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1

Introduction: A New Approach to Macroeconomics

In his 1844 essay, "On the Influence of Consumption upon Production," J. S. Mill endeavored to refute the belief that, "A great demand, a brisk circulation, a rapid consumption (three equivalent expressions) are a cause of national prosperity." In this book, we take up the old belief and propose that aggregate demand *does* matter in the determination of total output. The argument requires a drastic turn in macroeconomic, theory and introduces new methods. The purpose of this book is to explain the new approach. Readers will see how new methods and concepts broaden the scope of macroeconomics and shed new light on old problems such as demand deficiency, inflexible prices, business cycles, and asset prices.

The idea that demand matters was, of course, established by Keynes (1936) – indeed, macroeconomics used to be synonymous with Keynesian economics. Alas, no more! Keynes' principle of effective demand – that aggregate demand determines the level of aggregate production or output – is in stark contrast to the neoclassical doctrine that aggregate output is determined solely by supply factors such as factor endowments and technology, and that demand is relevant only with respect to composition of outputs. Despite its empirical attractiveness, Keynesian economics has long been charged with lacking *microeconomic foundations*. The need for microeconomic foundations meant that the optimization of agents had to be explicitly considered in models.

Many economists have come to believe that the first principle of economics is the optimization of economic agents such as household and firm. This principle and the notion of equilibrium – namely equality of supply and demand – constitute the core of the neoclassical theory. To some, this is the only respectable economic theory on earth. For example, Lucas (1987) concluded his Yrjo Jahnsson Lectures as follows:

> The most interesting recent developments in macroeconomic theory seem to me describable as the reincorporation of aggregative problems such as inflation and the business cycle within the general framework of "microeconomic" theory. If these developments succeed, the term "macroeconomic" will simply disappear from use and the modifier "micro" will become superfluous. We will simply speak, as did Smith, Ricardo, Marshall and Warlras, of *economic*

theory. If we are honest, we will have to face the fact that at any given time there will be phenomena that are well-understood from the point of view of the economic theory we have, and other phenomena that are not. We will be tempted, I am sure, to relieve the discomfort induced by discrepancies between theory and facts by saying that the ill-understood facts are the province of some other, different kind of economic theory. Keynesian "macroeconomics" was, I think, a surrender (under great duress) to this temptation. It led to the abandonment, for a class of problems of great importance, of the use of the only "engine for the discovery of truth" that we have in economics. Now we are once again putting this engine of Marshall's to work on the problems of aggregate dynamics. (Lucas, 1987, 107–108)

Thus, over the last 30 years, economics has attempted, in one way or another, to build maximizing microeconomic agents into macroeconomic models. To incorporate these agents into the models, the assumption of the representative agent is usually made. These exercises lead one to neoclassical macroeconomics. The real business cycle (RBC) theory (e.g., Kydland and Prescott, 1982) praised by Lucas (1987) is the foremost example.

In this book, we argue that the standard approach represented by RBC is misguided, and that a fundamentally different approach is necessary to analyze the *macroeconomy*. Such an approach is based on *statistical physics and combinatorial stochastic processes*, which are commonly used in physics, biology, and other natural sciences when one studies a system consisting of a large number of entities. Contrary to Lucas's assertion, we *do* need "some other, different kind of economic theory" when we study the macroeconomy.

As the founders of the neoclassical economics such as Walras, Marshall, and Pareto explicitly recognized, neoclassical theory is built on concepts and methods imported from classical Newtonian mechanics. Interestingly, Marshall was aware of the limitations of his method. At age 78, in the preface to the eighth edition of his *Principles of Economics*, he wrote:[1]

The Mecca of the economist lies in economic biology rather than in economic dynamics. But biological conceptions are more complex than those of mechanics; a volume on Foundations must therefore give a relatively large place to mechanical analogies; and frequent use is made of the term "equilibrium," which suggests something of statical analogy. This fact, combined with the predominant attention paid in the present volume to the normal conditions of life in the modern age, has suggested the notion that its central idea is "statical," rather than "dynamical." But in fact it is concerned throughout with the forces that cause movement: and its key-note is that of dynamics, rather than statistics. . . .

The main concern of economics is thus with human beings who are impelled, for good and evil, to change and progress. Fragmentary statical hypotheses are used as temporary auxiliaries to dynamical – or rather biological – conceptions: but the central idea of economics, even when its Foundations alone are under discussion, must be that of living force and movement. (Marshall, 1920, xii–xiii)

[1] This idea, an emphasis of biological analogy in economics, dates back to his earlier writing (see Marshall, 1898).

Marshall knew that his method, based on the assumption "other things being equal," is suitable for analyzing a single market but faces difficulty in the analysis of the macroeconomy because "gradually the area of the dynamical problem becomes larger; the area covered by provisional statical assumptions becomes smaller" (Marshall, 1920, xiii). Marshall was much more cautious than Lucas (1987); however, he lacked the method required to achieve his goal!

In physics, during the late nineteenth century, a fundamentally new approach called statistical mechanics had been advanced by Maxwell, Boltzmann, Gibbs, and others to study an entity consisting of a large number (typically 10^{23}) of units. Curiously, the method and concept of statistical mechanics have escaped economists' eyes for more than a hundred years though they perfectly fit the purpose of studying the macroeconomy as distinguished from microeconomic behavior.

Indeed, the macroeconomy consists of a large number of heterogeneous interacting agents. For example, the number of households is of the order of 10^7; the number of firms is of the order of 10^6. In analyzing a system composed of such a large number of units, it is meaningless and impossible to pursue precise behavior of each unit, because the economic constraints on each will differ, and objectives of the units are constantly changing in an idiosyncratic way. This does not mean that economic agents do not behave rationally or do not optimize their objective functions. They certainly do. Their rationality may be bounded, but this is not essential for macroeconomics. The point is that precise behavior of each agent is *irrelevant*. Rather, we need to recognize that microeconomic behavior is fundamentally stochastic, and we need to resort to proper statistical methods to study the macroeconomy consisting of a large number of such agents. The starting point of statistical mechanics was the recognition that it was impossible and meaningless to pursue precise motion of an individual molecule in a gas. Macroeconomics must be built on the same premise.

We also need to reconsider the notion of *equilibrium*. That microeconomic behaviors are all accompanied by *fluctuations* is of fundamental importance. Traditional economic theory abstracts from microeconomic fluctuations. Thus, the outcome of optimization by an economic agent is given by a deterministic "point" in some set or space. Accordingly, macro equilibrium is also given by such a point. The Walras–Arrow–Debreu general equilibrium model is an example. In this model, prices clear the way for aggregation of micro-equilibria of many agents into a macro-equilibrium, because microeconomic fluctuations are assumed away, and equilibrium is given by a deterministic point.

In contrast, the new approach leads us to a new concept of "equilibrium." Specifically, equilibrium is a *probability distribution* over a set of points, not a single point. Most importantly for the purpose of macroeconomics, productivities across sectors/firms *never* equalize (Salter, 1960). In equilibrium, we have a number of productivity levels in the economy, rather than a unique level of productivity. We will explain this in Chapter 3. We then find that demand plays a crucial role in the determination of the aggregate level of production or output, as the old Keynesian economics claims. Simply stated, high aggregate demand mobilizes production factors to high productivity sectors and thereby raises the level of total output. Okun (1973) made a similar point in his effort to explain Okun's Law. One of the goals of this book is to shed new light on Keynesian economics from this angle.

First, however, we must explain the new approach. Typically one analyzes the behavior of microeconomic agents in sophisticated dynamic models. Consider the consumer in the Ramsey model. The Ramsey (1928) model was once called the "optimum growth model" and was meant to be normative, not descriptive. However, as the economic profession has turned macroeconomics into the neoclassical equilibrium theory such as RBC, the Ramsey model is now taken as a descriptive model, and is usually taught as such (Blanchard and Fischer, 1989)

The Ramsey consumer maximizes the discounted utility sum under the constraint of lifetime income. Suppose households in the economy are, in fact, Ramsey consumers. However, there are a large number (10^7, for example) of households in the economy, and as we pointed out earlier, both their perceived lifetime constraints and their objectives are changing in idiosyncratic ways. For example, some may unexpectedly experience unemployment, which changes their constraints, while others may suffer from illness, which tilts their utility functions. Facing new situations, 10^7 households are continuously revising their best strategies.

This problem has been recognized by some. For example, Dixit and Pindyck (1994), after advancing their model of investment, note the following challenge for macroeconomic analysis:

> In the economy as a whole, different consumers have different thresholds and different historically determined initial positions relative to these thresholds. They are also subject to different (idiosyncratic) shocks as well as some common (economy-wide) shocks. (Dixit and Pindyck, 1994, 424–425)

Macroeconomic theory that deserves its name must resolve these problems.

It is useful to come back to the Ramsey model and explain the problem explicitly. The behavior of the Ramsey consumer who maximizes the discounted utility sum under the lifetime income constraint can be described in the well-known phase diagram (Figure 1.1). This analysis is routine for every macroeconomist or even graduate student. Now, economists are so accustomed to the deterministic Ramsey model that they are prone to use the optimal trajectory (shown by dotted lines in Figure 1.1) as the potential time path of consumption. This is not the actual time path of consumption chosen, however. Because the consumer's preferences and constraints keep changing stochastically, the optimal path also keeps changing. At each point in time, given the level of capital stock or assets, the consumer chooses the optimal consumption point on the newly revised optimal trajectory. In Figure 1.1, the optimal trajectories and the corresponding optimal

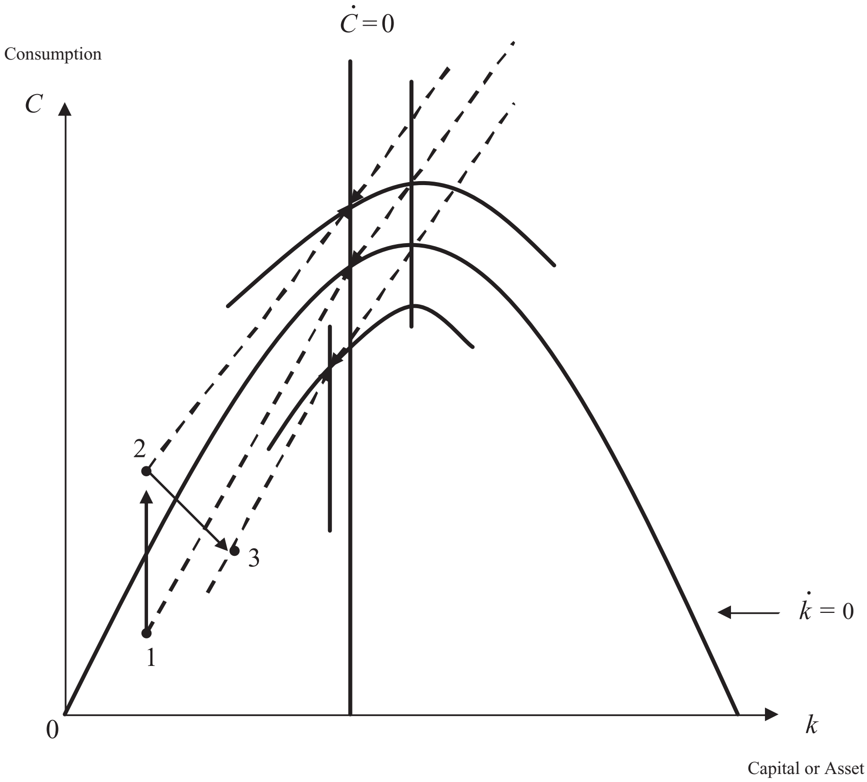

Figure 1.1. The Behavior of a Ramsey Consumer in Stochastic Environment.
Note: The explanation of this phase diagram can be found in any advanced textbook of macroeconomics such as Blanchard and Fischer (1989).

consumption points (points 1, 2, and 3) at time t_1, t_2, and t_3 are shown. The time path of consumption in this case is a line that goes through three points 1, 2 and 3 (shown in bold in Figure 1.1). In general, reflecting incessant shocks to both preferences and constraints, the optimal path of consumption would show zigzags. Note that shocks to preferences and constraints that affect the optimal consumption, as described in Figure 1.1, are basically microeconomic shocks, though they may reflect macroeconomic shocks. We, therefore, *never* know what those shocks are. Additionally, we have 10^7 consumers in the economy who all face different idiosyncratic shocks. Therefore, we have 10^7 different zigzag paths of consumption!

Table 1.1 shows means and standard deviations of changes in consumption and income across 768 Japanese households. Rate of change in consumption over half a year (April–September 1981) is *on average* 1.4 percent. For the same period, the average growth rate of income is −0.9 percent. However, the standard deviations of growth rates of consumption and income across 768 households

Table 1.1. Changes in Micro Consumption and Income: Means and Standard Deviations across 768 Japanese Households (April–September 1981)

	Food consumption	Total consumption	income
(1) Means	0.028	0.014	−0.009
(2) S.D.	0.179	0.309	0.440
(3) C.V.*	6.400	22.100	48.900

Source: Hayashi (1986)
* Coefficient of variation is standard deviation divided by mean ((2)/(1)).

are 30.9 percent and 44.0 percent, respectively. Large values of the coefficient of variation are striking. These figures show a great diversity of income and consumption patterns across households. They demonstrate that the representative consumer is imaginary. What is the bottom line? It is hopeless and meaningless to try to pursue the exact behavior of each economic agent. At the same time, it is wrong to associate the behavior of the macroeconomy with that of an individual economic agent.

The standard approach (RBC) takes the opposite position, relying heavily on the precise behavior of the representative economic agent. Prescott (1986), for example, advocates his own RBC by saying that

> Economists have long been puzzled by the observations that during peacetime industrial market economies display recurrent, large fluctuations in output and employment over relatively short time periods. Not uncommon are changes as large as 10 percent within only a couple of years. These observations are considered puzzling because of the associated movements in labor's marginal product are small.
>
> These observations should not be puzzling, for they are what standard economic theory predicts. For the United States, in fact, given people's ability and willingness to intertemporally and intratemporally substitute consumption and leisure and given the nature of the changing production possibility set, it would be puzzling if the economy did not display these large fluctuations in output and employment with little associated fluctuations in the marginal product of labor. (Prescott, 1986, 9)

Prescott's argument is based on the premise that macroeconomic phenomenon can be understood in terms of the behavior of the representative agent. Many economists take this premise for granted even if they do not entirely accept RBC. That is why they take "micro foundations" so seriously in macroeconomics.

Some economists have explicitly criticized the standard approach based on the representative agent. Kirman (1992), for example, in his paper "Whom or What Does the Representative Individual Represent?" argues as follows:

> There is simply no direct relation between individual and collective behavior. . . . Trying to explain the behavior of a group by that of one individual is constraining. The sum of the behavior of simple economically plausible individuals may generate complicated dynamics, whereas constructing one individual whose behavior has these dynamics may lead

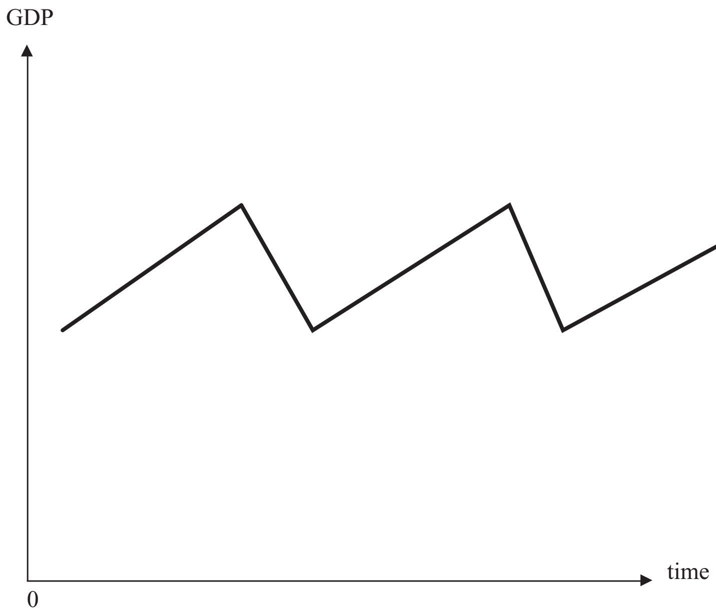

Figure 1.2. The Fluctuation of the Macroeconomy

to that individual having very unnatural characteristics. . . . In particular, I will argue that heterogeneity of agents may, in fact, help to save the standard model. . . . The way to develop appropriate microfoundations for macroeconomics is not to be found by starting from the study of individuals in isolation, but rests in an essential way on studying the aggregate activity resulting from the direct interaction between different individuals. (Kirman, 1992, 117–136)

Suppose that the macroeconomy fluctuates as shown in Figure 1.2. The standard approach attempts to explain these fluctuations by constructing a microeconomic model that produces similar fluctuations under appropriate aggregative shocks. It means that the behavior of the representative economic agent facing such shocks resembles Figure 1.2. To understand the point, consider the consumption of durable goods. If durability of consumables *were* constant, and if the timing of purchases of such consumables *were* synchronized, then *aggregate* consumption may be explained by the standard approach based on the representative agent. However, even in this simple example, the assumptions are actually too unrealistic. In many cases, as Kirman (1992) argues, the requirement that the microeconomic behavior mimics that of the macroeconomy is too harsh and constraining. We must begin our analysis on the assumption that the behavior of macroeconomy and that of microeconomic agent do not mutually correspond.

Summers (1991) made a similar point in his critical study of empirical macroeconomics. He took up the influential works of Hansen and Singleton (1982, 1983). Their works resulted in the rejection of a particular relationship between consumption and asset prices. Summers pointed out that although the two authors took the estimated parameters seriously, they may have rejected the representation of the household sector by one consumer with an additively separable utility function and constant relative risk aversion.

Davis, Haltiwanger, and Schuh (1996), in their study of job creation and destruction, made a similar point. On business cycles, they argue as follows:

> Prevailing interpretations of business cycles stress the role of aggregate shocks and downplay the connection between cycles and the restructuring of industries and jobs. Several aspects of gross job flow dynamics do not fit comfortably with prevailing views. Rather, the empirical evidence points to the need for a richer view of business cycles that highlights their connection with the restructuring process. (p. 83) . . .
>
> The focus on aggregate shocks leads economists to adopt a macroeconomic framework characterized by representative producers and consumers. That is, the production side of the economy is modeled as one firm whose economic behavior is thought to represent the average of all firms. Likewise, the consumption side of the economy is modeled as one household whose economic behavior represents the average of all households. This framework typically abstracts from differences in business cycle behavior among households and sectors, and among employers within sectors. (p. 85)

Why is the theory based on the representative agent wrong? Because micro agents differ so much. To demonstrate these differences, Davis and colleagues show employment growth rate distributions at (1) two-digit industry level and at (2) plant level. They are reproduced here as Figures 1.3 and 1.4, respectively. The distribution of industry-level growth rates is highly concentrated (Figure 1.3). This fits comfortably with a standard macroeconomic framework (RBC) that is built on the representative agent and stresses aggregate shocks. However, Figure 1.4 uncovers the enormous variance of *plant-level* growth rates (note Figures 1.3 and 1.4 are of the same scale). It demonstrates that the apparent high concentration of growth rates based on aggregated data is deceptive. In reality, there is a great variance among micro agents or units. Given these observations, Davis, Haltiwanger, and Schuh (1996) criticize the theories of representative consumers and producers and draw the conclusion that we need "a richer view of business cycles that highlights their connection with the restructuring process."

Now, the major reason these criticisms have failed to change the minds of many economists and lead them to abandon the assumption of the representative agent is, we suspect, that if it is abandoned, there is no alternative unifying principle or method to handle such complex situations with many heterogeneous agents. This book explains that there are, in fact, such principles and methods that fit the purpose of macroeconomics. Generally, the fundamental method we advocate in this book is an approach based on statistical physics and combinatorial stochastic processes.

The point that the behavior of a macro system cannot be directly inferred from the behavior of a micro unit is common knowledge in other disciplines, particularly in natural sciences. In physics, no one denies the law of motion

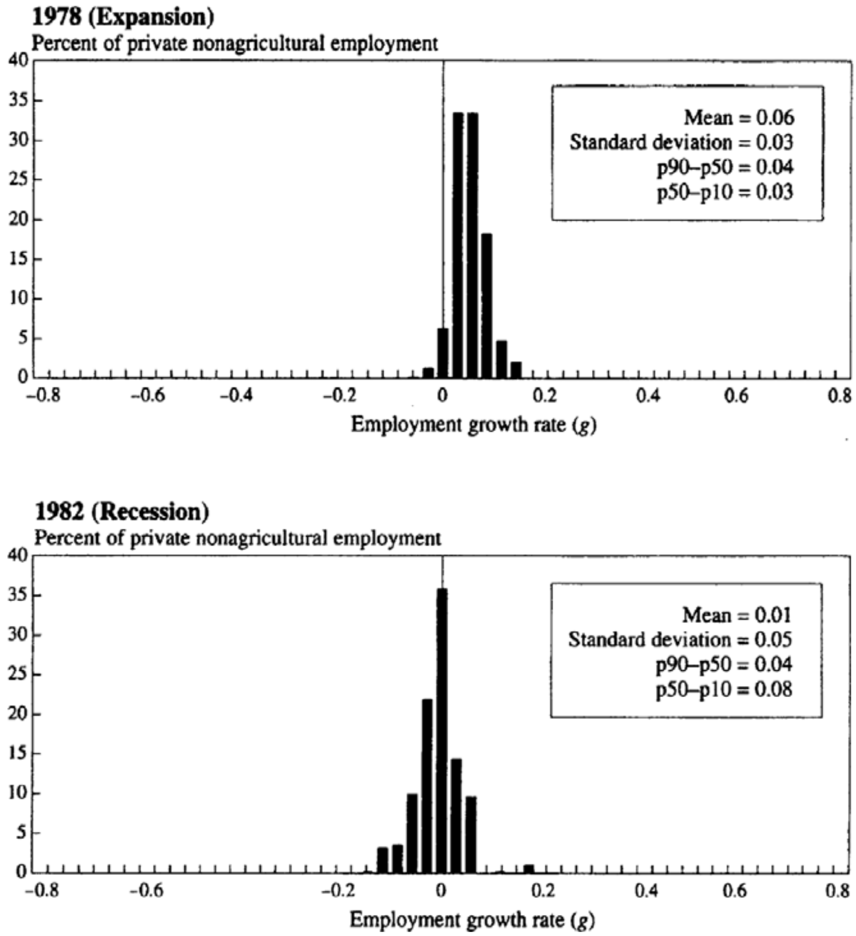

Figure 1.3. Two-Digit Industry-Level Growth-Rate Distributions: 1978–1982.
Source: Davis S J, Haltiwanger J C, and Schuh S (1996), 88.
Note: (p90–p50) is the 90th employment percentile minus the 50th employment percentile. (p50–p10) is the 50th employment percentile minus the 10th employment percentile.

The growth-rate distributions show the number of occurrences of each observed employment rate weighted by each industry's employment. The bars thus indicate the share of employment associated with each rate.

In this figure, the growth rate (g) is measured as the change in employment divided by the average of current and lagged employment. (Technical Appendix.)

for a micro unit; however the law does not really help our understanding of *macro* system, which consists of a large number of micro units such as atoms or molecules. In his classic lecture "*What is Life?*" Schrödinger (1944), a physicist and one of the founders of the quantum mechanics, made the following observation:

> ... we know all atoms to perform all the time a completely disorderly heat motion, which, so to speak, opposes itself to their orderly behaviour and does not allow the events that happen between a small number of atoms to enrol themselves according to any recognizable

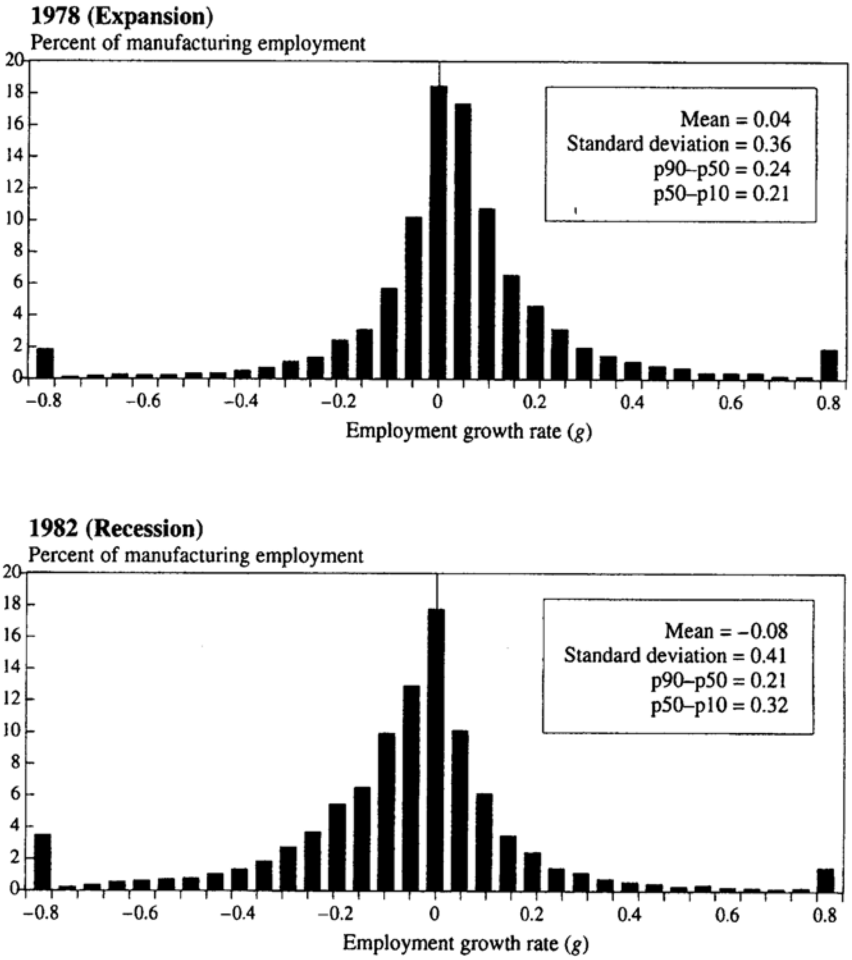

Figure 1.4. Plant-Level Employment Growth-Rate Distributions: 1978 and 1982.
Source: Davis S J, Haltiwanger J C, and Schuh S (1996), 100.
Note: (p90–p50) is the 90th employment percentile minus the 50th employment percentile. (p50–p10) is the 50th employment percentile minus the 10th employment percentile.

The growth-rate distributions show the number of occurrences of each observed employment rate weighted by each plant's employment. The bars thus indicate the share of employment associated with each rate.

In this figure, the growth rate (g) is measured as the change in employment divided by the average of current and employment. (Technical Appendix.)

laws. Only in the co-operation of an enormously large number of atoms do statistical laws begin to operate and control the behaviour of these *assemblées* with an accuracy increasing as the number of atoms involved increases. It is in that way that the events acquire truly orderly features. All the physical and chemical laws that are known to play an important part in the life of organisms are of this statistical kind. (Schrödinger, 1944, 10, p. xii)