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Allocation, Distribution, and Policy

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Notes, Problems & Solutions in Microeconomics

Samuel Bowles & Weikai Chen

July 7, 2024

CORE Econ

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Preface

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Samuel Bowles, Santa Fe Institute and CORE Econ
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Introduction: Doing post-Walrasian microeconomics

1

In 1790 the English royalist Edmund Burke railed against those who had insulted the Queen of France and the French aristocrats who had failed to come to her defence: "[T]he age of chivalry is gone," he lamented, "that of Sophisters, economists, and calculators has succeeded." [36, p. 86] Economics students working on homework late at night have probably also cursed "economists and calculators" namely, their instructors, who assigned the problem sets. That would mean, us.

But we offer no apologies. Learning economics is not simply (or even mostly) about transferring information; it is about skill building, more like learning a language than like filling up a jug with knowledge. Our mantra about pedagogy is: "If you are not doing something you are not learning anything!" Solving problems is something you can do.

1.1 "If you are not doing something, you are not learning anything" 1
1.2 Post-Walrasian microeconomics: A new set of benchmark models 2
1.3 What should economics be *about*? 5
1.4 By necessity, post-Walrasian microeconomics is dynamic, multi-disciplinary and pluralist. 6

[36]: Burke (1955), 'Reflections on the Revolution in France'

1.1 "If you are not doing something, you are not learning anything"

The notes and problems on microeconomic theory that follow were developed in both PhD-level and advanced undergraduate courses at the University of Massachusetts in Amherst, the University of Siena, Bogazici University in Istanbul, and Sciences Po in Paris.

Learning by doing economics is the approach that one of us (SB) adopted as a new assistant professor in the late 1960s when assigned to co-teach the advanced micro-economic theory course in the PhD program at Harvard. We did not give a single lecture; we just asked questions to be discussed based on the readings and set problems to be solved [29]. It appears to have been the first time that problem sets – already routinely used in physics – were made a centerpiece of teaching economic theory.

Our objective in *Allocation, Distribution and Policy* has been to design problems that illustrate important insights and intuitions about economics without being particularly demanding in terms of mathematics or computation. (This explains why we make such frequent use of simple easy-to-differentiate quasi-linear and quadratic functions.) The problems differ greatly in the level of difficulty: some are quite challenging, others are more like confidence-building warm-up exercises.

Some background for these problems is laid out in Bowles [13] and Bowles and Halliday [27]. At the beginning of each chapter that follows, we indicate the chapters in these two works that you may wish to consult. But most of the problems can be solved without reference to these works and also without reference to problems in other chapters of this book.

We have provided solutions to most of the problems, but you will learn a lot more if you work on the problem until you (and perhaps others who you are working with) get stuck. And then, rather than going to the answers we provide, it will be worth the extra time it takes in additional learning if you make brief presentations to others and giving your proposed solutions to the problems (both the analytical logic and

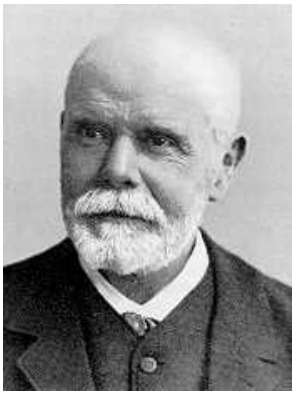

Figure 1.1: Léon Walras (1834-1910) was a French economist with a passion for social justice and mathematics. He advocated public ownership of land and cooperatives as a form of business organization. Notable among his contributions to economics was the refinement of the idea of marginal utility and the general equilibrium analysis of a multi-market economy. Along with Alfred Marshal, Walras is considered the founder of the "neoclassical school" of economics that in most countries was the predominant approach to microeconomics during the 20th century.

[29]: Bowles and Kendrick (1970), *Notes and Problems in Microeconomic Theory*

You may be interested in a similar book by John Harte [54] teaching ecology and environmental sciences through problem solving.

[54]: Harte (1988), *Consider a spherical cow: A course in environmental problem solving*

[13]: Bowles (2004), *Microeconomics*

[27]: Bowles and Halliday (2022), *Microeconomics*

the computations) and explain where you are having difficulty. We have not provided "answers" to a few of the more open ended questions (in the final chapter) that we have found work well for projects that groups of 2-3 students work on and present to an entire class.

In part thanks to the work of Léon Walras (along with Alfred Marshall and others who followed their lead), we are now able to express many important questions and some of the answers in mathematical terms. So learning how to do this through practice with problem sets is essential to doing economics.

An important part of doing economics (not just learning it) is developing the capacity to mathematically model the problems you have set for yourself, and learning how to manipulate these models to provide new insights and pose further questions. But there is much more to doing economics than solving problem sets: including learning econometric, experimental, computational, and other methods, studying society and its history so as have a better sense of what are interesting questions, and being able to pose and evaluate arguments that cannot be adequately tested experimentally or expressed as mathematical propositions (or at least not yet).

A word of warning from the introduction to book of problem sets based on the Harvard course is therefore worth repeating: the problem set method of teaching "itself tends to bias the choice of subject matter. By concentrating on solvable problems and confining ourselves to exercises which can be posed and solved mathematically we have diverted attention away from those areas in which there are no simple answers and where the present state of the theory does not admit precise mathematical formulation." [29, p. vi]

1.2 Post-Walrasian microeconomics: A new set of benchmark models

Reflecting the state of economic theory at the time, the problem sets introduced to Harvard PhD candidates in the late 1960s were focused on a rather limited skill: learning how the price-taking owners of firms or consumers could do constrained optimization in a variety of settings, all based on highly unrealistic institutional, technological, and behavioral assumptions. This brings us to *post-Walrasian microeconomics*.

This is the term we give to the main body of micro-economic theory that research economists today use and is taught to doctoral students [13],[71], and increasingly to undergraduates as well [27, 40]. Its central ideas are based on advances in economic theory made during the last century and continuing today, including the economics of limited and asymmetric information, strategic interaction and game theory, contract theory, behavioral economics, evolutionary dynamics, and mechanism design.

We treat the model of perfectly competitive equilibrium among price taking economic actors pioneered by Walras as a special case of limited empirical applicability or pedagogical value. But the main difference between post-Walrasian and Walrasian (also termed "neoclassical")

The Bowles and Halliday [27] book is available as a free pdf here. Closely related in approach is the free introductory-level course (with a calculus option) by the CORE Project titled *The Economy 2.0*, available as a free interactive e-text or a conventional book at www.core-econ.org. CORE Econ is a global team of economic researchers and teachers who create open-access economics courses and other free materials for learning economics.

The word of warning from [29] continued: "By viewing economic behavior broadly as part of a complex system of social relationships, theorists such as Schumpeter, Bohm-Bawerk, Marx and many of the classic writers have vastly enriched [economics]. But to capture the full contribution of any of these writers in a simply manipulated mathematical problem is virtually impossible."

Figure 1.2: John von Neumann (1903–1957) was a Hungarian-American mathematician, computer scientist, and physicist who is regarded as the father of game theory, which he hoped would allow us to better understand the anti-Semitism and fascist political upheavals that he had witnessed in the early 20th century and provide the basis for understanding how groups interact.

[71]: Mas-Colell, Green, et al. (1995), *Microeconomic theory*

Game theory

Game theory is a branch of applied mathematics that studies strategic interactions with important applications in economics, the other social sciences, biology, and computer science.

approaches is not about the degree of competition. It is about more fundamental questions, namely what the economy is and what do we want to know about it: who are the actors? how do they interact with each other and with our natural environment? how do we characterize the economic outcomes that form the basis of our predictions? and what are the important questions that we strive to answer?

Table 1.1 presents our view of the contrasting "default settings" of the conventional Walrasian model and a post-Walrasian alternative. A comparison of these two benchmarks in greater detail is in Bowles and Carlin [17] and Bowles and Gintis [23].

Post-Walrasian economics can be thought of as a new set of default settings or benchmark models that shape the way an economist will frame problems and the assumptions about the way the world works that come naturally to a researcher or policy analyst. The Walrasian default settings make up a benchmark model that has constituted the primary content of the required courses for economics majors since the middle of the last century.

The Walrasian benchmark is found, for example, in the content of two second year microeconomics textbooks written during the Second World War: George Stigler's *The Theory of Price*, and Abba Lerner's *The Economics of Control*, and in the subsequent intermediate microeconomics textbooks that dominated undergraduate instruction for the rest of the 20th century.

Over the same time period, the conceptual contributions that would make up the post-Walrasian benchmark emerged piecemeal and for very different reasons. John von Neumann wanted game theory to illuminate the hostilities that in the 1930s and 40s had riven his native Hungary and the rest of Europe. The models of credit and labor markets that do not clear in competitive equilibrium developed by Joseph Stiglitz, George Akerlof and others were initially considered to be contributions to macroeconomics — providing some missing pieces in the Keynesian model — rather than building blocks for a new benchmark in microeconomics.

Friedrich Hayek's contribution to the post-Walrasian benchmark – his observation that information is incomplete and local [55] – is now the foundation of modern contract theory, explaining why complete contracts are an exception rather than the rule. But it originated as the key point in Hayek's critique of centralized planning, at the time being practiced (with considerable success) in the Soviet Union.

In a few cases we provide what we call M-Notes, that look like this, to clarify the mathematical reasoning or derivation in the main text. With very few exceptions, the methods required to work these problems will be familiar to anyone who has fulfilled the mathematics requirements for a typical undergraduate economics major.

[17]: Bowles and Carlin (2020), 'What Students Learn in Economics 101'
[23]: Bowles and Gintis (2000), 'Walrasian Economics In Retrospect'

The fact that Lerner, a democratic socialist, and Stigler, a leading figure in the famously conservative University of Chicago Department of Economics could agree on the microeconomic theory that most undergraduates should know suggests the dominance of the Walrasian benchmark.

[55]: Hayek (1945), 'The Use of Knowledge in Society'

Figure 1.3: Friedrich Hayek (1899-1992) was an Austrian-born philosopher and economist. Hayek was a critic of the centrally planned economy and an advocate of limited government. But he had little time for the models of perfectly competitive equilibrium often deployed in opposition to government interventions in the economy. He won a Nobel Prize in economics for his work demonstrating (in the words of the prize committee) "how prices as such are the carriers of essential information on cost and demand conditions, how the price system is a mechanism for communication of . . . information." Source: Award ceremony speech for prize in economic sciences 1974

Table 1.1: Benchmark representations of the economy: Walrasian and post-Walrasian microeconomics.

Subject	Walrasian benchmark	A post-Walrasian benchmark
People...	... resemble *Homo economicus*, who is far-sighted and self-interested.	... are also cognitively limited and have social preferences and norms of fairness, reciprocity and 'us' versus 'them'.
Social interactions...	... for the most part, limited to buying and selling as price takers.	... also include price making and non market strategic interactions, including collective action.
Information...	... is complete and verifiable.	... is often incomplete, asymmetric, and non-verifiable.
Contracts...	... are complete and enforceable at zero cost to the exchanging parties.	... are incomplete in labor, credit and other markets, also there are missing markets (traffic congestion, knowledge).
Institutions...	... include markets, private property, and government as exogenous.	... are modeled generically as "rules of the game" including informal rules (norms), endogenous.
Technology...	... is exogenous, with constant or decreasing returns.	... is also endogenous with constant or increasing returns.
Competition...	... mostly "perfect" among price-taking agents.	... is typically monopolistic or monopsonistic, among price-making firms, often with winner take all outcomes.
Heterogeneous actors...	... due to differences in preference and budget constraint among buyers and sellers.	... also include asymmetric positions, e.g. as employers or employees, lenders or borrowers.
Power...	... is exercised in non-competitive markets and by government, exogenous.	... includes also a principal's power over an agent in labor, credit, and other markets; endogenous.
Economic rents...	... are inefficient and originate in mistaken public policy or limited competition.	... also create incentives to innovate, work hard, use borrowed funds prudently and to equilibrate markets.
Stability...	... a unique stable equilibrium is typically assumed to be what we will observe.	Stability and instability (along with tipping points between multiple equilibria) are both characteristics of the economy and our relationship with the biosphere.
Policy...	... is directed by a Pigou-Marshall style beneficent impartial social planner to correct market failures.	... also includes systemic state failures due to information limitations on policy design and implementation, and rent-seeking by states elites.
Evaluation...	... is confined to the presence of unexploited mutual gains (Pareto-inefficiency).	... also includes procedural and substantive fairness, and environmental sustainability.
20th century provenance...	Marshall, Walras...	... also Hayek, Robinson, Nash, von Neumann, Schumpeter, Coase, Ostrom.

1.3 What should economics be *about*?

We have provided this set of problems based on the post-Walrasian benchmark (rather than the Walrasian one) because we think that the new approach provides a more adequate theoretical framework for posing and addressing some of the key societal challenges today, especially the problems of unjust inequality and climate change.

We are not atypical in thinking that learning tools to better understand these challenges should be a top priority for those learning economics. The CORE Team posed the following question to students around the world on the first day of their introductory classes: "What is the most pressing problem economists today should be addressing?" The results from a total of 12,261 students from 67 universities in 25 countries over the years 2016-23 are summarized in the word cloud in Figure 1.4.

Figure 1.4: Student replies (2016-2023) to the question "What is the most pressing problem economists should be addressing?" The size of the font in the figure is proportional to the frequency with which subjects mentioned the word or term. The data are from. The students responding are from Australia, Canada, Chile, China, Colombia, France, Germany, Hong Kong, India, Indonesia, Italy, Mexico, Netherlands, New Zealand, Pakistan, Peru, Philippines, Portugal, Reunion Island, South Africa, Spain, Switzerland, Turkey, UK, US. The less frequently mentioned — smaller font — topics are more readable in the individual word clouds from each of the samples of students that you can access at https://tinyco.re/6235473.

As expected "Covid-19" was big during 2020-2022, and "inflation" came in following Covid. But the themes are remarkably consistent across countries and over time. Unemployment and inflation, important topics in most macroeconomics courses, are on the minds of students. But inequality (along with "poverty") is the overwhelmingly dominant issue, with environmental problems ("climate change", "sustainability", and "environment") a close second.

The microeconomic theory that you will learn how to use by solving the problems in this book has a lot to say about these issues. Included are tried and true workhorse concepts that you have probably already encountered, like opportunity costs, mutual gains from exchange, constrained optimization, and trade-offs. Also essential in understanding issues like those in the word cloud, however, are concepts that have more recently risen to prominence among economists but that are given less attention in economics courses, especially at the undergraduate level.

Examples include modeling institutions as a set of rules of the game, the importance of cooperation as well as competition, social motivations in addition to individualistic self-interest, incomplete contracts and markets that do not clear in competitive equilibrium, price setting (not just price taking) and other strategic aspects of interactions among economic actors, settings in which positive feedbacks (due for example to strategic complementarities) lead to a multiplicity of path-dependent equilibria

Complete contract

A contract is complete if it (a) covers all of the aspects of the exchange in which anyone affected by the exchange has an interest, and (b) is enforceable (by the courts) at close to zero cost to the parties.

Institutions

Institutions are the laws, informal rules, and mutual expectations which regulate social interactions among people and between people and the biosphere.

so that history matters, and conflicts over the distribution of mutual gains from exchange including the exercise of power by private economic actors (employers over workers, for example).

1.4 By necessity, post-Walrasian microeconomics is dynamic, multi-disciplinary and pluralist.

As these examples suggest, post Walrasian microeconomics by necessity goes beyond the usual comparative static analysis and draws upon the insights of many scholarly disciplines beyond economics and on ideas from many schools of thought. The societal problems motivating the new approach – suggested by Figure 1.4 – are part of the reason for this. But the new conceptual content, itself, requires a broader and more dynamic approach.

Here is an example. If positive feedbacks are common then there often will be a multiplicity of path dependent equilibria, some of them unstable, so that predictions or designing public policy will require an assessment of which of the multiplicity of equilibria is more likely to be observed. This is termed equilibrium selection, often accomplished by means of explicit analysis of out of equilibrium dynamics, history, or computational methods.

Another example. The post-Walrasian model of the firm and the labor market start from the fact that employer and employee have conflicting interests about the workers' level of effort on the job. The idea that the labor contract cannot ensure that the employee works hard and well is a common illustration of the modern microeconomics of incomplete contracts. But its provenance is Karl Marx, not Walras or Marshall.

The reason why the contract is incomplete is that information is both local and scarce, the cornerstone of the economics of Friedrich Hayek, although subsequently developed in very different ways by contributions to principal-agent modeling over the past three decades. The employer cannot possibly have the information needed to legally enforce the many dimensions of work effort.

We then learn from Ronald Coase that "the distinguishing mark of the firm is the suppression of the price mechanism" in favor of a system of authority in which the worker, "for a certain remuneration agrees to obey the directions of the entrepreneur." This, too, sounds more like Marx than the University of Chicago where Coase taught.

Wages and the amount of work done thus are determined in part by the exercise of power by the employer and the work ethic or other social norms that affect employees willingness to work hard and well, not simply by market competition. The importance of social norms and the exercise of power by employers over their employees [41] make sociology, psychology, political science and law all integral to understanding how the firm and the labor market work. Moving on to modeling these processes, we find that Herbert Simon—an economist and computer scientist whose degree was in political science— provided the first mathematical model of this process in the middle of the last century [87].

Economic analysis of what are termed complex systems and spontaneous order share many features with the post-Walrasian approach used here, including multiple equilibria, attention to dynamics, and interdisciplinarity. Herbert Simon defined a complex system as "made up of a large number of parts that interact in a non-simple way. In such systems, the whole is more than the sum of the parts [. . .] given the properties of the parts and the laws of their interactions, it is not a trivial matter to infer the properties of the whole." [88, pp. 183–184] The earliest example in economics is Adam Smith's surprising claim that under the right rules of the game, interactions of entirely self-interested individuals might by means of "an invisible hand" result in a socially beneficial allocation of society's resources. On complex systems and spontaneous order in economics, see for example, Arthur [4], Kirman [65], Miller [74], and Sugden [96].

[88]: Simon (1996), *The Sciences of the Artificial*

[4]: Arthur (1999), 'Complexity and the Economy'
[65]: Kirman (2010), *Complex Economics*
[74]: Miller (2016), *A Crude Look at the Whole*
[96]: Sugden (1989), 'Spontaneous Order'

[41]: Dahl (1977), 'On Removing Certain Impediments to Democracy in the United States'

[87]: Simon (1951), 'A Formal Theory of the Employment Relationship'

Pluralism is thus a necessity, not an option in the new benchmark model. Imagine that instead of the above model based on incomplete contracts, the labor market and the firm were represented as in the standard supply and demand market-clearing model. The firm is supposed to purchase labor (that is, work) from the worker in a transaction with a complete contract no different from the firm's purchase of kilowatt hours of electricity or any other input. The implications are profound. There would be no unemployment in the equilibrium of the labor market, no conflicts of interest over work, no exercise of power by the employer, and social norms would play no role.

Similar reasoning applies to the entire economy: if the benchmark model is based on a selfish economic man in a world of complete information, complete contracts and clearing markets, then pluralism seems a distraction. The conventional benchmark thus depicts a world in which key ideas of Coase, Hayek, Marx, Simon, and Schumpeter would be of little value.

Because we think that the ideas of these economists provide essential insights for understanding the economy of today the the future, in the pages that follow we consider models based on the view of the economy and people as economic actors in the second "post-Walrasian" column of the above table.