_i, with partial derivatives $f_v \leq 0$ and $f_\alpha \geq 0$.

Employers apply an opposing "force" on the evolution of β_i, conditioned by the behaviorally relevant measure of their own incomes: profitability. But the mobility of capital ensures that profitability tends to be equalized across all enterprises. Employers hiring in any given labor-market microsegment face measures of profitability that tend to be in line with average measures. In Classical Political Economy, average profitability is understood as proportional and causally grounded on $1 - \langle\beta\rangle$. The bargaining force exerted by employers is consequently conditioned by the average wage share across the economy. Formally, let that force be represented by $F[\langle\beta\rangle - \zeta_i;\mu]$, where ζ_i is an excess-returns measure of capital-market disequilibrium and μ is a measure of the bargaining power of employers, also taken as given to labor-market bargaining. Both partial derivatives of F are supposed to be positive.

The dynamic evolution of β_i may be understood as given by

$$\dot{\beta}_i \equiv \epsilon_i = f\left[v_i;\alpha_i\right] - F\left[\langle\beta\rangle - \zeta_i;\mu\right]. \quad (7)$$

Considering for simplicity linear forms for all bargaining forces, with a as a location parameter, this becomes

$$\epsilon_i = a - \frac{1}{\alpha_i}\frac{\delta_i\beta_i}{\langle\delta\rangle} - \mu\left(\langle\beta\rangle - \zeta_i\right). \quad (8)$$

Equation (8) offers a simple, linear illustration of how the competitive mobility of capital establishes a relationship between individual measures of β_i (which condition the bargaining behavior of workers) and its social measure $\langle\beta\rangle$ (which conditions that of employers) in labor-market bargaining. This relationship ensures wage incomes are shaped by socially scaled measures of the microsegmental bargaining power of wage earners.

This can be seen formally. In line with the most common supposition in economic analysis, consider that capital and labor markets are equilibrating. This supposition may be given a simple (and novel) statistical form with the statements that $\langle\zeta\rangle = \langle\epsilon\rangle = 0$. Suppose further that equilibrating tendencies in those markets operate independently of the measure of wage-earners' bargaining strength in the relevant labor-market segment, ensuring that $\langle\epsilon,\alpha\rangle = \langle\zeta,\alpha\rangle = 0$.

As shown in Appendix, this results in expressions for the aggregate wage share of trend income, and for the measure of individual wage income within a labor-market microsegment,

$$\begin{aligned} \langle\beta\rangle &= \frac{a\langle\alpha\rangle}{1+\mu\langle\alpha\rangle}; \\ w_i &= \langle\delta\rangle\frac{a\alpha_i}{1+\mu\langle\alpha\rangle} + \eta_i, \end{aligned} \quad (9)$$

where $\eta_i = \alpha_i\langle\delta\rangle(\mu\zeta_i - \epsilon_i)$ is a systemically uninformative measure of capital- and labor-market disequilibrium, with $\langle\eta\rangle = 0$ under the present assumption of equilibrating markets.

In this simple framework both the functional distribution of trend income between wages and profits and the individual distribution of income across wage earners are defined by measures of bargaining power across all labor-market microsegments. Wage earners are in effect bargaining collectively over the measure of $\langle\beta\rangle$ which is shaped by the aggregate or social measure of their bargaining power and that of employers.

At the same time, workers are also in competition among themselves over their individual appropriations from the aggregate wage share: equilibrating, competitive processes in labor and capital markets ensure individual wage income is shaped by the social scaling of bargaining capacity. Individual wages express not just the circumstances of the individual in question, but also the circumstances of all other individuals in the labor market. Wage earners enjoying comparatively higher bargaining capacities achieve comparatively higher levels of pay that come at least partly at the expense of other wage earners. This pattern of interdependence is capable of imposing an aggregate constraint on the first moment of the distribution of wages, given here by $\langle w\rangle = \langle\delta\rangle\langle\beta\rangle$.

In addition to accounting for the observed distributions of wage income, this novel framework motivates two related conclusions regarding the social content of economic competition and the constitution of wage inequality. First, unlike most conventional theorizations of wage determination, the account allows consideration of the widely acknowledged influence of socially constructed differences based on gender, race, ethnicity, class background, and so forth on levels of pay [35]. Those realities shape access to training, skills, and high-productivity jobs, as well as bargaining power over wages for any given job. The framework allows economic analysis to interpret wage outcomes as not simply a reflection of realities of productivity, but also a reflection of broad patterns of social discrimination. Second, the interdependences created by competition ensure that attempts to eliminate or reduce iniquities in wage income need to grapple with a difficult fact that without concerted action across all labor-market segments, wage increases for any group of historically discriminated workers will at least partly come at the expense of other wage earners. Both economic analysis and political efforts to address iniquities in pay would do well to pay careful attention to these processes.

5. Discussion and Further Work

This paper has shown how certain forms of economic competition can give rise to distinctive sociореferential processes capable of imposing emergent first-moment constraints on the distribution of important economic variables. Patterns of social scaling arising in capital- and labor-market competition were shown to be capable of imposing such constraints on the frequency distributions of wage income and Tobin's q. Given the centrality of these two variables to the processes conditioning levels of consumption and investment, social scaling may be understood as a central, emergent feature of the core functioning of capitalist economies. Social scaling is also very likely to influence the distributions of additional economic quantities shaped by competition, like monetary measures of labor productivity [36]. It is hoped that this paper encourages further work seeking to bear out this expectation and to test the generality and consequences of the principle it advances.

The discussion also motivates important methodological points. The paper illustrates the kind of observationally grounded, macroscopic approach to analysis of complex economic systems made possible by the application of the PME. This application sustains robust approaches to the inverse problem of making inferences concerning the "laws of motion" governing the functioning of economic systems from observation of functionally persistent, well-populated frequency distributions (salient uses of the PME along these lines are offered by Jaynes [23, 24]). This approach offers a useful alternative to the deductive methodological individualism informing much of today's mainline economic analysis, which typically accounts for macrolevel economic functioning on the basis of strongly specified descriptions of individual behavior. The nature and complexity of economic systems ensure those accounts face a number of important difficulties.

As is well established across a variety of disciplines, detailed descriptions of individual behavior are at best impractical bases to characterize the functioning of large systems composed of many interacting parts. This is true even when the laws or regularities governing individual behavior are very well understood. Myriad dynamic interdependences between many individuals ensure that even simple forms of interaction generally yield intractable nonlinearities. Economic (and social) systems pose an additional and characteristic difficulty relative to physical systems in this regard: all economically relevant features of individuals—factor "endowments," productive technologies, consumption "preferences," attitudes toward risk, "information sets," and so forth—are themselves shaped by economic competition and broader social interactions. If the characteristics of economic individuals and economic interactions are mutually defining, taking individual characteristics or behavior as an analytical starting point is not just impractical—it is arbitrary. Thought exercises taking that behavior as given will at best yield partial insights into the functioning of economic systems.

Further difficulties follow from the fact that the specifications of individual behavior that are commonly used in economic analysis have scant empirical justification. As a prominent mathematical sociologist put it, the canonical approach to individual behavior in Economics "makes a number of assumptions about human dispositions and cognitive capabilities that are so outrageous, several years of training in economic theory are required in order to take them seriously" [37, p 66]. This problem reflects in part the formidable conceptual and empirical obstacles to the development of scientifically successful characterizations of individual economic behavior. It is unclear how an observer of an individual's economic actions may draw robust conclusions about their subjective intentions. As emphasized by radical subjectivist economists [38], this would require the observer to share in every aspect of the observed individual's subjectivity. Even if this obstacle could somehow be overcome, an additional difficulty is posed by the fact that genuine laboratory conditions are not available in economic analysis. And while observational inquiry is possible, the frequencies at which economic data is generally available are far lower than the frequencies at which economic individuals interact. As a result, observed data typically reflects not just the intentions and actions of individuals but the accumulated outcomes of the interactions and structural interdependences between large numbers of individual agents.

It is here that the approach followed by this paper opens fruitful avenues for economic inquiry. In economic systems it is now often possible to sample most if not all individual values taken by certain variables. Where observations yield frequency distributions that can be consistently well approximated by known functions, it is possible to identify moment constraints that provide remarkably accurate descriptions of the real phase space occupied by the economic system in question. Those constraints give formal expression to the macroscopic outcome of the interaction between individual agencies and systemic interdependences shaping the observed distribution. The systemic regularities they represent hold independently of much of the detail of individual behavior. They describe emergent, macroscopic functioning that is irreducible to the behavior of any single individual or group of individuals. They set the *systemic* explanatory burden for observationally grounded theorizations, which should be explicitly macroscopic or social in their foundations.

The Principle of Social Scaling is one such explanation. It sustains theorizations that are based on accounting identities and parsimonious, classical suppositions about competitive behavior and emphasizes the social content of its aggregate outcomes. Those theorizations offer plausible economic accounts of macroscopic behavior implicit in a large and growing set of observational data. It is hoped that its conceptual novelty and empirical purchase help encourage renewed debate on the relationship between individual agencies and systemic interdependences in complex economic systems and on the development of observational foundations for aggregative, macroscopic characterizations of their functioning.

Appendix

To derive the two expressions in (9), start from the characterization of the dynamic evolution of the segmental wage share, ϵ_i in (8),

$$\epsilon_i = a - \frac{1}{\alpha_i}\frac{\delta_i \beta_i}{\langle \delta \rangle} - \mu\left(\langle \beta \rangle - \zeta_i\right). \qquad \text{(A.1)}$$

Simple manipulation allows this to be expressed as

$$\delta_i \beta_i = \langle \delta \rangle\, \alpha_i \left(a - \mu\left(\langle \beta \rangle - \zeta_i\right) - \epsilon_i\right) \qquad \text{(A.2)}$$

Applying the expectations operator to both sides of this expression and using the suppositions motivated above concerning the nature of equilibrating processes in capital and labor markets—namely, $\langle \zeta \rangle = \langle \epsilon \rangle = \langle \epsilon, \alpha \rangle = \langle \zeta, \alpha \rangle = 0$—it follows that

$$\langle \beta \rangle = \langle \alpha \rangle \left(a - \mu \langle \beta \rangle\right). \qquad \text{(A.3)}$$

Solving for the aggregate wage share $\langle \beta \rangle$ yields the first equation in (9),

$$\langle \beta \rangle = \frac{a \langle \alpha \rangle}{1 + \mu \langle \alpha \rangle}. \qquad \text{(A.4)}$$

The second equation in (9) specifying the measure of segmental wage income follows from consideration of (6), (A.2), and (A.4). The first two of these ensure that

$$w_i = \langle \delta \rangle\, \alpha_i \left(a - \mu\left(\langle \beta \rangle - \zeta_i\right) - \epsilon_i\right). \qquad \text{(A.5)}$$

Substitution of the expression for $\langle \beta \rangle$ from (A.4) and simple manipulation yields

$$w_i = \langle \delta \rangle \frac{a \alpha_i}{1 + \mu \langle \alpha \rangle} + \eta_i, \qquad \text{(A.6)}$$

where $\eta_i = \alpha_i \langle \delta \rangle (\mu \zeta_i - \epsilon_i)$, as reported in (9).

Conflicts of Interest

The author declares that they have no conflicts of interest.

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