Using a Simple Simulation Model to Help Students 'Think Like Economists' in Intermediate Macroeconomics

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Abstract

A decade ago, a national conference of macroeconomic educators called for fundamental reform in the teaching of intermediate macroeconomics, urging instructors to employ a single analytic framework rather than 'responding to the fragmentation of macroeconomics by teaching a separate model for each school of thought' (Erekson, Raynold and Salemi, 1996; Salemi and Siegfried, 1999). This paper describes the theoretical structure and learning applications of a simple, single-framework macroeconomic simulation model developed at Texas Christian University. When carefully integrated with other course activities, this computer-based learning tool can increase the intellectual value of intermediate macroeconomics by helping to strengthen students' understanding of basic macroeconomic principles and the types of complex causality, interdependence and unintended consequences that arise in macroeconomic settings, i.e. students' ability to 'think like economists' about macroeconomic phenomena.

Introduction

Intermediate macroeconomics poses a unique set of pedagogical challenges. Like intermediate microeconomics, it is a heavily theoretical course that most economics majors and many minors are required to take. But whereas the standard set of topics in intermediate microeconomics is unified by 'a commonly agreed upon core of concepts' (Davis and Erekson, 1998: 52), the topics covered in an intermediate macro course often are presented without such a unified structure. Most textbooks present two or three analytical apparatuses, seeking to survey 'the diversity of approaches to macroeconomic theory and policy in the professional economics literature' (Erekson, Raynold and Salemi, 1996: 100). When effectively taught and learned, this diversity of approaches can help students to 'think like economists who always keep various models in mind when analyzing economic events or public policies' (Mankiw, 1994). In many classrooms, however, the attempt to introduce multiple analytic structures in a one-semester course can actually impair student learning, especially for those students (arguably the majority) who lack the appetite and aptitude for 'the use of highly technical and formal modeling in intermediate macroeconomics' (Erekson, Raynold and Salemi, 1996; 103).

A decade ago, macroeconomic educators (gathered at Miami University of Ohio for a national conference on the intermediate macroeconomics course) placed this problem at the top of their reform agenda.[1] They also proposed a solution: a 'single framework' approach to intermediate macroeconomics:

> 'The most significant theme emerging from the conference was the desirability of adopting a single approach in teaching the intermediate macroeconomics course, as opposed to presenting numerous competing models' (Erekson, Raynold and Salemi 1996: 101).

This recommendation was strongly echoed by Salemi and Siegfried in their 1999 assessment of 'the state of economic education' wherein they urged intermediate macroeconomics instructors to (re)build their courses around a single mode of analysis rather than 'responding to the fragmentation of macroeconomics by teaching a separate model for each school of thought' (Salemi and Siegfried, 1999: 358). To date, however, there has been little professional discussion of the Miami proposal or how it might be implemented.

This paper takes a modest but concrete step in this direction. We describe the theoretical structure and learning applications of a computer-based simulation model we have created for intermediate macroeconomics students at Texas Christian University (McNertney, 2003). The model allows students to analyse, in increasingly

complex settings, how changes in selected behavioural, structural and policy parameters affect aggregate levels of employment, income, spending, savings, product prices, interest rates, exchange rates, international payments and other dependent variables. The pedagogical advantages of this simulation model are fourfold:

1. per the Miami proposal, it provides an integrated structure, 'a coherent model that progressively incorporates more aspects of the macroeconomy' (Davis and Erekson, 1998: 50);

2. it directly promotes active learning and thus serves to 'improve [students'] problem-solving abilities' and to 'stimulate their interest in economics' (Millerd and Robertson, 1987: 278–79);[2]

3. it strengthens students' macroeconomic insight by emphasising equilibration *processes*, unlike standard graphical and algebraic exercises which focus only on comparative static results; and

4. it foregrounds the modelling process and thus helps students to understand and 'appreciate model building' (Erekson, Raynold and Salemi, 1996: 102).

When carefully integrated with other course activities, this computer-based learning tool can increase the intellectual value of the intermediate macroeconomics course by helping to strengthen students' understanding of macroeconomic principles and the types of complex causality, interdependence and unintended consequences that arise in macroeconomic settings, i.e. their ability to 'think like economists' about macroeconomic phenomena.

Structure of the simulation model

The simulation model we have created for intermediate macroeconomics courses at Texas Christian University is a static IS-LM-AS-AD model, with a range of possible treatments of labour supply, product supply, and the financial and international sectors. The product supply curve is built on the assumption of imperfect competition, similar to the models developed in Solow (1998), Hahn and Solow (1995) and Michl (2002) in which the aggregate price level is treated as a mark-up over unit labour costs. The aggregate supply equation also includes the size of the labour force, labour productivity, supply shocks and the expected price level.

The structure and complexity of the simulated economy can be varied depending on the instructor's approach and preferences. The possibilities range from a one-market, three-sector system to a three-market, four-sector system. For instance, students can be guided through a standard intermediate-level progression:

1. a 'Keynesian cross' system that solves for the equilibrium level of national income
   - one equilibrium condition (representing the aggregate product [GDP] market)
   - three sectors (household, business and government);

2. an IS-LM system that solves for equilibrium levels of national income and the interest rate
   - two equilibrium conditions (representing the product and money/bond markets)
   - three sectors (household, business and government)
   - major variation: money supply can be made endogenous;

3. an IS-LM-BP system that solves for equilibrium levels of national income, the interest rate and international payments:
   - three equilibrium conditions (representing product and money/bond markets and the international balance of payments)
   - four sectors (household, business, government and foreign)
   - major variations: money supply and exchange rate can be made endogenous;

4. an international AS-AD system that solves for equilibrium levels of national income, employment, wage rate, interest rate, international payments and domestic price level
   - four equilibrium conditions (representing product, labour, and money/bond markets and the international balance of payments)
   - an aggregate supply equation linking the domestic price level to supply-side conditions (unit labour costs, size of labour force, labour productivity, supply shocks and expected price level)
   - four sectors (household, business, government and foreign)
   - major variations: money supply, exchange rate, population (labour force) and labour productivity can be made endogenous.

As this progression suggests, a key feature of the simulation package is how easily it allows users to modify or extend the model structure and thus to 'endogenize' key macro variables (e.g. making the interest rate endogenous via the move from model (1) to model (2); or making the price level endogenous via the move from model (3) to model (4); or modifying models (2), (3) or (4) to make the money supply endogenous).

The structural equations for aggregate demand (AD) and aggregate supply (AS) are:

AD: $Y = A + B/P$

AS: $P = C + D^*Y$

where the parameters A, B, C, and D can be progressively redefined based on the model specification. For instance, in a simple Keynesian cross model, the price level is treated as exogenous and equal to 1 (a perfectly price-elastic aggregate supply curve). Hence the parameters C and D are undefined. The aggregate demand parameters, A and B, are defined as:

$$A = (C_0 - C_y{}^*T_0 + I_0 + G_0)/(1 - C_y + C_y{}^*T_y - I_y)$$

$$B = -(C_r + I_r)^*r_0/(1 - C_y + C_y{}^*T_y - I_y)$$

where:

C_0 is the exogenous level of consumption expenditures;

C_y is the marginal propensity to consume ($\Delta C/\Delta YD$);

C_r is the relationship between consumption expenditures and the interest rate ($\Delta C/\Delta r$);

T_0 is the autonomous level of tax revenue;

T_y the income tax rate ($\Delta T/\Delta Y$);

I_0 is the exogenous level of investment expenditures;

I_y is the marginal propensity to invest ($\Delta I/\Delta Y$);

r_0 is the interest rate;

I_r is the relationship between investment expenditures and the interest rate ($\Delta I/\Delta r$); and

G_0 is the exogenous level of government expenditures.

In one of the more advanced international AS-AD systems, A, B, C, and D would be redefined as:

$A = (C_0 - C_y{*}T_0 + I_0 + G_0 + X_0 + X_{yf}{*}Y_{f,0} - e_0{*}(X_e + IM_e) - IM_0)/(1 - C_y + C_y{*}T_y - I_y + (C_r + I_r){*}MD_y/MD_r + IM_y)$

$B = ((C_r + I_r)/h){*}M_0/(1 - C_y + C_y{*}T_y - I_y + (C_r + I_r){*} MD_y/MD_r + IM_y)$

$C = (\text{markup} + 1){*}w_0 * PEXP + \text{supply shock}$

$D = (\text{markup} + 1){*}(w_1/(LFPR{*}POP{*}prod)) * PEXP/prod$

where (in addition to the variables previously defined):

MD_y is the marginal propensity to demand money;

MD_r is the relationship between the real quantity of money demanded and the interest rate;

P is the product price level;

M_0 is the original nominal money supply;

X_0 is the exogenous level of exports;

X_{yf} is the marginal propensity to export from foreign income ($\Delta X/\Delta Yf$);

Y_f is the level of foreign income;

$Y_{f,0}$ is the exogenous level of foreign income;

X_e is the relationship between exports and the exchange rate ($\Delta X/\Delta e$);

IM is the level of imports;

IM_0 is the exogenous level of imports;

IM_y is the marginal propensity to import ($\Delta IM/\Delta Y$);

IM_e is the relationship between imports and the exchange rate ($\Delta IM/\Delta e$);

e_o is the exogenous level of the exchange rate;

prod is the level of productivity (output per unit of labour);

w_t is the wage rate in time period t;

w_0 is the exogenous level of the wage rate;

w_1 is the sensitivity of the wage rate to labour market forces;

LFPR is the labour force participation rate;

POP is the population level;

PEXP is the expected price level; and

mkup is the mark-up of product prices over unit labour costs (w_t/prod).

These structural equations allow students to see that each new (more complex) version of the basic model contains all previous (simpler) versions within it. This is a unique and valuable feature of the single framework approach. Instructors can build students' macroeconomic knowledge and confidence throughout the course by emphasising the nested structure of the models.

Some instructors may fear that a 'single framework' entails the adoption of one particular paradigm to the exclusion of alternative schools of thought. But this is not the case. A single-framework system can be used to explore multiple approaches to macroeconomic theory and policy. By adjusting the values of key parameters, one can design simulation models to illustrate the major insights (and weaknesses) of classical, Keynesian and other traditions of macroeconomic thought. As Erekson, Raynold and Salemi put it: 'Adopting a single, organizing paradigm … does not mean embracing one side or another in policy debates. For instance, it is one thing to argue that aggregate supply and aggregate demand provide the best central paradigm. It is quite another to argue that the AS curve is vertical' (1996: 101). In addition, the relative simplicity of these models (compared to more complex forecasting models such as the Fair model) increases its effectiveness as a learning tool, even for the brightest intermediate students, since 'even a relatively simple, deterministic model generates data which look rather chaotic to the untrained eye … [Hence] complicated lessons can be illustrated even in a relatively simple model' (Dolbear, Attiyeh and Brainard, 1968, cited in Millerd and Robertson, 1987: 272).

Learning applications of the simulation model

To illustrate the potential range of learning applications that can be derived from a single-framework simulation model, we will describe three types of student assignments: theory exercises, empirical/historical exercises and policy exercises. All are geared to exploit the unique advantages of the simulation model. Whereas standard textbook assignments (graphical and algebraic) focus mostly on comparative static results, these simulation-based assignments emphasise the logic and importance of macroeconomic processes. In addition, they are designed to make students active participants in the learning process – giving them a more hands-on, experiential grasp of the interconnections among macroeconomic variables and facilitating the formulation of intelligent questions about macroeconomic phenomena and policies.

Theory exercises

1. As a basic exercise, ask students to produce a detailed comparative static analysis for a given set of exogenous shocks. For instance, ask them to use a particular version of the simulation model to (a) show how the original equilibrium values of the endogenous variables

are calculated; (b) use a given set of behavioral and structural equations to calculate the effect of parameter changes on the equilibrium values of the endogenous variables; (c) explain in words why the equilibrium values changed in the manner observed; (d) use the equations to calculate line-by-line changes in the variables (i.e. how the model moves from one equilibrium state to another); (e) explain in words why these variables change in the manner as observed; and (f) use graphs to show the overall results of the re-equilibration process.

2. After students have encountered several versions of the basic model, ask them to explain, in detail, the differential effectiveness of a given parameter change (such as an increase in government spending or reduction in tax rates) in two or more different models.

3. Give students a particular simulation model (algebraically and in computer-simulated form) and ask them to explain what the model is designed to do. Or, do the reverse: tell students something you would like a simulation model to do, then ask them to design a model to do it. Or a third variation: give them a model whose specification includes certain 'mistakes' or questionable assumptions, then ask them to find and explain the errors.[3]

4. Early in the course, create a simple assignment to clarify the meaning and importance of the endogenous/exogenous distinction. During the first week, for instance, give students a one-market 'micro' example (in graphical, algebraic and computer-simulated forms) and ask them to (a) list the exogenous and endogenous variables in the model and (b) to explain, in detail, the adjustment process whereby a change in one of the exogenous parameters will cause changes in the two endogenous variables, P and Q.[4]

5. Later in the course, continue the exogenous/endogenous lesson by asking students to think through the ramifications of treating certain variables (e.g. interest rate, price level, money supply, exchange rate, population or labour productivity) as endogenous rather than exogenous. Once students are aware that a variable's exogenous or endogenous status is a modelling choice rather than an objectively given fact, they naturally will want to know how they (or you, or macroeconomists generally) are supposed to make these decisions: for example, whether it is 'more correct,' say, to treat the LM curve as horizontal, vertical or upward-sloping. To get students thinking along these lines, ask them a critical, open-ended question such as, 'Even if it is not 100% realistic to treat the money supply as "exogenous" to the macroeconomy, can you think of any reason(s) why, for analytical or policy purposes, it might be useful to treat it this way?'

6. Toward the end of the course, develop exercises to explore the *limitations* of the simulation models. For example, ask students to consider why textbook macro models have a hard time explaining the non-neutrality of money.[5]

Empirical/historical exercises

1. Motivate the transition from simpler to more complex models by giving students a set of time series data and posing a series of suggestive empirical/analytical questions such as 'Why is consumption procyclical? Why have real interest rates shown little if any trend over time, while output has a pronounced positive trend? What determines the long-run rate of inflation? Why is output unusually high during wars?' (Davis and Erekson, 1998).

2. Give students a set of macro data, set for a certain time period, say the 1990s, and ask them to use an appropriate model to simulate key features of the period (e.g. rising output and falling unemployment combined with relatively stable prices).

3. Give students time series data for one country (or several countries) and ask them to estimate certain structural or behavioural parameters during a given time period, and to use an appropriate simulation model to explain how the country's macroeconomic performance would be affected (or how the effectiveness of certain macroeconomic policies might change) if the value of a particular parameter were to increase or decrease in the future. In a small class, it might be feasible to create a unique assignment for each student (e.g. one country or one time period per student).

4. As an individual or group assignment, ask students to use recent macroeconomic data along with an appropriate simulation model to generate a macroeconomic forecast for the USA (or some other nation's) economy.

5. Give students a well-chosen example of a macroeconomic forecast (e.g. drawn from a current or past edition of the *Economic Report of the President*) and ask them to use an appropriate simulation model to explore the assumptions and logic (or illogic) behind the forecasters' conclusions about the future direction of GDP, unemployment, interest rates, and so on.

Policy exercises

1. Ask students to use a particular simulation model (or set of models) to explore the possible causes (and cures) for recession, inflation, international trade imbalances, federal budget imbalances, and so on. Though reasonably straightforward, these exercises can teach valuable lessons about the interconnectedness of macroeconomic variables and the fact that every policy target is a *moving* target, i.e. an endogenous variable within a complex system.

2. Ask students to use an appropriate simulation model to design monetary and fiscal policies to achieve target levels of national income, interest rate, federal budget deficit or other variables of interest. Or, a related assignment, ask them to determine various ways to get more 'bang' from a given policy change (e.g. an increase in G_0, a cut in T_y or an increase in M_0).

3. As an extension of the aforementioned endogenous/exogenous exercises, ask students to

formulate a policy solution (or two) to a given macroeconomic disequilibrium. A special favourite of our students is to explore possible solutions to international currency market imbalances. Such an imbalance will naturally arise when the exchange rate is fixed and net foreign savings is a positive function of the differential between domestic and foreign interest rates. With the exchange rate fixed, there is no automatic mechanism to bring net foreign savings into line with net exports. Yet there are several ways that a nation might try to rectify this imbalance. For instance, it could allow its exchange rate to float. Or it could take direct measures to restrict imports, promote exports (e.g. by persuading major trading partners to expand their economies, relax trade restrictions, and so on), or restrict outflows of domestic savings to other nations. Or it could deliberately contract its economy by adopting a tighter monetary policy in order to slow imports and attract foreign savings (via a higher interest rate). What seems to catch students' interest in this scenario is the choice between fixed and floating exchange rates. Many countries choose not to let their exchange rate float. Hence they must find other ways to 'solve' the resulting currency and international payments imbalances.

4. Ask students to design a series of 'tests' to compare the results of different policy proposals, for example, activist vs. non-activist responses to a specified set of demand and supply shocks or 'money supply targeting' vs. 'interest rate targeting' policies by the Federal Reserve.

5. Use the simulation models in conjunction with historical data to simulate a major policy episode (e.g. the early 80s inflation vs. unemployment dilemma; or the late 90s growth vs. potential deflation dilemma), with special emphasis on the real-life problems of macroeconomic complexity, uncertainty and incomplete information that make economic policymaking an imprecise and partially subjective art rather than a precise, objective science. This follows the pedagogical suggestion of former Council of Economic Advisors chair, Michael Boskin:

   'We must also recognize that we are not at all certain of the full consequences of a large tax cut or major monetary expansion in any particular environment. They may very well depend on things that we do not control, and this has become especially true as our own macroeconomy has become internationalized' (Boskin, 1998: 24).

Conclusion

Among economic educators today, there is a growing movement to reform our introductory and intermediate courses. One major thrust of these efforts is to encourage a 'less is more' approach: to increase students' ability to understand and apply economic reasoning by exposing them to 'repeated applications of a short list of the core ideas of the discipline' (Frank, 1998: 13; also Frank, 2002; and Hansen, Salemi, and Siegfried, 2002). In addition, Becker, Watts and others have championed active learning as a vital yet lacking element in undergraduate economics education (Becker and Watts, 1996; Becker, 1997). '[T]he undergraduate teaching of economics [is] overly wedded to traditional "chalk and talk" teaching methods . . . [and] is lagging behind other disciplines in implementing instructional innovations that engage students more actively in the learning process' (Katz and Becker, 1999: 194).[6]

These were precisely the concerns, goals and strategies that inspired the 1994 Miami conference on intermediate macroeconomics. The central recommendations emerged from a less-is-more, active learning vision of the intermediate macroeconomics course. The appeal of an integrated analytic structure was to allow instructors to spend less time constructing different analytical apparatuses and more time cultivating students' macroeconomic sensibilities – to shift the focus of the course from breadth to depth (Davis and Erekson, 1998: 50). A related aim was to create more space for active learning. As Davis and Erekson argue: 'Active learning techniques dovetail well with our sense that depth is more important than breadth for intermediate theory courses' (Davis and Erekson, 1998: 52). A third goal, equally important, was to help intermediate macro students to become, in a rudimentary but meaningful sense, *producers* of economic questions and analysis, 'to develop [their] ability … to ask interesting questions about the world they live in … and to learn to approach those questions using the economic way of thinking' (Davis and Erekson, 1998: 47).

Our paper aims to affirm and extend this new vision of the intermediate macroeconomics course by offering a concrete illustration of how it might be implemented. Our simulation model is old-fashioned and low-tech in comparison to some of the simulation packages currently available as textbook supplements. And of course it is but one of many ways to operationalise the single-framework concept.[7] Yet we have found this particular package useful as a way of 'actively engaging students in doing economic analysis' (Siegfried *et al.*, 1991: 218) and helping them to gain a firmer grasp of 'how economic magnitudes are related, and how very complex and involved these relationships are' (Little, 1957).[8] In addition, students seem to emerge from our classes with a better sense of the usefulness, limitations and 'art' of macro-theoretical modeling.

The notion of 'thinking like an economist' is often associated with a microeconomic alertness to the role of incentives, opportunity costs and strategic interaction in individual and social life. Yet the ability to comprehend the complex causality, interdependence and unintended consequences that arise in macroeconomic settings is equally fundamental to economic reasoning. These core macroeconomic ideas are vividly conveyed and effectively reinforced by a single-framework simulation model.

Notes

1 The Conference on the Intermediate Macroeconomics Course was held at Miami University in Oxford, Ohio, October 23–24, 1994.

2 See also Bartlett and King (1990) and King and LaRoe (1991).

3 These exercises are inspired by Peter Kennedy's creative suggestions for the use Monte Carlo simulations in econometric theory courses (Kennedy 2001).

4 Murray (1999) offers a parallel suggestion for how to begin an econometrics course.

5 As Davis and Erekson suggest, 'These shortcomings should be admitted and can motivate more advanced discussion either toward the end of the semester or in more advanced electives' (Davis and Erekson 1998, 51).

6 In a similar spirit, Kennedy (2001) proposes a 'less is more' approach to econometric theory.

7 Stinespring (2004) offers another valuable approach.

8 With regard to commonly oversimplified matters like the causes or consequences of federal budget deficits (or current account deficits), our students emerge with an appreciation of why I.M.D. Little was absolutely right to say:

> Non-economists tend to be too academic. They abstract too much from the real world. No one can think about economic issues without some theory, for the facts and relationships are too involved to organize themselves … [I]f the theorist is untutored, he is apt to construct a very partial theory which blinds him to some of the possibilities. Or he falls back on some old and over-simple theory, picked up from somewhere or other. He is also, I believe, apt to interpret the past naively (Little 1957).

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