Enhancing Teaching using MATLAB Add-ins for Excel

Paul V. Hamilton
Visiting Assistant Professor of Economics
DePauw University
Greencastle, IN 46135
PVHamilton@DePauw.edu

Introduction

In this paper I will illustrate how to extend the capabilities of Microsoft Excel spreadsheets with add-ins created by MATLAB. Excel provides a broad array of fundamental tools but often comes up short when more sophisticated scenarios are involved. To overcome this short-coming of Excel while retaining its ease of use, I will describe how MATLAB's Excel-Builder converts MATLAB functions into Excel macros. The add-ins can be freely distributed and operate solely from Excel. To demonstrate the utility of add-ins, I will describe a project that I am currently working on in Excel that could be enhanced with the add-ins to carry out more sophisticated scenarios. The project deals with the question of when a person approaching retirement age should begin accepting social security.

Mathwork's Excel-Builder

MATLAB is a powerful software suite that is popular in mathematics, the sciences, and especially in economics and engineering/technical programs. Comparable products are Gauss, Mathmatica, and SAS although these products do not have the ability to create stand-alone add-ins as does MATLAB. I would envision that the type of project that will be discussed in this paper would be most useful for a discipline (or school) where the emphasis is not on programming. Engineering programs typically expect their students to interact directly with MATLAB and thus do not need the add-in capabilities. In my discipline of economics, many professors will have been introduced to this program in graduate school for computational models. Those who continue to work with the program in their research will find a new area to apply and hone their programming skills. At the same time, students who are interested in computational issues can have an indirect access to much more powerful and interesting programs.

MATLAB has specific 'toolboxes' devoted to programs in statistics, mathematics, genetics, and various engineering areas among many more. A professor teaching an introductory statistics class can easily run into the need for a more advanced function than in provided in Excel. For example, she may want to generate multivariate data that is correlated across several variables. A savvy professor (who remembers Cholesky decompositions) with a lot of time on their hands (an afternoon) could program this into Excel using Visual Basic. I suspect most of us we take the easier path of converting the MATLAB function to an add-in. This might take 15 minutes for someone who is familiar with the Excel-Builder.

The software is not inexpensive as a student version of MATLAB costs around $100 and the Excel-Builder retails for $500 although academic discounts are available (including a free 30-day trial on all MATLAB software for professors). Many schools will already have the core program and could add the peripheral programs with a reasonable amount of extra cost. In general a site

license should not be mandatory as it is unlikely that more than one user would need the Excel-Builder component at any one time.

For specific instructions and examples of the necessary steps to use the Excel-Builder, I refer the interested reader to the Mathworks site (www.mathworks.com). A free, downloadable pdf file contains the manual and the site also gives some fascinating applications in finance and other areas. The learning curve is rather steep for moderate to difficult applications (some include designing an graphical user interface using Visual Basic) but the simpler applications of converting a single m-file to an Excel add-in are not overly complicated to master. It took me an afternoon to figure out the fundamental steps.

The Dilemma: When to accept social security?

Each year the Social Security Administration sends a statement to individuals detailing their work and salary history. Additionally it includes a summary of the benefits of social security including how much your social security checks will be once you decide to accept and other items such as your benefits if you become disabled or your survivor benefits. The project that I have been recently working with for a class, asks the question, "When should I begin to accept social security checks?" Most people abide by one of two general approaches. The first follows the principal that 'a bird in the hand is worth two in the bush'. They take early retirement (although they could continue to work) at 62. There are some obvious benefits to accepting ASAP as this strategy will dominate for individuals who are 'cash-constrained' (e.g. they have little or no wage income) and/or have a relatively short life-expectancy. If you are only going to live into your early 70's, it may be worth it to draw a smaller payment for a decade rather than a larger check but only for a few years. This points out an important aspect of social security that, unlike private pensions, it is a defined benefit program not a defined contribution program. When you die your family will receive a "special one-time death benefit of $255". All future payments are forfeited!

A second strategy is the patient one – wait until 70 to receive your maximum size checks. Each year the SSA bumps up the check size for all ages of retirement but this merely reflects a cost-of-living allowance (COLA) that covers inflation. In contrast the person who can hold off on receiving social security receives a check that is roughly twice that of the person who retired at age 62. They receive this fatter check the remainder of their lifetime. The person who does not need extra income in their 60's and expects to live beyond the average life-expectancy due to good health, genes, lifestyle, or luck benefits for the patient strategy.

A third strategy (the one I favor) is to wait until full retirement age to begin benefits. The real hit in taking benefits before this is that prior to the year of full retirement your benefit levels are reduced $1 for every $2 you received in wage income above $11,280 (2002 level). It doesn't take a high-paying job to entirely cancel your social security benefit. Of course, if you have a low-paying or part-time job this problem will not arise. Even in the year of your retirement, you can only make $30,000 before your benefit is reduced $1 for every $3 you are above this limit.

Scenarios in Excel Spreadsheets

In the study I focus on a married couple who file their taxes jointly and are of the same age. Other living arrangements are easily analyzed within this framework. I begin with a barebones Federal Income Tax 1040 form:

		<65, w/oSS	<65, w/SS	65+, w/o SS	65+, w/ SS
Line	Description				
7	**Wages, salaries, tips**	**50000**	**50000**	**50000**	**50000**
8a	Taxable Interest	0	0	0	0
9a	Ordinary dividends	0	0	0	0
15b	Taxable IRA distributions	0	0	0	0
16b	Taxable Pensions and annuities	0	0	0	0
20b	Taxable Social Security benefits	0	22213	0	22213
34	Adjusted Gross Income	50000	72213	50000	72213
37	Itemized or standard deduction	9500	9500	11400	11400
38	AGI – deduction	40500	62713	38600	60813
39	Exemptions deduction	6100	6100	6100	6100
40	Taxable Income	34400	56613	32500	54713
41	**Federal Income Tax**	**4460**	**7792**	**4175**	**7507**

I have included only those lines that are most prominent in the analysis. [Please consult your tax accountant of financial advisor for a complete analysis!] The cells are formula-based such that by changing the first wage & salary cell, all other cells are automatically updated. Social security benefits are not income + one-half of the social-security benefit is less than $32,000 per year. The maximum taxable amount is 85% of the benefit that is attained when income + one-half the social security benefit reaches $44,000.

Part of the motivation of this study was based on my father approaching his early 60's and thinking about when to receive social security. There are a multitude of issues ranging from the purely tax issues to the complex lifestyle changes that can accompany the move from the workforce to living room. The next page lays out the three general scenarios – early retirement at age 62, normal retirement (65 years, 8 months for some one born in 1941) and 'late retirement' at age 70.

Retirement age #1 = 62										
Age	62	63	64	65	66	67	68	69	70	71+
Work Income	$50,000	$50,000	$50,000	$50,000	$50,000	$25,000	$25,000	$25,000	$25,000	$0
SS Benefits (gross)	$14,544	$14,544	$14,544	$14,544	$14,544	$14,544	$14,544	$14,544	$14,544	$14,544
Reduction of SS benefits due to work income	-$14,544	-$14,544	-$14,544	$0	$0	$0	$0	$0	$0	$0
SS Benefits (net)	$0	$0	$0	$14,544	$14,544	$14,544	$14,544	$14,544	$14,544	$14,544
Federal Tax w/o SS benefits	$4,460	$4,460	$4,460	$4,175	$4,175	$750	$750	$750	$750	$0
Federal Tax w/ SS benefits	$4,460	$4,460	$4,460	$6,029	$6,029	$764	$764	$764	$764	$0
Additional taxes due to SS benefits	$0	$0	$0	-$1,854	-$1,854	-$14	-$14	-$14	-$14	$0
Retirement age #2 = 65.67										
Age	62	63	64	65	66	67	68	69	70	71+
Work Income	$50,000	$50,000	$50,000	$50,000	$50,000	$25,000	$25,000	$25,000	$25,000	$0
SS Benefits (gross)	$0	$0	$0	$6,556	$19,668	$19,668	$19,668	$19,668	$19,668	$19,668
Reduction of SS benefits due to work income	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
SS Benefits (net)	$0	$0	$0	$6,556	$19,668	$19,668	$19,668	$19,668	$19,668	$19,668
Federal Tax w/o SS benefits	$4,460	$4,460	$4,460	$4,175	$4,175	$750	$750	$750	$750	$0
Federal Tax w/ SS benefits	NA	NA	NA	$5,011	$6,683	$892	$892	$892	$892	$0
Additional taxes due to SS benefits	NA	NA	NA	-$836	-$2,508	-$142	-$142	-$142	-$142	$0
Retirement age #3 = 70										
Age	62	63	64	65	66	67	68	69	70	71+
Work Income	$50,000	$50,000	$50,000	$50,000	$50,000	$25,000	$25,000	$25,000	$25,000	$0
SS Benefits (gross)	$0	$0	$0	$0	$0	$0	$0	$0	$26,148	$26,148
Reduction of SS benefits due to work income	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
SS Benefits (net)	$0	$0	$0	$0	$0	$0	$0	$0	$26,148	$26,148
Federal Tax w/o SS benefits	$4,460	$4,460	$4,460	$4,175	$4,175	$750	$750	$750	$750	$0
Federal Tax w/ SS benefits	NA	NA	NA	NA	NA	NA	NA	NA	$1,054	$0
Additional taxes due to SS benefits	NA	NA	NA	NA	NA	NA	NA	NA	-$304	$0

The user can enter the age they are (or are interested in studying) and the benefit levels provided by the SSA in the annual statement ($1212, $1639, and $2179 per month respectively for this individual). The Excel spreadsheet then calculates the gross SS check less penalty for wage income before full-retirement age and adds any extra tax liability occurring due to the extra support provided by social security.

It turns out the early retirement for this person is not a good idea as they make enough income working full-time to completely cancel their social security benefit. It thus appears that anyone earning more than around $40K should not take early-retirement. Waiting until full-retirement age avoids this issue completely which is the intent (I believe) of the law. The patient retiree who continues to work is rewarded with a $26,148 annual salary from age 70 until their death. Note that I have stated all dollar amounts in real terms (e.g. I have assumed inflation will be zero over this decade). In practice we will, of course, have some inflation but the COLA will offset this to retain the same buying power of the checks.

To get at the core of the timing issue I have calculated the cumulative SS payments less any tax disadvantage for the three scenarios.

Age	Retire @ 62	Retire @65.67	Retire @ 70
62	$0	0	0
63	$0	0	0
64	$0	0	0
65	$12,690	$5,720	0
66	$25,380	$22,880	0
67	$39,910	$42,406	0
68	$54,440	$61,932	0
69	$68,970	$81,458	0
70	$83,500	$100,984	$25,844
71	$98,044	$120,652	$51,992
72	$112,588	$140,320	$78,140
73	$127,132	$159,988	$104,288
74	$141,676	$179,656	$130,436
75	$156,220	$199,324	$156,584
76	$170,764	$218,992	$182,732
77	$185,308	$238,660	$208,880
78	$199,852	$258,328	$235,028
79	$214,396	$277,996	$261,176
80	$228,940	$297,664	$287,324
81	$243,484	$317,332	$313,472
82	$258,028	$337,000	$339,620
83	$272,572	$356,668	$365,768
84	$287,116	$376,336	$391,916
85	$301,660	$396,004	$418,064

Note that the first scenario dominates for only a few years (up to age 66). Retiring at 65 years, 8 months proves to be the best option all the way up to age 82. This looks only at non-compounded amounts; if the person valued having the money earlier rather than later a growth factor will push the middle-scenario into the mid-80's range before the patient-strategy catches up.

Extensions using MATLAB's Excel-Builder

The current model is able to provide significant insight into the retirement timing decision. However other simulations would be fruitful to explore that go beyond Excel's capabilities. For example, it is of interest for a person to know the distribution of the total payouts depending on the probabilities of survival to various ages. The SSA publishes a life-table that could be used to generate random 'end-of-life' scenarios with associated payouts. We could then address questions such as "How often could I expect to live to 90+ and enjoy the higher checks associated with 'late-retirement'?"

Currently I am working on implementing this and other extensions into the model. I would be more than willing to send the Excel file and the related MATLAB add-ins as they are developed. Please contact me for more information or any suggestions you have to better address the retirement timing dilemma.