

The Complexity Vision and the Teaching of Economics

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12. Teaching Macroeconomics while Taking Complexity Seriously

Kevin D. Hoover

When I teach macroeconomics, I start from a simple premise: economics is about something in the world; it is about the behavior of people, individually and collectively in social organizations with respect to their material well-being. I also start with an observation: for many, perhaps most, of our students the connection between what we teach in elementary and intermediate courses and the world is really very obscure.

A family friend, Kelley, confided to me as we sat watching our kids in the swimming pool that, although she had majored in history at Emory, she was just shy of enough units to have double-majored in economics. She said, 'I loved economics. I loved the beauty of all those shifting curves and the clever deductions. But, what I never understood, was what any of it had to do with life.' Many students face Kelley's problem. It is, I believe, more acute for macroeconomics than for micro. There is a case to be made that microeconomics is a normative discipline concerned with rationality, but with little descriptive or empirical content. But macroeconomics is largely justified by its empirical relevance and its usefulness in policy analysis. Intermediate macroeconomics textbooks have become, in large measure, watered down graduate textbooks, in which theory, rather than applications, take pride of place. This development is all the more unfortunate, since even graduate students have become rather poor at knowing how to connect that theory – watered down or neat – to the real world.

COMPLEXITY AND THE IMPASSE IN MACROECONOMICS

It is commonplace to talk about a 'crisis' in economics. But I regard the situation not so much a crisis as an *impasse*. How did we get to the point where clever students like Kelley are at a loss about the linkages between economics and the economy? And what, if anything, does the disconnection between textbook theory and the real world have to do with complexity?

The disconnection is especially disconcerting in macroeconomics. For most of its history, from Sir William Petty's 'political arithmetick' in the seventeenth century through Tinbergen's early econometric models in the twentieth, empirical economics and policy analysis was largely macroeconomics. Even early econometric studies of demand curves dealt with aggregated, time-series data that presented the same methodological issues as macroeconomic data.¹ Dealing at a macroeconomic level did not pose any particular theoretical difficulty for Petty or Quesnay or even, despite the increased importance of individualism in classical economic thought, for Smith and Ricardo and the Scottish and English political economists. It certainly did not for Marx. But after the classical period in economic thought, the rise of individualism helped to form what we now know as modern microeconomics. At the same time, the spread to economics of what might be called a Cartesian or French sensibility has placed a higher value on theoretical consistency than on empirical purchase. The French approach stands in sharp contrast to Anglo-Scottish pragmatism and is by no means confined to economics.

An early example of the French approach is found in Augustin Cournot's *Researches Into the Mathematical Principles of the Theory of Wealth* (1838). Cournot gives a recognizably modern account of microeconomics. And he presents the vision of the economy represented as a giant general equilibrium system with each agent described by his own curves. Still, Cournot had the good sense to observe that such a model was only a vision and empirically impractical.

By the 1930s, economics was in an embarrassing situation. Its theory – French or English, Walras or Marshall – was individualistic, but its policy problems, data, and methods for handling data, were aggregate. The principal macroeconomic theory of the time, the Quantity Theory of Money, was aggregative and, consequently, an uneasy companion for mainstream theory. The French dealt with this by giving up relevance; the English by adopting a pragmatic inconsistency. Keynes's great methodological achievement was to claim autonomy for macroeconomics. Aggregative economics was to have its own categories, its own relationships, and its own theories, and would no longer be a poor relation to microeconomic theory. This was surely a response to complexity in the most straightforward, ordinary language (but probably not Santa Fe) sense. As Cournot had realized, there were too many agents, their relationships were too complex, for the vision of modeling them one by one to ever succeed. This meant that there was a class of phenomena – the aggregate outcomes of the individuals' complex interactions – that could be analyzed only in its own terms, if at all. Complexity in this sense was understood not only by Cournot, but by Smith, Marshall, and many others before the rise of modern microeconomics.

Keynes was triumphant in practice. Policy makers became Keynesians in spirit, if not in name. This is still true today, despite the regular declarations in the *Wall Street Journal*, the editors of which routinely confuse the Phillips curve with Okun's law, that Keynes is dead. Practice aside, Keynes's intellectual triumph was short-lived. The animating Spirit of Economics is not Keynes, but Walras, Debreu and Bourbakism. The movement in this direction began immediately on the publication of the *General Theory* in 1936 and is now complete. It is not only the new classicals, but equally the new Keynesians, who have adopted the representative-agent model as the ultimate expression of the drive for microfoundations. Macroeconomic models now consist of a single agent – or sometimes a few agents – 'representing' the actors of the economy and solving dynamic optimization problems according to the usual microeconomic rules. Lucas, for one, expresses the hope that soon the distinction between micro and macroeconomics will be erased (Lucas 1987, pp. 107–8). But this is absurd. Everything that microeconomists have taught us about aggregation theory underlines the virtual impossibility of any aggregate outcome being correctly modeled by an agent whose utility function and production function look just like those of an individual agent, but who takes the entire GDP of the economy as his output and his income. The representative-agent model does not solve the aggregation problem, the problem of complexity that Cournot rightly saw stood in the way of the practical implementation of the vision of general equilibrium modeling. Despite the appeal to the mathematics of microeconomics, this is not microeconomics or microfoundations but the simulacrum of microeconomics and microfoundations. The prevailing view is that microeconomics is the only real economics. The representative-agent model *looks like* microeconomics. But as a reaction to the problems of complexity, it is a sleight of hand. Just as the quantity theory in 1930 was an uneasy companion for the prevailing price theory, so should the representative-agent model be an uneasy companion for modern microeconomics. It is a measure of the complacency of modern economics that this unease is not felt more acutely.

The problem posed by complexity in the wider sense is not unique to economics. Physics provides an instructive analogy. In *QED* Richard Feynman writes:

You might wonder how such simple actions could produce such a complex world. It's because phenomena we see in the world are the result of an enormous intertwining of tremendous numbers of photon exchanges and interferences. Knowing the three fundamental actions is only a very small beginning toward analyzing any *real* situation; where there is such a multitude of photon exchanges going on that it is impossible to calculate – experience has to be gained as to which possibilities are more important. Thus we invent such ideas as 'index of refraction' or 'compressibility' or 'valence' to help us calculate in an approximate way when there's an enormous amount of detail going on underneath.

The branches of physics that deal with questions such as why iron (with 26 protons) is magnetic, while copper (with 29) is not, or why one gas is transparent and another one is not, are called 'solid-state physics' or 'liquid-state physics' or 'honest physics'. (Feynman 1985, p. 114)

Feynman has an abiding faith in the fundamental unity of science and in the reduction in principle of complex phenomena to elementary ones. Nevertheless, he also believes both in the limitations of our ability to cope with complexity and, importantly, in the fact that we live in the complex rather than the simplified world.

Macroeconomics stands in a similar relationship to microeconomics as optics or chemistry does to quantum electrodynamics. 'Index of refraction', 'compressibility' and 'valence' are not the concepts of quantum electrodynamics. Yet, it is concepts like these that describe, and permit us practically to analyze, features of the world that are important to us. We use these concepts even though the features we care about may somehow reduce to photon exchanges, because we do not now, and may never, understand fully how to carry out the reduction.

Nancy Cartwright, the philosopher of physics, in a passage that I have worn out in quoting, takes the laws of physics down a peg. She makes a similar observation to Feynman's, although she has considerably less faith in the ultimate reduction of macro phenomena to micro:

It is hard to find [laws] in nature and we are always having to make excuses for them: why they have exceptions – big or little; why they only work for models in the head; why it takes an engineer with a special knowledge of real materials and a not too literal mind to apply physics to reality. (Cartwright 1989, p. 8)

To me macroeconomics should be the realm of the economists with a special knowledge of the actual economy and not too literal minds. Complexity in the old-fashioned sense drives us in that direction. Perhaps the greatest contribution of the insights of the Santa Fe approach is simply to demonstrate that, even if we begin with simple rules, real situations become complex fast. Complexity forces us, for the matters that we care about, to leave the realms of Feynman's experiments with a few photons and deal as Cartwright's engineers with autonomous phenomena. That is in itself an important methodological step. Whether complexity has anything more to offer macroeconomics remains to be seen.

Let me explain my view of complexity more carefully. There is an analogy with physics: microeconomics is constitutive, but not determinative, of macroeconomics. But there is also a disanalogy: unlike physics, micro is not constant. People are described as bundles of preferences, and preferences change. Modern microeconomics does not have really good ways of dealing with such change. But Marshall (and by extension, Keynes) dealt with it by

adopting the stance of Cartwright's engineer – cultivating a not-too-literal mind. For Marshall, the human realm divided into a hierarchy of interests, of which economic interests were the lowest and not always governing or dominant. Marshall treated the optimization results of price theory as attraction points for behavior rather than predictions of behavior, as forces that influenced human decisions rather than as complete decisions in themselves. For his purposes, a static, unrealistic microeconomics served rather like the rough calculations and approximations of Feynman's 'honest physics'. I doubt that Marshall would have been overly impressed by calls to rebuild microeconomics from first principles as some advocates of the Santa Fe program suggest, because he never took price theory too literally in the first place. For my own part, I will be interested to watch the *constructive* success of the Santa Fe program, although, in the meantime, I see no reason to despair entirely of traditional microeconomics. Marshall was, I think, right: microeconomics is not everything, but in the hands of the not-too-literal minded it has considerable power. It does not determine macroeconomics, but it may nonetheless help to illuminate it.

MY COURSE

Perhaps the best way to explain how these ideas about complexity relate to economics is to tell how I teach my macroeconomics course. My goal is to get students to relate macroeconomics to the world, to real data and policy: to appreciate the relationship between the taste of the wine and its chemistry. For this the molecular physics is, at best, intermittently useful. In many ways, this course is a throwback to an older pedagogy. Many of its elements would be familiar to students of a generation ago who studied Hansen (1949), the early editions of Samuelson (1948), or such intermediate macroeconomics textbooks as Dernberg and McDougall (1960). The course is Keynesian in two senses. First, it accepts macroeconomics as an autonomous study of the economic aggregates – the inevitable result of the fact of complexity – and often emphasizes the consequences of heterogeneity. Second, it takes it for granted that suboptimal outcomes are possible and that there is no *automatic* presumption that the economy is self-regulating in the sense of always returning to the most desired state of its own accord. Business cycles are not typically regarded, as new classical real-business cycle modelers regard them, as Pareto-efficient fluctuations around a steady-state growth path. Instead, they are seen as suboptimal deviations from a desirable path. The course is not backward looking. Like many recent macroeconomics textbooks, I give pride of place to growth and emphasize the constantly changing nature of the macroeconomy.

What most distinguishes my course from others is not the theory, but the emphasis on students learning the facts about the economy. They use simple graphical and statistical techniques that help them to see how the economy actually behaves and how, or to what extent, economic theory helps us to understand the data. In Chapter 7 of this volume, David Colander reports a remark made by a reviewer of his introductory textbook that the material he includes on the Santa Fe approach 'is nearly useless to the average business student'. I do not know whether that judgment is true of Colander's book (Colander 1998). But I do believe that most of what is found in intermediate macroeconomics textbooks today is presented in a manner that renders it nearly useless to the student. The emphasis on actual data is aimed at making the economics useful.

There are limits to how deeply the students can pursue data analysis. Because most programs place very limited quantitative and statistical demands on undergraduates, I cannot use any really sophisticated econometrics. The surprising thing, I find, is that one can go very far with very simple empirical methods. When those methods fail, there is often a useful lesson for the students in why we must avoid facile inductions. For example, if one plots the real interest rate against the investment share in GDP, the fitted regression line is upward sloping. I use that to point out to the students the limitations of the scatterplot and bivariate methods. They know from other graphical investigations that both real interest rates and investment are pro-cyclical, and they therefore learn a lesson about garden-variety complexity. There are many other such lessons related to spurious and nonsense correlation, causal direction, mismeasurement and so forth.

An empirical emphasis requires a reformulation of the normal presentation of macroeconomic theory. When students read the newspapers or listen to the radio or television, the economy is presented as changing. They hear about growth rates and inflation rates. The IS/LM/AS analysis of the typical textbook, however, talks about the levels of GDP and the level of the CPI. Most people, even professional economists, have a better idea of the inflation rate than the level of the CPI, and a better idea of last quarter's growth rate than of the level of real GDP. The textbook theory is easily reinterpreted by those who understand it to speak to the more familiar categories, but the need to reinterpret it is a pedagogical barrier for many students. My approach, which is very much in the spirit of Marshall, is to start with the theory matched to familiar categories.

So much for my general approach. Let me conclude with a description of some of the particular elements. I begin with what is often regarded as the dullest material in a macroeconomics text – national income accounting. While this may be dull stuff, it is important and students often get it very wrong. An accurate understanding of the national accounts provides without

much further economic analysis the tools to puncture many of the misconceptions that students have about the economy. For example, many students have a vision of the economy as one of oppressed workers and greedy capitalists; they believe that the labor share in GDP is low and profit share huge. They are surprised when they calculate the shares themselves to find the truth. Similarly, many students see the government as dominating the economy, and are surprised to see that government expenditure as a share of GDP is stable over the past 50 years. Quite a bit of useful fiscal policy analysis can be done with the national accounts alone; having students do it themselves drives home many truths. To take another example, students learn a healthy skepticism about popular economic arguments from knowing the data and how it is related. There was a widespread belief in the 1980s that the US trade deficit was caused by the government's budget deficit. The almost raw facts alone teach students that it must be more complicated than that: not only is the budget in surplus today, while the trade deficit persists, but every possible combination of trade positions and budget positions exists in the US time series or in other nations. To explain how this variety of outcomes is possible for quantities connected by an identity provides an excellent place, and an excellent case, to introduce the basic distinction between necessary accounting identities and economic behavior.

I spend a good deal of time teaching students to describe the data in useful ways. They learn, as every textbook teaches but few sufficiently emphasize, to distinguish real from nominal, as well as a complex of related skills: to convert nominal quantities to constant dollars, to calculate growth rates and index numbers, and to use shares, ratios and logarithms in the appropriate situations. These exercises may seem dull and a distraction from the economic analysis, but my experience is that students routinely get them wrong from having had insufficient practice and that it is an impediment to their understanding that the theory really does connect to the world.

After finishing with the national accounts, I move on to genuine economic analysis starting with growth. Here the approach is fairly mainstream. I start with a Cobb–Douglas production function and emphasize the roles of labor, investment and productivity in the growth process. This, of course, looks like the pseudo-microeconomics that I protested earlier. But I never meant to deny that microeconomic analogies could illuminate macroeconomics. I emphasize that we are dealing in analogies that, in the spirit of Marshall and Cartwright, must not be taken too literal-mindedly. While what I teach is not incompatible with the Solow growth model, I de-emphasize the self-adjusting mechanics of neoclassical growth. Students proceed immediately to the identification of business cycles from the historical data, and so never entertain the illusion that economies grow smoothly along steady-state paths.

My treatment of aggregate supply is really a treatment of factor markets, especially the labor market, and students never see an aggregate supply curve in price/GDP space. The analysis of labor markets is, for the most part, traditional static microeconomics, but recast so that it deals with the share of the workforce employed. In this way, the static model is easily related to the deviation of the actual growth path of the economy from a potential path defined by full employment of capital and labor. Students develop their own empirical estimates of this potential path. Some part of unemployment is regarded as involuntary unemployment in the Keynesian sense of workers being rationed in their supply of labor. It is easy to relate unemployment to its capital equivalent, capacity utilization, for which there is readily available data.

By this point, the students have a robust model, capable of dealing with a number of real world issues. Let me give an example. Several years ago, in a talk in Sacramento, David Colander argued that textbook macroeconomics was unable to account for important real world phenomena with institutional elements. He gave the example of the macroeconomics of the re-unification of East and West Germany. In contrast to Colander, I believe that simple textbook models in the hands of my students trained to cultivate a not-too-literal mind are able to address such questions. Reunification, for instance, can be seen as the sudden obsolescence of the East German capital stock, since, though it was physically unaltered, its future profitability, the basis for proper capital valuation, was largely destroyed. The consequence is just what Cobb–Douglas production function would tell you: a fall in output, a rise in the incentives to investment, a fall in the marginal product of labor which, combined with government insistence that real wages remain high, implies high unemployment.

Having completed the discussion of economic growth, I introduce the students to different possible sources of short-run fluctuations and their implications. On the one hand, I discuss how changes in productivity and capital, as emphasized by the real-business-cycle school, may cause fluctuations in potential GDP. On the other hand, I discuss how fluctuations in demand may cause departures from potential. My students use data to examine the implications of these different views for the behavior of real wages, which involves understanding the relationship between productivity growth and wage trends, as well as the necessity of empirically isolating trends in the data. The net result is ambiguous, which is another way of driving home the complexity of the economy and of forcing the students to ask whether our simple model of aggregate supply is fully adequate.

I deal with dynamics of prices and unemployment, once again using traditional tools: the Phillips curve and Okun's law. The approach is crude, but perfectly adequate to the level of statistical capabilities of the students. I

emphasize Okun's law more than most macroeconomics textbooks do, because it is so robust a relationship. I treat it as representing a causal relationship from output to unemployment and derive a version of it that demonstrates that the critical growth rate for a steady unemployment rate can be thought of as determined by the growth rates of labor productivity, population and the participation rate. This permits students to see clearly some of the ways in which the economy has changed over the postwar period and to isolate what factors would have to change if popular calls for faster sustained growth rates were to be achievable.

My treatment of the nonfinancial side of aggregate demand is relatively standard. Essentially, it is the IS curve and its components. These are once again adapted to the data by casting the real quantities as shares of potential GDP rather than real levels. On the empirical level this deals with the problem that the data are non-stationary and therefore subject to nonsense correlations. On the theoretical side, it makes it easy to see the static consumption and investment relationships as a freeze-frame of a growing economy and to related demand to unemployment and capacity utilization rates.

Where I differ radically from the treatment found in most textbooks is in de-emphasizing the LM curve. I regard the continued emphasis on the LM curve as one of the most misleading elements of macroeconomic pedagogy, a triumph of the Cartesian impulse. Financial markets are wonderfully complex. And there are robust patterns in their complexity: yield curves, the hierarchy of risk premia, and so forth. My students learn to identify and understand these patterns and to relate them to the business cycle and to policy. In the face of such complexity, to single out narrow money as the critical financial asset and to apply unwarranted aggregation and Walras's law to eliminate the vastly more important loan, bond, and stock markets (among others) in the determination of a single rate of interest of ambiguous maturity and risk category has only one advantage: it achieves closure. An IS/LM/AS model is a closed system that permits students to perform algebraic deductions, which are a great deal of fun, but not necessarily of much practical relevance. My approach emphasizes the interrelationships between interest rates. It pins down the whole structure at the short end through monetary policy and at the long end by the arbitrage between long bonds and shares reflecting the real returns on capital. What is missing is a mechanical deductive link between expansions of aggregate demand and real rates of interest. That is what the LM curve provides. But the not-too-literal minded can do without it and better appreciate the complexity of the financial system.²

David Colander suggests that an implication of the Santa Fe approach to complexity is that economics should be inductive rather than deductive. My course reflects the fact that I agree with this assessment – but only half way. If what Colander means is that a useful macroeconomics will always have to

look to the economy itself and not simply to first principles to characterize adequately how it works, then I agree. The marginal propensity to consume or the interest-elasticity of investment or the risk-premium on corporate bonds are not things that can with any likelihood be deduced from first principles. But neither can they be induced from raw data. These parameters and even the very data from which one might derive them are infused with a conceptual picture of the economy and it is only with the presupposition of that picture that we can measure them. When my students are looking at data, they are not, for the most part, pursuing Baconian inductions. Rather they are looking at the economy through a set of specially tinted lenses and asking whether it looks clearer and more understandable when viewed that way. I suggest ways of looking at the economy that I know, either because I have tried it in advance or because of general experience, look good through those lenses. The reasoning that got me there is more what philosophers of science refer to as 'inference to the best explanation' or what the American pragmatist philosopher C.S. Peirce calls abduction: given some facts, what is a story that might explain them?³ (Sherlock Holmes's famous elementary 'deductions' are really abductions.) While there is an element of pre-packaging from the students' point of view, occasionally they find something surprising – to them and to me. And that in itself should not surprise us. The economy after all is complex.

NOTES

1. On the history of econometric modeling of demand, see Morgan (1990) and Hendry and Morgan (1995).
2. David Colander has suggested to me that my own argument can be turned around here: the not-too-literal-minded should be able to use the LM curve despite its failure to capture some details of the economy. This is, of course, right; it explains why Robert Solow (1984) refers to the IS/LM model as the trained intuition of the macroeconomist. Pedagogically, it is a matter of judgment and experience. My experience is that it is difficult to get students to focus on those aspects of the financial markets that in fact matter for monetary policy and for investment behavior when they see the world through the LM curve. It is somewhat like those 'magic eye' pictures in which the floating object appears only when a practiced viewer stares at it just so. Many viewers never develop the knack. Sometimes it is better not to expect them to, but to provide a more accessible picture.
3. See Hoover (1994) on Peirce and Lipton (1991) on 'inference to the best explanation'.

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