

# Teaching Macroeconomics with Microsoft Excel®

By

Humberto Barreto

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Para mi familia:

Tami, Tyler, Nicolas, y Jonah

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All files are freely available online at [www.depauw.edu/learn/macroexcel](http://www.depauw.edu/learn/macroexcel).

## *Preface*

My simple idea is to deliver fundamental content in an undergraduate macroeconomics course via Microsoft Excel® in a way that any economist can easily utilize for teaching purposes. My contribution is to provide a complement to conventional teaching which gives professors a different way to present macro models and incorporate data into their courses. The Excel files are meant for students, while the audience for this book is my fellow professors.

A series of implications flow from the decision to target this book to professors:

- A great deal of basic information can be safely omitted
- Content is modular and standalone so teachers can pick and choose what to use
- Explanations will be less detailed
- Mathematics is used to present models compactly
- Successful pedagogical practices or suggestions are included
- Focus is placed on implementation of models in Excel, including how to modify the model
- There is an emphasis on data sources and ways to quickly update data for class presentation
- The writing style can be more conversational because my target reader is my peer

The Excel workbooks and add-ins, available on the web at [www.depauw.edu/learn/macroexcel](http://www.depauw.edu/learn/macroexcel), are designed to be used by students with any textbook. Each Excel workbook contains links to *screencasts*: recordings of the computer screen, also known as a video screen capture, with audio narration. Each screencast is short, usually around five to ten minutes, and walks the student through the steps needed to complete a task. All videos are grouped in a channel, available at [vimeo.com/channels/macroexcel](http://vimeo.com/channels/macroexcel). A complete listing of all screencasts, organized by workbook, is available at [www.depauw.edu/learn/macroexcel/screencasts](http://www.depauw.edu/learn/macroexcel/screencasts).

This printed book describes each screencast, highlighting important points, as a way to minimize the time needed to choose which ones to use. It is recommended, however, that you view screencasts selected for your students to make sure you are familiar with the material, especially Excel functions and add-ins.

Although primarily designed with Intermediate Macro in mind, many of the files and screencasts are useful for other courses. *MaddisonData.xls*, for example, could be used in Intro, Development, and Growth Theory courses. *Unem.xls* could serve as a supplement for any Labor Economics textbook. Because the content is modular, the professor can pick and choose what, when, and how to use a particular Excel file or screencast. For Intermediate Macro, simply plug in workbooks as appropriate into an existing syllabus—there is no need to follow the order in which the files are listed. If your course begins with a review of key macro variables, then it would make sense to jump right into the workbooks that use the FRED Excel add-in to download data.

The innovation and unique contribution of this book and the associated Excel files lies in my ability to recast existing knowledge into Excel, which turns out to have powerful advantages for communicating ideas and displaying data to students. Through using these macro-enhanced workbooks and materials, students will more fully learn sophisticated concepts that are often poorly absorbed through conventional books and lectures.

One powerful advantage of delivering the material to students via Excel files is that they can be easily updated by me or modified by you. Parameters can be quickly changed to create new questions, text can be altered or augmented as needed, and entirely new worksheets can be inserted with new material. If a workbook is used as an in-class lecture, you can simply delete or hide unwanted sheets such as the *ToDo* sheet (which has video links and a list of tasks for students).

I will keep the Excel workbooks updated, correcting mistakes and adding buttons and other features. I will not update the screencasts as frequently and they may not look exactly like the latest version of the Excel files. Of course, if major changes are made and the screencast is badly out of date, I will redo it.

I assume my audience (both student and professor) has used Excel, but is unfamiliar with advanced Excel functionality and has never opened Visual Basic or written a macro. The workbooks cover a wide range of Excel skills, such as basic and advanced charting (e.g., making a graph with two y axes, adding recession bars to a chart, and creating a population pyramid), Pivot Tables, conditional formatting, and using Solver and other add-ins. All code is open source and can be viewed by pressing *Alt-F11* while in Excel with a macro-enhanced workbook open.

I want to thank many people for contributions to this work, including generations of students and many colleagues. They had to listen to me complain about how economists had failed to take advantage of technology to improve their teaching and then put up with many Visual Basic errors and crashes. I thank the many colleagues and students that I imposed upon to read drafts and test drive Excel files. The following helped me by sending me specific comments and suggestions: Sean Brocklebank, Mary Dixon, Bill Goffe, Peter Mikek, Imad Moosa, Kerry Pannell, Alberto Posso, Guangjun Qu, Tikhon Savrasov, George Tawadros, and Dan Wachter. I also benefitted from the criticisms and comments of four anonymous reviewers.

In addition, three others deserve special thanks: Frank Howland, Kay Widdows, and Tami Barreto. Frank and I collaborated on an Econometrics book that uses Excel and we worked closely together for many years. A long time ago, he helped me implement and solve the Solow Model in Excel. He does not know this, but when I write something, I think of him reading and criticizing it, which then forces me to make it better. Kay and I team-taught several courses and created a series of Excel-based labs for Principles of Economics. She is neither a macroeconomist nor a programmer, but has a sharp eye for clear explanation and organization of ideas. I learned a great deal from both of them and much of the material in these workbooks and screencasts bears their imprint. Tami copyedited this book and the Excel files, greatly improving the exposition by toning down my colloquial style and pushing for clarity in expression. She has edited just about everything I have ever written and I am glad to be able to recognize her contribution.

Finally, I thank DePauw University, RMIT, and Cambridge University Press. DePauw's Elizabeth P. Allen Endowed Chair and Allen A. Wilkinson Faculty Fellowship programs provided generous

financial and course release support for this project. RMIT provided a supportive environment that helped me work on this book during a productive and enjoyable sabbatical year in Melbourne, Australia. I remain surprised that Cambridge University Press is willing to publish this book. They will not make much money since students do not have to buy this book and it really quite weird. Taking a chance on this unorthodox work is a testament to their mission as a publisher of high quality, innovative material. I deeply thank my editor, Karen Maloney, for all of her support.

I welcome all questions, criticisms, and suggestions. I hope my mistakes and deficiencies in exposition do not prevent you from helping your students learn.

Humberto Barreto  
hbarreto@depauw.edu  
Greencastle, Indiana

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The idea for the electronic spreadsheet came to me  
while I was a student at the Harvard Business  
School, working on my MBA degree, in the spring  
of 1978.

Dan Bricklin

## *Software Requirements and Opening a Macro-Enhanced Workbook*

The materials in this book will work on any Windows Excel version all the way back to 1997 (version 8). The workbooks and add-ins were created and are optimized for use with Windows Excel, but they can be accessed with a Macintosh computer. Microsoft removed Visual Basic from Mac Excel 2008, but reversed that decision in Mac Excel 2011 so this version should work. Solver in Mac Excel 2011 remains as temperamental as ever. The best solution for Mac users is to emulate Windows with software such as Parallels or Boot Camp. For on campus users, accessing Excel from a server (see, for example, VMWare's Horizon View client) is an easy solution for Mac users. This is my default method for enabling students with Macs and tablets to access the files.

To ensure that older versions of Excel can open these files, workbooks have been saved in "compatibility mode" (Excel 97 – 2003 Workbook) with the .xls filename extension. In Excel 2007 (version 12) or greater, be sure to save the workbooks as .xls files or in the special "excel macro-enabled workbook" format, which carries the .xlsm extension. If you save the workbook as an Excel workbook with the .xlsx extension, the macros will not be saved and functionality will be lost.

There was a substantial jump from Excel 2003 to Excel 2007. The interface was radically rearranged, with the Ribbon replacing menus and toolbars, while under the hood the charting engine was completely overhauled and the maximum size of a sheet was increased to

1,048,576 (2<sup>20</sup>) rows by 16,384 (2<sup>14</sup>) columns. The instructions in the files refer to Excel 2007 and greater versions, utilizing the Ribbon. The screencasts were made with Excel 2010 (version 14) and Excel 2013 (version 15), but other versions are similar enough that you can figure out what to do and the files will work on any version that utilizes Visual Basic. (You probably did not notice, but Excel 2007, version 12, was followed by Excel 2013, version 14. It turns out that Microsoft decided to skip version 13 because it is an unlucky number.)

For non-English versions of Excel, the files will work in the sense that buttons, scroll bars, and macros will function; however, the add-ins and other content will not be translated. Fortunately, you can easily add text boxes or other explanatory text in cells, as needed.

Finally, while OpenOffice did not provide much of a challenge, Google Docs caught Microsoft's attention. OneDrive.com and Office365.com offer cloud alternatives to traditional installation of software on your machine. Regrettably, as of this writing, because of security concerns, they do not support Visual Basic, a limitation which renders these options useless for working with these macro-enhanced files from within a web browser. You can save a file with macros in your favorite storage area in the cloud, but you will need to download and open it with desktop Excel to run the macros. Within a browser, macros cannot be executed.

#### *Accessing and Using the Excel Workbooks:*

Visit [www.depauw.edu/learn/macroexcel](http://www.depauw.edu/learn/macroexcel) to download the files that accompany this book. You may download files as needed, to as many different computers or devices as needed. For security and efficiency in transmission (some are quite large and should not be emailed), it is best if you send links to students and colleagues to screencasts and Excel workbooks.

Figure 1 shows that, when opening a workbook with macros, Excel will alert you to their presence with a security warning under the Ribbon (and right above the formula bar).

Click *Enable Content* to allow the buttons and other controls in the workbook to function properly. You may also be asked if you want to enable editing on the file—you should accept this offer.

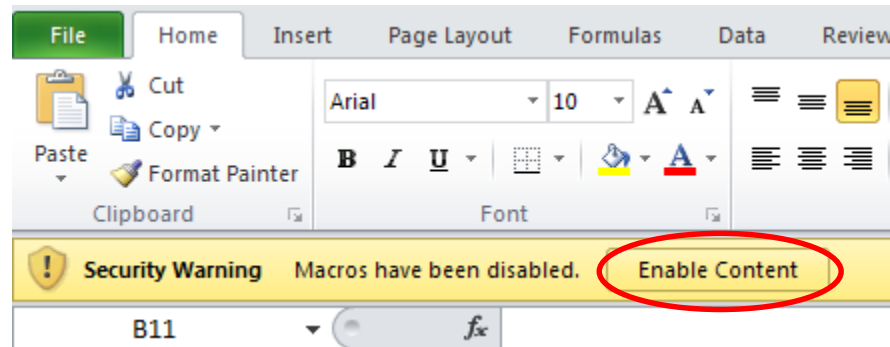


Figure 1: Opening a workbook with macros in Excel 2013.

If you do not see the security warning or have no opportunity to enable content, your security level has been set to block all files with macros. Although malicious code can be harmful, you must dial down the safety measures to allow Excel to utilize fully the information in the workbook. Close the file and change the security setting to allow Excel to open files with macros. In Excel 2010 and 2013, open the *Excel Options* dialog box (execute File → Options). Click *Trust Center* and then the *Trust Center Setting* button. In the *Trust Center* dialog box, click *Macro Settings* and select *Disable all macros with notification*. Click *OK* twice to return to Excel and reopen the file, which should now offer the enable content option displayed in Figure 1.

If buttons or other controls do not work, the first thing to check is to make sure that you have enabled macros. Another simple fix for many problems is to quit Excel and start over. Visit the website at [www.depauw.edu/learn/macroexcel](http://www.depauw.edu/learn/macroexcel) to see a list of problems and solutions. Contact me and I will do my best to help you. If you get a Visual Basic error, click *Debug* and carefully note the text in the yellow-highlighted line—this is the where the code crashed and where the search for a fix begins.

The screencast links embedded in the workbooks do not require any special software or other preparation. Simply click on a link and the user's default browser is used to display the video, streamed from vimeo.com. A complete listing of all screencasts, organized by workbook, is available at [www.depauw.edu/learn/macroexcel/screencasts](http://www.depauw.edu/learn/macroexcel/screencasts). Links can be sent via email or placed on your course web page.

### *Modifying Visual Basic Code*

Although the macros in the workbooks are meant to be simply run by button clicks, they can be viewed and modified. Most users would never have occasion to examine the code, but if you are able to read and write in Visual Basic, all of the macros are open and accessible.

Of course, the code from any button (or other object such as a scroll bar) can also be accessed via right-clicking and editing the assigned macro. It is not expected that a student or professor would need to modify a macro, but the potential is there. Examining the code in these workbooks can be an excellent way to learn Visual Basic.

### *Sources and Further Reading*

For more on the history of the electronic spreadsheet, as told by one of the creators, see [bricklin.com/visicalc.htm](http://bricklin.com/visicalc.htm). This is the source for the epigraph.

On Microsoft skipping version 13: "In December 2006, Eric Vigesaa, Program Manager for Office system client applications, stated during a TechNet radio chat: '13 is unlucky, so we're calling it Office 14.'" [www.neowin.net/news/office-14-slated-for-a-20092010-release](http://www.neowin.net/news/office-14-slated-for-a-20092010-release).

Visit [office.com](http://office.com) to determine your version number, download updates, and more.

I recommend these websites for Excel tips and tricks, workbook and add-in downloads, and Visual Basic code snippets:

- Ron de Bruin: [www.rondebruin.nl](http://www.rondebruin.nl)
- Charley Kyd: [www.exceluser.com](http://www.exceluser.com)
- Tushar Mehta: [www.tushar-mehta.com/excel](http://www.tushar-mehta.com/excel)
- Chip Pearson: [www.cpearson.com/excel](http://www.cpearson.com/excel)
- Jon Peltier: [peltiertech.com/Excel](http://peltiertech.com/Excel)
- Andy Pope: [www.andypope.info](http://www.andypope.info)

At this stage of the argument the general public, though welcome at the debate, are only eavesdroppers at an attempt by an economist to bring to an issue the deep divergences of opinion between fellow economists which have for the time being almost destroyed the practical influence of economic theory, and will, until they are resolved, continue to do so.

John Maynard Keynes

## *0. Introduction: Why Simulation and Excel?*

This book is meant to be read and used by professors and economists. It assumes familiarity with economic theory and data analysis so it will not make sense to a student or beginner. It is a manual for utilizing teaching materials that are available on the web at [www.depauw.edu/learn/macroexcel](http://www.depauw.edu/learn/macroexcel). It is assumed that the professor has a favorite textbook or readings which neither this book nor the online files will replace. Instead, delivery of content via Microsoft Excel® will supplement and improve the teaching and learning process.

After explaining what is available and how to use it, this introduction presents a pedagogical argument in favor of simulation and Excel. Much of our teaching in economics is based on how we were taught and what we feel works, but advances in neuroscience make clear that many of our strategies and methods are flawed.

### *Excel Files and Screencasts*

Professors who use these materials will have their students work with two types of resources: Excel files and screencasts (video recordings of the computer screen with audio narration). The Excel files include macro-enhanced workbooks that contain everything students need, including a *ToDo* sheet with links to screencasts and tasks (i.e., questions) to enable assessment. In addition, Excel add-ins, special files that extend the functionality of Excel, are provided.

Each chapter in this book lists the workbooks and screencasts available with a brief description providing a quick overview of the content and enabling professors to zero in on appropriate material. Each chapter begins with a section on common student problems and recommendations for ways to minimize confusion. The rest of the chapter is then devoted to more detailed description of the content in the workbooks and screencasts, answers to tasks, and suggestions for teaching.

The pedagogical principle behind the Excel workbooks and screencasts is that of strongly guided instruction via worked examples. The screencasts are meant to be viewed with Excel open so that each step can be replicated. The video can be paused or repeatedly replayed as often as needed. Some tasks are easy, requiring simple replication, while others do more than simply repeat the screencasts by asking the student to extend a result or consider a related, but different scenario.

#### *How to Provide Students with Files*

The easiest way to deliver a workbook or screencast to students is to send an email with the link. For example, suppose someone is having trouble creating a chart in Excel. Visit the *Teaching Macro with Excel* website at [www.depauw.edu/learn/macroexcel](http://www.depauw.edu/learn/macroexcel) and go to the *Screencasts* page. Right-click the first screencast and copy the link address ([vimeo.com/econexcel/how-to-chart-in-excel](https://vimeo.com/econexcel/how-to-chart-in-excel)). Paste the link in an email and send it. When the student receives the email and clicks on the link, he or she will go directly to the screencast.

This same procedure can be used to send an Excel workbook: right-click any file in the *Excel Workbooks* page of the *Teaching Macro with Excel* website, copy the address, and paste it in an email. When the recipient clicks on the link, the workbook will be downloaded and opened in Excel.

Links to workbooks and screencasts from a course management system (e.g., Moodle or Blackboard) or class web pages are another way to deliver files to students. In addition, Excel workbooks may be downloaded and saved on network drives, course folders, or other locations

where students have access. Finally, the link to the website itself, [www.depauw.edu/learn/macroexcel](http://www.depauw.edu/learn/macroexcel), can be shared with students and colleagues.

### *How to Teach with these Resources*

There are several ways for professors to use these materials. You can view the videos in a workbook, practice and perfect the tasks on your own, then project the file in class and incorporate it into your lecture. In a lab setting, the entire class could watch a video, after which you could provide personalized support as students work on specific tasks on their own. You can also simply distribute a workbook to your students (via a link in an email or by providing the workbook itself on a network drive) and have them view the screencasts and complete assigned tasks as homework. A truly radical idea would invert the classroom—assign a workbook so that students view and replicate the screencasts as homework, then have them come to class to do the tasks with your help and support. I did this in the spring of 2014 and I offer handouts, teaching notes, and exams online at [www.depauw.edu/learn/macroexcel](http://www.depauw.edu/learn/macroexcel).

The files can be projected in class as part of a lecture, used in lab settings, or assigned as homework, but they do not replace a textbook or professor. The Excel files are meant as complements, not substitutes, to a traditional book and the professor is responsible for picking and choosing which workbooks to use as supplements, as well as when and how to use them. This printed book offers guidance and information to help you make these pedagogical decisions. It has suggestions on how to teach the material and use the files. It also points out where and how students might struggle with concepts or in using Excel.

### *ToDo Sheet Task Answers*

Each workbook has a list of questions in a *ToDo* sheet which require students to replicate aspects of a screencast and apply a concept or test a claim. These tasks vary in difficulty and are described in this printed book.



There is no master answer key to the tasks, but some answers are provided in concealed sheets in the workbooks, which can be revealed by running the *ToggleHideUnhide* macro using any of these three methods: (1) from the Developer tab, click Macros, or (2) press Alt-F8, and select the *ToggleHideUnhide* macro and click Run; or (3) use the keyboard shortcut *Ctrl-Shift-u*. These answer sheets cannot be seen by simply viewing the hidden sheets in the workbook because they are given the special property of being *VeryHidden* and can only be revealed by running the macro. The code, however, is not password protected so a student expert in Visual Basic could access these sheets. This seems highly unlikely, but if this concerns you, reveal and delete the answer sheets before distributing the workbook. Answers to some tasks, along with tips for easy grading, are described in this book. Sometimes the question is so obvious that no answer is provided.

### *Why Simulation?*

All of the workbooks rely on using Excel to create concrete illustrations and strong visual displays of theoretical concepts. Models and theories are implemented in Excel and simulation is used to explore and explain properties and behavior. This is the fundamental advantage of teaching with a spreadsheet. Instead of a dead graph that has been prepared by someone else, Excel enables students to change a parameter and instantly observe its effect on endogenous variables. The ability to control which exogenous variable is manipulated and see the results on screen as a shift of or movement along a curve is key to the learning process. The student creates relationships between variables and can literally see theoretical connections that used to require difficult abstract thinking. They can also perform an endless series of experiments with random parameters, discovering and exploring comparative statics properties.

There is perhaps no better example of the power of simulation and visual presentation than the Solow Model. Its iterative, dynamic operation puts growth theory beyond the grasp of almost all undergraduate students. While a book can certainly show the model's solution in a Solow diagram, once technological progress is added so that the steady-state is displayed in terms of efficiency units, it is unreasonable to expect the typical undergraduate to be able to map the

solution to a graph of actual output or consumption over time. Excel can do this transformation quickly, with striking graphs that make clear how technological progress is the key to modern economic growth. Changing parameters and answering comparative statics questions enables students to truly understand the model. The easy access to data (population and GDP per capita) to calibrate the model and test theoretical predictions with real-world outcomes is icing on the cake.

In fact, I would argue that simulation should become part of every economist's teaching toolkit. Schmidt (2003) points out that there is a substantial literature on simulations, games, and experiments in the classroom and focuses on computerized simulations. After listing several benefits, Schmidt (2003, p. 154) turns to costs:

The instructor has to be able to install and run the simulation, and someone has to code the simulation.<sup>9</sup>

<sup>9</sup> Once written, however, the code can be easily shared with many different instructors. It would be desirable to have a central database of publically available simulation programs to facilitate sharing them.

Fortunately, because the simulation of the Solow Model is embedded in the Excel workbooks, the installation costs are negligible—simply download and open the workbook (enabling macros) and it is ready to go. As for the central database of simulation programs suggestion, visit “Teaching with Simulations,” available at [serc.carleton.edu/sp/library/simulations](http://serc.carleton.edu/sp/library/simulations), for an overview of simulation pedagogy and example applications.

Grossman (1999, p. 93) points out tangible advantages of teaching with simulation: “We find that performing queuing simulations in spreadsheets offers six benefits: explicitness, immediacy, insight, flexibility, active modeling, and accessibility. These benefits apply not only to students, but also to instructors with expertise in queuing theory.” Each of these benefits has a common root—it reduces abstraction. This is the core, pedagogical trump card of simulation and explains why teaching with spreadsheet implementations of models is so effective.

## *Why Excel?*

Even if one accepts that simulation is a powerful teaching tool, there is still the issue of the appropriate software to use. The choice set is large, from open source spreadsheets to R to Java applets or other browser-based implementations to high-end mathematical packages such as *Matlab* and *Mathematica*. Barreto (2015) makes the case that Excel is “just right,” not too easy so that anyone can master it and not too hard so it does not require large start-up investment.

A moment’s reflection should convince you of the latter claim. Students have experience with Excel and are quite comfortable with it. They can add and subtract cells and use formulas to compute sums and averages. You can tell any student to type “=RAND()” in a cell and hit F9, thereby instantly producing a random number generator. There is no programming needed. Of course, in a macro-enhanced workbook, they can click buttons and scroll bars to change variables and immediately see the updated display.

But there is a world of Excel knowledge beyond the rudimentary skills of the typical student. It is in acquiring advanced skills and mastery that Excel proves to be the optimal software choice. Charting provides a good example. Although most students can select data and create a chart, they must be taught how to properly label it and there are many additional charting features that they can apply (as described in the next chapter). Learning how to use advanced Excel functions, installing and managing add-ins, and analyzing data is the level of proficiency that is not easily attained and which employers keenly desire. By learning economics via Excel, the student is also acquiring valuable skills in Excel. They are aware of this value and are willing to work hard, certainly much harder than in a standard chalk-and-talk course. For the professor interested in maximizing student learning, this may be the best reason of all to use Excel.

## *Conclusion*

You would think that professors know how students learn, but just like everyone else, we hold onto incorrect beliefs and our intuition can lead us astray. For example, Brown, et al. (2014) point out that most people believe cramming is an effective method because it feels like hard

work. In fact, interleaved practice and spacing the material is vastly superior to repeating the same thing. Experiments have consistently shown that shooting a basketball from different areas or throwing different pitches is far better than shooting from the exact same place or throwing the exact same pitch for an entire practice.

Similarly, you might think that Excel is a big distraction that necessarily subtracts from economics content. After all, if the brain is a reservoir of fixed size, then Excel crowds out economics. This zero sum model is completely wrong. When it comes to learning, bombarding the mind with many sensory inputs is much better than a single channel. This is why listening to a lecture passively is inferior to listening and taking notes, which in turn is inferior to working with a computer (with its additional stimuli). The natural sciences take this to another level when students do lab work—now they are actively moving their hands and using all of their senses so their brains are making all kinds of connections.

The physical processes involved in learning, encoding information so it can be retrieved and used later, is complicated. Medina (2008, p. 104) says, “The little we know suggests that it is like a blender left running with the lid off. The information is literally sliced into discrete pieces as it enters the brain and splattered all over the insides of our mind.” When you look at a graph, your brain performs a series of remarkable steps. Lines are separated from curves and stored in different areas of the brain. Colors, numbers, sound, motion, and other information of what we see, hear, feel, smell, and taste are distributed all throughout the brain. What neuroscientists call the binding problem, i.e., how the brain manages and reconstructs all of these bits of data, is the focus of intense research.

With this model of the brain, it makes sense that multiple inputs entrench information more deeply and give more hooks for retrieval. A lecture on the Solow Model with a homework assignment one day that is followed by a screencast and in-class problem session and then a computer-lab meeting is better than three lectures on the same material. We exclusively lecture because it is low cost, not because it maximizes learning.

Augmenting your classroom with Excel (and other ways of delivering content) is sure to improve your teaching and how much your students learn. This book gives you the opportunity

to incorporate Excel into your curriculum with little effort. The material is modular so you can pick and choose what to use. You can also vary how you utilize the files, from displaying them in a lecture, to assigning as homework, or working together in a computer lab, or flipping the classroom. Experimentation and change are the keys to successful teaching. This book offers a low cost way to try out new ways to teach economics.

### *Sources and Further Reading*

The epigraph is from the preface to Keynes, J. M. (1936). *The General Theory of Employment, Interest and Money*. Full text online at [www.marxists.org/reference/subject/economics/keynes/general-theory](http://www.marxists.org/reference/subject/economics/keynes/general-theory).

On simulation as a teaching tool:

Grossman, T. (1999). "Teachers' Forum: Spreadsheet Modeling and Simulation Improves Understanding of Queues," *Interfaces* (29:3), pp. 88-103.

Schmidt, S. (2003). "Active and Cooperative Learning Using Web-Based Simulations," *The Journal of Economic Education* (34:2), pp. 151-167.

For a review of spreadsheets in the teaching of economics and a detailed argument in favor of Excel:

Barreto, H. (2015). "Why Excel?" *The Journal of Economic Education* (46:3), pp. 300-309. [www.tandfonline.com/doi/abs/10.1080/00220485.2015.1029177](http://www.tandfonline.com/doi/abs/10.1080/00220485.2015.1029177)

The lessons of modern neuroscience with respect to learning make for interesting and helpful reading for professors and advisers:

Brown, Peter C., Henry L. Roediger, and Mark A. McDaniel (2014). *Make it Stick: The Science of Successful Learning*, The Belknap Press of Harvard University Press.

Medina, John M. (2008). *Brain Rules: 12 Principles for Surviving and Thriving at Work, Home and School*, Pear Press.