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FINANCIAL LITERACY AND ENGAGEMENT IN BANKING

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Irwan Trinugroho, Universitas Sebelas Maret

ABSTRACT

Financial literacy has been a global issue as it is widely considered that financial literacy is important for economic growth. In this paper, we investigate the impact of financial literacy on banking engagement by employing aggregate data at sub-district level in a province in Indonesia. It is expected that the higher the level of financial literacy could lead to more households' engagement in formal financial institutions, more specifically in banking. According to some previous studies, we use the index of financial literacy adjusted to the specific setting of the country. As expected, after controlling for some factors, we do find that financial literacy is positively associated with the level of engagement in banking. Policy recommendations are provided.

Keywords: *Financial literacy, Households, Engagement in Banking, Formal financial institutions, Indonesia*

INTRODUCTION

It has been widely considered that access to finance is important especially to the deficit spending people (Karsidi et al., 2015). A well distributed access to finance is positively correlated with economic growth as the financing could be optimized for innovation and other productive activities (King and Levine, 1993; Rajan and Zingales, 2003). However, as we have seen, access to formal financial institution is quite imbalanced particularly for the poor. In Indonesia, the fourth most populous country, according to the 2013 national survey, only 59.7% of adult people have access to formal financial institutions (financial inclusion). Santoso et al. (2015) argue that the level of financial inclusion could be explained from the demand and supply side. On the demand side, the level of financial inclusion is mainly determined by economic security, while on the supply side, the reluctance of formal financial institutions to channel loans to poor people and micro, small and medium enterprises (MSMEs)¹ contribute to determine the level of financial inclusion (Rosengard and Prasetyantoko, 2011).

In this paper, we argue that engagement of poor people to the formal financial institutions, more specifically banks is mostly driven by how financially literate they are as it is generally considered that financially poor people are associated with lower level of financial literacy (Cameron et al., 2014). Financial literacy is defined as the “a combination of awareness, knowledge, skill, attitude and behavior necessary to make sound financial decisions and ultimately achieve individual financial wellbeing” (Atkinson and Messy, 2012). Some contend that financial literacy is important especially with regards to knowledge and accessibility to financial product (Cameron et al., 2014). Low level of financial literacy might not be sufficient to ensure that households make appropriate financial decisions (Calcagno and Monticone, 2015). Subsequently, financial literacy could improve the participation in the financial markets (Lusardi, 2008; Santoso et al., 2015). The Indonesian government, under the Indonesia financial supervisory agency (OJK), has also declared a national campaign program

to accelerate the level of financial literacy².

The present paper therefore investigates the impact of financial literacy on banking engagement. We study the financial literacy and its impact on engagement of poor people to formal financial institutions aggregately at the sub-district level³ instead of at the individual or household level. Arguably, the more financially literate the society, it would lead to more engagement in formal financial institutions. Engagement in the formal financial institutions could be considered as a part of financial inclusion program which has become a global initiative.

RESEARCH METHODS

To study the link between financial literacy and engagement in banking, we use aggregate data of 78 sub-districts of 5 districts in a province in Indonesia (the Special Province of Yogyakarta). Information comes from primary and secondary data. The primary data which is the degree of financial literacy and banking engagement of poor people are gathered from the survey conducted by Bank Indonesia using in-depth interview to the head of households (Santoso et al., 2015). However, instead of working on household's level, our study focuses on the aggregate data at sub-district level. The secondary data such as the number of banks in the sub-district, number of cooperation in the sub-district, population of sub-district, number of industry in sub-district and the degree of ruralness are collected from various sources mainly from the Statistics Central Bureau (BPS).

As explained earlier, our dependent variable is the engagement in banking, while, financial literacy is main determinant variable. We include a number of variables to explain the variation in engagement in banking between sub-districts which are the ratio of population per bank, the number of bank, and the ratio of cooperation to control for the availability of the supply side. We also take into account the characteristic of sub-districts which is number of industries exist in the sub-district which can be considered to represent the economic condition of a sub-district. Another characteristic of sub-district that we include in our model is the degree of ruralness of sub-district following the work of Santoso et al. (2015). Finally, we control for district fixed effects by including a vector of dummy variables representing sub-districts.

As the data is typically cross-sectional, we run the empirical models presented below using the ordinary least square (OLS):

$$ENGAGEMENT_i = \alpha_0 + \alpha_1 LITERACY_i + \alpha_2 POP_BANK_i + \alpha_3 POP_COOP_i + \alpha_4 LN_INDUSTRY_i + \alpha_5 RURALNESS_{i,t} + DISTRICTS + \varepsilon_{i,t} \dots \dots \dots (1)$$

$$ENGAGEMENT_i = \alpha_0 + \alpha_1 LITERACY_i + \alpha_2 N_BANK_i + \alpha_3 POP_COOP_i + \alpha_4 LN_INDUSTRY_i + \alpha_5 RURALNESS_{i,t} + DISTRICTS + \varepsilon_{i,t} \dots \dots \dots (2)$$

where i represents the sub-district. $LITERACY$ is the financial literacy index. $ENGAGEMENT$ is the index of engagement in banking. POP_BANK is the ratio population of sub-district to number of bank in the sub-district. POP_COOP is the ratio population of sub-district to number of cooperation in the sub-district. N_BANK is the number of bank in sub-district. $LN_INDUSTRY$ is the logarithm natural of number of industry in sub-district. $RURALNESS$ is the degree of ruralness of a sub-district. $DISTRICTS$ represents a vector of district (municipal) dummies. We estimate the empirical model in equation 1 and 2 using OLS regression.

EMPIRICAL RESULTS

We investigate the impact of the level of financial literacy on the extent to which poor people engage with formal financial institutions using data at sub-district level. Table 1 exhibits the descriptive statistics of variables. The mean of engagement index and financial literacy index are 5.415 and 4.318, respectively. The average ratio of population per bank is 8,591 people per bank, while the average ratio of population per cooperation is 4,559 people per cooperation. The average (median) number of bank within a sub-district is 8.081 (5.5). Table 2 presents the correlation matrix of variables. As expected the engagement index and financial literacy index is significantly and positively correlated which means that the higher the degree of financial literacy, it would lead to the higher engagement in banking.

We run two empirical models (equation 1 and 2) by employing OLS. The results of our regressions are presented in Table 3. As population per bank (POP_BANK) and number of bank (N_BANK) is highly correlated, we do not introduce these two variables in the same model to avoid multicollinearity bias. Column 1 of table 3 is the result when we use the population per bank, while column 2 of table 3 presents the result if we employ the number of bank.

Table 1
DESCRIPTIVE STATISTICS OF VARIABLES

This table presents the descriptive statistics of variables. ENGAGEMENT is index of engagement of poor households in banking. LITERACY is the financial literacy index. POP_BANK is the ratio population of sub-district to number of bank in the sub-district. POP_COOP is the ratio population of sub-district to number of cooperation in the sub-district. N_BANK is the number of bank in sub-district. LN_INDUSTRY is the logarithm natural of number of industry in sub-district. RURALNESS is the degree of ruralness of a sub-district. DISTRICTS represents a vector of district (municipal) dummies.

	engagement	literacy	pop_bank	pop_coop	n_bank	ln_industry	ruralness	bantul	gunungkidul	kulonprago	sleman	yogya
Mean	5.415	4.318	8.592	4.559	8.081	5.811	1.481	0.203	0.216	0.162	0.230	0.189
Median	5.404	4.436	6.976	3.590	5.500	5.773	1.400	0.000	0.000	0.000	0.000	0.000
Maximum	9.125	8.143	30.035	16.960	34.000	8.249	2.000	1.000	1.000	1.000	1.000	1.000
Minimum	0.750	0.273	1.090	0.565	1.000	2.944	1.000	0.000	0.000	0.000	0.000	0.000
Std. Dev.	1.760	1.620	6.113	3.892	6.717	1.013	0.428	0.405	0.414	0.371	0.424	0.394
Skewness	-0.202	-0.250	1.488	1.280	1.653	-0.134	0.080	1.479	1.379	1.833	1.285	1.587
Observation	7	74	7	7	7	7	7	7	7	7	7	7

Table 2
CORRELATION MATRIX

This table presents the correlation matrix of variables. ENGAGEMENT is index of engagement of poor households in banking. LITERACY is the financial literacy index. POP_BANK is the ratio population of sub-district to number of bank in the sub-district. POP_COOP is the ratio population of sub-district to number of cooperation in the sub-district. N_BANK is the number of bank in

sub-district. LN_INDUSTRY is the logarithm natural of number of industry in sub- district. RURALNESS is the degree of ruralness of a sub-district. DISTRICTS represents a vector of district (municipal) dummies.

	engagem ent	literacy	pop_bank	pop_co op	n_bank	ln_indus try	ruralness	bantul	gunungkid ul	kulonpr ogo	sleman	yogya
ENGAGEM ENT	1.000											
LITERACY	0.142	1.000										
POP_BAN K	0.155	-0.342	1.000									
POP_COO P	-0.041	-0.252	0.489	1.000								
N_BANK	-0.221	0.089	-0.574	-0.278	1.000							
LN INDUS TRY	-0.086	-0.070	-0.029	0.136	0.142	1.000						
RURALNES S	0.031	-0.304	0.333	0.355	-0.414	0.029	1.000					
BANTUL	0.125	0.004	0.243	0.170	-0.087	0.305	-0.225	1.000				
GK	-0.028	-0.394	0.328	0.430	-0.203	-0.081	0.613	-0.265	1.000			
KP	-0.041	0.281	-0.171	-0.193	-0.088	0.025	0.400	-0.222	-0.231	1.000		
SLEMAN	-0.015	-0.163	-0.134	-0.026	0.297	0.036	-0.227	-0.275	-0.287	-0.240	1.000	
YOGYA	-0.044	0.320	-0.288	0.417	0.067	-0.290	-0.546	-0.244	-0.254	-0.213	-0.264	1.000

In the two regression results, as expected, we do find that financial literacy have positive and significant effect on engagement in banking. As argued by some previous studies (e.g. Cameron et al., 2014; Calcagno and Monticone, 2015) financial literacy could be considered to reflect the extent to which one has knowledge and skill regarding financial products. Therefore, those who are more financially literate may be more confident to come to bank and have relationship with such formal financial institution. It is in line with the finding of Karsidi et al. (2015) in which their respondents (those who borrow money from predatory lenders) explained that they are not confident enough to come to banks and perceive themselves as not bankable.

Table 3
REGRESSION RESULTS

This table presents the regression results. ENGAGEMENT is index of engagement of poor households in banking. LITERACY is the financial literacy index. POP_BANK is the ratio population of sub-district to number of bank in the sub- district. POP_COOP is the ratio population of sub-district to number of cooperation in the sub-district. N_BANK is the number of bank in sub-district. LN_INDUSTRY is the logarithm natural of number of industry in sub-district. RURALNESS is the degree of ruralness of a sub-district. DISTRICTS represents a vector of district (municipal) dummies. The values in parentheses are t-statistics. *, ** and

***indicate significance at the 10%, 5%, and 1% levels, respectively.

	ENGAGEMENT	ENGAGEMENT
Constant	3.034	4.301**
	(1.5513)	(2.145)
LITERACY	0.328**	0.310**
	(2.082)	(2.008)
POP_BANK	0.060	
	(1.397)	
N_BANK		-0.053
		(-1.394)
POP_COOP	-0.094	-0.065
	(-1.364)	(-1.004)
LN_INDUSTRY	-0.174	-0.178
	(-0.780)	(-0.821)
RURALNESS	1.182	0.768
	(1.155)	(0.687)
BANTUL	0.845	1.102
	(1.031)	(1.372)
GUNUNGKIDUL	-0.100	0.103
	(-0.084)	(0.083)
KULONPROGO	-0.823	-0.553
	(-0.735)	(-0.475)
SLEMAN	0.545	0.826
	(0.722)	(1.035)
Method	OLS	OLS
R-squared	0.131	0.136
Observations	74	74

Surprisingly, the regression results provide no significant effect of other determinant variables on engagement in banking. It may be caused by the facts that the determinant of engagement in formal financial institutions is mostly driven by the demand side more specifically the individual aspect rather than the characteristics of sub-district (and district) and the availability of supply side.

Robustness checks

To ensure that our conclusion is robust, we do some come checks. First, we run the regression model at the individual/ household level instead of using aggregate data at sub-district level. We find consistent results that the more financially literate households, they more engage in banking. Second, we exclude the vector of dummy variables representing the district effects to enable us to control for some variables at the district level. With regard to our main variable, the results remain consistent.

CONCLUSION AND POLICY IMPLICATIONS

We analyze the effect of financial literacy on the engagement of poor people to formal financial institutions. Robustness, we do find that the more financially literate society, the engagement of poor people in the society to the banking is higher as well.

Our finding brings some policy implications. First, of course financial literacy should continuously be bolstered by regulators and financial institutions in the forms of educating poor people about simple financial products and knowledge. It will improve their confidence to approach banks. Financial literacy could also reduce the number of people who still engage (borrow) money from predatory lenders which charge strangling interest rate (Karsidi et al., 2015). Second, the regulators should impose banks to penetrate their business to the rural areas to approach those who are still excluded from the access to formal financial institutions.

ENDNOTES

¹ Trinugroho et al. (2014) contend that banks are reluctant to grant loans to the poor and MSMEs due to the high risk and costly.

² The 2013 national survey shows that the level of financial literacy nationally is 21.8% which is relatively still low.

³ Indonesian: Kecamatan

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VIDEO SCRAPBOOKING: AN ART FORM REVIVED IN THE ECONOMICS CURRICULUM

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ABSTRACT

Economic educators are constantly searching for new ways to motivate and engage their students. In this paper, we present a twist on an old art form to use in the classroom. Video scrapbooking is new way to engage and assess students in the economics curriculum. Video scrapbooking as an economic assessment tool is a new way for students to actively apply economic concepts to the world around them. We have provided several different video scrapbook assignment options that allow for seamless implementation for instructor integration into the economics curriculum.

INTRODUCTION

Economic education has had a growing focus on new media integration in the classroom. As the days of “chalk and talk” lectures give way, more emphasis has been placed on increasing student engagement (Harter, Becker and Watts, 1999). Given the current college student generation’s fascination with technology, media has become a new learning tool. In this paper, we present a twist on an old art form to use in the classroom. Video scrapbooking is new way to engage and assess students in the economics curriculum.

VIDEO SCRAPBOOKING

One form of technology that has yet remained untapped in the economics curriculum is that of the video scrapbook. The traditional, physical scrapbooks are “albums into which flat physical items (e.g. photographs) or written notes can be pasted” (West, Quigley, and Kay 2006). Alternatively, a video scrapbook is a multimedia presentation that streams images, articles, and photographs while playing audio clips of music, sound bites, or voice recordings. Originally, video scrapbooks were a means of digitally storing and viewing mementos that would normally be stored in a physical scrapbook (West, Quigley, and Kay 2006). Today, there are more than forty software packages available whose sole purpose is the digital creation of “live multimedia presentations” (Kaskalis, Tzidamis, and Margaritis 2007). Scrapbooking has traditionally always been a means of preserving personal history or interests in an album using pictures, media, or artwork. As we are moving towards a more digital based society that is valued highly in the workforce, this idea of scrapbooking is conducted electronically. Keeping up to date with this information helps retain economic concepts better. Some of the best sources of economic information are your newspaper and magazines, which are all accessible online. Students will bridge the gap between economics and concepts through a video that streams clippings with concepts and narratives in a sequential order as the chapters are covered in class.

Students are asked to either take screenshots from online news articles or take pictures from hard copies of newspaper or magazines. They can also take EconSelfies (Al-Bahrani et al. 2015) and use them as part of the streaming. To help retain the concepts better, students are

required to add a small description of each snap included in the stream. Instructors have the flexibility to tweak the requirements to their preferences and students also have the opportunity to be creative with their streaming.

GRADING CRITERIA	COMMENTS	POSSIBLE POINTS
Title Slide or Image	Is there a title slide/image with the group members' names, video scrapbook title, and date?	2.5
Articles	Are there at least 3 articles present that relate to the macroeconomic issue?	2.5
Images/Photos	Are there at least 3 images/photos of group members portraying a relationship to the macroeconomic issue?	2.5
Article/Image/Photo Explanation	Are there 25-word explanations associated with each article, image, and/or photo? Did you explain how the article/image/photo illustrates the topic or did you just list concepts?	5
Economic content: clarity in explaining macroeconomic issue using an appropriate economic concept	Can I understand the connection between the macroeconomic issue you have chosen and the economic concepts you are using to analyze the situation? Are there at least 4 explanations of articles/photos that include economic content? Did you use correct terminology and/or models when explaining the issues and solutions?	5
Creativity/originality	Fun to watch? Interesting overall? Are the graphics appealing and enhance the quality?	2.5
Total:		20

LITERATURE REVIEW

Much attention recently has been placed on utilizing media as learning tools. Some instructors make economic connections to television (Al-Bahrani et al. 2014; Al-Bahrani and Patel 2015; Considine 2006; Hall 2005; Kuester et al. 2014; Luccasen and Thomas 2010; Mateer et al. 2011; Tierney et al. 2015), while others use movies (Leet and Houser 2003; Mateer and Herman 2008; Sexton 2006). Economic podcasts are both assigned to students (Choi et al. 2015; Moryl 2013; Moryl 2014; Moryl and Jiang 2013) and created by students (Moryl 2015). The hybrid of vodcasting (video podcasting) has been introduced as a potential educational instrument (Gkatzidou and Pearson 2009). Even social media has become a source for student involvement in the economics curriculum (Al-Bahrani and Patel 2015). Technology creates learning opportunities for all students.

Research involving scrapbooks as therapeutic measures has been extensive. Most of the literature centers on the use of scrapbooks as coping mechanisms (Kohut 2011; Lowenstein 1995; McCarthy and Sebaugh 2011; Williams and Lent 2008). Some studies analyze the effects of scrapbooks on memory in the elderly (Charness and Holley 2010; Mizen 2004; Tang et al. 2007). Minimal research has been conducted on the effects of scrapbooks as a learning tool.

Burnley (2004) presents an earth science scrapbook project as an alternative assessment technique for middle school and high school introductory earth science classes. In another study, students self-reported that a scrapbook assignment in their college microbiology class was “helpful for learning the material for the course” (Hoffman 2001). To the best of our knowledge, no research has examined the measured effectiveness or level of engagement of scrapbooks - physical or video-as a learning tool.

RUBRIC

GRADING CRITERIA	COMMENTS	POSSIBLE POINTS
Title Slide or Image	Is there a title slide/image with the student's name, essay title, and date?	5
Articles	Are there at least 3 articles present that relate to the policy or issue?	5
Articles/Images/Photos	Is there at least 1 clipping per chapter?	5
Article/Image/Photo Explanation	Are there 25-140 word explanations associated with each article, image, and/or photo? Did you explain how the article/image/photo illustrates the topic or did you just list concepts?	10
Economic content: clarity in explaining policy issues using an appropriate economic concept	Can I understand the connection between the policy/issue you have chosen and the economic concepts you are using to analyze the situation? Are there at least 4 explanations of articles/photos that include economic content? Did you use correct terminology and/or models when explaining the issues and solutions?	10
Creativity/originality	Fun to watch? Interesting overall? Are the graphics appealing and enhance the quality?	5
Total:		40

ASSIGNMENT AND ASSESSMENT

Video scrapbooking is an excellent new assessment tool in the economics curriculum as it fulfills the “educational objectives” for the “cognitive domain” of Bloom et al.’s “Taxonomy” (1956). Bloom et al. 1956 describes six educational objectives that show increased student abstraction as he/she moves up through the categories. The educational objectives in order from least abstract to the most are knowledge, comprehension, application, analysis, synthesis, and evaluation (Bloom et al. 1956). While there are many ways to incorporate video scrapbooking into the economics classroom, we will evaluate one such assignment below. The assignment instructions and grading rubric are provided in the appendix. Instructors interested in incorporating this assignment into their curriculum should be able to do so easily.

Knowledge: The students must describe a policy or economic issue and define the economic concepts and terms they wish to incorporate.

Comprehension: The students must summarize the policy or economic issue, as well as the theories or models that they choose to relate to the topics.

Application: The students must apply the economic concepts, terms, models, and/or theories to their chosen policy or economic issue.

Analysis: The students must analyze the impacts of the policy or economic issue using their models and theories as guides.

Synthesis: The students must provide a policy prescription based on their analysis for the situation they described.

Evaluation: The students must assess the validity and implementation of the policy prescription they provide.

Beyond being a viable assessment tool, video scrapbooking increases students’ technological literacy in a society largely based on technology. They are applying skills that may make them more marketable in the job market. Furthermore, preliminary student feedback suggests that video scrapbooks increase students’ engagement and concept retention. Further study on measurable impacts of video scrapbooking in the economics curriculum is still needed.

CONCLUSION

Economic educators are constantly searching for new ways to motivate and engage their students. Video scrapbooking as an economic assessment tool is a new way for students to actively apply economic concepts to the world around them. We have provided several different video scrapbook assignment options that allow for seamless implementation for instructor integration into the economics curriculum.

Appendix Assignment 1

DIRECTION/GUIDELINES

The purpose of this assignment is to allow you to connect the economic concepts we have discussed thus far to real-world problems that our country/world is facing and that affect you personally. Discuss one macroeconomic issue covered in class that personally relates to you. Analyze the issue using models, theories, and concepts from class. As a group, decide on a policy prescription for the macroeconomic issue that you analyzed. Collect articles from magazines and newspapers (these can be electronic versions) that relate to your macroeconomic issue you describe. You will also be required to take photos of yourself and group members that illustrate how the issue personally relates to you and your group. Be creative.

Collect all of the files (articles, images, and photos) and stream them in a video format. You will need no less than 3 and no more than 5 articles for this project. You will need no less than 3 and no more than 5 photos of yourself and/or your group members. Create a 25-word explanation of how each article/photo connects to the issue. In at least 4 of your explanations, there must be a reference to some of the economic content from class. Voice record the explanations and play them while the file being described is shown. Note that this means your video scrapbook will have audio and visual. As such, please save your video scrapbook as an mp3 file or as a PowerPoint slideshow. Other formats may not be compatible with my computer's viewing capabilities. Please add a title slide/image with your name, your group's video scrapbook title, and the date.

Note that the following is not an extensive list and groups are welcome to choose a topic not from the list. More than 1 group *is* allowed to pick the same topic, as long as the groups do not work together and the analysis is original to each group.

Groups will have class time on Thursday, Friday and Monday to complete the assignment. The video scrapbook is due in the dropbox account in the learning management system by a date to be decided by the instructor. If you email me your mp3 file, then the attachment will likely be too large to send.

Groups will consist of 3 or 4 randomly selected students. This means that there are 9 or 10 groups in each class. Groups cannot consist of members from different sections. All group members will evaluate each other's' participation in this assignment on a scale from 0 (did no work) to 5 (did all of the work). Your overall quiz scores will reflect your participation based on these evaluations. Your group members have been selected using a random number generator. It is the group members' responsibilities to get in touch with each other to schedule time to work on the assignment. You have scheduled class time on Thursday, Friday, and Monday to work on it as hours that all students are available. Groups are listed below.

List of Possible Macroeconomic Issues to Choose From:

1. Growth
2. Inflation
3. Unemployment
4. Savings
5. Investment
6. Recession

7. Interest Rates
8. Spending
9. Globalization
10. Infrastructure
11. Crime/Underground Economies

The grading rubric for this assignment is outlined in the Table below. READ CAREFULLY.

Appendix Assignment 2

DIRECTION/GUIDELINES

Video Scrapbooking with Narratives

Economics can be found everywhere. There is economics in newspapers, movies, literature, and most importantly in our daily lives. Keeping up to date with this information helps retain economic concepts better. Some of the best sources of economic information are your newspaper and magazines, which are all accessible online. In them, you will find current information and opinions on nearly every topic and issue discussed in the textbook.

The goal of this project is to revive the concept of scrapbooking and use this method to make economic connections to the world around us. Scrapbooking has traditionally always been a means of preserving personal history or interests in an album using pictures, media or artwork. As we are moving towards a more digital based society that is valued highly in the workforce, the idea of scrapbooking will be conducted electronically.

To provide yourself with a file of information on economic events, clip out and save portions of news articles and take pictures that you find interesting and informative. It may be useful to save them according to the chapter headings in the textbook.

In this way, when you are dealing with a particular chapter you will have clippings to supplement the information and opinions that arise in classroom work and discussion. When saving the clipping, write down summary of how the piece is connected to the chapter theme or policy issue discussed in class in a minimum of 25 words (MAX 140 WORDS). Also ensure to properly cite the location of the clipping. For example, if the clipping was found in an online newspaper, please provide the title of the article, the website retrieved from and the date.

One can then bring all clipping together and stream them like pictures. With each clipping you can add a running narrative or if the narrative is short enough it can be present around the clipping. The streaming process continues with other clippings and narratives being introduced.

The overall goal is to produce a video that streams the clippings with narratives in a sequential order as the chapters are covered in class. Thoroughness, creativity & colorfulness, organization and quality will be graded

There is no length requirement. However, there must be a clipping for every chapter covered in class. Between each clipping, there should be enough time for the viewers to read every clipping and its narrative. Ensure at least 3 clippings discuss a policy issue covered in class. Finally, you should include some nice soothing background music.

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THE RELATIONSHIP BETWEEN ECONOMICS AND ETHICS AND THE EFFECTIVENESS OF NORMATIVE ECONOMICS ON STUDENT ATTITUDES AND LEARNING

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ABSTRACT

The field of economics has its roots in ethics. Indeed, Adam Smith, the recognized father of economics, was a professor of moral philosophy. However, despite its moralistic origins, economics has transitioned away from normative discussions and has instead embraced the scientific approach, which demands the field be wertfrei (value-free). This transition has made its way into the economics classroom where students now rarely encounter discussions of a normative nature. In this paper we discuss our experience of incorporating normative materials, analysis, and discussion into the economics classroom on students' political and economic views. No statistically significant change in student's political philosophy or learning due to the addition of normative materials and discussion was found.

INTRODUCTION

Ethics and normative values are generally not considered proper topics of discussion in the economics classroom. Indeed, most modern economists believe that a scientific and positivist approach is the only legitimate methodology in economics and that the study and teaching of economics should be value-free (i.e., free of normative discussions or analysis). Although economics is sometimes referred to as the “Queen of the Social Sciences” it seems that the profession has succeeded in removing her crown of morality and ethics in the name of “rigorous science.” However, it is clear that many economists forget that economics originated as a moral science and that Adam Smith, the recognized “father of economics,” viewed it as a moral science.

Tension exists between those who want economics to be considered a natural science and those who want economics to be viewed as “political economy.” It is for this reason that many classrooms consist of lectures based on textbook theory only (positive analysis) where students are not challenged to think of the ethical consequences of various economic actions or public policies. To counter this typical pedagogical philosophy, The National Council on Economic Education published *Teaching the Ethical Foundations of Economics* (Wight and Morton 2007), a book of lesson plans for teachers to use in the classroom where students are asked to consider and analyze various ethical issues and the economic consequences of those issues. Additionally, the Acton Institute for the Study of Religion and Liberty publishes the *Journal of Markets and Morality*, which includes essays on religion, economics, and even the overlap with economic education (Stapleford 2000; Lee and Schug 2011). Even the new principles textbook released by Cowen and Tabarrok (2010) contains a chapter entitled “Economics, Ethics, and Public Policy.”

So it appears there are still those who have not forgotten the history of economics nor the importance of incorporating discussions of normative issues into the economics classroom.

In a previous paper we not only looked at the effectiveness of alternative teaching methods on student learning demonstrated by measuring differences in pre- and post-tests on the topics of supply and demand and property rights, we also assessed the impact of normative economic analysis, discussions, and materials on those objective assessments (Malek et al. 2014). In this paper we examine the effects of incorporating normative materials, analysis, and discussion into the economics classroom on students' political and economic views, in order to determine if students became more market-oriented with the addition of the normative teaching components. We first look at student political and ethical attitudes before and after taking a principles class and then assess whether or not adding normative economic analysis, discussions, and materials significantly changed student attitudes--making them more market-oriented and philosophically libertarian.

To determine student political philosophy we use two instruments: *The World's Smallest Political Quiz* (WSPQ) and an assessment entitled the *Personal Philosophy Quiz* (PPQ). The WSPQ is a quiz created by the Advocates of Self-Government. In the WSPQ, there are two sections: Personal Issues and Economic Issues, each with five statements in which students can respond with Agree, Maybe, or Disagree. Each response has a particular point value--"Agree" is worth 20, "Maybe" is worth 10, and "Disagree" is worth 0. The scores for each category range from 0 to 100. A score closer to zero implies leaning toward government intervention while a score closer to 100 implies a more libertarian slant. The two scores are then matched up and the point of intersection represents the student's political philosophy. A score of 0, 0 would be "statist"; a score of 100, 100 would be "libertarian"; a score of 50, 50 would be "centrist"; a score of 0, 100 would be "right, conservative"; and finally, a score of 100, 0 would be "left, liberal." Liberals and libertarians would be closer to 100 on the Personal Issues, while conservatives and libertarians would be closer to 100 on the Economic Issues.

In the *Personal Philosophy Quiz*, students are given forty statements where they choose 0, 1, or 2 for each statement--0 for Yes, 1 for Maybe, and 2 for No. The statements cover both economic and public policy topics--i.e., philosophy of government, trade, property rights, freedom of association, drug prohibition, prostitution, "sweatshops," and outsourcing--the full list of which is included in the appendix. The scores range from 0 to 80. A person scoring near 0 would be closer to "statist" (to use the term in the *World's Smallest Political Quiz*). In other words, a score closer to 0 would imply one is favorable to government intervention. A student scoring closer to 80 would be more libertarian or free-market oriented.

Having laid out the basic structure of the experiment, the remainder of the paper is organized as follows: Section II contains a brief overview of the historical roots of economics as a moral science and the eventual paradigm shift that removed moral philosophy and ethics from the study of economics. Section III discusses the research on the effectiveness of normative economics on student learning. Section IV presents a discussion of our experiment using normative materials and economics in the classroom. Section V concludes with some thoughts on normative economics, economic education, and ethics.

THE MORAL ROOTS OF ECONOMICS AND THE EVOLUTION OF ECONOMICS AS A SEPARATE DISCIPLINE

Economics was once considered part of the broader study of politics, ethics, and theology (Alvey 2000) and was taught as a division of moral philosophy in European universities during the 1700s (Canterbery 1995). Notably, Adam Smith, the recognized father of economics, was a professor of moral philosophy at Glasgow University. Though best known for his famed *Wealth of Nations*, Smith's prior work, *The Theory of Moral Sentiments*, discusses virtue, justice, and prudence. However, even in *The Wealth of Nations*, Smith discusses topics such as benevolence and self-interest, which are clearly framed in an ethical framework. Alvey (2000) argues, "Smith's political economy, by aiming to promote economic growth, is inherently a moral enterprise."

Conversely, in today's world of economics it is considered unscientific to allow ethical values or "should or shouldn't" evaluations to enter into economic analysis. On that front, Hume is considered to be the first to make a distinction between "what is" and "ought" analysis and Walras considered economics a pure science that pursued truth with no regard to good or bad (Drakopoulos 1997). Alvey (2000) argues that there are two reasons why there has been a divorce between economics and morality. First, as the natural sciences were becoming successful, there was a move to apply natural science methods and mathematics to economics. Second, the adoption of positivism led to the abandonment of moral issues from economics.

The notion of *wertfrei* (value-free) has been paramount in economic analysis and economists, notably Friedman (1953), made this clear. This is why the modern economist considers economics to be a positive science. While economists do have their own sets of values, it is considered unscientific to allow those values to enter into economic analysis. Many economists consider it a victory that economics has evolved from its roots in the moral sciences. The modern view is that economics is similar to the physical sciences and that its methodology should be the same. This view inherently required the elimination of normative or value-laden analysis in economics. Kenneth Boulding (1969) in his essay "Economics as a Moral Science" writes,

We are strongly imbued today with the view that science should be wertfrei and we believe that science has achieved its triumph precisely because it has escaped the swaddling clothes of moral judgment and has only been able to take off into the vast universe of the 'is' by escaping from the treacherous launching pad of the 'ought.' Even economics, we learn in the history of thought, only became a science by escaping from the casuistry and moralizing of medieval thought.

However, Boulding also states "that no science of any kind can be divorced from ethical considerations..."

Economics viewed from this perspective as a strict science rather than as an art or deductive logic is important to the modern economist. Indeed, many mainstream economists do not view the analysis of the Classics, Austrians, or perhaps even some of Nobel laureate James Buchanan's work as science but rather as moral philosophy or polemics. According to Princeton economist Alan S. Blinder (1999):

There is little doubt that economics circa 1900 was not a science. Peruse copies of the leading economics journals around the turn of the last century, and you will find articles with titles like 'The Anthracite Miners' Strike of 1900,' 'The Commercial Legislation of England and the American Colonies, 1660-1760,' and 'Our Trade Prosperity and Outlook.' You will find an almost complete absence of equations....More generally, you will find little in the way of what I take to be the hallmark of science:

formulating theoretical models and confronting them with facts...Most of the truly great ideas of economics-such as the invisible hand, comparative advantage, and the gains from specialization and division of labor-predate the twentieth century. But ideas alone, even profound ones, do not constitute science.

One wonders if Adam Smith, the recognized “father of economics,” would receive a Ph.D. today based on his work.

It is evident that the field of economics has largely been taken over by positive economic analysis. This has caused normative analysis and the discussion of ethical consequences of economic actions to be brushed aside. Whether this is something to be cheered or scorned is a topic for another paper. However, it is clear that today’s economics bears very little resemblance to its original roots. The evolution of economics from “political economy” to “economic science” is apparent.

RESEARCH ON THE EFFECTS OF LEARNING ECONOMICS

Effect of Economics Education on Political Attitudes

Does economics change students’ political views? Does it change their views on what is “fair” or “unfair” or what the government should or should not do? Explicit discussions of the fairness or the morality and ethics of private property, voluntary exchange, or the price system are rare in the typical economics class. Most classes focus on positive economic analysis without regard to the normative implications (Frey et al. 1993; Whaples 1995). Colander (1987) found that “teachers neglect topics beyond Pareto efficiency.” In other words, most teachers focus on neutral, value-free economic analysis and stay away from “right and wrong” and “fair and unfair” discussions. In classes such as these, students’ critical thinking skills, and their ability to weigh ethical issues, are not challenged or tested.

Research shows that students do change their perception of fairness of the price-setting process after learning the supply and demand model in a favorable fashion (Whaples 1995). Riddle (1978) concluded that an introductory course in economics changed student opinions on economic issues and that students became more conservative, supporting the conclusion of Stigler (1983) and the findings of Scott and Rothman (1975). However, Frey et al (1993) found that studying economics did not affect student attitudes of the fairness of the price system. They conclude:

The evidence brought forward by our experiments contradicts the indoctrination and supports the selection hypothesis. Students of economics start with the same degree of sympathy/antipathy for the price system that they exhibit four years later. Thus, it seems that economics students represent a special group of people who prefer the price system more than the general population does. That could be one of the reasons why they decide to study economics.

The Case for Including Normative Analysis and Ethics

The typical economics professor views the discipline of economics as strictly a positive, value-free science and believes that only positive economics should be taught in class. However, as Watts (1987) asks:

Many mainstream economists at the university level would claim that they teach, or attempt to teach, only positive concepts. Most would claim they consider ends or normative statements only when they discuss matters of public policy and that, even then, they scrupulously try to avoid teaching prescriptively about any normative proposition. Is this approach itself ideologically biased or restricted, and is it the appropriate stance for pre-college teachers who teach economic concepts and issues to their own students?

He also suggests that the mainstream view is that economics has no special insight into normative issues.

In contrast, Horton (1972) argues that while positive economics should be taught, economics *and* ethical values (normative views) should be included in the class. However, he does warn against pushing any particular values upon students and notes the importance of respecting them enough to let them determine what normative views they have. Stapleford (2000) argues, “Grappling with ethical issues will return substance, relevance, and excitement to the learning of economics.”

We have found that on our own student evaluations at the university level, students had a higher overall rating of our teaching and their educational experience in the classes where normative and ethical issues of property rights, trade, and the price system were discussed and analyzed. Moreover, students mentioned that they enjoyed the class sessions more when we had a chance to talk about real-life public policies and debates.

However, we do agree with Watts that we must devote time to positive economics before we move to discussion or debate of normative issues. Of course, this presupposes that we are to discuss normative and ethical issues in the classroom in the first place. Our contention is that: (1.) Positive economic analysis does have unique insight into normative issues, and (2.) Students come to our classroom with a desire to find answers to their public policy questions, and economics classes can uniquely enrich the educational experience of students.

There are critics who argue that using class time to teach and discuss normative issues is not only improper for a scientific discipline but also that devoting class time to normative discussions does not lead to any measurable gains in student outcomes. Moreover, discussion of normative issues is seen as a way for a teacher to escape real teaching (Watts 1987 citing Walstad and Soper 1982). The rebuttal to this perspective is that viewing the introductory economics course as a vehicle for teaching technical concepts in an encyclopedic fashion is exactly the problem. Perhaps it would be more optimal for the student and the Economics department (in terms of additional student enrollment in Economics classes) to discuss issues that students already come to class thinking about and to teach students tools that they can add to their own process of analysis. After all, if students do change their attitudes and opinions, perhaps it is not a matter of “brainwashing” but rather that the positive economic analysis simply shows that there are good and bad policies.

NORMATIVE TEACHING EXPERIMENT AND RESULTS

The main objective of this paper is to test whether using normative materials and discussing normative economics and ethical issues makes a difference in student political attitudes or if neutral, positive economics make a difference. If *both* affect student political attitudes, we seek to determine if there is a significant increase in students becoming more market-oriented when normative materials and issues were incorporated into the classroom. Our results here should be taken as a first look at this issue, however, and not as strong evidence for

or against the use of normative economics in the classroom. An important point in favor of our results being tentative is that our unit of observation is the class, not the student.

Our study made use of the class-level scores of students in different semesters wherein the students were given two different assessments (WSPQ and PPQ) at the beginning of the semester and the same two assessments at the end of the semester. The control group consisted of seven courses of students who were in classes where only positive economics was taught and discussed, while there were seven other principles courses where they were required to read normative economic articles and discuss normative economic issues (i.e., sweatshops, legalization of organ selling, freedom of association and property rights, and the fairness of market prices) and where they watched clips and videos from the *Stossel in the Classroom* series. The series includes topics such as rent control, price gouging, pharmaceutical drug prices, sweatshops, outsourcing, and private property. In addition, instances of playing “devil’s advocate” were included in the experimental classes.

For example, students were challenged with questions such as, “If you think it’s a rip off that Starbucks charges so much for a cup of coffee or that the gas station charges so much for a gallon of gas, what would be a fair price?” followed by, “Now how many of you, who just told me you would pay \$5.00 for that cup of coffee, and actually only paid \$4.00, or would pay \$4.00 for that gallon of gas but actually only paid \$3.00, would go back and give the business that extra \$1.00 of consumer surplus? Or how many of you like getting things for free or at a discount? How many of you would like to pay less for your rent? So, if you are not evil for wanting something for free or as cheap as possible, are businesses evil when they want to sell at the highest price possible or if they want to pay the lowest wage possible to earn their profits? Do you have a right to that cup of coffee or gallon of gas? Is it Starbucks’ or Chevron’s duty to give you coffee or gas--their private property?” In other words, in the experimental classes, these types of ethical or moral questions were included throughout the positive economics lectures, especially on the topics of trade (where we would think about “sweatshops” from a different perspective), prices, and property rights. Discussion also covered private property and the morality of freedom of association in the workplace and smoking laws regulating private establishments. All sections had the same instructor.

To determine the impact of the normative discussions and materials on the control and experimental classes, class scores were compared by calculating the mean difference between the pre- and post-tests. The difference would imply the “improvement” that the students had over the semester. That is, scoring “higher” would imply becoming more market-oriented and philosophically libertarian.

For the *Personal Philosophy Quiz*, the difference between the pre- and post-test of the experimental samples is significantly higher than that of the controlled. Further, the two-tail p-value of 0.01 indicates that the scores differ significantly. Thus, the use of normative materials in the experimental classes “improved” scores from the pre-test to the post-test (i.e., students became more market-oriented or more libertarian). Comparison of the mean differences of pre- and post-tests for the *World’s Smallest Political Quiz* indicate that the experimental groups showed greater “improvement” (closer to 100) in both the Personal and Economic issues. However, these were not deemed to be significant in terms of the t-test for independent samples. Therefore, the normative materials and discussions were not enough to provide significantly improved scores for the experimental groups over the control groups.

CONCLUSION

As we have previously noted, economics has its roots in the moral sciences and it was once not unusual for economists to consider and discuss ethical and normative issues. However, as the discipline has evolved it has become more “scientific,” thereby dismissing normative analysis as something outside the scope of true science. This concept of economics, while accepted by the majority of modern economists, has its critics. As Wight (2003) states:

Some economists consider their discipline a science, and thereby divorced from messy ethical details, the normative passions of right and wrong. They teach in a moral vacuum, perhaps even advocating economic agents operating independently and avariciously, asserting that this magically produces the greatest good for society. Never mind such a view woefully misinterprets Adam Smith’s “invisible hand....” It is time for moral inquiry to be included as a part of economics education—or more accurately to be reintroduced.

Nobel laureate Amartya Sen lamented that economics “has been substantially impoverished by the distance that has grown between economics and ethics.”

In our own experience we have found that students enjoy classes more when normative issues are discussed and debated. Additionally, they enjoy classes that do not consist of just “chalk and talk.” However, more formal analysis shows no statistically significant improvement in objective economics knowledge on the topics of supply and demand and property rights when normative materials and discussion (i.e., “political economy”) are used as supplements to traditional teaching methods.

Our intent was to investigate whether or not students’ political and philosophical views would change as a result of taking an economics class that included normative components, based on comparing pre- and post-tests of two instruments: (1) *World’s Smallest Political Quiz* and (2) a *Personal Philosophy Quiz*. In conclusion, students became more market-oriented (libertarian) by learning traditional positive economics. However, this increase (i.e., scores becoming more market-oriented or libertarian) in the political philosophy scores due to the addition of normative materials and discussion was not a statistically significant factor. While our efforts here are not by any means conclusive given our crude approach, we hope that by discussing our attempt other economic educators will be stimulated to see normative economics improves learning.

APPENDIX 1

Personal Philosophy Quiz

1. The government has ownership rights over its citizens’ bodies.
2. It should be illegal for a person to donate their own organ(s) to a person in need.
3. It should be illegal for a person to voluntarily sell their own organ(s) to a willing buyer.
4. Even if somebody does something voluntarily they could still be taken advantage of or exploited (the assumption is that there is no fraud or misrepresentation of the terms of agreement).
5. In voluntary trade, somebody wins and somebody loses.
6. When a product is made in another country rather than in the United States this is harmful to the United States.
7. If a corporation makes a lot of money it is because they are able to force their consumers to pay more money.
8. The government should regulate what people put into their bodies.

9. It is fair for the government to tax high income individuals and redistribute income to low-income individuals.
10. The government should continue funding the War on Drugs.
11. The government should protect consumers by controlling certain prices of important goods and services.
12. People have a right to a job.
13. It should be illegal for a business to not hire somebody because of their race, religion, sexual orientation, or gender.
14. Restaurants and bars should be smoke-free by law.
15. Premarital sex should be illegal.
16. Two people (unmarried) who meet at a bar and then go home and have sex should be prosecuted.
17. A man approaches a woman at a bar and offers her \$1,000 to have sex and she accepts. The government should prosecute both parties.
18. Minimum wage is necessary to protect workers from exploitation.
19. When a corporation makes excessive profits, this hurts consumers.
20. Outsourcing hurts the United States.
21. It is the government's responsibility to provide health-care.
22. If a potential employee does not want to accept a job because his manager is a particular race or ethnic background, he should be prosecuted and fined.
23. Oakridge Mall (owned by Westfield) must allow all law-abiding citizens to shop at their stores.
24. Government should protect workers with hiring and firing laws.
25. Alcohol consumption and production should be illegal.
26. Fatty, unhealthy foods should be regulated by the government.
27. Monopolies should be broken up by the government in order to protect consumers.
28. Most businesses and corporations exploit their employees.
29. Many businesses gouge (take advantage with high prices) their consumers.
30. Businesses should receive subsidies from the government.
31. Rich people should pay the highest percentage of income taxes in the United States.
32. Sweatshops exploit their workers.
33. Socialism is the best and most just economic system to ensure prosperity.
34. Prostitution should be illegal.
35. Cocaine and marijuana should be illegal.
36. Alcohol should be illegal.
37. Cigarettes should be illegal.
38. The government should prohibit private businesses from discriminating against people based on race, religion, sexual orientation, or gender.
39. In a national disaster it is the government's responsibility to fund relief efforts.
40. Funding education is a government responsibility.

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DO SMART STUDENTS STUDY HARDER? AN INVESTIGATION OF EFFICIENT EFFORT AMONG UNDERGRADUATE UNIVERSITY STUDENTS

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ABSTRACT

Study time and level of intelligence are arguably the two most important inputs to determine a student's final grade. Research in this area has been limited, partly due to the common belief that a smart student may exert less effort to achieve the same academic performance. However, smart students may have incentive to spend more time studying based on the belief that more effort can lead to greater results. Raw Effort (RE) is defined as time spent studying, alone or with peers, while Efficient Effort (EE) was defined as final course grade divided by RE. Intelligence indicators included perceived intelligence, final grade and contribution in class. The purpose of this paper is to investigate the relationship between these factors.

Using a two-period utility maximization model, we predicted that smart students would put in more effort to achieve academic success. Furthermore, we hypothesized that the inclusion of social capital would have no impact on this relationship. Surveys were used to collect data ($n=217$, response rate = 55%) from a sample of first year economics students at a liberal arts university in Western Canada. Students were asked to rate their intelligence and class contribution relative to their peers, to estimate their final course grade, and indicate hours spent studying alone or while socializing. Final course grades were compared to these results.

For the whole sample, a significant positive relationship was found between final grade and RE. RE was also related to class contribution, but only for female participants. EE was related to perceived intelligence, but again, only for females. Interestingly, males tended to have higher self-perceptions of intelligence, although final grades did not differ between gender groups. This perception bias may influence effort. This paper adds valuable information to the literature on the relationship between student effort, intelligence, and academic success.

INTRODUCTION

Effort and intelligence are arguably the two most important inputs to determine a student's grade point average (GPA; Busato et al., 2000). The influence that intelligence has on academic success is well documented (Ackerman & Heggestad, 1997; Busato et al., 2000; Farsides & Woodfield, 2003; Hirschberg & Itkin, 1978; Neisser et al., 1996; Poropat, 2009). For example, according to Jensen (1998), academic achievement scores of high school students

correlate between 0.5 and 0.7 with IQ scores. Ridgell and Lounsbury (2004) found that general intelligence was significantly related to both course grade and GPA, and Shuman (1985) found that grades were best predicted by SAT scores. Other factors that play into academic success include the personality traits of Conscientiousness and Openness to Experience (Beaujean et al., 2011; Nofle & Robins, 2007; O'Connor & Paunonen, 2007), Emotional Intelligence (Parker et al., 2005; Miller et al., 2013) and social support (Hogan et al., 2010), but still, success requires effort.

In spite of vast research on the relationship between intelligence and GPA, there has been limited research investigating the relationship between intelligence and level (or amount) of student effort. One reason for the lack of research may be a common belief that a smart student may exert less effort to achieve the same academic performance. However, a positive relationship between the GPA and earning [see Jones & Jackson, 1990; and Loury & Garman, 1995] can provide smart students with sufficient incentive to exert greater effort to achieve higher GPA and consequently higher lifetime earnings.

Effort can be measured as time spent on task, and Strauss and Volkwein (2002) reported that amount of study time per week was positively related to a student's GPA. Other studies have found a weak or unreliable relationship between the amount of study time and grade point average for college students (Schuman et al., 1985; Plant et al., 2005). Measuring time-on-task may not capture students' effort in studying, an idea that has led us to investigate the concept of "efficient effort" (EE).

Efficient effort, for us, suggests that students spend time on task in such a way that their return on investment is maximized. We hypothesize that smarter students are more efficient with their time on task and more strategic in their approach to study time. Strategic studying refers to the application of effective study techniques (Kirschenbaum & Perri, 1982); and has been linked with higher student achievement particularly when course loads are high (Sansgiry et al., 2006). The literature identifies several specific strategies used in strategic studying including survey-question-read-recite-review (McDaniel et al., 2009), distributed practice (Willingham, 2009), self-questioning (Karpicke & Roediger, 2008) and mind-mapping (Farrand et al., 2002). It is not clear if students with varying levels of intelligence make use of these strategies in a uniform manner although fluid intelligence has been positively linked with motivation to learn (Silvia & Sanders, 2010),

The purpose of this paper is to investigate this issue of efficient effort. If leisure and lifetime earnings are the only two determinants of the welfare of a person, and furthermore, if a higher GPA and intelligence lead to a higher lifetime earning, smart students will be expected to study more efficiently than other students.

Another factor that can be related to lifetime earnings is the different forms of productive capital accumulated over time (Leung, 2002). While human capital is accumulated through investment in education and training (Becker, 1975), social capital is built from social interactions and networking (Becker & Murphy, 2000). The accumulation and formation of both human and social capital can positively contribute to higher lifetime earnings. Thus, the positive relationship between intelligence and effort can be further enhanced when human and social capital is also taken into consideration.

This paper will add valuable information to the literature on the relationship between effort, intelligence, and academic success. The research outcome of this project - i.e., smart

students do study harder - may provide students, educators, and policy makers with important practical implications. In particular, an inter-disciplinary approach using tools from both economics and psychology serves to provide new insights to the existing literature.

The rest of this paper is organized as follows. Section 2 sets up a two-period economic model to clarify the relationship between intelligence and effort. While Section 2 focuses on the private benefit of the smart student's effort, Section 3 adds the social capital to the human capital and accounts for the social benefit (i.e., positive externalities) provided by the student's effort. Section 4 introduces a psychological approach by proceeding survey and psychological experiment. Adding a psychological methodology verifies and reinforces theoretical results and policy implications based on an economic approach. Section 5 summarizes our work and provides conclusions and considerations for future study.

A TWO-PERIOD MODEL

Consider a university student i with preference $U^i(L_i, w_i)$, defined over leisure L_i , and lifetime earnings w_i . Assume that the GPA, G_i , acquired in university and the intelligence, say I_i , are the two most important determinants of the student's lifetime earnings such that $w_i = w(G_i, I_i)$. In university life, each student chooses a level of effort, $E_i = 1 - L_i$, subject to $L_i \in [0, 1 - L_0]$, where L_0 is a subsistence level of leisure (e.g., sleeping, eating time) less than 1 in accordance with her intelligence I_i which is a random variable distributed on $[I_{min}, I_{max}]$. The GPA positively depends on both the student's effort level and intelligence: $G_i = G(E_i, I_i)$.

Also we assume that the undergraduate student has two periods in her life. In the first period, the student allocates times between leisure and study. Leisure is the only determinant of her utility for the first period. In the second period, the GPA obtained in the first period and the level of intelligence governs her lifetime earnings, which are two determinants of her utility for the second period. Thus, a student's intelligence affects her lifetime income twice: first, indirectly through a higher GPA and second, directly through a positive relationship between intelligence and income after graduation. Then by assuming a risk-averseness, we can define the student's separable utility function as:

$$U = U(L, w; I) = U(L(I)) + \beta U(w(G(1 - L(I), I), I)) \quad (1)$$

subject to

$$U_L > 0, U_w > 0, U_{LL} \leq 0, U_{ww} \leq 0, U_{Lw} = 0, w_G > 0, w_{GG} \leq 0, w_I > 0, w_{II} \geq 0, \\ G_L < 0, G_I > 0, G_{LL} \geq 0, G_{II} \leq 0, G_{LI} = 0,$$

where $\beta > 0$ depends on the relative duration of working life with respect to the university life and on the discount rate for the future.¹ Then, due to the envelope theorem, the first order condition of (1) with respect to intelligence to maximize her lifetime utility is as follows:

$$\frac{dV(I)}{dI} = U_L \frac{dL}{dI} + \beta U_w \left[\frac{dw}{dG} \left(-\frac{dG}{dL} \frac{dL}{dI} + \frac{dG}{dI} \right) + \frac{dw}{dI} \right] = 0 \quad (2)$$

By substituting $\frac{dL}{dI} = -\frac{dE}{dI}$ into (2) and rearranging it, we derive Proposition 1 showing a relationship between level of intelligence and level of effort as (3).

$$\frac{dE}{dI} = \frac{\beta U_w (w_G G_I + w_I)}{U_L - \beta U_w w_G G_L} > 0 \quad (3)$$

Proposition 1: If the GPA and intelligence are positively related to the lifetime earnings, a smarter student will increase her effort level to maximize her lifetime utility.

HUMAN AND SOCIAL CAPITAL

The positive relationship between GPA and earning can be further enhanced through the accumulation of human and social capital. Human capital is a form of resource that an individual can acquire to improve one's labour productivity most commonly through education and schooling (Becker, 1975). Social capital is another form of productive resource that an individual can accumulate through interactions and networking with other people (Becker & Murphy, 2000). The two forms of capital are often complementary. For instance, the process of schooling can create human capital by increasing the knowledge base of an individual, but interactions with others in the schooling process can also create social capital (Leung, 2002). Hence, the formation of social capital can happen at the same time during the process of human capital creation (Coleman, 1988).

The literature has further pointed out that both human and social capital can be generated and accumulated through various channels and settings. For example, Leung and Brittain (2009) argued that different social institutions such as school, family, church, and peer networks are all possible channels for people to accumulate both human and social capital. Dufur et al. (2013) used a sample of American high school students to show that school social capital and family social capital complement each other to enhance student academic achievement.

Research has shown that higher level of education, that implies higher level of both human and social capital, is positively related to various aspects of life such as better health, more sustainable marriage, happiness, higher level of income and wealth (Hout 2012). This implies that lifetime earnings increase with the level of capital accumulated. Hauser (2000) found that education has a positive impact on human capital, but an even stronger positive impact on social capital of young people. Brewster and Bowen (2004) showed that support from teachers as a form of school social and human capital helped to increase students' engagement in school, prevent dropping out from school, and improve academic outcomes among a sample of high-risk Latino students from the United States. School engagement which can be considered a form student effort to engage in school work is therefore positively related to the level of capital accumulation.

Consider the case of human and social capital accumulated (K) as an additional factor to GPA (G) and intelligence (I) that can increase lifetime earnings (w), such that $w_K > 0$ in our model. Given the evidence provided by the literature, capital accumulation through education has been shown to be positively related to student's effort, $1 - L_i$ in our model. For simplicity, further

assume that leisure and capital accumulation are competing and mutually exclusive activities such that capital accumulation is negatively related to leisure, L_i , such that $K_L < 0$ in our model. The simple model presented in section II can then be extended to incorporate the accumulation of human and social capital as follows, where K represents the accumulated stock of human and social capital subject to $w_K > 0$ and $K_L < 0$:

$$U = U(L(I)) + \beta U(w(G(1-L(I), I), I, K(1-L(I)))) \quad (4)$$

Then, the first order condition of (4) with respect to intelligence to maximize the individual's lifetime utility can be derived as follows

$$\frac{dU}{dI} = U_L \frac{dL}{dI} + \beta U_w \left[\frac{dw}{dG} \left(-\frac{dG}{dL} \frac{dL}{dI} + \frac{dG}{dI} \right) + \frac{dw}{dI} - \frac{dw}{dK} \frac{dK}{dL} \frac{dL}{dI} \right] = 0 \quad (5)$$

By substituting $\frac{dL}{dI} = -\frac{dE}{dI}$ into (5) and rearranging it, Proposition 2 can be derived to show the relationship between intelligence and level of effort as follows:

$$\frac{dE}{dI} = \frac{\beta U_w (w_G G_I + w_I)}{U_L - \beta U_w (w_G G_L + w_K K_L)} > 0 \quad (6)$$

Proposition 2: If lifetime earnings are positively related to GPA, intelligence, and the level of human and social capital accumulated, a smarter student will increase her effort level to maximize her lifetime utility.

Note that the inclusion of human and social capital accumulation does not change the positive relationship between level of intelligence and level of effort as suggested by the initial simple model, but such inclusion slows the rate at which leisure time decreases as the level of intelligence increase, *ceteris paribus*.

METHOD

Participants

Surveys were distributed during class time to students enrolled in first year microeconomics and macroeconomics courses at a mid-sized university in western Canada. A total of 217 students (117 males, 99 females, and 1 student with unidentified gender) completed the survey out of a possible 375 registered students, representing a response rate of 58%.² Participants ranged from 18 years to 31 years of age (mean = 20.18, SD = 2.34), with 60% majoring in business (n=132), 8% in policy studies, 13% in other majors and 18% in “open studies” (undeclared major). Fourteen of the students who participated in the survey did not consent to having their final grades included in the study, one did not provide gender information and some of the ID numbers provided by students could not be matched with ID numbers

provided by instructors. Final grade data was therefore matched for a total of 190 participants (105 males and 85 females).

Procedures

All students who attended class on the day of the research project were invited to complete a brief, in-class survey. The survey was comprised of 12 questions which gathered information about the student's perceived level of intelligence, estimated number of hours spent studying for the course, estimated number of hours spent socializing with the purpose of studying and estimated hours spent socializing with no connection to studying. Students were also asked to indicate the degree to which they thought they contributed positively to the class learning environment, the number of courses they were taking this semester, and the number of hours spent working each week for employment. Students were also asked to indicate their gender, age, program of study, anticipated final grade for the course and student identification number. Actual final course grades were later matched to survey data based on student identification number. (See Appendix A for the questionnaire.)

Information that could identify individuals was then removed and data was subjected to statistical analyses. The empirical analysis aimed to examine the relationship presented in equations (3) and (6) of the theoretical model discussed earlier, looking particularly at the relationship between effort spent on school work and perceived level of intelligence. Two measures of effort, Raw Effort (RE) and Efficient Effort (EE), were formulated for the analysis. RE measures the average number of hours spent studying per course each week:

$$RE = \frac{\text{hours spent studying each week}}{\text{number of courses taken in the term}}$$

Raw Effort with Social Capital (RESC) expands on the original concept of RE and was defined as:

$$RESC = \frac{\text{hours spent each week studying alone and with peers}}{\text{number of courses taken in the term}}$$

EE is a measure of final grade received in a first year economics course after accounting for RE:

$$EE = \frac{\text{final grade}}{RE}$$

That is, EE indicates how a student uses her study hours efficiently.

The extended concept, Efficient Effort with Social Capital (EESC) is defined as follow:

$$EESC = \frac{\text{final grade}}{RESC}$$

Two measures of perceived intelligence were derived from the student survey. General Intelligence (GI) was based on the 3-category survey question "I think that my intelligence is

(higher than average/about the same/lower than average) compared to other students in this class” and Classroom Intelligence (CI) was based on the 4-category survey question “I think that I contribute positively to the class learning environment.”

The two measures of effort and the two measures of perceived intelligence were used as dependent variables and independent variables (respectively) in the data analyses presented below.

RESULTS

Analysis of Variance

Using data where final grade and gender information was present ($n=190$), one-way ANOVAs were performed to investigate similarities and differences among genders (males $n=105$ and females $n=85$) for each survey question. Males and females in this sample were not statistically different in terms of age, course load, employment status (working/not working), or hours of employment per week. Responses showed that males and females spent equal amounts of time socializing each week with peers for the purposes of studying, and also equal time socializing for other (non-academic) reasons. Male and female students also perceived themselves to contribute positively to the class learning environment in relatively equal amounts. Results are presented in Table 1.

Table 1 SUMMARY OF ANALYSIS OF VARIANCE RESULTS LOOKING BETWEEN GENDER GROUPS				
	Mean	SD	F (1, 188)	Sig.
Age	20.25	2.47	0.126	0.723
Course Load	4.08	0.84	0.139	0.710
Employment Status	1.39	0.49	3.361	0.068
Hours of Employment	17.66	8.62	0.971*	0.327
Socializing for the Purpose of Studying	2.83	4.54	0.614	0.434
Socializing NOT for Studying	11.54	9.73	1.929	0.167
Positive Contribution to Class	2.34	1.32	0.581	0.447
* $n=116$, $df(1, 114)$				

When asked about the number of hours spent each week studying (excluding class) there were no gender differences ($F(1,188)=0.077$, $p=0.781$). However, when asked “how many hours do you spend each week studying (excluding class) *for this course*”, males reported putting in less study time than their female peers (means = 2.4 hours and 3.4 hours respectively, ($F(1,188)=3.874$, $p=0.05$). Further, 12% of the males ($n=13$) and only 4% of the females ($n=3$) indicated that they did not study at all for this course outside of class time.

Raw Effort scores (where RE equals hours spent studying divided by total courses per week) revealed no significant differences among gender groups ($F(1,188)=0.222$, $p=0.638$). Likewise, when we consider total study time as including number of study hours per course taken along with social time used for the purposes of studying and learning, no gender differences were evident ($F(1,188)=0.095$, $p=0.758$).

Perception of intelligence did reveal a gender difference. Based on responses to the question “I think that my intelligence is (choose one of below average/average/above average) compared to other students in this class”, males rated their perceived intelligence as being above average more often than their female peers (means = 2.34 and 2.11 respectively, $F(1,188)=9.592$, $p<0.002$). Males also estimated their final grade to be higher on average than females did (means = 7.0 and 6.2 on a 10 point scale respectively, $F(1,188)=9.279$, $p<0.003$), yet final grades for the course showed no significant difference between gender groups ($F(1,188)=0.479$, $p=0.490$).

Gender differences on RE, RESC, EE and EESC were further investigated using an Analysis of Variance, looking for differences between these two groups. The only significant difference was found between males and females on the EESC measure, ($F(1,181)=4.595$, $p<0.033$, where males reported higher levels of EESC than did their female peers (means=1.39 and 0.77 respectively).

Regression Analysis

The purpose of the regression analyses was to examine the relationship between students' effort spent studying and students' perception on their own level of intelligence. Of the 190 participants with final grades and gender information, 11 reported no time spent studying alone on a weekly basis, and resulted in a value of 0 on RE. Consequently, these participants' scores on EE are mathematically undefined (as RE is the denominator of EE). As a result, the sample used for the regression analysis was 179 (95 males and 84 females) after all participants with undefined EE values were excluded. Before examining this relationship, we first looked at the relationship between hours spent studying each week per course (Raw Effort) and the final grade received in a first year economics course as shown in Table 2. Results show a significant positive relationship between grade received in the economics course and time spent studying for both male and female students alike.

Table 2				
RELATIONSHIP BETWEEN RAW EFFORT AND ACTUAL GRADE				
Explanatory Variable	Gender	Constant	Coefficient (t-stat)	Adjusted R²
Actual Grade	Males	0.620 (0.54)	0.448*** (2.58)	0.057
	Females	1.330*** (2.309)	0.259*** (2.85)	0.079
Males (n=95);Females (n=84) **significant at the 5% level, ***significant at the 1% level				

Empirical results on the relationship between raw effort spent studying and students' perception of their own level of intelligence are presented in Table 3.

Regression #1 and #2 from Table 3 show no statistically significant relationship between GI and RE for either gender group. Regression #3 and #4 from Table 3 indicate a significant positive relationship between CI and RE among female students (with or without social capital), although the R² value is small.³ No such relationship was found among male students. Among female students then, as perceived positive contribution to class increases, so too does the

number of hours spent studying for class. This result is consistent with equations (3) and (6) of the theoretical model.

Table 3 RAW EFFORT REGRESSION				
Explanatory Variable	Gender	Constant (t-stat)	Coefficient (t-stat)	Adjusted R ²
Regression #1 Perceived General Intelligence	Males	1.954 (0.97)	0.594 (0.71)	-0.01
	Females	0.625 (0.52)	1.043 (1.84)	0.03
Regression #2 Perceived General Intelligence with Social Capital	Males	6.251 (0.79)	3.150 (0.96)	0.01
	Females	3.075 (0.64)	4.189 (1.87)	0.03
Regression #3 Perceived Classroom Intelligence	Males	3.366*** (3.66)	-0.007 (-0.02)	-0.01
	Females	1.808*** (3.16)	0.415** (1.96)	0.03
Regression #4. Perceived Classroom Intelligence with Social Capital	Males	13.967*** (3.87)	-0.137 (-0.10)	-0.01
	Females	7.919*** (3.50)	1.628** (1.96)	0.03
Males (n=95); Females (n=84) **significant at the 5% level, ***significant at the 1% level				

Empirical results on the relationship between efficient effort spent studying and students' perception of their own level of intelligence are presented in Table 4.

Table 4 EFFICIENT EFFORT REGRESSION				
Explanatory Variable	Gender	Constant (t-stat)	Coefficient (t-stat)	Adjusted R ²
Regression #1 Perceived General Intelligence	Males	4.941** (2.40)	-0.273 (-0.32)	-0.01
	Females	-0.327 (-0.18)	1.793** (2.12)	0.04
Regression #2 Perceived General Intelligence with Social Capital	Males	1.211** (2.54)	-0.092 (-0.47)	-0.01
	Females	0.021 (0.06)	0.357** (2.03)	0.04
Regression #3 Perceived Classroom Intelligence	Males	5.395*** (5.82)	-0.467 (-1.38)	0.01
	Females	4.243*** (4.86)	-0.337 (-1.04)	0.001
Regression #4. Perceived Classroom Intelligence with Social Capital	Males	1.304*** (6.12)	-0.132 (-1.70)	0.02

	Females	0.972*** (5.37)	-0.084 (-1.25)	0.01
Males (n=95); Females (n=84) **significant at the 5% level, ***significant at the 1% level				

Regression #1 and #2 from Table 4 show a positive relationship between GI and EE among female students (with or without social capital), but not male students. This implies that the more that a female student perceives herself as being intelligent compared to other students, the higher her final grade in a first year economics course after accounting for the amount of time spent studying for school work. This result is consistent with the suggestion from equation (3) and (6) of the theoretical model (but only for female students). Regression #3 and #4 from Table 4 show that there is no statistically significant relationship between CI and EE on either male or female students.

CONCLUSION

While time spent on task (RE) and level of intelligence certainly play a role in academic achievement, this study revealed that other factors also contribute to student success. The study here aimed to investigate how smart students approach their studies using more efficient strategies (Efficient Effort) with or without social capital (EE and EESC).

In our sample of undergraduate students (n=190), gender groups were statistically equivalent in terms of age, course load and level of employment. Both groups reported relatively equal levels of social capital in terms of time spent socializing for the purposes of studying and time spent socializing for purposes other than studying. Both gender groups also perceived themselves as contributing positively to the class environment to a similar degree. Overall time spent studying was equal for the gender groups, but there was a statistically significant difference in study time for the class under investigation for this project such that female students reported spending about an hour per week more studying for this class than did their male peers. Male students were also more likely to claim that they spent no time outside of class studying (12%) compared to their female peers (4%). Results revealed that males were more likely to perceived themselves as having above-average intelligence than were their female classmates, and males also estimated their final grade to be higher on average than did their female peers. Actual final grades revealed no significant difference between gender group, suggesting that males were more likely to overestimate their academic achievement.

In this study, we examined two measures of effort: Raw Effort (RE) and Efficient Effort (EE). RE was defined as hours spent studying per week for all classes, divided by the total number of courses per week. EE was defined final letter grade divided by RE. Regression analysis were performed on a sample of 179 students to examine the relationship between effort spent on studying and students' perception of their own intelligence level. There were no gender differences in RE scores, and overall, RE was significantly related to final course grade for both male and female students. It is important to note that R^2 measures in this study are low which is not unusual for cross-sectional data (Wooldridge, 2012, p. 370).

This study confirms that time spent on task is important for student success, such that as RE increases, final grades were also likely to increase. RE scores were not influenced by a student's perception of their own level of intelligence, but for female students results did show

that RE was influenced by how much they perceived themselves to positively contribute to their class. EE scores were shown not to be influenced by perceived contribution in class, but for female students results did show that EE was positively related to students' perception of their own level of intelligence. The two measures of effort that included social capital, RESC and EESC generate similar results which imply that the social engagement piece seems to be significant for female students, but not for their male peers.

Overall, the empirical results lend some evidence to the relationship between perceived student intelligence and effort spent studying among female students, but no significant relationship can be identified for male students. One potential explanation is that male students in our sample may be overly confident on their perceived level of general intelligence such that study effort is considered unnecessary. Female students from our sample, however, may perceive effort invested into studying as efficient use of intelligence with rewarding payoff in terms of their final course grade. Measures on actual level of intelligence (for example, IQ tests) may yield different findings that are deemed valuable for comparison purposes.

This study would have been strengthened by employing a more objective measure of intelligence, or by using more precise information about time spent studying. Further, more information about social capital and class contribution would have been an asset. The classroom survey for this study was conducted at the end of the term when students typically invest more effort and spend more time on studying as various deadline for end-of-term projects and final exams approach. An interesting comparison of our current findings can be made by conducting the survey earlier in the term to perhaps capture more "normal" study habits of students. Furthermore, class attendance, especially that among weaker students, tend to be lower at the end of the term as students become busy to catch up with end-of-term projects. Consequently the timing of our survey for this study may under-represent the population of weaker students.⁴ That is, as also mentioned by Dolton et al. (2003), there may be a potential bias for this research since more successful students have been included in this sample.

Do smart students study harder? It seems that the answer to this question is gender sensitive, and depends on one's perception of ability, contribution and effort. More investigation into these factors is warranted.

ENDNOTES

- 1 Even with the discount for the future, it may be normal that $\beta > 1$ since the duration of working life is usually much longer than that of college life.
- 2 This sample represents 33.8 % all students who enrolled in the first year microeconomics and macroeconomics courses at Mount Royal University during the academic term of Winter 2014 (January-April).
- 3 Since there is no significant coefficients in Regressions #1 and #2 in Table 3, in that case R^2 is not meaningful. In regressions #3 and #4, the coefficient of the constant dominates the coefficient of the explanatory variable. In that case, the R^2 could be impacted by a gender bias.
- 4 A two-sample t-test has been conducted to compare the sample of students who participated in the survey to the population of all students registered in the courses surveyed. The hypothesis that the two groups have equal mean has been rejected and weaker students were shown to be under-represented by our sample.

APPENDIX A

Survey

Please take your time and carefully answer all the questions below.

1. MRU Student ID Number: _____
2. Gender _____ Age _____
3. Program of Study at MRU _____
4. I think that I contribute positively to the class learning environment (circle one).
Strongly-Agree Agree Disagree Strongly-Disagree No opinion
5. I think that my intelligence is _____ compared to other students in this class (circle one).
Higher than Average About the same (Average) Lower than Average
6. How many hours do you spend each week studying (excluding class)?
On average, _____ hours/week
7. How many credit courses did you take this semester? _____
8. How many hours do you spend each week studying (excluding class) for this course?
On average, _____ hours/week
9. For this course, I think my final grade will be (circle one).
A+ A A- B+ B B- C+ C C- below C
10. On average, how many hours do you spend each week socializing with other people for the purposes of studying/learning? Approximately _____ hours/week.
11. On average, how many hours do you spend each week socializing with other people NOT for the purposes of studying/learning? Approximately _____ hours / week.
12. Are you employed? (circle one) Yes No
If you are employed, how many hours a week do you spend working? _____ hours/week.
13. I agree that my instructor can transmit my final grade to the research team (circle one).
Yes No

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THE EFFICIENT DESIGN OF AN ONLINE COURSE: PRINCIPLES OF ECONOMICS

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ABSTRACT

This paper presents a course design template which can be used to bring clarity and simplicity to the online course design process. In order to meet suitable course design standards, it is necessary to have a well-organized course, which would also make for smooth course delivery. This template uses Gagne's 9 Events of Instruction as a framework to design a Principles of Economics Course. It launches off from an official course description, goals or objectives of a course and the standardized departmental core learning outcomes (CLOs), and works through all the course components including schedule of assignments, discussion boards, and feedback. Two CLOs from a standard Principles of Economics course are used to demonstrate how this template can be implemented to meet Quality Matters (QM) standards.

Keywords: Online, Principles of Economics, core learning outcomes, CLOs, course design, Gagne's 9 Events of Instruction, Quality Matters

INTRODUCTION

Online education has become an increasingly popular delivery medium of course content for degree programs in higher education (Harasim, 1996; Phipps & Merisotis, 2000; National Center for Education Statistics, 2013; Allen & Seaman, 2014). Faculty members in traditional brick and mortar universities are finding that they have to reconfigure their face-to-face (F2F) course offerings into online format or design afresh new courses for online delivery. Many of these attempts use an ad hoc approach to online course planning. As noted by Carr-Chellman (2000), "The essence of an online course is the organization of learning activities that enable the student to reach certain learning outcomes." For an online course to be effective and to "provide significant learning experiences" (Fink, 2013), it needs to be designed systematically, mapping the course content to each Core Learning Outcome (CLO) in order to fulfill the overall Course Objective. This illustrates the concept of alignment, where critical course elements work together to ensure that students achieve the desired learning outcomes (Hirumi, 2014; Maryland Online, 2014).

Traditional classes have face-to-face (F2F) interaction with the instructor where much of the information is shared verbally. In the fully online format, however, all of the course delivery is done online. As a result, faculty members, when assigned online courses, are required to change the format of delivery of the course and make it fully online. The approach to course design or the reconfiguring of the course to meet online standards, in many cases, could benefit from improvements to make course planning more effective and efficient.

LITERATURE REVIEW

There are benefits to any well-designed course. For online courses in particular, a well-designed course has significant benefits to instructors as well as students. According to Newberry & Logofatu (2008), instructors desire to maintain a certain level of autonomy over the development of their courses. They do not want to have a course created for them, but prefer to develop their own courses. However, a certain level of standardization across courses would help, and this would give instructors more time to devote to content development and course facilitation (p. 585). This helps instructors who teach the same or similar courses (e.g. Principles of Microeconomics and Principles of Macroeconomics) be able to share instructional resources, and to ensure a quality learning experience for students.

On the part of the students, they need to have a meaningful and memorable learning experience while achieving the desired learning outcomes. When courses are standardized, it decreases the amount of time and effort that students need to put in to learn the course structure and they have more time to spend learning the course material. This is consistent with findings about the importance of consistent course structure and navigation in an online environment (Ralston-Berg, P., Buckenmeyer, J., Barczk, C., & Hixon, E; 2015).

Neuhauser (2002) evaluated two courses with the same content. One was taught online and the other was taught F2F. Her results support prior research findings that there is no significant difference in the major metrics-test scores, assignments, participation grades, and final grades. With the right resources and a good plan, a very strong, effective course can be developed and implemented. Studies have shown that equivalent learning activities can be equally effective for online and F2F learners (Navarro & Shoemaker, 2000; Sitzmann, Kraiger, Stewart & Wisher, 2006; Lovern, 2010).

Johnson-Curiskis (2006) recommends the use of a course template for instructors to use to get started in planning and creating course materials. A template brings clarity and simplicity to the online course design process. In this paper, we outline how to use a course template to create an online course. While other design frameworks are available, Gagne's systematic approach to instructional development and delivery in the form of 9 events that address the conditions of learning, are based in the information-processing model of the mental events that occur when adults are presented with various stimuli.

The Quality Matters (QM) Rubric is a set of standards used to evaluate the design of online and blended courses. The Rubric is complete with annotations that explain the application of the standards and the relationship among them. A scoring system and set of online tools facilitate the evaluation by a team of reviewers.

The focus of QM is to promote student learning, and is essentially a faculty-driven, peer review process. It is restricted to institutions that subscribe to QM Program. QM standards are utilized in this paper while implementing the course template.

The eight broad QM standards are:

1. Course Overview and Introduction
2. Learning Objectives (Competencies)
3. Assessment and Measurement
4. Instructional Materials
5. Learner Interaction and Engagement
6. Course Technology

7. Learner Support
8. Accessibility

Each of these general standards has about four or five specific standards attached to it, making it a total of 43. For this paper, the relevant general standards are #2, #3, and #4.

Quality Matters is the national benchmark designed to certify the quality of online courses and online components. It is sponsored by Maryland Online, Inc, and has generated widespread interest and received national recognition for its peer-based approach to quality assurance and continuous improvement in online education.

METHODS

Syllabus

The first document that students see in any course is the syllabus. The syllabus contains the same information as you would have in a F2F class - such as instructor information, (with online universities, it is always good to include a picture of the instructor to fit a face to the name), course description, textbook and materials, list of the CLOs, attendance and participation requirements, grading policies, and course schedule.

Core Learning Outcomes (CLOs)

Course planning begins with course objectives and clear, specific student outcomes (Johnson-Curiskis, 2006). CLOs drive the entire course development process. They define the learning objectives that the student will be required to grasp and demonstrate upon completion of the course. As Saunders (1998) says to instructors: "It's not what we cover, it's what they learn." This indicates that there are tradeoffs to adding more and more topics to a course. Rather than add more topics, "... the best way to teach introductory microeconomics (or any subject for that matter) is to expose students to repeated applications of a short list of core ideas in the discipline. What students need is repeated exposure to basic concepts through applications (Frank, 1998; Saunders, 1998; Hansen et al, 2001, Salemi, 2005).

At many online universities, the CLOs are provided to the Course Developer by the University. The CLOs are specified in the course Curriculum Guide which the Course Developer or Subject Matter Expert (SME) is to take and use without altering. In other institutions, instructors write their own CLOs. In either case, Vinlove (2006) gives tips on how to write effective CLOs specifically for undergraduate economics courses, giving details about how many CLOs each course should have to adequately cover the course material, at what level of detail the CLOs should be written, and the need to focus on fewer core concepts. This paper also discusses the appropriate language to use in devising CLOs. For example, key words used in writing CLOs are action verbs such as analyze and explain, not know or understand, which are passive words. Bloom's taxonomy can be used as a guide for choosing the right language for writing CLOs. The more specific and precise CLOs are, the clearer it is for students to understand what is expected of them, the end product being better learning taking place (Angelo, 1995; Jiang & Elen, 2011). This communication of expectations is particularly important in online environments, where students are physically separated from the instructor (Hirumi, 2014).

After identifying a few general CLOs (six to ten CLOs would be sufficient for an eight week course), the SME proceeds to write detailed associated sub outcomes, or the enabling

objectives. These enabling objectives refer to what learners must know and be able to do and achieve or otherwise demonstrate the terminal objectives - those at the end of an instructional unit (Hirumi, 2014). A good place to start with devising these enabling objectives is the textbook chapter introduction. The textbook and other course components are applied to fit the CLOs, not the other way around.

An example of a simple CLO typically covered in Week 2 of an 8 Week Principles of Economics Course would be:

CLO #2: Describe and analyze the demand and supply model.

Enabling Objectives for this CLO would be:

1. Define Demand, Supply and Equilibrium
2. Explain the Law of Demand and the Law of Supply
3. Analyze shifts in Demand and Supply and Market dynamics
4. Evaluate government set Price Controls

Another CLO example, for Week 4 of an 8 week Principles course would be one on Gross Domestic Product (GDP).

CLO #4: Explain the different components of GDP

Enabling Objectives for this CLO would be:

1. Define/measure/analyze GDP using Income & Expenditure Approaches
2. Identify elements of GDP – C, I, G, NX
3. Differentiate between Nominal GDP and Real GDP
4. Locate/ interpret GDP data.
5. Evaluate limitations of GDP as measure of economic well-being

APPLYING GAGNE'S NINE EVENTS OF INSTRUCTION

Gagne (1985) posits the existence of nine events that are needed for effective learning. He proposed a systematic approach to instructional development and delivery in the form of instructional events (or Events of Instruction). These nine events are listed in the table below.

Table 1	
GAGNE'S NINE EVENTS OF INSTRUCTION	
1.	Gain Attention
2.	Inform the learner of the objectives
3.	Stimulate recall of prior knowledge
4.	Present the material to be learned
5.	Provide guidance for learning
6.	Elicit Performance (Practice)
7.	Provide informative feedback
8.	Assess performance
9.	Enhance Retention and transfer to new situations

Many universities that offer online courses use Gagne's 9 events of instruction for course design and it has proven to be effective. For this paper, as each event is discussed, suggestions for integration into an online course will be provided, using the Principles of Economics course

as the example.

These Events of Instruction are not iron-clad rules but instead, general considerations to be taken into account when designing instruction. While some steps may work best if rearranged, and some steps may be redundant for some particular lessons, we believe that this is a good checklist to use when designing a course.

1. Gain Attention

The first event describes the process of gaining student's attention. Students are informed why they need to learn what is being taught. This provides motivation for students to persevere through the entire instructional unit.

An instructional strategy that can be used to gain the attention of the learners in an online setting would be to present a dilemma, issue or some controversy as a way to pique their interest. This process needs to be in a relaxed, conversational style of writing.

An appropriate example for an online course would be to start the week in the Introduction Tab with a statement or observation such as:

Class: Do you remember when gasoline prices were around \$1.30 per gallon? Compare to \$3.75 today (hopefully you would be teaching this topic on a day when gas prices are outrageous!)

2. Inform the learner of the objectives

After gaining the attention of students, the next step communicates to the learners what they are expected to do and how they will be assessed. It is important for this to be done in a brief manner, restating the CLO and enabling objectives in the instructor's own words.

Here is an example of this event in practice:

This week, we will be learning some fundamental economics concepts - Demand, Supply and Market Equilibrium. We will learn the Law of Demand which says that when the price of a good rises, the quantity demanded will fall, everything else held constant...

At the end of the week, you will be able to define demand and supply and show how they relate on a graph; explain the factors that determine demand and supply; explain how a market reaches equilibrium, evaluate what happens when the government intervenes in the market to set prices (such as minimum wage and rent control) ...

Going back to the relevant CLO and enabling objectives and rephrasing them in natural language i.e. in your own words is what this step entails.

3. Stimulate recall of prior knowledge

This step bridges prior knowledge to upcoming instruction. This is the "hook" or the idea that relates the newly presented information to what the student may be already familiar with, such as information from a prior week's lesson or life experience.

A good way to stimulate recall of prior knowledge is to initiate a discussion on the Discussion Board (DB) asking students to discuss prior learning that is relevant to this topic. Students get a chance to build on what they already know. This gives a framework to help them learn the new material.

Using our previous gasoline price example, an initial DB question to stimulate recall would be:

If gas prices were still in the \$1.30 - \$1.50 price range, you probably would have a couple of gas guzzlers in your garage and not be feeling the pinch as much as you do today. Right? How would your choices have been different if gas prices were as low as \$1.30 today?

From this discussion, the instructor would be ready to launch into the new topic for the week-i.e. the Law of Demand and related topics. The DB question needs to be one that is broad and open ended, thus allowing for unique contributions from students, while they are still new to the concepts and may not have sufficiently engaged the material.

4. Present the material to be learned

Once the first three steps are completed, the material to be learned in this week's CLO is presented. There are several ways to do this. The primary reason for writing or presenting the lecture is to cover the CLOs. Presenting the lecture in several formats addresses students' differences in learning styles. Multimedia, written text, graphics, audio, video, are all effective vehicles to present the new material to the students. Some universities provide online lectures using Breeze, Wimba, iConnect Live, Class Live Pro, Collaborate, or any of the various platforms for holding synchronous lectures.

In a course such as principles of economics, it is always good to find recent relevant articles from the *Economist*, the *Wall Street Journal*, *New York Times*, and local news sources, which relate to the material and assign readings to the class. The principles course is an opportunity to train students on how to follow current economic news to enhance their interest in economics, and help them learn how to think through economic issues and questions (Hansen et al, 2002). The content is typically explained and then demonstrated with an example or analogy.

The live lecture serves as a vehicle to go over any difficult concepts in-depth, demystify any graphs, and explain equations that the textbook has. It is essential to use real-world examples, anecdotes, case studies, graphical representations, and analogies. If possible, providing a scenario for how the new information can be applied to an industry and career can help reinforce the message in as many ways as possible. However, the lecture must address the CLO. The live lecture could be broken up into mini lectures covering each CLO.

5. Provide learning guidance

This step evaluates the progress of the students, provides guidelines to help them make progress through the course, and supports learning. The discussion board is a great place to provide learning guidance. As students interact in the discussion threads deliberating on the concepts, the instructor can serve as a facilitator, guiding them in their understanding and asking thought-provoking questions to practice those critical thinking skills.

Guidelines, checklists, study guides are also effective ways to help students stay focused and engaged with the material. In this step, key study areas can be listed in a study guide by CLO. Additionally, student instructions for rubrics and deadlines can be provided.

Below are two examples of instructor follow up posts on a Discussion Board:

Jane: Great post! Gasoline prices are on everyone's mind these days! Would you prefer the government to put a price ceiling on gas prices?

Newsflash: Price Cap on Gas = \$2.50 per gallon! What problems would this type of

price control bring in the market for gasoline?

Onodipe & Ayadi (2013) applied the CREST+ model to online principles of economics course to demonstrate how to write effective discussion questions that promote critical thinking and higher order learning in the online classroom. Their paper lists several examples of initial and follow up discussion questions in economics to give instructors ideas to lead online discussion threads successfully. Given the importance of student participation in online learning, it is essential that online instructors produce solid educational discussion questions that engage the students in learning course concepts (Onodipe & Ayadi, 2013).

In a face-to-face class, students may have up to three hours of contact with the instructor each week. The Discussion Board tool of a learning management system (LMS) is a primary avenue for interaction with the instructor in an online classroom. As such, students spend a significant amount of time using this tool as part of their coursework. Most fully online universities have this as a requirement. On the Discussion Board, the instructor makes frequent substantive posts and asks leading questions.

Learning guidance can also be provided during office hours, via prompt responses to email questions (no more than 24 - 48 hours), by creating a "Help" Discussion Board Forum for students to ask and have their general questions answered, or by using the class announcements feature of the LMS.

Below is example of a tip given to students on the Help DB forum:

Class: On this week's assignment, you are required to show the effect that certain scenarios will have on the demand and supply of some goods. If you are trying to show shifts of the Demand curve and you do not have numbers, an easy way to do this is to use MS Paint. Avoid using MS Excel on these types of questions where you are not given any numbers to use to plot a graph.

6. Elicit performance (Practice)

In this step, students get to try out what they have learned. They are not just consumers of their own learning, they are also producers of learning. Quizzes, small group projects, homework assignments, and draft paper submissions are good ways to elicit performance and give ample opportunities for students to practice. This is consistent with a holistic view of active learning (Fink, 2013; Maryland Online, 2014).

A way to practice on the Discussion Board is to ask a relevant question such as:

Class: Think about a product that you have purchased recently (e.g. a laptop, can of soda, Huggies diapers, a Big Mac Meal). How could the law of demand affect your purchase? If the price of this item was higher (or lower), what would you have done differently?

Follow up questions on DB - Give examples of scenarios that would cause a change in demand versus a change in quantity demanded for this product. Discuss the new equilibrium price and quantity that result from these changes. Please demonstrate these changes graphically.

7. Provide informative feedback

Feedback can come in various forms - from self-tests, peers, or the instructor. In this step, the instructor could provide informative feedback to the students. Students can evaluate their understanding of the material and receive prompt feedback when the course is designed to have self-tests such as auto-graded quizzes, Hide and Shows, You Decide, and Study Mate. Making it a requirement for students to respond substantively to other students' posts on the discussion thread, creates a learning community where students can peer evaluate.

The instructor can also provide formative feedback using follow-up posts on the DB. This step is very important when students are learning new information. The instructor is able to evaluate students' progress, and adjust teaching strategy while teaching and learning is still in progress.

Providing informative feedback on the Discussion Board is a way of teaching effectively. This can be done by the instructor posting a follow up question to a student's posts. Assume a student goes off topic while discussing demand and supply. It is the role of the instructor to steer the class back on track with a post such as this:

Jane: How can you relate your example to the topic we are discussing this week? Please be sure to make the connection and use key economics concepts from this week's material to help us make sense of the topic. For example, in your post, you stated that Would this be a MOVEMENT along the same demand curve or a SHIFT of the demand curve?

8. Assess performance

At this point in the course, students would have had practice and feedback to the degree that they should be ready for summative assessment. Summative assessments happen weekly (quizzes), in Week 4 (Midterm) and Week 8 (Final Exam). Some summative assessments happen too late in the learning path (final exam) to provide information at the classroom level and to make instructional adjustments and interventions during the learning process. It takes formative assessment (Step #7) to accomplish this. In this step, the instructor gives general progress information.

A discussion thread assignment assessment/feedback would go as follows:

Jane: We covered CLO #2 this week dealing with SUPPLY and DEMAND. Great posts! You demonstrate a good understanding of Law of Demand in your example where you discussed stocking up on chicken when there was a sale going on at the grocery store.

Recall the participation and quality requirements for this course:

By Wednesday Requirement - Your first post must be by Wednesday. You joined the class discussion on Friday this week.

Frequency of Participation - Recall that you must participate actively during the week (i.e. 3 response posts to each thread).

Quality of Posts - Please use more Economics Vocabulary in each post.

Partial Credit Earned

Frequency of posts = 12/16 points

Quality of posts = 20/24 points

Total points = 32/40 points

The CLO is linked to the gradebook feedback. In this example, the grading rubric for the class is 16 points for frequency of participation, 24 points for quality of posts, for a total of 40 points on this assignment. This student got 12 and 20 respectively. This level of detail in assessment gives a clear breakdown of the 32 points that the student received.

9. Enhance retention and transfer to new situations

In the ninth and final step, the Instructor debriefs the class on what has been learned. This is where a summarization of the learning that has occurred takes place and application to new situations discussed.

Students are able to link what they have learned in the classroom to real world situations. They may be asked to write a reflection on their learning experience (using the Journal Experience which is an add-on feature in Blackboard where students can enter in weekly or daily entries).

For example, as a wrap up post on the DB, the instructor could post the following:

Folks, great contributions! This week, we tackled the issues of demand and supply, market equilibrium, and government intervention in markets. As consumers, we shared many examples of goods and services we purchase regularly. By now we should be able to explain how an event or a policy change can affect supply and demand

Our CLO for the week was:

TCO #2 - Describe and analyze the demand and supply model.

From our discussion in this thread, we confirmed the law of demand which states that consumers buy more when prices rise and buy less when prices rise, everything else held constant. We also saw that price controls such as rent control and minimum wage laws affect equilibrium in the market and lead to shortages and surpluses. Next time, when you hear that prices have risen or fallen for a particular good, you will be able to explain how the forces of demand and supply affect market prices. You will also be able to explain clearly why price controls distort market equilibrium.

We are moving on to Week 3 now. Please continue to post to this forum until you satisfy the participation requirements - you have until Sunday midnight.

TEMPLATE

The format for the online course is CLO driven, not textbook driven. For the template, it is ideal to have one page per CLO. Then proceed to content mapping via Gagne's 9. This template gives a detailed roadmap of the entire course even before you begin writing the content. When you have your course template ready - a page for each CLO - you are ready to do the work of putting in the detailed content into the tabs.

Typically, online courses have tabs for:

1. Introduction
2. Course Objectives and Enabling Objectives
3. Lectures
4. Discussions Board
5. Assignments
6. Exams

Varied skills are required to design and deliver an online course, skills that are not likely to be found in one single individual (Oblinger & Hawkins, 2006; Newberry & Logofatu, 2008). For many fully online universities, the process of course development takes about eight weeks to develop an 8-week course. Typically, a master course is developed and all instructors use this course shell to teach the different sections of the same course. The course development process involves an entire Course Development Team, or an Executive Team (Oblinger & Hawkins, 2006). This team consists of a Project Manager (PM) who oversees and directs the course development and ensures that each course follows university standards and guidelines (e.g. requirements on the proportion of questions that can be Multiple Choice, True/False, or Short Answer, length of time allowed for exams, etc.). The SME is the faculty member who develops the course content, while the Instructional Designer (ID) uploads the course content and suggests any appropriate multimedia interactives (such as StudyMate, Hide & Show, You Decide) to incorporate into the course.

Multimedia takes on a significant role in student learning in the online environment because a course is not just about the content. It involves the creation of a learning environment, the right sequencing of activities, the interaction between faculty and students, and all the activities that will encourage students to lean into the course and be motivated to learn (Oblinger & Hawkins, 2006; Fink, 2013). In fact, interaction between faculty and students and student-to-student is considered the most important element of successful online education. Online discussions and online chatting are an integral part of the online environment (Kearsley, 1998). When students are given multimedia options in the classroom, they tend to have a more gratifying learning experience. The Instructional Designer makes recommendations for content presentation & assignment instructions and implements knowledge-building and interactives.

CONCLUSION

This paper looked at how to create a template for effective online course design using Gagne's Nine Events of Instruction as a framework. We present the nine-step process very simply using two core learning outcomes from a Principles of Economics course as our example.

We believe that systematically implementing this framework for online course design allows professors to be well-organized, students are able to achieve their learning outcomes more smoothly, and the course more easily meets national quality assurance standards for online courses as set by Quality Matters.

The importance of aligning the course's learning goals to the teaching and learning activities is considered a best practice by QM and using Gagne as an instructional strategy provides clarity to the student in terms of what is expected of them. This multifaceted approach to alignment allowed this course to go through QM certification and made the course one where there is significant learning taking place.

Appendix GAGNE'S 9 EVENTS OF INSTRUCTION APPLIED TO CORE LEARNING OUTCOMES (CLO) #2 & #4						
CLO	Enabling Objectives	Week	Introduction (Gagne 1, 2, 3)	Topics/Lectures (Gagne 4, 5)	Assignments/Discussion (Gagne 6, 7)	Assessment (Gagne 8, 9)
#2. Describe/analyze D & S model	<ol style="list-style-type: none"> 1. Define D, S 2. Show D & S relationship graphically 3. Explain Law of D & Law of S 4. Explain the determinants of D & S. 5. Differentiate between a change in quantity demanded/quantity supplied and a change in demand/change in supply. 6. Explain and illustrate how market equilibrium is reached. 7. Illustrate the movement of S & D curves and the resulting new equilibrium price & quantity. 	2	<p>(1). Gain Attention;</p> <p>(2). Describe Goal;</p> <p>(3). Stimulate Recall of Prior Learning Events</p> <p>Intro blurb</p> <p>Restate Objectives</p> <p>Stimulate Recall (example)</p>	<p>(4). Present the Material to be Learned;</p> <p>(5). Provide Guidance Topic</p> <p>1: DD/SS</p> <p>Textbook: Chap. 2</p> <p>Live Lecture Topics: Demand, Law of Demand Determinants of Demand Shifts vs. Movements of Demand Curve ...</p> <p>Videos: Video 2.1 & 2.2.</p> <p>Podcasts: ...</p> <p>Follow up DB Posts: (List of suggested posts)</p> <p>Relevant Articles: link to articles from www.npr.org Wall Street Journal, etc.</p>	<p>(6). Elicit Performance (Practice);</p> <p>(7). Provide Feedback</p> <p>DB1: DD/SS</p> <p>End-of-Chapter Homework Assignment: Ch. 2 (#1, 3, 5, 7)</p> <p>All graded assignments feedback</p>	<p>(8). Assess Performance ;</p> <p>(9). Enhance Retention and Transfer</p> <p>Quiz</p> <p>Term Paper Topic</p>

#4. Explain the different components of GDP	<ol style="list-style-type: none"> 1. Define/measure/analyze GDP using Income & Expenditure Approaches 2. Identify elements of GDP – C, I, G, NX 3. Differentiate between Nominal GDP and Real GDP 4. Locate/analyze/interpret GDP data. 5. Examine trends in U.S. economic growth 6. Evaluate limitations of GDP as measure of economic well-being 7. Identify the sources of economic growth in the US 	4	(1). Gain Attention; (2). Describe Goal; (3). Stimulate Recall of Prior Learning Events Intro blurb Restate Objectives Stimulate	(4). Present the Material to be Learned; (5). Provide Guidance Topic 1: GDP Textbook: Chap. 5 Live Lecture Topics: Defining GDP Components of GDP Real vs. Nominal GDP GDP & Econ. Wellbeing Videos: Video 5.1 & 5.2 Podcasts: ... Follow up DB Posts: Relevant Articles: link to articles from www.npr.org <i>The Economist</i> <i>Wall Street Journal</i> <i>New York Times, etc.</i>	(6). Elicit Performance (Practice); (7). Provide Feedback All graded assignments DB1: GDP Data Analysis DB 2: GDP and Economic Wellbeing End-of-Chapter Homework: Ch. 5 (#1, 2, 3, 4)	(8). Assess Performance ; (9). Enhance Retention and Transfer Quiz Midterm Exam Term Paper Topic
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THE IMPACT OF BRAZIL'S "BROADBAND AT SCHOOL PROGRAM" ON STUDENT ACHIEVEMENT

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ABSTRACT

Instituted in Brazil in 2008, the "Broadband at School" program aimed to bring broadband to all urban public schools. This paper examines the effect of this program on the schools' average Portuguese standardized scores of 9th graders. To establish causality, the possibility of endogeneity, specifically, that better schools are more likely to participate in the program which would bias the effects of program participation upwards, must be considered. We address this issue in several ways. First, we investigate official policy dictating program participation to verify if it is linked to school performance. In addition, we verify how exogenous program participation is to observed characteristics that are likely to be correlated with unobserved and potentially problematic variables and perform falsification exercises. Although we find no definitive evidence that program participation is endogenous, an extensive list of controls is considered and the method used is system GMM, which explores the panel aspect of the data and is robust under the assumption of endogeneity of program participation. Our overall finding is that "Broadband at School" program improves students' scores.

INTRODUCTION

In Walter Isaacson book *Steve Jobs*, Jobs and Bill Gates are discussing the use of the internet in the future. Isaacson notes that "Gates sketched out his vision of what schools in the future would be like, with students watching lectures and video lessons on their own while using classroom time for discussions and problem solving. They agreed that computers had, so far, made surprisingly little impact on schools-far less than on other realms of society such as media and medicine and law (pp. 553-554)." This conversation was in May 2011. While we are not at Jobs and Gates vision for the future yet, this paper illustrates that schools and students having access to the internet has, over time, increased student achievement in both developed and developing countries.

This paper examines the effects of the Broadband as School Program, a nationwide program that aimed to connect all urban public schools to the internet, on students' academic performance in Brazil. Utilizing a very detailed dataset collected by the governmental agency "Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira" (National Institute of Educational Research Anísio Teixeira) or INEP, we are able to control not only for the use of the internet at home and at school but also for many variables that, according to the literature, affect the impact of technology on students' performance, such as parental support and teachers' education and pedagogical practices. The data is also a panel (years 2007, 2009 and 2011) and we exploit this aspect in our identification strategy.

Using Arellano and Bover (1995) methodology, we find evidence that, as the number of months the school participates in the program increases, the school average achievement scores in Portuguese improve. This is consistent with the idea that Internet and other computer tools are more effective the longer that teachers have time to get used to the technology and software. The results are particularly relevant considering the amount of money spent by governments around the world on the implementation of technology in the classroom in both developed and developing countries, including Britain (Becta, 2009a, b), Europe (Korte & Husing, 2006), USA (Office of Educational Technology, 2004), Brazil (Sprietsma, 2012; Fidalgo-Neto, Tornaghi, Meirelles, Berçot, Xavier, Castro, & Alves, 2009), Nigeria (Aboderin, Fadari & Kumuyi, 2012; Edoho & Umoh, 2013; Adebule & Adebule, 2013), Peru (Cristia, Czerwonko, & Garofalo, 2014), Romania (Malamud, 2011), Turkey (Inal, Kelleci & Canbulat, 2012) and Zimbabwe (Musiyandaka, Ranga & Kiwa, 2013).

However, even though recent studies find that small increments in standardized test performances yield considerably higher annual growth rates (Hanushek and Kimko, 2000, World Bank, 2008), the magnitude of the impact is small. This is not completely unexpected since previous studies investigating the impact of broadband find negative or at best ambiguous results. We discuss potential explanations for why our results differ. In particular, we speculate that, in addition to the fact that the impact of the internet seems to be small, the lack of recognition that academic performance should be modeled as dynamic process and weak instruments may be driving those differences.

The rest of this paper is organized as follows. Section 2 presents a literature review, Section 3 summarizes the Broadband at Schools program. The methodology is described in Section 4, Section 5 presents the results, and Section 6 concludes.

LITERATURE REVIEW

Hundreds of studies investigate the impact of computer technology instruction (CTI) on student achievement. For instance, Li and Ma (2010) presents a meta-analysis of 46 studies conducted since 1999 and, in most cases, CTI has a statistically significant improvement on students' math achievement. Similarly, Sivin-Kachala (1998) reviews 219 research studies and reports that students using CTI experience positive effects on achievement tests in all major subject areas.

However, these studies have been criticized since they do not take into account the possibility of endogeneity (Cuban & Kirkpatrick, 1998; Webbink, 2005, Belo et al., 2011). For instance, assume that the overall quality of the school is unobserved or cannot be measured. If higher quality schools are more likely to adopt CTI, then the students' better performance may result from the schools' quality level, not from the policy implementing CTI.

The traditional way to handle endogeneity is to find an instrument, that is, an exogenous variable that is correlated with students' performance and with CTI but it is uncorrelated with any unobserved effects. Belo et al. (2011) summarizes more recent works that circumvent endogeneity by exploiting a variety of instruments. In contrast to previous studies, most of these authors find that CTI has ambiguous or even negative effects on students' performance. Those include Angrist & Lavy (2002), who use the randomly determined (by a lottery) timing of school computerization in Israel as an instrument, Leuven et al. (2007), who use discontinuity in subsidies given to schools to acquire computers to instrument their equations, and Malamud &

Pop-Eleches (2010), who use discontinuity in subsidies given to disadvantaged families to acquire a home computer.

Regarding the impact of specifically the internet on students' academic performance, as in the case of this paper, the results are also inconclusive, ranging from positive (Jackson, von Eye, Biocca, Barbatsis, Zhao & Fitzgerald, 2006; Judge, Puckett & Bell, 2006; Lei & Zhou, 2012) to neutral (Goolsbee & Guryan, 2006; Adebule & Adebule, 2013) and even negative (Inal, Kelleci & Canbulat, 2012, Vigdor & Ladd, 2010; Wainer, Dwyer, Dutra, Covic, Magalhães & Ferreira, 2008, Kozma, 2003).

Two discussions emerge from these conflicting results. The first regards the correct implementation of technology. For instance, Vigdor & Ladd (2010), Belo et al. (2011), and Malamud (2011) argue that increased availability of high speed internet is associated with less frequent computer use for homework and access to broadband internet may actually crowd out studying effort by introducing new options for recreational use. Having monitored research on the effectiveness of technology in education on students' outcomes for more than 20 years, ISTE (2008) researchers claim as one of their main conclusion that correct implementation of education technology is key. Lei (2012) finds that home internet, when combined with parental support, improves students exams' scores.

We agree that not only availability but also the correct use of internet is required to improve students' academic performance. Although specific details regarding the implementation of internet are absent in our data, one way to look at it is that it takes time for teachers to adapt successfully to the new technology and feel comfortable using it in their school. We use the time between program participation initial date and the date of the exam, measured in months, to proxy the instructors' adjustment to the policy.

A second discussion regards the statistical methodology used to control for endogeneity. Blundell and Bond (1998) consider the estimation of firms' production functions using a dataset characterized by 1) large number of cross section units; 2) a small number of time periods; 3) highly persistent series, including dependent and independent variables; and 4) not necessarily exogenous dependent variables. While we are estimating human capital production functions, note that our data is similar to theirs in these four aspects. The persistence of academic performance suggests a dynamic modeling approach, a fact that has been ignored by most authors probably because of the statistical difficulties it adds to the already existing issue of endogeneity. Specifically, one must not only find an instrument for internet adoption but also tackle the endogenous lagged dependent variable included as a control.

One standard procedure in this case is the use of difference GMM estimators which take first differences to eliminate unobserved cross-section units (schools) effects and lagged instruments to correct for the simultaneity in the first difference equation (Blundell and Bond, 1998). Another advantage of this approach is that it only requires instruments that are "internal"-based on lags of the instrumented variables. This is important since, in all papers cited in this literature review that use instruments, one must be willing to accept, for identification purposes, that the instrument, after controlling for the independent variables, is not a relevant determinant of academic performance and thus can be excluded from the second-stage regression.

However, because the dependent variables are also highly persistent, lagged levels are only weakly correlated with subsequent differences and, thus, constitute a weak instrument, which can result in large finite-sample biases (Blundell and Bond, 1998). Blundell and Bond (1998) also show that these biases can be dramatically reduced by exploiting reasonable

stationarity restrictions on the initial conditions process. Specifically, they proposed “the use of lagged first differences as instruments for equations in levels, in addition to the usual lagged levels as instruments for equations in first differences (pp. 2).” This methodology, called System GMM, is the one adopted in this paper.

Finally, since this paper is based on student achievement in Brazil, we review some papers that study the use of CTI in the Brazilian school system. Those are rare and also find that technology has an ambiguous impact on academic performance. Most authors argue that this ambiguity is caused by a lack of effectiveness on the implementation of CTI. For instance, Fidalgo et al. (2009) examine 35 schools in Brazil. They find that in the schools they study there were 46,958 students and only 416 computers. The paper reports that “most of the teachers use the laboratories once in 2 months for their classes (pp. 683).” Teachers were too busy to use the CTI. Some teachers spent over 60 hours a week in classes. The paper also reports a lack of technical support for the use of the computers. Teachers in this study were not trained to use CTI and therefore avoided it.

Güzel and Berberoğlu (2005) study student assessment on the PISA 2000 for students in Brazil, Japan and Norway. They point out that some teachers in Brazil “are insufficiently prepared with low levels of education, low salaries and few material resources... Few people want to be teachers and many teachers have other jobs to complement their salaries... And that many teachers leave their present jobs as teachers to get other jobs with better salaries (Güzel and Berberoğlu, 2005, pp. 286).” Despite these conditions, in some schools they find that “When the magnitudes of the path coefficients were taken into consideration, the latent independent variable having the strongest effect on reading literacy is the Use of Technology in Brazil (Güzel and Berberoğlu, 2005, pp.298).”

Badasyan and Silva (2012) use a similar data set and find that CTI can result in higher achievement levels for students if they are combined with home internet access, encouraging Brazil to use policies to encourage access to the internet for students in the home. Note, however, that while we use school level data, they use student level data and, therefore, are unable to explore, in the same depth, its panel aspect.

THE BROADBAND AT SCHOOLS PROGRAM

Launched on April 4, 2008 by the Federal Government, The Broadband at Schools program aims to connect all urban public schools to the internet (The information in this section comes from the Ministry of Education website). In most cases, the type of service is ADSL (Asymmetric Digital Subscriber Line), but in some regions satellite connections are being used. According to the plan, connection speed to download must be at least two megabit per second and at least a quarter of that speed to upload. The management program is made jointly by the Ministry of Education and the National Telecommunications Agency (ANATEL), in partnership with the Ministry of Communications, the Ministry of Planning, the States Department of Education and other government agencies at the municipal level. The participant carriers [Oi (Telemar), Telefônica (Telesp), SERCOMTEL e CTBC] were supposed to enable the connection of all of urban public schools before the year of 2010 and keep the service free until 2025. In return, the carriers were freed from certain previous requirements to install telephone services. In addition, the Government waived the collection of any tax that would focus on the provision of the service or the donation equipment, so there's a greater sense of public-private partnership

established to solve the problem of connecting schools (Ministry of Education, 2010). By April 2013, of the 70,399 schools contemplated in the project, 65,207 were already connected (ANATEL, 2013).

For the purpose of this paper, it is important to mention that the installation of the connection must be made available in the computer lab of each school and the priority of its use is for educational activities. It can be used for administrative demands only if it does not interfere or compete with the use of the internet by students.

DATA AND METHODOLOGY

Data Description

The data comes from two sources. The first is the “Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira” (National Institute of Educational Research Anísio Teixeira), or INEP, in 2007, 2009 and 2011 (The methodology allows one to compare the performance of schools over time. The grade scale ranges from 0 to 350 points. For a detailed description of the levels of scale performance and its pedagogical interpretation, see INEP’s website). It contains the average Portuguese standardized scores of 9th graders in all urban public schools. The data also comes from 3 questionnaires that were administered along with the performance tests. The first contains information regarding the school, the second was answered by each instructor, the third by each student. The final data was put together at the school level. Thus, the student and the instructor level data were transformed into averages or percentages; for instance, the percentage of teachers in the school that have a graduate degree and percentage of students in the school that are female.

The second part of the data comes from the “Agência Nacional de Telecomunicações” (ANATEL), the Brazilian telecommunication regulation agency. It contains the complete list of schools that participate in the program along with the date when the broadband connection was first installed. We used this data to construct our main control variable of interest, that is, the number of months since program participation. Both datasets were merged using the school’s identification number system created by INEP and present in both datasets. The complete list of variables and their descriptive statistics for each year are presented in Appendix A.

The list of variables is extensive: 46 from the schools’ questionnaire, 75 from the instructors’, and 50 from the students’. This is reassuring since we are able to control for many important determinants of test scores such as the infrastructure and safety of the schools, the experience and level of education of instructors, the students’ parents attitudes towards school, permanent assets, and so on. Nevertheless, the inclusion of so many variables can complicate the analysis since it may introduce multicollinearity among the regressors. Additionally, observing the aggregate effect of some of these variables may be more efficient than modeling each variable separately (Çoban and Topcu, 2013). Note that multicollinearity does not violate the data generating process assumptions required in the estimation procedure and simply dropping variables may cause omitted variable bias (Wooldridge, 2013, pp. 95-96). However, if the variable of interest (number of months since program participation) is highly collinear with the other explanatory variables, the variance of the estimated parameter of this variable may be so high that its coefficient is not useful (Wooldridge, 2013, pp. 95-96). As it turns out, the variance

inflation factor of program participation is 2.65, far below 10, which is the rule of thumb for considering multicollinearity a “problem”.

Although we also report results where all variables are included as part of our robustness checks, in our main results we reduce the number of regressors by performing PCA (Principal Components Analysis). This technique is vastly used in the literature (Recent theoretical discussions include, for instance, Doz et al. (2011) and Breitung and Eickmeier (2011). For some empirical applications, see Adrian et al. (2013), Castle et al. (2013), Çoban and Topcu (2013), Marshall et al. (2010), among others). The choice of variables to be grouped was natural in this paper’s case because the questionnaires are organized in blocks (see Appendix A). For instance, from the first 11 variables, from Building_1 to Building_9 and then Classroom_10 and Classroom_11, were extracted 11 Principal Components. We used the traditional rule of thumb and retained the components whose Eigenvalue was larger than one. More details regarding the PCA are in Appendix B.

Identification Strategy

Two likely sources of endogeneity are the inclusion of the lagged dependent variable as a control and the possibility that school enrollment and program participation are not exogenous. In particular, if better schools are more likely to participate in the program, the coefficient of program participation will be biased upward. In this section we investigate these issues further and find no definitive evidence that program participation is endogenous, although this possibility is still taken into account in this paper’s choice of methodology.

The central concern is the possibility that unobserved variables relevant to academic performance may be correlated with program enrollment. However, the time-invariant unobserved heterogeneity, such as geographic location, is already being controlled for by the panel aspect of the data. Therefore, this paper’s main concern is related to unobserved variables that vary over time, such as pedagogical improvements.

One way to address this possibility is by investigating the official policy dictating program participation. The procedure to determine the order in which schools are selected does not seem to rely on time-variant characteristics, but mainly on geographic ones. Specifically, according to the official process of building the participation schedule, the broadband carriers take the first step and prepare an initial proposal for installation of broadband for each quarter. The proposal is based initially on expanding the network structure achieved in this period by each of the carriers. Second, the Ministry of Education analyzes the proposals and directs them to the Secretaries of State and Local Education, which return the proposals to the same Ministry with suggestions of replacement schools. The suggestions are submitted to carriers and, if there is technical feasibility, must be met.

Another approach is to verify how exogenous program participation is to observed characteristics that are likely to be correlated with unobserved and potentially problematic variables. Consider first income and parents’ education. In Figure 1, for each number of months of program participation (all schools that do not participate in the program, all schools in the program for one month, 2 months, and so on), the average of the first income index and the first parents’ education index obtained by PCA were calculated.

Note that the schools in the program for a longer period of time tend to have higher income and more educated parents. On the other hand, up to 25 months of program participation,

the relationship between these variables is not clear. It is also interesting to graph the language scores versus program participation as illustrated in Figure 2.

There is no indication that the schools with higher grades were more likely to be selected in the program first. Finally, the possibility of selection bias is further investigated by a methodology similar to those of Fitzsimons and Mesnard's (2013) and Maio and Nandi's (2013). These authors propose a falsification exercise following the idea that, if program participation is quasi-random, then future participation in the program should not depend on current performance. For that purpose, we construct a dummy variable that is equal to one if a school is not currently participating in the program but starts participating in the next year and zero in case the school does not participate in both periods. (Note that once schools start participating, they are excluded from this regression.) We then estimate the following probit models. In the first, the probability of starting participation in the next period is a function of the current language scores of each school. In the second, the same probability is a function of the difference between this year's and last year's scores. Unexpectedly, in our sample, the higher the performance of the school, the lower the probability of starting to participate in the program (coefficient is -0.02, p-value equals 0.000). Similarly, the higher is the improvement in the score, the lower is the probability of future participation (coefficient is -0.08, p-value equals 0.000). The inclusion of dummy for states or income index does not change this result.

Figure 1
INCOME INDEX AND PARENT'S EDUCATION INDEX VERSUS PROGRAM PARTICIPATION

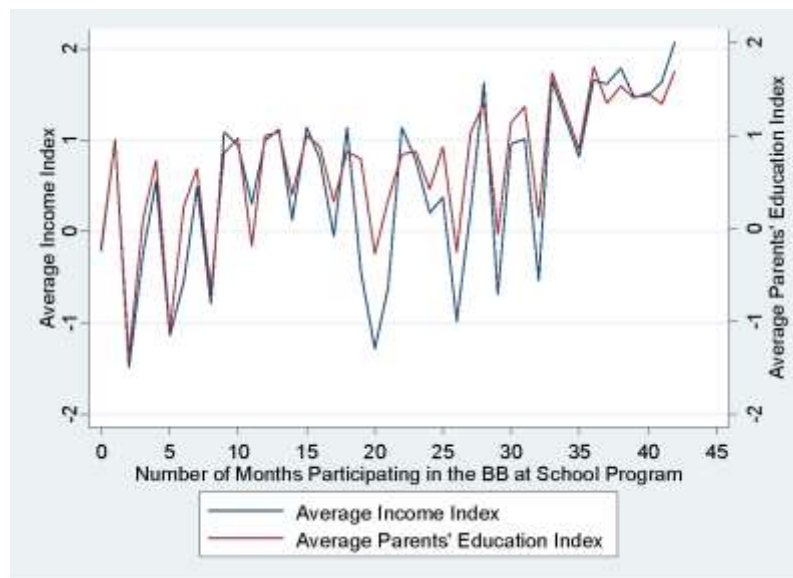
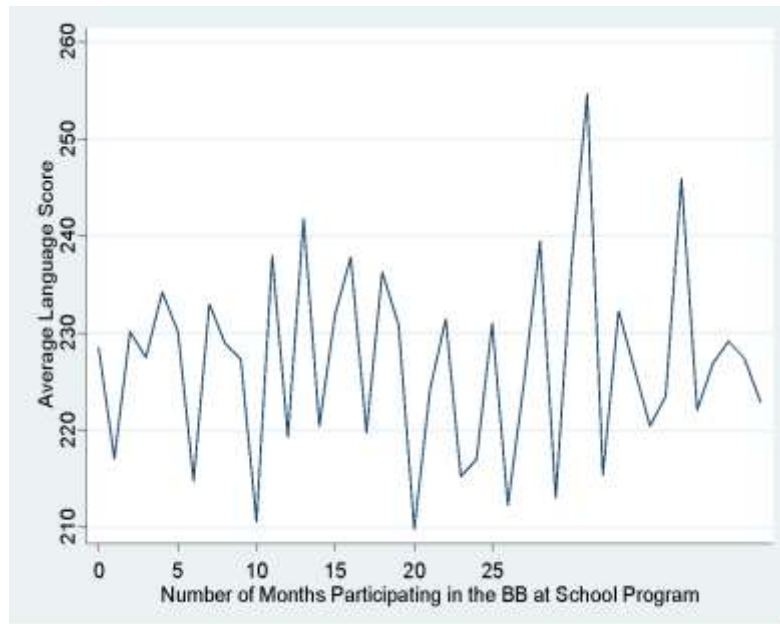


Figure 2
AVERAGE LANGUAGE SCORES VERSUS PROGRAM PARTICIPATION



Considering these pieces of evidence together, one cannot conclude unambiguously that better schools are more likely to participate in the program first. Figure 1 may indicate a “try-out” period where the more privileged schools were selected first, but according to the falsification exercise, after that better schools did not seem to have priority in program participation. If program participation is exogenous, the interpretation of its coefficient is straightforward and independent of the inclusion of any control variable. However, although we are cautiously optimistic, we still address the possibility of endogeneity in different ways. First, we include many school, student, and instructor related variables as controls. Second, the dynamic panel-data methodology developed by Arellano and Bond (1991) and Arellano and Bover (1995) is utilized. These authors’ methodology is appropriate for our dynamic model and data since it is designed for situations with few time periods and many cross-section units, independent variables that are possibly endogenous (such as program participation, our variable of interest), correlated with past and possibly current realizations of the error, fixed effects, and is also robust in case of heteroskedasticity and autocorrelation within schools (Roodman, 2006; Çoban and Topcu, 2013).

Methodology: System GMM

Following Arellano and Bond (1991) and Arellano and Bover (1995), the following equation is estimated:

$$Average\ Score_{i,t} = \alpha + \beta\ Average\ Score_{i,t-1} + \gamma BB_{i,t} + \delta' x_{i,t} + \varepsilon_{i,t} \quad (1)$$

where i indicates the school, t the time period (2007, 2009 or 2011), the average score represents the average language score of the nine graders taking the test, BB is the number of

months since the school started participating in the Broadband at School program, x is the vector of controls (which include time dummies), and α , β , γ and δ are the parameters to be estimated.

The estimation method is an extended version of GMM known as system GMM where a system of two versions of equation (1) is estimated, the first in levels (with lagged first differences as instruments) and the second in differences (with lagged levels as instruments). Estimating only the first version, a method known as Difference GMM, has the disadvantage that lagged levels are often poor instruments for first differences, especially for variables that are close to a random walk. Monte Carlo simulations show that the extra instruments (in the second version) bring more relevant information (Blundell and Bond, 1998), but require the extra assumption that lagged change in the dependent variable to be uncorrelated with the errors. Difference-in-Hansen tests of exogeneity of the extra instruments show that they are valid (See Table 1). The variable $BB_{i,t}$ is assumed endogenous (that is, not independent of current disturbances). Finally, since two-step System GMM systematically produces downward biased standard errors, standard errors reported in the paper were computed by Windmeijer (2005) small sample correction procedure.

RESULTS AND DISCUSSION

The main results are presented in Table 1. For conciseness, considering our lengthy list of controls, only the results concerning the variables of interest are reported (the complete table is presented in Appendix C). As expected, the current school average performance of Portuguese scores is highly dependent on the previous period's scores, as can be seen by the positive sign and significance of the coefficients of this variable's lag (first row). Thus, ignoring that academic performance is a dynamic process would be a mistake. Our main variable of interest is, however, the number of months since the school has started participating in the program (second row). Note that the coefficient is positive and significant. This is interesting in a country such as Brazil where, due to high repetition and dropout rates, fewer than 22 percent of students attend through ninth grade and only 8 percent are deemed literate (World Bank, 2008). To use the internet requires a minimum level of reading skills and, in a country where even the basic reading is lacking, the use of internet seems to have a larger impact. We also display the results of a second regression where the sample is restricted to schools with up to 25 months of program participation, going back to the issue addressed by Figure 1. The results still have the same sign but are less significant. This may be due to the sample being smaller. However it still confirms the results reported with all of the observations. Finally, we divide the observations into three group based on the average of the first income index of the students attending the schools and run regressions for the lowest income level and the highest income level schools. Once again the results for months of program participation and months squared have the same sign but have a higher level of statistical significance for the schools that have students that come from higher income level households. There are a number of possible reasons for this result. These students are more likely to come from households with more human capital and are more likely to have more involved parents and perhaps have more opportunities outside of school to use the internet. The three extra regressions make us more confident of the robustness of our results. The square of the number of months in the program is also included since the effects of this variable are not expected to be linear. The estimated coefficient is negative, of smaller magnitude, and significant, indicating that the effects of this program are positive but decreasing.

Table 1
DETERMINANTS OF SCHOOL-LEVEL LANGUAGE SCORES

Specification	All observations coef/p-value	Restricted Sample: up to 25 months of program participation coef/p-value	Restricted Sample: 1/3 lowest income coef/p-value	Restricted Sample: 1/3 highest income coef/p-value
Lag of language Score	0.158**	0.282***	0.192**	0.113
	(0.011)	(0.000)	(0.014)	(0.259)
Program participation (months)	1.059***	0.753*	0.781*	1.876***
	(0.003)	(0.081)	(0.069)	(0.000)
Program participation (months) squared	-0.021**	-0.021	-0.014	-0.040***
	(0.011)	(0.358)	(0.145)	(0.001)
Percentage of students with internet at home	17.673***	19.047***	33.069***	17.602**
	(0.003)	(0.010)	(0.000)	(0.026)
Number of observations	20,467	14,210	9,333	7,585
Sargan test p-value (null: validity of instruments)	0.458	0.439	0.938	0.650
Hansen test p-value (null: validity of instruments)	0.192	0.034	0.736	0.315
Hansen test of level equations p-value (null: validity of level equations)	0.587	0.430	0.660	0.180
Number of instruments	199	199	199	199
Notes: *** p<0.01, ** p<0.05, * p<0.1. Controls (as described in text, see Appendices A and B) and time dummies included.				

It is also important to note that the magnitudes of these coefficients are small. Approximately, one extra month in the program tend to increase the average score by a little more than 0.15 points, not much considering that the scores range from 0 to 336 points. On the other hand, the results must be interpreted in the light of recent contributions in the economic growth literature. For instance, The World Bank (2008) cites studies performed in the United States which consistently suggest that one standard deviation increase in standardized mathematics tests at the end of high school translates into around 12 percent higher annual earnings. Although this result cannot be generalized to 9th graders in Brazil, there is evidence that the returns to the quality of education may be even larger in developing countries (Hanushek and Wößmann, 2007). The World Bank (2008) also reviews studies examining the effect of the quality of education on economic growth. For instance, using country cross-sectional data, Hanushek and Kimko (2000) find that one standard deviation higher test performance would

yield around one percentage point higher annual growth rates. Despite all known limitations of such empirical estimations, these results suggest that even small increments on the quality of education may represent significant economic impacts. As in Badasyan and Silva (2012), the effect of the internet at home is much larger than that of program participation. However, internet at home is highly positively related to other determinants such as income and parents education. In any case, internet at home and all other controls were included to increase precision.

The crucial assumption for the validity of GMM estimates is that the instruments are exogenous (Rodman, 2006). Both the Sargan and Hasen statistics, the null being the exogeneity of the instruments, are mostly not significant, providing evidence of the validity of the methodology. In addition, the Hansen test for the validity of the level equations is also not significant, a result that is especially important since it justifies the use of System GMM instead of Difference GMM. (For details on these tests, see Rodman, 2006.)

Robustness Checks

To verify if the choice of technique is driving our results, we re-estimate equation (1) using a simple OLS where the possible non exogenous variables are proxied by their lags (That is, all variables except for the dummies indicating the students' gender, ethnicity, presence of mother or female guardian, presence of father or male guardian, parents' educational level and the year dummy. A lag of the previous year dependent variable is also included). The variance matrix is estimated by the Huber (1967) and White (1982) sandwich estimator, which provides asymptotically consistent estimates of the covariance matrix without making distributional assumptions about the error term and even if the parametric model fails to hold. We also take into account that the data is clustered at the school level by repeating the procedure above but assuming the population average model, which uses the generalized estimating equation (GEE) approach, in place of OLS. The results are presented in Table 2 (first two rows). Only the coefficients of our main variable of interest are presented in order to save space, all other results are available upon request. Note that both specifications present significant coefficients. However, both of them ignore the issue of endogeneity.

Given the possibility that the use of PCA is somewhat altering our main results, we run the system GMM estimations again including all variables (without reducing the dataset by PCA). We also investigate if our main results are being compromised by the presence of missing values. Frequently researchers perform their analysis using only the complete units, excluding all observations with missing variables, a procedure known as listwise deletion (Truxillo, 2005; SAS, 2011). However, as the number of variables increases, the number of incomplete cases may augment drastically. For instance, a one percent probability of missing for 10 variables would leave 90 percent of the data for analysis, while the same one percent probability of missing for 100 variables would leave only 37 percent of the data (Truxillo, 2005). In this paper, there are at least 170 control variables and, for some variables, as common in social studies, more than 10 percent of the observations are missing. A common procedure in the literature in these cases is to use multiple imputations (For recent applications, see Cheatham and Elliot, 2013, and Zhang, 2013). Specifically, we create several complete datasets using the imputation model suggested by Raghunathan, Lepkowski, Hoewyk & Solenberger (2001) which estimates the missing values of each variable conditional on all other observed variables on a "variable-by-variables bases"

(UCLA, 2012b, pp. 11). The parameters of interest are estimated in all datasets and those estimates are later combined to obtain an improved parameter estimate (Acock, 2005). The reasoning is that, since a single imputation omits possible differences between multiple imputations, the standard errors will be underestimated and, therefore, the level of precision overestimated (Schafer, 1997; Acock, 2005).

Table 2 ROBUSTNESS CHECKS		
Specification	Coefficient of Program Participation (months) coef/p-value	Coefficient of Program Participation (months) squared coef/p-value
Robust OLS	0.130*	-0.000
	(0.091)	(0.873)
Average Population Model	0.130*	-0.000
	(0.091)	(0.869)
System GMM, no PCA	0.840***	-0.017***
	(0.002)	(0.007)
System GMM, Multiple Imputations	0.791***	-0.016***
	(0.002)	(0.007)
Notes: *** p<0.01, ** p<0.05, * p<0.1. Controls (as described in text, see Appendices A and B) and time dummies included.		

As can be seen in Table 2, in these alternative specifications, similar to our main results, the coefficients of our variable of interest are positive and significant. Therefore, they support that program participation has a positive effect on the student's' performance.

CONCLUSION

As far as we know this paper is the first that focuses on the months that the schools are in the program as a key determinant of achievement scores. We show that, as the number of months the school participates in the program increases, the achievement scores in Portuguese slightly improves. This is consistent with the idea that CTI is more effective the longer that teachers have time to get used to the technology and software.

While this study is limited to Brazil, we think that the analysis of CTI should include some measure of time especially if the program is in a country or area where CTI is new. We also recognize that student achievement can be measured in many ways besides scores on standardized tests. We encourage research that evaluates CTI on other outcomes. It is our belief that CTI does enhance student learning whether the measure of output is scores on standardized tests, credit retention, or other measures of achievement.

APPENDIX A

Table A1
SCHOOLS' QUESTIONNAIRE

		2007		2009		2011	
Variable	Definition	Mean	SD	Mean	SD	Mean	SD
language_9	School's average language score	227.2	17.22	237.8	18.61	217.2	67.56
math_9	School's average language score	238.9	18.96	241.0	19.89	223.1	70.20
BB_PB	Number of months between Prova Brasil and participating in the program BB at schools	0.00	0.00	4.91	5.39	22.56	13.60
size_class	Average class size (weighted by the number of students)	24.7	6.81	25.13	6.17	31.40	6.87
Dummy: building structure listed below is adequate							
Building_1	Roof	0.87	0.34	0.85	0.35	0.87	0.34
Building_2	Walls	0.94	0.25	0.93	0.26	0.93	0.25
Building_3	Floor	0.87	0.34	0.87	0.33	0.89	0.31
Building_4	Doors	0.85	0.35	0.84	0.37	0.84	0.37
Building_5	Windows	0.85	0.36	0.84	0.37	0.85	0.35
Building_6	Bathrooms	0.78	0.42	0.78	0.41	0.79	0.41
Building_7	Kitchen	0.86	0.35	0.88	0.32	0.89	0.32
Building_8	Plumbing	0.81	0.39	0.81	0.40	0.82	0.39
Building_9	Electric system	0.80	0.40	0.79	0.41	0.79	0.41
Dummy: classrooms' characteristic listed below is adequate							
Classroom_10	Illumination	0.89	0.31	0.91	0.29	0.92	0.27
Classroom_11	Air circulation	0.82	0.38	0.79	0.41	0.85	0.36
Dummy: safety measure listed below is adequate							
Safety_21	Fences or walls	0.73	0.44	0.78	0.42	0.80	0.40
Safety_22	Control of students arriving and leaving the school	0.93	0.25	0.95	0.23	0.96	0.20
Safety_23	Control of strangers arriving and leaving the school	0.92	0.28	0.93	0.26	0.94	0.24
Safety_24	Locked gates	0.83	0.38	0.85	0.36	0.88	0.32
Safety_25	Security Guard during the day	0.50	0.50	0.52	0.50	0.54	0.50
Safety_26	Security Guard during the night	0.61	0.49	0.61	0.49	0.62	0.49
Safety_27	Security Guard during holidays and weekends	0.55	0.50	0.55	0.50	0.57	0.50
Safety_28	Safety Measures against theft	0.33	0.47	0.35	0.48	0.37	0.48
Safety_29	Safety Measures against drugs inside school	0.23	0.42	0.25	0.43	0.29	0.45
Safety_30	Safety Measures against drugs around school	0.31	0.46	0.34	0.47	0.39	0.49
Safety_31	Fire alarms	0.47	0.50	0.50	0.50	0.52	0.50
Safety_32	Rooms where expensive equipment is stored are locked	0.86	0.34	0.90	0.31	0.92	0.27
Safety_33	School does not present signs of vandalism	0.64	0.48	0.68	0.47	0.67	0.47
Safety_34	Outside school is illuminated	0.65	0.48	0.68	0.47	0.72	0.45
Safety_35	Safety measures to protect students around school	0.35	0.48	0.38	0.48	0.41	0.49
Score attributed to the adequacy of the equipment listed below. The range of scores is 0 (absent), 1, 2, 3 (adequate).							
Equipment_42	Television	2.78	0.54	2.78	0.54	2.80	0.51
Equipment_43	Parabolic antenna	1.56	1.25	1.37	1.29	1.42	1.34
Equipment_44	Video cassette recorder	2.28	1.01	2.01	1.18	2.70	0.68
Equipment_45	Copy Machine	1.31	1.38	1.84	1.37	2.18	1.22
Equipment_46	Mimeograph machine	2.08	1.02	1.93	1.14	1.64	1.28
Equipment_47	Slides projector	0.80	1.25	1.43	1.43	1.91	1.37
Equipment_48	Projector	2.28	1.12	2.31	1.10	2.41	1.04
Equipment_50	Printing machine	2.57	0.83	2.71	0.65	2.70	0.63
Equipment_51	Sound System	2.49	0.83	2.54	0.81	2.61	0.77

Library	Dummy: school has a library	0.86	0.35	0.75	0.43	0.92	0.28
Librarian	Dummy: school has a librarian	0.72	0.45	0.58	0.49	0.75	0.43
	Score attributed to library use: members of the following groups do not check out books from the library because 0 (school does not allow), 1 (members do not want to), and 2 (they do check out books).						
Books_61	Students	1.63	0.76	1.39	0.91	1.76	0.63
Books_62	Instructors	1.63	0.74	1.39	0.88	1.78	0.60
Books_63	Members of the community	1.02	0.86	0.75	0.82	1.07	0.87

Table A2
INSTRUCTOR'S QUESTIONNAIRE

Variable	Definition	2007		2009		2011	
		Mean	SD	Mean	SD	Mean	SD
d_Teacher_UG	Percentage of teachers with college degree*	0.96	0.15	0.97	0.13	0.98	0.11
d_Teacher_G	Percentage of teachers with graduate degree	0.02	0.09	0.03	0.11	0.03	0.12
d_Teacher_E_5	Percentage of teachers with 5 or less years of experience	0.18	0.26	0.19	0.28	0.15	0.25
d_Teacher_E_20	Percentage of teachers with more than 20 years of experience	0.24	0.30	0.23	0.31	0.25	0.32
d_20_hours	Percentage of teachers who lecture 20 hours a week or less	0.15	0.26	0.15	0.26	0.13	0.24
d_40_hours	Percentage of teachers who lecture 40 hours a week or more	0.50	0.36	0.52	0.37	0.53	0.37
d_Ped_Project	Percentage of teachers who claim school has a pedagogical project	0.96	0.16	0.97	0.14	0.98	0.11
d_Material	Percentage of teachers who covered at least 60% of the material	0.80	0.29	0.79	0.30	0.83	0.27
Percentage of teachers that agree with the following statements regarding the causes of learning difficulties							
Learning_Diff_59	Lack of pedagogical structure	0.31	0.35	0.30	0.35	0.33	0.36
Learning_Diff_60	Inappropriate core curriculum	0.20	0.28	0.21	0.29	0.16	0.26
Learning_Diff_61	Lack of safety	0.11	0.23	0.13	0.25	0.14	0.26
Learning_Diff_62	Lack of intellectual opportunities for the students	0.20	0.29	0.25	0.32	0.17	0.28
Learning_Diff_63	The core curriculum is not entirely covered	0.13	0.23	0.15	0.25	0.10	0.21
Learning_Diff_64	The teachers' workload is too heavy	0.43	0.35	0.42	0.36	0.41	0.36
Learning_Diff_65	The students have no discipline	0.71	0.33	0.72	0.33	0.74	0.33
Learning_Diff_66	The teachers' wages are too low	0.38	0.35	0.39	0.36	0.38	0.35
Learning_Diff_67	The environment the students live is not appropriate	0.81	0.27	0.83	0.26	0.81	0.28
Learning_Diff_68	The students' parents have low cultural level	0.74	0.31	0.75	0.31	0.73	0.32
Learning_Diff_69	The students' family does not help with the homework	0.95	0.15	0.94	0.16	0.96	0.14
Learning_Diff_70	The students are not apt	0.41	0.35	0.45	0.36	0.46	0.36
Learning_Diff_71	The students are not interested	0.92	0.18	0.92	0.19	0.94	0.16
Learning_Diff_72	The students have no self-esteem	0.76	0.30	0.72	0.32	0.70	0.33
Percentage of teachers that agree with the following statements regarding the work environment.							
Work_Enviroment_7_3	The principal motivates the teachers	0.70	0.35	0.72	0.34	0.74	0.33
Work_Enviroment_7_4	The teacher trusts the principal	0.81	0.30	0.82	0.29	0.83	0.28
Work_Enviroment_7_5	The principal convinces the teachers to commit to the school	0.76	0.32	0.77	0.32	0.77	0.32
Work_Enviroment_7_6	The principal supports new ideas	0.77	0.31	0.78	0.31	0.79	0.31
Work_Enviroment_7_7	The principal gives special attention to topics related to students' learning	0.77	0.31	0.78	0.32	0.80	0.30
Work_Enviroment_7	The principal gives special attention to topics related to	0.88	0.23	0.87	0.25	0.90	0.22

8	administrative issues						
Work_Enviroment_79	The principal gives special attention to topics related to school maintenance	0.89	0.23	0.88	0.25	0.90	0.22
Work_Enviroment_80	The teacher feels the principal respects her/him	0.91	0.20	0.89	0.23	0.92	0.20
Work_Enviroment_81	The teacher respects the principal	0.98	0.10	0.95	0.16	0.98	0.10
Work_Enviroment_82	The teacher attends work related meetings	0.93	0.17	0.90	0.22	0.93	0.18
Work_Enviroment_83	The other teachers take the teacher's ideas into account	0.85	0.25	0.84	0.27	0.86	0.24
Work_Enviroment_84	The teacher takes into account the other teachers ideas	0.95	0.15	0.93	0.19	0.95	0.15
Work_Enviroment_85	The core curriculum is influenced by the teachers' ideas	0.79	0.30	0.75	0.32	0.78	0.30
Work_Enviroment_86	The teachers coordinate the core curriculum across classes	0.80	0.29	0.76	0.32	0.79	0.30
Work_Enviroment_87	The principal, the teachers and the staff collaborate to the schools performance	0.91	0.21	0.86	0.27	0.90	0.22
Percentage of teachers that agree that the following problems occurred at school (significant severity)							
School_Problems_88	Lack of financial resources	0.13	0.26	0.12	0.25	0.10	0.23
School_Problems_89	Lack of teachers	0.17	0.30	0.25	0.35	0.20	0.32
School_Problems_90	Lack of administrative staff	0.15	0.28	0.15	0.28	0.13	0.26
School_Problems_91	Lack of pedagogical coordinators	0.18	0.31	0.21	0.33	0.14	0.27
School_Problems_92	Lack of pedagogical resources	0.16	0.27	0.15	0.28	0.09	0.22
School_Problems_93	Teachers miss classes too often	0.07	0.19	0.15	0.29	0.09	0.21
School_Problems_94	Students miss classes too often	0.14	0.25	0.14	0.26	0.14	0.26
School_Problems_95	Students have no discipline	0.19	0.29	0.24	0.33	0.20	0.30
Percentage of teachers in the school that are aware of the occurrence of the following acts of aggression							
School_Violence_96	Verbal aggression from student to teacher	0.66	0.36	0.64	0.38	0.68	0.36
School_Violence_97	Verbal aggression from teacher to teacher	0.09	0.21	0.18	0.32	0.13	0.24
School_Violence_98	Verbal aggression from staff to teacher	0.06	0.18	0.11	0.25	0.05	0.16
School_Violence_99	Physical aggression from student to teacher	0.09	0.21	0.19	0.33	0.08	0.20
School_Violence_100	Physical aggression from teacher to teacher	0.01	0.08	0.11	0.27	0.01	0.08
School_Violence_101	Physical aggression from staff to teacher	0.01	0.07	0.07	0.20	0.01	0.06
School_Violence_102	Verbal aggression from student to student	0.51	0.37	0.53	0.39	0.56	0.36
School_Violence_103	Verbal aggression from teacher to student	0.12	0.24	0.20	0.33	0.14	0.25
School_Violence_104	Verbal aggression from staff to student	0.08	0.20	0.12	0.26	0.09	0.21
School_Violence_105	Physical aggression from student to student	0.41	0.37	0.46	0.39	0.41	0.37
School_Violence_106	Physical aggression from teacher to student	0.01	0.08	0.11	0.27	0.01	0.08
School_Violence_107	Physical aggression from staff to student	0.01	0.07	0.07	0.20	0.01	0.07
School_Violence_108	Verbal aggression from student to staff	0.37	0.36	0.42	0.39	0.43	0.38
School_Violence_109	Verbal aggression from teacher to staff	0.04	0.13	0.13	0.29	0.05	0.15
School_Violence_110	Verbal aggression from staff to staff	0.05	0.16	0.10	0.24	0.06	0.17
School_Violence_111	Physical aggression from student to staff	0.05	0.15	0.16	0.31	0.04	0.15
School_Violence_11	Physical aggression from teacher to staff	0.01	0.06	0.10	0.27	0.01	0.07

2							
School_Violence_113	Physical aggression from staff to staff	0.01	0.06	0.07	0.20	0.01	0.06
Book_126	Percentage of teachers whose all students have the book adopted in class	0.56	0.39	0.63	0.39	0.79	0.31
Book_131	Percentage of teachers that consider the quality of the book adopted in class good	0.70	0.33	0.65	0.37	0.79	0.29

TABLE A3
STUDENTS QUESTIONNAIRE

		2007		2009		2011	
Variable	Definition	Mean	SD	Mean	SD	Mean	SD
d_female	Percentage of female students	0.54	0.10	0.54	0.09	0.53	0.09
d_white	Percentage of white students	0.35	0.20	0.35	0.20	0.35	0.20
d_mulatto	Percentage of mulatto students	0.46	0.17	0.47	0.17	0.48	0.17
d_black	Percentage of black students	0.11	0.09	0.11	0.08	0.11	0.08
d_asian	Percentage of asian students	0.04	0.04	0.04	0.04	0.03	0.04
d_native	Percentage of native students	0.04	0.04	0.03	0.04	0.02	0.03
d_8_15	Percentage of students 15 years or younger	0.73	0.18	0.76	0.16	0.77	0.14
d_8_16	Percentage of students 16 years old	0.14	0.08	0.14	0.08	0.13	0.08
d_8_17	Percentage of students 17 years old	0.06	0.06	0.06	0.06	0.06	0.06
d_8_18	Percentage of students 18 years old	0.03	0.04	0.02	0.03	0.02	0.03
d_8_19	Percentage of students 19 years or older	0.04	0.08	0.03	0.06	0.01	0.04
TV	Average score of number of TVs: 0 (absent), 1, 2, 3 (3 or more)	1.58	0.36	1.67	0.34	1.75	0.34
radio	Average score of number of radios: 0 (absent), 1, 2, 3 (3 or more)	1.35	0.29	1.32	0.28	1.24	0.27
d_DVD_1	Percentage of students with DVD or video cassette	0.77	0.16	0.87	0.10	0.90	0.08
refrigerator	Average score of number of refrigerators: 0 (absent), 1, 2 (2 or more)	1.01	0.13	1.05	0.11	1.08	0.09
d_laundry_1	Percentage of students with laundry machine	0.53	0.29	0.60	0.27	0.66	0.25
car	Average score of number of cars: 0 (absent), 1, 2, 3, (3 or more)	0.46	0.28	0.50	0.30	0.57	0.32
d_internet_1	Percentage of students with internet at home	0.20	0.18	0.30	0.21	0.45	0.24
bathroom	Average score of the number of bathrooms: 0 (absent), 1, 2, 3 (3 or more)	1.31	0.20	1.25	0.24	1.28	0.23
d_maid_1	Percentage of students with housekeeper	0.11	0.07	0.09	0.06	0.10	0.06
bedroom	Average score of the number of bedrooms: 0 (absent), 1, 2, 3, 4 (4 or more)	2.53	0.34	2.54	0.32	2.54	0.31
HH	Average score of the number of people living in the household: 2 (1 to 2), 3, 4 (4 or more)	5.12	0.57	5.07	0.52	4.89	0.45
d_mother_g	Percentage of students that live with the mother or female guardian	0.91	0.07	0.91	0.07	0.95	0.04
d_p_edu_0	Percentage of students whose neither parents completed elementary school	0.09	0.10	0.08	0.08	0.12	0.12
d_p_edu_1	Percentage of students whose at least one parent completed elementary school	0.29	0.15	0.28	0.14	0.21	0.12
d_p_edu_2	Percentage of students whose at least one parent completed middle school	0.22	0.10	0.23	0.10	0.22	0.10
d_p_edu_3	Percentage of students whose at least one parent completed high school	0.28	0.15	0.30	0.14	0.32	0.15
d_p_edu_4	Percentage of students whose at least one parent completed college	0.11	0.10	0.12	0.09	0.13	0.10
d_m_read	Percentage of students who live with mother or female guardian can read and writ	0.84	0.11	0.85	0.10	0.89	0.08
d_m_read_u	Percentage of students who have seen mother	0.76	0.11	0.76	0.10	0.80	0.09

	or female guardian reading books						
d_father_g	Percentage of students who live with the father or male guardian	0.72	0.11	0.68	0.11	0.76	0.09
d_f_read	Percentage of students who live with father or male guardian who can read and wr	0.64	0.13	0.61	0.12	0.69	0.11
d_f_read_u	Percentage of students who have seen seen father or male guardian reading books	0.54	0.12	0.52	0.11	0.57	0.11
d_meet	Percentage of students whose parents often attend school meetings	0.57	0.16	0.58	0.16	0.58	0.15
d_p_study	Percentage of students whose parents motivate child to study	0.98	0.03	0.98	0.02	0.99	0.02
d_p_h_w	Percentage of students whose parents motivate child to do homework	0.94	0.05	0.95	0.04	0.95	0.04
d_p_r	Percentage of students whose parents motivate child to do read	0.91	0.06	0.91	0.05	0.90	0.05
d_p_a	Percentage of students whose parents motivate child to attend school	0.98	0.03	0.98	0.02	0.98	0.02
d_p_t	Percentage of students whose parents talk about what happens at school	0.76	0.09	0.75	0.09	0.74	0.09
h_TV	Average score of the number of hours watching TV on weekdays: 1 (1 or less), 2, 3, 4 (4 or more)	2.38	0.34	2.43	0.38	2.51	0.40
w_h	Average score of the number of hours per day spent on domestic work: 0 (no domes	1.60	0.29	1.50	0.25	1.49	0.24
d_w_o	Percentage of students that work outside the home	0.22	0.12	0.21	0.11	0.20	0.10
r_g	Average score of the number of years students repeated: 0 (never repeated), 1, 2 (2 or more)	0.47	0.23	0.47	0.22	0.47	0.22
d_s	Average score of the number of years students dropped school: 0 (never dropped), 1, 2 (2 or more)	0.10	0.12	0.07	0.08	0.07	0.08
d_l_p	Percentage of students that like to study Portuguese	0.77	0.12	0.77	0.12	0.74	0.13
d_h_p	Percentage of students that often do Portuguese homework	0.59	0.13	0.60	0.12	0.58	0.13
d_l_m	Percentage of students that like to study mathematics	0.65	0.13	0.64	0.12	0.66	0.12
d_h_m	Percentage of students that often do mathematics homework	0.57	0.14	0.57	0.13	0.57	0.13
d_g_s	Percentage of students that intent to only continue to study (not work)	0.27	0.11	0.38	0.13	0.31	0.12
language_9	School average Portuguese score: 9th graders	227.18	17.22	237.80	18.61	217.20	67.56
math_9	School average Mathematics score: 9th graders	238.89	18.96	240.99	19.89	223.09	70.21
number_s_9	Number of students: 9th graders	66.12	48.69	68.60	46.78	69.03	46.89
	Number of observations	26,442		24,172		26,456	

APPENDIX B

Table B1 SUMMARY OF PCA				
Variables	Number of Variables	Number of Indexes (Principal Components) kept	Index(es)	Percentage of Explained Variance
Building_1 - Building_9, Classroom_10 - Classroom_11	11	2	Building structural quality index 1, Building structural quality index 2	0.45
Safety_21 - Safety_35	15	4	Safety index 1, Safety index 2, Safety index 3, Safety index 4	0.53
Equipment_42 - Equipment_51	10		Equipment index 1, Equipment index 1	0.40
Library, Librarian, Librarian, Books_61 - Books_63	6	1	Library index	0.73
Learning_Diff_59 - Learning_Diff_72	14	4	Reasons for learning difficulties index 1, Reasons for learning difficulties index 2, Reasons for learning difficulties index 3, Reasons for learning difficulties index 4	0.48
Work_Environment_73 - Work_Environment_87	15	3	Work environment index 1, Work environment index 2, Work environment index 3	0.57
School_Problems_88 - School_Problems_95	8	2	School problems index 1, School problems index 2	0.48
School_Violence_96 - School_Violence_113	18	4	School violence index 1, School violence index 2, School violence index 3, School violence index 4	0.64
Book_126, Book_131, d_Ped_Project, d_Material	4	1	Pedagogical quality index	0.33
TV, radio, d_DVD_1, refrigerator, d_laundry_1, car, bathroom, d_maid_1, bedroom	9	2	Income index 1, Income index 2	0.67
d_p_edu_1 - d_p_edu_4, d_m_read, d_m_read_u, d_f_read, d_f_read_u	8	3	Parents' education index 1, Parents' education index 2, Parents' education index 3	0.79
d_meet, d_p_study, d_p_h_w, d_p_r, d_p_a, d_p_t	6	2	Parents' support index 1, Parents' support index 2	0.61
r_g, d_s	2	1	Repeated or dropped school years index	0.73
d_h_p, d_h_m	2	1	Homework index	0.75
d_l_m, d_l_p	2	1	Enjoy studying index	0.52

APPENDIX C

TABLE C1 COMPLETE				
	All observations	Restricted Sample: up to 25 months of program participation	Restricted Sample: 1/3 lowest income	Restricted Sample: 1/3 highest income
	coef/p-value	coef/p-value	coef/p-value	coef/p-value
Lag of language Score	0.158** (0.011)	0.282*** (0.000)	0.192** (0.014)	0.113 (0.259)
Program Participation (months)	1.059*** (0.003)	0.753* (0.081)	0.781* (0.069)	1.876*** (0.000)
Program Participation (months) squared	-0.021** (0.011)	-0.021 (0.358)	-0.014 (0.145)	-0.040*** (0.001)
Percentage of students with internet at home	17.673*** (0.003)	19.047*** (0.010)	33.069*** (0.000)	17.602** (0.026)

TABLE C1 COMPLETE				
	All observations	Restricted Sample: up to 25 months of program participation	Restricted Sample: 1/3 lowest income	Restricted Sample: 1/3 highest income
	coef/p-value	coef/p-value	coef/p-value	coef/p-value
Average class size	0.227*** (0.000)	0.281*** (0.000)	0.130 (0.150)	0.233 (0.104)
Number of students: 9th graders	-0.028** (0.013)	-0.033*** (0.006)	-0.037** (0.025)	0.012 (0.666)
Building structural quality index 1	0.273* (0.089)	0.234 (0.128)	0.522** (0.039)	0.259 (0.465)
Building structural quality index 2	0.096 (0.727)	0.078 (0.777)	0.123 (0.755)	-0.046 (0.940)
Safety index 1	-0.366* (0.070)	-0.243 (0.226)	-0.597* (0.089)	0.313 (0.426)
Safety index 2	0.332 (0.214)	0.219 (0.395)	0.342 (0.459)	0.641 (0.184)
Safety index 3	-0.131 (0.589)	0.010 (0.965)	-0.393 (0.339)	0.577 (0.210)
Safety index 4	-0.297 (0.295)	-0.436 (0.113)	-0.583 (0.210)	0.218 (0.699)
Equipment index 1	-0.221 (0.357)	-0.299 (0.190)	-0.436 (0.266)	0.090 (0.846)
Equipment index 2	0.601* (0.056)	0.545* (0.072)	0.143 (0.755)	0.781 (0.237)
Library index	-0.492*** (0.000)	-0.489*** (0.000)	-0.059 (0.886)	-0.353* (0.089)
Percentage of teachers with college degree	-1.768 (0.613)	-0.113 (0.976)	-4.146 (0.433)	8.948 (0.149)
Percentage of teachers with graduate degree	-1.189 (0.632)	-3.133 (0.264)	-5.192 (0.400)	2.299 (0.553)
Percentage of teachers with 5 or less years of experience	-0.889 (0.405)	-1.054 (0.303)	0.161 (0.925)	-1.403 (0.506)
Percentage of teachers with more than 20 years of experience	-1.624 (0.153)	-1.876* (0.098)	-3.381* (0.081)	-1.239 (0.552)
Percentage of teachers who lecture 20 hours a week or less	-0.305 (0.825)	-0.031 (0.982)	-2.212 (0.329)	3.579 (0.168)
Percentage of teachers who lecture 40 hours a week or more	1.272 (0.179)	1.284 (0.179)	2.029 (0.205)	0.872 (0.617)
Reasons for learning difficulties index 1	-0.145 (0.460)	-0.203 (0.311)	-0.313 (0.323)	0.057 (0.877)
Reasons for learning difficulties index 2	-0.037 (0.855)	0.022 (0.911)	-0.133 (0.707)	-0.262 (0.487)
Reasons for learning difficulties index 3	-0.197 (0.453)	-0.169 (0.501)	-0.400 (0.380)	0.091 (0.855)
Reasons for learning difficulties index 4	-0.175 (0.509)	-0.208 (0.428)	-0.081 (0.854)	0.139 (0.791)
Work environment index 1	-0.021 (0.882)	0.033 (0.814)	-0.079 (0.730)	0.214 (0.398)
Work environment index 2	-0.011 (0.957)	-0.093 (0.645)	0.104 (0.764)	0.262 (0.500)
Work environment index	0.190	0.274	0.568	-0.627

TABLE C1 COMPLETE				
	All observations	Restricted Sample: up to 25 months of program participation	Restricted Sample: 1/3 lowest income	Restricted Sample: 1/3 highest income
	coef/p-value	coef/p-value	coef/p-value	coef/p-value
3	(0.421)	(0.237)	(0.156)	(0.131)
School problems index 1	0.380* (0.063)	0.371* (0.065)	0.274 (0.392)	0.837** (0.045)
School problems index 2	-0.328 (0.267)	-0.395 (0.186)	-0.502 (0.251)	0.003 (0.996)
School violence index 1	-0.019 (0.814)	-0.066 (0.414)	0.082 (0.518)	-0.166 (0.329)
School violence index 2	0.079 (0.656)	-0.010 (0.955)	0.169 (0.539)	0.640* (0.079)
School violence index 3	0.253 (0.172)	0.314* (0.079)	0.507* (0.093)	0.221 (0.529)
School violence index 4	0.081 (0.600)	0.020 (0.891)	-0.091 (0.721)	0.430 (0.178)
Pedagogical quality index	0.899*** (0.001)	0.838*** (0.001)	1.515*** (0.000)	0.758 (0.175)
Income index 1	-1.417 (0.252)	-0.315 (0.852)	-2.213 (0.166)	9.323*** (0.000)
Income index 2	1.137 (0.431)	0.083 (0.967)	1.345 (0.427)	-4.560** (0.021)
Average score of the number of people living in the household: 2 (1 to 2), 3, 4 (4 or more).	-3.539*** (0.005)	-3.863*** (0.005)	-5.495*** (0.003)	-11.747*** (0.000)
Parents' support index 1	-0.404 (0.125)	-0.519** (0.050)	-0.134 (0.733)	-0.645 (0.248)
Parents' support index 2	-0.969*** (0.007)	-1.304*** (0.000)	-0.815 (0.144)	-0.767 (0.270)
Average score of the number of hours watching TV on weekdays: 1 (1 or less), 2, 3, 4 (4 or more).	2.604 (0.126)	1.010 (0.553)	1.564 (0.530)	-7.605** (0.035)
Average score of the number of hours per day spent on domestic work: 0 (no domestic work), 2, 3, 4 (4 or more).	3.406* (0.088)	3.216 (0.121)	8.697*** (0.002)	-4.035 (0.308)
Percentage of students that work outside the home	-24.572*** (0.000)	-28.334*** (0.000)	-37.235*** (0.000)	-11.834 (0.215)
Repeated or dropped school years index	-1.375 (0.186)	-2.624** (0.013)	-2.426* (0.065)	1.303 (0.625)
Homework index	0.637* (0.085)	0.601 (0.103)	0.739 (0.186)	-0.193 (0.783)
Enjoy studying index	0.442 (0.245)	0.592 (0.115)	-0.716 (0.240)	1.497** (0.042)
Percentage of students that intent to only continue to study (not work)	-4.351 (0.225)	-3.995 (0.313)	-6.528 (0.185)	-2.506 (0.691)
Percentage of female students	7.391 (0.205)	8.892 (0.169)	-7.934 (0.311)	30.741*** (0.001)

TABLE C1 COMPLETE				
	All observations	Restricted Sample: up to 25 months of program participation	Restricted Sample: 1/3 lowest income	Restricted Sample: 1/3 highest income
	coef/p-value	coef/p-value	coef/p-value	coef/p-value
Percentage of white students	12.031 (0.357)	6.332 (0.650)	11.647 (0.439)	-51.112* (0.087)
Percentage of mulatto students	2.395 (0.850)	5.082 (0.705)	12.381 (0.398)	-38.706 (0.207)
Percentage of black students	-11.925 (0.390)	-23.399 (0.105)	-4.421 (0.788)	-65.801** (0.043)
Percentage of asian students	28.596 (0.118)	18.134 (0.359)	39.084* (0.078)	-53.006 (0.187)
Percentage of students 16 years old	-18.683** (0.037)	-5.353 (0.568)	-8.540 (0.408)	-57.361*** (0.008)
Percentage of students 17 years old	-13.846 (0.270)	-10.783 (0.412)	10.132 (0.474)	-42.680 (0.143)
Percentage of students 18 years old	-16.962 (0.360)	7.442 (0.711)	-4.936 (0.814)	58.802 (0.190)
Percentage of students 19 years or older	-20.535 (0.181)	2.618 (0.869)	-17.604 (0.359)	-86.366** (0.020)
Percentage of students that live with the mother or female guardian	-8.909 (0.393)	-2.289 (0.824)	-11.403 (0.390)	11.822 (0.539)
Percentage of students who live with the father or male guardian	-22.612*** (0.007)	-19.040* (0.071)	-21.049** (0.044)	-14.795 (0.327)
Parents' education index 1	1.124 (0.144)	0.200 (0.836)	-0.485 (0.520)	-0.607 (0.696)
Parents' education index 2	1.722*** (0.001)	2.062*** (0.000)	3.312*** (0.000)	2.822** (0.032)
Parents' education index 3	1.406** (0.017)	1.478** (0.045)	1.024 (0.185)	1.890** (0.036)
Dummy year: 2011	-30.955*** (0.000)	-27.943*** (0.000)	-29.756*** (0.000)	-30.106*** (0.000)
Constant	224.210*** (0.000)	190.365*** (0.000)	225.064*** (0.000)	294.518*** (0.000)
Number of observations	20,467	14,210	9,333	7,585
Sargan test p-value (null: validity of instruments)	0.458	0.439	0.938	0.650
Hansen test p-value (null: validity of instruments)	0.192	0.034	0.736	0.315
Hansen test of level equations p-value (null: validity of level equations)	0.587	0.430	0.660	0.180
Number of instruments	199	199	199	199
Note: *** p<0.01, ** p<0.05, * p<0.1				

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EFFECTS OF MACROECONOMIC AND UNCERTAINTY FACTORS ON EXTERNAL DEBT: EMPIRICAL ANALYSIS FOR BAHRAIN

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ABSTRACT

This paper investigates the effects of macroeconomic and uncertainty factors on external debt of Bahrain during the period 1990-2014. The estimation results of the long run model identified seven significant macroeconomic factors that are responsible for 97 percent variation in external debt. The Error Correction model identified five significant factors that affect external debt in the short run. There are five factors related to economic uncertainty that are responsible for variation in external debt in the short run. The impulse response analysis also provided useful information about the behavior of external debt to various shocks. The study proposed several policy options for reduction of external debt of the country.

INTRODUCTION

The objective of economic planning is to improve the standard of living of people through economic growth and development. However, the domestic resources that could bring about an optimal level of economic growth are scarce, for most developing countries. Low growth is associated with low tax revenue, low productivity and limited foreign exchange earnings. As a result, these countries mostly rely on external borrowings to finance the development expenditures for economic growth. Continued bilateral and multilateral external borrowing results in accumulation of external debt with serious debt servicing problems.

Most of the literature on external debt is focused on impact of external debt on economic growth, while little attention has been paid to the factors which lead to growth of the external debt. Clear understanding of factors behind growth of external debt would shed light on how to deal with the debt problem. The first objective of this study is to identify the short run and long run economic factors that are responsible for external indebtedness taking the case of the Kingdom of Bahrain. The identification of major economic factors of external debt will not only be helpful for policy makers in Bahrain but also for other indebted countries in the region.

There is also growing role of uncertainty in accumulation of external debt. However, little attention is paid in the literature on this factor. Ensuring debt sustainability requires better understanding of uncertainty-related factors in addition to macroeconomic factors. The second objective of this study is to highlight the effects of different economic uncertainty-related factors on external debt. By focusing on the main macroeconomic determinants and uncertainty-related variables, the policy makers can design a strategy for reduction of external debt of Bahrain. There are good reasons for making Bahrain a focal point of analysis. First, it has a growing trend of external debt from 2007. Second, there is no such rigorous time series study on determinants of external debt of Bahrain. Finally, long time-series data on different variables are available for the country.

For empirical analysis, the paper is divided into five sections. Following introduction, the next section presents a critical review of theoretical and empirical literature. Then, the modelling

framework and data sources are discussed. The estimation results and the significant macroeconomic and uncertainty factors that affect external debt are highlighted in the section before conclusion. Last section concludes the study and discusses the policy implications and sets directions for further research.

REVIEW OF LITERATURE

The economic justification to borrow externally is associated with the rising gap between national savings and domestic investment, which is explained by the well-known two gap model of Chenery and Strout, 1966. The external borrowing is bound to fill the gap by generating resources that domestic savers are unable or unwilling to scarify. In the case of Bahrain the saving-investment gap has alternated between positive and negative. This study will examine the effect of saving and investment on external debt.

Another equally important theoretical justification behind the external borrowing is that of the foreign exchange gap identified by the two gap model. For development, the imports of capital goods are vital. However, the export earnings are insufficient and vulnerable for developing countries. This makes external borrowing indispensable for gaining access to the technology and expansion of output. Bahrain is also developing its infrastructure which requires imports of capital goods. Due to low domestic production the country also imports consumer goods, which take a large share of export earnings. Since less resources are left for capital goods, the country relies on external borrowing. In this study, the exports and imports are taken separately to evaluate their individual effects on external debt. Eaton and Gersovitz (1981) found that variability of export revenue increases both the demand for and supply of debt.

Looney (1989) using the data of 61 less-developed countries investigated the relationship between external debt and military expenditure. Three types of expenditures (military, health and education) and GNP, imports, exports, international reserve holdings were included in the model. The author found that the effect of military expenditures on external debt of countries is different. For resource constrained countries, the military expenditure or arms' imports contribute to external indebtedness but for countries which do not have resource constraints the relationship between military expenditure and external indebtedness is negative. The author suggested conducting country-specific studies and single country analysis to get clear results.

Selami (2004) empirically examined the relationship between defense expenditure (arms imports) and external debt for Turkey by using Engle-Granger methodology for the period 1979-2000. The variables included in the model were GDP, trade balance and military expenditure. Three proxies are employed for military expenditure, which includes arms imports, defense, equipment expenditure and total defense expenditure. The estimation results showed that there is a negative relationship between external debt and defense expenditure in the long run. The external debt is positively related to arms import in the short run. However, due to small sample size, the author recommended that the results should be interpreted with caution.

Zaffar and Butt (2008) studied the impact of trade liberalization on the external debt burden. The study used time-series data of Pakistan from 1972 to 2007 and estimated the model using ARDL techniques. The study found positive effect of export to GDP ratio and negative effect of import to GDP ratio on the external debt. The authors concluded that trade liberalization is acting as a stimulator of external debt accumulation. The explanatory power of the model was 86 percent. This shows that there were some other variables that were affecting external debt but not considered in the study.

Bader and Magableh (2009) examined the determinants of external and domestic debt in Jordan during the period 1980 to 2005, using Johanson Cointegration test. The study confirmed

the significant positive effect of the budget deficit on external debt. The study found a significant negative effect of foreign aid and real exchange rate on external debt. Both saving gap and government budget deficit were found to have significant positive effect on the central government domestic debt. The study concluded that an increase in the saving gap plays a key role in domestic debt accumulation. Furthermore, budget deficits, real exchange rate and foreign aid were responsible for external debt accumulation in Jordan.

Awan et al., (2011) examined the short run and long run determinants of external debt and the direction of the causality among these variables in Pakistan for the period 1974-2008 using Johansen cointegration approach. The study found a significant long run relationship between external debt, exchange rate and terms of trade. The fiscal deficit was not a statistically significant variable in the long run model. The short-run model did not show any significant results. The study also found uni-directional causality from fiscal deficit to external debt. In a similar study Awan et al. (2015) examined the macroeconomic determinants of external debt in Pakistan using annual time-series data from 1976 to 2010. The results of ARDL model showed that fiscal deficit, nominal exchange rate and trade openness are significant determinants of external debt in Pakistan.

Bittencourt (2013) investigated the determinants of external debt in young democracies of nine South American countries during the period 1970-2007. The study used principal component and dynamic panel data analyses. The study found that economic growth has reduced external debt in the region. Other important variables such as inflation and inequality did not present the expected or conclusive results on external debt. The important lesson from the study was that generalizations seeking to establish the determinants of external debt should be avoided. The study highlights the importance of country specific studies.

The evolution of the debt crisis in developing countries goes back to the oil price shocks in 1973-74 and 1979-1980, and the subsequent recession of the world economy. The case of Bahrain is, however, different since it is an oil exporting country and a rise in oil prices improves its terms of trade. In recent years, there is a sharp fall in oil prices, which has led to a dramatic fall in the terms of trade and widened the financial gap. Sachs and Berg (1998) believe that in many of the indebted countries the accumulation of external debt in the 1970s was a result of the incorrect decision to borrow overseas rather than raising the tax rates.

After reviewing the existing literature, it is concluded that there is extensive literature on external debt but most of them focused on either debt-growth nexus or economic factors that are responsible for external debt accumulation, neglecting uncertainty-related factors. This study will try to fill the gap in existing literature by focusing not only on the economic factors but also uncertainty-related factors that are responsible for accumulation of external debt.

METHODOLOGICAL FRAMEWORK

There are several studies that investigated the possible factors that are responsible for external debt accumulation. They all have the same fundamental arguments, but they differ with respect to methodology and the choice of sample countries. This study uses the following model to explore the economic and uncertainty-related factors that are responsible for accumulation of external debt in Bahrain. Because this is a debt accumulation model, it includes both demand side and supply side factors as explanatory variables.

$$EDGDP_t = \beta_0 + \beta_i X_{it} + \beta_j U_{jt} + \omega_{it} \quad (1)$$

In the above model, EDGDP is the gross external debt to GDP ratio. X_{it} is the vector of macroeconomic factors that affect external debt while U_{jt} is the vector of economic uncertainty factors that affect external indebtedness. The following macroeconomic factors were included in the model; (i) real GDP (GDPR), (ii) Inflation rate (INFL), (iii) broad money as a percent of GDP (MSGDP), (iv) export to high income countries as a percent of total exports (EXPHIC) (v) Foreign exchange reserves (FERT), (vi) gross national saving as percent of GDP (GNSGDP), (iv) financial sector's credit as percent of GDP (FSCGDP). Among economic uncertainty, the included factors in the model are (i) uncertainty related to investment (UINV), (ii) uncertainty related to trade (UTRD), (iii) uncertainty related to budget deficit (UBD), (iv) uncertainty related to oil rent (UOR), (v) uncertainty related to the money supply (UMS).

Economic growth is amongst the most important variables that is identified in the literature and which reduces external debt. This suggests that fast and consistent economic growth is important in keeping external debt under control, or even in reducing it to lower levels. Thus, the coefficient of GDPR is expected to be negative.

In this study inflation is used as a measure of macroeconomic instability. High inflation increases uncertainty in the economy and a government with a history of high inflation may need to issue foreign currency debt in order to credibly sign its commitment to pursuing a strong and stable monetary policy (Calvo, 1988). The coefficient of INFL variable is expected to be positive.

The holding of international reserves is another important factor that affects external debt, but the relationship between external debt and reserve holding is more complex. Logically, an increase in international reserves increases the country's ability to service external debt. This may result in higher external borrowing due to increase in the credit worthiness. On the other hand, all else being equal, high international reserves may result in less additional borrowing. Therefore international reserves may result in a larger or smaller volume of external debt and the coefficient of FERT in the model can be positive or negative.

Money supply can also affect external indebtedness. Broad money to GDP (MSGDP) is expected to have a positive effect on external debt. An increase in the money supply over nominal GDP may cause a pressure on the exchange rate to devalue under the fixed exchange rate system¹. To reduce pressure on the currency exchange rate in the period of a higher money supply, a country would need a larger foreign exchange reserve, which can be achieved through external borrowing and results in debt accumulation.

Exports are the greatest source of foreign exchange for a country. An increase in exports lowers the need of foreign borrowing and may help to reduce the external debt by repayment of past debt. The coefficient of (EXPHIC) is expected to be positive. Financial sector credit is expected to increase the need for foreign borrowing. The coefficient of FSCGDP is expected to be positive. The increase in national savings may increase or decrease external debt. If saving is higher than investment, it may reduce the need for foreign borrowing. But for a country where investment is more than saving, foreign borrowing is required to supplement domestic saving. Thus, the sign of the coefficient of GNSGDP is an empirical issue.

Economic uncertainty may exist in a developing country because of lack of information. The uncertainty may affect external debt positively due to its negative effects on investment and growth. Accordingly, all kinds of economic uncertainty may result in accumulation of external debt in the country. The coefficients of all uncertainty-related variables are expected to be positive except uncertainty related to the money supply, which is expected to be negative.

This study is based on secondary data of Kingdom of Bahrain over the period from 1990 to 2014. The data have been collected from various sources such as, IMF's International

Financial Statistics (IFS) and Regional Economic Outlook: Middle East and Central Asia, World Bank's World Development Indicators (WDI) and Global Development Finance (GDF), and OECD's historical data set.

MODEL ESTIMATION AND RESULTS

Macroeconomic Factors for External Debt

The proposed model has been estimated using conventional Ordinary Least Square (OLS) technique. The OLS estimation has been chosen because it is assumed that the relationship is linear among variables, which is made possible by transformation of variables in the logarithmic form. OLS is also the preferred estimation technique because the data is continuous. Before estimation of the model the unit root test for the order of integration was performed on all variables to determine their time series properties.

For any time-series econometric estimation, it is important to check whether variables used in the model are stationary or non-stationary. Granger and Newbold (1974) identified the dangers of spurious regression results while working with non-stationary series and which would lead to incorrect inferences. This study uses two unit root tests - Dickey and Fuller (1979) augmented test (in short ADF test) and Phillips and Perron (1988) test, (in short PP test), for observing the order of integration of the variables used in the model. The use of two different tests for checking the stationarity of data series is simply to confirm that results are not sensitive to one test.

Table 1
LONG RUN MACROECONOMIC DETERMINANTS OF EXTERNAL DEBT

Variable	Coefficient	Std. Error	t-Stat.	Prob.
Constant	177.27	92.73	1.91	0.07
GDPR	-0.17	0.04	-4.46	0.00
INFL	3.67	1.16	3.17	0.01
MSGDP	2.53	0.46	5.52	0.00
EXPHIC	-0.31	0.18	-1.70	0.10
FERT	0.08	0.01	7.86	0.00
GNSGDP	2.25	0.43	5.23	0.00
FSCGDP	1.58	0.59	2.68	0.02
Adj.-R ²	0.97	F-statistic		108.49
DW Statistic	2.26	Probability (F-stat.)		0.00

The results in Table A1 in appendix show the unit root tests performed (with constant and trend) on both level and first difference of all the variables used in the model. The results of ADF and PP tests indicate that all variables are non-stationary at levels but become stationary at first

difference. Thus, all variables are integrated at order one which indicates the possibility of a long run relationship among variables.

The long-run model is estimated using a sample of 25 years data over the period 1990 to 2014. The general to specific approach was then utilized to arrive at a good fit model. Table 1 shows the long run macroeconomic determinants of external debt of Bahrain.

The results of long-run model presented in Table 1 are quite satisfactory from the perspective of sign, significance and magnitude of the coefficients. To check whether the variables in the models are cointegrated, a quicker method is to check the stationarity of the residuals obtain from the OLS regression results. The ADF and PP tests are used to determine the unit root in residuals.

Table A2 in appendix reports the results of stationary tests of residuals of the long-run model using ADF and PP tests. Both test results indicate that the residuals are stationary at levels. Since the variables in the model are $I(1)$ and the residuals are $I(0)$, there exists a valid long run relationship between external debt and macroeconomic variables of the model². Real output and exports to high-income countries are significant economic factors in reducing external debt of the country in the long run. Furthermore, inflation, money supply, foreign exchange reserves, gross national saving and financial sector credit are the important economic factors for accumulation of external debt in the country.

Table 2
SHORT RUN MACROECONOMIC DETERMINANTS OF EXTERNAL DEBT

Variable	Coefficient	Std. Error	t-Stat.	Prob.
Constant	0.12	5.92	0.01	0.98
D(EDGDP(-1))	0.17	0.14	1.23	0.24
D(GDPR)	-0.01	0.01	-1.75	0.26
D(INFL)	3.59	1.19	3.02	0.01
D(MSGDP)	2.25	0.54	4.15	0.00
D(EXPHIC)	-0.29	0.18	-1.59	0.13
D(FERT)	0.02	0.01	3.27	0.01
D(GNSGDP)	1.89	0.58	3.26	0.01
D(FSCGDP)	1.23	0.65	1.90	0.08
RESID(-1)	-1.15	0.33	-3.48	0.00
Adj.-R ²	0.77	F-statistic		9.34
DW Statistic	2.25	Probability (F-statistic)		0.00

The test results clearly indicate that there exists a valid long run equilibrium relationship between external debt and macroeconomic variables of the model. To integrate the short-run dynamics with long equilibrium this study uses the Error Correction Model (ECM) developed by

Granger (1981) and elaborated by Engle and Granger (1987). The results of the Error Correction Model are reported in Table 2.

The results of Table 2 show that the short-run coefficients of inflation, money supply, foreign exchange reserve and national savings are positive and significant at one percent level confirming them as important factors in accumulation of external debt in the short run. The coefficient of financial sector credit variable is positive and significant at 10 percent level. The coefficient of error term is negative as expected and highly significant. This suggests the presence of long-run equilibrium relationship between external debt and the macroeconomic variables shown in Table 1. The high coefficient of RESID(-1) suggests that the model converges very fast to the long run equilibrium.

The diagnostic tests of the long-run and short-run models are reported in Table A2 appendix-2. The null hypothesis of Serial Correlation LM test is that there is no serial correlation in residuals. Both F-statistic and Chi-square statistic were statistically insignificant for this test. This confirms that there is no problem of serial correlation in the residuals of both long-run and short-run models. The White Heteroskedasticity and Autoregressive Conditional Heteroskedasticity (ARCH LM) are a test of no Heteroskedasticity. Both tests indicate that residuals are homoscedastic and there is no problem of heteroskedasticity in both short-run and long-run models. The insignificant values of Jarque-Bera statistic confirms that the residuals are normally distributed. Banerjee et al. (1986) have shown that there is a possibility of bias in the cointegrating vector estimators. The value of $(1-R^2)$ is an indicator of this bias. In case of long-run model the adjusted- R^2 is 0.97, which indicates that the bias is very small.

The CUSUM test is helpful to analyze the possible parameter instability. The study also uses the CUSUM and CUSUM of squares tests to analyze the variation in parameters. Both tests plot the recursive residuals and its square under the 5% critical region. Both tests confirm that the residual movement does not go outside the critical line as shown in Figure A1 and Figure A2 in appendix. This indicates the stability of parameters in both the long-run and short-run models. The forecast evaluation shows that the Theil inequality coefficient for long-run model is 0.04, bias proportion is zero and variance proportion is 0.01. These results indicate a very good forecast ability of the model.

Figure A1
CUSUM AND CUSUM OF SQUARES PLOTS FOR LONG RUN MODEL

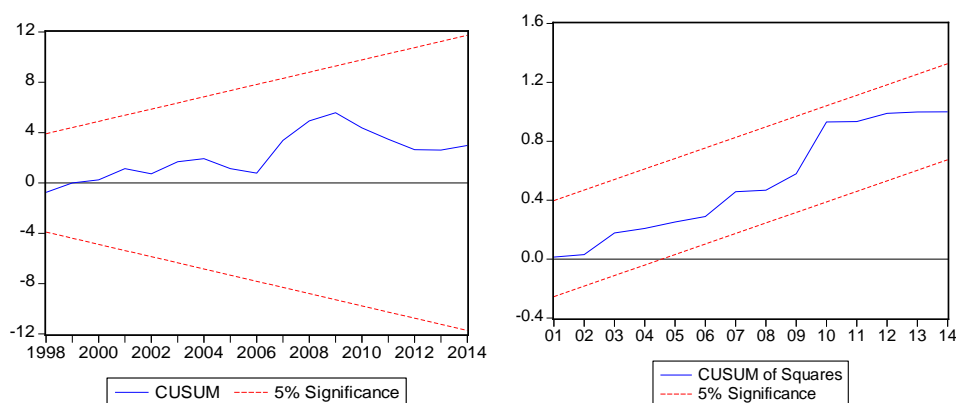
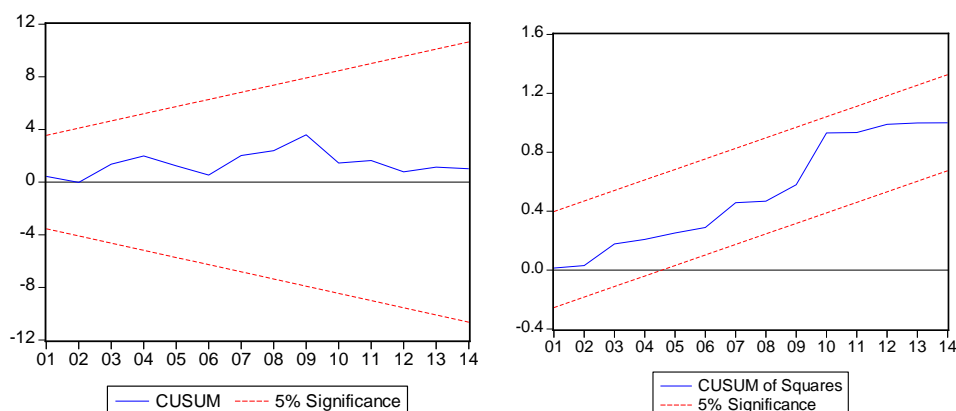


Figure A2
CUSUM AND CUSUM OF SQUARES PLOTS FOR SHORT RUN MODEL



Economic Uncertainty Factors for External Debt

The study uses five economic uncertainty-related factors in the short-run model. These are uncertainty related to investment (UINV), uncertainty related to external trade (UTRD), uncertainty relate to money supply (UMS), uncertainty related to oil rent (UOR) and uncertainty related to the government budget deficit (UBD).

Goel and Ram (2001) identified several methods that are used in literature to proxy uncertainty variable. The standard deviation, five year moving average, five years moving standard deviation of the variable or the conditional variance of the variable estimated from Generalized Autoregressive Conditional Heteroscedasticity (GARCH) is mainly used in the literature to proxy the uncertainty. In this study the conditional variances of investment, trade, money supply, oil rent and budget deficit were estimated from GARCH model to generate relevant uncertainty variable. Table 3 reports the effect of all five uncertainty-related variables on external debt in separate regression models.

Table 3
EFFECTS OF ECONOMIC UNCERTAINTY ON EXTERNAL DEBT

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	4.29 (0.36)	2.97 (0.57)	0.34 (0.94)	0.59 (0.91)	-1.15 (0.85)
D(EDGDP(-1))	0.15 (0.17)	0.28 (0.04)	0.33 (0.02)	0.19 (0.13)	0.14 (0.28)
D(GDPR)	-0.01 (0.04)	-0.02 (0.05)	-0.01 (0.07)	-0.01 (0.14)	-0.01 (0.20)
D(INFL)	2.72 (0.01)	2.71 (0.02)	3.15 (0.01)	3.04 (0.01)	3.29 (0.01)
D(MSGDP)	1.78 (0.00)	1.90 (0.00)	1.86 (0.00)	1.88 (0.00)	1.86 (0.00)
D(EXPHIC)	-0.13 (0.36)	-0.67 (0.01)	-0.39 (0.02)	-0.58 (0.01)	-0.60 (0.12)
D(FERT)	0.03 (0.00)	0.03 (0.00)	0.03 (0.00)	0.02 (0.00)	0.02 (0.00)

D(GNSGDP)	1.06 (0.05)	1.68 (0.01)	1.8 (0.00)	2.04 (0.00)	1.99 (0.00)
D(FSCGDP)	0.65 (0.22)	1.79 (0.01)	1.66 (0.01)	1.68 (0.02)	1.87 (0.02)
RESID(-1)	-0.65 (0.04)	-1.20 (0.00)	-1.20 (0.00)	-1.07 (0.00)	-1.05 (0.01)
Uncertainty	UINV	UTRD	UMS	UOR	UBD
Coefficient	0.06 (0.00)	0.002 (0.03)	-0.01(0.02)	0.11 (0.04)	0.39 (0.07)
Adj.-R ²	0.87	0.83	0.84	0.82	0.81
F-statistic	16.93 (0.00)	12.24 (0.00)	13.25 (0.00)	11.27 (0.00)	10.21 (0.00)
DW stat.	2.40	2.17	2.41	2.26	1.75

Note: Figures in parentheses are the probability of t-statistics for the respective coefficient.

Table 3 shows that all uncertainty variables have significant positive effect on external debt except the money supply, which has the negative effect. The uncertainty related to investment (UINV) and trade (UTRD) forces the government to borrow more resulting in external debt accumulation. Similarly, uncertainty related to oil rent (UOR) and budget deficit (UBD) also results in higher borrowing and debt. The uncertainty related to the money supply (UMS) has the negative effect on external debt.

Test for Dynamic Interaction

To test the dynamic interaction among variables, the impulse response method is used. The impulse response evaluates how dependent variable respond to one standard deviation shock in each variable estimated in VAR equation by using the method suggested by Sim (1980).

The study investigates the response of external debt to shocks in economic uncertainty variables in the short run. To get the response of external debt to each uncertainty variable, a VAR model is first estimated including each uncertainty variable. Then it is studied how the shock in uncertainty variables affects the behavior of external debt in that and subsequent periods. Figure (1a) shows that one standard deviation shock (increase) in uncertainty related to investment would cause external debt to GDP ratio to increase by 11 percent in the second period and afterwards it will return to its steady state in 9th period. The external debt also responds to trade uncertainty shock. Figure 1b shows that one standard deviation shock to trade related uncertainty will increase external debt to GDP ratio by 6 percent in second period and revert to steady state after 8th period. Figure 1c also gives similar results for a shock to uncertainty related to oil rent. Finally, Figure 1d shows that one standard deviation shock to budget deficit uncertainty will increase external debt to GDP ratio by more than 2 percent in the second period, and then it reverts to steady state after 9th period. These findings reveal that there is a significant response of external debt to economic uncertainty in the country.

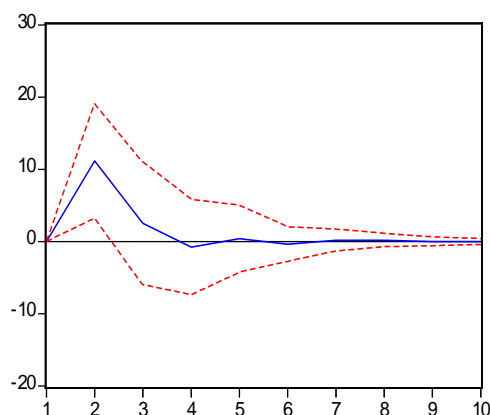


Figure 1a
Response of External Debt to
Investment Uncertainty

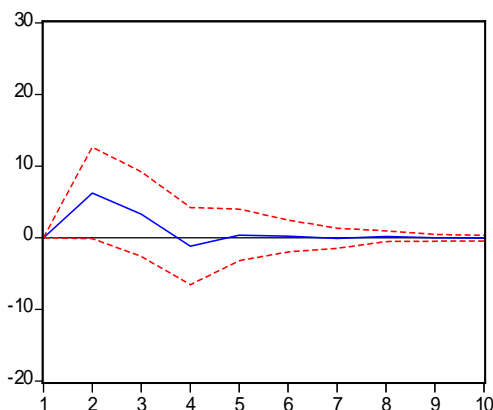


Figure 1b:
Response of External Debt to
External Trade Uncertainty

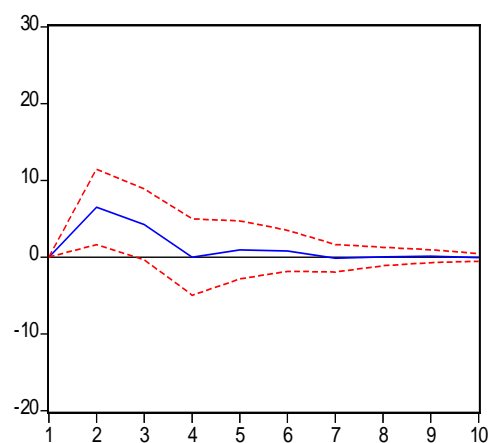


Figure 1c
Response of External Debt to
Oil Rent Uncertainty

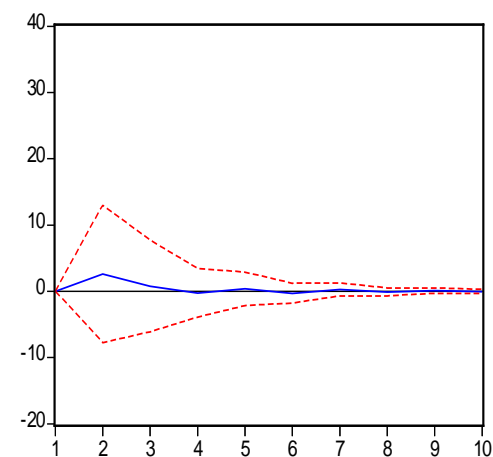


Figure 1d
Response of External Debt to
Budget Deficit Uncertainty

CONCLUSION AND POLICY IMPLICATIONS

The main objective of this study was to identify the effects of both macroeconomic and uncertainty factors on external debt of Bahrain for the period 1990-2014. The key findings of the study are that the high economic growth and higher exports can significantly reduce external debt of the country. The study also found that high inflation, money supply, national saving, foreign exchange reserves and financial sector credit contribute significantly in external debt accumulation in the long run. The error correction model identified that high inflation, increased money supply, greater national savings and increased financial sector credit are the important factors in accumulation of external debt in the short run. The study found that uncertainty related to investment, trade, oil rent and budget deficit are the significant factors in accumulation of external debt. It is also found that external debt responds highly to uncertainty related to investment, trade and oil rent.

Keeping in view the results of the study, following policy perspectives may be helpful for policy makers in reducing the external debt of Bahrain. The government needs to follow the policy of boosting exports on particularly high income countries and relying less on external borrowing for foreign exchange. In a separate study (Waheed and Abbas, 2015), the author identified potential export markets for Bahrain. Following the guidelines for such new markets, there are chances to increase the foreign exchange earnings which will result in reduced external borrowing.

There is a need to check the financial sectors' credit expansion in productive vs non-productive sectors. Credit expansion in productive sectors will contribute to high investment and economic growth and will ultimately reduce external debt. Policy makers need to keep an eye on investment and provide incentives to create investment friendly environment as uncertain investment environment and low economic growth will transform into high external debt. High money supply growth will increase inflation in the economy and ultimately result in external debt accumulation. There is a need for more policy reforms to reduce the inefficiency of public sector and to control unnecessary expenditures, which is causing growth in money supply and ultimately debt accumulation.

The current study can be extended in different directions in the future. Similar analysis can be performed on disaggregated (short-term and long-term) external debt. This study identified determinants of external debt which do not contain any information on currency composition. The study can further be extended for determinants of external debt in different currency compositions. The most important extension would be to analyze the external debt in a macroeconomic framework. This will allow us how different debt burden and debt service indicators will respond to various policy shocks.

ENDNOTES

- ¹ Bahrain is following fixed exchange rate system. In practice 1BD = 2.6 US dollar. It is the second highest-valued currency unit in the world.
- ² There is a possibility of more than one cointegrating relationship which can be tested through Johansen and Juselius (1990) test. Since the sample size is small such a test is not performed and it is assumed that there is only one cointegrating equilibrium relationship.

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APPENDIX

Table A1
RESULTS OF STATIONARY TEST

Augmented Dickey Fuller test statistics					Phillips-Perron test statistics			
At Level			At First difference		At Level		At First difference	
Variable	t-Stat	p-value	t-Stat	p-value	Adj. t-Stat	p-value	Adj. t-Stat	p-value
EDGDP	-1.76	0.69	-3.96	0.02	-1.91	0.62	-3.96	0.02
GDPR	-1.05	0.92	-3.82	0.03	-0.70	0.96	-3.82	0.03
INFL	-3.42	0.07	-7.20	0.00	-3.42	0.07	-7.49	0.00
MSGDP	-3.02	0.14	-5.23	0.00	-3.12	0.12	-5.85	0.00

EXPHIC	-3.49	0.06	-6.69	0.00	-3.35	0.08	-5.37	0.00
FERT	-1.66	0.74	-6.04	0.00	-1.51	0.80	-6.26	0.00
GNSGDP	-1.81	0.67	-4.79	0.00	-1.81	0.67	-4.79	0.00
FSCGDP	-2.54	0.31	-4.53	0.01	-2.54	0.31	-1.53	0.01

Note: Both tests are performed with constant and trend in the model.

Table A2
DIAGNOSTIC TEST RESULTS OF LONG RUN AND SHORT RUN MODELS

		Long Run Model		Short Run Model	
Test	Test Statistic	Test Value	Prob.	Test Value	Prob.
Jarque-Bera statistic	χ^2 -statistic	1.32	0.51	0.86	0.65
Breusch-Godfrey Serial	F-statistic	1.08	0.36	0.38	0.70
Correlation LM Test	χ^2 -statistic	3.15	0.20	1.41	0.49
ARCH LM Test	F-statistic	0.001	0.98	0.001	0.97
	χ^2 -statistic	0.001	0.98	0.002	0.96
White Heteroskedasticity test	F-statistic	2.18	0.11	2.49	0.16
	χ^2 -statistic	18.83	0.17	21.60	0.25
Residual Stationarity Test at Level	t-statistic	-5.23	0.00	-5.35	0.00
Augmented DF	Adj.t-stat	-7.68	0.00	-5.37	0.00
Phillips-Perron					

THE IMPACT OF AGE DIFFERENCES AND RACE ON THE SOCIAL SECURITY EARLY RETIREMENT DECISION FOR MARRIED SAME SEX COUPLES

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Rich Fortin, New Mexico State University
Stuart Michelson, Stetson University

ABSTRACT

The purpose of this study is to examine the impact of race and age differences on the social security early and delayed retirement decision for same-sex married couples. This paper extends the analysis of Docking, Fortin and Michelson's previous studies, which assumed a heterosexual couple, to same-sex couples. We analyze the eighteen married couple combinations for the following races: Whites (W), Hispanics (H) and Blacks (B). We develop an Excel model to compute the breakeven internal rate of return (BE IRR) for each of the race-gender combinations under different retirement scenarios. The primary substantive conclusions from this study depend on the age comparisons that are being made. For couples who retire at the same age or at different ages, the greater the age difference the greater the incentive to retire early as the hurdle rate is lower to overcome.

INTRODUCTION

The Defense of Marriage Act (DOMA) of 1996 defined "marriage" as a legal union between one man and one woman (1 U.S. Code §7). As a consequence, it effectively barred same-sex married couples from receiving federal marriage benefits such as social security. In June 2013 the Supreme Court overturned the section of the DOMA denying federal benefits to legally married same-sex couples (U.S. vs Windsor, June 26, 2013). Furthermore, on June 26, 2015 the U.S. Supreme Court ruled that the U.C. Constitution guarantees a right to same-sex marriage and all of the benefits entitled under such union. The purpose of this study is to examine the impact of race and age differences on the social security early and delayed retirement decision for same-sex married couples.

Early retirement is attractive for many reasons: social security benefits (SSB) and rules can change, health concerns, and increased demand for leisure, to name a few. However, SSB are permanently reduced by an actuarial reduction factor ($5/9^{\text{th}}$ of 1% for the first 36 months and $5/12^{\text{th}}$ of 1% per month thereafter) for early retirement. Delayed retirement is attractive because SSB are increased by a delayed retirement credit (DRC) of 8% for each year of delay after FRA up to age 70.

In this study we analyze the eighteen same-sex married couple combinations for the following races: Whites (W), Hispanics (H) and Blacks (B). The nine spouse_1/spouse_2 combinations for males (M) are: WM_WM, BM_BM, HM_HM, WM_BM, BM_WM, WM_HM, HM_WM, BM_HM and HM_BM and for females (F) are: WF_WF, BF_BF, HF_HF, WF_BF, BF_WF, WF_HF, HF_WF, BF_HF and HF_BF. We develop an Excel model to compute the breakeven IRR (BE IRR) for each of the race-gender combinations. Following

Blanchett (2013), three claiming scenarios are considered: receiving benefits early (e.g., at age 62 versus 66), the maximum realistic delay period (e.g., at age 62 versus 70), and delaying benefits past full retirement age (e.g., age 66 versus 70). Within these 3 claiming scenarios we examine couples by race combination who retire at the same age and with age differences of 0, 4, 7 and 10 years. We also look at a specific scenario where the spouses retire at different ages and the impact of age differences on their retirement decision.

LITERATURE REVIEW

There have been an extensive number of studies on the early versus delayed social security retirement decision for heterosexual married couples but none on same-sex married couples. For a review of prior literature, see Docking, Fortin and Michelson (2012, 2013, 2015).

Docking, Fortin and Michelson compute the BE IRRs between different retirement ages. These BE IRRs can be viewed as “hurdle rates.” That is, if a couple could invest their SSBs at a rate greater than (less than) the computed BE IRR over the given time horizon, the couple should retire at the earlier (later) age. Docking, Fortin and Michelson (2013) found that for heterosexual couples who are the same age and retire at same age that the highest BE IRRs consistently had a Hispanic working spouse and the lowest BE IRRs consistently had a white working spouse.

Docking, Fortin and Michelson (2015) found that for heterosexual couples who are different ages, but retire at same age that the highest BE IRRs consistently had a Hispanic working spouse and the lowest BE IRRs consistently had a white working spouse. For heterosexual couples who are different ages and retire at different ages, the highest BE IRRs consistently had a Hispanic working spouse and a Hispanic non-working spouse and the lowest BE IRRs consistently had a white working spouse and a black non-working spouse. Also, as the age difference increased, the BE IRRs decreased.

Irrespective of who is the breadwinner, Hispanics have higher hurdle rates; while Whites have lower hurdle rates. For a given retirement age comparison/age difference the results can be interpreted as follows: the high (low) breakeven group would prefer to retire later (earlier) since the hurdle rate is more difficult (less difficult) to overcome. Thus, Hispanics have a more difficult time retiring early and Whites have a less difficult time retiring early.

HOW SOCIAL SECURITY WORKS

Who is eligible for benefits?

The Social Security system pays benefits to retirees, spouses, children, survivors, the disabled, and the aged. Individuals aged 62 or older who had earned income that was subject to the Social Security payroll tax for at least 10 years (40 quarters) since 1951 are eligible for retirement benefits. This study will focus on same-sex married couples. We do not study divorced spouses, surviving spouses, surviving spouses with dependents, and disabled workers.

Early Retirement Age (ERA) versus Full Retirement Age (FRA) versus Delayed Retirement

Table 1 contains the retirement ages and SSB adjustments for workers born 1943 and later.

Table 1: Age for Early, Full, and Delayed Retirement Benefits, and Reductions and Credits for Early and Delayed Benefits										
Year of birth ^a	Year of attainment of age 62	Year of attainment of FRA	Year of attainment of age 70	Full retirement age	Per month reduction if SSB begin prior to FRA ^b	Maximum reduction months	Maximum reduction at age 62	Age 62 SSB as % of FRA	Per year DRC	Age 70 SSB as % of FRA
1943	2005	2009	2013	66 years	5/9% for 36 mos. + 5/12%/ mos.	48	25%	75%	8%	132%
1944	2006	2010	2014	66 years	5/9% for 36 mos. + 5/12%/ mos.	48	25%	75%	8%	132%
1945	2007	2011	2015	66 years	5/9% for 36 mos. + 5/12%/ mos.	48	25%	75%	8%	132%
1946	2008	2012	2016	66 years	5/9% for 36 mos. + 5/12%/ mos.	48	25%	75%	8%	132%
1947	2009	2013	2017	66 years	5/9% for 36 mos. + 5/12%/ mos.	48	25%	75%	8%	132%
1948	2010	2014	2018	66 years	5/9% for 36 mos. + 5/12%/ mos.	48	25%	75%	8%	132%
1949	2011	2015	2019	66 years	5/9% for 36 mos. + 5/12%/ mos.	48	25%	75%	8%	132%
1950	2012	2016	2020	66 years	5/9% for 36 mos. + 5/12%/ mos.	48	25%	75%	8%	132%
1951	2013	2017	2021	66 years	5/9% for 36 mos. + 5/12%/ mos.	48	25%	75%	8%	132%
1952	2014	2018	2022	66 years	5/9% for 36 mos. + 5/12%/ mos.	48	25%	75%	8%	132%
1953	2015	2019	2023	66 years	5/9% for 36 mos. + 5/12%/ mos.	48	25%	75%	8%	132%
1954	2016	2020	2024	66 years	5/9% for 36 mos. + 5/12%/ mos.	48	25%	75%	8%	132%
1955	2017	2021	2025	66 years and 2 months	5/9% for 36 mos. + 5/12%/ mos.	50	25 5/6%	74 1/6%	8%	130 2/3%
1956	2018	2022	2026	66 years and 4 months	5/9% for 36 mos. + 5/12%/ mos.	52	26 2/3%	73 1/3%	8%	129 1/3%
1957	2019	2023	2027	66 years and 6 months	5/9% for 36 mos. + 5/12%/ mos.	54	27 1/2%	72 1/2%	8%	128%
1958	2020	2024	2028	66 years and 8 months	5/9% for 36 mos. + 5/12%/ mos.	56	28 1/3%	71 2/3%	8%	126 2/3%
1959	2021	2025	2029	66 years and 10 months	5/9% for 36 mos. + 5/12%/ mos.	58	29 1/6%	70 5/6%	8%	125 1/3%
1960 or later	2022 or later	2027	2030	67 years	5/9% for 36 mos. + 5/12%/ mos.	60	30%	70%	8%	124%

^a If birthday is January 1, refer to previous year

^b The monthly reduction is 5/9% per month for the first 36 months prior to FRA, and 5/12% per month for every month after the first 36 months.

Source: Social Security Act of 1935 as amended through December 31, 2007. <http://www.socialsecurity.gov/regulations/index.htm>; Jennings and Reichenstein, "Planning for Retirement: What to Expect from Social Security," AAIJJournal, February 2002, p.12.

No matter what your FRA is, you may start receiving benefits as early as age 62. However, if you start your benefits early, they will be reduced a fraction of a percent for each month before your FRA. This reduction is permanent. Workers claiming before FRA have their SSB reduced by a factor of 5/9 of 1% per month for the first 36 months prior to FRA and 5/12 of 1% per month for every month thereafter. Thus, a worker with a FRA of 66 who claims early at age 62 receives 75% of their FRA benefit amount; a worker with a FRA of 67 who claims at age 62 receives only 70% of their FRA benefit amount.

A worker may choose to defer receipt of SSB past his FRA. In this case a delayed retirement credit (DRC) will be added to the FRA benefit. For each month in which the worker is at least FRA, but not yet age 70, his SSB will increase. For workers reaching FRA in 2015 or later, their monthly percentage increase will be 2/3 of 1% or a yearly percentage increase of 8%. Thus, a worker with a FRA of 66 who delays claiming until age 70 receives 132% of their FRA benefit amount; a worker with a FRA of 67 who claims at age 70 receives only 124% of their FRA benefit amount.

Earnings Test Adjustments to SSB

Workers who claim early retirement benefits, but continue to work, may have their SSB reduced. This is referred to as the Earnings Test (ET). The Social Security Administration (SSA) withholds \$1 in benefits for every \$2 of earnings in excess of the lower exempt amount. In the year a worker reaches FRA, monthly benefits are reduced \$1 for every \$3 of earnings in excess of the higher exempt amount. Earnings in or after the month you reach FRA do not count toward the earnings test. The low and high exemption amounts for 2015 are \$15,720 and \$41,880 (Social Security Administration Handbook, 2015). Since 2000, there has been no ET above the FRA (Social Security Administration Handbook, 2015).

For example, assume Jodie, a white female, whose FRA is 66 decides to retire at age 62

and to continue working at her \$36,000 per year salary. Assuming her SSB at FRA are \$2,000 per month (\$24,000 annual), her early retirement benefit will be 75% of \$2,000 or \$1,500 per month (\$18,000 annual). Since Jodie's earnings of \$36,000 will be \$20,280 over the lower exemption amount of \$15,720, her SSB will be further reduced by \$1 for every \$2 in her excess earnings of \$20,280. This amounts to another reduction of \$10,140. Her annual SSB are now \$7,860 (\$18,000 - \$10,140). The SSA does not adjust each monthly SSB check by a proportional amount. Instead, Jodie will receive no SSB for months one through six, \$360 in month seven, and then \$1,500 per month for months eight through twelve, for an annual amount of \$7,860. (Annual reduction amount of $\$10,140 / \$1,500 = 6.76$ months. Months 1 – 6 recovers $6 \times \$1,500 = \$9,000$ of the reduction amount. $\$10,140 - \$9,000 = \$1,140$ is subtracted from the \$1,500 month seven benefit to yield a \$360 SSB payment. The remaining five months Jodie receives her \$1,500 per month benefit.)

The question for Jodie is: Do I retire early at reduced benefits and continue working, or do I wait until FRA to retire? Jodie's before tax earnings and SSB total $\$36,000 + \$7,860 = \$43,860$. Had Jodie's salary been less than the lower exemption amount, her before tax earnings and SSB would have been $\$15,720 + \$18,000 = \$33,720$. If Jodie waits until FRA, her before tax earnings and SSB total $\$36,000 + \$24,000 = \$60,000$. Of course, the decision to retire early or wait is more complicated than the simple scenario presented above and is further complicated if Jodie is married.

A spouse has dual entitlements to SSBs. A spouse is entitled to the larger of 100% of benefits at FRA based on his or her own earnings record or up to 50% of the spouse's benefits at FRA.

$$SSB_{\text{spouse}_1} = \text{Max} \{SSB_{\text{own}}; .5(SSB_{\text{spouse}_2})\}$$

For example, spouse_1 receives one-half of his/her spouse_2's full retirement benefit unless the spouse_1 begins collecting benefits before his/her FRA. If the spouse_1 begins collecting benefits before his/her FRA, the amount of the spouse_1's benefit is reduced by a percentage based on the number of months before he/she reaches FRA. (The percentage reduction for spousal benefits is 25/36 of 1% per month for the first 36 months and 5/12 of 1% for each additional month.) For example, based on the FRA of 66, if spouse_1 begins collecting benefits:

At age 65, the benefit amount would be about 45.8 percent of the retired worker's (spouse_2's) full benefit;
 At age 64, it would be about 41.7 percent;
 At age 63, 37.5 percent; and
 At age 62, 35 percent.

If spouse_1's FRA is greater than 66, spousal benefits are further reduced for early retirement.

For example, assume Jodie, age 66, is married to Carol, age 62, both with a FRA of 66. Jodie retires at 66 with SSB at FRA of \$2,000 per month. Carol retires early at 62 and receives 35% of \$2,000 or \$700 per month in spousal SSBs. If Carol waits and retires at her FRA of 66 she receives 50% of \$2,000 or \$1,000 in spousal SSBs.

Once one begins SSBs based on his/ her own work record they cannot later switch to SSBs based on the spouse's record. Also, one cannot begin SSBs based on the spouse's record and then later switch to SSBs based on his or her own work record. However, there is an exception: spouse_1 can retire and begin collecting their own SSBs while their spouse_2 still works and delays benefits. Upon spouse_2's retirement, spouse_1 can switch over to 50% of spouse_2's benefits, if spousal benefits are greater than their own benefits. Spouse's benefits do

not include any accrued delayed retirement credits.

For example, assume Henry and George, are both 62 with a FRA of 66. Currently, Henry's SSBs at FRA are \$2,200 per month and George's SSBs at FRA are \$1,000. George retires at 62 and receives 75% of 1,000 or \$750 per month. Henry continues to work until age 66. His SSBs at FRA are still \$2,200 per month and he retires at FRA. Assuming no COLA for George's SSBs, he can now switch over to spousal benefits of 50% x \$2,200 = \$1,100 per month.

MODEL

Similar to McCormack and Perdue (2006) we avoid the problem of an uncertain discount rate (DR) by computing the internal rate of return (IRR) equating two retirement options.

Married couples of the same age, retiring at the same age.

Following Docking, Fortin and Michelson (2015), the IRR can be solved for by using the following equation:

$$\begin{aligned} & \%Benefit_1 \times \sum_1^i \left(\frac{1}{1 + \frac{IRR}{12}} \right)^i + \%Benefit_2 \times \sum_1^j \left(\frac{1}{1 + \frac{IRR}{12}} \right)^j \\ & = \%Benefit_3 \times \sum_1^m \left(\frac{1}{1 + \frac{IRR}{12}} \right)^m \times \left(\frac{1}{1 + \frac{IRR}{12}} \right)^{N3-N1} \\ & + \%Benefit_4 \times \sum_1^n \left(\frac{1}{1 + \frac{IRR}{12}} \right)^n \times \left(\frac{1}{1 + \frac{IRR}{12}} \right)^{N4-N2} \end{aligned}$$

where:

Benefit_X = percent of SSB received based on retirement age

$i = 1$ to months to life expectancy for retirement Age 1 of Spouse_1 (N1)

$j = 1$ to months to life expectancy for retirement Age 1 of Spouse_2 (N2)

$m = 1$ to months to life expectancy for retirement Age 2 of Spouse_1 (N3)

$n = 1$ to months to life expectancy for retirement Age 2 of Spouse_2 (N4)

$N3 - N1$ and $N4 - N2$ = difference in months between retirement Age 1 and retirement Age 2, where retirement Age 2 is greater than retirement Age 1.

The two terms on the left-hand side of the equation,

$$\%Benefit_1 \times \sum_1^i \left(\frac{1}{1 + \frac{IRR}{12}} \right)^i \quad \text{and} \quad \%Benefit_2 \times \sum_1^j \left(\frac{1}{1 + \frac{IRR}{12}} \right)^j,$$

represent the present value of initiating receipt of benefits at retirement age 1. The two terms on

the right-hand side of the equation,

$$\%Benefit_3 \times \sum_1^m \left(\frac{1}{1 + \frac{IRR}{12}} \right)^m \quad \text{and} \quad \%Benefit_4 \times \sum_1^n \left(\frac{1}{1 + \frac{IRR}{12}} \right)^n,$$

represent the present value of initiating receipt of benefits at retirement age 2; the two second terms on the right-hand side,

$$\left(\frac{1}{1 + \frac{IRR}{12}} \right)^{N3-N1} \quad \text{and} \quad \left(\frac{1}{1 + \frac{IRR}{12}} \right)^{N4-N2},$$

discount the present value of benefits at retirement age 2 back to retirement age 1 so that the IRR can be computed at the same point in time. For example, if the first retirement age is 62 and the second retirement age is 66, the IRR computation for the age 66 term must be discounted back to the same point in time as the age 62 term.

It should be emphasized that the above model is appropriate only for same aged couples retiring at the same age.

Married couples of different ages, retiring at the same age.

When the couples are different ages but still retire at the same age, an additional discount factor $\left(\frac{1}{1 + \frac{IRR}{12}} \right)^D$ is required to discount all expected cash flows back to the initial start of benefits. The model now becomes:

$$\begin{aligned} & \%Benefit_1 \times \sum_1^i \left(\frac{1}{1 + \frac{IRR}{12}} \right)^i + \%Benefit_2 \times \sum_1^j \left(\frac{1}{1 + \frac{IRR}{12}} \right)^j \times \left(\frac{1}{1 + \frac{IRR}{12}} \right)^D \\ & = \%Benefit_3 \times \sum_1^m \left(\frac{1}{1 + \frac{IRR}{12}} \right)^m \times \left(\frac{1}{1 + \frac{IRR}{12}} \right)^{N3-N1} \\ & + \%Benefit_4 \times \sum_1^n \left(\frac{1}{1 + \frac{IRR}{12}} \right)^n \times \left(\frac{1}{1 + \frac{IRR}{12}} \right)^{N4-N2} \times \left(\frac{1}{1 + \frac{IRR}{12}} \right)^D \end{aligned}$$

where:

D = the age difference in months between the spouses ($Age_{Spouse_1} - Age_{Spouse_2}$) and $Age_{Spouse_1} > Age_{Spouse_2}$.

Married couples of different ages, retiring at different ages.

In addition, if the couples are different ages and retire at different ages, additional discounting complications are introduced. The model now becomes:

$$\begin{aligned}
 & \%Benefit_1 \times \sum_1^i \left(\frac{1}{1 + \frac{IRR}{12}} \right)^i + \%Benefit_2 \times \sum_1^j \left(\frac{1}{1 + \frac{IRR}{12}} \right)^j \times \left(\frac{1}{1 + \frac{IRR}{12}} \right)^{D-(N1-N2)} \\
 & = \%Benefit_3 \times \sum_1^m \left(\frac{1}{1 + \frac{IRR}{12}} \right)^m \times \left(\frac{1}{1 + \frac{IRR}{12}} \right)^{N3-N1} \\
 & + \%Benefit_4 \times \sum_1^n \left(\frac{1}{1 + \frac{IRR}{12}} \right)^n \times \left(\frac{1}{1 + \frac{IRR}{12}} \right)^{N4-N2} \times \left(\frac{1}{1 + \frac{IRR}{12}} \right)^{D-(N3-N4)}
 \end{aligned}$$

Assumptions in the Model

The following assumptions are made:

1. SSB are received monthly.
2. The retirement decision is made annually because life expectancy tables only provide annual data.
3. The 2006 United States Life Tables and the 2010 National Center for Health Statistics provide life expectancies. (See Table 2). Life expectancy is adjusted for when a worker retires. For example, a white male who retires at age 62 is expected to live approximately 19 more years to age 81; whereas if he waits and retires at age 66 he is expected to live approximately 16 more years to age 82. We look at life expectancies based on gender and race.
4. We assume excess earnings are \$0 and that early retirement SSB are not further reduced by the earnings test.
5. If a retiree has substantial income (earned and unearned) in addition to his SSB, up to 85% of his annual benefits may be subject to Federal income tax. In our analysis we assume other income is below the minimum such that 0% of SSB are taxed. However, by using the IRR method to find the optimal retirement age, taxation of SSB really becomes irrelevant, since (1-tax rate of SSB) shows up on both the left- and right-hand sides of our equation, effectively cancelling out one another.
6. Since 1983, the SSA provides for an automatic increase in SSB if there is an increase in the CPI-W from third quarter last year to third quarter of the current year. Spitzer (2006) finds that only longevity and expected rates of return are determining factors as the optimal time to retire and that inflation and taxes play no significant role. As a consequence, we assume COLA is zero.
7. We also assume the couple has no dependents, and that neither party receives a government pension. Furthermore, the couple may be forced into a higher federal or state tax bracket due to other income; this, too, is irrelevant in our analysis and is ignored.
8. We assume Spouse_1 is the same age as or older than Spouse_2. We look at age differences ($Age_{Spouse_1} - Age_{Spouse_2}$) of 0, 4, 7, and 10.
9. We assume a one-earner family. Spouse_1 is the working spouse, and Spouse_2 is the non-working spouse.

Table 2: Average life expectancy given current age								
Age	All Males		White Males		Black Males		Hispanic Males	
	Avg # years remaining	Expected age to die	Avg # years remaining	Expected age to die	Avg # years remaining	Expected age to die	Avg # years remaining	Expected age to die
62	19.19	81.19	19.32	81.32	16.90	78.90	21.26	83.26
63	18.46	81.46	18.57	81.57	16.29	79.29	20.48	83.48
64	17.73	81.73	17.83	81.83	15.69	79.69	19.71	83.71
65	17.01	82.01	17.10	82.10	15.10	80.10	18.96	83.96
66	16.30	82.30	16.38	82.38	14.51	80.51	18.21	84.21
67	15.60	82.60	15.67	82.67	13.93	80.93	17.48	84.48
68	14.90	82.90	14.97	82.97	13.36	81.36	16.77	84.77
69	14.22	83.22	14.28	83.28	12.80	81.80	16.07	85.07
70	13.55	83.55	13.60	83.60	12.25	82.25	15.38	85.38
Age	All Females		White Females		Black Females		Hispanic Females	
	Avg # years remaining	Expected age to die	Avg # years remaining	Expected age to die	Avg # years remaining	Expected age to die	Avg # years remaining	Expected age to die
62	22.11	84.11	22.18	84.18	20.72	82.72	24.24	86.24
63	21.30	84.30	21.37	84.37	19.99	82.99	23.39	86.39
64	20.50	84.50	20.56	84.56	19.27	83.27	22.55	86.55
65	19.71	84.71	19.76	84.76	18.57	83.57	21.72	86.72
66	18.93	84.93	18.97	84.97	17.87	83.87	20.90	86.90
67	18.15	85.15	18.18	85.18	17.17	84.17	20.10	87.10
68	17.38	85.38	17.41	85.41	16.48	84.48	19.30	87.30
69	16.62	85.62	16.64	85.64	15.80	84.80	18.51	87.51
70	15.87	85.87	15.89	85.89	15.14	85.14	17.74	87.74
Source: National Vital Statistics Report, June 28, 2010, Volume 58, Number 21; United States Life Tables, 2006; Arias E. United States life tables by Hispanic origin. National Center for Health Statistics. Vital Health Stat 2(152). 2010.								

EXAMPLES

Married couples of the same age, retiring at the same age:

Spouse_1 earner, Spouse_1 and Spouse_2 same age, Spouse_1 and Spouse_2 retire at same age.

Michael, a black male born in 1948, is married to Derrick, a black male born in 1948. They are trying to decide if they should retire early at age 62 or wait until FRA of 66. Michael is the sole breadwinner of the family. Derrick has no SSBs of his own. According to Table 2, Michael's and Derrick's life expectancy at age 62 is an additional 16.90 years (202.8 months) to age 78.90; while their life expectancy at age 66 is an additional 14.51 years (174.12 months) to age 80.51. Based on current Social Security requirements, Michael will receive 100% of his SSB at age 66, but only 75% of his FRA benefits at age 62. Derrick is able to claim up to 50% of Michael's SSB if he is at FRA, but only 35% at age 62.

Using Excel we can find the IRR that will equate both sides of the following equation:

$$\begin{aligned}
& 75\% \times \sum_1^{202.8} \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^i + 35\% \times \sum_1^{202.8} \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^j \\
& = 100\% \times \sum_1^{174.12} \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^m \times \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^{(66-62) \times 12} \\
& + 50\% \times \sum_1^{174.12} \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^n \times \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^{(66-62) \times 12}
\end{aligned}$$

The IRR that equates both sides is equal to 5.3222% or approximately 5.32% (See Table 3, Panel B1). If the couple could invest their SSBs at a rate greater (less) than 5.32%, then they should retire at the earlier (later) age.

Assume Michael's SSB at FRA of 66 is \$1,600 per month and his early retirement benefit is 75% or \$1,200 per month at age 62. Based on Michael's FRA benefit of \$1,600 per month, Derrick's SSB will be 35% of \$1,600 or \$560 per month at age 62. At age 66 Michael will receive \$1,600 per month and Derrick will receive 50% of \$1,600 or \$800 per month. If the current market interest rate is 3%, then the present value (PV) of the left-hand side of the equation (retire early at age 62) is \$190,713 (Michael) plus \$89,000 (Derrick) for a total of \$279,713. The PV of the right-hand side of the equation (delay retirement to age 66) is \$200,163 (Michael) and \$100,082 (Derrick) for a total of \$300,245. This results in a difference of \$20,532, implying that Michael and Derrick should wait until age 66 to retire. If Michael and Derrick believe they could invest their monthly SSB at 5.32% or greater over the next four years, then they should retire early, at age 62; if not, they should delay retirement until age 66. Of course, this assumes they do not need any of their SSB on which to live - a highly unlikely assumption.

Married couples of different ages, retiring at the same age:

Spouse_1 earner, Spouse_1 age > Spouse_2 age, Spouse_1 and Spouse_2 retire at same age.

Now, assume Derrick was born in 1952 and is 4 years younger than Michael. There is an additional 4 years of discounting required (48 months) for Spouse_2's spousal benefits at both age 62 and 66. This is reflected in the following formula:

$$75\% \times \sum_1^{202.8} \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^i + 35\% \times \sum_1^{202.8} \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^j \times \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^{(4 \times 12)}$$

$$\begin{aligned}
&= 100\% \times \sum_1^{174.12} \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^m \times \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^{(66-62) \times 12} \\
&+ 50\% \times \sum_1^{174.12} \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^n \times \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^{(66-62) \times 12} \times \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^{(4 \times 12)}
\end{aligned}$$

Note that the age 62 spousal benefits are now discounted 48 months (instead of none previously) and the age 66 spousal benefits are now discounted 96 months instead of 48 months. Using Excel we find the BE IRR is 5.2247% (approximately 5.22%) which is reflected in Table 6 with a 4 year age difference. If the couple could invest their SSBs at a rate greater (less) than 5.22%, then they should retire at the earlier (later) age.

Again, if we assume Michael's SSB at FRA of 66 is \$1,600 per month and if the current market interest rate is 3%, then the present value (PV) of the left-hand side of the equation (retire early at age 62) is \$190,713 (Michael) plus \$78,947 (Derrick) for a total of \$269,660. The PV of the right-hand side of the equation (delay retirement to age 66) is \$200,163 (Michael) and \$88,778 (Derrick) for a total of \$288,941. This results in a difference of \$19,281, implying that Michael and Derrick should wait until age 66 to retire. If Michael and Derrick believe they could invest their monthly SSB at 5.22% or greater over the next four years, then they should retire early, at age 62; if not, they should delay retirement until age 66. Again, this assumes they do not need any of their SSB on which to live.

Now, assume Derrick was born in 1958 and is 10 years younger than Michael. There is an additional 10 years of discounting required (120 months) for Derrick's spousal benefits at both age 62 and 66. Based on current Social Security requirements, Michael will receive 100% of his SSB at age 66, but only 75% of his FRA benefits at age 62. Derrick is able to claim up to 47.2% of Michael's SSB at age 66, but only 33.3% at age 62. (Since Derrick is born in 1958, his FRA is 66 and 8 months. Thus his spousal benefits are reduced by an extra 8 months.)

This is reflected in the following formula:

$$\begin{aligned}
&75\% \times \sum_1^{202.8} \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^i + 33.3\% \times \sum_1^{202.80} \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^j \times \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^{(10 \times 12)} \\
&= 100\% \times \sum_1^{174.12} \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^m \times \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^{(66-62) \times 12} \\
&+ 47.2\% \times \sum_1^{174.12} \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^n \times \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^{(66-62) \times 12} \times \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^{(10 \times 12)}
\end{aligned}$$

Note that the age 62 spousal benefits are now discounted 120 months and the age 66 spousal benefits are now discounted 168 months. Using Excel we find the BE IRR is 5.0263% (approximately 5.03%) which is reflected in Table 6 with a 10 year age difference.

Again, if we assume Michael's SSB at FRA of 66 is \$1,600 per month and if the current market interest rate is 3%, then the present value (PV) of the left-hand side of the equation (retire early at age 62) is \$190,713 (Michael) plus \$62,754 (Derrick) for a total of \$253,467. The PV of the right-hand side of the equation (delay retirement to age 66) is \$200,163 (Michael) and \$70,017 (Derrick) for a total of \$270,180. This results in a difference of \$16,713, implying that Michael and Derrick should wait until age 66 to retire. If Michael and Derrick believe they could invest their monthly SSB at 5.03% or greater over the next ten years, then they should retire early, at age 62; if not, they should delay retirement until age 66. Again, this assumes they do not need any of their SSB on which to live.

Married couples of different ages, retiring at different ages.

Spouse_1 earner, Spouse_1 age > Spouse_2 age, Spouse_1 and Spouse_2 retire at different ages.

Consider the same couple above with a 4 year age difference but with the Spouse_1/Spouse_2 early retirement ages of 66/62 and delayed retirement ages of 70/66. The formula to solve this example would be:

$$\begin{aligned}
 & 100\% \times \sum_1^{174.12} \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^i + 35\% \times \sum_1^{202.80} \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^j \times \left[\left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^{[4 - (66 - 62)] \times 12} \right] \\
 & = 132\% \times \sum_1^{147} \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^m \times \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^{(70 - 66) \times 12} \\
 & + 50\% \times \sum_1^{174.12} \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^n \times \left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^{(66 - 62) \times 12} \times \left[\left(\frac{1}{1 + \frac{\text{IRR}}{12}} \right)^{[4 - (70 - 66)] \times 12} \right]
 \end{aligned}$$

Using Excel to solve for the BE IRR yields 4.5856% or approximately 4.59% (see Table 9A).

Again, if we assume Michael's SSB at FRA of 66 is \$1,600 per month and if the current market interest rate is 3%, then the present value (PV) of the left-hand side of the equation (retire at FRA 66) is \$225,650 (Michael) plus (retire early at age 62) is \$78,947 (Derrick) for a total of \$304,597. The PV of the right-hand side of the equation (delay retirement to age 70) is \$230,224 (Michael) and (retire at FRA of 66) is \$88,778 (Derrick) for a total of \$319,002. This results in a difference of \$14,405, implying that Michael and Derrick should wait until age 70 and 66 respectively to retire. If Michael and Derrick believe they could invest their monthly SSB at 4.59% or greater over the next four years, then they should retire early, at ages 66 and 62

respectively; if not, they should delay retirement until ages 70 and 66. Again, this assumes they do not need any of their SSB on which to live.

RESULTS

Married couples of the same age, retiring at the same age.

Table 3 provides the BE IRR's for the nine race combinations (Whites (W), Hispanics (H) and Blacks (B)) for married males (M). The nine spouse_1/spouse_2 combinations for males (are: WM_WM, BM_BM, HM_HM, WM_BM, BM_WM, WM_HM, HM_WM, BM_HM and HM_BM).

Table 4 provides similar results for females (F): WF_WF, BF_BF, HF_HF, WF_BF, BF_WF, WF_HF, HF_WF, BF_HF and HF_BF.

The breakeven IRRs reported in Tables 3 and 4 may be variously interpreted as the minimum investment yield (or hurdle rate) required to justify retirement at Age 1 versus Age 2.

For example, Table 3, Panel A1 shows the breakeven IRR for married white men. Married couple, Ralph and John, were both born in 1953 turn 62 in 2015 and 66 in 2019. They are faced with the decision to retire today, at age 62 or wait another year and retire at age 63. According to Table 3, Panel A1, their breakeven IRR between ages 62 and 63 is 3.94%. In deciding whether to retire early or wait another year, they need to consider current market rates. If they could invest their monthly SSBs at a rate greater than the 3.94% hurdle rate, then they should retire early at age 62; if not, then they should delay retirement to age 63. In January 2015 the 1-year U.S. Treasury Bond rate was 0.20% (Federal Reserve.gov). This rate is less than the couple's 3.94% breakeven IRR and thus dictates that they should postpone retirement one more year, to age 63. Next year in 2016, they will be faced with the same decision, retire at age 63 or postpone retirement to age 64. The breakeven IRR between age 63 and age 64 is 6.84%. They will then need to compare this rate to current market rates to make an informed retirement decision.

		Panel A1: White Male1_White Male2								Panel B1: Black Male1_Black Male2								Panel C1: Hispanic Male1_Hispanic Male2							
Retirement Age 2		63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70	63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70	63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70
Retirement Age 1	62/62	3.94%	5.41%	5.45%	5.27%	4.49%	3.86%	3.32%	2.85%	4.01%	5.43%	5.49%	5.32%	4.59%	4.01%	3.53%	3.11%	4.29%	5.76%	5.82%	5.66%	4.90%	4.30%	3.80%	3.36%
	63/63		6.84%	6.19%	5.71%	4.62%	3.84%	3.22%	2.69%		6.81%	6.21%	5.75%	4.73%	4.01%	3.45%	2.98%		7.18%	6.57%	6.10%	5.05%	4.31%	3.72%	3.23%
	64/64			5.53%	5.13%	3.85%	3.05%	2.45%	1.96%			5.60%	5.21%	4.02%	3.29%	2.75%	2.32%			5.95%	5.55%	4.31%	3.55%	2.99%	2.53%
	65/65				4.73%	2.99%	2.19%	1.65%	1.21%				4.82%	3.21%	2.49%	2.02%	1.65%				5.14%	3.46%	2.72%	2.21%	1.80%
	66/66					1.17%	0.87%	0.57%	0.28%					1.55%	1.30%	1.06%	0.83%					1.69%	1.45%	1.19%	0.93%
	67/67						0.56%	0.27%	-0.01%						1.06%	0.82%	0.59%						1.21%	0.94%	0.68%
	68/68							-0.02%	-0.30%							0.59%	0.36%							0.67%	0.42%
	69/69								-0.59%								0.14%								0.16%
Panel A2: White Male1_White Male2 - Marginal Change in IRR		Panel B2: Black Male1_Black Male2 - Marginal Change in IRR								Panel C2: Hispanic Male1_Hispanic Male2 - Marginal Change in IRR															
Retirement Age 2		63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70	63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70	63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70
Retirement Age 1	62/62	-	1.48%	0.04%	-0.18%	-0.79%	-0.63%	-0.54%	-0.47%	-	1.42%	0.06%	-0.17%	-0.74%	-0.58%	-0.48%	-0.42%	-	1.47%	0.06%	-0.17%	-0.76%	-0.59%	-0.50%	-0.44%
	63/63		2.90%	-0.65%	-0.48%	-1.09%	-0.78%	-0.62%	-0.53%		2.80%	-0.60%	-0.46%	-1.02%	-0.72%	-0.56%	-0.47%		2.89%	-0.61%	-0.47%	-1.05%	-0.74%	-0.59%	-0.49%
	64/64			-1.31%	-0.40%	-1.28%	-0.80%	-0.60%	-0.50%			-1.21%	-0.39%	-1.20%	-0.73%	-0.53%	-0.43%			-1.23%	-0.40%	-1.24%	-0.76%	-0.56%	-0.46%
	65/65				-0.80%	-1.74%	-0.79%	-0.55%	-0.44%				-0.78%	-1.61%	-0.71%	-0.47%	-0.38%				-0.81%	-1.69%	-0.74%	-0.50%	-0.41%
	66/66					-3.56%	-0.30%	-0.29%	-0.29%					-3.27%	-0.25%	-0.24%	-0.23%					-3.45%	-0.24%	-0.26%	-0.26%
	67/67						-0.60%	-0.29%	-0.29%						-0.50%	-0.23%	-0.23%						-0.49%	-0.27%	-0.26%
	68/68							-0.58%	-0.28%							-0.47%	-0.22%							-0.53%	-0.26%
	69/69								-0.57%								-0.45%								-0.51%
Panel D1: White Male1_Black Male2		Panel E1: Black Male1_White Male2								Panel F1: White Male1_Hispanic Male2															
Retirement Age 2		63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70	63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70	63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70
Retirement Age 1	62/62	3.95%	5.39%	5.43%	5.25%	4.52%	3.94%	3.44%	2.99%	4.00%	5.46%	5.51%	5.35%	4.55%	3.93%	3.41%	2.96%	4.06%	5.55%	5.61%	5.43%	4.62%			

RaceM1 is earner and RaceM2 is non-earner. Both are same age and retire at same age. Breakeven IRR between consecutive ages are bolded and highlighted. FRA is 66.

Table 4: Breakeven IRR and Changes in IRR between Alternative Retirement Ages, 1943-1954 Birth Year Cohort																											
		Panel A1: White Female1_White Female2								Panel B1: Black Female1_Black Female2								Panel C1: Hispanic Female1_Hispanic Female2									
Retirement Age 2		63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70	63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70	63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70		
Retirement Age 1		62/62	4.38%	5.84%	5.88%	5.71%	4.92%	4.30%	3.76%	3.29%	4.38%	5.83%	5.90%	5.74%	4.99%	4.39%	3.89%	3.46%	4.65%	6.12%	6.18%	6.02%	5.27%	4.67%	4.16%	3.71%	
	63/63		7.24%	6.61%	6.14%	5.06%	4.28%	3.65%	3.13%	7.23%	6.63%	6.18%	5.14%	4.39%	3.81%	3.32%		7.52%	6.91%	6.47%	5.43%	4.67%	4.07%	3.57%			
	64/64			5.97%	5.58%	4.29%	3.49%	2.88%	2.38%		6.03%	5.65%	4.41%	3.65%	3.08%	2.63%			6.29%	5.92%	4.69%	3.91%	3.32%	2.85%			
	65/65				5.18%	3.41%	2.62%	2.05%	1.61%			5.26%	3.57%	2.82%	2.31%	1.91%				5.54%	3.85%	3.07%	2.53%	2.11%			
	66/66					1.51%	1.24%	0.93%	0.65%				1.80%	1.53%	1.26%	1.03%					2.06%	1.74%	1.45%	1.19%			
	67/67						0.98%	0.64%	0.36%					1.26%	1.00%	0.78%						1.42%	1.14%	0.89%			
	68/68							0.30%	0.05%						0.74%	0.54%							0.86%	0.63%			
	69/69								-0.19%							0.34%									0.40%		
		Panel A2: White Female1_White Female2 - Marginal Change in IRR								Panel B2: Black Female1_Black Female2 - Marginal Change in IRR								Panel C2: Hispanic Female1_Hispanic Female2 - Marginal Change in IRR									
Retirement Age 2		63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70	63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70	63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70		
Retirement Age 1		62/62	-	1.46%	0.04%	-0.17%	-0.79%	-0.62%	-0.54%	-0.47%	-	1.45%	0.07%	-0.16%	-0.75%	-0.60%	-0.50%	-0.43%	-	1.47%	0.06%	-0.16%	-0.75%	-0.60%	-0.51%	-0.45%	
	63/63		2.86%	-0.63%	-0.47%	-1.09%	-0.77%	-0.63%	-0.53%	2.85%	-0.59%	-0.45%	-1.05%	-0.74%	-0.59%	-0.48%		2.87%	-0.61%	-0.45%	-1.04%	-0.75%	-0.60%	-0.50%			
	64/64			-1.28%	-0.39%	-1.29%	-0.80%	-0.61%	-0.50%		-1.19%	-0.38%	-1.24%	-0.76%	-0.57%	-0.45%			-1.24%	-0.37%	-1.23%	-0.78%	-0.58%	-0.47%			
	65/65				-0.78%	-1.77%	-0.79%	-0.56%	-0.44%			-0.77%	-1.69%	-0.76%	-0.51%	-0.39%				-0.75%	-1.69%	-0.79%	-0.54%	-0.42%			
	66/66					-3.67%	-0.27%	-0.31%	-0.28%				-3.47%	-0.27%	-0.26%	-0.23%					-3.48%	-0.32%	-0.29%	-0.26%			
	67/67						-0.54%	-0.34%	-0.28%					-0.54%	-0.26%	-0.22%						-0.64%	-0.28%	-0.25%			
	68/68							-0.68%	-0.24%						-0.52%	-0.20%							-0.56%	-0.23%			
	69/69								-0.48%							-0.40%									-0.46%		
		Panel D1: White Female1_Black Female2								Panel E1: Black Female1_White Female2								Panel F1: White Female1_Hispanic Female2									
Retirement Age 2		63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70	63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70	63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70		
Retirement Age 1		62/62	4.37%	5.82%	5.87%	5.70%	4.94%	4.34%	3.82%	3.37%	4.38%	5.85%	5.91%	5.75%	4.96%	4.35%	3.82%	3.38%	4.47%	5.95%	6.00%	5.84%	5.03%	4.39%	3.84%	3.36%	
	63/63		7.22%	6.60%	6.14%	5.08%	4.34%	3.73%	3.22%		7.25%	6.65%	6.19%	5.11%	4.34%	3.73%	3.23%		7.36%	6.74%	6.28%	5.17%	4.38%	3.73%	3.20%		
	64/64			5.97%	5.58%	4.34%	3.58%	2.99%	2.51%			6.03%	5.65%	4.36%	3.57%	2.97%	2.51%			6.10%	5.72%	4.40%	3.57%	2.94%	2.43%		
	65/65				5.19%	3.50%	2.74%	2.20%	1.78%				5.26%	3.48%	2.69%	2.16%	1.75%				5.34%	3.50%	2.66%	2.08%	1.62%		
	66/66					1.73%	1.46%	1.15%	0.88%					1.58%	1.31%	1.04%	0.81%					1.48%	1.18%	0.87%	0.59%		
	67/67						1.18%	0.86%	0.60%						1.05%	0.78%	0.55%						0.89%	0.57%	0.30%		
	68/68							0.54%	0.30%							0.50%	0.30%							0.24%	0.00%		
	69/69								0.06%								0.10%								-0.24%		
		Panel D2: White Female1_Black Female2 - Marginal Change in IRR								Panel E2: Black Female1_White Female2 - Marginal Change in IRR								Panel F2: White Female1_Hispanic Female2 - Marginal Change in IRR									
Retirement Age 2		63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70	63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70	63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70		
Retirement Age 1		62/62	-	1.45%	0.05%	-0.17%	-0.76%	-0.60%	-0.52%	-0.45%	-	1.46%	0.06%	-0.16%	-0.78%	-0.62%	-0.52%	-0.45%	-	1.48%	0.05%	-0.16%	-0.80%	-0.64%	-0.55%	-0.48%	
	63/63		2.84%	-0.62%	-0.46%	-1.05%	-0.75%	-0.61%	-0.51%	2.87%	-0.60%	-0.46%	-1.08%	-0.77%	-0.61%	-0.50%		2.89%	-0.62%	-0.46%	-1.11%	-0.80%	-0.64%	-0.54%			
	64/64			-1.25%	-0.39%	-1.24%	-0.77%	-0.59%	-0.48%		-1.22%	-0.38%	-1.29%	-0.79%	-0.59%	-0.47%			-1.26%	-0.38%	-1.32%	-0.83%	-0.63%	-0.51%			
	65/65				-0.78%	-1.69%	-0.76%	-0.54%	-0.42%				-0.78%	-1.77%	-0.79%	-0.54%	-0.41%				-0.77%	-1.84%	-0.84%	-0.58%	-0.45%		
	66/66					-3.46%	-0.28%	-0.30%	-0.27%					-3.68%	-0.26%	-0.27%	-0.24%					-3.86%	-0.29%	-0.31%	-0.28%		
	67/67						-0.55%	-0.32%	-0.27%						-0.52%	-0.27%	-0.23%						-0.58%	-0.33%	-0.27%		
	68/68							-0.64%	-0.24%							-0.55%	-0.20%							-0.65%	-0.24%		
	69/69								-0.48%								-0.40%								-0.48%		
		Panel G1: Hispanic Female1_White Female2								Panel H1: Black Female1_Hispanic Female2								Panel I1: Hispanic Female1_Black Female2									
Retirement Age 2		63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70	63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70	63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70		
Retirement Age 1		62/62	4.56%	6.01%	6.06%	5.90%	5.17%	4.58%	4.08%	3.64%	4.48%	5.96%	6.03%	5.88%	5.08%	4.44%	3.91%	3.45%	4.56%	6.00%	6.05%	5.89%	5.19%	4.62%	4.14%	3.72%	
	63/63		7.41%	6.79%	6.34%	5.32%	4.59%	4.00%	3.51%		7.37%	6.78%	6.33%	5.23%	4.43%	3.81%	3.30%		7.39%	6.78%	6.33%	5.35%	4.64%	4.07%	3.60%		
	64/64			6.16%	5.78%	4.59%	3.84%	3.27%	2.81%			6.17%	5.79%	4.47%	3.64%	3.03%	2.55%			6.16%	5.79%	4.64%	3.92%	3.37%	2.93%		
	65/65				5.40%	3.78%	3.03%	2.51%	2.11%				5.41%	3.57%	2.73%	2.18%	1.76%				5.40%	3.86%	3.14%	2.65%	2.26%		
	66/66					2.10%	1.80%	1.51%	1.24%					1.54%	1.25%	0.98%	0.75%					2.29%	1.99%	1.70%	1.45%		
	67/67						1.50%	1.21%	0.95%						0.97%	0.71%	0.48%						1.68%	1.40%	1.16%		
	68/68							0.91%	0.68%							0.44%	0.24%							1.12%	0.90%		
	69/69								0.45%								0.04%								0.67%		
		Panel G2: Hispanic Female1_White Female2 - Marginal Change in IRR								Panel H2: Black Female1_Hispanic Female2 - Marginal Change in IRR								Panel I2: Hispanic Female1_Black Female2 - Marginal Change in IRR									
Retirement Age 2		63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70	63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70	63/63	64/64	65/65	66/66	67/67	68/68	69/69	70/70		
Retirement Age 1		62/62	-	1.45%	0.05%	-0.16%	-0.73%	-0.59%	-0.50%	-0.44%	-	1.48%	0.07%	-0.15%	-0.80%	-0.63%	-0.53%	-0.46%	-	1.44%	0.06%	-0.16%	-0.70%	-0.57%	-0.48%	-0.42%	
	63/63		2.85%	-0.62%	-0.46%	-1.02%	-0.73%	-0.59%	-0.49%	2.89%	-0.60%	-0.45%	-1.10%	-0.79%	-0.62%	-0.51%		2.83%	-0.61%	-0.45%	-0.98%	-0.71%	-0.57%	-0.47%			
	64/64			-1.25%	-0.38%	-1.19%	-0.75%	-0.57%	-0.46%		-1.20%	-0.38%	-1.32%	-0.82%	-0.61%	-0.48%			-1.22%	-0.38%	-1.15%	-0.72%	-0.54%	-0.44%			
	65/65				-0.76%	-1.62%	-0.74%	-0.52%	-0.41%				-0.76%	-1.84%	-0.83%	-0.56%	-0.42%				-0.76%	-1.54%	-0.72%	-0.50%	-0.39%		
	66/66					-3.30%	-0.30%	-0.29%	-0.26%					-3.87%	-0.29%	-0.27%	-0.24%					-3.12%	-0.30%	-0.28%	-0.26%		
	67/67						-0.60%	-0.29%	-0.25%						-0.57%	-0.26%	-0.22%						-0.61%	-0.28%	-0.24%		
	68/68							-0.59%	-0.23%							-0.52%	-0.20%							-0.56%	-0.23%		
	69/69								-0.46%								-0.40%								-0.46%		

Another way to interpret the IRRs reported in Tables 3 and 4 is to view them as the optimal retirement age. That is, one should retire at the age that gives the maximum IRR. The breakeven IRRs between consecutive ages for male couples are bolded and highlighted in Table 3, Panels A1 through I1. Table 3, Panels A2 through I2, shows the marginal change in breakeven IRR between different retirement ages for male couples. The optimal time to retire would then be at the point when the marginal change turns from positive to negative. This occurs at one point for male couples and for all race combinations: age 64/64. The highest IRR is at age 64. The choice to delay retirement past age 64 is suboptimal since the marginal change in IRR decreases. Thus a couples IRR is maximized at age 64.

Results for women are similar. Table 4, Panels A1 through I1, shows the breakeven IRR for female couples under various race combinations. Table 4, Panels A2 through I2, shows the marginal change in breakeven IRR between different retirement ages for female couples. The major difference between the sexes is that in all cases the breakeven IRR is higher for women than it is for men. The higher hurdle rates for women are due to their longer life expectancies. For example, a white female couple's breakeven IRR between retirement ages of 62 and 63 is 4.38%, or 0.44% higher than a white male couple's 3.94% breakeven IRR. Market rates therefore must be higher in order to entice women to entertain the idea of early retirement. For example, if a 1-year investment yields 4.10% in 2015, then the while male couple would retire at age 62 ($4.10\% > 3.94\%$), while the white female couple would postpone retirement for another year ($4.10\% < 4.38\%$). Again, the optimal time to retire, the point when the marginal change turns from positive to negative, is at age 64 for female couples and for all race combinations.

Irrespective of race or gender, age 64 is the optimum retirement age. Given this age, Table 5 shows that the highest Breakeven IRR for males is when Spouse_1 and Spouse_2 are both Hispanic and the lowest Breakeven IRR is when Spouse_1 is White and Spouse_2 is Black. Female couples have higher hurdle rates than male couples: HF1_HF2 is 7.52% which is 0.34% higher than HM1_HM2 of 7.18%; likewise WF1_BF2 is 7.22% which is 0.44% higher than WM1_BM2 of 6.78%. Hispanic men and women have the highest life expectancies so it seems logical that their breakeven IRR is the highest.

Table 5: IRR Comparison at Optimal Retirement age of 64.				
	Same-Sex Male		Same-Sex Female	
	Race Combinations	Breakeven IRR	Race Combinations	Breakeven IRR
64/64				
	WM1_WM2	6.84%	WF1_WF2	7.24%
	BM1_BM2	6.81%	BF1_BF2	7.23%
Highest	HM1_HM2	7.18%	HF1_HF2	7.52%
Lowest	WM1_BM2	6.78%	WF1_BF2	7.22%
	BM1_WM2	6.87%	BF1_WF2	7.25%
	WM1_HM2	6.99%	WF1_HF2	7.36%
	HM1_WM2	7.04%	HF1_WF2	7.41%
	BM1_HM2	7.02%	BF1_HF2	7.37%
	HM1_BM2	6.99%	HF1_BF2	7.39%

Married couples of different ages, retiring at the same age.

Three claiming scenarios are considered: receiving benefits early (e.g., at age 62 versus 66); the maximum realistic delay period (e.g., at age 62 versus 70) and delaying benefits past full retirement age (e.g., age 66 versus 70). Within these 3 claiming scenarios we examine couples by race combination who retire at the same age with age differences of 0, 4, 7 and 10 years with the non-working spouse_2 younger than the working spouse_1.

Table 6 shows BE IRRs for male couples; Table 7 for female couples. The results presented are based on applying the previously described Excel models for a birth year of 1948 for both spouses initially and progressively later years for the non-working spouse_2.

Age Difference	Male1 Retirement Age1	Male2 Retirement Age1	Male1 Retirement Age2	Male2 Retirement Age2	WM1_WM2 Breakeven IRR	BM1_BM2 Breakeven IRR	HM1_HM2 Breakeven IRR	WM1_BM2 Breakeven IRR	
0	62	62	66	66	5.2740%	5.3222%	5.6558%	5.2499%	
4	62	62	66	66	5.1723%	5.2247%	5.5485%	5.1507%	
7	62	62	66	66	5.0768%	5.1333%	5.4504%	5.0584%	
10	62	62	66	66	4.9646%	5.0263%	5.3375%	4.9506%	
0	62	62	70	70	2.8466%	3.1108%	3.3591%	2.9936%	
4	62	62	70	70	2.9357%	3.2007%	3.4624%	3.0742%	
7	62	62	70	70	3.0616%	3.3215%	3.5956%	3.1869%	
10	62	62	70	70	3.3033%	3.5463%	3.8356%	3.4023%	
0	66	66	70	70	0.2818%	0.8325%	0.9336%	0.6748%	
4	66	66	70	70	0.3092%	0.9048%	1.0236%	0.7304%	
7	66	66	70	70	0.5375%	1.1424%	1.2932%	0.9494%	
10	66	66	70	70	1.1907%	1.7374%	1.9512%	1.5192%	
Age Difference	Male1 Retirement Age1	Male2 Retirement Age1	Male1 Retirement Age2	Male2 Retirement Age2	BM1_WM2 Breakeven IRR	WM1_HM2 Breakeven IRR	HM1_WM2 Breakeven IRR	BM1_HM2 Breakeven IRR	HM1_BM2 Breakeven IRR
0	62	62	66	66	5.3457%	5.4339%	5.5078%	5.5061%	5.4879%
4	62	62	66	66	5.2458%	5.3108%	5.4217%	5.3846%	5.4039%
7	62	62	66	66	5.1511%	5.1993%	5.3391%	5.2740%	5.3241%
10	62	62	66	66	5.0398%	5.0705%	5.2424%	5.1460%	5.2371%
0	62	62	70	70	2.9607%	2.9414%	3.2784%	3.0552%	3.4153%
4	62	62	70	70	3.0595%	3.0236%	3.3889%	3.1468%	3.5163%
7	62	62	70	70	3.1940%	3.1466%	3.5252%	3.2781%	3.6394%
10	62	62	70	70	3.4459%	3.3895%	3.7645%	3.5308%	3.8541%
0	66	66	70	70	0.4308%	0.2401%	0.9785%	0.3860%	1.3267%
4	66	66	70	70	0.4750%	0.2634%	1.0715%	0.4256%	1.4351%
7	66	66	70	70	0.7237%	0.5080%	1.3283%	0.6906%	1.6770%
10	66	66	70	70	1.4061%	1.2111%	1.9442%	1.4232%	2.2203%

W=white, B=black, H=hispanic, M=male

Assuming couples retire at the same age, for the retirement ages 62 versus 66, the BE IRR's uniformly decrease as the age difference increases. This implies that the greater the age difference between couples, the earlier the couples should retire. BE IRRs range from a low of 4.9506% for the WM1_BM2 combination with a 10-year age difference, to a high of 5.6558% for the HM1_HM2 combination with a zero year age difference.

For the retirement ages 62 versus 70, the BE IRR's uniformly increase as the age

difference increases. This implies that the greater the age difference between couples, the later the couples should retire. However, the BE IRRs are much lower in this retirement decision, ranging from a low of 2.8466% for the WM1_WM2 combination with a zero year age difference, to a high of 3.8541% for the HM1_BM2 with a 10-year age difference.

Results for the 66 versus 70 retirement age decision are similar to the 62 versus 70 decision, however the BE IRRs are even lower. BE IRRs range from a low of 0.2401% for the WM1_HM2 combination with a zero year age difference, to a high of 2.2203% for the HM1_BM2 with a 10-year age difference.

Table 7: Breakeven IRRs for a Sample of Married Female Couples, Retirement Ages With Increasing Age Differences with Female1 as Breadwinner and the Older Spouse (Female1 born 1948; Female2 born 1948, 1952, 1955, 1958)									
Age Difference	Female1 Retirement Age1	Female2 Retirement Age1	Female1 Retirement Age2	Female2 Retirement Age2	WF1_WF2 Breakeven IRR	BF1_BF2 Breakeven IRR	HF1_HF2 Breakeven IRR	WF1_BF2B reakeven IRR	
0	62	62	66	66	5.7077%	5.7399%	6.0200%	5.7010%	
4	62	62	66	66	5.5986%	5.6333%	5.9069%	5.5925%	
7	62	62	66	66	5.4991%	5.5362%	5.8059%	5.4942%	
10	62	62	66	66	5.3851%	5.4252%	5.6919%	5.3818%	
0	62	62	70	70	3.2867%	3.4578%	3.7091%	3.3698%	
4	62	62	70	70	3.3907%	3.5617%	3.8244%	3.4676%	
7	62	62	70	70	3.5264%	3.6937%	3.9655%	3.5952%	
10	62	62	70	70	3.7728%	3.9288%	4.2093%	3.8270%	
0	66	66	70	70	0.6511%	1.0323%	1.1877%	0.8811%	
4	66	66	70	70	0.7175%	1.1289%	1.3068%	0.9621%	
7	66	66	70	70	0.9848%	1.3995%	1.6089%	1.2209%	
10	66	66	70	70	1.6767%	2.0454%	2.3020%	1.8607%	
Age Difference	Female1 Retirement Age1	Female2 Retirement Age1	Female1 Retirement Age2	Female2 Retirement Age2	BF1_WF2 Breakeven IRR	WF1_HF2 Breakeven IRR	HF1_WF2 Breakeven IRR	BF1_HF2 Breakeven IRR	HF1_BF2 Breakeven IRR
0	62	62	66	66	5.7465%	5.8371%	5.8990%	5.8754%	5.8933%
4	62	62	66	66	5.6392%	5.7097%	5.8040%	5.7497%	5.7989%
7	62	62	66	66	5.5410%	5.5967%	5.7161%	5.6380%	5.7121%
10	62	62	66	66	5.4284%	5.4688%	5.6157%	5.5115%	5.6131%
0	62	62	70	70	3.3751%	3.3623%	3.6430%	3.4493%	3.7196%
4	62	62	70	70	3.4854%	3.4597%	3.7650%	3.5529%	3.8351%
7	62	62	70	70	3.6255%	3.5925%	3.9091%	3.6900%	3.9712%
10	62	62	70	70	3.8753%	3.8393%	4.1527%	3.9401%	4.2013%
0	66	66	70	70	0.8051%	0.5924%	1.2435%	0.7457%	1.4455%
4	66	66	70	70	0.8885%	0.6537%	1.3660%	0.8243%	1.5755%
7	66	66	70	70	1.1686%	0.9367%	1.6543%	1.1199%	1.8530%
10	66	66	70	70	1.8665%	1.6773%	2.3064%	1.8653%	2.4605%

W=white, B=black, H=hispanic, F=female

Results for female couples are virtually the same as for male couples. For the retirement ages 62 versus 66, the BE IRR's uniformly decrease as the age difference increases. BE IRRs range from a low of 5.3818% for the WF1_BF2 combination with a 10-year age difference, to a high of 6.0200% for the HF1_HF2 combination with a zero year age difference.

For the retirement ages 62 versus 70, the BE IRR's uniformly increase as the age difference increases. Again, the BE IRRs are much lower in this retirement decision, ranging from a low of 3.2867% for the WF1_WF2 combination with a zero year age difference, to a high

of 4.2093% for the HF1_HF2 with a 10-year age difference.

Results for the 66 versus 70 retirement age decision are similar to the 62 versus 70 decision, however the BE IRRs are even lower. BE IRRs range from a low of 0.5924% for the WF1_HF2 combination with a zero year age difference, to a high of 2.4605% for the HF1_BF2 with a 10-year age difference.

COMPARISON OF MALE COUPLES VS. FEMALE COUPLES

Table 8: IRR Comparison at Varying Retirement Ages.				
	Same-Sex Male		Same-Sex Female	
	High Breakeven IRR	Low Breakeven IRR	High Breakeven IRR	Low Breakeven IRR
62/62 versus 66/66				
Age Difference				
0	HM1_HM2	WM1_BM2	HF1_HF2	WF1_BF2
4	HM1_HM2	WM1_BM2	HF1_HF2	WF1_BF2
7	HM1_HM2	WM1_BM2	HF1_HF2	WF1_BF2
10	HM1_HM2	WM1_BM2	HF1_HF2	WF1_BF2
62/62 versus 70/70				
Age Difference				
0	HM1_BM2	WM1_WM2	HF1_BF2	WF1_WF2
4	HM1_BM2	WM1_WM2	HF1_BF2	WF1_WF2
7	HM1_BM2	WM1_WM2	HF1_BF2	WF1_WF2
10	HM1_BM2	WM1_WM2	HF1_HF2	WF1_WF2
66/66 versus 70/70				
Age Difference				
0	HM1_BM2	WM1_HM2	HF1_BF2	WF1_HF2
4	HM1_BM2	WM1_HM2	HF1_BF2	WF1_HF2
7	HM1_BM2	WM1_HM2	HF1_BF2	WF1_HF2
10	HM1_BM2	WM1_WM2	HF1_BF2	WF1_WF2

Overall the highest BE IRRs have an older Hispanic spouse as the breadwinner; while the lowest BE IRRs have an older White spouse as the breadwinner. In all instances, the BE IRRs for female couples is higher than it is for male couples. For example, in the 62 versus 66 category, the highest BE IRR is 5.6558% for the HM1_HM2 combination with a zero year age difference and 6.0200% for the HF1_HF2 with a 0-year age difference; a difference of 0.3642%.

When deciding to retire early or later, the higher the BE IRR, the more difficult it is to retire early. That is, for a given retirement age comparison/age difference the high (low) breakeven group would prefer to retire later (earlier) since the hurdle rate is more difficult (less difficult) to overcome. The implication is that it is more difficult for female couples to retire early than it is for male couples. And, irrespective of gender, Hispanics have higher BE IRRs; while Whites have lower BE IRRs. Thus, Hispanics have a more difficult time retiring early and Whites have a less difficult time retiring early.

Married couples of different ages, retiring at different ages

The results presented in Table 9A and 9B are based on applying the previously described Excel models for a birth year of 1948 for both spouses initially and progressively later years for the non-working spouse₂. The spouses are assumed to retire at different ages.

Table 9A: Breakeven IRRs for a Sample of Married Male Couples Retirement Ages, With Different Retirement Ages and Increasing Age Differences. Male1 as Breadwinner and Male1 Older (Male1 born 1948; Male2 born 1948, 1952, 1955, 1958)									
Age Difference	Male1 Retirement Age1	Male2 Retirement Age1	Male1 Retirement Age2	Male2 Retirement Age2	WM1_WM2 Breakeven IRR	BM1_BM2 Breakeven IRR	HM1_HM2 Breakeven IRR	WM1_BM2 Breakeven IRR	
0	66	62	70	66	NA	NA	NA	NA	
4	66	62	70	66	4.3996%	4.5856%	4.9176%	4.3662%	
7	66	62	70	66	4.2777%	4.4715%	4.7950%	4.2484%	
10	66	62	70	66	4.1336%	4.3377%	4.6536%	4.1097%	
Age Difference	Male1 Retirement Age1	Male2 Retirement Age1	Male1 Retirement Age2	Male2 Retirement Age2	BM1_WM2 Breakeven IRR	WM1_HM2 Breakeven IRR	HM1_WM2 Breakeven IRR	BM1_HM2 Breakeven IRR	HM1_BM2 Breakeven IRR
0	66	62	70	66	NA	NA	NA	NA	NA
4	66	62	70	66	4.6161%	4.5648%	4.7707%	4.7770%	4.7442%
7	66	62	70	66	4.4982%	4.4258%	4.6647%	4.6420%	4.6419%
10	66	62	70	66	4.3591%	4.2638%	4.5407%	4.4850%	4.5228%
W=white, B=black, H=hispanic, M=male, F=female NA = Not applicable because if spouses are same age, spouse2 cannot retire and draw spousal benefits before spouse1 retires.									

Table 9B: Breakeven IRRs for a Sample of Married Female Couples Retirement Ages, With Different Retirement Ages and Increasing Age Differences. Female1 as Breadwinner and Female1 Older (Female1 born 1948; Female2 born 1948, 1952, 1955, 1958)									
Age Difference	Female1 Retirement Age1	Female2 Retirement Age1	Female1 Retirement Age2	Female2 Retirement Age2	WF1_WF2 Breakeven IRR	BF1_BF2 Breakeven IRR	HF1_HF2 Breakeven IRR	WF1_BF2 Breakeven IRR	
0	66	62	70	66	NA	NA	NA	NA	
4	66	62	70	66	4.8493%	4.9721%	5.2694%	4.8395%	
7	66	62	70	66	4.7200%	4.8485%	5.1403%	4.7117%	
10	66	62	70	66	4.5709%	4.7066%	4.9943%	4.5647%	
Age Difference	Female1 Retirement Age1	Female2 Retirement Age1	Female1 Retirement Age2	Female2 Retirement Age2	BF1_WF2 Breakeven IRR	WF1_HF2 Breakeven IRR	HF1_WF2 Breakeven IRR	BF1_HF2 Breakeven IRR	HF1_BF2 Breakeven IRR
0	66	62	70	66	NA	NA	NA	NA	NA
4	66	62	70	66	4.9812%	4.9834%	5.1478%	5.1118%	5.1399%
7	66	62	70	66	4.8562%	4.8396%	5.0330%	4.9722%	5.0815%
10	66	62	70	66	4.7123%	4.6754%	4.9017%	4.8133%	4.8970%
W=white, B=black, H=hispanic, M=male, F=female NA = Not applicable because if spouses are same age, spouse2 cannot retire and draw spousal benefits before spouse1 retires.									

A specific scenario of the impact of age differences on an early spouse₁/spouse₂ retirement of 66 and 62 respectively versus a late spouse₁/spouse₂ retirement of 70 and 66 respectively is examined. There is a Not Applicable (NA) in the table for an age difference of 0 since spousal benefits cannot be claimed by younger spouse₂ until the older spouse₁ retires. In all race combinations the BE IRR's decline as the age differences increase. This is true for both male and

female couples. This suggests that the greater the age difference the greater the incentive to retire early as the hurdle rate is lower to overcome.

From Table 9C and 9D we can see that in all scenarios, the BE IRRs are greater for female couples than it is for male couples.

Table 9C: Percentage Difference* in Breakeven IRRs for a Sample of Married Retirement Ages With Different Retirement Ages and Increasing Age Differences. Same-Sex Females vs. Same-Sex Males Marriages.									
Age Difference	Spouse1 Retirement Age1	Spouse2 Retirement Age1	Spouse1 Retirement Age2	Spouse2 Retirement Age2	WS1_WS2 Breakeven IRR	BS1_BS2 Breakeven IRR	HS1_HS2 Breakeven IRR	WS1_BS2 Breakeven IRR	
0	66	62	70	66	NA	NA	NA	NA	
4	66	62	70	66	10.2214%	8.4286%	7.1539%	10.8401%	
7	66	62	70	66	10.3397%	8.4312%	7.2013%	10.9053%	
10	66	62	70	66	10.5792%	8.5045%	7.3212%	11.0714%	
Age Difference	Spouse1 Retirement Age1	Spouse2 Retirement Age1	Spouse1 Retirement Age2	Spouse2 Retirement Age2	BS1_WS2 Breakeven IRR	WS1_HS2 Breakeven IRR	HS1_WS2 Breakeven IRR	BS1_HS2 Breakeven IRR	HS1_BS2 Breakeven IRR
0	66	62	70	66	NA	NA	NA	NA	NA
4	66	62	70	66	7.9093%	9.1702%	7.9045%	7.0086%	8.3407%
7	66	62	70	66	7.9587%	9.3497%	7.8955%	7.1133%	9.4703%
10	66	62	70	66	8.1026%	9.6534%	7.9503%	7.3200%	8.2736%

W=white, B=black, H=hispanic, S=same-sex spouse
 *Percentage Difference calculated as (Female IRR - Male IRR) divided by Male IRR or { (Table 9B IRR - Table 9A IRR) / Table 9A IRR}.

Table 9D: Percent Difference* in Breakeven IRRs for a Sample of Married Retirement Ages With Different Retirement Ages and Increasing Age Differences.									
Age Difference	Female/Male Retirement Age1	Male/Female Retirement Age1	Female/Male Retirement Age2	Male/Female Retirement Age2	WM_WF Breakeven IRR	BM_BF Breakeven IRR	HM_HF Breakeven IRR	WM_BF Breakeven IRR	
0	66	62	70	66	NA	NA	NA	NA	
4	66	62	70	66	0.4497%	0.3865%	0.3518%	0.4733%	
7	66	62	70	66	0.4423%	0.3770%	0.3453%	0.4633%	
10	66	62	70	66	0.4373%	0.3689%	0.3407%	0.4550%	
Age Difference	Female/Male Retirement Age1	Male/Female Retirement Age1	Female/Male Retirement Age2	Male/Female Retirement Age2	BM_WF Breakeven IRR	WM_HF Breakeven IRR	HM_WF Breakeven IRR	BM_HF Breakeven IRR	HM_BF Breakeven IRR
0	66	62	70	66	NA	NA	NA	NA	NA
4	66	62	70	66	0.3651%	0.4186%	0.3771%	0.3348%	0.3957%
7	66	62	70	66	0.3580%	0.4138%	0.3683%	0.3302%	0.4396%
10	66	62	70	66	0.3532%	0.4116%	0.3610%	0.3283%	0.3742%

W=white, B=black, H=hispanic, S=same-sex spouse
 *Percent Difference calculated as (Female IRR - Male IRR) or (Table 9B IRR - Table 9A IRR).

It is also interesting to examine the high and low BE IRR's for this comparison for each age difference by race category. Table 10 shows the high and low BE IRRs for the retirement age comparisons examined in Tables 9A and 9B.

Table 10: IRR Comparison at Varying Age Differences				
	Same-Sex Male		Same-Sex Female	
	High Breakeven IRR	Low Breakeven IRR	High Breakeven IRR	Low Breakeven IRR
66/62 versus 70/66				
Age Difference				
0	NA	NA	NA	NA
4	HM1_HM2	WM1_BM2	HF1_HF2	WF1_BF2
7	HM1_HM2	WM1_BM2	HF1_HF2	WF1_BF2
10	HM1_HM2	WM1_BM2	HF1_HF2	WF1_BF2

Remember that a higher (lower) BE IRR would imply retiring later (earlier) since the hurdle rate opportunity cost is more difficult (less difficult) to overcome. The high BE IRR column is dominated by Hispanic couples. The low BE IRR is dominated by an older working white spouse and a younger non-working black spouse.

APPLICATIONS/IMPLICATIONS

What is the optimal age for retirement? It depends on several factors: the age difference between the couple, investment rates in the market, and the use of the SSBs.

If a couple plans on spending their SSBs and not investing them, then they should both retire at age 64. This is the age that gives the highest BE IRR. This is true for all age differences, all race combinations and for both male and female couples.

The practical applications/implications of our results primarily depend on the couple's opportunity cost of capital and available other resources. If the couple's portfolio expected return or opportunity cost of capital is greater than (less than) the computed BE IRR, this would suggest that this couple retire at the earlier (later) date in the comparative analysis. These results should be useful for couples of different ages facing the Social Security early versus delayed retirement decision and financial planners. Using the analytics described in this paper, couples and/or their financial planners could first compute their breakeven Internal Rates of Return at various comparison ages and then compare this BE IRR to their expected portfolio return over the comparison period. If their expected portfolio return was greater than (less than) their BE IRR, then they should consider retiring at the earlier (later) age.

CONCLUSIONS

The primary substantive conclusions from this study depend on the age comparisons that are being made.

For married couples of the same age retiring at the same age, irrespective of race or gender, age 64 appears to be the optimum retirement age. This can be seen in the Table 3 and Table 4 marginal changes in IRR (Panels A2 through I2) which turn negative moving from age 64 to age 65.

For married couples of different ages retiring at the same chronological age, irrespective of who is older and the breadwinner, the age 62 versus 66 comparisons show BE IRR's

uniformly decrease as the age difference increases while the BE IRR's uniformly increase for the age 62 versus 70 and the age 66 versus 70 comparisons.

Finally, for married couples of different ages retiring at different ages, the BE IRR's decline as the age difference increases which implies that the greater the age difference the greater the incentive to retire early as the hurdle rate is lower to overcome. This is true irrespective of who is older or the breadwinner.

Women always have higher BE IRRs. The implication is that it is more difficult for the couple to retire early in same-sex female marriages than it is for same-sex male marriages. Irrespective of gender, Hispanics have higher hurdle rates, while Whites have lower hurdle rates. For a given retirement age comparison/age difference the results can be interpreted as follows: the high (low) breakeven group would prefer to retire later (earlier) since the hurdle rate is more difficult (less difficult) to overcome. Thus, Hispanics have a more difficult time retiring early and Whites have a less difficult time retiring early.

ENDNOTES

1. U.S Code §7 – Definition of “Marriage” and “Spouse.” Available at: <http://www.gpo.gov/fdsys/granule/USCODE-2011-title1/USCODE-2011-title1-chap1-sec7/content-detail.html>.

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APPENDIX A

<u>Abbreviation</u>	<u>Meaning</u>
COLA	Cost of Living Adjustment
DR	Discount Rate
DRC	Delayed Retirement Credit
ERA	Early Retirement Age
ET	Earnings Test
FRA	Full Retirement Age (receive full 100% of benefits)
IRR	Internal Rate of Return
PV	Present Value
SSA	Social Security Administration
SSB	Social Security Benefit

TEACHING MICRO AND MACRO IN ALL PRINCIPLES COURSES

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ABSTRACT

This paper tells the story about the directed evolution in the Principles of Economics courses at our university. Why did we make changes in our curriculum? We were not satisfied with the economic literacy of our one-semester students and our student “DFW” rates (earning a D, an F, or withdrawing from the course) seemed higher than necessary.

Fifteen years ago, we transformed a standard, segregated sequence of Macro and Micro into three Principles courses that each covered Macro and Micro. One course is for students who only take one Principles course. It uses a more intuitive approach to Macro and Micro with a focus on economic literacy, public policy, and topical applications. Another course is the first of our two-course Principles sequence-again using a more intuitive approach with a focus on literacy, policy, and applications, but using more rigor than in the literacy course for non-majors. The third course is the second Principles course for majors-covering Macro and Micro at a more technical level, so that the two courses for majors are equivalent to a standard two-course sequence in Principles of Economics.

In this paper, I describe the three courses in some detail. I compare and contrast our approaches in Principles to the standard, segregated courses in Macro and Micro, describing the strengths and weaknesses of each. And I analyze the empirical measures we had available to measure “success” (or not): complaints, upper-level enrollments, number of economics majors, and the DFW rate for students. Unfortunately, more compelling analysis is limited by a number of confounding factors-in particular, a.) the implementation of empirically-based pre-requisites during the same time period; b.) changes in the faculty who teach the courses; and c.) a general move from the use of adjuncts to full-time faculty.

Although our faculty valued all of these changes pedagogically, my colleagues and I can only recommend the one-semester literacy course for non-majors. With the continued growth of on-line courses and the increasing need for seamlessness in transfers, our integrated two-semester sequence is probably too difficult to implement in the face of the dominant, segregated Principles of Economics model.

INTRODUCTION

In April 2001, John Siegfried was the keynote speaker for the annual Teaching Conference at the University of Kentucky. His topic was the need to promote economic literacy through alternative approaches to Principles of Economics in college.¹ Our faculty had already implemented one of his ideas-a one-semester literacy-based course for those who only take one Econ course-that would begin in Fall 2001. (It’s tempting to describe “students who only take one Principles course” as “non-majors”. But many students take both Principles courses-particularly those in the various Business majors.) A colleague and I were excited about his more

innovative ideas on reforming the two-semester Principles sequence. The other faculty members were also enthusiastic-and in Spring 2002, we implemented a two-course Principles sequence with Micro and Macro in both semesters.

We had not been satisfied with the limited economic literacy that comes from taking one course in the standard, segregated Principles sequence. If a student is only going to take one Econ course, why not construct a course to cover economic literacy in both Micro and Macro? And we were not satisfied with the low success rate of our students, particularly in the first Principles course. We're a liberal-admissions university and Economics was often the first difficult course for students in their university experience, as they tried to enter the School of Business. We wondered whether there was a better way for students to "break into" the challenges of Econ.

THE CONCEPT

Our first semester course within the two-course sequence (1stSem) would use a more intuitive and conceptual approach, with a focus on basic concepts, economic literacy, and public policy applications-in both Micro and Macro.² Our second-semester course (2ndSem) would cover the more technical material that remained from the standard Macro/Micro coverage. The two courses, together, would be equivalent to the standard pair of segregated Principles courses.

As an example, we cover elasticity in both semesters. In our 1stSem course, we describe own-price elasticity of demand conceptually-the extent to which quantity demanded varies with changes in price and the impact of available close substitutes (including the role of tastes and preferences, time frame, and narrow vs. broad categories). Instructors also discuss applications to pricing decisions (e.g., increasing or decreasing pizza prices by a dollar) and public policy (e.g., determining revenue-maximizing public transit fares; the impact of prohibition on drug use). Instructors are also free to take things a bit further-e.g., light coverage of the basic equation with simple numerical examples and the implications of elasticity for demand and supply graphs-as they see fit.

In our 2ndSem course, instructors briefly review the concept of own-price elasticity-and then cover the equations, the graphical implications, and other types of elasticity. By the end of the second semester, students have been taught the usual material about elasticity, but divided more so by difficulty rather than segregating all of it into a Principles of Micro course. In a word, our 1stSem course covers the key concepts and applications, while the more technical aspects are left to the 2ndSem course.

There are three other potential combinations of coverage. First, along the same lines, the 1stSem course can use a modest model-and then move to a more sophisticated model in the 2ndSem course. Examples of this include AD and AS in Macro; the use of simple and then complex cost curves in Micro; and the use of computer simulations in producer theory (Gold and Gold, 2010; Dolvin and Pyles, 2011).

Second, the 1stSem course can carry most of the load on conveying important, basic concepts. From Micro, this would include opportunity costs, comparative advantage, property rights, variable, fixed and sunk costs, and so on. From Macro, this would include inflation, unemployment, and GDP; the functions of money; the role of banks; and so on. (One might reserve coverage of how to calculate inflation indices for the second-semester course.) In a nutshell, coverage here would be topics that are easier and more relevant to basic economic literacy. These concepts would be used again in the 2ndSem course-as part of the knowledge

brought into the 2ndSem course-but have already been developed fully (or nearly so) by the 1stSem course.

Third, the 1stSem course can take care of some of the more difficult concepts. Here, you're looking for topics that are vital to economic literacy, but still somewhat technical or otherwise challenging. For example, economic literacy in Macro requires coverage of Federal Reserve policy options. And in discussing producer theory, profit-maximization, and market structure, one must describe the trade-offs for the "price searcher" in Micro-a topic that benefits greatly from both a graphical and a numerical approach.

FIRST-SEMESTER VS. ONLY-ONE-SEMESTER ECON COURSES

Many college students only take one course in Economics. One question is whether they should be offered a combined Micro-Macro course or whether they should simply take one of the two traditional, segregated Micro or Macro courses. The former has a number of advantages-broader economic literacy (instead of just Macro or Micro) and flexibility in addressing policy topics, rather than being so constrained to prepare students for future business and economics courses.

In any case, *any* 1stSem course in Economics has some similarities with a "one-semester" course (OnlyOneSem). First, in both contexts, the audiences are less able. Within an OnlyOneSem course or any 1stSem course, students are new to economics. They don't know the lingo. Coming into the course, they may not have developed their critical thinking skills much. And Econ may be the most rigorous course they've encountered in college. On top of those factors, with some obvious exceptions (engineering, math, physics, etc.), OnlyOneSem students are not usually as competent with math and graphs-even to the point of disdain or fear.

In both contexts, the audiences are also less interested (Fitzpatrick et. al., 2006). 1stSem students are more interested in business, but often know little about economics. For OnlyOneSem students in particular, economics is not as closely connected to their major-and thus, merely one more piece of their "general education". It's unlikely that they have much if any interest in the topic, at least until they study it. As such, the primary goal is not coverage that prepares them for a major. Instead, the objective is to encourage basic economic literacy, preparing them for broad competence to be effective in the world as citizens, consumers, etc.

Thus, for both OnlyOneSem and 1stSem students, the lack of interest, coming into the course, calls for an approach that is more "memorable" and less "technical". Will OnlyOneSem students remember all of those graphs and equations? Why not offer an easier warm-up course for 1stSem students? Why not offer a course that is "sexier" to both-with more time on applications-policy or otherwise?³

So, the audiences for 1stSem and OnlyOneSem are quite similar-and the goals can be quite similar as well. In fact, when we first implemented this model, we used the same course for both the 1stSem course and the OnlyOneSem course. This worked reasonably well, but we ultimately decided it was sub-optimal and split the OnlyOneSem and the 1stSem courses in Fall 2010. We wanted to make the 1stSem course more rigorous than the OnlyOneSem course-and we wanted to tailor the OnlyOneSem course for those who only take one Econ course. (Another advantage is that our OnlyOneSem course is largely irrelevant to the AACSB accreditation process for our School of Business, since it is only applicable for non-majors.)

The differences? First, our 1stSem course uses a slightly more rigorous book (although considerably less rigorous than a standard Macro or Micro split). The OnlyOneSem course uses a lighter book with shorter chapters and more topics. (We use Guell [2015] for our OnlyOneSem

course and McLean et. al. [2012] for our 1stSem course.) Second, our OnlyOneSem course has a required "personal finance" component; the 1stSem course treats the subject as one of many optional topics chosen by the instructor.

Third, the 1stSem course includes use of the *Wall Street Journal*, making more connections to the business world. In contrast, the OnlyOneSem course has room for some optional elements that are attractive, especially for education majors. (We have found that they tend to struggle moreso in terms of aptitude and interest.) We can assign a paper on the costs and benefits of various aspects of course structure (getting them to think about how they would administer their own classes in the future) and/or a project to teach some aspect of economics in a K-12 setting (in a standard K-12 classroom or through a youth-based program such as Junior Achievement).

THE ADVANTAGES OF OUR 1STSEM COURSE VS. THE STANDARD 1STSEM COURSE

Any 1stSem course faces challenges in aptitude and interest. So, what are the advantages of our 1stSem course in contrast to the standard model of starting a two-course sequence with a segregated Macro or Micro course?⁴

First, addressing the above considerations, it's easy to make our 1stSem course more interesting than either segregated Macro or Micro. The course allows for more policy coverage-which many students find quite interesting. Students are also attracted to the more intuitive and conceptual parts of Economics-and teaching those first would seem to be a more effective way to get their attention, attract majors, and so on. As such, the course is also more effective as a "freshmen" seminar or "cornerstone" course for Business and Economics.(The use of pop culture in the Econ classroom is another approach to make Econ sexier. On music, see: Hall and Lawson [2008] and Lawson et. al. [2008]; on TV, see: Hall [2005], Mateer et. al. [2011], Gillis and Hall [2010]; on movies, see: Mateer and Li [2008], Mateer and Stephenson [2011].)

Second, our 1stSem course provides a warm-up for what students generally consider to be a relatively challenging topic-especially important at a liberal-admissions university. We start with an easier Econ course, before moving on to the second, more challenging course. This approach also makes it easier to signal difficulty with our course numbers. We had used E107/108 for our segregated Macro and Micro courses, which indicated an easier pair of courses with its freshman-level course numbers. Another option was E201/202, which would signal difficulty more effectively, but make it less likely for us to attract qualified freshmen. With our novel two-course sequence, we had a 100-level course and then a 200-level course-ideal for a combination of signaling difficulty and attracting qualified students. Again, this is more important in a liberal-admissions university like ours; for many of our students, a standard Macro or Micro Principles course is a significant hurdle.

Third, it is much easier to find adjuncts who can teach our 1stSem course well, since the coverage is less technical. In contrast, it is more challenging to find an adjunct to teach a standard Micro course-or especially, a standard Macro course.

Fourth, it gives us the opportunity to cover some material twice. It's often said that we make the mistake of thinking that "teachers saying it" is equivalent to "students learning it". Beyond that, it's often unsatisfying to see students struggle with a concept-and know that you won't have an opportunity to revisit it. In contrast, our two-course sequence allows us to cover some concepts twice-and to build from conceptual to technical. You usually see in the standard Macro/Micro sequence-with demand and supply taught in both courses. But why not do that with

a handful of other topics as well-moving from less-technical to more-technical coverage of elasticity, cost curves, AD & AS, and market structure?

THE DISADVANTAGES

Unfortunately, this last advantage also leads to the primary (potential) disadvantage. If we're covering things twice, how does one cover all of the material? In a word, what are the opportunity costs?

First, additional policy topics are at the instructor's discretion. In the standard segregated sequence, it's common to cover some policy topics in both Macro and Micro. So, many of these would be shuffled in our model from the 2ndSem course to the 1stSem course.

Second, the larger concern is the potential overlap in coverage of economic concepts. Back to the earlier example: if you're covering elasticity twice, you cannot reinvent the wheel when you teach it the second time. You must assume that they bring 1stSem-level understanding to the 2ndSem course. Consider inflation, unemployment, and GDP. You must assume that they are understood from the 1stSem-level course, going into the 2ndSem-level coverage.

At times, it might be wise to assign a review worksheet; offer a set of potential test questions over review material; or to provide a list of definitions or terms they should already understand. But it will not work to fully teach those basic topics a second time. As such, one must trust-and hopefully, have an occasion to trust-one's colleagues in their coverage of the 1stSem-level material. At the least, this should promote discussion and accountability between colleagues-certainly more than in the standard, segregated pair of courses.

Remember also that an easier and slower-paced 1stSem course necessarily implies a tougher and faster 2ndSem course. Students should be prepared for this, perhaps with a cost-benefit discussion of this two-course sequence in the first class meeting. And teachers must be comfortable with these differences as well.

A few other modest considerations: First, the cost of textbooks will typically be higher with this sequence, since they are buying one book for the 1stSem course and another for the 2ndSem course. Second, there are only a few good books for our 1stSem course (or an OnlyOneSem course). These markets are not nearly as well-developed as the standard Principles market.⁵

Third, there are certainly transaction costs from making this switch-getting consensus from the faculty, approval from the school, and navigating the university's process for curriculum change. Getting agreement from Econ faculty would typically be the largest barrier-and presumably more difficult in larger departments.

Another transaction cost: You must work harder than normal to establish articulation agreements with other universities for course transfers. Since most schools have the segregated courses, our non-standard sequence required clarity and legwork to pin schools down on their willingness to accept our two-course sequence. Beyond the articulation agreements, there is no guarantee that students transferring to other schools will receive reasonable transfer decisions and good advising.

Finally, in theory, students should self-select appropriately into the OnlyOneSem and 1stSem courses. But in our experience, given that the courses are similar in terms of difficulty, we found that a number of OnlyOneSem students chose the 1stSem course for scheduling convenience and other factors. Another concern: With an OnlyOneSem course for non-majors-that does not count as credit for those who need two Econ courses-students may enjoy the OnlyOneSem course so much that they want to change majors. This is another reason for

students to hedge their bets and take the 1stSem course-if they are unsure whether they are going to major in a field which requires two courses instead of one.

RESULTS

Anecdotally, with the new OnlyOneSem course and the new two-course sequence, we had far fewer complaints-to faculty through student evaluations of teaching; to advisors about Econ courses; and to me as coordinator of the program.

Other, more formal metrics? Sadly, we did not think to measure changes in literacy and knowledge through pre-tests and post-tests. If so, we could have compared our model to the standard, segregated models.

What do we have in terms of data? Although the presence of many variables makes it difficult (or impossible) to measure well, we don't seem to have had greater enrollments in upper-level economics courses. But upper-level enrollments are less effective as a proxy than one would hope, given that we've also changed our curriculum and reduced the number of upper-level elective courses.

Likewise, measuring the number of majors accurately and consistently has been challenging for our institution. Among other reasons, the calculation is complicated by students who declare economics as a second major. That said, by these measures, we have had significantly more graduates in Econ. But there is no significant change when that number is normed by the number of graduates at our university or the number of economics graduates nationally (Siegfried, 2014). So, this may be less impressive than it seems on the surface.

We might have seen evidence in our Educational Testing Service (ETS) scores in Economics. But we did not start using the ETS until 2000. No obvious pattern emerges-and in any case, there are not enough data to draw confident inferences.

Another complication: In Spring 2000, three semesters prior to the changes in our Principles curriculum, we implemented a pre-requisite for our Econ courses. The empirical model, analyzing correlates with student success, revealed that math grades and college GPA were most predictive for existing students-while high school GPA, SAT scores, placement test scores in reading and math were best for new students. The resulting empirically-ideal pre-requisites for new students were too difficult to implement by the administration, so we settled on math placement and "full admission status". For the data used in the analysis, students with these pre-requisites earned a GPA of 2.52 with 72% "success" in Principles (earning a C- or better). Those without the pre-requisites earned a 1.02 with a 24% success rate.

The "DFW rate" is the opposite of that measure of "success"-the percentage of students who earned a D or an F, or withdrew (W) from the course. Comparing the four semesters before and after the pre-requisites were implemented, our DFW rate fell dramatically, from 34.2% to 25.7%.

Looking at the new Principles courses, in their first four semesters, the DFW rate was virtually unchanged at 25.4%. Did we squeeze all of the potential gains in DFW from our change in pre-requisites-or is there another explanatory factor?

In 2013-14 and 2014-15, the DFW rate had risen again to 32.1%. Beyond this increase, there are other oddities in the data. For example, the DFW rates in all of our new OnlyOneSem and 1stSem courses are higher than the DFW rate in our old, Macro-only, 1stSem course-a considerably more challenging course.

Not surprisingly, there are many potential confounding factors and explanations for such results-changes in student quality over time, changes in teacher expectations, and so on. But the

most compelling explanation is that our use of adjuncts happened to drop dramatically, starting in Fall 2002. From 1997-2002, we used adjuncts in 40.7% of Principles courses. Thanks to an increase in full-time faculty (lecturers), our use of adjuncts decreased dramatically—only 15.0% since Fall 2002. And our adjuncts have historically had much lower DFW rates: 22.9% vs. 34.0% for full-timers.

A far tighter measure would be to compare individual professors before and after the curriculum changes. Unfortunately, due to retirements and new hires over this time period, we only have six examples of teachers with enough data to draw inferences with any confidence. Of these, three teachers exhibit change in the expected direction: two with significantly lower DFW rates in the 1stSem and Only OneSem course; and one with a significantly higher DFW rate in the 2ndSem course. The other three teachers showed no appreciable change in DFW rates.

A lack of change could be explained by a change in faculty expectations with the new course, declining student quality over time, the idea that students rise or fall to the level of expectations set out for them, or simply, a lack of difference in the various courses. At the end of the day, we don't have much empirical support for (or against) our curriculum change.

EPILOGUE AND A CAVEAT

We continue to be quite satisfied with our OnlyOneSem course. We have little direct evidence to support the move, but the change seems like a dramatic pedagogical improvement. It's definitely more fun and rewarding to teach the course—compared to Micro-only or Macro-only. As a faculty, we unanimously advocate the “Micro and Macro”, economic-literacy approach to an OnlyOneSem course.

But in Spring 2015, we began to transition back to the standard two-course sequence of segregated Micro and Macro courses. (We started this journey from a Macro-first sequence and a 100-level numbering system. Our journey has now taken us to a Micro-first sequence and a 200-level numbering system.) The majority of our faculty was content with our non-standard approach. But the growing prevalence of on-line course offerings and an increasing need to deal with transfer students made it increasingly difficult to hold our line.

We're curious about the impact of this move. We suspect that our DFW rate will:

- a.) increase significantly for our new 1stSem course (Micro);
- b.) decrease slightly for our new 2ndSem course (Macro); and
- c.) increase slightly for the two-course sequence overall.

A Micro-only course is more difficult than our old 1stsem economic literacy course. But a Macro-only course is less difficult than the relatively technical 2ndsem course in our old sequence. And overall, we would expect more students to have trouble with the jump to Micro's difficulty, compared to easing into Econ through our economic literacy approach.

Since the transition, we only have data for two semesters of Micro and one semester of Macro. The early data are consistent with our expectations: 38.9% in Micro; 20.7% in Macro; and 36.2% overall. As students continue through the two-course sequence, the proportion taking the second course will increase, probably resulting in a drop in the overall DFW rate.

In sum, our faculty would recommend the addition of a one-semester course tailored for those who only take one Econ course. And although our old two-semester sequence is a provocative idea, its usefulness probably pales in comparison to more important issues. As noted above, an effective pre-requisite may be eminently useful. As another example, teaching methods are surely a more important consideration—say, in comparing weak or rigorous Socratic approaches to lecturing's chalk and talk (Becker and Watts, 2001; Watts and Becker, 2010). At

the end of the day, perhaps energy would be better spent in determining an appropriate pre-requisite or addressing teaching methods within economics departments than in reforming the two-course Principles sequence.

ENDNOTES

¹ His presentation was a cousin of a future journal article, Hansen et. al. (2002). On the broader topic of economic literacy, see: Stigler (1970), Jenkins and Sharp (2003), and Salemi (2005). On the testing of economic literacy, see: Walstad et. al. (2013). On the question of what to cover for literacy purposes in a high school economics course, see: Gwartney (2012). Kudos to Bob Gillette and Gail Hoyt for their work on this excellent, economics education conference over the last 20+ years. The author would like to thank participants at the 2015 conference for their comments on this paper.

² In addition to personal finance, there are a number of prospective policy topics that are a.) more conceptual and easy to cover in a 1stSem course; but b.) less likely to be included in a standard Macro or Micro course. Examples include K-12 education, drug prohibition, welfare, poverty, discrimination, and health care/insurance. Although we address externalities conceptually in the first course, we save the graphs and the topic of pollution for the second course. Other popular topics can be covered in either semester-e.g., farm policy, unions, Social Security.

³ Hansen et. al. (2002) suggest material to drop (p. 466-468) and to add (p. 468) in the OnlyOneSem and 1stSem courses. Gilleskie and Salemi (2012) compare a literacy-targeted OnlyOneSem course with a one-course Principles “sequence” at the University of North Carolina, where students are only required to take one Principles course before taking Intermediate Theory courses. They find no appreciable, significant differences in outcomes. Marcal et. al. (2009) share their experience at California State University-Northridge. They moved from a standard two-semester sequence to a single semester course-for budget reasons-and found that the move resulted in statistically-significant, but only slightly lower, course grades.

⁴ In the two forms of the standard model, there are a number of important considerations in using Macro or Micro first: finding effective adjuncts, student preference for relatively concrete or abstract material, balance in the amount of material coverage between semesters, etc. (Fizel and Johnston 1986; Lopes and Maxwell 1995). For a survey of the relevant literature, see: Walstad and Siegfried (2014), including a discussion of what they call “P2” (p. 469).

⁵ We’ve used Guell (2015) for our OnlyOneSem course; McLean and Applegate (2012) for our 1stSem course; and Gwartney/Stroup (a standard macro/micro text) for our 2ndSem course. Our faculty strongly considered Heyne et. al. (2014) for the OnlyOneSem and 1stSem courses, given its lighter and market-process oriented approach. Grant (2016) is another issues-based text. For “econ lite” texts, see: Sexton (2014), Parkin et. al. (2012), and Mandel (2012). Hansen et. al. (2002) call for more books (p. 469), but there are still relatively few on the market.

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A REEXAMINATION OF SAFE RETIREMENT WITHDRAWAL RATES

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ABSTRACT

Since William Bengen's pioneer paper on sustainable withdrawal rates for retirement savings was first published in 1994, financial planners have used the results of that study, four percent of the total portfolio at retirement with future annual withdrawals adjusted for inflation, as a fundamental rule in retirement planning. It is generally considered a safe withdrawal rate. If an individual or a couple were to use a different withdrawal methodology, how would that methodology compare based on the probability they would outlive their retirement savings and what remained in their estate. This paper evaluates the viability of the four percent withdrawal rate and a number of other withdrawal methodologies using a Monte Carlo simulation, historical financial data, current mortality data, differences in the age of spouses and a variety of investment portfolios to answer that question.

INTRODUCTION

One of a retiree's primary financial concerns is that they will outlive their retirement savings. Bengen's 1994 article "Determining Withdrawal Rates Using Historical Data" provided an answer to that question - four percent of the total portfolio at retirement with future annual withdrawals adjusted for inflation. He determined that level of withdrawal was sustainable for thirty years based on return data from rolling thirty year periods from 1926 to the time of the article. Other authors (Guyton and Klinger, 2006, Robinson, 2007, and Tezel, 2004) have addressed this issue subsequent to Bengen and have introduced adjusting withdrawal rates based on current conditions and providing information on the effects of higher withdrawal rates. All have used historical data to provide a basis for their conclusions.

More recent contributions have taken different approaches. Pfau (2011) determines maximum withdrawal rates at the time of retirement based on market conditions at the time of retirement. He develops a model that determines maximum withdrawal rates based on the ten year cyclically adjusted earnings yield, the nominal bond yields for ten year government bonds, and the ten year dividend yield. His model finds maximum withdrawal rates as high as 8.8 percent in 1982 and under two percent in 2003. Blanchard and Blanchard (2008) use average returns and their standard deviation and predictions of future returns from a variety of different investments. They calculate the probability of exhausting ones resources based on investments with a given mean return and standard deviation. Finke et al (2013) conclude in a time when real returns for bonds are at or below zero, the four percent withdrawal rate may no longer be valid.

What these studies have in common is they make assumptions about rates of return, inflation, and life expectancy and then evaluate whether the four percent withdrawal rate and a variety of alternatives are valid. This paper uses a different methodology to evaluate variations of the four percent methodology and the endowment and minimum distribution methods. First, Bengen (1994) and a number of other authors used a series of actual returns in their studies, usually a thirty year duration. Rather than using a thirty year time frame to determine the validity

of a given withdrawal rate, the necessary duration of retirement savings is determined based on the age of the female spouse based on census data and the actual life expectancies of each spouse. The thirty year time frame used in other studies is not relevant if the actual years in retirement are twenty or thirty-five. Second, history may not be a good predictor of future returns, but volatility in the markets is a certainty. To determine rates of return, historical monthly information is used, but the rate of return is selected randomly from returns from a twenty-six year period, September 1987 to December 2013. Therefore, actual rates of return are used in this study, not in the order that they occurred, and are different for each observation.

THE MODEL

To evaluate the propriety of the various methodologies for determining withdrawal rates, a model was developed that utilizes a Monte Carlo simulation with ten thousand observations.

The first step was to determine the life expectancy for each observation. In the first iteration of the model, it was assumed that the male would retire at the age of sixty-five. The age of his spouse was then determined based on a uniform distribution applied to US Census data on differences in age between a husband and wife (2000). The life expectancy of both members of the couple was then determined based on a uniform distribution applied to mortality tables provided by the Social Security Administration (2012). The number of years the retirement income would be required was then based on the maximum of the life expectancy of the couple.

The second step was to determine the rate of return for each month during the couple's maximum life expectancy. One of the three hundred and sixteen observations of monthly rates of return for ten year Treasury bills, the Dow industrials, the S & P 500, the NASDAQ, and the Russel 2000 were then selected based on a random number generated for each month utilizing the uniform distribution. The consumer price index for that same month was also identified. Thirteen portfolios were then formed, one each for the five indices identified above, one each for portfolio consisting of sixty percent ten year Treasury bills and forty percent of each of the four stock indices, and portfolios consisting of forty percent bonds, sixty percent stocks for each stock index. The stock and bond portfolios were rebalanced each month to maintain the given percentages.

The third step was then to evaluate seven different withdrawal methodologies. The first five methodologies calculated an initial withdrawal of .2500%, .2917%, .3333%, .3750% and .4166% of the initial retirement balance (the monthly withdrawal associated with 3, 3.5, 4, 4.5, and 5 percent annual withdrawal). For subsequent months, the monthly return was then added to the retirement balance and the monthly withdrawal, adjusted for inflation, was subtracted resulting in the current retirement balance. This process continued until the life expectancy of the surviving spouse was reached or the retirement balance was exhausted. Upon completion of these calculations for all observations, the probability that the surviving spouse outlived their retirement savings and the average positive retirement balance were calculated for each percentage of retirement savings methodology and each portfolio.

The sixth methodology is known as the endowment method. In this method, the initial monthly withdrawal for each year is determined by calculating average retirement balance at the end of the previous three years, multiplied by five percent, and divided by twelve. For subsequent months, the monthly return was then added to the retirement balance and the monthly withdrawal was subtracted resulting in the current retirement balance. This process continued until the life expectancy of the surviving spouse was reached. Under this method it is nearly

impossible for the surviving spouse to outlive their retirement savings, but their monthly withdrawal may approach zero. Similar to the above methodologies, the retirement balance for each portfolio was calculated. In addition, the average minimum, maximum and range of annual withdrawals and the minimum observed annual withdrawal adjusted for inflation were calculated for each portfolio.

The seventh methodology evaluated was based on the Internal Revenue Service's minimum withdrawal requirements for deferred income retirement plans. Under this methodology, in the sixth year of retirement upon reaching age seventy and a half, a distribution must be made equal to the current retirement balance divided by a factor, which is 27.4 in year one, and decreases each year based on life expectancy. Monthly withdrawals are calculated by dividing the defined minimum distribution amount for each year by twelve. In subsequent months after the initial withdrawal, the monthly return was then added to the retirement balance and the monthly withdrawal was subtracted. This process continued until the life expectancy of the surviving spouse was reached. Like methodology six, it is nearly impossible for the balance to be exhausted, so the same statistics as in methodology six were calculated for each portfolio.

THE RESULTS

Table 1, Panel A presents the probability that a couple will outlive their retirement savings in their joint lifetimes and the number of years they would have no withdrawals if the surviving spouse outlived their retirement savings. These amounts are calculated for the five percentages of initial withdrawal methodologies and the thirteen portfolios. The four percent withdrawal rate used by Bengen (1994) yields a 3.32 percent chance of a couple outliving their retirement portfolio if they invest in ten year Treasury bills. The all stock portfolios all provide a risk too significant for most retirees at this withdrawal rate, however, the forty percent stocks and sixty percent bond portfolio may provide an alternative for some retirees for they have only a slightly higher probability of the surviving spouse outliving their retirement income. A 3.5 percent withdrawal rate reduces the risk and the risk associated with a three percent withdrawal rate approaches zero for these five portfolios. These results are different from Bengen (1994) for a number of reasons. This paper uses actual life expectancies rather than a static thirty years. The average life expectancy for the surviving spouse is twenty six years in this simulation. Since Bengen published his paper in 1994, life expectancies for males increased three years and females two years (Clark et al 2013). Bengen (1994) and others have used the assumption that if you retire at sixty-five, thirty years of retirement income should be sufficient. However, what they do not take into account is that only 32.4 percent of females are the same age as their spouse and 55.4 percent are younger (US Census 2000). Based on these statistics and mortality tables (Social Security Administration 2012) at least one spouse will exceed thirty years in retirement 27.7 percent of the time if the couple retires when the male reaches age sixty-five

The major difference in the portfolios is the balance in the couple's estate of the five portfolios. Table 1 Panel B presents the average balance in the estate after the death of the surviving spouse. If a secondary objective of the couple is to provide an estate for their heirs while still maintaining a safe withdrawal of retirement savings methodology, the sixty percent ten year Treasury bonds forty percent stocks portfolios provide a larger estate with only a slightly larger probability that the surviving spouse will outlive the couple's retirement savings. For the endowment and the minimum distribution methods, in almost all circumstances, the surviving spouse cannot outlive their retirement savings for they use a percentage of the

remaining retirement savings balance for determining withdrawals. However, the amount of the withdrawal can vary dramatically. Table 1, Panel C presents the average minimum, maximum and range of withdrawals and the minimum withdrawal for all observations adjusted for inflation. These methodologies provide for a possibility of withdrawals in excess of the \$4,000 initial withdrawal used in the percent withdrawal adjusted for inflation methodology, but also provide a possibility of withdrawals significantly less than the \$4,000 withdrawal. In selecting among any of the methodologies and portfolios, a retiree must balance risk and reward according to their own risk tolerances.

Table 1
PANEL A
PROBABILITY COUPLE WILL OUTLIVE THEIR RETIREMENT SAVINGS FOR VARIOUS
WITHDRAWAL PERCENTAGES IF COUPLE OUTLIVES THEIR RETIREMENT SAVINGS, NUMBER
OF YEARS WITH NO WITHDRAWALS

	3.0%		3.5%		4.0%		4.5%		5.0%	
	Prob	Years	Prob	Years	Prob	Years	Prob	Years	Prob	Years
Ten Year Treasury	0.00	.	0.16	3.50	3.22	4.38	16.14	4.99	37.46	5.98
S&P 500	6.95	7.85	11.72	8.34	17.41	8.94	23.93	9.57	30.86	10.16
Dow	5.70	7.54	9.67	8.21	14.92	8.80	20.77	9.40	27.92	9.84
NASDAQ	9.48	9.72	13.15	10.49	17.61	10.86	22.14	11.43	26.69	11.93
Russel 2000	10.51	9.19	15.06	9.83	20.28	10.39	25.33	11.02	30.98	11.45
Sixty Percent Stocks, Forty Percent Bonds										
S&P 500	1.62	5.20	4.03	6.28	8.79	6.84	15.97	7.42	25.23	8.11
Dow	0.94	5.21	3.12	5.87	7.20	6.69	13.64	7.28	22.65	7.80
NASDAQ	2.22	7.50	4.54	7.68	8.10	8.19	12.93	8.72	18.90	9.20
Russel 2000	2.46	6.86	5.52	7.18	9.96	7.90	16.28	8.34	23.45	9.00
Forty Percent Stocks, Sixty Percent Bonds										
S&P500	0.21	3.95	1.55	4.87	5.03	5.63	12.51	6.23	23.80	7.02
Dow	0.08	2.88	0.96	4.72	4.27	5.19	10.67	6.08	21.78	6.70
NASDAQ	0.57	5.67	1.71	6.43	4.37	6.60	8.95	7.10	15.96	7.66
Russel 2000	0.63	4.76	2.12	5.87	5.56	6.46	12.00	6.88	20.76	7.58

Table 1
PANEL B
AVERAGE SAVINGS BALANCE AT DEATH FOR NON-ZERO BALANCES (IN THOUSANDS) INITIAL
RETIREMENT SAVINGS OF \$100,000

	Percent of Savings at Retirement Left in the Estate Adjusted for Inflation					Endowment Method	Minimum Distribution
	3.0%	3.5%	4.0%	4.5%	5.0%		
Ten Year Treasury	88	68	49	32	20	54	166
S&P 500	236	207	180	155	132	103	304
Dow	267	236	206	178	153	113	331
NASDAQ	795	737	682	628	577	267	732
Russel 2000	404	367	331	297	265	155	442
Sixty Percent Stocks, Forty Percent Bonds							
S & P 500	161	136	112	90	70	79	238
Dow Industrials	174	148	123	99	78	84	251
NASDAQ	347	310	274	239	207	138	398
Russel 2000	226	197	169	142	118	100	297
Forty Percent Stocks, Sixty Percent Bonds							

S & P 500	132	109	86	65	47	69	211
Dow Industrials	139	116	92	70	51	72	218
NASDAQ	224	195	165	137	111	100	296
Russel 2000	167	141	116	93	72	81	244

Table 1**Panel C**

**ANNUAL WITHDRAWAL ADJUSTED FOR INFLATION STATISTICS (IN THOUSANDS)
ENDOWMENT AND MINIMUM DISTRIBUTION METHODS INITIAL RETIREMENT SAVINGS OF
\$100,000**

	Endowment				Minimum Distribution			
	Average			Minimum Observation	Average			Minimum Observation
	Min	Max	Range		Min	Max	Range	
Ten Year Treasury	2,662	4,916	2,254	680	3,912	5,716	1,804	944
S&P 500	2,954	7,879	4,925	74	3,759	12,575	8,816	202
Dow	3,088	8,225	5,137	122	3,904	13,461	9,557	248
NASDAQ	3,087	16,983	13,896	20	4,239	31,454	27,215	66
Russel 2000	2,913	11,100	8,187	25	3,813	19,109	15,296	98
Sixty Percent Stocks, Forty Percent Bonds								
S&P 500	3,185	5,964	2,779	281	3,988	8,944	4,956	566
Dow	3,294	6,074	2,780	356	4,077	9,313	5,236	605
NASDAQ	3,510	8,863	5,353	163	4,358	15,285	10,927	456
Russel 2000	3,293	7,109	3,816	167	4,076	11,416	7,340	592
Forty Percent Stocks, Sixty Percent Bonds								
S&P 500	3,175	5,314	2,139	439	4,048	7,574	3,526	808
Dow	3,262	5,353	2,091	512	4,104	7,781	3,677	806
NASDAQ	3,606	6,582	2,976	363	4,338	10,751	6,413	812
Russel 2000	3,356	5,827	2,471	330	4,137	8,878	4,741	748

Table 2 presents the results of the calculations if the couple delays retirement by two years for select portfolios. These are the same people and the same investment returns as presented above, but have two years with no withdrawals. The results are better for all combinations of methodology and portfolio. However, only portfolios presented above with acceptable results are included. The minimum distribution method is not presented since the results would not change since no withdrawals are made during the first five years. Table 2 Panel A indicates delaying retirement by two years reduces the risk of the surviving spouse outliving the couple's retirement savings approach to near zero for the four percent methodology for the ten year Treasury rate but also makes a forty percent stock and sixty percent bond portfolio more acceptable. Table 2 Panel B presents the value of the estate. In each case it is also larger than if the couple were to retire when the male reaches age 65. Table 2, Panel C confirms that delaying retirement by two years is also beneficial when using the endowment method of withdrawals.

Table 2 Panel A PROBABILITY COUPLE WILL OUTLIVE THEIR RETIREMENT SAVINGS FOR VARIOUS WITHDRAWAL PERCENTAGES IF COUPLE OUTLIVES THEIR RETIREMENT SAVINGS, NUMBER OF YEARS WITH NO WITHDRAWALS RETIREMENT IS DELAYED TWO YEARS										
	3.0%		3.5%		4.0%		4.5%		5.0%	
	Prob	Years	Prob	Years	Prob	Years	Prob	Years	Prob	Years
Ten Year Treasury	0.00	.	0.01	2.00	0.75	3.65	5.72	4.51	18.48	5.10
Forty Percent Stocks, Sixty Percent Bonds										
S&P500	0.11	2.55	0.76	4.14	2.49	5.46	6.72	5.71	13.79	6.25
Dow	0.01	1.00	0.51	3.24	1.94	4.77	5.60	5.49	11.51	6.22
NASDAQ	0.35	5.43	1.08	6.14	2.55	6.48	5.33	6.76	9.66	7.10
Russel 2000	0.35	4.37	1.22	5.54	3.29	6.02	7.13	6.39	12.83	6.93

Table 2 Panel B AVERAGE SAVINGS BALANCE AT DEATH FOR NON-ZERO BALANCES (IN THOUSANDS) RETIREMENT IS DELAYED TWO YEARS INITIAL RETIREMENT SAVINGS OF \$100,000						
	Percent of Savings at Retirement Left in the Estate Adjusted for Inflation					Endowment Method
	3.0%	3.5%	4.0%	4.5%	5.0%	
Ten Year Treasury	99	82	64	47	33	59
S & P 500	148	127	106	87	69	77
Dow Industrials	156	134	113	93	74	80
NASDAQ	247	221	195	170	146	111
Russel 2000	185	162	140	118	98	90

Table 2 Panel C ANNUAL WITHDRAWAL ADJUSTED FOR INFLATION STATISTICS ENDOWMENT METHOD RETIREMENT IS DELAYED TWO YEARS INITIAL RETIREMENT SAVINGS OF \$100,000				
	Average			Minimum
	Min	Max	Range	Observation
Ten Year Treasury	2,949	5,075	2,126	753
Forty Percent Stocks, Sixty Percent Bonds				
S&P 500	3,471	5,712	2,241	492
Dow	3,561	5,766	2,205	573
NASDAQ	3,874	7,183	3,309	403
Russel 2000	3,639	6,316	2,677	371

Highly rated corporate bonds provide a relatively safe investment but provide a higher yield than ten year Treasury bonds. Elton et al (2013) calculate the risk premium for A rated corporate bonds after adjusting for defaults to be seventeen basis points. Although not extremely significant, this investment medium does provide better results as shown in Table 3.

Table 3 PROBABILITY COUPLE WILL OUTLIVE THEIR RETIREMENT SAVINGS FOR VARIOUS WITHDRAWAL PERCENTAGES IF COUPLE OUTLIVES THEIR RETIREMENT SAVINGS, NUMBER OF YEARS WITH NO WITHDRAWALS TEN YEAR TREASURY AND A RATED CORPORATE BONDS										
	3.0%		3.5%		4.0%		4.5%		5.0%	
	Prob	Years	Prob	Years	Prob	Years	Prob	Years	Prob	Years
Ten Year Treasury	0.00	.	0.16	3.50	3.22	4.38	16.14	4.99	37.46	5.98
Forty Percent Stocks, Sixty Percent Ten Year Treasury Bonds										
S&P500	0.21	3.95	1.55	4.87	5.03	5.63	12.51	6.23	23.80	7.02
Dow	0.08	2.88	0.96	4.72	4.27	5.19	10.67	6.08	21.78	6.70
NASDAQ	0.57	5.67	1.71	6.43	4.37	6.60	8.95	7.10	15.96	7.66
Russel 2000	0.63	4.76	2.12	5.87	5.56	6.46	12.00	6.88	20.76	7.58
A Rated Corporate Bonds	0.00	.	0.05	3.00	2.14	4.17	12.46	4.99	33.33	5.81
Forty Percent Stocks, Sixty Percent A Rated Corporate Bonds										
Standard & Poors 500	0.17	4.12	1.45	4.70	4.69	5.59	11.95	6.16	23.04	6.94
Dow Industrials	0.06	2.50	0.91	4.37	3.93	5.16	9.99	6.10	20.98	6.62
NASDAQ	0.55	5.47	1.62	6.45	4.09	6.69	8.64	7.05	15.48	7.60
Russel 2000	0.58	4.79	1.96	5.88	5.33	6.37	11.47	6.86	20.24	7.49

The portfolios used in this paper are based on actively managed portfolios. This paper uses return on bonds and stock indices as a proxy for these portfolios. However, most individuals saving for retirement have portfolios that consist primarily of mutual funds, i.e. they leave the management of the portfolio to mutual fund management. According to the Investment Company Institute (2013), the average expense ratio for mutual funds is seventy seven basis points. To account for the cost of maintaining mutual funds in the portfolios, each portfolio's returns were adjusted to reflect this expense. Table 4 presents the results for select portfolios. The results show that the four percent withdrawal rate proposed by Bengen (1994) is problematic. The three and a half percent methodology reduces the probability of the surviving spouse outliving the couple's retirement income to below five percent, but the three percent methodology is the only acceptable alternative for the risk adverse. The endowment method has no portfolio where the couple outlives their retirement savings; however, the possibility of very low withdrawals is an even greater issue when mutual fund expenses are incorporated into the model.

Table 4 Panel A PROBABILITY COUPLE WILL OUTLIVE THEIR RETIREMENT SAVINGS FOR VARIOUS WITHDRAWAL PERCENTAGES IF COUPLE OUTLIVES THEIR RETIREMENT SAVINGS, NUMBER OF YEARS WITH NO WITHDRAWALS RETURNS ADJUSTED FOR MUTUAL FUND EXPENSES										
	3.0%		3.5%		4.0%		4.5%		5.0%	
	Prob	Years	Prob	Years	Prob	Years	Prob	Years	Prob	Years
A Rated Corporate Bonds	0.17	3.35	3.16	4.42	15.56	4.99	36.36	5.91	55.98	7.10
S&P500	10.20	7.94	16.05	8.53	22.96	9.16	30.33	9.77	38.55	10.22
Dow	8.36	7.77	13.84	8.30	19.71	9.04	27.21	9.50	34.97	10.04
NASDAQ	12.00	9.78	16.35	10.46	21.32	10.95	26.03	11.58	30.94	11.99
Russel 2000	13.53	9.36	19.04	9.88	24.64	10.51	30.24	11.11	36.64	11.48
Forty Percent Stocks, Sixty Percent Bonds										
S&P500	1.17	4.65	4.47	5.34	12.10	5.90	23.65	6.72	37.84	7.53
Dow	0.83	3.78	3.73	4.92	10.13	5.84	21.39	6.49	35.20	7.39

NASDAQ	1.29	6.37	3.71	6.47	8.28	6.83	15.70	7.30	24.40	8.13
Russel 2000	1.64	5.63	4.88	6.19	11.28	6.57	20.46	7.25	31.53	7.99

Table 4 Panel B ANNUAL WITHDRAWAL ADJUSTED FOR INFLATION STATISTICS (IN THOUSANDS) ENDOWMENT AND MINIMUM DISTRIBUTION METHODS RETURNS ADJUSTED FOR MUTUAL FUND EXPENSES INITIAL RETIREMENT SAVINGS OF \$100,000								
	Endowment				Minimum Distribution			
	Average			Minimum	Average			Minimum
	Min	Max	Range	Observation	Min	Max	Range	Observation
Ten Year Treasury	2,461	4,988	2,527	474	3,604	4,906	1,302	2,461
Forty Percent Stocks, Sixty Percent Bonds								
S&P 500	2,989	5,042	2,053	337	3,727	6,499	2,772	-
Dow	3,076	5,075	1,999	401	3,788	6,661	2,873	-
NASDAQ	3,502	6,131	2,629	271	4,033	9,118	5,085	-
Russel 2000	3,208	5,485	2,277	253	3,820	7,582	3,762	-

The results presented in this paper are averages based on a Monte Carlo simulation with ten thousand observations. Table 5 is presented in order to warn the reader about interpreting averages. The table presents the probability a couple, the male spouse, the female spouse, and a female age sixty-five at retirement will outlive their/his/her retirement savings for a portfolio consisting of unadjusted ten year Treasury notes. Comparing the four percent withdrawal rate, the couple has a 3.22 percent chance of outliving their savings while the probability for a male is only a 0.09 percent and a female is 3.13 percent. These probabilities are for the same people with the same investments and the same withdrawal amounts. The reason the male and female probabilities are lower than the couple is because sometimes the male is the surviving spouse and sometimes it is the female. The probabilities are consistent with the female generally living longer and is more often than not younger than her spouse. However, neither of these assumptions based on government data may be true for a given couple. To illustrate how an adjustment to the assumptions may affect the results, compare the probability a female age sixty-five will outlive her retirement savings to a female given her age at retirement is statistically determined based on her husband's age. Using the four percent withdrawal rate adjusted for inflation, the probability of her outliving her retirement savings is 3.13 percent for the statistically determined retirement age rather than the 0.69 percent for her retiring at age sixty-five.

Table 5 PROBABILITY COUPLE WILL OUTLIVE THEIR RETIREMENT SAVINGS FOR VARIOUS WITHDRAWAL PERCENTAGES IF COUPLE OUTLIVES THEIR RETIREMENT SAVINGS, NUMBER OF YEARS WITH NO WITHDRAWALS										
	3.0%		3.5%		4.0%		4.5%		5.0%	
	Prob	Years	Prob	Years	Prob	Years	Prob	Years	Prob	Years
Couple	0.00	.	0.16	3.50	3.22	4.38	16.14	4.99	37.46	5.98
Male	0.00	.	0.00	.	0.09	2.11	2.12	2.99	10.25	3.76
Female *	0.00	.	0.16	3.50	3.13	4.44	14.28	5.24	30.43	6.40
Female age 65	0.00	.	0.00	.	0.69	2.17	7.03	3.41	25.99	4.27

* Female's age is determined statistically based on the male's age given as sixty-five

CONCLUSION

Since William Bengen's pioneer paper on sustainable withdrawal rates for retirement savings was first published in 1994, financial planners have used the results of that study, a four percent withdrawal rate adjusted for inflation, as a fundamental rule in retirement planning. It is generally considered a safe withdrawal rate. This paper questions the viability of the four percent withdrawal rate utilizing a Monte Carlo simulation, more recent return data, statistics for life expectancies, the disparity in the ages of married couples, and an investment medium more consistent with current retirement savings. The results suggest that using a four percent of initial retirement savings adjusted for inflation withdrawal rate may cause the surviving spouse to outlive the couple's retirement savings by a probability of nearly twenty-five percent for a portfolio based on the Russel 2000, the riskiest portfolio, and by eight to fifteen percent for the lower risk portfolios. When the surviving spouse did outlive the life of the less risky portfolios, they averaged six to seven years with no withdrawals. These results clearly call into question the viability of the four percent withdrawal rate. The three and a half percent withdrawal rate reduces the risk of the surviving spouse outliving the couple's retirement savings to below five percent for the less risky portfolios, but a three percent withdrawal rate appears to be the only percentage of initial retirement savings adjusted for inflation option for the risk adverse. The endowment and minimum distribution methods do nearly eliminate the possibility of the surviving spouse outliving the couple's retirement savings and are alternatives to the percentage of initial retirement savings methodologies. These are viable alternatives for persons who are more concerned with not outliving their retirement savings than a consistent income.

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