Should Calculus Be a Requirement for Intermediate Macro?

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Many of the top liberal arts programs require calculus for intermediate macro. That's a stupid idea. Understanding calculus is not necessary for understanding the ideas that we should be teaching in intermediate macro, and if the ideas that are being taught require calculus, something is wrong with the course.

A variety of reasons why calculus should be a macro requirement have been advanced, but none of them hold water. The two reasons that I have heard most are (1) other schools do it, and (2) students who have taken calculus make better students. The first argument is irrelevant — if a liberal arts program cannot make its own decisions about what requirements make sense, it doesn't deserve to be called a liberal arts program. The second is probably true but also irrelevant. The same could be said about students who have A averages, or who have taken advanced physics, but we don't require those.

The overriding reason for having a requirement for a course should be whether the knowledge learned in that required course — in this case, a one-semester calculus course — is actually needed to understand what will be presented. Italian 1 *should* be a requirement for Italian 2, and Calculus 1 *should* be a requirement for a differential equations course. On the basis of this reasoning, a reasonable argument can be made to require calculus for an intermediate *micro* course; understanding calculus can help in understanding the ideas presented in intermediate micro. Whether it actually does help is debatable since the calculus training that students receive in an introductory calculus course is often not the calculus that students use in intermediate micro, and their understanding of the calculus actually relevant to micro from a one-semester course is often shaky.

That's not the case with intermediate macro. Most intermediate macro texts have no presentations that even use calculus, and any micro-focused presentation that does could easily, and as efficiently, be explained without it. For example, the Solow growth model can be explained using calculus, but it can be easily presented in words and tables. Indeed, most intermediate macro texts present the Solow growth model without the calculus.

The biggest push to teach the macro course using calculus often comes from those who want to teach a "micro foundations" approach to macro. They try to justify the calculus indirectly as a foundation to micro, which in turn is justified as a foundation to macro. If that is what one wants to do, why not make intermediate micro a prerequisite for intermediate macro? That would make a lot more sense. I suspect there are some schools that do that, but I don't know of any; it is certainly not widespread.

Actually if the department really wants to teach a micro-grounded macro course (rather than just teaching a sub-course in some minor micro aspects of the macro economy, which is what is often incorrectly considered a “micro-grounded macro course”), that micro-grounded macro course would have to be an advanced course. It is certainly not a part of any reasonable undergraduate core course. The reason is that in order to understand micro-grounded macro theory, one must understand general equilibrium theory. Almost no undergraduate student completing the standard intermediate micro course has a firm understanding of the general equilibrium theory. This makes trying to teach a rigorous micro-grounded macro theory course to students who have only had one semester of calculus the equivalent to teaching an advanced Italian literature course to someone who has had only first semester Italian. You can pretend to do it, but the students aren’t going to learn much literature (or in the case of economics, macro.) Almost all their efforts will go to learning the language, not the deep ideas.

A LARGER QUESTION ABOUT MACRO “THEORY”

The question about the calculus requirement raises a larger question about macro theory with which neither the Keynesian nor the Dynamic Stochastic General Equilibrium (DSGE) parts of the profession have come to grips. The problem for DSGE advocates is that any tractable formal general equilibrium model is so simple, relative to the macro problem that the economy faces, that the jump to policy discussions does meet the smell test. As Robert Solow put it, telling someone that he or she should understand macro policy problems based on a tractable DSGE model is the equivalent to someone coming to you and saying, “Assume I am Napoleon” and then wanting to start debating war strategies with you. Solow, quite reasonably, suggests that faced with such a request, it makes most sense to walk away.

American graduate students have walked away; they have voted with their feet, and graduate school interest in applied micro has expanded while interest in macro (which today in almost all top graduate programs is some variant of DSGE macro) has waned, which has made it difficult, if not impossible, for liberal arts programs to hire someone who can teach a reasonable undergraduate policy-oriented macro course. The result is a serious imbalance in undergraduate economic programs; they are becoming far too heavily applied micro focused.

Let me be clear. The issue is not that the DSGE mathematics are too complicated; the issue is that they are not complicated enough to deal with the complexities that arise in an economics system of heterogeneous agents, unknown models, and highly interdependent expectations. After a thoughtful, highly mathematically oriented student has worked through all that math, he or she should be left wondering: What have I actually captured about the workings of a real-world macro economy with the limited math that I am using? Unfortunately, a reasonable answer to that is: Not much that you couldn’t have captured by simply thinking deeply about the problems and not formally modeling it at all.

I am not arguing that Keynesians have resolved the problem. It was the problems with their models that brought about the movement to DSGE models. The reality is that Keynesian models are at best engineering models that are then put into a comparative static framework unable to handle the difficulties presented by the complexities of the macro economy. To the degree that Keynesians present their models as theoretical models, not heuristic *ad hoc* engineering models, they are not conveying to students the analytical difficulties of developing a formal macroeconomic theory. They face the same problems that DSGE modelers face. The general equilibrium theoretical grounding for Keynesian-

type arguments about how the macro economy works is in the analysis of non-linear dynamical systems with turbulence. To have any reasonable formal model of such turbulent systems, you need a lot (lot) more than a beginning course in the calculus. If we were going to teach a meaningful formal Keynesian theory in intermediate macro, we should require not only the calculus but differential equations and non-linear dynamical systems. I suspect such a course would not have a large enrollment.

The point I am making is that what is called Keynesian theory is far from a formal theory, just as what was called Classical macro theory was far from a formal theory. The models that became enshrined in the Keynesian–Classical synthesis were a collection of simple algebraic comparative static multi-market models, which talked about interrelated goods, labor, and money markets. From a theoretical standpoint, the composite model never held water, was inconsistent with much economic reasoning, and only became understandable when accompanied by a lot of hand waving and fuzzy reasoning. The models that resulted were unrealistic and their underlying logic easily undermined. When these Keynesian, Classical, or synthesis models were taken to the data, they were inevitably tweaked and massaged with fudge factors to make them fit the data.

Modern applied DSGE models are little better. The original DSGE models provided a logical core for a general equilibrium economy with a representative agent so they had a core logic to them, if you could stomach the assumptions. However, in terms of thinking about an actual economy, those core models were so simplistic and filled with such unrealistic assumptions that their relevance to the actual macro economy was close to nil, except to those who have been indoctrinated into the DSGE groupthink. When DSGE models are taken to the data, they too are massaged and tweaked with a variety of *ad hoc* assumptions to make them fit. Thus, for example, the Fed's DSGE model is full of *ad hoc* assumptions and modifications that are a far cry from the DSGE models that purists had called for.

The reality is that we do not teach scientific macro theory in intermediate macro. The reason is that the economics profession does not have an acceptable macro theory that meets any reasonable scientific empirical criteria of confirmability. We have a variety of models that we teach, but they are merely suggestive, not definitive. The reason is not lack of effort; the reason is the complexity of macro interrelationships and the lack of the data that is necessary to seriously deal empirically with that complexity that the underlying relationships present. What we present to students as a formal macro theory is better described as a collection of insights into the macro economy that some bright economists have put together, and blended into some baby math models to give it an aura of sophistication. To present it as other than that is to mislead students.

TEACHING MACRO SENSIBILITY, NOT MACRO THEORY

Despite the lack of a formal theory, much of the content of the standard intermediate macro course is nonetheless useful to teach students. Any economics major should know about monetary policy, banking institutions, inflation, financial institutions, fiscal policy, interest rates, the efficient market hypothesis, financial valuation, the difficulties of macro modeling, the problems of dynamic inconsistencies, and other similar insights and information. That is what students should get from a reasonable intermediate macro course. Therefore, the intermediate macro course is a useful one for students, and something like what we currently teach in the standard macro courses belongs in the core. The main problems I see is that (1) we call it “macro theory,” which it isn't, and (2) we

don't teach students just how little we scientifically know, and how to apply the heuristics and insights that they learn to analyze macroeconomic problems.

So where does a beginning course in calculus (especially the way first semester calculus is actually taught) fit in to understanding these issues? The ideas learned in a one-semester calculus course are so tangentially related to macro policy issues that whether the students have had a calculus course before considering these issues is irrelevant. Using the calculus is simply a way to make the hand waving look a little more impressive, and make students think we understand more than we do.

Not only is there no need to require calculus for intermediate macro, having it as a requirement, and using it to teach macro, actually harms students because it gives them a sense that the models are telling them more than they are. Why don't we just tell intermediate macro students that the aggregate economy is a highly complex system, and that the analytics of capturing it in a theory or model are really really hard, and then get on with presenting the models we have, and the useful thinking that macroeconomists have about policy issues. You can deal with issues without theory. (We have no theory of love, but we deal with it—well sort of.) However, let us present any models we present with appropriate nuance, thereby providing students with an appreciation of the important insights that economists, both Keynesian and Classical, have had in considering macro policy issues.