

Complexity and Macro Pedagogy:  
The Complexity Vision as a Bridge between Graduate and Undergraduate Macro  
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## **Complexity and Macro Pedagogy:**

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**Dave Colander and Casey Rothschild**

The macro economy is complex; everyone knows that. Complex systems are difficult to analyze and manage; everyone knows that too. The best approach to teaching and describing the complex macro economy is something we know much less well. Currently, in teaching macro to both graduate and undergraduate students, we don't stress just how complex the economy really is. The argument in this paper is that we should emphasize that complexity to frame the macro question.<sup>1</sup> Having done that, we can get on with what we do, and much of the structure of both the graduate and undergraduate macro can be taught as it currently is. But instead of seeing the approaches at the two levels as substitutes for one another, complexity helps to frame as what they really are: complementary approaches to addressing a challenging set of questions.

The standard academic approach employed today at the graduate level is to downplay the complexity and to de-emphasize the interactions among agents that make the macro economy so complex. Given their assumptions, the graduate models are intellectually satisfying and internally consistent. They may even help to shed light on certain key macro questions such as the need for policy consistency, and the importance of expectations. However, in teaching these models to graduate students, instructors generally don't emphasize the complexity of the economy that the models assume away. Similarly, they don't explain to students why, because of the assumptions necessary to make the models tractable, these models are not particularly useful for addressing short run real-world macro policy concerns. This means that students come out of graduate macro with little understanding of how the models relate to policy in practice. As one graduate student noted: "Monetary and fiscal policy are not abstract enough to be a question that would be answered in a macro course." (Colander, 2007, p. 46.)

The standard academic approach employed today at the undergraduate level is also to downplay the complexity, but in a quite different way. Specifically, since short run stabilization policies are the very issues that are important to most undergraduates, undergraduate macro pedagogy focused on those. It presents a set of seemingly formal models that are, at best, a hodgepodge of rough-and-ready models that are only loosely grounded in theory. Because the complexity of the economy isn't emphasized, and the enormous limitations of the models isn't noted, undergraduate students are led to believe they are learning a scientifically based macro theory, when in fact, they aren't. This

means that when students move on to graduate work, the first thing many graduate macro professors tell them is that everything they learned in undergraduate theory is wrong.

In our view, the lack of connection between the formal graduate teaching and the rough-and-ready teaching of macro at the undergraduate level has been detrimental to pedagogy at both levels. We believe that a connection can be made by bringing a vision of the macro economy as a complex system to the fore of both graduate and undergraduate instruction. Once one does that, both approaches can be seen as reasonable ways of dealing with that complexity, albeit with different aims in mind.

### **The Graduate DSGE Model**

At the graduate level, macro theory is presented to students as a dynamic stochastic general equilibrium (DSGE) system. This framework nicely captures some of the intertemporal dimensions of individuals' and policy makers' decisions, but it has limitations. Specifically, to make the model tractable, the framework requires making strong simplifying assumptions, such as positing a single representative agent or an (often implicit) Walrasian auctioneer who solves all the inter-agent coordination problems. In our view, there is nothing wrong with presenting stylized but tractable DSGE models to graduate students: it reflects where the profession is in our understanding of those aspects of macro that we can tackle with a top-down modeling approach. It also provides a common formal language for exploring this frontier. One might reasonably even hope that by successively enriching an abstract model that is tractable enough to permit full analytic understanding, we will eventually gain insight into many or even most key macroeconomic issues.<sup>2</sup>

The problem with this top down approach is that the simplifying assumptions with which it buys tractability make it unsuitable for addressing certain sets of questions – at least for now. Insofar as it is precisely inter-agent interaction and coordination problems that ultimately underlie the macroeconomics with which most policy makers are concerned, the DSGE approach involves abstracting away from the essence of most actual policy problems. If interactions and coordination failures drive short-run macroeconomic fluctuations, the DSGE approach is not, and will likely never be, particularly helpful for informing the standard macro policy responses, such as countercyclical monetary and fiscal policy, which are central to real-world policy discussions. Graduate macro has responded to the unsuitability of these models by either avoiding policy discussions entirely or else by focusing on those few aspects of policy (capital taxation, aspects of social insurance) that *can* be addressed in a DSGE framework. This typically means that countercyclical policies are almost never discussed;

if anything, only the *long run* consequences of fiscal and monetary policies receive any attention.

Were graduate instructors clear in their teaching of graduate students that DSGE models are currently only useful in helping to address a small subset of macro issues (and that the failure of the industry-standard models to fruitfully address short-run policy issues doesn't make those issues any less important), we would have no problem with what is taught in graduate macro. We can accept the argument that emphasizing DSGE models and downplaying policy is perfectly appropriate at the graduate level – just as it can be natural to teach string theory and de-emphasize specific applications to physics PhDs. But the students should have a sense that that is what is being done. Currently, they too often don't.

### **The Undergraduate IS/LM Model**

While the DSGE model may be appropriate for graduate macro, it is clearly inappropriate for undergraduates. Their eyes would gloss over long before one reached the point where one could teach them what a Bellman equation is – and why they should be concerned about it. It would be like teaching Chinese to them, in Latin.

Ultimately, the typical undergraduate economics student is not going to be a macro theorist any more than the typical introductory physics student will end up being a string theorist (well... perhaps a bit more). Undergraduate economics students want and need to cultivate a practical working knowledge of *policy*. They need an engineering approach, not a scientific one. The macro theory taught in undergraduate intermediate macro courses reflects this, having evolved into a mishmash of microfoundations, rough-and-ready semi-developed policy models (such as IS/LM and AS/AD), and equilibrium growth models that let the policy discussion move beyond a focus on short run stabilization.

In our view, there is nothing wrong with presenting this mishmash to undergraduate students: it reflects where the profession is in our understanding these aspects of macro policy, crucial aspects like how to respond in the short run to the fluctuations and coordination failures that plague complex systems. One cannot expect much more than a mishmash when dealing practically with a system as complex as the macro economy. Further, the mishmash successfully captures the models that policy makers have in mind when they think about policy, so it is precisely what undergraduate courses should be teaching.

Were undergraduates first presented with a complexity frame of the macro economy, and the undergraduate models were presented for what they are – a mishmash of empirical regularities and reasonable conjectures, and not as *macro theory*, we would have no problem with it. In fact, we believe that undergraduate students would better *understand* the models, were these models explicitly presented as a set of engineering models – models developed to deal practically with the difficult dynamic problems that can develop in complex systems, rather than as a set of scientifically grounded models that rely on rigorous micro foundations.

### **The Complexity Frame**

What allows both graduate and undergraduate models to make sense and fit together is the complexity frame for the economy. Thus, helping students to envision the aggregate economy's fundamental complexity can and should play a central role in teaching students macro theory and macro policy. The macro economy should be framed as a complex system we will likely never be fully able to control, predict, and analyze. Thus, the role of theory is limited, and the role of engineering models is limited; the two approaches complement one another.

Only after appreciating the incredibly difficult task of understanding complex dynamic systems like the economy can undergraduate students fully appreciate why previous work has made the many simplifications it has. The complexity frame allows almost all of “standard” intermediate macro to stay at the core of undergraduate macro. As well it should: as Robert Solow (1984) and James Tobin (1980) noted, it is the shared intuition of macro policy economists, or, in James Tobin's words, this “simple apparatus is [our] trained intuition ... when we confront questions of policy and analysis” (Tobin, 1982). Moving to a complexity frame is not difficult; it simply involves a pedagogical shift away from presenting the standard undergraduate material as if it has scientific microfoundations. (Indeed, if macro theorizing has taught us anything in the past forty years, it is that the intermediate undergraduate macro models are decidedly lacking in formal microfoundations.)

Similarly, only after appreciating the incredibly difficult task of understanding complex dynamic systems like the economy can graduate students fully appreciate why previous work has made the simplifications it has. If students are bothered by the representative agent model, try solving for an equilibrium in a two person model. If students are bothered by single model consistency assumptions, try formally solving a dynamic optimization problem with multiple models. Shifting to the complexity frame explicitly acknowledges these tradeoffs, and, once presented with them, graduate students

can understand and admire the simplifications made by previous researchers. They can want to acquire the technical skills to be able to further develop the model.

This shift highlights a more practical reason to teach within the complexity frame: within this frame, the analytic apparatus of undergraduate macro theory – poor microfoundations and all – is entirely consistent with modern developments in macro theory. It is consistent within this frame because it explicitly distinguishes engineering models (models useful for policy, but not fully grounded in theory) from scientific models (models grounded in theory, but because of the simplifications necessary to make them tractable, not necessarily useful for policy).

### **A Return to Classical Economics**

In many ways, our proposed “new” approach to undergraduate pedagogy in macro theory reflects a return to the Classical approach to macro. Classical macro economists (that is, the majority of macro economists before the 1940s, and, yes, this include Keynes) saw the macro economy as far more complicated than the average economist of subsequent vintage. They saw it as beyond full analytic understanding, and thus did not try to formally model it. They saw the aggregate economy as a complex system, and they saw macro policy as an engineering, not a scientific, problem. They either didn’t theorize about it, recognizing its complexity, or they theorized about it using heuristic models without micro foundations, something A. C. Pigou (1920) called realistic theorizing.

That classical approach to teaching macro faded in the 1950s, as it was replaced with what – for want of a better term – can be called the neoclassical/neoKeynesian synthesis. This shift reflected a belief within the profession that macro economists had figured out how to surmount the problems of analyzing the complex macro economy and could now treat and study the economy and offer policy advice scientifically. In this new synthesis, the multiplier model and IS/LM models were presented as simplifications of larger multi-sector aggregate macro econometric models that were taught in graduate programs and were used by government and business. These models blended science and engineering, statics and dynamics, and made it seem as if the macro economy could be captured by a set of solvable static equations. These models were closely tied to macro econometric models, and undergraduate macro texts of the time were simply simpler versions of macro graduate texts. Students then, unlike now, could move almost seamlessly from undergraduate to graduate work, and graduates could easily teach undergraduate courses in macro.

Within these models, distinctions were often made between Keynesians and Classicals; they were presented as differing in the degree of wage and price flexibility

they assumed for the elasticities of demand for money functions. The result was a teachable set of models that conveyed a sense of a controllable macro economy, except in special circumstances. Going into a recession? – run a deficit and expand the money supply. Have inflation? – run a surplus and cut the money supply. Have both inflation and unemployment? – struggle with the Phillips Curve tradeoff.

There were, of course, many variations – debates about identification of variables, and the nature of reduced form equations, for example – and for a while the monetarist-Keynesian debate was part of standard textbooks. But that debate was quickly subsumed into the model; monetarists were presented as believing the LM curve was inelastic and Keynesians were presented as believing the LM curve was elastic. Dynamics, where much of the debate actually centered, were left to sidebars. The presentation did justice to neither side, but it captured some of the debate and was easy for students to learn.

In the 1970s, that synthesis approach came under fire, and it rapidly ceased to be viewed as scientific or well founded. The fixed wages and prices models were abandoned by macroeconomists as both theoretically and empirically unjustified. Microfoundations, rational expectations, the Lucas Critique, and real business cycle analysis all became central to graduate macro. Theoretical debates moved from discussions of slopes of IS and LM curves to more diverse issues as the New Classical/New Keynesian macroeconomic debate replaced the neoclassical/neoKeynesian debate. The evolving debate was marked by a significant change in the nature of macroeconomic theorizing; it emphasized a much more technical analysis of intertemporal agent choice, and deemphasized the multi-market equilibrium analysis that underlay IS/LM analysis. These debates ultimately evolved into the DSGE synthesis, which is essentially the real business cycle model with some added institutional rigidities. This DSGE synthesis is what is generally taught in graduate macro today.

While graduate macro theorizing and teaching changed fundamentally over the past decades, undergraduate macro did not; it has remained tied to the IS/LM presentations in part because the other was too hard to present to undergraduate students. While IS/LM analysis remained and even expanded (there are three IS/LM graphs in Ackley's book – the top selling book in the 1960s; there are more than 28 in Mankiw) the careful analysis of the foundations of IS/LM analysis disappeared, since the IS/LM model was no longer being related to a multi sector general equilibrium model, but instead was being used as a heuristic model to discuss policy. Determination of elasticities of the curves was deemphasized, replaced with reduced-form relationships that captured empirical regularities in the macro economy. This has led to pedagogical debates about issues such as whether the LM curve should be abandoned, and whether the aggregate supply/aggregate demand model should be presented in output/inflation space rather than output/price space.

These debates highlight the different way in which the IS/LM and the AS/AD models are now presented compared to how they were presented when they actually were seen as being connected to scientific theory. Today, these models are presented more as rough-and-ready policy models rather than as a carefully derived summary of a well-specified general equilibrium model. They have, in a sense, come nearly full circle and returned to their Classical roots. But the circle has not quite been completed: modern undergraduate macro texts have not made a full break with the past and still carry some of the vestiges of a time when they were viewed as scientific. Intermediate macro is consequently very difficult to teach, both for young professors whose training emphasizes DSGE modeling, and for older professors whose training is in the multi-market equilibrium approach. It is easy to understand how it arose, but the current approach satisfies no one.

Explicitly severing the standard undergraduate models from their scientific past by viewing them as engineering approaches to a complex system – by teaching them within the complexity frame – completes its return to its Classical roots. This is valuable in its own right. The complexity frame is also a unifying worldview: within it, the IS/LM undergraduate standard and the graduate-level DSGE standard are two complementary ways of gaining some understanding of a complex system we do not, and may never fully understand.

The approach taught to undergraduates is deeply practical and policy centered, as it well should be: we don't have time to worry much about deep theoretical foundations (or even internal consistency) when we need to respond to the credit crunch, posthaste. Lacking strong foundations, it is inherently error prone, however: we might end up *thinking* that a model is useful when it turns out not to apply at all. The Phillips Curve and the experience of the 1970s is a natural example here. On the other hand, the DSGE standard is well founded, scientific, and potentially more progressive. It involves idealizing to a world we *can* fully understand in the hope that understanding this simplified world will help us better understand our own. It can provide insight, for example, into *why* our engineering models didn't work as well as we originally expected – the Lucas Critique being a natural example. The concern with it, of course, is that it is not yet of much more practical use to policy makers than string theory is for helping mousetrap engineers.

The complexity frame does not involve an enormous change in the way intermediate macro is presented. Indeed, macro pedagogy can be taught in pretty much the same way as the current standard (Blanchard/Mankiw) approach. It differs only in how those models are framed; it returns to the earlier Classical vision that sees the macro economy as involving so many complex interactions of heterogeneous agents that a full model of it is impossible to construct, at least at this point. Once that frame has been presented to students, they can get on with learning the standard material as engineering

relationships that have developed over time as useful – but ultimately heuristic – ways of dealing with the macro economy. That approach also permits a discussion of “modern” insights, such as time-inconsistency and Ricardian equivalency problems with policy, right alongside the standard presentation. Thus, it allows us to present a modern approach to macro, while maintaining much of the standard intermediate macro apparatus.

Even though moving to a complexity frame represents a relatively minor pedagogical shift, the benefits of presenting undergraduate material in this way are likely to be substantial. In addition to the intellectual benefits of a more honest presentation of difficult material, the shift will have non-trivial practical benefits: by reconnecting intermediate undergraduate macro with graduate macro, it makes macro more easily teachable, both by older professors (for whom the DSGE model is often thought of a technical gobbledygook) and recent grads (for whom the IS/LM model is often thought of as simply gobbledygook).

## **Conclusion**

The economy is complex, and, as such, is inherently difficult to understand. The profession’s current approach to teaching undergraduate macro economics compounds this difficulty: it presents heuristic practical models as if they were well-founded scientific theories, even though nobody really believes the theories any more. Admitting up-front that we don’t “get” the economy – and using the complexity vision to explain why not – will go a long way towards resolving this problem and improving undergraduate macroeconomic pedagogy.

It will also go some way towards bridging the yawning divide between graduate and undergraduate pedagogy. The vestiges of a more scientific past in current approach to undergraduate macro make it come across as a substitute to modern scientific macro – a particularly poor substitute in light of the intellectual coherence and the mathematical elegance of DSGE models. We are arguing here that they should not be viewed as substitutes at all. Thanks to DSGE we know more than we used to about the economy. Not much more, though, and certainly not much more about the practical responses to short-run macroeconomic fluctuations that are, and should continue to be, the bread and butter of undergraduate macro. Teaching at *both* levels should reflect our lack of understanding – groping to gain small footholds in a complex system that is inherently difficult to understand.

The two approaches represent two distinct approaches to gaining such a foothold: DSGE offers deeper insights into a currently limited set of questions – an approach appropriate for graduate instruction. The “tools” of undergraduate macro, IS/LM, AS/AD

and so forth, deliberately spurn deep insight – a perfectly appropriate approach given its goal of helping to guide policy-makers as they deal with real, practical, and pressing macroeconomic concerns in a complex world. A pedagogical emphasis on the complex nature of the economy highlights this complementary nature of the two approaches and better reflects our modern, self-consciously imperfect, understanding of the macro economy.

### **Endnotes**

<sup>1</sup> Elsewhere Colander (200x) has called this complexity frame a Post Walrasian approach. The term used is unimportant.

<sup>2</sup> Views on the potential long-run usefulness of DSGE approach vary widely. Robert Solow would see it as close to useless; Robert Lucas would see it as highly useful. In this paper we do not discuss such issues. Our concern here is simply pedagogical – how can one justify the current graduate approach to macro to students?

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