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Abstract

This paper motivates the content and analytical significance of processes of "social scaling" in competitive economic settings, postulating a general Principle that describes the regulations they impose on the functioning of certain economic systems. Economic competition often defines behavioral relationships between individual measures of certain variables and average or social measures of themselves. These relationships ensure a number of behaviorally significant economic variables are socially scaled measures. Individual values of such variables are subject to systemic interdependences, which may take the form of aggregate first-moment constraints on their distributions. The paper shows how processes of social scaling in capital and labor markets can help account for the observed frequency distributions of wage income and Tobin's q, suggesting such processes may be a pervasive in economic systems. Finally, the paper's discussion illustrates and motivates the distinctive usefulness of statistical-mechanical methods in Economics, both in defining new conceptualizations of the relationship between individual agencies and aggregate regulations in economic systems, and in the development of logically robust observational methods in economic analysis.

Keywords: Social Scaling, Economic Distribution, Statistical Mechanics, Observational Economics
JEL codes: B41, C18, C69

1 Introduction

This paper motivates the content and analytical significance of processes of "social scaling" in competitive economic settings, postulating a general Principle that describes the regulations they impose on the functioning of certain economic systems.

Across a number of theoretical and real-world settings, Economics encounters competitive processes that define quantitative relationships between individual measures of certain variables and

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their average or social measures across the relevant economic system. These relationships may arise as explicit features of individual behavior: We can think that hypothetical individuals attempting to "keep up with the Joneses" evaluate their consumption levels relative to average levels of consumption; or it may be that the behavior of real-world capital markets is conditioned by the rates of return investors expect on individual assets measured relative to the average rates of return they expect across all assets. They may also arise as an effective, unintended result of specific patterns of economic competition: Labor-market segmentation and capital-market mobility may ensure that wage bargaining pits workers who care about measures of their individual wages against employers that also care about the average measure of wages across the economy, which conditions average returns on capital. In such settings, bargaining conflict would establish a relationship between individual and average wages across the economic system.

Socio-referential processes like these ensure that important economic quantities are subject to "social scaling." Socially scaled variables are given or shaped by the value of other variables relative to or scaled by their own average or social measure across the relevant economic system. In the examples above, all of which are developed in what follows, the individual welfare of some hypothetical agents may be a socially scaled measure of individual consumption relative to average measures of consumption; Tobin's q may be a socially scaled measure of the total rate of expected returns to investors on a corporation's assets relative to average expected returns across all corporations; and individual wage incomes may be partly conditioned by socially scaled measures of the wage-bargaining capacities of individual wage earners relative to the average bargaining capacity of all workers.

Individual values of socially scaled variables are fundamentally interdependent, ensuring they are shaped by emergent, systemic determinations. The paper shows the simple conditions under which it is possible to characterize these interdependences and influences as a *Principle of Social Scaling*: That the distributions of socially scaled variables across individual members of their respective economic systems are subject to aggregate first-moment constraints. While formally analogous to the operation of a conservation principle, these first-moment constraints do not express the conservation of *anything*. They reflect instead the irreducibly social content of many forms of economic competition and conflict.

Drawing on the analytical approach of Statistical Mechanics and on an epistemological interpretation of the Principle of Maximum Entropy (PME),[1] the paper offers two lines of discussion that motivate the empirical and methodological significance of the Principle of Social Scaling.

First, processes of competitive social scaling may help account for the observed frequency distributions of a number of important economic variables. Recent contributions have identified stable functional forms in the frequency distributions of wealth and personal income,[2] returns on stocks

[1] Developed byJaynes, 1957; Jaynes, 1979b and Jaynes, 2003

[2] Yakovenko and Rosser, 2009; Dragulescu and Yakovenko, 2001; Schneider, 2013; Ragab, 2013; Shaikh et al., 2014

over middle-run time horizons,[3] Tobin's q across all U.S. private non-financial corporations,[4] corporate rates of growth and profitability,[5] and daily changes in foreign-exchange rates.[6] Many of the observed functional forms for these quantities correspond to distributions that maximize entropy for a variable subject to a first-moment constraint (and possibly to others). The paper develops accounts showing how capital- and labor-market competition and conflict can result in processes of social scaling capable of generating aggregate first-moment constraints on the distributions of Tobin's q and individual wage income.

The application of the Principle of Social Scaling not only helps account for empirical observation of those quantities, but it also points economic inquiry to interesting and largely under-theorized systemic influences bearing on their individual values. The strategic interactions between corporate managers and investors that condition the value of Tobin's q will be shown to involve competition not only between investors and insiders of an individual corporation, but also between insiders of all corporations, whose prospects condition the opportunity rate of return available to investors. The differential wage-bargaining capacities of different groups of workers will be shown to define a distinctive form of distributional conflict *between* wage earners. This suggests that the individual distribution of income and all the macroeconomic quantities it influences are conditioned by a wide array of economic, social, and political realities, including patterns of trade union organization and socially defined differences by class, gender, race, immigration status, etc. that shape the wage-bargaining capacities of different workers. This should invite Economics to broaden its currently accepted analytical toolkit, so as to grapple with these important facets of social life.

Second, the prevalence of competitive social scaling highlights the importance of grappling deliberately with the complex interactions between systemic or social interdependences and individual agencies in the functioning of economic systems. The paper illustrates how the PME may be used to develop logically robust methods of inference that can inform theorizations of the nature of those interactions based on observed regularities in the distributions of economic variables. The resulting methodological approach is argued to improve significantly on the almost exclusively deductive, representative-agent approaches dominating contemporary economic theory. It also exemplifies the means by which much needed *observational* foundations may be established for a new type of systemic, aggregative approach to economic inquiry grounded on statistical-mechanical methods.

The rest of this brief paper proceeds as follows. Section two discusses the conceptual and methodological tools that help define the Principle of Social Scaling. Section three develops a series of thought exercises that illustrate the formal similarities and differences between conservation and scaling principles in economic systems, and establishes their logical connection to exponential probability distributions as descriptions of common knowledge states in economic analysis. Section

[3] A. Silva et al., 2004

[4] Scharfernaker and dos Santos, 2015; dos Santos and Scharfernaker, 2016

[5] Alfarano and Milaković, 2008 and Scharfernaker and Semieniuk, 2016

[6] Kozubowski and Podgórski, 2001

four establishes how the observed frequency distribution of Tobin's q across U.S. private non-financial corporations and the personal distribution of income in a number of countries may be understood to reflect competitive social scaling in markets for capital, labor, and goods. It also illustrates the distinctive insights that the methodological approach taken by the paper can yield into those competitive processes. Section five offers a number of concluding observations that may inform future inquiry and invite methodological innovations in the conduct of economic analysis.

2 Probabilities, Frequencies, and Maximum Entropy

Since the epistemic interpretation of the Principle of Maximum Entropy used below to define the Principle of Social Scaling is largely unknown to economists and social scientists (many of whom may be highly skeptical about its applicability to social systems), a summary conceptual and methodological discussion is in order.

As argued most deliberately by mathematical physicist E.T. Jaynes, the PME is a formalization of the rules for logical, scientific reasoning about the functioning of complex systems composed of large numbers of interdependent parts.[7] Its common association with Thermodynamics is largely a result of historical accident, since gases were the first family of such systems to be subjected to rigorous, scientific analysis. This paper belongs to a nascent but growing literature seeking to establish the PME's broader applicability to economic inquiry, which also faces complex systems containing myriad interdependent (and, in fact, mutually defining) individuals.[8] The foundations of the PME and its centrality to inquiry into the functioning of physical or social systems may be briefly summarized. This section is necessarily abstract and ancillary to the paper's main discussion in sections three and four below. Some readers may wish to read it after those two sections or altogether to skip it.

In line with the epistemic interpretation of the PME, most sharply enunciated in Jaynes, 1989, probability distributions may be understood in relation to the following *thought exercise*. Suppose we are considering a system with N individuals and k individual degrees of freedom, with each individual n characterized at any given point in time by a k-dimensional vector $\mathbf{s_n}$ measuring their individual state, defined by specific values taken by each of their degrees of freedom. Let $\mathbb{M}$ be the kN-dimensional set of all possible micro-level configurations for individuals and their states in the system; and let S be the k-dimensional space of all possible vectors $\mathbf{s_n}$ describing individual states. If we divide S into small k-dimensional"bins" $\{s_i\}$, it is possible to define the state of the *system* with i-dimensional histogram vectors $\{n_i\}$, where where n_i of the total N individuals have their individual state $\mathbf{s_n}$ in bin s_i. At the infinitesimal limit for bin size, states may be described

[7] Jaynes, 2003; Jaynes, 1979b; Jaynes, 1979a

[8] Foley, 1994 and Farjoun and Machover, 1983 offered early applications of Statistical Mechanics to economic theory. The papers cited in Section one above offer a small, germane sample of more recent contributions with more of an observational emphasis.

by functions $p : S \to \mathbb{R}^{+}$ that integrate to unity over S.

It should be clear that since the system states defined above are unordered, in the sense that only the total number of individuals n_i is each bin matters, there will generally be a multiplicity of configurations in $\mathbb{M}$ resulting in any given state $p\,[\mathbf{s}]$. The multiplicity of a system state is measured by its entropy, which is given by the expected value over S of $ln\,p\,[\mathbf{s}]^{-1}$. Formally,

$$H\,[p] = -\left\langle ln\,p\,[\mathbf{s}]\right\rangle^{S} \tag{1}$$

Suppose now that we as observers of such a system possess knowledge about its functioning that may be represented as constraints defining a subset $\mathbb{B}$ of $\mathbb{M}$ containing configurations compatible with what we know.[9] If our knowledge includes constraints on the values taken by $\mathbf{s_n}$, it also defines a subset Σ of S. The set $\mathbb{B}$ defines an *ensemble*, and embodies what we know about the system in a very specific way. All configurations in $\mathbb{B}$ are compatible with what we know. Since we would like to be maximally non-committal with respect to what we do not know, we consider that each of those configurations is equally likely.[10] Any other supposition would constitute a bias favoring configurations for reasons other than our stated knowledge.

While all points in the ensemble are, conditional on our knowledge, equally likely, we know that different system states or functions $p\,[\mathbf{s}]$ will have different multiplicities in those configurations. The deductive statement of the PME consists of the contention that the system state or function $p^{*}\,[\mathbf{s}]$ with the maximum measure of entropy $\left\langle ln\,p\,[\mathbf{s}]\right\rangle^{\Sigma}$ over $\mathbb{B}$ can be taken as the logical expression of our knowledge state. Why? Because it will, particularly in settings of very large $N >> i$, be "overwhelmingly the most likely to be observed in a real experiment, provided that the physical constraints operative in the experiment are the same as those assumed in the calculation."[11] Put differently, if there were an actual system whose functioning was exactly in line with the knowledge represented by the constraints defining our ensemble, we would expect repeated observations of the system to generate frequency distributions formally in line with $p^{*}\,[\mathbf{s}]$. This probability thus describes our best estimation of what will happen when we carry out a measurement of a vector $\mathbf{s_n}$. It is in this sense that exponential probability functions will be shown below to be the logical description of our state of knowledge when all we know about a variable in an economic system is that it is bounded and either fundamentally scarce or a socially scaled measure.

Using this deductive line of maximum-entropy thinking, early Statistical Mechanics offered empirically successful characterizations of non-trivial relationships involving macroscopic properties of gas systems like pressure, temperature, energy, viscosity, etc. It did this not by using the well-

[9]In Physics this often consists of knowledge of the conservation of energy.

[10]In line with the Laplace-Bayes-Keynes epistemic interpretation of probability, this is a statement not about the functioning of any real system, but about our state of knowledge. It amounts to the logical recognition that our prior beliefs about what we do not know must, by consistency, be non-informative.

[11]Jaynes, 1979b

established understanding of Classical Mechanics embodied in Newton's Laws to obtain detailed descriptions of the states of motion of individual particles, but by drawing on little more than knowledge that across all interactions between particles total systemic energy is conserved. In economic and broader social inquiry we typically face a different type of problem, calling for a converse, *inductive* application of the PME. Unlike physicists,[12] we do not have good *a priori* knowledge about the laws or regularities governing individual interactions–those are usually what we are seeking to characterize. But we are sometimes able to observe many if not all of the individual states over certain time frequencies. These observations allow us to construct frequency distributions, which reflect not our beliefs or knowledge, but the actual functioning of the system in question.[13]

The observation of a persistent functional form in a frequency distribution allows us to use the PME to make inferences about the individual interactions in the observed system. It suggests that frequency function corresponds to a system state supported by the greatest multiplicity of micro-level configurations permitted by the "laws of motion" of the system. Put differently, the observed frequency distribution achieves maximum entropy among all functions or system states defined on the real phase space $\mathbb{B}^*$, which contains all micro-level configurations compatible with the real laws or regulations of the system.

In many instances, it will be possible to identify explicitly the aggregate or macroscopic constraints on the broader configuration space $\mathbb{M}$ that define $\mathbb{B}^*$. These constraints will be a formal and aggregate expression of the effective functioning of the system. While they will not generally permit us to recover all the micro-kinetic details of the operation of the system, they do represent formally the systemically relevant consequences of individual behavior, which emerge from the myriad interdependent micro-level interactions taking place in the system. As first stated explicitly in Scharfernaker and dos Santos, 2015, these inferred constraints constitute the observational, scientific criterion for testing the purchase of any given theorization of the functioning of the system. Any accounts that cannot be shown to be formally equivalent to those constraints should be discarded for lack of observational support.[14]

By allowing the deduction of probability distributions describing specific states of knowledge, and by sustaining inferences about the functioning of a system from persistent observation of certain functional forms in the frequency distributions it generates, the PME offers the formal, logical link guiding scientific inquiry into the functioning of complex systems made up of large numbers

[12]For whom Newton's Laws and Schrödinger's equation provide overwhelmingly successful descriptions of the micro-level dynamical evolution of their systems.

[13]The epistemological difference between probability and frequency distributions has a sharp, if under appreciated topological expression. As noted by Jaynes, 1979b probability distribution functions are defined over the space Σ constituted by all possible values of a variable during a single trial. Frequency distributions are defined over $j >> 0$ observations or trials, ensuring they are defined over the space $\Sigma^j = \Sigma \bigotimes \Sigma \bigotimes ... \bigotimes \Sigma$.

[14]As discussed explicitly in Section five, this approach implicitly contains a way to think about the relationship between individual behavior and aggregate outcomes that is at variance with currently conventional individualist and aggregative approaches to economic analysis.

of interdependent parts. The discussion that follows illustrates its applicability and distinctive usefulness in economic analysis.

3 Conservation, Social Scaling, and Exponential Probabilities

This section discusses two types of process capable of generating aggregate, first-moment constraints on economic or more broadly social quantities. The first type follows from the fact that societies face material scarcities. In many settings, economic systems may be understood to be subject to the “conservation” of a certain total quantity of a finite resource or factor of production, in an analogous fashion to the conservation of energy in physical systems.

The second type of process is at the center of the original contribution made by this paper. It follows from the effective social scaling of certain quantities in economic and social competition. Social scaling can impose first-moment constraints on the distribution of certain variables. While those constraints are formally analogous to the constraints imposed by any fundamental scarcity, they do not result from any meaningful form of conservation. They follow instead from competitive, socio-referential processes capable of generating very specific, emergent forms of regulation on the functioning of economic and social systems.

This section establishes formally how both conservation or scarcity and social scaling can be related to exponential probability functions as logical representations of knowledge states that are common in the course of social and economic inquiry. Section 3.1 demonstrates the long-understood logical association between conservation principles and exponential probability distributions. It is provided for the benefit of social scientists who may be unfamiliar with the derivation and its underlying reasoning, and to establish that exponential probability functions appear rather naturally in the processes of inquiry into social distribution. Section 3.2 shows how socially scaled variables may come to be subject to first-moment constraints, thus establishing the conditions under which the Principle of Social Scaling describes the aggregate regulations bearing upon individual values of such variables.

3.1 Fundamental Scarcity and Conservation

It is in the very essence of economic analysis to confront situations where certain resources or factors of production are inherently scarce, in the sense that over the relevant time horizons their total quantity in an economic system is either given or approximately so. It is reasonably straightforward to show that if we know that an economic quantity has a given aggregate measure across an economic system and that its individual values are subject to at least one bound, but we know nothing about the mechanisms that distribute this quantity across individuals, our logical expectation concerning the distribution of the variable is given by an exponential probability distribution. As such, exponential distributions appear rather naturally in inquiry into issues of distribution of scarce resources or factors in economic systems, at least in its early stages.

To see this formally, consider the following situation in the process of social inquiry. Suppose we are considering the functioning of a general economy populated by a large number N of individuals facing a fundamental social scarcity, in the sense that they have at their collective disposal a total quantity of a fundamentally scarce quantity X. Suppose further that we do not know anything about the processes through which this total quantity is divided among these individuals. All we know is that *somehow* they each end up appropriating a quantity $x_n \geq 0$, with $\sum x_n = X$. For generality, suppose x_n is also subject to an upper bound b. Along the lines of a common Neoclassical abstraction, the quantity X may be thought of as a collective endowment of a single consumption good of interest to members of an economy. Alternatively, we may think along the lines of the Classical abstractions of Smith, 1982's "early, rude state," or Marx, 1992's "simple commodity economy," and hold X to represent the total quantity of homogeneous labor time members of society supply in any given time period, and x_n to represent the amount of social labor time an individual appropriates in the form of commodities or output goods produced by members of the society.

Irrespective of the school of economic thought in question, we face the same formal setting. Individuals will make appropriations x_n in the set $S = [0, b]$, which together with the scarcity constraint $\sum x_n = X$ define the N-dimensional ensemble $\mathbb{B}_e$ of all possible configurations for a system in line the knowledge we have. Along the lines outlined in the previous section, this situation can be represented in terms of system states or probability functions $p : S \to \mathbb{R}^+$. By definition, these will integrate to one over S, while the scarcity constraint ensures that the average allocation x_n is equal to $X/N \equiv \bar{c}$. In these representations, a conservation principle is expressed as a first-moment constraint on probability functions describing the state of the system.

By the PME, the expectation concerning the state of this system that is maximally non-committal toward knowledge we do not posses is represented by the probability function with greatest multiplicity over $\mathbb{B}_e$. This probability is the solution of the programming problem of maximizing entropy across all probability functions compatible with the given constraint on their first moment and with a normalization constraint. Formally,

$$\begin{aligned} \max_{p[x]\geq 0,\ x\in[0,b]} H &= -\int_0^b p[x]\ln[p[x]]dx \\ \text{subject to } &\int_0^b xp[x]dx = \bar{c} \\ &\int_0^b p[x]dx = 1 \end{aligned} \tag{2}$$

The well-known solution is given by,

$$p[x] = \frac{\lambda}{1 - e^{-b\lambda}} e^{-\lambda x} \tag{3}$$

Where $\lambda > 0$ is the Lagrange multiplier associated with the mean constraint in the entropy maximization problem in 2. In the general setting under consideration, its value is given implicitly by the transcendental equation,

$$\frac{1}{\lambda} + \frac{b}{1 - e^{b\lambda}} = \bar{c} \tag{4}$$

For simplicity, consider from now on the simpler, less general case where $b \to \infty$, under which maximum entropy is achieved by the probability function, defined over $x \in [0, \infty)$,

$$p[x] = \frac{1}{\bar{c}} e^{-\frac{x}{\bar{c}}} \tag{5}$$

The exponential probability density functions expressed by 3 and 4, and by 5 are logical descriptions of the states of knowledge specified above. A large, real economic system subject to no systemic regulations other than an aggregate scarcity constraint on a resource and the relevant bounds on individual appropriations of that resource is logically expected to be in states described by those functions. It is reasonable to contend that whenever faced with any such scarcity, economic analysis should *start* with the presumption that the quantity in question will obey an exponential distribution. Those distributions provide a fairly general expression of the outcome of zero-sum processes in the interactions between large numbers of individuals, imposed in this case by a fundamental aggregate scarcity or conservation.

Obviously as our inquiry into this economy progresses we may learn more about the processes effecting the allocation of the scarce resource. Perhaps we come to learn that for some individuals, success in appropriating one unit of the resource makes it more likely that they will appropriate additional units; or we find out that certain bounds are imposed on the appropriations of certain individuals. Additional knowledge we acquire rules out additional phase-space points, resulting in the formulation of a new ensemble. In some cases, this updating may take the form of the imposition of additional moment constraints on the aggregate distribution of the scarce resource. The addition of new constraints ensures that in general the maximum-entropy distribution providing a logical description of our new knowledge states is unlike the simple exponential functions derived above. The probabilistic descriptions of our new knowledge state reflect the conjugation of scarcity with other aspects of the allocative processes in the economy we have come to discover. As our understanding of the economy in question improves, probabilistic descriptions of our knowledge will more closely resemble the frequency distributions we observe.

3.2 Social Scaling

Economic and social systems exhibit a different type of process capable of generating aggregate, first-moment constraints on certain variables that reflect neither conservation principles nor any fundamental scarcity. Various types of competitive processes explicitly or effectively establish quantitative relationships between individual and social measures of certain variables. Such socio-referential relationships ensure that important economic quantities are subject to processes of social scaling. That is, that those quantities are either given or shaped by scaled or socially averaged measures of other variables. Under fairly general conditions, socially scaled variables will be subject to first-moment constraints on their distribution across individuals in the relevant economic system. This is the Principle of Social Scaling articulated by this paper.

To see this, consider very simple, plausible features of individual economic or social behavior. Suppose that individuals in a community are strictly trying to "keep up with the Joneses." That is, they evaluate their welfare not in proportion to their absolute level of consumption, but by their consumption relative to some average measure of consumption across the entire community. Alternatively, suppose they value their well-being in line with some other measure of their social standing relative to the average social standing in the community. In both cases, individual welfare or well-being would be a socially scaled variable–individual consumption or any other measure of social standing relative to their respective socially averaged measures. An analogous result may apply to investors considering the future gains they expect to receive from investment in a particular asset. In forming their valuations of those expected gains they may actively compare them to some average measure of the expected gains across all assets in which they may invest. The resulting valuations would also define a socially scaled variable. As discussed below in connection to the distribution of individual wage income, economic competition can ensure certain important quantities are effectively socially scaled, even without explicit attempts by individuals to compare or measure individual values against social ones.

The mechanism through which social scaling can generate first-moment constraints is straightforward (once it is recognized). By definition, an increase in an individual measure of a socially scaled variable is necessarily associated with decreases in the variable's measure across all other individuals. If the Joneses improve their consumption or social standing, their neighbors will necessarily see reductions in their welfare. If the prospects for a number of investments worsen, investor valuations of all other investments will improve. If the wage bargaining capacity of a worker or group of workers improves, capital-market competition ensures the resulting wage increases puts pressure on the profitability of all capitalist enterprises. Inasmuch as this pressure impels enterprises to bargain harder across all sections of the labor market, workers whose bargaining capacity has not improved will experience increased downward pressures on their wages. Social scaling reflects the irreducibly social content of economic competition.

It is not hard to see how these interactions may ensure some economic systems experience only zero-sum changes in the individual values of the variables in question. Such processes would be formally akin to conservation principles that can throw up first-moment constraints on the distribution of the scaled variables. The ubiquity of observed exponential distributions (and of other distributions that may be understood as defined by first-moment constraints) in economic systems suggests this type of behavior may be pervasive in economic and social life.

To understand the mechanism formally, suppose that in an economic system a variable x_i is a function of another variable y_i and its own simple average across the set N of all individuals in the system, $\langle y_i \rangle$. In the two simplest possible cases, suppose that the function in question effectively imposes a multiplicative or additive scaling of y_i to its simple social average,

$$x_i \equiv \frac{y_i}{\langle y_i \rangle} \quad \text{or} \quad x_i \equiv y_i - \langle y_i \rangle \tag{6}$$

It should be obvious that in such cases the expected value of the variable x is constant, ensuring its distribution across N is subject to a first-moment constraint. In the first case, $\langle x_i \rangle = 1$, while in the second case, $\langle x_i \rangle = 0$.

It should also be evident that these results are only particular instances of a more general possibility that, for a vector $\mathbf{a}$ that helps define a weighted average measure of a variable y_i, we have a variable x_i,

$$x_i \equiv f\left[y_i, \langle a_i y i \rangle\right] \quad \text{and} \quad \langle x_i \rangle = \bar{c} \tag{7}$$

There are many different ways in which social scaling to a weighted average can ensure that over some relevant time periods 7 holds.[15] If we believe that 7 holds and that x_i is subject to at least one bound, but have no additional detailed knowledge of the processes determining the distribution of that variable, exponential distributions will be the logical description of our state of knowledge. This would not be the expression of any form of conservation. It would simply reflect our beliefs concerning the social content of the process of economic competition embodied in that variable. Note finally that, as made very clear by 5, these beliefs lead to the conclusion that the distribution of a socially scaled variable is scale-free, in the sense that it depends only on the values it takes *relative* to its mean.

[15] This will typically require that $\langle a_i \rangle$ is constant, which can follow either from fact that the behavior of economic systems is *intensive* not extensive (as in 6, where this average equals one), or as the result of some other known or posited behavioral pattern.

4 Exponential Frequencies and Likely Instances of Social Scaling

This section considers two important observations suggesting social scaling may be an ubiquitous feature of economic competition: The frequency distribution of Tobin's q for U.S. private, non-financial corporations, and the distribution of individual income for the overwhelming majority of people in the U.S. and in Britain. For both variables, frequency distribution functions that maximize entropy while subject to first-moment constraints have been consistently observed. As motivated in Section Two above, this suggests that the systemic result of the manifold determinations of individual values of these variables is mathematically equivalent to the presence of an aggregate mean constraint on them. The section discusses competitive processes in capital and labor markets that are capable of generating such constraints as a result of specific patterns of social scaling. The accounts illustrate not only the possible empirical purchase of the Principle of Social Scaling, but also the distinctive analytical insights that may follow from the systemic approach to economic inquiry it embodies.

4.1 Tobin's q

Scharfernaker and dos Santos, 2015 offered the first examination of the frequency distribution of Tobin's q for U.S.-listed private, non-financial corporations. That paper established that since 1962, the end-of-year distribution for $z_i \equiv ln\,[q_i]$ has consistently conformed to Asymmetric Laplace or double-exponential functions, as evident in the semi-log plots of frequency distributions in figure 1.

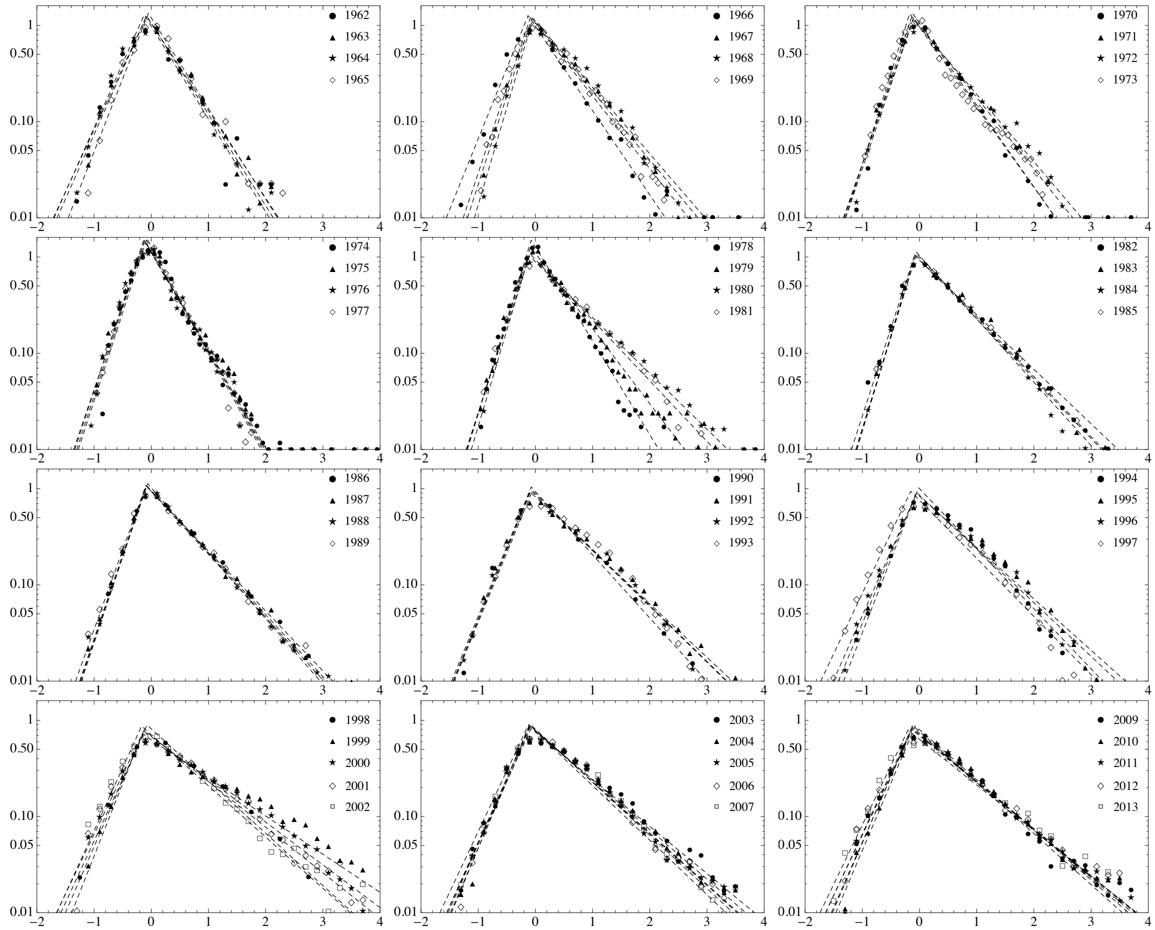

Figure 1: Stacked empirical densities of centered y on a log probability scale, 1962-2014, with maximum likelihood fitted Asymmetric Laplace distributions (dashed lines). Each point corresponds to the center of a histogram bin and each shape represents a particular year. Source: Scharfernaker and dos Santos, 2015.

The Asymmetric Laplace distribution is the maximum-entropy distribution for a variable subject to constraints on its average value and on its average absolute value. In line with the thinking detailed above, this suggests that whatever the micro-level details, the processes shaping individual measures of Tobin's q effectively boil down to two emergent, aggregate relationships, $\langle z_i \rangle = c_1$ and $\langle |z_i| \rangle = c_2$. Given the persistence of the observed functional form in the frequency distribution for almost the entire population of corporations in question, it is reasonable to contend that any successful theory of Tobin's q must be formally compatible with these two relationships.

One such theorization is offered by dos Santos and Scharfernaker, 2016, which relies on the idea of social scaling of rates of return to account for the observed first-moment constraint bearing on the distribution of z_i.[16] Tobin's q is a measure of market valuations of a corporation's liabilities

[16]The absolute value constraint is taken to reflect the fact that capital markets function as if they were an infor-

relative to (book or replacement) measures of the value of its assets. As such, it can be understood as a ratio of two *forward-looking* and *risk-adjusted* expected rates of return:[17] The risk-adjusted rate return on the assets of the corporation expected by investors, ρ_i, divided by the opportunity, risk-adjusted expected rate of return they demand on the corporation's securities, $\bar{\rho}$. Formally,

$$q_i \equiv \frac{\rho_i}{\bar{\rho}} \tag{8}$$

Once understood along these lines, it is easy to see that Tobin's q is very likely to be a socially scaled measure. This requires only that instead of taking the opportunity rate of return $\bar{\rho}$ as exogenous, we recognize that it very likely reflects some average measure of the risk-adjusted expected rates of return on assets that are available across all corporations. This implies that Tobin's q is effectively a measure of the excess expected, risk-adjusted rate of return on the assets of an individual corporation, relative to an average measure of that rate across all corporations.[18]

A very simple possibility would be that, $\bar{\rho} = \langle \rho_i \rangle / a$, in which case,

$$q_i = \frac{a\rho_i}{\langle \rho_i \rangle} \quad \text{and} \quad z_i = ln \frac{\rho_i}{\langle \rho_i \rangle} + ln\ a \tag{9}$$

A Taylor approximation of the first term in this expression for z_i ensures that $\langle z_i \rangle \approx ln\ a$. If over some time horizons, a is a given average measure of bullishness investors apply to their valuations of expected, risk-adjusted returns on individual corporations, this ensures that the distribution of z_i is subject to a first-moment constraint.

The Principle of Social Scaling is capable in this instance of accounting for (part of) the persistently observed characteristics of the frequency distribution of Tobin's q. It does so by emphasizing the role of fundamental competitive interdependences among individual capital-market valuations, and highlighting how they can give rise to a stable, emergent pattern of regulation of those valuations. In relation to capital-market competition, this suggests that salient, deliberate contributions inquiring into the strategic interaction between investors and corporate insiders–like Myers and Majluf, 1984's Pecking Order Hypothesis–may have underplayed the fact that investors' evaluations of any characteristic of a corporation or set of actions by its managers are most likely conditioned by the corresponding characteristics and management actions of potentially all other corporations.

mationally constrained system effectively tasked with allocating capital so as to equate the total expected benefits to investors across all corporate assets.

[17] Risk adjustments can include any hedging or broader risk-management services rendered by the future returns on a corporation's assets.

[18] This allows dos Santos and Scharfernaker, 2016 to develop a new appreciation of the relationships between individual values of Tobin's q and measures of the allocative efficiency, and the distribution of Tobin's q and the informational efficiency of capital markets

In line with the approach of Statistical Mechanics, the Principle of Social Scaling invites analysis to consider economic interactions within the terms of their systemic context.

4.2 Income Distribution among Wage Earners

A further, potentially significant instance of social scaling involves the distribution of personal income. Starting with the pioneering paper by Dragulescu and Yakovenko, 2000, a number of contributions have established that at least in the U.S. and in Britain, the distribution of personal income appears to follow at least two distinct patterns. For those in the top few percentiles, the distribution of income conforms very closely to a power law. For the rest of the population, income distribution appears to follow exponential distributions, with remarkable precision for all but the very lowest-percentile of income earners, as shown in figures 2 and 3.[19]

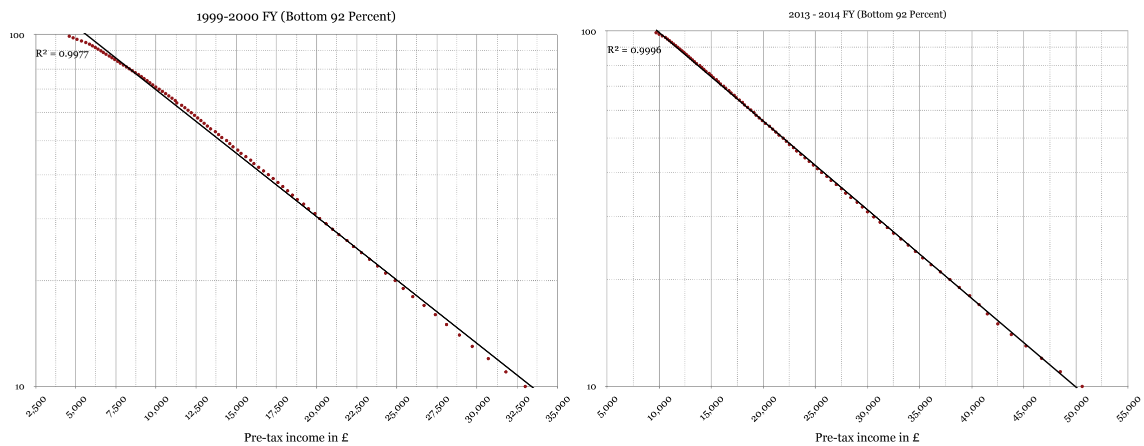

Figure 2: Semi-log inverse or counter-cumulative distributions of income in Britain, exponential fits (linear in this space) and their R^2. Selected years, bottom 92 percent of taxpayers. Calculated from HM Revenue and Customs data.

[19] Exponential fits of IRS income data for the U.S. have been reported widely. In line with Shaikh et al., 2014, data from the U.S. Census Bureau's Current Population Survey is used here as corroboration of those finding, even though it does not include sufficiently fine-grained data for respondents reporting incomes in excess of 100,000 Dollars.

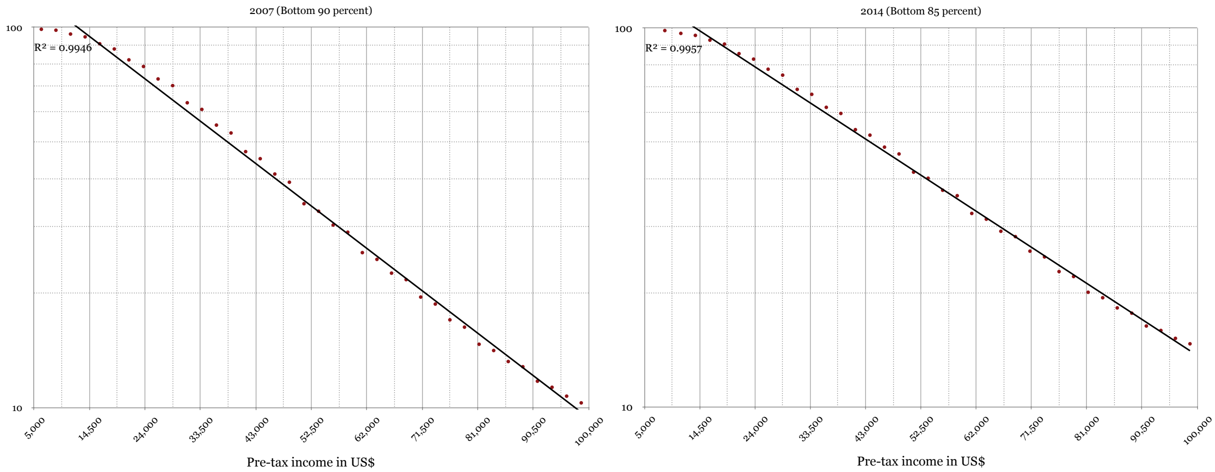

Figure 3: Semi-log inverse or counter-cumulative distributions of income in U.S., exponential fits (linear in this space) and their R^2. Bottom 90 percent of surveyed households for 2007, bottom 85 percent for 2014. Calculated from U.S. Census Bureau data.

Yakovenko and A. C. Silva, 2005, Shaikh, 2016, and Schneider, 2013 have suggested that the persistent presence of different distributional forms point to the existence of distinct forms of income appropriation. The first two contributions suggest a two-fold distinction between wage and profit income, with the former dominating total individual income across the bulk of the bottom of the distribution, and the latter dominating incomes at the very top. The third contribution makes a compelling case for a further distinction, between two forms of labor-based, wage appropriations. This follows from the observation that a mixture model with exponential and lognormal components offers an even better account of the observed frequency distributions, especially for the very lowest income percentiles, suggesting the existence of two labor-market segments with different micro-generative processes.[20]

The association between property-based, profit income and Power-Law distributions has been well-understood since the work of Wilfredo Pareto in the late 19th century and that of Gibrat, 1931 a few decades later. But the exponential distributional form for the overwhelming majority of income earners opened a hitherto unresolved puzzle in economic analysis.

The physicists who first established exponential distributional forms for individual income have argued those distributions may follow from a "conservation of money," in a manner analogous to the way in which energy conservation yields Boltzman-Gibbs exponential distributions for energy in gases. Given the history of Statistical Mechanics, this is entirely understandable. It is also entirely understandable that most economists will not readily accept this interpretation, since neither gross money stocks nor money flows can in any meaningful way be understood to be (even

[20] Using Ehsan S Soofi, 1995's Informational Distinguishability index, Schneider, 2013 establishes that pure exponential fits are consistently less than five percent informationally distinguishable from the observed frequencies. The mixture model is consistently less than one percent distinguishable.

approximately) constant at annual frequencies–despite the fact that levels and changes in the *net* monetary positions of all individual agents in an economy must always add up to zero, by the aggregate identity of incomes and expenditures.

Two recent contributions have offered interesting economic arguments based on the observed frequency distributions of individual income. In line with Keynes, 1936's contention that workers may value their wages according to their measure relative to the average level of wages, both Ragab, 2013 and Shaikh, 2016 have offered simple micro-kinetic models where the evolution of individual wages relative to the average wage follows Gaussian "shocks." In effect, those accounts are contending that in the evolution of an individual's wage, the only systemically and informationally significant variable is the socially scaled measure of that individual's wage. All other determinations effectively boil down to an uninformative "noise," ensuring that exponential distributions emerge as statistical equilibria for individual income for wage earners.

In arguing that wages are behaviorally relevant in labor-market bargaining not in their absolute measure, but in their measure relative to some average measure of wages, and that this dependence conditions the emergence of an exponential frequency distribution for wage income, these contributions offered an early, kinetic account of a specific process embodying what this paper is terming social scaling. While formally congruous with observation, these accounts face two interpretative difficulties. The first is that *in themselves* the models do not contain endogenous accounts of the emergence of the aggregate functional distribution of income between wages and profits. They imply a separation in the determination of the wage share of aggregate income and the determination of individual measures of wage income. And second, they suppose a very high degree of labor mobility, explicitly offering no account of why different wage earners end up with higher or lower wages.

The more recent contribution in dos Santos, 2016 offers an alternative interpretation, centered on the contention that competition in labor and capital markets can result in a distinctive form of social scaling capable of imposing, over some time horizons, a first-moment constraint on individual wage earnings. This scaling is defined by two observations. First, realities of skills, trade union organization, as well as and broader social realities of gender, race, ethnicity, immigration status, etc., ensure that the labor market is in effect made up of myriad, fine-grained segments. There may be significant limits in the mobility by workers across those segments, even though the typical capitalist enterprise hiring across a broad range of them. This is in stark contrast to capital markets, where capital value is generally able to move across possible allocations with few restrictions, in search of the best expected yield.

Second, within each labor-market segment, wages are conditioned by distributional conflict involving contending bargaining forces of wage earners and capitalist enterprises. In this conflict, the distributional share represented by a given segmental wage shapes the bargaining forces of workers and enterprises in a labor-market segment. But the mobility of capital ensures that enterprises also bargain across all labor-market segments according to *aggregate* profitability, which in turn reflects the average or social distributional share of *all* wage earners. This latter influence of the aggregate measure of distribution on capitalist bargaining in individual labor-market segments creates systematic interdependences between the wage outcomes of workers in different market segments. In such a setting, the functional distribution of income is an emergent outcome of the confrontation between the aggregate effective bargaining strength of all wage earners and the aggregate bargaining strength of capital. The individual distribution of wage income, in turn, emerges as an expression of the socially scaled measure of the bargaining strength of wage earners in each labor-market segment.

To see this formally, consider a simple, abstract version of the broader account developed by dos Santos, 2016. Following Shaikh, 2016, consider a simple decomposition of individual wages w_i into a product of two quantities. First, the money value-added generated as a result of the efforts of the worker in question, δ_i. This generally observable measure reflects physical productivity–of the worker in question or of the enterprise employing them; it matters not for present purposes. It also reflects the turbulent processes of product-market competition, which condition prices. Second, wages are also shaped by a distributional factor β_i measuring the share of money value-added the worker appropriates–termed here the rate of appropriation. Formally,

$$w_i = \delta_i \beta_i \tag{10}$$

It should be obvious that the average measure of the rate of appropriation across the economy, $\langle \beta_i \rangle$ is the aggregate wage share of income, and that the money value added per employed worker is given by $\langle \delta_i \rangle$. Since money value added is shaped by physical productivity and output-market competition, there is no reason to expect it to have any informational association with the rate of appropriation, ensuring that $\langle \delta_i, \beta_i \rangle = 0$.

For present purposes it is sufficient to consider a setting where wage earners bargain for increases in their wage according to a social measure of its purchasing power: its distributional share, measured by its value relative to the average money value added. Formally, suppose the bargaining behavior of workers in a market segment i is described by a function $f_i = f_i \left[\frac{\delta_i \beta_i}{\langle \delta_i \rangle} \right]$ describing the effective force with which they push for increases in their wage. Suppose further (and plausibly) that the first derivatives of all these functions are negative. Along similar lines, suppose that the mobility of capital ensures that enterprises bargain for reductions in wages according to the aggregate rate of appropriation or wage share. Formally, their bargaining behavior is described by, $F_i = F_i \left[\langle \beta_i \rangle \right]$, with positive first partial derivatives. Finally, since changes in the measure of money value added per worker are small at the annual frequencies at which incomes are measures, consider a setting where those measures do not experience any change.

To simplify matters further, suppose all bargaining force functions are linear on their arguments. Thus, the bargaining strength of wage earners takes the form,

$$f_i = a - \frac{1}{\theta_i} \frac{\delta_i \beta_i}{\langle \delta_i \rangle} \tag{11}$$

Where a is a common measure of the hypothetical bargaining strength exerted by wage earners trying to increase their wages from zero, and θ_i measures the bargaining capacities of workers in the relevant labor-market segment,[21] taken here to be conditioned by a wide array of different economic, social, and political realities bearing upon each of the economy's fine-grained labor-market segments.

Enterprises may be taken to exert bargaining pressures according to the aggregate distributional share,

$$F_i = \mu \langle \beta_i \rangle \tag{12}$$

Where μ offers an overall measure of bargaining strength for enterprises across the labor market. In the vicinity of labor-market equilibria, these forces roughly balance each other, so that,

$$a - \frac{1}{\theta_i} \frac{\delta_i \beta_i}{\langle \delta_i \rangle} = \mu \langle \beta_i \rangle \tag{13}$$

Since the money value added, appropriation, and bargaining strength measures are taken as independent of each other, we can manipulate this expression and use the expectations operator to obtain an expression for the aggregate wage share,

$$\langle \beta_i \rangle = \frac{a \langle \theta_i \rangle}{1 + \mu \langle \theta_i \rangle} \tag{14}$$

In this simple framework, the aggregate wage share emerges as the result of an aggregate confrontation between wage earners and enterprises, and will in effect be a function of the parameters describing their respective aggregate bargaining strengths. Inasmuch as those parameters are approximately constant over the annual frequencies at which individual incomes are measured, we may understand that wage share to be constant over those time horizons.

Behind the relative simplicity of 14 there are important systemic interdependences between the

[21] Under the present linear specifications, this may be taken as a net measure, reflecting the interaction of the gross bargaining force exerted by wage earners and that exerted by employers in response to any given measure of the distributional share represented by the wage in the labor-market segment in question.

wage incomes of individuals in different labor-market segments. Substitution of that expression into 13 and some manipulation results in an expression for the wage paid in each segment,

$$w_i = \langle \delta_i \rangle \, a \frac{\theta_i}{1 + \mu \langle \theta_i \rangle} \tag{15}$$

Here the wage in a given fine-grained labor-market segment emerges in part as a socially scaled measure of the bargaining force of its wage earners relative to an average measure of the bargaining strength of all workers. This points to an important, hitherto neglected form of competition *among* workers. While 14 points to the fact that the aggregate, average effective bargaining power of wage earners helps condition the economy's wage share, 15 highlights that the division of the wage share among workers is conditioned by the relative bargaining power of workers in different labor-market segments.

This dependence of wages on the relative bargaining power of different workers is what dos Santos, 2016 tentatively terms a "Social Law of Wages." Capital-market competition and mobility ensure that the gains in levels of pay achieved by workers with high bargaining capacities come at least in part at the expense of workers with lower bargaining capacities. Since differential bargaining capabilities across different wage earners are conditioned not only by skills, but also by stubborn patterns of effective discrimination based on gender, race, ethnicity, immigration status and other socially constructed categories, this finding has potentially profound socio-political and analytical implications. Without concerted, collective action across many segments of the labor market, some of the wage gains realized by certain wage earners come at the expense of other wage earners less effective in labor-market bargaining. This creates considerable potential for the reproduction of political antagonisms among wage earners belonging to different socially defined groups. Analytically, this finding points to ways in which it is possible to integrate consideration of these patterns of discrimination into theories of value capable of revealing the full social content of and antagonisms expressed in the prices and wages that competition and conflict establish. Such theories could usefully inform the development of political interventions capable of reducing the significance of various forms of social discrimination in labor markets and in society at large.

5 Scaling and Aggregate Regulations in Economic Systems

The discussion above motivated the existence and analytical relevance of processes of social scaling defined by different forms of economic and broader social competition. Social scaling creates systemic interdependences between individual values of important quantities in economic systems, since increases in one individual value of a socially scaled quantity are necessarily associated with decreases in its value across other individuals. Across a variety of settings, these interdependences define zero-sum interactions across individuals in an economic system, imposing an aggregate constraint on the first moment of the distribution of the socially scaled variable in question. This is the Principle of Social Scaling, which expresses not the influence of any conservation principle but the consequences of the irreducibly social content of economic competition.

Social scaling was shown to enable the formulation of accounts of the economic processes generating the persistently observed frequency distributions of Tobin's q and personal income. In economic terms, those accounts relied on nothing more than simple suppositions concerning the broad outlines of competitive processes in capital and labor markets. It is hoped that this explanatory ability encourages further work identifying frequency distributions of economic variables that reveal the presence of first-moment constraints that may be plausibly understood to emerge as the result of distinct patterns of competition and conflict.

Because of its grounding on fundamental interdependences between individual outcomes, the Principle of Social Scaling yields accounts that invite the adoption of broad, systemic perspectives of the content and evolution of quantities like individual wage incomes and Tobin's q. Those perspectives may pose interesting new avenues of socio-economic inquiry. The understanding of Tobin's q as a socially scaled measure suggested that the competitive interaction between corporate insiders and investors is not primarily conditioned by the absolute measure of the expected returns on a corporation's assets, but by the socially scaled measure of those expected returns. Along those lines, the actions of managers may be less important in their own right than inasmuch as they conform or diverge from "typical" management actions. This points to possibly complex patterns of social interaction in capital-market competition between investors and insiders, and to the need to broaden the single-firm game-theoretic analyses offered by salient contributions like Myers and Majluf, 1984.

The understanding of segmental measures of equilibrium wages as variables embodying a distinctive form of social scaling of the bargaining capabilities of wage earners pointed to important emergent patterns of competition (and potential antagonisms) among wage earners. This suggests that grappling with issues of income distribution, and with their potential implications for welfare, aggregate demand, and other macroeconomic outcomes, requires grappling with the broad economic, social, and even political realities conditioning differential labor-market bargaining capabilities across different segments of the labor market. This opens the interesting (and indeed exciting) possibility of integrating analysis of complex realities of social class, trade-union organization, gender, race, immigration status, and other socially constructed categories that condition people's bargaining capacities, into the very heart of our understanding of capitalist economies.

The paper's discussion also poses a series of important methodological issues. The likely pervasiveness of social scaling underlines the importance of systemic interdependences between individuals in economic life. These interdependences are capable of generating emergent, aggregate regulations of individual outcomes in economic systems. In this sense, competitive social scaling may be as significant to the functioning of macroeconomic systems as input-output relationships established by the technical requirements of production, or as the aggregate identity between expenditures and incomes–both of which also impose aggregate patterns of organization onto economic systems. It is also possible that certain forms of social scaling are capable of generating paradoxes and results that appear counterintuitive from an individualist perspective, along the lines of the "Paradox of Thrift" identified by Keynes, 1936, the independent influence of aggregate investment on profits motivated by Kalecki, 1971, or the "Paradox of Debt" motivated by Steindl, 1976.

The existence of fundamental interdependences between individuals in economic systems poses the question of how Economics should conceptualize the relationship between individual agency and systemic regulations, and how we may be able to investigate it empirically. The statistical-mechanical approach underlying the discussion offered by this paper is ultimately the result of a methodological revolution that took place in Physics when it was confronted with large systems subject to fundamental interdependences. Despite having in Newton's laws (and later in Schrödinger's Equation) overwhelmingly successful descriptions of the mechanics of individual particles, physicists came to understand that those descriptions were at best impractical bases for characterizing the macroscopic, emergent behavior of certain physical systems. Statistical Mechanics and the Principle of Maximum entropy were developed in response to this recognition, resulting in remarkably successful scientific programs in Thermodynamics, Condensed Matter Physics, and other fields.

The persistent prevalence of "representative-agent" formalisms based on detailed specifications of individual economic behavior (deduced from axioms purporting to represent the bases of that behavior) reveals that an analogous methodological revolution has not yet taken place in Economics. This persistence is remarkable. First, our knowledge of any possible regularities in the actual micro-level behavior of economic individuals is qualitatively inferior to physicists' knowledge of the natural Laws of Classical and Quantum Mechanics. In fact, it is unclear how experimental or observational inquiry could be used to establish the general empirical purchase of the strong suppositions regarding individual subjectivities, "rationality," preference relations, foresight, "information sets," and the capacity to process information, that underlie the most widely accepted microeconomic analytical approaches.[22] Second, even if it were somehow possible to develop successful characterizations of individual behavior, these would still be at best impractical bases for characterizing the functioning of economic systems involving large numbers of individuals and interactions. Finally and most poignantly, in economic life not only are the rules of interaction social, as noted by Arrow, 1994, but the behavior of individuals themselves is socially conditioned.[23] The

[22] As argued by Hayek, 1943 (from a methodological perspective very different from the one informing the present discussion) if the subjectivity governing economic actions is indeed inherently individual, it is likely impossible for any researcher to understand the processes determining any individual's economic actions.

[23] Reflecting the frustration in other social sciences with the unwillingness of much of Economics to grapple with this latter point, mathematical sociologist Duncan Watts considers that 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." Watts, 2003, p

corollary difficulties for methodological individualism are manifold. For instance, if consumption preferences are socially conditioned, including by the actions of entrepreneurs, individual preference relations will not generally be a suitable starting point for developing characterizations of the market interaction between buyers and sellers, which will contain irreducibly social determinants.

The converse, inductive application of the PME used in this paper points to a different methodological approach that can both overcome these limitations and provide sound observational foundations for a new kind of systemic theorization of the functioning of economic systems. This type of theorization offers a distinctive conceptual link between observable macroscopic properties of economic systems and the systemically relevant aspects of individual agencies, and is inherently grounded on observed patterns of organization in economic life.

The relatively new availability of large data sets for important economic variables enables us to construct well-populated frequency distributions that may be taken as good, if not complete, representations of entire populations of individuals in certain economic systems (corporations or some broader set of enterprises, taxpayers, or the working-age population, for instance). A number of the resulting distributions display remarkably high measures of organization and functional stability over time. As argued and illustrated above, the PME allows identification of summary, formal expressions of the systemic constraints defining the phase space traced by the functioning of the system. Those constraints reflect the outcome of complex patterns of interaction between myriad individuals and the systemic interdependences economic life imposes upon them. They will not generally convey every detail of the actions of individuals, but they will capture the systemically relevant aspects of those actions. It should be most generally accepted that in economic systems exhibiting a variety of fundamental interdependences between individuals, persistently observed frequency distributions are robustly indifferent to at least some details of individual behavior.

The constraints we may infer in exercises of this type set the explanatory burden for theorization about the functioning of the economic system in question, in the sense that theorizations that cannot be shown to be formally compatible with them should be discarded. Unfortunately, there are no widely accepted, formal criteria for choosing among theorizations formally compatible with the inferred constraints. Here inquiry must appeal to established knowledge of the functioning of economic systems and the general rules of sensible scientific inquiry. By Occam's Razor we should expect simpler accounts to be more successful than elaborate ones. We should also expect accounts that are plausible in light of our established knowledge about the functioning of economic systems to be more successful than other accounts. Most importantly, all accounts must be subjected to further inquiry, based on any and all methods of investigation at our disposal. It may be possible to identify implications of successful accounts that lend themselves to additional investigation. Or it may be possible to consider different, broader, or more detailed observations that will effectively test our best hitherto account. An integral part of the epistemic interpretation of the PME is

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the recognition that scientific inquiry is an ongoing process, and that concluding that our hitherto understanding of some thing is wrong is the first step in learning more about it.

This is the broad approach that guided the development of the Principle of Social Scaling advanced by this paper. It was motivated by the sheer pervasiveness of economic quantities whose frequency distributions across individuals in certain economic systems are given by functions that maximize entropy subject to first moment constraints (among others); a dissatisfaction with the implausible transposition of the idea of conservation principles from Physics to Economics; and a recognition that many of the variables in question are generated by competitive processes where it is very likely that explicit or effective comparisons to averages are consistently made. It is hoped that the unusual combination of analytical novelty and potential empirical purchase of the Principle of Social Scaling encourages further work contributing to its analytical development and investigating its empirical applicability.

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