TWO ESSAYS ON COLLEGE ECONOMICS:
AN EVALUATION OF THE COLLEGE FED CHALLENGE COMPETITION
THE EFFECTS OF MATHEMATICS REQUIREMENTS ON STUDENT PERFORMANCE IN INTRODUCTORY ECONOMICS

by

David Nsingang Simon

A dissertation submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Economic Education

Fall 2018

© 2018 David Nsingang Simon
All Rights Reserved
TWO ESSAYS ON COLLEGE ECONOMICS:
AN EVALUATION OF THE COLLEGE FED CHALLENGE COMPETITION

THE EFFECTS OF MATHEMATICS REQUIREMENTS ON STUDENT
PERFORMANCE IN INTRODUCTORY ECONOMICS

by

David Nsingang Simon

Approved: __________________________________________________________
Michael A. Arnold, Ph.D.
Chair of the Department of Economics

Approved: __________________________________________________________
Bruce Weber, Ph.D.
Dean of the Alfred Lerner College of Business and Economics

Approved: __________________________________________________________
Douglas Doren, Ph.D.
Interim Vice Provost for Graduate & Professional Education
I certify that I have read this dissertation and that in my opinion it meets the academic and professional standard required by the University as a dissertation for the degree of Doctor of Philosophy.

Signed:

______________________________
Saul D. Hoffman, Ph.D.
Professor in charge of dissertation

I certify that I have read this dissertation and that in my opinion it meets the academic and professional standard required by the University as a dissertation for the degree of Doctor of Philosophy.

Signed:

______________________________
Robert L. Hampel, Ph.D.
Member of dissertation committee

I certify that I have read this dissertation and that in my opinion it meets the academic and professional standard required by the University as a dissertation for the degree of Doctor of Philosophy.

Signed:

______________________________
Vera Brusentsev, Ph.D.
Member of dissertation committee

I certify that I have read this dissertation and that in my opinion it meets the academic and professional standard required by the University as a dissertation for the degree of Doctor of Philosophy.

Signed:

______________________________
Jeffrey B. Miller, Ph.D.
Member of dissertation committee
ACKNOWLEDGMENTS

First, I am eternally grateful to my late mother, Mama Celestina Nsingang and my late brother, Jeremiah Lenkoh for their decision to send me to the United States in pursuit of my education. This decision required a great deal of financial sacrifice on their part, but more importantly, on my late brother’s part, given that as my older brother, he could have chosen to come to the U.S. himself instead of sending me.

Second, I am equally grateful to late Mr. and Mrs. Kreutzer for their support as my American host parents during my formative years in the U.S. Their love and support kept me focused and dedicated to my studies at a time that I was still trying to adapt to a new culture and environment in the United States.

Third, I am also very grateful to Professor Saul Hoffman, my advisor and chair of my dissertation committee for his support and guidance, but more so, the dedication he has shown towards my success in this endeavor.

Last but not least, a special thank you to the rest of my dissertation committee members: Professor Jeffrey Miller, Professor Robert Hampel and Dr. Vera Brusentsev for their guidance and countless hours of reading through all my dissertation drafts.

Finally, I would also like to thank the following persons for their valuable and emotional support: Professor Kenneth Lewis, Professor James Mulligan, Ms. Debra Sharpley, Mr. & Mrs. Pinyin, Mr. Carlos & Degaule Tenkeu, Mr. Richard Gwananji, Mr. Simon Kiungua, Ms. Ethel Eko, Dr. Marie-Jeanne Medjeu, Ms. Florence Njome, Mrs. Ronda Chu, Mr. Emmanuel Bayo, Dr. & Mrs. Ngwang, Mr. & Mrs. Willayi, Mr. & Mrs. Apande, Ms. Carol Apande, Mr. & Mrs. Kwo, and Ms. Linda Fonkoue.
# TABLE OF CONTENTS

LIST OF TABLES .................................................................................................................. viii
ABSTRACT .......................................................................................................................... x

Chapter

1 INTRODUCTION .................................................................................................................. 1

1.1 Outline of my Study ...................................................................................................... 2

2 THE EDUCATIONAL BENEFITS OF THE CFC COMPETITION ................................ 3

2.1 Background of the College Fed Challenge Competition ....................................... 3
2.2 Literature Review ...................................................................................................... 8

   2.2.1 Current Research on the CFC competition ....................................................... 17
   2.2.2 Summary of the Literature Review ................................................................. 20
   2.2.3 My contribution to the literature ................................................................. 22

2.3 Data Sources and Collection .................................................................................. 22
2.4 Sample Size ............................................................................................................... 25
2.5 Methodology and Modeling .................................................................................... 27
2.6 Results ....................................................................................................................... 34

   2.6.1 Survey Results of the Process Question ......................................................... 34
   2.6.2 Analysis of the Outcome Measure ................................................................. 35
   2.6.3 Results of the Outcome measure for the Control Group ............................... 40
   2.6.4 Comparing the Results of the Outcome Measure for both Groups ............... 43
   2.6.5 Regression Results ......................................................................................... 45

   2.6.5.1 Regression Analyses of School Type and School Size............................. 48

   2.6.6 Problem of Selection Bias ............................................................................... 52

2.7 Qualitative Analyses of CFC Team Coaches Responses and Open Ended Responses by CFC Participants ............................................................. 53
2.7.1 Qualitative Results of the CFC Participants …………...54
2.7.2 Qualitative Results of the CFC Team Coaches………………62

3 THE EFFECTS OF MATHEMATICS BACKGROUND ON STUDENT PERFORMANCE IN INTRODUCTORY ECONOMICS………………68

3.1 Background and Motivation………………………………………………68
3.2 Literature Review………………………………………………………70

3.2.1 Factors Influencing Success in Introductory Economics Courses………………………………………………………70
3.2.2 The Importance of Mathematics Background in Introductory Economics Courses………………………………………72

3.2.2.1 The Importance of Graphs and Remedial Mathematics in Introductory Economics Courses…………………………..73

3.2.3 The Reliance of Mathematics in Economics Courses Worldwide……………………………………………………………75
3.2.4 Quantitative Evidence of the Importance of Algebra and Higher-Level Mathematics in Economics in the US……………79
3.2.5 My Contribution to the Literature……………………………………85

3.3 Data Sources, Collection and Sample Size…………………………85
3.4 Methodology and Modeling……………………………………………88
3.5 Results……………………………………………………………………90

3.5.1 The Effects of Intermediate Algebra on Student Grades in Economics, 2002-2008……………………………………90
3.5.2 Comparing Performances of Economics Students Without Intermediate Algebra 2002-2008 vs. 2009-2014…………………92
3.5.3 Regression Results…………………………………………………..95
3.5.4 Analyzing the Effects of Cumulative Units and Cumulative GPA on Performances of Economics Students………………….99
3.5.5 The Effects of Intermediate Algebra and Higher-Level Mathematics Grades on Student Performance in Introductory Economics………………………………………104
3.5.6 The Effects of Intermediate Algebra and Higher-Level Mathematics on Macroeconomics vs. Microeconomics……109
3.6 Data Limitations.................................................................113

4 CONCLUSIONS AND RECOMMENDATIONS..............................115

4.1 Ideas for Future Research.....................................................119

REFERENCES..............................................................................122

Appendix

A COLLEGE FED CHALLENGE STUDENT SURVEY.......................129
B COLLEGE FED CHALLENGE (CFC) COMPETITION CONTROL GROUP SURVEY (UNIVERSITY OF DELAWARE)..............................132
C COLLEGE FED CHALLENGE SURVEY FOR TEAM COACHES..........134
D THE LOGIC MODEL OF THE CFC COMPETITION SELECTION PROCESS AT THE UNIVERSITY OF DELAWARE.....................135
E IRB/HUMAN SUBJECTS APPROVAL...........................................136
LIST OF TABLES

Table 2.1  History of the CFC Competition ........................................ 6
Table 2.2  Colleges and Universities that Offer a Class supporting the CFC
           Competition ........................................................................... 6
Table 2.3  Number of Surveys completed by Group and Type ................... 26
Table 2.4  CFC Student Participation by Fed District ............................. 26
Table 2.5  Overall Value of CFC for CFC Participants Compared to Average
           Economics Course .................................................................... 35
Table 2.6  Effects of CFC Participation on Specific Economics Skills ........ 36
Table 2.7  Kendall’s tau_b Correlation between the Process Question and Outcome
           Measure .................................................................................. 39
Table 2.8  Effects of Economics Coursework on Specific Economics Skills .... 41
Table 2.9  Comparison of the Effects of CFC vs. Economics Coursework on
           Specific Economics Skills ......................................................... 44
Table 2.10 OLS Estimates of Effect of CFC on Broad Skill Categories .......... 45
Table 2.11 CFC School/Universities by School Categories ........................ 48
Table 2.12 Breakdown of CFC Students by School Type .......................... 49
Table 2.13 OLS Estimates for School Type and School Size on Broad Skill
           Categories .............................................................................. 51
Table 2.14 Results of Students Written Responses to Question 1 ............... 55
Table 2.15 Results of Students Written Responses to Question 2 ............... 56
Table 2.16 Results of Students Written Responses to Question 3 ............... 57
Table 2.17 Results of Students Written Responses to Question 4 ............... 58
Table 2.18 Results of Students Written Responses to Question 5

Table 2.19 Results of Students Written Responses to Question 6

Table 2.20 Results of Question 1, CFC Coaches Survey

Table 2.21 Results of Question 2, CFC Coaches Survey

Table 2.22 Results of Question 3, CFC Coaches Survey

Table 2.23 Results of Question 4, CFC Coaches Survey

Table 3.1 Records of Economics Students Based on their Mathematics Coursework at PCCD

Table 3.2 Effect of Intermediate Algebra on Student Economics Performance 2002-2008

Table 3.3 Performances of PCCD Economics Students Without Intermediate Algebra 2002-2008 vs. 2009-2014

Table 3.4 OLS Estimates of the Effects of Intermediate Algebra and Higher-level Mathematics on Economics Performance in the PCCD

Table 3.5 Descriptive Statistics, Cumulative Units and Cumulative GPA, PCCD Students 2008-2014

Table 3.6 OLS Estimates of the Effects of Cumulative Units and Cumulative GPA on Economics Performance in the PCCD

Table 3.7 OLS Estimates of the Effects of Intermediate Algebra and Higher-level Mathematics Grade on Economics

Table 3.8 OLS Estimates of the Effects of Intermediate Algebra Grade and Higher-Level Mathematics Course Grade on Type of Economics Course 2002-2014
ABSTRACT

My dissertation evaluates two efforts to improve undergraduate economics education – the College Fed Challenge (CFC) competition and requiring intermediate algebra as a prerequisite for taking introductory economics courses. Using survey data of undergraduate students who participated in the CFC competition and a control group of students who did not participate in the competition, I examine the impact of the CFC on economics skills. I find that students who participate in the CFC competition improve less than students in the control group. The reason is likely that the CFC participants are evaluating their improvements in these skills based on one specific activity (i.e., the CFC competition) as opposed to the entire economics curriculum for the control group.

Secondly, using administrative data from the Peralta Community College District (PCCD), I find that intermediate algebra background has mixed effects on student outcomes in introductory economics. A plausible reason for this is that the students taking intermediate algebra at the PCCD are the weakest students or that the intermediate algebra courses at PCCD are inadequate in providing students the proper mathematics background. I also find that the grade that the student receives in his or her intermediate algebra and/or higher-level mathematics courses does matter in terms of their performance in economics.

I conclude that these findings about the CFC competition and intermediate algebra background have implications on how economics courses are taught in the
undergraduate level and provide insights as to which instructional methods or approaches might be good for teaching introductory economics courses.
Chapter 1

INTRODUCTION

Economics is a very theoretical subject. At the same time, many of the concepts in economics have important practical and policy applications to the real world. As such, one of the major challenges of teaching college economics is how to help students not only see the connections between theory and policy but also how to bridge the gap between theory and real world applications. Economics also relies heavily on quantitative methods, including mathematics and statistics, and this is sometimes an important impediment to student success. In this dissertation, I examine these two issues.

First, I focus on the relationship between economic theory as taught in the classroom and economic policy by examining the impact of the College Fed Challenge (CFC) on student outcomes. The CFC is a college competition organized by the Federal Reserve System (the Fed) of the United States in which college students play the role of the Fed Federal Open Market Committee (FOMC) in predicting the future decision of the FOMC with respect to monetary policy and more specifically in deciding on whether to change interest rates. The CFC participants conduct research, gather data on key economic indicators, analyze the data, and make a presentation in front of a panel of Fed officials who serve as judges. For my dissertation, I use data that I obtained from the CFC participants from a series of surveys that I conducted in 2011 and 2012 coupled with a series of control group surveys during the same time period to evaluate the educational benefits of the competition to its participants.
Second, I examine the relationship between student outcomes in introductory economics courses and prior coursework in mathematics. To do this, I use administrative data obtained from the Peralta Community College District (PCCD) in Oakland, California from 2002 – 2014 to evaluate whether intermediate algebra and/or higher-level mathematics courses help students learn introductory economics courses better.

1.1 Outline of my Study

I approach each essay separately. I first review the relevant literature for the CFC competition followed by a discussion of the data, methodology, modeling, and model estimations in chapter 2. Chapter 3 begins with a literature review of the role of mathematics background in student’s performance in economics, which is followed by a discussion of the data, methodology, modeling, and model estimations. The conclusions and recommendations for both essays are presented in chapter 4.
Chapter 2

THE EDUCATIONAL BENEFITS OF THE CFC COMPETITION

This chapter presents an analysis of the educational benefits of the College Fed Challenge (CFC) competition based on survey data collected from participants in the Eastern Fed District and the Chicago Fed District in 2012 and from a comparable group of students (i.e., a control group), mainly from the University of Delaware, who did not participate in the CFC competition during the same time period. Section 2.1 provides a background perspective of the CFC competition. A review of the relevant literature is presented in section 2.2. Data sources and collection are presented in section 2.3. Section 2.4 discusses the sample size, while section 2.5 presents the methodology and modeling used in the study. Estimation results are presented in section 2.6 and section 2.7 captures the results of the qualitative analyses.

2.1 Background of the College Fed Challenge Competition

The Federal Reserve System (Fed) plays a major role in the U.S. economy and the world economy by conducting monetary policy in the U.S. Despite the Fed’s importance as a major policy player, its role in the economy is not well understood either by economics students or a vast majority of the population. For that reason, in 1998, the Fed introduced the College Fed Challenge (CFC) competition to help
students become more informed about its role and its decision-making process, which is conducted through the Federal Open Market Committee (FOMC), the Fed’s monetary policy setting body. The most important goal of the CFC competition is for students to be able to bridge the gap between economic theory and the real world by applying what they learn in the classroom to a real world economic context by playing the role of the FOMC members in its formulation of monetary policy. As noted by Olbrecht (2015, p. 466), “the College-level Fed Challenge competition has been highly successful in helping students understand how theory plays out in the real world of monetary policymaking.”

According to the College Fed Challenge Handbook, prepared by the Federal Reserve Bank of Richmond for its CFC participants, “Research suggests that students acquire knowledge best through their active involvement in the learning experience. With that in mind, the College Fed Challenge asks economics and business students, represented by three to five-member teams, to undertake research, analyze data about current and near-term economic conditions and then decide upon a specific course for monetary policy. The teams then make presentations based upon their research and analysis and make interest rate recommendations before a panel of judges” (Federal Reserve Bank of Richmond (2007, p. 2)).
The competition begins at the Fed district level where each college/university selects its team of participants typically from the department of economics and/or business administration. Different schools use different criteria for selecting their team participants as well as preparing them for the competition. In some schools the preparation is done through a formal course on the CFC competition while in others it is done as an extracurricular activity. In the Fed district-level competition, the schools in that district compete with each other and the winner of the competition is chosen to represent the district at the national championship at the Fed headquarters in Washington, DC. Typically, the district-level competitions are held between September and October each year and the national championship competition is held in November. Winning the national championship can bring notoriety to a school as well as speak to the strength of its economics department and students.

Table 2.1 below shows the increasing popularity of the CFC competition as illustrated by the number of Federal Reserve districts that are participating in the competition. As of 2017, five of the Fed’s twelve districts participated in the CFC competition.

1 There are twelve Fed districts spread across the US of which five of the districts mainly in the Northeast and Midwest participate in the CFC competition. The five participating districts include Boston, Chicago, New York, Philadelphia, and Richmond.
Table 2.1 History of the CFC Competition

<table>
<thead>
<tr>
<th>Participating Fed District</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baltimore branch of the Richmond Fed District</td>
<td>1998</td>
</tr>
<tr>
<td>New York Fed District</td>
<td>2001</td>
</tr>
<tr>
<td>Chicago Fed District</td>
<td>2001</td>
</tr>
<tr>
<td>Boston Fed District</td>
<td>2001</td>
</tr>
<tr>
<td>Philadelphia Fed District</td>
<td>2010</td>
</tr>
</tbody>
</table>

As mentioned above, many colleges and universities that participate in the CFC competition today offer a course geared towards helping students prepare for the competition. See table 2.2, which lists colleges and universities that offer a course on the CFC competition (adopted from Gulley and Jackson, (2015)).

Table 2.2  Colleges and Universities that offer a class supporting the CFC

- Albion College
- Ball State University
- Bentley University
- Bryant University*
- College of New Jersey
- Dartmouth College
- Furman University
- Gettysburg College
- Lafayette College
- Lehigh University
- Lenoir Rhyne University
- Marquette University
- Mount St. Mary’s University
- Old Dominion University
- Pace University
- Quinnipiac University
- Roanoke College
Roger Williams University
University of Iowa
University of Mary Washington
University of North Carolina at Chapel Hill
University of North Carolina at Wilmington
University of Notre Dame
University of Richmond
University of Wisconsin-Oshkosh
Virginia Commonwealth University
Western Illinois University

*Students enroll as an independent study. It is also possible that other schools offer credit for participation through an independent or directed study course.
Note: This list is of schools for which courses could be located in course catalogs.

Gulley and Jackson (2015) emphasize the significance of the CFC course by noting that a majority (60 percent) of the schools that reached the national competition between 2009 and 2012 offered a course on the CFC competition. More importantly, the authors suggest from their experience that success in the competition is enhanced when students enroll in a CFC course compared to when students participate in the competition as an extracurricular activity.

In some colleges and universities, participants in the CFC competition are drawn from a pool of honors students, department of economics award recipients, and the top 5 percent or upper-end students of a closely related major to economics such as business administration. In other colleges, the preparation and selection of the participants is part of a formal class. For example, at Lafayette College and St. Lawrence University, the CFC participants are drawn from a CFC economics elective course (Bansak and Smith (2011)).
At the University of Delaware, the CFC competition is led mostly by students and treated as an extracurricular activity. The selection process for the team is guided by a faculty advisor from the department of economics and senior economics and business students who have previously participated in the competition. While at the University of Delaware in the fall of 2012, I observed the selection process for their CFC competition team (described in a logic model shown in Appendix D).

2.2 Literature Review

As an educator, I seek the most effective methods for a real-world application of acquired classroom knowledge. This conceptual process of educating and guiding students allows for the successful transition from theoretical understanding to effective execution through practical applications. A common concern is addressed by Olbrecht (2015, p. 466): “When teaching monetary economics, professors often struggle with balancing economic theory with institutional knowledge and real-world applications.” Hansen (1986) was concerned with the same struggle and provided a foundation for addressing the question of how economics students can pivot from theory to practice. He proposed that economics students in their college senior year should engage in a hands-on testing program that will help them demonstrate a mastery of the proficiencies that an economics major should have. Hansen (1986) proposed five proficiencies for a graduating economics major: 1) gaining access to existing knowledge through published research in economics and related fields; 2) displaying command of existing knowledge by summarizing current economic conditions and
principal ideas of eminent economists; 3) displaying the ability to draw from existing knowledge in technical and non-technical publications such as journals, newspapers, magazines, 4) utilizing existing knowledge to explore issues; and 5) creating new knowledge. Siegfried and Wilkinson (1982) had called for an active honors program in economics as a way to encourage students to practice what they learn. Siegfried (1991) argues for the adaptation of Hansen’s proficiencies, as effective learning requires active participation by students. Salemi and Siegfried (1999, p. 358) suggest that a capstone experience as a supplement to Hansen’s fifth proficiency “might be a course, a thesis, or an independent project.” These studies remain relevant today because they provide the foundation for most of the current literature and research in undergraduate economic education.

The traditional method of instructing undergraduate economics courses has emphasized lectures, which Watt and Becker (2008, p. 273) describe as the “chalk and talk” method. This method is passive learning and does not give students the opportunity to practice and/or apply what they learn.

Hansen (2001) proposed an addition to the proficiencies approach of instruction and understanding, which is for graduating students in economics to be able to apply the knowledge and skills they acquire in the major. This approach places more emphasis on learning outcomes rather than merely fulfilling the appropriate degree requirements for the major. More importantly, in recognizing the recommendation of a capstone experience addressed by Salemi and Siegfried (1999),
Hansen also calls for the development of a capstone experience designed to integrate the various tools, skills and experiences that students have gained throughout their undergraduate coursework in economics. Simkins and Maier (2009, p. 85) note that the skills proposed by Hansen “… are best developed and reinforced through repeated hands-on, interactive, and collaborative learning that encourages students to analyze trends and correlations in economic data, apply economic theory to real-world problems, and evaluate economic policies.” Myers, Nelson, and Stratton (2009) make the case for an assessment of the undergraduate economics curriculum based upon Hansen proficiencies. Additionally, Siegfried (2001) asserts the need to change the standard teaching methods in economics and notes the emphasis of an honors program that is based firmly on substance rather than a quantitative fulfillment of the coursework.

Some schools have enhanced the economics major by introducing an undergraduate economics honors program. As noted earlier, Siegfried (2001, p. 169) emphases that an honors program based “on quality rather than quantity can add a valuable dimension to most economics degree programs.” Such a program will enable students, through active learning, to not only complete a project similar to what they would be doing in their future professional life, but also allows them to acquire some of the Hansen proficiencies, particularly the capstone experience. As we shall see, the CFC competition by its very design is an embodiment of an honors program and a Hansen capstone experience.
Students who major in economics should be able to attain the Hansen proficiencies, which would ensure that they: a) can independently make sense of problems, b) propose meaningful solutions, and c) have the ability to seek out resources necessary for tackling challenges in the real world. The CFC competition provides an excellent platform for developing the Hansen proficiencies. Since the participants are mostly college juniors and seniors, they are tasked with specific learning objectives, and the competition gives them the opportunity to demonstrate their understanding of the materials through presentations and performance.

The CFC competition affords participating students the opportunity to enhance the development of research, presentation skills, and critical thinking. Interestingly, these are the same skills and competencies that are stressed in a liberal education. As Colander and McGoldrick (2009, p. 6) notes: “Employers are looking for inquisitive students who have a passion for learning, not ones who have learned specific skills. They prefer general skills such as critical thinking, quantitative, and communication skills. In other words, they want a liberally educated student.” Moreover, McGoldrick (2008, p. 352) assert that participants learn “… what it means to act like an economist as they work through the process of developing original economic arguments.” The survey conducted by Jones et al. (2009, p. 198) found that 63 percent of economics majors “want more discussion of real world issues.” Since participants of the CFC competition play the role of members of the Federal Reserve System’s Open Market Committee (FOMC), they are naturally engaged in the translation of theory into practice. Students who participate in the competition achieve the capstone experience,
which is the highest level of the Hansen proficiencies. The CFC competition provides a platform for students to develop the Hansen proficiencies, given that the participants are mostly college juniors and seniors. Additionally, the CFC competition offers a platform for examining the translation of theory into practice and provides a capstone experience for economics students that requires higher-level cognitive skills.

Given that the CFC competition is an embodiment of active, collaborative and cooperative learning, it is important to provide definitions of these concepts. Prince (2004, p. 1) defines active learning as “any instructional method that engages students in the learning process. In short, active learning requires students to do meaningful learning activities and think about what they are doing.” Collaborative learning is defined as “any instructional method in which students work together in small groups toward a common goal.” Cooperative learning is “a structured form of group work where students pursue common goals while being assessed individually.” (The Merriam-Webster Dictionary) defines competition as “the act or process of trying to get or win something (such as a prize or a higher level of success) that someone else is also trying to get or win: the act or process of competing.”

Huynh, Jacho-Chavez, and Self (2010) make the case for incorporating collaborative learning in introductory economics courses to lay the foundation for a fundamental understanding of economics. The authors argue that economics students might not fully appreciate the subject and might consider it to be too difficult, given the abstract nature of the subject. In a quasi-random experiment, the researchers used
program evaluation while controlling for student selection to measure the effect of collaborative learning on student outcomes and found that such learning was positively correlated to student performance. These findings are consistent with those by Moore (1998) and Khandker and Elfessi (2000), who also found that incorporating a collaborative learning lab into introductory economics courses was considered worthwhile by students and improved their performance on standardized tests. Similarly, in a follow-up study that included such student specific factors as demographics, Brooks and Khandker (2002) were able to confirm the results reported by Khandker and Elfessi (2000). Jensen and Owen (2001) found that when students were assigned to groups to solve problems, they were more likely to take more courses in economics, as their perception of the importance of the subject increased.

Yamarik (2005) incorporated cooperative learning in an intermediate macroeconomics course and Yamarik (2007) incorporated collaborative learning in an intermediate microeconomics course. In both cases, the author found that students performed better in exams than students in a similar course without cooperative learning or collaborative learning, respectively. In courses in computer science and engineering, Oakley et al. (2007) found evidence supporting the use of teamwork and its positive effect on student performance. They proposed that students be assigned to projects that allow them to work in teams and for instructors to be trained to handle conflicts that might undermine the effectiveness of teamwork. The authors concluded that students are more likely to achieve the learning objectives of a course when they work together as a team rather than individually. These studies support the basis for
programs such as the CFC competition, since the CFC competition embodies active, cooperative, and collaborative learning.

Prior to 2015, there was little literature on the effects of the CFC competition on participants. Some research that could be viewed as relevant to the CFC competition focused on the benefits of active, cooperative, collaborative, and competition-based learning in other settings. There is compelling evidence to suggest that students learn more and better in teamwork settings than working independently.

The CFC competition potentially benefits students because of its competitive, cooperative, collaborative, and active learning nature. Johnston, James, Lye, and McDonald (2000) found that through collaborative learning, students learn to discuss and assimilate new ideas, which helps them learn more thoroughly. Students also explore how concepts relate to each other and utilize the students’ prior knowledge. Johnston et al. also assert that to successfully learn economics, students must be able to think in an abstract manner, as well as apply what they have learned. Christoffersen (2002, p. 66) shows that “experience suggests that consistent collaborative work is more effective than sporadic group assignments.” Posatko (2005), McGoldrick (2008) and Jones et al. (2009) echoed the sentiments of Johnston et al. (2000) and Christoffersen (2002). Posatko (2005, p. 109) points out that “… the traditional course requirements and grades earned, reflecting content mastery, may not in themselves ensure that graduates are effectively prepared to utilize and apply their knowledge and skills.” McGoldrick (2008) claims that there is a greater need for economics students
to engage in research that will allow them to communicate their findings, thus applying the knowledge they have acquired.

Santos and Lavin (2004) argue for the importance of sharing with students what economists do and how they go about doing it. Attle and Baker (2007) argue for effective learning based on cooperation and competition by pointing to evidence showing that employers prefer their employees to work in teams – which supports the idea that students benefit more in courses that employ both cooperation and competition. Cerny and Mannova (2011) also found collaboration, competition, teamwork, and social skills to be effective in computer science classes. The authors found that when computer science students participate in inter-collegial competitions such as the International Collegiate Programming Contest (ICPC), they not only learn to work effectively in teams, but also learn through their active involvement. Becker (1997) identifies the need for cooperative learning on structured tasks to allow students to work in groups on both in and out of class projects.

It is important to recognize the potential for distraction in a competition such as the CFC. As argued by Wang and Yang (2003), the element of competition (as in the CFC competition) poses a distraction from learning. Wang and Yang argued that competition in an academic environment can be double-edged for students. On one hand, it can motivate students particularly those with “optimistic ego” to prove themselves, which may result in them increasing their effort in an attempt to maintain their favorable perception of abilities. On the other hand, competition can easily
discourage students including those that are highly motivated if they unexpectedly lose or get toppled, which could lead them to scale back their efforts by trying less or quitting completely when they fail to maintain their top performance. As Wang and Yang explain: “Although competition among firms in a market system can help allocate economic resources efficiently, it can be harmful to introduce it into schools as an incentive scheme. In a sound education system, learning and intellectual development should be a human capital investment process rather than a means to beat each other” (p. 126). While this potential for distraction in competition does deserve acknowledgement, the benefits of the CFC competition being a highly interactive activity greatly outweigh any shortcoming resulting from the distraction posed by the competition.

Moreover, the importance of the CFC as an integrated learning competition for undergraduate students cannot be overlooked, judging from the results of a survey that was conducted on 305 employers and 510 four-year college graduates by Peter D. Hart Research Associates, Inc. in 2006 on behalf of the Association of American Colleges and Universities. Although the survey is not directly related to the CFC competition, the results boost the relevance of collegial competitions. They find that more than 60 percent of employers and recent graduates think colleges and universities should emphasize: 1) “teamwork skills and the ability to collaborate with others in diverse group”; 2) “the ability to apply knowledge and skills to real-world settings through internships or other hands-on experiences”; 3) “the ability to effectively communicate orally and in writing”; 4) “critical thinking and analytical reasoning skills”; 5) “the
ability to locate, organize, and evaluate information from multiple sources”; and 6) “the ability to work with numbers and understand statistics” (Hart, (2006), p. 2).

2.2.1 Current Research on the CFC Competition

The current research literature on the CFC competition consistently points to the fact that it is beneficial to students and to the colleges/universities which participate, as well as for the instructors who teach courses geared toward preparing for the competition and for the coaches of CFC teams. Some of the strongest attributes of the competition are documented in a series of symposium articles published in the *Eastern Economic Journal* (2015). Olbrecht (2015, p. 468) notes: “In the symposium articles, an argument is made that participation and winning in the competition require a depth of learning about monetary policy and the federal reserve system that is unlikely to be replicated in any course during a student’s career. Quite simply, students are not likely to study monetary policy in a class to the same depth level. Additionally, because most Fed Challenge teams are extracurricular clubs, it is doubtful that this type of team learning would occur without the existence of the program.”

Gulley and Jackson (2015) provide a firsthand account of their experiences teaching a course that prepared students for the CFC competition. They describe how the course brought the participants and instructors closer together and gave the participants more time to practice on their presentation. They noted that 60 percent of
the schools that made it to the national competition in Washington DC between 2009 and 2012 offered a course that prepared students for the CFC competition and that winning the competition gave the winner a bragging right and marketing tool for recruiting new students. The authors’ observation that the students who took a course in the CFC competition are motivated and hardworking is consistent with the findings of the benefits of the CFC competition by Bansak and Smith (2011), who found a similar strong correlation between CFC participation and hard work and intellectual stimulation. Brusentsev and Miller (2011) noted a positive correlation between winning the competition and the strength of the economics department of the participating school.

A similar study by Croushore (2015) examines a capstone course organized around a money and banking textbook. Students were given specific topics in macroeconomics, microeconomics and statistics covering current monetary policy issues to assist them attain the last two of Hansen proficiencies namely “applying existing knowledge and creating new knowledge” (p. 506) by focusing on the ideas behind the CFC competition. Like the CFC competition, the course taught students how to conduct “research with a small project” and provided them with news articles by Fed economists. Students worked independently to study a sector of the economy and analyze, interpret, graph and report data using Excel. The author notes:

“My experience in teaching the course is that it is extremely rewarding for the faculty member teaching it. You get to see the full range of skills of your students and can predict which of them are likely to be successful at endeavors. Sadly, there are some students who are simply unable to complete the course because they lack the organizational skills to do so; such students are not ready
for the real world. But it is exciting to see the level of intellectual maturity of many students at the end of their college careers” (p. 511).

Bansak and Smith (2015) report on their experience teaching a course on the CFC competition at Lafayette College and St. Lawrence University that incorporates cooperative learning. They advocate for the adoption of the elements of active learning in some undergraduate economics courses. Their course is structured around five key elements of a cooperative learning exercise: 1) positive interdependence, 2) individual accountability, 3) face-to-face interaction, 4) interpersonal and small group social skills, and 5) group processing. The researchers examined seven years of course evaluation data (3 years from Lafayette College and 4 years from St. Lawrence University) and reached similar conclusions that the CFC course was more intellectually challenging, had higher educational value, and required more effort from students both in terms of involvement and success than other economics electives. Overall, the researchers noted that “those students who participate in the CFC state that they work harder and are more intellectually challenged than in other courses in the field. Therefore, it seems likely that the CFC participants learn more than their peers in a more traditional classroom setting and the cooperative learning elements may be a positive contributor to that enhanced learning” (Bansak and Smith (2015, p. 480)).

Brusentsev and Miller (2015) analyze how the CFC competition improves undergraduate economic education. Their study is premised on the notion that “Experienced-based education engages students in active learning that challenges their
assumptions and deepens the way they understand concepts and issues within a broad context of content knowledge” (p. 514). The study examines the results of two surveys of CFC participants— one of students who participated in the CFC competition in 2010 and 2011 and the other of graduates from the University of Delaware who participated in the CFC competition in previous years. The participating student survey captured their perceptions about whether their participation in the competition helped them enhance the skills described in Hansen (1986) and, for the graduates, whether it impacted their lives after graduation. The sample included 178 students who participated in the Philadelphia Federal Reserve district CFC competition in 2010 and 2011, and 10 graduates from the University of Delaware. The researchers noted that about 89 percent of the participants of the 2010 and 2011 CFC competition reported seeing some improvement in the skills that the CFC competition is supposed to foster, while the post-graduate students felt that their skills increased at least to some extent or substantially. The study also demonstrated that the CFC competition enhances the Hansen proficiencies in students.

### 2.2.2 Summary of the Literature Review

The fact that students develop a more thorough understanding of academic concepts through hands-on application is well-recognized and documented. It is crucial for students to master various theories and concepts in order to effectively apply them to economic situations. Several studies have also documented and
highlighted the importance of active, cooperative, collaborative, and competition-based learning through teamwork as a way to reinforce theory.

The CFC competition provides students the opportunity to put their economic knowledge to use in a simulated FOMC setting. This experience can be viewed as a suitable and beneficial capstone experience for college juniors and seniors. The CFC competition helps students to achieve the proficiencies presented by Hansen. The competition demonstrates that students must work cohesively as a team while simultaneously being held accountable for their own contribution. As such, the CFC competition greatly enables active, collaborative and cooperative learning. Studies have shown that students achieve better course performance through active, collaborative and cooperative learning. This course performance is in addition to such real-world skills as critical thinking, teamwork, organization, communication, and presentation skills. Despite arguments made by Wang and Yang (2003) that the presence of the competition factor is a negative influence, the majority of research concludes that the CFC competition is a positive educational contributor. As discussed by Gulley and Jackson (2015), other benefits of the CFC competition include enhanced school reputation and the rewarding experience for instructors in observing students successfully express economic knowledge by accurately applying theory and conducting research. Overall, studies analyzing the effects of the CFC on student learning and performance have been vastly positive concerning its contribution to deeper economic understanding and more motivated students.
2.2.3  My contribution to the literature

The purpose of my study is to expand on Brusentsev and Miller (2015). While their study focused on measuring the educational benefits of students who participated in the CFC competition from nine schools in the Philadelphia Federal Reserve district in 2010, I expand on their study in two ways. First, I survey students from other Federal Reserve districts; second, I survey a comparable group of students who did not participate in the CFC competition. My reason for doing this is twofold. First, by surveying students from other Federal Reserve districts, I hope to generalize the results of Brusentsev and Miller (2015). Second, by surveying a comparable group of students who did not participate in the CFC competition, I hope to compare the outcomes of both groups (that is, CFC participants and a control group) as well as demonstrate whether the CFC competition is an effective teaching tool for economic education.

2.3  Data Sources and Collection

The data for this study were obtained from a series of surveys I conducted in 2011 and 2012. The survey instruments for these surveys were adopted from Brusentsev and Miller (2011). The surveys involved three instruments. The first was a questionnaire administered to student participants of the CFC competition from the New York, Philadelphia, and Chicago Fed Districts. The survey questionnaire was administered to the students directly during the competition and online through
SurveyMonkey for those students who were not able to complete the questionnaire during the competition. The second survey instrument was a questionnaire administered to a control group of students from the CFC-participating schools as well as upper-level undergraduate economics students from the University of Delaware. The non-University of Delaware students completed the survey online through SurveyMonkey. The third survey was administered to faculty members who coached CFC teams. The reason for using the first two surveys was to ensure that the potential educational benefits of participants could be compared to those of a comparable group of nonparticipants. The reason for taking a survey of the coaches was to ascertain which methods or approaches they use in preparing their team for the CFC competition.

Appendix A shows the survey instrument used in collecting the data for the CFC participants. The survey questionnaire was designed to obtain information about how the CFC competition contributed to student knowledge and understanding of economics. The survey collected information about specific skills and proficiencies students may have acquired or which were strengthened while participating in the CFC competition.

The survey questionnaire is divided into two parts. The first part asked students to rate how their skills and proficiencies in 12 specific areas were affected by their participation in the competition. The second part of the questionnaire asked the students to evaluate the overall value of their CFC experience. This part of the questionnaire had open-ended questions.
I collected data for the CFC participants in two ways: some participants directly filled out a questionnaire on-site during the competition, while others specifically those who were not able to complete the survey on-site as well as the non-University of Delaware control group students, responded through an online survey using SurveyMonkey.

Appendix B shows the survey instrument used in collecting the data for the control group. The survey questionnaire was designed to obtain information about the same skills and proficiencies asked in the CFC student survey and whether nonparticipants acquired them either through their economics coursework or other undergraduate coursework.

The data for the control group were collected at two intervals. In the spring of 2012, a survey questionnaire was emailed to the coaches of teams in the 2011 CFC competition that were part of the sample. The coaches were asked to identify students who did not participate in the 2011 competition but would best represent a comparable group of students to those who participated on their team. Suggestions were provided to the team coaches to assist them in identifying a control group. I contacted those students through email and they had the option of either completing and emailing the survey questionnaires directly to me or completing the survey online through SurveyMonkey.

Due to the relatively low response rate from administering the survey online, I conducted a second survey of University of Delaware undergraduate students in 2012.
taking upper-level courses in economics and business. All the responses from the University of Delaware students were obtained through direct responses. The data for both groups were used in my analyses with the exception of the regression results involving school affiliations since the non-University of Delaware control group students cannot be identified by their respective schools. As a result, the control group sample (i.e., University of Delaware control group and non-University of Delaware control group) was excluded in the analyses involving school affiliations.

Appendix C shows the survey instrument used for the faculty members who coached the CFC competition. Coaches were asked to provide information about the selection process of their CFC team, identifying a control group, evaluating the educational value of the competition, surveying past students, and effective techniques they used in coaching a CFC team.

2.4 Sample Size

Table 2.3 shows the number of responses from all survey respondents including team coaches. My sample includes a total of 286 students of which 131 were CFC participants and 155 were in the control group. Of the 131 CFC participants, 83 provided direct responses to the survey, while 48 completed the survey through

2 The survey instrument for the control group of students not attending the University of Delaware was slightly different from that which was administered to the University of Delaware students depicted in Appendix B.
SurveyMonkey. Of the 155 control group participants, 127 were from the University of Delaware and 28 were students from other universities). Sixteen faculty members responded to the team coach’s survey.

Table 2.3 Number of surveys completed by group and type

<table>
<thead>
<tr>
<th>Participating group</th>
<th>Direct responses</th>
<th>SurveyMonkey</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFC participants</td>
<td>83</td>
<td>48</td>
<td>131</td>
</tr>
<tr>
<td>Control group</td>
<td>127</td>
<td>28</td>
<td>155</td>
</tr>
<tr>
<td>Team coaches</td>
<td>16</td>
<td>0</td>
<td>16</td>
</tr>
</tbody>
</table>

Altogether, a total of 22 colleges and universities participated in the survey of the CFC competition in the fall of 2011. These colleges and universities covered the Federal Reserve Districts of Chicago, New York, and Philadelphia. Of the 22 colleges and universities, 6 were from the Chicago Fed District, 8 from the New York Fed District, and 8 from the Philadelphia Fed District. The students who completed the survey online via SurveyMonkey did not provide their school affiliation.

Table 2.4 below identifies the colleges and universities and the number of direct responses completed from each school in the CFC sample.

Table 2.4 CFC Student Participation by Fed District

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Queensborough Comm. College</td>
<td>2</td>
<td>1. St. Francis University</td>
<td>4</td>
<td>1. Northwestern University</td>
<td>2</td>
</tr>
<tr>
<td>2. Iona College</td>
<td>1</td>
<td>2. Ursinus College</td>
<td>7</td>
<td>2. Ball State</td>
<td>1</td>
</tr>
<tr>
<td>3. Manhattan College</td>
<td>1</td>
<td>3. Lehigh University</td>
<td>5</td>
<td>3. Uni. of Illinois at Chicago</td>
<td>4</td>
</tr>
<tr>
<td>5. Suny Oneonta</td>
<td>2</td>
<td>5. Shippensburg University</td>
<td>7</td>
<td>5. Indiana Uni. - Fort Wayne</td>
<td>2</td>
</tr>
<tr>
<td>7. Fordham University</td>
<td>1</td>
<td>7. University of Delaware</td>
<td>4</td>
<td>Other</td>
<td>4</td>
</tr>
<tr>
<td>8. New York University</td>
<td>2</td>
<td>8. The College of New Jersey</td>
<td>6</td>
<td>Other</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td>Subtotal</td>
<td>19</td>
</tr>
<tr>
<td>Subtotal</td>
<td>13</td>
<td>Subtotal</td>
<td>51</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.5 Methodology and Modeling

In order to quantify the educational benefits of the CFC competition, I employ two different approaches. First, I develop two measures of the benefits of the CFC competition, based on the survey questionnaire administered to the participants of the CFC competition (Appendix A). I refer to the first as the “process question” and the second as the “outcome measure.”

1) Process question: The CFC participants were asked “Given the opportunity costs of the time you spent on the College Fed Challenge, it was…”, where the six possible answers ranged from “much less valuable than the average economics course” to “more valuable than any economics course I have taken”. This question asked students to evaluate their CFC experience in terms of their time based on how worthwhile their participation was. This question is shown as question 1 in part 2 of the survey questionnaire (Appendix A).

2) Outcome measure: This measure is based on a set of 12 questions that asked whether students’ participation enhanced specific research, critical thinking, and presentation skills. The questions were directly presented to students as forced choice questions with five different response options, ranging from “I mastered this skill before participating in the CFC so my participation in the CFC did not improve this skill” to “The CFC helped to improve this skill substantially.”
The process question and outcome measure are linked to one another in the sense that if a student reported that the CFC was “more valuable than any economics course they took” in the process question that would be consistent with a response to the outcome measure that the student’s CFC competition participation was beneficial. In other words, although the outcome measure did not directly speak to whether the students’ participation was beneficial, the presumption is that if their participation enhanced their research, critical thinking, and presentation skills, then it would be viewed as an overall benefit to the students. I test the link between the process question and the outcome measure with a correlation test. The correlation test establishes the degree of linkage between the process question and each of the outcome measure.

I analyze the process question and outcome measure by tabulating the distribution of the student responses. The tabulated data is used to show the frequencies of responses for each of the 12 outcome measures.

A similar tabulation is done to analyze the responses for the control group, which allows me to compare the results of the outcome measure obtained from the CFC participants to those of the control group. The tabulated data for the control group is used to show the frequencies of responses and to determine the percentage of

---

3 The control group survey also had the same outcome measure based on the same set of twelve questions. The only difference between the control group survey and the CFC survey is that in the control group students were asked whether their studies and/or coursework in economics enhanced specific research, critical thinking, and presentation skills as opposed to their participation in the CFC competition.
students who rated each of the 12 outcome measures as not helping them improve their skills in the aforementioned categories to helping them improve their skills substantially. I also compare the results for both the participants of the CFC competition and the control group.

For the second part of my analysis of the benefits of the CFC competition, I use regression analysis to estimate the quantitative effects of CFC participation on the various outcomes. I employ a three-step process for this analysis. I first group the five response choices for the outcome measure for the CFC participants into two categories. I combine the responses “I had not mastered this skill before participating in the CFC but my participation did not improve this skill” and “The CFC helped to improve this skill a little” into one category. I combine the responses “The CFC helped to improve this skill to some extent” and “The CFC helped to improve this skill substantially” into another category. In so doing, I capture the student response choices into two distinct categories measuring whether or not the CFC competition helped to improve the student’s skill to some extent or substantially or it did not improve their skills at all or just a little. These four responses combined into two categories excludes the response, “I mastered this skill before participating in the CFC so my participation in the CFC did not improve this skill.”

A similar step is taken to combine the responses for the control group. The responses “I mastered this skill through my studies/course work at the University of Delaware,” “My studies/course work at the University of Delaware helped to improve this skill to some extent” and “My studies/course work at the University of Delaware
helped to improve this skill substantially” was combined into one category, while the response “My studies/course work at the University of Delaware helped to improve this skill a little” formed another category. These four responses combined into two distinct categories excludes the response “I mastered this skill but not through my studies/course work in economics at the University of Delaware.”

Grouping the responses of the CFC participants and the control group into two categories for each group allows for the creation of a dummy variable for each outcome measure coded as 1 if the CFC or course work in economics help students improve or acquire the 12 outcome measures and 0 if the CFC or course work in economics did not help students improve or acquire the 12 outcome measures.

Second, I group the 12 competencies or outcome measures into three categories that reflect broad skill areas: 1) research skills; 2) general knowledge and understanding of the economy; and 3) presentation and explanation skills. I then summed the responses (recoded into a dummy variable as explained above) across the competencies in each category to create a summary variable that is the number of skills a student acquired by participating in the CFC competition or through their coursework in economics. The category “research skills” included five competencies:

4 The survey taken from the control group of students attending colleges other than the University of Delaware is slightly different but is coded in the same manner. Also, because there might be differences between the University of Delaware control group students and the non-University of Delaware control group students, I use ANOVA test to determine if the two groups are statistically different.
“retrieve, assemble and organize information on particular topics and issues in economics,” “evaluate the analyses published in newspapers and magazines,” “understand and interpret data published by government agencies,” “prepare and organized analysis of a current economic problem” and “identify and formulate a question or series of questions about economic issues to facilitate an investigation.” The category “general knowledge and understanding of the economy” included the competencies “understand an economic question to stimulate productive discussion of the issues and keep discussion centered on these issues,” “understand how the economy functions,” “make you feel confident in your command of economic theories” and “make you feel confident in applying economic theories to policy questions.” The third category “presentation and explanation skills” include the competencies “explain key economic concepts and describe how they can be used,” “explain key economic theories and describe how they can be used” and “explain the economic principles in analytical articles published in newspapers and magazines.

Finally, I conduct ordinary least squares (OLS) regression analyses using the data for the three categories of broad skill areas to determine the level of correlation and significance between these broad skill categories and student’s participation in the CFC competition or coursework in economics. The basic regression model for this test is as follows:

\[ Y_s = \alpha + \beta_1 \text{CFC}_s + \epsilon_s \]  

(1)
where $Y$ represents the sum of recoded dummy variables for the various competencies in each category, $s$ = a given student, CFC = a dummy variable if a student participated in the CFC competition (CFC = 1 if a student participated in the CFC competition, = 0 otherwise).

I also inquire if the benefits of participating in the CFC competition vary by school type. I examine whether students from smaller schools gain more from their participation in the CFC competition than do students from large schools and whether students from selective or semi-selective schools gain more from their participation in the CFC competition than students from non-selective schools. Likewise, do students from private schools benefit more from participating in the CFC competition than do students from public schools? To my knowledge, no research has focused on these questions. I group the 22 colleges and universities that participated in the competition into small versus large institutions, private versus public schools, and selective (including semi-selective) versus non-selective schools to analyze this. I recognize that private universities on average tend to be smaller and perhaps more selective compared to public universities and that there might be a correlation between private universities, smaller institutions and selective schools and between public universities, large institutions and non-selective schools. As a result, I conducted an ANOVA test to test for the similarities between the different groups. In order to classify the schools,

---

5 The maximum value for the first category is 5, 4 for the second category and 3 for the third.
I use the U.S. Department of Education categorization/designations of schools to determine which schools are small, large, private and/or public. I create the following dummy variables: small = 0 for large colleges/universities or small = 1 for small colleges/universities, public = 0 for private schools or public = 1 for public schools and selective = 0 for non-selective schools or selective = 1 for selective and semi-selective schools.6

The proposed regression model specification for the above analysis is as follows:

\[ Y_s = \alpha + \beta_1 \text{Small}_s + \beta_2 \text{Public}_s + \beta_3 \text{Selective}_s + \epsilon_s \]  

(2)

All variables are as previously defined above. The sample size is limited to the 68 students who participated in the CFC competition and completed the survey questionnaire directly; I exclude those who used SurveyMonkey because I do not have information on their school affiliations.

Finally, I summarize the results of the survey by the team coaches focusing on the questions that asked the coaches to evaluate the educational value of the CFC competition as well as which techniques they considered to be most effective in preparing a team for the CFC competition. This summary is done mainly by directly citing and commenting on the responses of the team coaches. I also summarize the

6 The classifications of schools as either selective or non-selective was determined based on the acceptance rate for each school according to US News and World Report (https://www.usnews.com/best-colleges). I classified those schools with acceptance rate of 1 - ≤ 50% as selective and those with acceptance rate of > 50% as non-selective.
open-ended responses for the student survey– specifically, those students who participated in the CFC competition (Appendix A part II – questions 2-7).

2.6 Results

This section presents the results of the model estimations. First, I break down the responses to the process question and the outcome measure for the CFC participants. Section 2.6.1 presents the survey results of the process question based on the multiple-choice responses students were given to evaluate the opportunity cost of the time they spent on the CFC competition. Section 2.6.2 analyzes the survey results for the outcome measure. Section 2.6.3 presents the outcome measure for the control group. Section 2.6.4 compares the results of both the CFC participants and the control group. Next, I focus on the results of the regression analyses which are presented in section 2.6.5, and section 2.6.6 addresses the problem of selection bias, and finally, section 2.7 presents the qualitative results of the CFC participants and the team coaches.

2.6.1 Survey Results of the Process Question

As shown in Table 2.5, 106 of the 121 (87.6 percent) participants who responded to the process question rated their time spent on the CFC competition as “somewhat more valuable” than the average economics course to “more valuable” than any economics course they have taken. More than one in five participants rated the CFC competition as more valuable than any economics course they had taken.
Eight of the participants (6.6 percent) rated their time spent on the CFC competition at about the same value as the average economics course and 5.8 percent said their participation in the CFC was much less or somewhat less valuable as the average economics course.

Table 2.5 Overall Value of CFC for Participants of CFC Compared to Average Economics Course

<table>
<thead>
<tr>
<th>Much less valuable</th>
<th>Somewhat less valuable</th>
<th>About the same value</th>
<th>Somewhat more valuable</th>
<th>Much more valuable</th>
<th>More valuable than any economics course</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8%</td>
<td>5.0%</td>
<td>6.6%</td>
<td>23.1%</td>
<td>43.0%</td>
<td>21.5%</td>
</tr>
</tbody>
</table>

Table Notes: Responses shown are answer to question "Given the opportunity cost of the time you spent on the College Fed Challenge, it was…"
Sample N=121 as 10 students did not answer this question

2.6.2 Analysis of the Outcome Measure

Table 2.6 presents the frequency distribution of the outcome measure based on the set of twelve questions that asked whether students’ participation in the CFC competition enhanced specific research, critical thinking, and presentation skills. The results clearly show that the number of students who rated each of these questions as helping them improve their skills a little to improve their skills substantially range from 82.9 percent for competency #10 (“Understand how the economy functions”) to 93.0 percent for competency #11 (“feel confident in command of economic theories”). The highest percentage of participants who reported they had not mastered any of the skills before participating in the CFC competition and that their participation did not improve any of the skills was 5.4 percent for competency #9 (“Understand an
economic question to stimulate productive discussion of the issues and keep
discussion centered on these issues”). Some participants felt they mastered the skill
before their participation in the competition and so their participation did not improve
this skill; the percentage reporting this varied from 6.2 percent for competencies #11
and #12 (“Make you feel confident in your command of economic theories” and
“Make you feel confident in applying economic theories to policy questions”)
respectively to 14.7 percent for competency #10 (“Understand how the economy
functions”). For all of the competencies more than 4/5 of the students who participated
in the CFC competition felt they benefited from the competition. This is consistent
with the results obtained from the process question presented above and with the
results reported by Brusentsev and Miller (2015, p. 520) which found “Approximately,
89 percent of respondents reported seeing some improvement in the Hansen-based
skills listed after participating.”

Table 2.6 Effect of CFC Participation on Specific Economics Skills

<table>
<thead>
<tr>
<th>Competency</th>
<th>Mastered Skill Before (%)</th>
<th>Did Not Improve Skill (%)</th>
<th>Improved Skill a Little (%)</th>
<th>Improved Skill to Some Extent (%)</th>
<th>Improved Skill Substantially (%)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Retrieve, assemble and organize information on particular topics/ issues in economics.</td>
<td>9.2</td>
<td>3.1</td>
<td>17.7</td>
<td>25.4</td>
<td>44.6</td>
<td>130</td>
</tr>
<tr>
<td>2. Explain key economic concepts; describe how they can be used.</td>
<td>6.9</td>
<td>1.5</td>
<td>10.7</td>
<td>37.4</td>
<td>43.5</td>
<td>131</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>3. Explain key economic theories; describe how they can be used.</td>
<td>7.7</td>
<td>2.3</td>
<td>10.8</td>
<td>43.8</td>
<td>35.4</td>
<td>130</td>
</tr>
<tr>
<td>4. Explain economic principles in analytical articles published in newspapers and magazines.</td>
<td>7.7</td>
<td>5.4</td>
<td>20.8</td>
<td>34.6</td>
<td>31.5</td>
<td>130</td>
</tr>
<tr>
<td>5. Evaluate analyses published in newspapers and magazines.</td>
<td>10.1</td>
<td>3.1</td>
<td>21.7</td>
<td>36.4</td>
<td>28.7</td>
<td>129</td>
</tr>
<tr>
<td>6. Understand and interpret data published by government agencies.</td>
<td>8.5</td>
<td>2.3</td>
<td>13.2</td>
<td>32.6</td>
<td>43.4</td>
<td>129</td>
</tr>
<tr>
<td>7. Prepare an organized analysis of a current economic problem.</td>
<td>7.7</td>
<td>2.3</td>
<td>13.1</td>
<td>31.5</td>
<td>45.4</td>
<td>130</td>
</tr>
<tr>
<td>8. Identify and formulate a question/series of questions about economic issues to facilitate an investigation.</td>
<td>7.8</td>
<td>4.7</td>
<td>21.7</td>
<td>31.8</td>
<td>34.1</td>
<td>129</td>
</tr>
<tr>
<td>9. Understand an economic question to stimulate productive discussion of the issues and keep discussion centered on these issues.</td>
<td>6.9</td>
<td>5.4</td>
<td>17.7</td>
<td>32.3</td>
<td>37.7</td>
<td>130</td>
</tr>
<tr>
<td>10. Understand how the economy functions.</td>
<td>14.7</td>
<td>2.3</td>
<td>14.0</td>
<td>37.2</td>
<td>31.8</td>
<td>129</td>
</tr>
<tr>
<td>11. Feel confident in command of economic theories.</td>
<td>6.2</td>
<td>0.8</td>
<td>21.7</td>
<td>40.3</td>
<td>31.0</td>
<td>129</td>
</tr>
</tbody>
</table>
As noted in my methodology section, it is reasonable to expect that the process question and outcome measure are linked in the sense that if students reported that the opportunity cost of the time they spent on the CFC competition was worthwhile (as evidenced by the fact that 87.6 percent of the respondents felt the time they spent on the CFC competition was worthwhile), this would translate to a response to the outcome measures that showed that the students’ participation in the CFC competition was beneficial.

To quantify the relationship between the process question and the outcome measure, I first coded the responses to the process question numerically ranging from 1 to 6 since there were six response choices to the process question. Higher values correspond to the time spent on the CFC competition being more valuable than the average economics course. I similarly coded the responses to the outcome question, with higher values corresponding to a greater effect on learning a particular skill. Next, I correlated the coded values of the responses to the process question with the corresponding value for how much the CFC improved a particular skill by conducting a Kendall’s tau_b correlation test between the process question and the outcome measure. The Kendall’s tau_b correlation test is more appropriate for analyzing variables that are ordinal, measured on a continuous scale, and exhibit a monotonic
relationship. The Kendall’s tau_b correlation coefficient ranges from -1 to 1. A negative coefficient signifies an inverse relationship between the ranks of the two variables and a positive coefficient signifies a direct relationship between the ranks of the two variables. The result is shown in table 2.7 below.

Table 2.7 Kendall’s tau_b Correlation Between the Process Question and Outcome Measure

<table>
<thead>
<tr>
<th>Measure</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Retrieve, assemble and organize information on particular topics and issues in economics.</td>
<td>0.206**</td>
</tr>
<tr>
<td>2. Explain key economic concepts and describe how they can be used.</td>
<td>0.318**</td>
</tr>
<tr>
<td>3. Explain key economic theories and describe how they can be used.</td>
<td>0.154</td>
</tr>
<tr>
<td>4. Explain the economic principles in analytical articles published in newspapers and magazines.</td>
<td>0.243**</td>
</tr>
<tr>
<td>5. Evaluate the analyses published in newspapers and magazines.</td>
<td>0.229**</td>
</tr>
<tr>
<td>6. Understand and interpret data published by government agencies.</td>
<td>0.265**</td>
</tr>
<tr>
<td>7. Prepare an organized analysis of a current economic problem.</td>
<td>0.285**</td>
</tr>
<tr>
<td>8. Identify and formulate a question or series of questions about economic issues to facilitate an investigation.</td>
<td>0.159*</td>
</tr>
<tr>
<td>9. Understand an economic question to stimulate productive discussion of the issues and keep discussion centered on these issues.</td>
<td>0.202**</td>
</tr>
<tr>
<td>10. Understand how the economy functions.</td>
<td>0.250**</td>
</tr>
<tr>
<td>11. Feel confident in command of economic theories.</td>
<td>0.305**</td>
</tr>
<tr>
<td>12. Feel confident in applying economic theories to policy questions.</td>
<td>0.220**</td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.05 level (2 tailed)
** Correlation is significant at the 0.01 level (2 tailed)
There is a positive correlation between the responses of all twelve outcome measures and the process question. Also, ten of the twelve correlations are significant at the 0.01 confidence level and one at the 0.05 confidence level. The only exception is outcome measure #3 which is not statistically significant. The correlation between the responses to the process question and the outcome measures ranges from 0.15 to 0.32, which can be considered a weak to moderate effect or correlation. The strongest correlation between the process question and outcome measures occurred in competency #2 ("Explain key economic concepts and describe how they can be used"), which had a .318 correlation. Ten of the twelve competencies reported a correlation above 0.20.

2.6.3 Results of the Outcome Measure for the Control Group

Table 2.8 presents the frequency distribution of the outcome measure based on the set of 12 questions that asked non-CFC students whether their studies and/or coursework in economics enhanced specific research, critical thinking, and presentation skills. The number of students who rated their studies/coursework as helping them improve their skills to some extent to mastered this skill range from 78.7 percent for competency #5 ("Evaluate analyses published in newspapers and  

\[\text{\textsuperscript{7}}\text{ Since students from the University of Delaware comprised 81.9\% of the control group students and only 18.1\% came from other universities, a t-test was conducted comparing the means of the two groups. The results show that the means of both groups are similar.} \]
magazines”) to 96.7 percent for competency #10 (“Understand how the economy functions”). This demonstrates that more than 3/4 of comparable students who did not participate in the CFC competition felt that they benefited from their studies/coursework at their universities in terms of the specific skills that students developed from their participation in the CFC competition.

Table 2.8 Effect of Economics Coursework on Specific Economics Skills

<table>
<thead>
<tr>
<th>Competency</th>
<th>Mastered Skill but not through university courses (%)</th>
<th>Improved this skill a little (%)</th>
<th>Improved this skill to Some Extent (%)</th>
<th>Improved this skill substantially (%)</th>
<th>Mastered this skill (%)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Retrieve, assemble and organize information on particular topics/ issues in economics.</td>
<td>2.6</td>
<td>9.7</td>
<td>26.5</td>
<td>49.0</td>
<td>12.3</td>
<td>155</td>
</tr>
<tr>
<td>2. Explain key economic concepts; describe how they can be used.</td>
<td>1.3</td>
<td>3.9</td>
<td>14.8</td>
<td>58.1</td>
<td>21.9</td>
<td>155</td>
</tr>
<tr>
<td>3. Explain key economic theories; describe how they can be used.</td>
<td>1.3</td>
<td>3.2</td>
<td>20.1</td>
<td>53.2</td>
<td>22.1</td>
<td>154</td>
</tr>
<tr>
<td>4. Explain economic principles in analytical articles published in newspapers and magazines.</td>
<td>3.2</td>
<td>10.3</td>
<td>34.2</td>
<td>39.4</td>
<td>12.9</td>
<td>155</td>
</tr>
<tr>
<td>5. Evaluate analyses published in newspapers and magazines.</td>
<td>3.2</td>
<td>18.1</td>
<td>33.5</td>
<td>32.9</td>
<td>12.3</td>
<td>155</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>6. Understand and interpret data published by government agencies.</td>
<td>2.6</td>
<td>15.1</td>
<td>30.3</td>
<td>40.1</td>
<td>11.8</td>
<td>152</td>
</tr>
<tr>
<td>7. Prepare an organized analysis of a current economic problem.</td>
<td>2.6</td>
<td>14.6</td>
<td>30.5</td>
<td>41.7</td>
<td>10.6</td>
<td>151</td>
</tr>
<tr>
<td>8. Identify and formulate a question/series of questions about economic issues to facilitate an investigation.</td>
<td>1.3</td>
<td>18.4</td>
<td>37.5</td>
<td>34.2</td>
<td>8.6</td>
<td>152</td>
</tr>
<tr>
<td>9. Understand an economic question to stimulate productive discussion of the issues and keep discussion centered on these issues.</td>
<td>2.0</td>
<td>7.9</td>
<td>33.8</td>
<td>40.4</td>
<td>15.9</td>
<td>151</td>
</tr>
<tr>
<td>10. Understand how the economy functions.</td>
<td>2.0</td>
<td>1.3</td>
<td>18.5</td>
<td>47.0</td>
<td>31.1</td>
<td>151</td>
</tr>
<tr>
<td>11. Feel confident in command of economic theories.</td>
<td>1.3</td>
<td>7.3</td>
<td>26.7</td>
<td>49.3</td>
<td>15.3</td>
<td>150</td>
</tr>
<tr>
<td>12. Feel confident in applying economic theories to policy questions.</td>
<td>2.0</td>
<td>11.3</td>
<td>28.0</td>
<td>46.0</td>
<td>12.7</td>
<td>150</td>
</tr>
<tr>
<td>Average</td>
<td>2.1</td>
<td>10.1</td>
<td>27.9</td>
<td>44.3</td>
<td>15.6</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: The total N for some questions may not sum to 156 if some students did not complete that question on the survey questionnaire.
2.6.4 Comparing the Results of the Outcome Measure for both Groups

Table 2.9 compares the effects of the CFC competition to coursework in economics on specific skills. The table shows the proportion of students who rated their coursework or the CFC competition as helping them improve the 12 competencies “to some extent” to “mastered this skill” for the control group and “to some extent” to “substantially” for the CFC participants. The table shows that the percentage of students who rated their coursework as helping them improve this skill “to some extent” to “mastered this skill” was higher in all twelve competencies compared to the students who participated in the CFC competition.

This unexpected result might be due to the fact that the baseline for the two groups (CFC participants compared to the control group) is different. CFC participants are asked to evaluate their improvement in the twelve competencies based on their participation in one specific activity after having already completed much of their coursework in the economics major compared to the control group basing its evaluation on their exposure to the entire economics curriculum. As such, the control group might reasonably exhibit more gains compared to the CFC participants. This puts the CFC results in a more favorable light, since they suggest improvement over and above the standard curriculum.

Participation in the CFC competition, however, helps students more in those competencies that speak to the core nature of the CFC competition, such as
“understand and interpret data published by government agencies”; “prepare an organized analysis of a current economic problem;” and “make them feel confident in applying economic theories to policy questions.”

Table 2.9 Comparison of the Effects of CFC vs. Economics Coursework on Specific Economics Skills

<table>
<thead>
<tr>
<th>Competency</th>
<th>CFC competition improved this skill to some extent to substantially (%)</th>
<th>Study/coursework improved this skill to some extent to mastered (%)</th>
<th>Difference</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Retrieve, assemble and organize information on particular topics/ issues in economics.</td>
<td>77.1</td>
<td>90.1</td>
<td>-12.9</td>
<td>2.83*</td>
</tr>
<tr>
<td>2. Explain key economic concepts; describe how they can be used.</td>
<td>86.9</td>
<td>96.1</td>
<td>-9.2</td>
<td>2.68*</td>
</tr>
<tr>
<td>3. Explain key economic theories; describe how they can be used.</td>
<td>85.8</td>
<td>96.7</td>
<td>-10.9</td>
<td>3.11*</td>
</tr>
<tr>
<td>4. Explain economic principles in analytical articles published in newspapers and magazines.</td>
<td>71.7</td>
<td>89.3</td>
<td>-17.7</td>
<td>3.66*</td>
</tr>
<tr>
<td>5. Evaluate analyses published in newspapers and magazines.</td>
<td>72.4</td>
<td>81.3</td>
<td>-8.9</td>
<td>1.71</td>
</tr>
<tr>
<td>6. Understand and interpret data published by government agencies.</td>
<td>83.1</td>
<td>84.5</td>
<td>-1.4</td>
<td>0.31</td>
</tr>
<tr>
<td>7. Prepare an organized analysis of a current economic problem.</td>
<td>83.3</td>
<td>85.0</td>
<td>-1.7</td>
<td>0.38</td>
</tr>
</tbody>
</table>
8. Identify and formulate a question/series of questions about economic issues to facilitate an investigation.

9. Understand an economic question to stimulate productive discussion of the issues and keep discussion centered on these issues.

10. Understand how the economy functions.

11. Feel confident in command of economic theories.

12. Feel confident in applying economic theories to policy questions.

Average

* Significant at the 0.05 level (2 tailed)
** Significant at the 0.01 level (2 tailed)

### 2.6.5 Regression Results

Table 2.10 presents the OLS results for the CFC and control group participants based on the three categories of broad skill areas. The dependent variable represents the sum of recoded dummy variables for the various competencies in each of the three categories.

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Constant</th>
<th>CFC</th>
<th>R-Square</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Research skills</td>
<td>4.065* (0.113)</td>
<td>-0.458* (0.168)</td>
<td>0.026</td>
<td>282</td>
</tr>
<tr>
<td>2. General knowledge and understanding of the economy</td>
<td>3.636* (0.082)</td>
<td>-0.636* (0.122)</td>
<td>0.090</td>
<td>276</td>
</tr>
</tbody>
</table>
It is obvious from the above regression results that coursework in economics help students achieve economics competencies comparable to those proposed by Hansen (1986) more than participation in the CFC competition. For the control group, the mean value of the competencies ranges from 2.8 for “presentation and explanation skills” to 4.1 for “research skill” out of a maximum score of 5, 4, and 3, respectively. Research skills for the CFC participants is 0.458 lower compared to the control group. The categories of “general knowledge and understanding of the economy” and “presentation and explanation skills” are lower by 0.636 and 0.475, respectively, compared to the control group.

These results can be misleading, however, and any interpretations of the results should be taken in context. Participation in the CFC competition does not suggest the absence of coursework in economics. In fact, those who participate in the CFC have typically taken coursework in economics prior to their participation in the competition, in which case, the only difference between the CFC participants and those who simply take coursework in economics is the actual participation in the CFC competition itself. Therefore, it is not totally correct to say that coursework in economics help students achieve the competencies comparable to those proposed by Hansen (1986) more than

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Constant</th>
<th>CFC</th>
<th>R-Square</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Presentation and explanation skills</td>
<td>2.797*</td>
<td>-0.475*</td>
<td>0.101</td>
<td>280</td>
</tr>
<tr>
<td></td>
<td>(0.057)</td>
<td>(0.085)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Standard errors in parentheses
*p<0.01; **p<0.05
participation in the CFC competition. Instead, the findings suggest an important role for the CFC beyond what is learned in coursework.

It is likely that the unexpected result that students who participate in the CFC competition exhibit fewer improvements in the three categories of broad skills compared to the control group might hinge on the fact that my analysis compares the effects of one specific activity which only lasts 2-3 months with the effects of an entire economics curriculum. It is likely that CFC participants have also taken coursework in economics comparable to those in the control group. The survey that was administered to the CFC competition participants asked them to evaluate the effects of the competition relative to their current level of skills in each area. Also, because the CFC participants were generally selected from a pool of honor students, economics award recipients and/or the top 5 percent of upper-end students of a closely related major to economics such as business administration, it is also reasonable to suppose that the baseline skills for the CFC participants was already high and, as such, the CFC participants had very little room for improvement despite their participation in the CFC competition. Therefore, the gains the students attribute to the CFC competition might well be moderate, thus providing a possible explanation for why the data showed smaller gains for the CFC participants. On the other hand, it is very possible and/or plausible that the control group students will report the skills they gained from their entire coursework in economics as more contributory to improvements in these categories of broad skills than do participation in the CFC competition, everything being equal.
2.6.5.1 Regression Analyses of School Type and School Size

In this section, I discuss whether the effects of students’ participation in the CFC competition vary based on the type of schools that students attend. I first grouped the 22 colleges and universities that participated in the CFC competition into small, medium and large institutions, selective compared to non-selective institutions, and private compared to public schools. Table 2.10 shows the breakdown of colleges and universities among these various criteria.  

Table 2.11 CFC Schools/Universities by School Categories

<table>
<thead>
<tr>
<th>Name of schools</th>
<th>School Type</th>
<th>School Size</th>
<th>Selectivity Type</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Ball State</td>
<td>Public</td>
<td>Large</td>
<td>2</td>
<td>22,000</td>
</tr>
<tr>
<td>2  Baruch College</td>
<td>Public</td>
<td>Large</td>
<td>1</td>
<td>18,000</td>
</tr>
<tr>
<td>3  Binghamton University</td>
<td>Public</td>
<td>Large</td>
<td>1</td>
<td>17,292</td>
</tr>
<tr>
<td>4  Fordham University</td>
<td>Private</td>
<td>Large</td>
<td>1</td>
<td>15,582</td>
</tr>
<tr>
<td>5  Gettysburg College</td>
<td>Private</td>
<td>Small</td>
<td>1</td>
<td>2,600</td>
</tr>
<tr>
<td>6  Indiana University</td>
<td>Public</td>
<td>Medium</td>
<td>2</td>
<td>12,010</td>
</tr>
<tr>
<td>7  Iona College</td>
<td>Private</td>
<td>Small</td>
<td>2</td>
<td>4,019</td>
</tr>
<tr>
<td>8  Lafayette College</td>
<td>Private</td>
<td>Medium</td>
<td>1</td>
<td>2,450</td>
</tr>
<tr>
<td>9  Lehigh University</td>
<td>Private</td>
<td>Medium</td>
<td>1</td>
<td>7,059</td>
</tr>
<tr>
<td>10 Manhattan College</td>
<td>Private</td>
<td>Small</td>
<td>2</td>
<td>3,970</td>
</tr>
<tr>
<td>11 Marquette University</td>
<td>Private</td>
<td>Medium</td>
<td>2</td>
<td>11,200</td>
</tr>
<tr>
<td>12 New York University</td>
<td>Private</td>
<td>Large</td>
<td>1</td>
<td>50,000</td>
</tr>
</tbody>
</table>

8 School size is classified as: 1-5,000 = Small; 5,001-15,000 = Medium; and 15,001 ≥ Large. Selectivity type: 1 = ≤ 50% acceptance rate = selective; and 2 = ≥ 50% acceptance rate = non-selective.
Table 2.12 provides a breakdown of the 131 students who participated in the CFC competition by the type of schools they attended, whether private or public, small or large. For simplicity, I combined the category of medium and large schools into one category representing large schools.

Table 2.12 Breakdown of CFC Students by School Type

<table>
<thead>
<tr>
<th></th>
<th>Small</th>
<th>Large</th>
<th>Other</th>
<th>Missing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private</td>
<td>18</td>
<td>19</td>
<td>0</td>
<td>0</td>
<td>37</td>
</tr>
<tr>
<td>Public</td>
<td>0</td>
<td>31</td>
<td>0</td>
<td>0</td>
<td>31</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Missing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>50</td>
<td>15</td>
<td>48</td>
<td>131</td>
</tr>
</tbody>
</table>

NOTE: 83 students responded to the survey directly and 48 students by survey monkey. 15 of the direct respondents and all the survey monkey respondents did not provide their school affiliation.
After classifying the schools as noted in the table, I conducted a t-test of the homogeneity between the mean outcome scores of private, small and selective institutions and between public, large and non-selective institutions as well as their significance. The t-test shows that private, small and selective schools are similar and that public, large and non-selective schools are similar as well. Given these results, I excluded two of the categories from each group⁹ from my analysis since my goal is to inquire if the benefits of participating in the CFC competition vary by school type and size.

To conduct the regression analysis of school type and school size, I focused on the CFC participants who provided information about their school affiliation. As shown in table 2.12 above, a total of 68 students provided information about their school affiliation, of which 37 came from private schools and 31 from public schools. Of the 37 students from private schools, 18 students were from small private schools and 19 were from large private schools. All of the 31 students from public schools came from large public schools and none from small public schools. In order to conduct the regressions for school type and school size, I first created dummy variables for school type and school size. To do so, I coded private schools as zero and public schools as one for school type and for school size, I coded large schools as zero and small schools as one. As a result, the independent variables are the dummy

⁹ I excluded small and selective schools from the first group and public and non-selective schools from the second group.
variables for school type, school size and the dependent variable represents the sum of recoded dummy variables for the various competencies in each of the three categories of broad skill areas. Table 2.13 below presents the results of the regression analysis of school type and school size.

Table 2.13 OLS Estimates for School Type and School Size on Broad Skill Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Coefficients</th>
<th>R-Square</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Constant</td>
<td>Public</td>
<td>Small</td>
</tr>
<tr>
<td>1. Research skills</td>
<td>3.263*</td>
<td>.479</td>
<td>-.485</td>
</tr>
<tr>
<td></td>
<td>(0.367)</td>
<td>(0.467)</td>
<td>(0.527)</td>
</tr>
<tr>
<td>2. General knowledge and understanding of the economy</td>
<td>2.895*</td>
<td>.073</td>
<td>-.207</td>
</tr>
<tr>
<td></td>
<td>(0.306)</td>
<td>(0.389)</td>
<td>(0.453)</td>
</tr>
<tr>
<td>3. Presentation and explanation skills</td>
<td>2.421*</td>
<td>-.131</td>
<td>-.656**</td>
</tr>
<tr>
<td></td>
<td>(0.215)</td>
<td>(0.273)</td>
<td>(0.313)</td>
</tr>
</tbody>
</table>

Note: Standard errors in parentheses
*p<0.01; **p<0.05

Although the effects are not statistically significant, they suggest that students from public schools may benefit more from their participation in the CFC competition than do students from private institutions. Students from public schools showed greater improvement in two of the three categories of broad skills areas, namely research skills and general knowledge and understanding of the economy, compared to students from private institutions who showed greater improvement in only the presentation and explanation skills. One explanation might be that public institutions are typically larger than private institutions, which means they have larger class sizes and less direct involvement or interaction between students and faculty. As a result, students from public institutions may be less exposed to intensive group projects such as the CFC competition. This might explain why public school students exhibit more
gains from the CFC than students from private institutions. The lack of statistical significance may reflect the small sample size.

When it comes to the difference between smaller institutions compared to larger institutions and their impact on students’ participation in the CFC competition, the results are clearly in favor of larger institutions. Students from larger institutions on average benefit more from their participation in the CFC competition than students from smaller institutions in all three categories of broad skill areas. The result for presentation and explanation skills is statistically significant at the 0.05 confidence level and the overall results show that students from larger institutions exhibit more benefits from their participation in the CFC competition. One possible explanation for why students from larger institutions benefit more from their participation in the CFC competition compared to students from smaller institutions might be because students from larger institutions have less interactions with their teachers as a result of larger class sizes, higher student-teacher ratio, etc. The two findings--1) that students from public institutions gain more than their counterparts from private institutions and 2) that students from larger institutions benefit more than students from smaller institutions from their participation in the CFC competition--could be viewed as consistent, given that public institutions tend to be larger in size while private institutions tend to be smaller in size.

2.6.6 Problem of Selection Bias

A typical problem associated with an analysis of this sort is selection bias, that is, do those who elect to participate in the competition significantly differ from those who do not in ways that are not measured? At the University of Delaware, students
who participate in the CFC competition volunteer to do so and are chosen for the
team, which creates a potential selection bias in terms of motivation and ability. The
selection bias problem can be corrected for in a regression analysis in some cases. The
problem in this study is that it involves 22 colleges/universities, each of which had its
own selection process for picking its CFC competition team. Participants are selected
based on different criteria in different schools, for example, whether the student is an
honor student, department of economics award recipient, student in a course on CFC
competition, contemporary macroeconomics and/or money and banking, or the top 5
percent of upper end students of a major. It becomes difficult to measure or determine
the extent of the selection bias problem across the different schools as a result. This
might present a potential weakness of this study, given that it is not possible to correct
for this problem across the various colleges/universities.

2.7 Qualitative Analyses of CFC Team Coaches Responses and Open-Ended
Responses by CFC Participants

To include a qualitative dimension to my study, the survey questionnaire that
was administered to the CFC students also included open-ended questions. These
questions were aimed at gathering information about how the participants felt their
skills and proficiencies may have been affected by their participation in the CFC
competition. In addition, the team coaches were also surveyed with the aim of
understanding which coaching method(s) and/or techniques are most effective in
preparing a team for the CFC competition.
2.7.1 Qualitative Results of the CFC Participants

This section highlights various comments from the CFC participants. There were six open ended questions posed to respondents: 1) How did your CFC experience contribute to your economic education? 2) What is your impression of the CFC experience as it relates to your college experience? 3) Do you think your CFC experience will influence your choice of career? 4) Do you think your CFC experience will help with your career? 5) Do you think your CFC experience will help you in the non-career aspects of your life? and 6) What did you learn about monetary policy from participating in the CFC?

In order to analyze the responses to these questions, I coded the responses into the following categories:

Question 1: Not at all; helped me learn more about economics; not sure; and no response
Question 2: Not valuable; valuable; not sure/no impression; and no response
Question 3: Not at all; yes; not sure; and no response
Question 4: Not at all; yes; determine my career choice and increase my confidence; helped with presentation skill, research, debate, public speaking, analytical skill, internship, teamwork, etc.; helped with job interviews and networking; not sure; and no response
Question 5: Not at all; yes; improve my presentation skill, public speaking, team building, analytical, and critical thinking, etc.; helped with portfolio management and investment; not sure; and no response
Question 6: Nothing; helped me learn about the FED and FOMC; helped me learn about inflation targeting, helped me learn about key economic indicators; and helped me learn about the power of monetary policy; not sure; and no response.

A total of 131 students responded to the open-ended questions. Tables 2.14 – 2.19 below capture the responses by the CFC participants to the open-ended questions.
Table 2.14  Results of Students Written Responses to Question 1

<table>
<thead>
<tr>
<th>Question</th>
<th>Not at all</th>
<th>Helped me learn more about economics</th>
<th>Not sure</th>
<th>No response</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How did your CFC participation contribute to your economic education?</td>
<td>1</td>
<td>110</td>
<td>1</td>
<td>19</td>
<td>131</td>
</tr>
<tr>
<td></td>
<td>(0.8%)</td>
<td>(84.0%)</td>
<td>(0.8%)</td>
<td>(14.5%)</td>
<td>(100%)</td>
</tr>
</tbody>
</table>

As shown in Table 2.14, 84.0 percent of the CFC participants felt their participation in the CFC competition contributed to their economic education by helping them learn more about economic concepts. Less than one percent (0.8 percent) of the CFC participants felt their participation in the competition did not help them at all. Below are some of the written comments:

1) “Very valuable, understanding fed policy and economic policy really creates a platform for future growth in academic knowledge.”
2) “The increased ease that I can discuss monetary policy and how I can do research better.”
3) “Gained appreciation of monetary policy formulation.”
4) “It helps us not only learn economics theory and monetary policy, but also work in teams.”
5) “I learned about current policies I otherwise would not have experienced.”
6) “Helped me apply the theory I learned in the classroom to real life policy situation.”
7) “I understand how to interpret economic reports and articles much more thoroughly.”
8) “I believe I have essentially had a crash course in macroeconomics that is a lot more useful than a basic macro class. I learned about a host of different economic data and their relevance.”
9) “I think a pretty good evaluation of the CFC is that I know more what my professors are talking about in class.”
10) “Whereas many of my economic classes focused mainly on theory, the Fed challenge stressed the importance of actual data and using those facts for practical application.”
In summary, the benefits of participating in the CFC competition as highlighted by the students written comments exhibit the student’s acknowledgement of possessing a more fortified economic education that has real world functionality.

Table 2.15  Results of Students Written Responses to Question 2

<table>
<thead>
<tr>
<th>Question</th>
<th>Not valuable</th>
<th>Valuable</th>
<th>Not sure / No impression</th>
<th>No response</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. What is your impression of the CFC experience as it relates to your college experience?</td>
<td>1 (0.8%)</td>
<td>101 (77.1%)</td>
<td>7 (5.3%)</td>
<td>22 (16.8%)</td>
<td>131 (100%)</td>
</tr>
</tbody>
</table>

As shown in Table 2.15, 77.1 percent of the CFC participants felt their participation in the CFC competition was valuable with regards to their college experience. Less than one percent (0.8 percent) of the CFC participants felt their participation in the competition was not valuable in relation to their college experience. Below are some of the written comments:

1) “It will always be remembered when I look back to the times of college.”
2) “CFC was great. It was a good chance to see how practical the concepts we are learning in class really are.”
3) “It has made me value the critical thinking and analytical skills we practice daily in class discussion and through examination.”
4) “It has improved my knowledge of what we learned in the class room because it creates an opportunity for open discussion on topics covered in class.”
5) “The experience was definitely a team building experience as well as one where my economic knowledge was tested.”
6) “Definitely a great learning experience, worthwhile.”
7) “One of my favorite experiences.”
8) “A valuable asset to any college undergraduate education.”
9) “It was more beneficial than most classes.”  
10) “By far the most intellectually challenging activity.”

In summary, students report a favorable and worthwhile CFC experience, as it enhanced analytical intellectual skills while contributing positively to team building.

Table 2.16 Results of Students Written Responses to Question 3

<table>
<thead>
<tr>
<th>Question</th>
<th>Not at all</th>
<th>Yes</th>
<th>Not sure</th>
<th>No response</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Do you think your CFC experience will influence your choice of career?</td>
<td>42 (32.1%)</td>
<td>63 (48.1%)</td>
<td>9 (6.9%)</td>
<td>17 (13.0%)</td>
<td>131 (100%)</td>
</tr>
</tbody>
</table>

As shown in Table 2.16, 48.1 percent of the CFC participants felt their participation in the CFC competition had an influence on their choice of career. 6.9 percent said they were not sure if their participation in the CFC competition influenced their choice of career. Roughly a third (32.1 percent) of the CFC participants said the competition did not influence their choice of career. Some of the written comments are presented below:

1) “Yes, I am so much more excited to use my economic and finance majors.”
2) “I think it will. It has more of a re-affirmation that my choice was the correct one.”
3) “Yes, because of my personal CFC experience, I plan to seek employment in a federal research regional bank.”
4) “No, because I am a Finance and Accounting major but I definitely spoke about it in interviews.”
5) “No, I don’t plan to work for the Federal Reserve.”
6) “Yes definitely. I am much more interested in macroeconomics now.”
7) “No, that was already set before CFC.”
8) “No, this was purely extra-curricular.”
9) “Yes, I like economic forecasting and would like to work for the Fed.”
10) “I don’t know if it will influence my choice in a career but I do think it will help me get a job.”
11) “Yes, doing research made me consider getting a PHD in economics.’

Participation in the CFC competition helps students in solidifying their choice to pursue careers in economics, with others reflecting positively upon their CFC experiences since their career choices have already been determined.

Table 2.17 Results of Students Written Responses to Question 4

<table>
<thead>
<tr>
<th>Question</th>
<th>Not at all</th>
<th>Yes</th>
<th>Determine my career choice and increase my confidence</th>
<th>Helped with presentation skills, research, debate, public speaking, analytical skills, etc.</th>
<th>Helped with job interviews and networking</th>
<th>Not Sure</th>
<th>No response</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Do you think your CFC experience will help with your career?</td>
<td>4</td>
<td>19</td>
<td>39</td>
<td>39</td>
<td>4</td>
<td>3</td>
<td>23</td>
<td>131</td>
</tr>
<tr>
<td></td>
<td>(3.1%)</td>
<td>(14.5%)</td>
<td>(29.8%)</td>
<td>(29.8%)</td>
<td>(3.0%)</td>
<td>(2.3%)</td>
<td>(17.6%)</td>
<td>(100%)</td>
</tr>
</tbody>
</table>

As shown in Table 2.17, 14.5 percent of the CFC participants felt their participation in the CFC competition will help them in their career. 59.6 percent said their participation in the CFC competition had some effect on their career either by helping them determine their career, increased their confidence and/or helped them with their presentation skills, research, debate, public speaking, analytical skills, etc., all of which can positively helped their career. Some of the written comments follow:

1) “This experience increased my confidence in what it is I apply to my career.”
2) “It will definitely help me because now I have a greater understanding of how the FED operates and also how the economy affects us.”
3) “Yes. Public speaking.”
4) Learning about public policy, key players in monetary policy will definitely help me with my career.”
5) “Yes, I learned to work in groups and compete. I also learned to do research.”
6) “Yes. Definitely help me a lot with my job interview.”
7) “Most definitely- many interviews are very impressed with it and enjoy talking about it. The skills learned will apply to my post-graduation life.”
8) “Through this I have learned how to be a better team worker and also research better. I believe these lessons would be very valuable in any field I choose to pursue.”
9) “Yes, the ability to apply theory at high level will boost my resume.”
10) “Yes, it will help me evaluate the state of the economy, which is necessary almost in any career.”
11) “Yes as I gained invaluable experience using government sites to gather economic data and gained an appreciation for economic research in general.”

The value of the CFC competition in the future careers of students goes beyond economics. Many students acknowledged their participation in the CFC competition made great contributions to their public speaking, presentation and team-working capabilities.

Table 2.18  Results of Students Written Responses to Question 5

<table>
<thead>
<tr>
<th>Question</th>
<th>Not at all</th>
<th>Yes</th>
<th>Improve my presentation skill, public speaking, team building, analytical, and critical thinking, etc.</th>
<th>Helped with portfolio management and investment</th>
<th>Not sure</th>
<th>No response</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5. Do you think your CFC experience will help you in the non-career aspects of life?

<table>
<thead>
<tr>
<th></th>
<th>9</th>
<th>39</th>
<th>41</th>
<th>14</th>
<th>4</th>
<th>24</th>
<th>131</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(6.9%)</td>
<td>(29.8%)</td>
<td>(31.3%)</td>
<td>(10.7%)</td>
<td>(3.1%)</td>
<td>(18.3%)</td>
<td>(100%)</td>
</tr>
</tbody>
</table>

As shown in Table 2.18, 29.8 percent of the CFC participants felt their participation in the CFC competition will help them in the non-career aspects of life. 10 percent of the students were either not sure or said their participation in the CFC will not help in the non-career aspects of their life. Some of the written comments are:

1) “Yes the better understanding of economics that I gain will help me better plan some of the larger decisions I will have to make in life.”
2) “I think it was mostly a great team building experience when can help me get along better with teammates in any aspect at my life.”
3) “Yes in portfolio management.”
4) “No.”
5) “The CFC experience allowed me to approach a wide variety of opinions or views in regards to economics material, something I hope to replicate in other subjects.”
6) “Probably. Again the transferable skills such as team work and collaboration are relevant to many aspects of life.”
7) “I feel like I can analyze better now.”
8) “It was an enjoyable bonding experience with team mates even if it has little impact on my career.”
9) “Yes connecting ideas (A to B to C).”
10) “Yes, it will help me understand the economy from a consumer viewpoint.”
11) “Yes, my analytical thinking skills have been enhanced.”

In summary, the benefits of the CFC competition are projected by participants to extend outside of their careers, contributing greatly to essential life skills such as team-building and critical thinking abilities.
<table>
<thead>
<tr>
<th>Question</th>
<th>Nothing</th>
<th>Helped me learn about the FED and FOMC</th>
<th>Helped me learn about inflation targeting</th>
<th>Helped me learn about key economic indicators</th>
<th>Helped me learn about the power of monetary policy</th>
<th>Not sure</th>
<th>No response</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. What did you learn about monetary policy from participating in the CFC?</td>
<td>1</td>
<td>28</td>
<td>2</td>
<td>20</td>
<td>28</td>
<td>31</td>
<td>21</td>
<td>131</td>
</tr>
<tr>
<td></td>
<td>(0.8%)</td>
<td>(21.4%)</td>
<td>(1.5%)</td>
<td>(15.3%)</td>
<td>(21.4%)</td>
<td>(23.7%)</td>
<td>(16.0%)</td>
<td>(100%)</td>
</tr>
</tbody>
</table>

As shown in Table 2.19, 59.6 percent of the CFC participants felt their participation in the CFC competition will help them learn about monetary policy. It includes those who felt their participation helped them learn about the Fed, FOMC, inflation targeting, key economic indicators, and monetary policy. 23.7 percent of the CFC participants were not sure whether their participation helped them learned about monetary policy. This result is surprising as a major responsibility of the FED is to implement monetary policy in the United States. Given that the FOMC is responsible for setting interest rates and that the role of the CFC participants is to simulate FOMC decisions, it is surprising that such a large percentage of the CFC participants (23.7 percent) indicate they are not sure whether their participation in the CFC helped them learn about monetary policy. Some of the written comments follow:
1) “Monetary policy is a very powerful tool that must be welded with great discipline and wisdom.”
2) “It gave me a great overview of monetary policy and showed how the FED operates.”
3) “How to solve economic problems by experimenting with economic theory models and research.”
4) “I learned how exactly it is used and the differing views and dynamics on the FOMC.”
5) “Just how interconnected all the factors are. You can’t just change one without affecting the others.”
6) “Every choice, in life and monetary policy, has costs and benefits. The key to monetary policy is discussing the costs and benefits of each situation carefully in order to fulfill the dual mandate.”
7) “The power and importance of the FED.”
8) “That it is complicated.”
9) “That there is only so much the FED can do.”
10) “I understand the tools of the FED much more thoroughly.”
11) “I have learned the wide range of economic data that goes into policy making and a vast amount of information behind the data, such as say employment-population.”

In summary, the overwhelming majority of CFC participants report gaining a robust understanding of the FED, FOMC and monetary policy, as well as their inner workings after participating in the CFC.

2.7.2 Qualitative Results of the CFC Team Coaches

As previously stated, the purpose of surveying the team coaches was to understand which coaching method(s) and/or techniques the coaches believed are good for coaching a CFC team, to find out the selection process or mechanism for selecting their CFC team, and to obtain feedback regarding the educational value of the CFC competition. I focus on four open-ended questions:

Question 1: Please explain the process of selecting the finalists for the CFC competition at your school;
Question 2: Do the finalists take a special course in order to prepare for the CFC competition? Is this course a credit course?
Question 3: How would you evaluate the educational value of the CFC competition?  
Question 4: Which techniques do you consider to be most effective in preparing a team for the CFC competition?

Sixteen team coaches responded to the survey. The following tables 2.20 – 2.23 present the responses by the team coaches.

Table 2.20  Results of Question 1, CFC Coaches Survey

<table>
<thead>
<tr>
<th>Question</th>
<th>Informal or haphazard</th>
<th>Formal</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Please explain the process of selecting the finalists for the CFC competition at your school.</td>
<td>4 (25%)</td>
<td>12 (75%)</td>
<td>16 (100%)</td>
</tr>
</tbody>
</table>

As shown in Table 2.20, 75 percent of the team coaches stated that there is a formal process for selecting the CFC participants at their school and 25 percent said the selection process at their school was informal or haphazard. The fact is that different colleges and universities use different approaches in selecting and preparing for the CFC competition. In 2012, I observed the selection process of the CFC competition team at the University of Delaware. The logic model presented in Appendix D gives a picture of the selection process of the CFC competition at the University of Delaware in 2012.

Some of the written comments by the team coaches are:

1) “Any student who has taken Principles of Macroeconomics is eligible to take the College Fed Challenge course. If more than five people take the course, the finalists for the CFC competition are chosen by the faculty of the Economics, Finance, and Accounting faculty on the basis of an oral presentation and Q&A session that resembles the competition itself.”
2) “Haphazard. The “finalists” on the school team are those who have “stuck it out.””
3) “Word of mouth and some faculty recommendation bring students to me. They are invited to attend Sunday evening sessions and then work among themselves to prepare for the competition. Presenters are selected based on knowledge, oral presentation skills, motivation, etc. Students who want to present are asked to do a short presentation. Also some students show up at Fed Challenge via a forecasting competition sponsored by ODE in the spring.”

4) “We send out email announcements in the spring semester to all students soliciting applications for the fall team. Students are asked to submit a letter of interest, a resume, and a brief PowerPoint presentation on some aspect of monetary policy. Students are selected out of this period.”

5) “We recruit in Monetary Policy and Intermediate Macroeconomics classes.”

6) “The director of undergraduate studies and the professor of Monetary Policy provide a list of outstanding students to invite to participate.”

7) “We select 5 students from Money and Banking course based on their knowledge of monetary policy.”

8) “Students are “nominated” by four faculty who teach macroeconomics courses, based on their presentation skills, understanding of monetary policy and their self-expressed interest.”

9) “There is an economics professor who is in charge for the CFC competition. This professor selects the finalists from a pool of nominees submitted by the entire economics department.”

In summary, students are selected to participate in the CFC, based on their dedication and academic success in economic and related courses, with the majority being determined by even more strenuous measures.

Table 2.21  Results of Question 2, CFC Coaches Survey

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Do the finalists take a special course in order to prepare for the CFC competition? Is this a credit course?</td>
<td>10 (62.5%)</td>
<td>6 (37.5%)</td>
<td>16 (100%)</td>
</tr>
</tbody>
</table>

As shown in Table 2.21, 62.5 percent of the team coaches stated that there is a special course for the CFC competition at their school and 37.5 percent said there is no
special course. Of the 10 schools that offered a special course, nine offered the course as a credit course and only one school did not offer the course as a credit course.

Table 2.22 Results of Question 3, CFC Coaches Survey

<table>
<thead>
<tr>
<th>Question</th>
<th>Extremely Educational</th>
<th>No response</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. How would you evaluate the educational value of the CFC competition? Please explain.</td>
<td>15 (93.75%)</td>
<td>1 (6.25%)</td>
<td>16</td>
</tr>
</tbody>
</table>

Note: Question 3 was actually question 5 on the survey questionnaire.

As shown in Table 2.22, 93.75 percent of the team coaches stated that they found participation in the CFC competition to be extremely educational. One of the team coaches did not answer this question. Below are some of the written comments by the team coaches:

1) “Very high-besides simply gaining an increased understanding of macroeconomics and monetary policy, the CFC is a great way for students to enhance their research skills, presentation skill (both in terms of preparing a presentation and then doing a presentation), and the ability to answer questions in a pressure situation—one former team member said after a job interview: Do you think I was nervous talking to a person from Wells-Fargo after I’d been questioned by an economist from the NY Fed? Hell No!"
2) “Extremely education….”
3) “It is a huge benefit for our students who stick with it. They are highly motivated and learn a huge amount about fed policy….”
4) “Excellent….”
5) “Very valuable. The competition forces students to keep up to date with current economic conditions”
6) “The experience of being a part of the CFC truly helped me get a better grasp of my discipline.”
7) “It’s a great experience for students, and they learn more when they have same sort of goal.”
8) “Phenomenal. Students gain a lot of knowledge of macroeconomics, finance, and monetary policy. They also become avid news-followers.”

65
In summary, coaches report the profound benefits experienced by their students, especially pertaining to the development of student’s interest in current economic conditions.

Table 2.23  Results of Question 4, CFC Coaches Survey

<table>
<thead>
<tr>
<th>Question</th>
<th>Faculty-led effort</th>
<th>Student-led effort</th>
<th>No response</th>
<th>Q/A</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. (Optional) Which techniques do you consider to be most effective in preparing a team for the CFC competition? Has your CFC coaching experience changed the way you teach other courses?</td>
<td>1 (6.25%)</td>
<td>5 (31.25%)</td>
<td>8 (50.0%)</td>
<td>2 (12.5%)</td>
<td>16 (100%)</td>
</tr>
</tbody>
</table>

Note: Question 4 was actually question 6 on the survey questionnaire.

As shown in Table 2.23, 31.25 percent of the team coaches stated that preparation of the CFC competition is a student led effort and only 6.25 percent said it was a faculty led effort. 12.5 percent of the team coaches said the preparation is done mainly by question and answer. Half of the team coaches did not answer this question.

Below are some of the written comments by the team coaches:

1) “Lots of q and a; letting students work on their own to develop teamwork as they work to complete their presentation and script. Can’t say Fed Challenge has changed the way I teach other courses though I will say that competition brings out the best in the right sort of student who like the idea of winning something….”

2) “Question and answer session….”

3) “Technique depends a lot on the team. Some teams require hand holding. Others you have to plant a seed, provide them access to faculty and resources and wait for the idea to bloom…”

4) “Judging presentations and slides with suggestions….”
In summary, coaches reported that the CFC competition was a unique experience, making it challenging to specify preparation techniques. However, it is essential to provide participants with necessary resources and let them navigate their way.

Overall, these qualitative responses from the CFC students and the team coaches show that both groups of respondents felt the CFC competition is beneficial in helping students achieve the Hansen competencies as well as bridging the gap between theory and the practical applications of economics concepts. In short, the responses tell us that the CFC competition can be a powerful teaching tool for macroeconomics policy formulation.
Chapter 3

THE EFFECTS OF MATHEMATICS BACKGROUND ON STUDENT PERFORMANCE IN INTRODUCTORY ECONOMICS

Because introductory economics courses inherently involve the tools of mathematics, this chapter evaluates the effects of mathematics, specifically intermediate algebra preparation, on students’ success in introductory economics courses. To evaluate this, I take advantage of a policy change that was instituted in the Peralta Community College District (PCCD) in Oakland, California in 2008 requiring intermediate algebra as a pre-requisite for introductory economics courses. Section 3.1 provides background and motivation for my second essay. Section 3.2 reviews the relevant literature. Data sources, collection and sample size are presented in section 3.3, while section 3.4 discusses the methodology and modeling used. Model estimation results are presented in section 3.5 and section 3.6 looks at data limitations.

3.1 Background and Motivation

The PCCD was created in 1964 with the purpose of educating, training, and mentoring students in the surrounding communities. The PCCD has a student population of approximately 25,000 students and is comprised of four colleges: Laney College, Merritt College, College of Alameda, and Berkeley City College. The instructional programs are designed to provide students with general education
courses, career and technical education courses, transfer education courses, English curriculum for non-citizen and citizens with English as a Second Language emphasis, and cooperative work experience education. All four colleges offer courses in economics, primarily in introductory macroeconomics and microeconomics.

Historically, economics courses at PCCD were open to any student who wanted to take them, however in 2008, the California State University (CSU) system required California community colleges to implement intermediate algebra as a pre-requisite for introductory economics courses in order for the community colleges to maintain their Articulation Agreements with the CSU system. In this essay, I investigate whether the implementation of intermediate algebra as a pre-requisite for economics courses in community colleges in California had a significant impact on the performance of economics students as measured by students’ grades in economics courses before and after the change.

The introductory macroeconomics and microeconomics courses offered by the PCCD are taught both in-class and online. Yearly, on average, about 62 sections of the introductory macroeconomics and microeconomics courses were offered by the PCCD. The average class size is approximately 35-45 students. In a typical year, PCCD offers 34 sections of macroeconomics and 28 sections of microeconomics. Of the 34 macroeconomics courses, 21 sections are taught in-class and 13 online, while for the microeconomics courses, 20 sections are taught in-class and the remaining 8 are taught online.
3.2 Literature Review

Many factors contribute to students’ academic success in a specific subject or course, and economics is no exception. In the following paragraphs I discuss a variety of factors influencing a student’s success in introductory economics courses. In doing so, I will place great emphasis on the importance of a strong mathematics background, especially algebra, in an effort to highlight the relationship between economic course success and background in mathematics. Other factors I will cover include GPA and aptitude tests to show their tendency to predict a student's performance in introductory economics. I will also show that the role of mathematics background in academic success in economics is not exclusive to the United States, but is an international phenomenon as well. It is my goal in this literature review to survey the literature that measures and/or quantifies the correlation between mathematics aptitude or background and performance in introductory economics courses, paying close attention to the importance of those studies using regression analyses.

3.2.1 Factors influencing success in introductory economics courses

Several studies have attempted to identify and measure the effects of some of the contributing factors to students’ success in introductory economics. For example, in the first issue of the *Journal of Economic Education*, Paden and Moyer (1969) describes several significant variables for explaining variation of scores on tests in introductory economics. Their study lists ability, an initial level of competence in
economics, class level (senior, junior), attendance record, major area of study, and the sex of the student as some of the contributing factors for success in economics. A study by Kara, Bagheri, and Tolin (2009) found similar contributing factors that affect students’ performance in principles of economics courses, including gender, mathematics skills, instructor, teaching methods, absenteeism, class size, student effort, employment, seating location, and personality type. Moreover, the paper provides a broad literature on each of the contributing factors on student performance in principles of economics courses. Other studies such as Johnson and Kuennen (2006) underscore the importance of GPA in preparatory courses for economics as the next best contributor after mathematics in determining success in introductory economics courses.

Of particular interest to my dissertation is the significance of a strong foundation in mathematics, specifically intermediate algebra, in the learning and understanding of introductory economics. As an instructor of introductory economics courses for over twenty-four years, I find it hard to imagine students performing well in these courses with very little or no foundational background in mathematics. As Dawson (2014, p. 6) notes: “Survey evidence (from the Economics Network Student Survey) suggests that over 80% of students stated there was much more Mathematics involved in their Economics degree program than they expected.” The results of the above student survey reaffirm my experience and belief that mathematics courses deserve to be strongly recommended for the economics major and for those taking introductory economics courses.
3.2.2 The importance of mathematics background in introductory economics courses

Many colleges have adopted a similar curriculum for economics majors, consisting of coursework heavily based upon mathematics, including intermediate algebra and sometimes, calculus. A good example of this is the University of Delaware, where students are required to take at least College Mathematics and Statistics (Math 114) or Pre-Calculus (Math 115 or Math 117) or higher-level mathematics course as a co-requisite for Introduction to Microeconomic Theory. A similar requirement was imposed in the Peralta Community College District in Oakland, California in 2008, mandating that all students taking an economics course must first take an intermediate algebra course.

To underscore the point, a joint survey conducted by the American Economic Association (AEA) and the Joint Council on Economic Education (JCEE) in 1980 involving 546 four-year U.S. colleges and universities offering an undergraduate major in economics found that specific courses such as statistics, algebra, accounting and computer science were the only other prerequisites (besides calculus, general liberal arts, an overall “C” grade, and a “C” grade or better in introductory economics) required for majoring in economics by more than one school (Siegfried and Wilkinson (1982)). These findings suggest the importance of algebra in the study of introductory economics and are consistent with those obtained by Ely and Hittle (1990) that found mathematics background to be instrumental in the learning of managerial economics.
3.2.2.1 The importance of graphs and remedial mathematics in introductory economics courses

All economics instructors and those in the field of economic education know the importance of graphs in introductory economics courses specifically to express key concepts such as demand and supply, the production possibilities curve, indifference curves, the budget line, deadweight loss resulting from taxation, tariff, quotas, and monopoly. Two studies have investigated the use of graphs in economics. Cohn et al. (2001) reported on two experiments at the University of South Carolina using a pretest/posttest experiment to evaluate student performance in the principles of economics course. Students were randomly assigned to a lecture with graphs vs a no-graphs lecture. The researchers found that students who had above-average mathematics knowledge did better in the lectures with graphs than those with below-average mathematics knowledge.

In a follow-up study conducted at the University of South Carolina involving 663 student volunteers enrolled in different sections of an undergraduate one-semester introductory economics course in 2000 and 2001, Cohn et al. (2004) examined student attitudes toward graphs in comparison to their performance in economics. The researchers measured attitudes based on whether a student indicated having difficulty with the types of graphs used in the course or whether the graphs were helpful. The researchers employed a probit regression model to test the probability of whether student attitudes with graphs affected their performance in economics classes. The
researchers found no significant evidence that students who thought graphs were helpful performed better than those who did not.

Meanwhile, in the study mentioned earlier by Kara, Bagheri, and Tolin (2009), the researchers found that both the number of math classes taken and the use of graphs to explain a topic were positively correlated to student's performance in economics, although the effects were not statistically significant.

Next, I examine whether remedial mathematics affects student performance in introductory economics. Espey (1997) employed Ordinary Least Squares to examine student success in an introductory agricultural economics course at the University of Nevada - Reno. The study was carried out during the spring and fall 1995 and fall 1996 semesters using data for 116 students and a series of math competency tests. Students took a test during the first week of class covering basic college math skills such as algebra and graphs. Students who did not pass the test had to take remedial math tutoring in the university's Mathematics Center. During the semester, students took three tests covering quantitative topics such as elasticities and consumer surplus. The score on the second test was used as the dependent variable while the mathematics competency test score, the student's scores in college algebra or higher-level mathematics, the student's score on the first test were the independent variables. Espey found: 1) “that achieving a basic level of math competency positively affects success on the second test, increasing the test score by more than 10 points out of 100;” and 2) “While completing a college algebra course before enrolling in
economics contributed positively to student’s success, the requirement of learning or reviewing basic math skills at the beginning of the course contributed significantly more to those students’ success in economics than would an algebra prerequisite (11.7 points versus 3.4)” (p. 487). These findings demonstrate that while college-level algebra is essential, of even more significance is administering a fundamental math skills review.

The above results by Espey are corroborated by Ballard and Johnson (2004), which tested the effects of basic mathematics skills on student's performance in an introductory economics class. The authors measured basic mathematics skills by student's score in four measures of quantitative ability: (1) the mathematics portion of the ACT, (2) math quiz given early in the semester, (3) whether the student took calculus, and (4) remedial mathematics. The authors concluded that not only did all four basic mathematics skills significantly affect students’ performance in an introductory economics class, but the results were also consistent, regardless of whether information was self-reported or obtained from official administrative records. Their results confirm the finding that basic algebra can improve students’ performance in introductory economics.

3.2.3 The reliance of mathematics in economics courses worldwide

The importance of a mathematics background in learning introductory economics is not unique to the United States. In fact, a substantial international literature documents the importance of a strong mathematics background on success in
introductory economics courses around the world. As Darlington and Bowyer (2017, p. 101) note: "Undergraduate economics incorporates a significant amount of mathematics and statistics, regardless of which country the course is in." Monteiro and Lopes (2007) found that more than 75 percent of the top 20 universities for economics in Europe and the US offered courses in mathematics, statistics and econometrics in their undergraduate economics programs, and Dawson (2014) found about 25 percent of the first-year economics degree programs in the United Kingdom offered courses in mathematics and statistics.

More evidence is found demonstrating the link between economics and the analytical sciences. For example, in a study conducted to examine the effects of mathematics on first-year undergraduate economics students at the Universidad Carlos III de Madrid, Spain from 2002/03 – 2005/06, Dolado and Morales (2006) found that students who enroll in the technical track (i.e., quantitative track) in high school prior to taking a first-year economics course do better in the course than those who enroll in a social sciences or humanities track. In another similar study conducted at Erasmus University Rotterdam in the Netherlands, Arnold and Straten (2012) employed both factor analysis and regression of the motivational variable from the factor analysis, combined with the students’ preparatory background, to predict the success rate of students in first-year economics. The researchers relied on two data sources--1) A survey administered to freshmen students at the start of the academic year when students can easily recollect why they chose to take a course in economics; and 2) Official university data that tracks student's progress and background. The researchers
discovered that students in preparatory education, particularly those in analytical science tracks, have a better foundation for success during their first-year study in economics. The authors also note that motivation could substitute for the lack of mathematics skills when a student’s preparatory background is inadequate.

A 2011 survey of 145 faculty members from universities across the United Kingdom conducted by The Economics Network (2011) listed student math skills and motivation as the number one issue in teaching economics by about two-thirds of the lecturers. Based on another survey conducted in Britain that included more than 4,000 undergraduates of which 238 were economics students, Darlington and Bowyer (2017) reported on economics students experiences of taking both the A-level Mathematics and Further Mathematics10 courses in preparation for undergraduate economics. They conclude that “A-level Mathematics not only benefits undergraduate performance but can also give more accurate expectations about the reality of an economics degree” (p. 102). The same was true for Naylor and Smith (2004) which found that students’

10 The A-level Mathematics and Further Mathematics courses are two courses that are offered in high schools in the United Kingdom and other former British colonies for students that are interested in the science track. The courses are meant to help students acquire a deeper understanding of the principles of mathematics as well as develop their mathematics skills and applications. More importantly, the courses provide students with a strong foundational background in mathematics for undergraduate studies.
performance in the A-level (i.e., an extra A-level grade) increases their chances of obtaining a degree in economics by about 2 percentage points.

The latter surveys further solidify the need for an increased emphasis on mathematics skills in economics worldwide, as well as highlight my personal experience in Cameroon, Africa where I studied the A-level Mathematics course in high school and sat for the GCE Advanced Level entrance examination into the university. The GCE Advanced Level examination is a standardized entrance examination that students take in their senior year of high school, which is used as a gauge for students applying to the university comparable to the ACT and SAT examinations in the US. The GCE Advanced Level Mathematics course covers both basic mathematics skills and also higher-level mathematics skills such as differentiation, integration and linear algebra. As a result, the course provides a good foundation and mathematics background for undergraduate economics. My undergraduate experience in economics supports the above findings that A-level Mathematics is beneficial in the study of undergraduate economics. As Darlington and Bowyer (2017, p. 110) puts it: “Only 4.4% of those who took Mathematics and 3.5% of those who took Further Mathematics reported that they thought that these A-levels were bad preparation for undergraduate economics. Furthermore, the proportion of participants describing Mathematics and Further Mathematics as good preparation (83.3% and 77.9%, respectively) indicates that Further Mathematics does have additional benefits to A-level Mathematics in terms of preparing students mathematically for tertiary economics.”
In another study conducted in England, Lagerlof and Seltzer (2009) performed a natural experiment using a differences-in-differences approach based on administrative data of students enrolled in the economics program at the Royal Holloway University of London from 1997 to 1999. The dependent variable was the grade a student obtained in first-year subjects while the independent variables included dummy variables for students with an A-Level economics background, foundation of mathematics, time, and other student characteristics. They found a student's mathematics background before university has a significant effect on their performance in introductory economics.

3.2.4 Quantitative evidence of the importance of algebra and higher-level mathematics in economics in the U.S.

The next series of articles focus on studies conducted in the U.S. showing the importance of mathematics in undergraduate economics and the correlation between aptitude tests and economics performance. First, unlike the above studies that simply examine the correlation between mathematics background and performance in introductory economics, Pozo and Stull (2006) examine whether assigning a grade to a mathematics module taken prior to taking an introductory economics course had an impact on student’s performance in the introductory economics course. The researchers applied a random assignment experiment that included a control group for their study. The experiment involved 273 students at Western Michigan University enrolled in two sections of principles of macroeconomics taught by one professor.
during the 2004 spring semester. Students in both groups completed an Aplia\textsuperscript{11} online math test during the first week of class; the test score was then used as part of their final grade in the course for those in the treatment group. Additionally, those in the treatment group who did not do well on the test could improve their score by working through the online tutorial in Aplia and by taking a post-review test. The control group students were simply encouraged to complete the math test as well as the online tutorial. Their score, however, was not used in computing their final grade in the course. The authors concluded that “… requiring a math unit appears to have raised student performance in these classes by 2 percentage points” (p. 440). This study exemplifies the significant role that motivational strategies can play in a student’s performance.

Using a large dataset of U.S. Naval Academy undergraduate economics majors from 1994 to 2003, Swope and Schmitt (2006) examined course grades in economics for students who completed at least 31 credit hours of economics, controlling for the student’s Scholastic Aptitude Test Mathematics and Verbal scores, gender, race, and personality. The authors utilized Tobit regression to analyze their data and concluded that both mathematics and verbal skills were significant predictors of a student’s success in the economics major.

\textsuperscript{11} Aplia is an interactive online course management platform developed by Cengage Learning. It provides students with study tools, digital textbooks, and homework exercises, as well as a discussion board where students can pose questions and interact with other students and the instructor.
Another study found substantial evidence that SAT scores provide reliable insight as to the expected success of students in economics. Elzinga and Melaugh (2009) used an ordered probit regression model to analyze data of over 35,000 students who took principles of economics courses from a single professor at the University of Virginia over a period of 40 years. They found "that math SAT scores are the best predictor of success in the principles course…” (p. 32). The results provide evidence supporting the effectiveness of aptitude testing as a predictive tool when estimating successful performance in economics courses.

The correlation between aptitude tests and economic proficiency is studied, this time using regression analysis, in Schuhmann, McGoldrick and Burrus (2005), who investigate whether quantitative skills measured in terms of mathematics aptitude result in a better understanding and improve knowledge of economic content. Utilizing a pre/post course survey data with multiple choice questions administered to 633 principles of economics students at the University of Richmond during the fall of 2002, the researchers examined whether students with higher math aptitude have a better understanding of basic economics concepts and whether the former led to improved economic learning. Both quantitative skills and economic knowledge were measured based on the correct answers in the math and economics questions students provided before and after taking an introductory economics course. Using Ordinary Least Square (OLS) regression with the dependent variable of economic knowledge and mathematics learning as the independent variable, they show that quantitative
literacy is a significant predictor of economic literacy before and after the course surveys.

The level of mathematics involved in introductory economics courses add to the apprehension that students might have about economics. Benedict and Hoag (2002) were interested in the factors that make students apprehensive about taking an economics course. The researchers administered a survey questionnaire to students asking them whether they were apprehensive about taking an economics course and the reason(s) behind their apprehension. The researchers provided a formal definition of apprehension that guided their study and used a probit model with apprehension as a dependent variable and student characteristics including demographics, math ACT scores, GPA, and year of schooling as the independent variables. The researchers found that “students who come into an economics class with better mathematics skills are less likely to report being apprehensive, and the conditional probability of apprehension falls 1 percentage point with every unit increase in the ACT Math score” (p. 39).

Finally, to provide a broad understanding of the effects of mathematics on introductory economics, I will now pivot my attention towards the importance of or lack thereof of higher-level mathematics courses such as statistics, trigonometry and calculus on introductory economics performance. Unlike the previous studies that focus specifically on the effects of algebra on introductory economics, Bosshardt and Manage (2011) examined the importance of calculus in introductory economics. The
researchers used data of 2,993 freshmen students from fall 2000 to fall 2003 who attended Florida Atlantic University. Employing a matching method that paired students based on similar characteristics and backgrounds with the exception of whether they took calculus or not, along with OLS regression, the authors conclude that calculus is instrumental in student’s performance both in macroeconomics and microeconomics. They also found the impact of calculus on macroeconomics and microeconomics to be similar. Interestingly, these results support those obtained by Anderson, Benjamin and Fuss (1994) that found taking calculus in high school to be one of the most significant contributors to success in first-year economics and in reducing the student's chances of dropping the economics course during the first semester of college. Meanwhile, in another study conducted by Durden and Ellis (1995), the researchers surveyed several sections of the Principles of Microeconomics and Macroeconomics courses to determine the correlation between student absences, GPA, MSAT, VSAT, calculus, etc. and performance in the principles of economics courses. Using OLS regressions where the student’s grade in the principles of economics courses was the dependent variable, the researchers found that taking calculus is positively and significantly correlated to student grades in the principles of economics courses.

In summary, many studies in this literature review show that there is an advantage to students having skills or competence in mathematics prior to taking an economics course. Algebra provides some background and familiarity to work with graphs, which are frequently used throughout economics courses. Additionally,
algebra helps economics students with many other mathematical formulations in economics, such as elasticities of demand and supply, indifference curve analysis, consumer equilibrium, the theory of the firm, the theory of the consumer, the budget equation, exchange rate parity, etc. While the study by Cohn et al. (2004) showed no beneficial use of graphs in introductory economics, it is my belief and experience that the visual representation offered by graphs aid in solidifying economic concepts. As I have repeatedly noted in this literature review, it is important for students to have a strong mathematics foundation before taking introductory economics courses. Furthermore, there is a strong case for the role of mathematics in understanding key analyses such as supply and demand that require a deeper understanding of graphs.

This literature review shows that taking an intermediate algebra course or higher-level mathematics course prior to taking an introductory economics course can provide students with an advantage and a better starting point to begin to learn economics. For students without a strong background in mathematics, particularly at the community college level, intermediate algebra or, better yet, a higher-level mathematics course can give them the skills they need to be better prepared and able to grasp the areas of introductory economics that include mathematical concepts.

In conclusion, lectures with graphs, or higher-level mathematics such as calculus can improve performance in introductory economics, I hypothesize that with everything being equal, for the principles or introductory economics courses taken at the community college level, intermediate algebra and/or higher-level mathematics
provides sufficient mathematics background and aptitude for introductory economics courses.

3.2.5 My contribution to the Literature

My study and the previous studies that have examined the effects of mathematics background on student learning of introductory economics differ in two ways: 1) My study focuses on student learning of introductory economics at the two-year college/community college level as opposed to a four-year college/university, which has been the primary focus of the research thus far. 2) My study includes multiple colleges as opposed to a single college/university, which has also been the norm for research in this area. As a result, my study uses a larger dataset of economics students covering four colleges and more than twenty faculty members and to the best of my knowledge, this makes my study unique.

3.3 Data Sources, Collection and Sample Size

The data for this study consist of all PCCD students records from 2002 – 2014 who took an economics course and received a letter grade. This study includes students who took economics with and without a prior mathematics course, a total of 21,508 student records. Of those student records, 11,005 took an economics course prior to 2009 when the policy to institute intermediate algebra as a pre-requisite for economics was implemented, and 10,503 took an economics course after the policy was implemented. Some students took intermediate algebra before taking an
economics course, while other students did not prior to the policy. I have information for each record on the economics course a student took, the grade earned, and on all mathematics courses taken and grades earned associated with that record. This allows me to link mathematics courses taken with the grades that students receive in their economics course. I focus on whether a student had taken intermediate algebra prior to taking an economics course. Since intermediate algebra is a pre-requisite for a higher-level mathematics course, I treat students who took a higher-level mathematics course without taking intermediate algebra at PCCD as having taken intermediate algebra. This distinction is only applicable prior to the implementation of the policy (i.e., 2002 – 2008). This distinction also allows me to reclassify my sample, allowing me to identify those students who took no mathematics course or only lower-level mathematics course before taking an economics course, those students who took intermediate algebra before taking an economics course, and those students who took a higher-level mathematics course before taking an economics course.

After 2008, the student records indicate that some students took an economics course without having taken intermediate algebra at PCCD. I assume that these students must have fulfilled the mathematics requirement at another college/university other than the four PCCD campuses and obtained a waiver from a counselor to enroll in economics or the student may have taken the mathematics placement test and placed higher than intermediate algebra. I treat these students as having met the mathematics requirement. I also treat the students who did not take intermediate algebra at PCCD but took a higher-level mathematics course after 2008 as having met
the mathematics requirement as well. Table 3.1 below displays the breakdown of my sample among these categories.

Table 3.1 Records of Economics Students based on their Mathematics Coursework at PCCD

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Took no mathematics course or lower-level mathematics:</td>
<td>7,246</td>
<td>N/A</td>
</tr>
<tr>
<td>2. Received a waiver:</td>
<td>N/A</td>
<td>3,232*</td>
</tr>
<tr>
<td>3. Took intermediate algebra:</td>
<td>868</td>
<td>3,231</td>
</tr>
<tr>
<td>4. Took higher-level mathematics12:</td>
<td>2,891</td>
<td>4,040</td>
</tr>
<tr>
<td></td>
<td>11,005</td>
<td>10,503</td>
</tr>
</tbody>
</table>

* The students either took intermediate algebra outside of the PCCD or tested above intermediate algebra in the mathematics placement test.

In summary, for 2002-2008, students in category 1 did not meet the subsequent mathematics requirement, while students in categories 3 and 4 met the mathematics requirement. I treat all students as meeting the mathematics requirement including category 2 for the period 2009-2014.

The dataset for this study is free of the measurement error that might exist if students were surveyed directly about their grades and coursework because the dataset was obtained from the PCCD Office of Institutional Research.

12 Trigonometry, introduction to statistics and pre-calculus are the only courses considered under higher-level mathematics given that these are the three upper-level mathematics courses requiring intermediate algebra as a pre-requisite.
3.4 Methodology and Modeling

I use grades as a measure of student’s performance in mathematics courses. The dependent variable is the grade a student received in his/her economics courses (macroeconomics and microeconomics principles). For statistical analyses, I convert grades to numerical values where A=4, B=3, C=2, D=1, F=0.\(^{13}\)

My main objective is to determine whether the policy of instituting intermediate algebra as a pre-requisite for introductory economics made a difference. To accomplish this, I first compare the performance (average grades) for economics students who took intermediate algebra before taking an economics course (category 3 in Table 3.1) with those who did not (category 1) from 2002 - 2008. Secondly, I compare the performances of students who did not take intermediate algebra prior to taking an economics course between 2002 and 2008 (category 1) with the performance of students who did not take intermediate algebra or a higher-level mathematics course at PCCD before taking an economics course (category 2) in 2009-2014. Since all of the latter group of students must have received a waiver after 2008 to take an economics course, they must have more mathematics background than the students who did not take intermediate algebra in 2002-2008. There are two main hypotheses of this study. First, I analyze whether intermediate algebra enhanced student

\(^{13}\) At the PCCD, economics cannot be taken on a pass/fail basis and no +/- grades were given.
performance in introductory economics. Second, I analyze whether the grade a student receives in intermediate algebra has an impact on his or her grade in economics.

To test these hypotheses, I create seven dummy variables as follow:

- $I_{A_s} = 1$ if student took intermediate algebra at PCCD, $= 0$ otherwise;
- $Waiver_s = 1$ if student did not take intermediate algebra at PCCD between 2009-2014 and received a waiver, $= 0$ otherwise;
- $HM_s = 1$ if student took higher-level mathematics course, $= 0$ otherwise;
- Period 2 $= 1$ if year is 2009-2014, $= 0$ otherwise;
- Berkeley $= 1$ for Berkeley City College, $= 0$ otherwise;
- Alameda $= 1$ for College of Alameda, $= 0$ otherwise;
- Laney $= 1$ for Laney College, $= 0$ otherwise.

The first hypothesis is tested by estimating the following regression model using Ordinary Least Squares (OLS):

$$Y_{st} = \alpha + \beta_1 I_{A_{st}} + \beta_2 Waiver_{st} + \beta_3 HM_{st} + \beta_4 Period2_{st} + \beta_5 Berkeley_{st} + \beta_6 Alameda_{st} + \beta_7 Laney_{st} + \varepsilon_{st} \quad (1)$$

In (1), $s =$ a given student, $t =$ year, $Y$ is the grade the student received in economics (i.e., the numerical equivalent of A, B, C, D, or F), $\alpha$ is the constant term, and all variables are as previously defined. $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7$ are the coefficients of interest, and $\varepsilon$ is a random error term.

To test whether the grade a student receives in intermediate algebra and higher-level mathematics course has an impact on his or her grade in economics (i.e.,
my second hypothesis), I estimate the following regression model using Ordinary Least Squares (OLS):

\[ Y_{st} = \alpha + \beta_1 I_{A_{st}} + \beta_2 I_{A_{st}} \times Grade_{st} + \beta_3 Waiver_{st} + \beta_4 H_{M_{st}} + \beta_5 H_{M_{st}} \times Grade_{st} + \beta_6 Period2_{st} + \beta_7 Berkeley_{st} + \beta_8 Alameda_{st} + \beta_9 Lane_{st} + \epsilon_{st} \]  

(2)

Here, \( I_{A} \times Grade \), and \( H_{M} \times Grade \) are the grades the student received in intermediate algebra and higher-level mathematics course, respectively (i.e., the numerical equivalent of A, B, C, D, or F).

Last, I examine whether the impact of intermediate algebra and higher-level mathematics and their respective grades on student’s performance in introductory economics vary based on the type of economics course (i.e., macroeconomics vs. microeconomics). To accomplish this, I estimate the above regression equation (2) separately for macroeconomics and microeconomics.

3.5 Results

The following sections present the results of the model estimations.

3.5.1 The Effects of Intermediate Algebra on Student Grades in Economics, 2002-2008

Table 3.2 compares the grades of economics students who took intermediate algebra before taking an economics course with those who did not from 2002-2008. The reason for comparing these two groups is to determine if the groups were different prior to the policy change in 2008. If intermediate algebra helps students learn introductory economics better, then it is reasonable to expect that students who take
intermediate algebra before taking an introductory economics course will perform better in the economics course compared to those who take an introductory economics course without first taking intermediate algebra.

As shown in Table 3.2, prior to the policy change in 2008, 94.0 percent of economics students who took intermediate algebra prior to taking an economics course received a “D” grade or higher compared to 90.1 percent of economics students who did not take intermediate algebra. These results are consistent with many of the studies cited in the literature review section that show that mathematics background is relevant in the study of introductory economics. The result is statistically significant at the 0.01 confidence level, as demonstrated by the t-statistic of 4.31. On the other hand, the results also surprisingly show that a student who took intermediate algebra before taking an economics course was less likely to receive an “A” grade in the economics course, but more likely to receive a “B” or “C” grade in the economics course. 26.9 percent of economics students who took intermediate algebra before taking an economics course received an “A” grade in the economics course compared to 34.6 percent of economics students who did not. The difference is statistically significant at the 0.05 confidence level.

There are two possible explanations for why that might be so: 1) As noted in the literature review section, mathematics background is not the only contributing factor to students’ performances in economics. Other factors, including gender, age, socio-economic background, year of schooling, type of instructor, teaching methods, class size, student effort, employment, seating location, personality, overall GPA, etc.,
are also factors that can contribute to a student’s performance in introductory economics courses; and 2) If a student took intermediate algebra outside of the PCCD during this time period or took the mathematics placement examination (as previously noted), that student will be identified as not having taken intermediate algebra even though that might not be true. Therefore, it is very possible that some of the economics students who took economics without intermediate algebra background from 2002-2008 might have taken intermediate algebra from outside of the PCCD.

Table 3.2  Effect of Intermediate Algebra on Student Economics Performance 2002-2008

<table>
<thead>
<tr>
<th>Grade</th>
<th>No Intermediate Algebra</th>
<th>Intermediate Algebra</th>
<th>Diff.</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent (Percent)</td>
<td>N (N)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>34.6 (0.0095)</td>
<td>2,510 (205)</td>
<td>-0.0774 (0.0324)</td>
<td>2.39*</td>
</tr>
<tr>
<td>B</td>
<td>27.4 (0.0100)</td>
<td>1,985 (310)</td>
<td>0.0691 (0.0288)</td>
<td>2.40*</td>
</tr>
<tr>
<td>C</td>
<td>21.5 (0.0104)</td>
<td>1,555 (243)</td>
<td>0.0464 (0.0300)</td>
<td>1.54</td>
</tr>
<tr>
<td>D</td>
<td>6.6 (0.0114)</td>
<td>478 (58)</td>
<td>-0.0020 (0.0341)</td>
<td>0.06</td>
</tr>
<tr>
<td>F</td>
<td>9.9 (0.0112)</td>
<td>718 (52)</td>
<td>-0.0361 (0.0355)</td>
<td>1.02</td>
</tr>
<tr>
<td>Total</td>
<td>100.0 (6,528)</td>
<td>7,246 (816)</td>
<td>0.0392 (0.0091)</td>
<td>4.31**</td>
</tr>
</tbody>
</table>

Note: Standard errors in Parentheses
* Significant at the 0.05 level (2 tailed)
** Significant at the 0.01 level (2 tailed)

3.5.2 Comparing Performances of Economics Students without Intermediate Algebra 2002-2008 vs. 2009-2014

Table 3.3 compares the grades of economics students who did not take intermediate algebra before taking an economics course in both periods (2002 – 2008...
versus 2009 – 2014). The latter group received a waiver prior to taking an economics course. I expect that this group (i.e., those with waivers) would outperform their counterparts in the earlier period since the waiver students must have taken intermediate algebra or a higher-level mathematics course outside of the PCCD or passed a placement test.

As shown in Table 3.3, economics students from both periods are equally likely to receive an “A” or a “B” grade while those from 2002 – 2008 are slightly less likely to receive a “D” grade compared to those with waivers from 2009 – 2014. An economics student who did not take intermediate algebra prior to taking an economics course from 2002 – 2008 is more likely to receive a “C” grade and less likely to receive an “F” grade compared to a student who received a waiver between 2009 – 2014. Overall, 83.8 percent of economics students who received a waiver prior to taking an economics course from 2009-2014 passed the economics course (i.e., received a “D” grade or higher) compared to 90.1 percent of economics students who did not take intermediate algebra prior to taking an economics course from 2002-2008. This result is significant at the 0.01 confidence level.

At first glance, these results seem counter-intuitive since the 2009-2014 students must have received a waiver to take an economics course. To receive a waiver, a student must show that he or she took intermediate algebra outside of the PCCD or test higher than intermediate algebra in the mathematics placement test. As such, it is reasonable to assume that a student with a waiver would have more mathematics background than a student who did not take intermediate algebra from
2002 – 2008. However, because there is no way of telling whether a student who did not take intermediate algebra prior to taking an economics course from 2002 – 2008 might similarly have taken intermediate algebra outside of the PCCD, it is possible that or at least some of these students might have taken intermediate algebra outside of the PCCD. If this is true, then that might be one possible explanation why economics students without intermediate algebra background from 2002 – 2008 might outperform their counterparts after the policy change was instituted. Additionally, there are many contributing factors that account for students’ success in introductory economics besides intermediate algebra background. Therefore, it is possible, based on the results presented in Table 3.3, that the economics students without intermediate algebra prior to 2008 might exhibit more of the other contributing factors compared to the students with waivers.

Table 3.3 Performance of PCCD Economics Students Without Intermediate Algebra 2002-2008 vs. 2009-2014

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent</td>
<td>N</td>
<td>Percent</td>
<td>N</td>
</tr>
<tr>
<td>A</td>
<td>34.6 (0.0095)</td>
<td>2,510</td>
<td>34.3 (0.0143)</td>
<td>1,107</td>
</tr>
<tr>
<td>B</td>
<td>27.4 (0.0100)</td>
<td>1,985</td>
<td>27.0 (0.0150)</td>
<td>873</td>
</tr>
<tr>
<td>C</td>
<td>21.5 (0.0104)</td>
<td>1,555</td>
<td>15.1 (0.0162)</td>
<td>488</td>
</tr>
<tr>
<td>D</td>
<td>6.6 (0.0114)</td>
<td>478</td>
<td>7.4 (0.0169)</td>
<td>239</td>
</tr>
<tr>
<td>F</td>
<td>9.9 (0.0112)</td>
<td>718</td>
<td>16.2 (0.0161)</td>
<td>525</td>
</tr>
<tr>
<td>Total</td>
<td>100.0 (0.0000)</td>
<td>7,246</td>
<td>100.0 (0.0000)</td>
<td>3,232</td>
</tr>
<tr>
<td>≥ D</td>
<td>90.1 (0.0037)</td>
<td>6,528</td>
<td>83.8 (0.0071)</td>
<td>2,707</td>
</tr>
</tbody>
</table>
The surprising results obtained from tables 3.2 and 3.3 above indicating that economics students without prior intermediate algebra background were more likely to receive an “A” grade in both periods compared to those with prior intermediate algebra background or waivers raises an important question concerning the justification of the policy change: was the policy misguided given that economics students without intermediate algebra prior to taking an economics course were already outperforming their counterparts with prior mathematics background?

3.5.3 Regression Results

The subsequent sections delve deeper into the question raised in the previous section by presenting the OLS estimates of the effects of intermediate algebra and higher-level mathematics background on economics performance in the PCCD. Using Ordinary Least Squares (OLS), I estimate equation (1) presented earlier.

Table 3.4 below presents the OLS results of the effects of both intermediate algebra and higher-level mathematics on student performance in introductory economics courses at the PCCD. The OLS regression included the entire sample.
Table 3.4  OLS Estimates of the Effects of Intermediate Algebra and Higher-Level Mathematics on Economics Performance in the PCCD

<table>
<thead>
<tr>
<th></th>
<th>Coefficients</th>
<th>t-statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>2.715*</td>
<td>73.994</td>
</tr>
<tr>
<td></td>
<td>(0.037)</td>
<td></td>
</tr>
<tr>
<td>IA</td>
<td>-0.151*</td>
<td>-4.741</td>
</tr>
<tr>
<td></td>
<td>(0.032)</td>
<td></td>
</tr>
<tr>
<td>Waiver</td>
<td>-0.035</td>
<td>-0.951</td>
</tr>
<tr>
<td></td>
<td>(0.037)</td>
<td></td>
</tr>
<tr>
<td>HM</td>
<td>0.219*</td>
<td>8.470</td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
<td></td>
</tr>
<tr>
<td>Period 2</td>
<td>-0.115*</td>
<td>-4.437</td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
<td></td>
</tr>
<tr>
<td>Berkeley</td>
<td>-0.042</td>
<td>-1.000</td>
</tr>
<tr>
<td></td>
<td>(0.042)</td>
<td></td>
</tr>
<tr>
<td>Alameda</td>
<td>0.049</td>
<td>1.304</td>
</tr>
<tr>
<td></td>
<td>(0.038)</td>
<td></td>
</tr>
<tr>
<td>Laney</td>
<td>-0.050</td>
<td>-1.327</td>
</tr>
<tr>
<td></td>
<td>(0.038)</td>
<td></td>
</tr>
<tr>
<td>Sample size</td>
<td>21,508</td>
<td></td>
</tr>
<tr>
<td>Adjusted R-square</td>
<td>0.015</td>
<td></td>
</tr>
<tr>
<td>ANOVA F-statistic</td>
<td>48.881*</td>
<td></td>
</tr>
</tbody>
</table>

Note: Standard errors in Parentheses
*p<0.01; **p<0.05

Based on Table 3.4, I find that the grade a student receives in his or her introductory economics course is negatively related to having taken intermediate algebra at PCCD, having received a waiver, and if the student took economics in period 2. An economics student who took intermediate algebra before taking an economics course had a grade average that was 0.151 points lower than that of an economics student without prior intermediate algebra. Likewise, an economics student with a waiver or who took economics in period 2 had a grade average that was 0.035 and 0.115 points lower respectively compared to their counterparts. As such, the above results seem to contradict what one would expect. Moreover, the results for
intermediate algebra and period 2 are statistically significant at the 0.05 confidence level although quantitatively very small. The result for waiver is quantitatively small (-0.035) and not statistically significant.

Given the contradictory or counter-intuitive results for intermediate algebra, it is important to explain why students without prior intermediate algebra might perform higher in introductory economics compared to those with prior intermediate algebra background. I suspect there are two plausible explanations: 1) It is possible that the students who took intermediate algebra prior to taking an introductory economics course were the weakest students. In other words, these students might not have taken intermediate algebra in high school and as such they may not have had the proper foundation or preparation for college-level intermediate algebra; and 2) It is also possible that the intermediate algebra courses offered at the PCCD are inadequate in providing these students the proper mathematics background to overcome their quantitative weaknesses. As a result, these students are incapable of handling the mathematics in introductory economics courses.

On the other hand, taking a higher-level mathematics course prior to taking an introductory economics course has a positive effect on the grade received in introductory economics. An economics student who took higher-level mathematics before taking an economics course had a grade average that was 0.219 points higher than that of an economics student without prior higher-level mathematics course. The result of higher-level mathematics is statistically significant at the 0.01 confidence
level and quantitatively larger in absolute size (0.219) compared to the negative quantitative effects of intermediate algebra, waiver and period 2. What these results taken together suggest is not that mathematics background does not help students learn introductory economics, but rather that the level of mathematics background matters. In short, the results seem to suggest that higher-level mathematics background is more important in the learning and understanding of introductory economics at the community college level than intermediate algebra.

Finally, since Merritt College was the omitted college dummy variable, the results also demonstrate that students who take an introductory economics course at Berkeley City College and Laney College on average perform below those students who take an introductory economics course at Merritt College. Students who take an introductory economics course at the College of Alameda on average do better than their counterparts at Merritt College. However, none of these results are statistically significant either at the 0.05 or 0.01 confidence level.

The adjusted R-square of 0.015 tells us that the model (i.e., the independent variables) accounts for only 1.5 percent of students’ performance in introductory economics courses as measured by the student’s grade in economics, which is very low. However, the regression F-statistic of 48.881 is significant at the 0.01 confidence level. The significance of the F-statistic suggests that there is strong evidence that the model has explanatory power of predicting a student’s performance in introductory
economics courses. In other words, the specified model fits the data well even though it only explains 1.5 percent variations in students’ grades in introductory economics.

3.5.4 Analyzing the Effects of Cumulative Units and Cumulative GPA on Performances of Economics Students

Because many factors contribute to student success in introductory economics and given the low adjusted R-square of the above model, I decided to augment the model by including two additional variables: cumulative units taken and cumulative GPA. The cumulative units and GPA variables are measured as of the semester the student took his or her economics course. Table 3.5 presents descriptive statistics of these variables. When the PCCD changed its academic records database to PeopleSoft in 2007, some of the prior student record data were not transferred into the new system, creating substantial missing data in the database. As a result, the data for cumulative units and cumulative GPA is from 2008 – 2014 only, which includes one year from the first time period (i.e., 2008 – 2009) and the entire second time period (i.e., 2009 – 2014). This reduces the sample size from 21,508 to 11,659. Additionally, the sample size was further reduced to 11,384 since there were a total of 275 first semester students (i.e., students with cumulative units of zero). The descriptive statistics in table 3.5 were obtained using SPSS and the means were calculated excluding the first semester students since these students do not yet have a PCCD.

14 Cumulative units stand for the number of credit units a student has completed at the PCCD.
GPA. To do this, first, I select only those cases of cumulative units greater than zero in order to exclude the first semester students. However, with respect to cumulative GPA, it is possible that a student with cumulative units greater than zero could have a cumulative GPA of zero if the student received an “F” grade in all of his or her courses. Therefore, the students with cumulative GPA of zero that are not first semester students are not excluded from calculating the mean for cumulative GPA in table 3.5. Given that a full-time student takes between 12-15 units of coursework a semester, which translate to 24-30 units a year, the mean cumulative units of 32.31 units implies that a typical average student will be a sophomore and with a slightly above “C” grade (i.e., GPA of 2.107). Also, it is important to note that at two-year colleges, most students do not exceed 60 cumulative units and this is the case at the PCCD where 83 percent of all students had 1-60 cumulative units, and 94 percent had less than 80 cumulative units. A very small percentage of the students accumulated more than 90 units.15

15 Students who took more than 90 units are likely students who took more courses in departments such as Mathematics, Physics, Chemistry, and English where most courses offered are 4-5 units as opposed to the standard 3 units courses. This could also be students who attend the PCCD without the intention of transferring to a four-year college/university and in turn end up taking a larger course load at the community college level, as well as students who transfer to a four-year college/university but return to take classes at the PCCD simply because those courses may be cheaper compared to a four-year college/university.
The new regression model is similar to the previous model reported above with one exception – it includes the cumulative units and cumulative GPA variables.

Because both cumulative units and cumulative GPA capture several characteristics of a student, particularly effort and ability, respectively, I hypothesize that the effects of both of these variables on students’ performance in introductory economics will be positive, everything being equal. The new regression model is as follows:

\[
Y_{st} = \alpha + \beta_1 I_{A_{st}} + \beta_2 Waiver_{st} + \beta_3 H_{M_{st}} + \beta_4 Period2_{st} + \beta_5 Berkeley_{st} + \beta_6 Alameda_{st} + \beta_7 LANEY_{st} + \beta_8 CumulativeUnits_{st} + \beta_9 CumulativeGPA_{st} + \varepsilon_{st}
\]

All variables are as previously defined.

Table 3.6 presents the OLS results of the effects of intermediate algebra and higher-level mathematics on economics performance when cumulative units and cumulative GPA are included in the model.

<table>
<thead>
<tr>
<th></th>
<th>Coefficients</th>
<th>t-statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.272*</td>
<td>20.835</td>
</tr>
<tr>
<td></td>
<td>(0.061)</td>
<td></td>
</tr>
<tr>
<td>IA</td>
<td>-0.141**</td>
<td>-2.080</td>
</tr>
<tr>
<td></td>
<td>(0.068)</td>
<td></td>
</tr>
<tr>
<td>Waiver</td>
<td>0.145**</td>
<td>2.072</td>
</tr>
<tr>
<td></td>
<td>(0.070)</td>
<td></td>
</tr>
<tr>
<td>HM</td>
<td>0.184*</td>
<td>2.808</td>
</tr>
<tr>
<td></td>
<td>(0.066)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coefficients</td>
<td>t-statistics</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Period 2</td>
<td>-0.163*</td>
<td>-2.937</td>
</tr>
<tr>
<td></td>
<td>(0.056)</td>
<td></td>
</tr>
<tr>
<td>Berkeley</td>
<td>-0.319*</td>
<td>-6.710</td>
</tr>
<tr>
<td></td>
<td>(0.048)</td>
<td></td>
</tr>
<tr>
<td>Alameda</td>
<td>-0.115*</td>
<td>-2.568</td>
</tr>
<tr>
<td></td>
<td>(0.045)</td>
<td></td>
</tr>
<tr>
<td>Laney</td>
<td>-0.197*</td>
<td>-4.384</td>
</tr>
<tr>
<td></td>
<td>(0.045)</td>
<td></td>
</tr>
<tr>
<td>Cumulative units</td>
<td>0.006*</td>
<td>13.739</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td></td>
</tr>
<tr>
<td>Cumulative GPA</td>
<td>0.704*</td>
<td>68.266</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td></td>
</tr>
<tr>
<td>Sample size</td>
<td>11,383</td>
<td></td>
</tr>
<tr>
<td>Adjusted R-square</td>
<td>0.317</td>
<td></td>
</tr>
<tr>
<td>ANOVA F-statistic</td>
<td>588.464*</td>
<td></td>
</tr>
</tbody>
</table>

Note: Standard errors in Parentheses
*p<0.01; **p<0.05

As the above results show, once again, intermediate algebra and period 2 are negatively related with students’ performance in introductory economics. An economics student who took intermediate algebra before taking an economics course had a grade average that was 0.141 points lower than that of an economics student without prior intermediate algebra. For period 2, the student’s grade average is 0.163 points lower. The negative effects of both intermediate algebra and period 2 on introductory economics are quantitatively small and are statistically significant at the 0.05 and 0.01 confidence level respectively. When the model is expanded to include both cumulative units and cumulative GPA, the effect of waiver is reversed from negative to positive and it is statistically significant at the 0.05 confidence level.
On the other hand, the effects of higher-level mathematics course did not change – it remains positive and statistically significant at the 0.01 confidence level. The quantitative effect of higher-level mathematics is larger in size (0.184) compared to that of intermediate algebra, waiver and period 2. Taken together, these results once again suggest not that mathematics background does not help students learn introductory economics, but rather that the level of mathematics background matters. Moreover, the results suggest that higher-level mathematics background is more important in the learning and understanding of introductory economics at the community college level than intermediate algebra. Interestingly, these results confirm similar findings by Hoag and Benedict (2010) that suggest that the effect of higher-level mathematics on introductory economics was statistically significant and more likely to result in either an “A” or “B” grade in the introductory economics course.

Cumulative units and cumulative GPA are also both positively related to students’ performance in introductory economics and both results are statistically significant at the 0.01 confidence level. A student with a cumulative GPA 1 point higher, earned on average, a grade in introductory economics that is about 0.704 points higher. This implies that a student with a cumulative GPA of 1.42 points higher earned on average a grade in introductory economics that is 1 point higher (i.e., an equivalent of a letter grade higher).

A similar interpretation is provided for cumulative units. A student with 1 additional cumulative unit earned, on average, a grade in introductory economics that is about 0.006 points higher. This implies that a student with 12 additional cumulative
units, which is equivalent to a semester of full-time coursework, earned on average, a
grade in introductory economics that is about 0.072 points higher, everything being
equal.

Finally, the adjusted R-square of the expanded model is greatly improved from
0.015 for the reduced model to 0.317 for the expanded model. The F-statistic of
588.464 is significant at the 0.01 confidence level. The significance of the F-statistic
suggests that there is strong evidence that the model has explanatory power of
predicting a student’s performance in introductory economics courses.

3.5.5 The Effects of Intermediate Algebra and Higher-Level Mathematics
Grades on Student Performance in Introductory Economics

To test whether the grade a student receives in intermediate algebra and
higher-level mathematics has an impact on his or her grade in economics, I estimate
the following regression model twice--one without cumulative units and cumulative
GPA (i.e., full sample) and the second with cumulative units and cumulative GPA
(i.e., reduced sample--using Ordinary Least Squares (OLS):

\[ Y_{st} = \alpha + \beta_1 IA_{st} + \beta_2 IA_{st} \times \text{Grade}_{st} + \beta_3 \text{Waiver}_{st} + \beta_4 \text{HM}_{st} + \beta_5 \text{HM}_{st} \times \text{Grade}_{st} + \\
\beta_6 \text{Period}_{2 st} + \beta_7 \text{Berkeley}_{st} + \beta_8 \text{Alameda}_{st} + \beta_9 \text{Laney}_{st} + \beta_{10} \text{CumulativeUnits}_{st} + \\
\beta_{11} \text{CumulativeGPA}_{st} + \epsilon_{st} \]

To obtain the grade for higher-level mathematics (HM), I computed the
average grade a student received in their trigonometry, introduction to statistics and
pre-calculus courses. Table 3.7 shows the OLS regression results of the effects of intermediate algebra grade and higher-level mathematics grade on economics grade.

Table 3.7  OLS Estimates of the Effects of Intermediate Algebra and Higher-Level Mathematics Grade on Economics

<table>
<thead>
<tr>
<th></th>
<th>Full Sample</th>
<th></th>
<th>Reduced Sample</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficients</td>
<td>t-statistics</td>
<td>Coefficients</td>
<td>t-statistics</td>
</tr>
<tr>
<td>Constant</td>
<td>2.758*</td>
<td>77.501</td>
<td>1.444*</td>
<td>23.688</td>
</tr>
<tr>
<td></td>
<td>(0.036)</td>
<td></td>
<td>(0.061)</td>
<td></td>
</tr>
<tr>
<td>IA</td>
<td>-1.261*</td>
<td>-20.128</td>
<td>-0.754*</td>
<td>-8.844</td>
</tr>
<tr>
<td></td>
<td>(0.063)</td>
<td></td>
<td>(0.085)</td>
<td></td>
</tr>
<tr>
<td>IA Grade</td>
<td>0.377*</td>
<td>20.550</td>
<td>0.204*</td>
<td>11.726</td>
</tr>
<tr>
<td></td>
<td>(0.018)</td>
<td></td>
<td>(0.017)</td>
<td></td>
</tr>
<tr>
<td>Waiver</td>
<td>-0.016</td>
<td>-0.443</td>
<td>0.131**</td>
<td>1.909</td>
</tr>
<tr>
<td></td>
<td>(0.036)</td>
<td></td>
<td>(0.069)</td>
<td></td>
</tr>
<tr>
<td>HM</td>
<td>-1.072*</td>
<td>-22.008</td>
<td>-0.467*</td>
<td>-5.900</td>
</tr>
<tr>
<td></td>
<td>(0.049)</td>
<td></td>
<td>(0.079)</td>
<td></td>
</tr>
<tr>
<td>HM Avg. Grade</td>
<td>0.421*</td>
<td>31.017</td>
<td>0.210*</td>
<td>14.133</td>
</tr>
<tr>
<td></td>
<td>(0.014)</td>
<td></td>
<td>(0.015)</td>
<td></td>
</tr>
<tr>
<td>Period 2</td>
<td>-0.134*</td>
<td>-5.353</td>
<td>-0.149*</td>
<td>-2.721</td>
</tr>
<tr>
<td></td>
<td>(0.025)</td>
<td></td>
<td>(0.055)</td>
<td></td>
</tr>
<tr>
<td>Berkeley</td>
<td>-0.093**</td>
<td>-2.310</td>
<td>-0.369*</td>
<td>-7.862</td>
</tr>
<tr>
<td></td>
<td>(0.040)</td>
<td></td>
<td>(0.047)</td>
<td></td>
</tr>
<tr>
<td>Alameda</td>
<td>0.016</td>
<td>0.436</td>
<td>-0.156*</td>
<td>-3.537</td>
</tr>
<tr>
<td></td>
<td>(0.037)</td>
<td></td>
<td>(0.044)</td>
<td></td>
</tr>
<tr>
<td>Laney</td>
<td>-0.105*</td>
<td>-2.874</td>
<td>-0.251*</td>
<td>-5.670</td>
</tr>
<tr>
<td></td>
<td>(0.036)</td>
<td></td>
<td>(0.044)</td>
<td></td>
</tr>
<tr>
<td>Cumulative units</td>
<td></td>
<td></td>
<td>0.005*</td>
<td>11.787</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.000)</td>
<td></td>
</tr>
<tr>
<td>Cumulative GPA</td>
<td></td>
<td></td>
<td>0.653*</td>
<td>61.811</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.011)</td>
<td></td>
</tr>
<tr>
<td>Sample size</td>
<td>21,508</td>
<td></td>
<td>11,383</td>
<td></td>
</tr>
<tr>
<td>Adjusted R-square</td>
<td>0.075</td>
<td></td>
<td>0.336</td>
<td></td>
</tr>
<tr>
<td>ANOVA F-statistic</td>
<td>194.079*</td>
<td></td>
<td>524.468*</td>
<td></td>
</tr>
</tbody>
</table>

Note: Standard errors in Parentheses
*p<0.01; **p<0.05
According to the above results, simply taking intermediate algebra and/or a higher-level mathematics course may not matter when it comes to students’ performance in introductory economics courses, but the grade that the student receives in these courses does matter. This is true for both samples – the full sample and the reduced sample. For example, the effects of the grade a student receives in intermediate algebra on his or her grade in economics is estimated as follow: \(-1.261 + 0.377 \times \text{IA Grade}\) for the full sample and \(-0.754 + 0.204 \times \text{IA Grade}\) for the reduced sample respectively. Thus, if a student receives an “A” grade in intermediate algebra, his or her grade in introductory economics will be higher by 0.247 points (i.e., \(-1.261 + 0.377 \times 4\)) for the full sample and 0.062 points (i.e., \(-0.754 + 0.204 \times 4\)) higher for the reduced sample. For all other grades below an “A” grade in intermediate algebra, the effects on the student’s grade in introductory economics will be negative for both samples. These results are statistically significant at the 0.01 confidence level.

For higher-level mathematics, the results are similar but slightly stronger compared to that of intermediate algebra. For example, the effects of the grade a student receives in his or her course of higher-level mathematics on his or her grade in economics is estimated as follow: \(-1.072 + 0.421 \times \text{HM Grade}\) for the full sample and \(-0.467 + 0.210 \times \text{HM Grade}\) for the reduced sample. Thus, if a student receives an “A” grade in a higher-level mathematics course, his or her grade in introductory economics will be higher by 0.612 points (i.e., \(-1.072 + 0.421 \times 4\)) for the full sample and 0.373 points (i.e., \(-0.467 + 0.210 \times 4\)) higher for the reduced sample. For a student with a “B” grade in a higher-level mathematics course, his or her grade in introductory economics
economics will be higher by 0.191 points (i.e., -1.072 + 0.421*3) for the full sample and 0.163 points (i.e., -0.467 + 0.210*3) higher for the reduced sample. For all other grades below a “B” in a higher-level mathematics course, the effects on the student’s grade in introductory economics will be negative for both samples. These results are statistically significant at the 0.01 confidence level. It is worth noting that the marginal effects for both intermediate algebra and higher-level mathematics is greater for the full sample compared to the reduced sample.

Receiving a waiver, cumulative units and cumulative GPA all have a positive effect on a student’s performance in introductory economics course and are significant at the 0.05 and 0.01 confidence level respectively. With respect to cumulative units, a student with an additional 12 cumulative units, which is equivalent to a semester of coursework, earned on average, a grade in introductory economics that is about 0.06 points higher (.005*12). For cumulative GPA, the results can be interpreted similarly. A student with a cumulative GPA that is higher by 1 point, earned, on average, a grade in introductory economics that is about 0.653 points higher, when I control for a student’s grades in both intermediate algebra and higher-level mathematics. This implies that a student with a cumulative GPA that is higher by 1.53 points, earned on average, a grade in introductory economics that is 1 point higher (i.e., an equivalent of a letter grade higher). With respect to the full sample, receiving a waiver has a negative effect on student’s performance in introductory economics course. However, this result is not statistically significant.
Taking an introductory economics course in period 2 has a negative effect on a student’s performance in the course and is significant at the 0.01 confidence level for both samples. For the full sample, students who take an introductory economics course at Berkeley City College and Laney College on average perform below those students who take an introductory economics course at Merritt College and the results are statistically significant at the 0.05 and 0.01 confidence level respectively. Students from the College of Alameda perform higher than those from Merritt College although the result is not statistically significant. Meanwhile, for the reduced sample, students who take an introductory economics course at Berkeley City College, College of Alameda and Laney College on average perform below those students who take an introductory economics course at Merritt College and the results are statistically significant at the 0.01 confidence level.

The fact that the regression F-statistic is significant for both samples means that there is strong evidence that the independent variables (i.e., taking intermediate algebra, intermediate algebra grade, waiver, higher level mathematics course, higher-level mathematics course grade, cumulative units, and cumulative grade) do have explanatory power is predicting a student’s grade in introductory economics course. The adjusted R-square of 0.075 for the full sample and 0.336 for the reduced sample means that 7.5% for the full sample and 33.6% for the reduced sample of the variation in students’ grades in introductory economics course can be explained by either model respectively.
3.5.6 The Effects of Intermediate Algebra and Higher-Level Mathematics on Macroeconomics vs. Microeconomics

Finally, I examine whether the impact of intermediate algebra and higher-level mathematics and their respective grades on student’s performance in introductory economics vary based on the type of economics course. To do so, I estimate the following regression equation for macroeconomics and microeconomics.

\[ Y_{st} = \alpha + \beta_1 I_{A_{st}} + \beta_2 I_{A_{st}} \times \text{Grade}_{st} + \beta_3 \text{Waiver}_{st} + \beta_4 \text{HM}_{st} + \beta_5 \text{HM}_{st} \times \text{Grade}_{st} + \beta_6 \text{Period2}_{st} + \beta_7 \text{Berkeley}_{st} + \beta_8 \text{Alameda}_{st} + \beta_9 \text{Lane}y_{st} + \varepsilon_{st} \]

All the variables are as previously defined.

Before going further, I will like to shed additional light in terms of what the literature has to offer concerning the effects of mathematics background on macroeconomics vs. microeconomics as well as from my own personal experience. The evidence from the literature shows that mathematics background has more of an effect on microeconomics compared to macroeconomics. This is consistent with my own personal experiences having taught both courses for more than twenty-four years. The nature of the topics covered in microeconomics (i.e., elasticities of demand and supply, utility maximization, profit maximization, etc.) invariably involves more mathematics than macroeconomics at the undergraduate level. Therefore, I hypothesize that the effects of mathematics background on student’s performance in introductory economics will be higher for microeconomics compared to macroeconomics.
Table 3.8 presents the OLS regression estimates for the effects of intermediate algebra, higher-level mathematics course and grades on macroeconomics vs. microeconomics. Because cumulative units and cumulative GPA are excluded from the model, the sample size is expanded to include the entire sample.

Table 3.8  OLS Estimates of the Effects of Intermediate Algebra Grade and Higher-level mathematics course Grade on Type of Economics Course (2002 – 2014)

<table>
<thead>
<tr>
<th></th>
<th>Macroeconomics</th>
<th>Microeconomics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>2.473*</td>
<td>3.217*</td>
</tr>
<tr>
<td></td>
<td>(0.046)</td>
<td>(0.056)</td>
</tr>
<tr>
<td>IA</td>
<td>-1.432*</td>
<td>-1.058*</td>
</tr>
<tr>
<td></td>
<td>(0.086)</td>
<td>(0.091)</td>
</tr>
<tr>
<td>IA Grade</td>
<td>0.431*</td>
<td>0.310*</td>
</tr>
<tr>
<td></td>
<td>(0.025)</td>
<td>(0.026)</td>
</tr>
<tr>
<td>Waiver</td>
<td>-0.078</td>
<td>0.027</td>
</tr>
<tr>
<td></td>
<td>(0.050)</td>
<td>(0.051)</td>
</tr>
<tr>
<td>HM</td>
<td>-1.042*</td>
<td>-1.134*</td>
</tr>
<tr>
<td></td>
<td>(0.067)</td>
<td>(0.070)</td>
</tr>
<tr>
<td>HM Grade</td>
<td>0.422*</td>
<td>0.425*</td>
</tr>
<tr>
<td></td>
<td>(0.019)</td>
<td>(0.019)</td>
</tr>
<tr>
<td>Period2</td>
<td>-0.126*</td>
<td>-0.153*</td>
</tr>
<tr>
<td></td>
<td>(0.035)</td>
<td>(0.035)</td>
</tr>
<tr>
<td>Berkeley</td>
<td>0.146*</td>
<td>-0.485*</td>
</tr>
<tr>
<td></td>
<td>(0.054)</td>
<td>(0.061)</td>
</tr>
<tr>
<td>Alameda</td>
<td>0.281*</td>
<td>-0.401*</td>
</tr>
<tr>
<td></td>
<td>(0.048)</td>
<td>(0.056)</td>
</tr>
<tr>
<td>Laney</td>
<td>0.194*</td>
<td>-0.565*</td>
</tr>
<tr>
<td></td>
<td>(0.048)</td>
<td>(0.056)</td>
</tr>
<tr>
<td>Sample size</td>
<td>11,949</td>
<td>9,559</td>
</tr>
<tr>
<td>Adjusted R-square</td>
<td>0.080</td>
<td>0.079</td>
</tr>
<tr>
<td>ANOVA F-statistic</td>
<td>116.637*</td>
<td>92.382*</td>
</tr>
</tbody>
</table>

Note: Standard errors in Parentheses  
*p<0.01; **p<0.05

The above results show that the grade a student receives from his or her intermediate algebra course and/or higher-level mathematics course is positively and
significantly correlated to his or her grade in macroeconomics and microeconomics respectively. However, the marginal effects of the student’s grade in intermediate algebra has a greater impact on macroeconomics (0.431) compared to (0.310) for microeconomics. These results are consistent with McCarty et al. (2006, p. 4) that found that “When the sample was divided into micro and macro, the macro students’ improvement averaged 0.7 points higher than for those in micro.” The results also contradict most of the literature as well as my personal experiences for over twenty-four years that predict that the effects of mathematics background specifically intermediate algebra is greater for microeconomics compared to macroeconomics.

On the other hand, with respect to higher-level mathematics course, an economics student who took a higher-level mathematics course before taking a microeconomics course had a grade average that was 0.425 points higher compared to a grade average that was 0.422 points higher for macroeconomics. These results are statistically significant at the 0.01 confidence level as well as consistent with most of the literature and my personal experiences. In short, the results for higher-level mathematics are what I would have predicted. In other words, holding everything else constant, a one point (one letter grade) increase in a student’s grade in higher-level mathematics, increases the student’s grade in microeconomics by 0.425 points compared to 0.422 points for macroeconomics.

Interestingly, when the impact of intermediate algebra and higher-level mathematics on macroeconomics and microeconomics are compared, a different story emerges in the sense that the impact (i.e., the marginal effect) of the grade a student
receives in intermediate algebra is higher than that of higher-level mathematics for macroeconomics. In other words, intermediate algebra helps students learn macroeconomics more so than higher-level mathematics. For macroeconomics, the marginal effect of intermediate algebra grade is 0.431 compared to 0.422 for higher-level mathematics grade. However, when it comes to microeconomics, the reverse is true. In other words, higher-level mathematics helps students learn microeconomics more so than intermediate algebra. For microeconomics, the marginal effect of higher-level mathematics grade is 0.425 compared to 0.310 for intermediate algebra grade.

The results show that receiving a waiver is negatively correlated with taking macroeconomics and positively correlated with taking microeconomics. The marginal effect of waiver on microeconomics although not statistically significant and relatively small (0.027), is positive compared to -0.078 for macroeconomics. Taken together, these results suggest that the majority of the literature and my personal experience are correct in suggesting that a strong mathematics background has a larger effect in microeconomics than macroeconomics. First, a student with higher-level mathematics likely possesses a stronger mathematics background than a student with just intermediate algebra since intermediate algebra is a pre-requisite for higher-level mathematics. Second, receiving a waiver assumes that the students must have at least achieved intermediate algebra. Thus, the above results are not unexpected based on most of the literature as well as my personal experience of over twenty-four years that mathematics background will help students learn microeconomics more so than macroeconomics.
Finally, the significance of the ANOVA F-statistic for both macroeconomics and microeconomics suggest that the model as specified has explanatory power (i.e., the independent variables seem to explain the dependent variable as predicted).

3.6 Data limitations

Because there are no common exams or standardized textbook within the economics department in the PCCD, it is expected that some variation in course content and grading policy would exist among faculty members. One possible solution to control for the potential variation in grade distribution by the different faculty members might be to limit this study to only those economics students taught by one faculty member – preferably, one of the three full-time faculty members. In doing so, the sample size for the study would be greatly reduced as well as render the study less robust. Another possible solution to correct for the grade disparity might involve averaging the student’s grade in economics with their overall grade during the semester that the student took an economics course and using the average grade as a proxy of the student’s grade in economics that semester. Due to the lack of data of student’s overall semester grade, this approach could not be used either. As a result, for this study, I have not controlled for grade comparability.

I further recognize that students’ understanding and/or performance in economics courses may be dependent on a host of factors including gender, age, socio-economic background, the student’s year of schooling, type of instructor, number of
math courses taken by the students, etc. However, for this study, I do not have information that allows me to control for these factors.
Chapter 4

CONCLUSIONS AND RECOMMENDATIONS

My goal in this dissertation was twofold: 1) I analyze survey data of undergraduate students who participated in the College Fed Challenge (CFC) competition and compare the effect on skills (similar to the Hansen proficiencies) to a comparable group of students who did not participate in the competition; 2) Using administrative data of students at the Peralta Community College District (PCCD), I evaluate the effects of mathematics background on students’ grades in introductory economics.

The college-level CFC competition was introduced by the Federal Reserve System (Fed) in 1998 and since its introduction many colleges/universities have participated in the competition. Several studies have focused on the educational benefits and importance of the CFC competition, including a series of symposium articles published in the June 2015 edition of the Eastern Economic Journal. Of these studies, the study by Brusentsev and Miller (2015) provides the foundation for my dissertation. Brusentsev and Miller (2015) documents the educational benefits of the CFC competition and demonstrates how the competition enhances the Hansen competencies in students. However, the absence of a control group was a major weakness of the study as well as all other previous studies on the CFC competition.
The lack of a control group in these previous studies meant these studies could not effectively compare the benefits of participating in the CFC competition with coursework in economics. This deficiency prompted my research on the educational benefits of the CFC competition. Thus, my first aim in this dissertation was to address the weakness in Brusentsev and Miller (2015) as well as expand their study. To accomplish this, I collected data of CFC participants from the New York, Philadelphia and Chicago Fed Districts in 2011 and a control sample primarily of University of Delaware students in 2012, and compared the effects of CFC competition vs. coursework in economics on a set of specific skills that economics majors ideally should have.

The key conclusions of this chapter of my dissertation are as follow: 1) Students who take coursework in economics gain or improve more in all three of the broad categories of skills (namely, research skills, general knowledge and understanding of the economy, and presentation and explanation skills) compared to students who simply participate in the CFC competition; 2) I find no statistical significant evidence that students from public institutions on average benefit more from their participation in the CFC competition than students from private institutions, and that students from larger institutions on average benefit more from their participation in the CFC competition than students from smaller institutions.

A potential reason for the unexpected result that the CFC competition is no better in enhancing its participants’ skills than coursework in economics is because the baseline for the CFC participants is different from that of the control group. The CFC
participants are asked to evaluate their improvements in the twelve competencies based on their participation in one specific activity after having already completed much of their coursework in the economics major compared to the control group basing its evaluation on their exposure to the entire economics curriculum. As such, the results, although unexpected, are not surprising. Because the CFC participants are generally selected from a pool of top students, their baseline skills are already high. Thus, the gains the students attribute to the CFC competition suggest that the competition has an effect over and above what even the best students learn in a typical economics curriculum.

For my second topic, I evaluate the effects of mathematics background, specifically intermediate algebra, on students’ performance in introductory economics courses using administrative data from the PCCD from 2002 to 2014. In 2008, the California State University (CSU) system required California community colleges to implement intermediate algebra as a pre-requisite for introductory economics courses in order for the community colleges to maintain their Articulation Agreements with the CSU system. This policy change led to my second topic. I analyze whether taking intermediate algebra enhanced student performance in introductory economics and whether the grade a student receives in intermediate algebra has an impact on his or her grade in economics. I use regression analyses of the relationship between these different measures of mathematics ability and student grades in introductory economics. I also analyze the impact of mathematics background on macroeconomics vs. microeconomics.
The key findings of my second topic are: 1) Taking Intermediate algebra prior to taking Economics has mixed effects that are more often negative than positive. I find that students who take intermediate algebra before taking an economics course are less likely to fail, or to receive an “A” grade, but more likely to receive either a “B” or a “C” grade; 2) Simply taking intermediate algebra and/or a higher-level mathematics course may not matter when it comes to students’ performance in introductory economics courses, but the grade that the student receives in these courses does matter. For example, receiving below an “A” grade in intermediate algebra or below a “B” grade in higher-level mathematics has a negative effect on the grade a student receives in introductory economics; 3) Intermediate algebra has more of an impact on macroeconomics compared to microeconomics while the reverse is true for higher-level mathematics; 4) Higher-level mathematics background is more important in the learning and understanding of introductory economics courses at the community college level than intermediate algebra.

There are two plausible explanations for the lack of consistently positive effect of intermediate algebra. 1) It is possible that the students who took intermediate algebra prior to taking an introductory economics course were the weakest students. These students did not take intermediate algebra in high school, which suggests that their core mathematical skills were weak. As such, they may not have had the proper foundation or preparation for college-level intermediate algebra or economics; and 2) It is also possible that the intermediate algebra courses offered at the PCCD are inadequate in providing these students the proper mathematics background to
overcome their quantitative weaknesses. As a result, these students are incapable of handling the mathematics in introductory economics courses.

One potential shortcoming of these results has to do with the low adjusted R-square despite having statistically significant F-statistic for the results. The low adjusted R-square may be due to the lack of information on students’ demographic background, their socio-economic background, as well as some of the other known contributing factors that affect students’ performance in introductory economics courses listed by Paden and Moyer (1969) and Kara, Bagheri, and Tolin (2009). Therefore, it is important that any future studies in this area should incorporate as many of these contributing factors to students’ performance in introductory economics as possible.

These results obviously have policy implications, since they clearly demonstrate that higher-level mathematics courses such as trigonometry, introduction to statistics and pre-calculus result in better student success in introductory economics courses at the community college level than intermediate algebra. As a result, economics students at the community college level will be better served if one of these higher-level mathematics courses was established as a pre-requisite for introductory economics instead of intermediate algebra.

4.1 Ideas for future research

I believe that the two topics of my dissertation are interconnected. This interconnection can be shown through a typical education production function which
is an input-output model. Dickey and Houston Jr. (2010) show that such a model can be specified as a linear regression model of the form: $S_1 = bS_0 + f(x) + \varepsilon$; where $S_1$ is posttest score, $S_0$ is pretest score, and $f(x)$ are other factors such as GPA, ACT, SAT, etc. that affect a student’s posttest score performance. As I have demonstrated in this dissertation, a student’s grade in mathematics, specifically intermediate algebra and/or higher-level mathematics, can be a strong predictor of his or her performance in introductory economics courses. Thus, one element in $f(x)$ in the above specification can be a student’s grade in intermediate algebra and/or a higher-level mathematics course.

Secondly, I hypothesize that $S_1$ in the above model specification can be the skills that students gain from participating in the CFC competition or undergraduate curriculum. In essence, the outcomes of an education production function in economics can be measured by a student’s performance in his or her introductory economics course as well as the specific skills that a student acquires from the CFC competition including the student’s job market performance after graduation, etc. The latter point, not surprisingly, is consistent with findings by Lochner (2011) that shows that education can improve a person’s health, raise their earning potential, reduce crime, and make them good citizens.

Third, it is reasonable to assume that having a strong background in intermediate algebra and/or higher-level mathematics before taking an economics course will lead to improve student’s performance in the CFC competition and a strong mathematics background also improves a student’s performance in economics
courses. As Brusentsev and Miller (2011, p. 6) write, “In an important sense, preparation for the competition begins in the introductory courses and culminates in the final presentations. Without a solid background in economic literacy established in the classroom, students will not be able to perform well in the competition.”

Not being able to connect these two topics through an input-output education production function model creates a potential weakness of my dissertation as well as the need for future research in this area. In retrospect, I recommend for future research studies that the survey questionnaires for both the CFC participants and the control group should be amended to include the student’s grade in intermediate algebra, higher-level mathematics courses, and other demographic factors such as gender, etc. Likewise, the data to evaluate students’ performance in introductory economics courses should also be expanded as well to include some of the variables suggested by Paden and Moyer (1969) and Kara, Bagheri, and Tolin (2009). The goal is to link the performance of an economics student in his or her mathematics course (i.e., intermediate algebra and/or higher-level mathematics) to his or her success in the CFC competition as measured by the number of Hansen competencies the student improved on.
REFERENCES


Hart, Peter. "How should Colleges Prepare Students to Succeed in Today's Global Economy?",


Hoag, John and Mary Ellen Benedict. 2010. "What Influence does Mathematics Preparation and Performance have on Performance in First Economics"


Appendix A

COLLEGE FED CHALLENGE SURVEY

Part I:
We would like to know how your participation in the College Fed Challenge (CFC) competition may have contributed to your knowledge and understanding in the field of economic education. Rather than ask questions about specific economic principles, theories and policies, the survey asks you to convey your impression about certain skills and proficiencies you may have acquired while participating in the competition.

The survey is divided into two parts. The first part asks you to respond to general/broad questions which may not necessarily relate directly to your experience in the competition. The aim is to gather information about how your skills and proficiencies may have been affected by your participation in the CFC. The second part asks you to evaluate your CFC experience.

Check the appropriate box:

<table>
<thead>
<tr>
<th>Retrieve, assemble and organize information on particular topics and issues in economics</th>
<th>I mastered this skill before participating in the CFC so my participation in the CFC did not improve this skill</th>
<th>I had not mastered this skill before participating in the CFC but my participation did not improve this skill</th>
<th>The CFC helped to improve this skill a little</th>
<th>The CFC helped to improve this skill to some extent</th>
<th>The CFC helped to improve this skill substantially</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explain key economic concepts and describe how they can be used</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Explain key economic theories and describe how they can be used
| Explain the economic principles in analytical articles published in newspapers and magazines.
| Evaluate the analyses published in newspapers and magazines.
| Understand and interpret data published by government agencies.
| Prepare an organized analysis of a current economic problem.
| Identify and formulate a question or series of questions about economic issues to facilitate an investigation.
| Understand an economic question to stimulate productive discussion of the issues and keep discussion centered on these issues.
| Understand how the economy functions. |
Part II:
This part of the survey asks you to evaluate your Fed Challenge experience.
1. Please check the appropriate box. Given the opportunity costs of the time you spent on the College Fed Challenge it was:

<table>
<thead>
<tr>
<th>Much less valuable than the average economics course</th>
<th>Somewhat less valuable than the average economics course</th>
<th>About the same value as the average economics course</th>
<th>Somewhat more valuable than the average economics course</th>
<th>Much more valuable than the average economics course</th>
<th>More valuable than any economics course I have taken</th>
</tr>
</thead>
</table>

2. How did your CFC experience contribute to your economic education?
3. What is your impression of the CFC experience as it relates to your college experience?
4. Do you think your CFC experience will influence your choice of career? Please explain.
5. Do you think your CFC experience will help with your career? Please explain.
6. Do you think your CFC experience will help you in the non-career aspects of your life? Please explain.
7. What did you learn about monetary policy from participating in the CFC? Please explain.
Appendix B

COLLEGE FED CHALLENGE (CFC) COMPETITION CONTROL GROUP
SURVEY (UNIVERSITY OF DELAWARE)

1) What year of college are you? Freshman:____ Sophomore:____ Junior:____ Senior:____

2) Did you participate in the CFC competition in 2010 or 2011? Yes:____ No:_____

Check the appropriate box:

<table>
<thead>
<tr>
<th>I mastered this skill through my studies / course work at the University of Delaware.</th>
<th>My studies / course work at the University of Delaware helped to improve this skill substantially.</th>
<th>My studies / course work at the University of Delaware helped to improve this skill to some extent.</th>
<th>My studies / course work at the University of Delaware helped to improve this skill a little.</th>
<th>I mastered this skill but not through my studies / course work in economics at the University of Delaware.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrieve, assemble and organize information on particular topics and issues in economics.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain key economic concepts and describe how they can be used.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain key economic theories and describe how they can be used.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain the economic principles in analytical articles</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

132
<table>
<thead>
<tr>
<th>Published in newspapers and magazines.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluate the analyses published in newspapers and magazines.</td>
</tr>
<tr>
<td>Understand and interpret data published by government agencies.</td>
</tr>
<tr>
<td>Prepare an organized analysis of a current economic problem.</td>
</tr>
<tr>
<td>Identify and formulate a question or series of questions about economic issues to facilitate an investigation.</td>
</tr>
<tr>
<td>Understand an economic question to stimulate productive discussion of the issues and keep discussion centered on these issues.</td>
</tr>
<tr>
<td>Understand how the economy functions.</td>
</tr>
<tr>
<td>Make you feel confident in your command of economic theories.</td>
</tr>
<tr>
<td>Make you feel confident in applying economic theories to policy questions</td>
</tr>
</tbody>
</table>
Appendix C

COLLEGE FED CHALLENGE SURVEY 2011 FOR TEAM COACHES

What college are you coaching in the College Fed Challenge competition?

In order to identify a control group for our project we would like to ask you some questions about the team selection process at your school. While we realize that the selection varies from school to school, we hope to gather information that will help us identify a uniform control group across the various College Fed Challenge (CFC) competition teams. In addition, your feedback on the educational value of the CFC competition would be appreciated. Lastly, we would like to know if you would identify past graduates of the CFC competition from your school so that we can administer a survey to them.

1. Please explain the process of selecting the finalists for the CFC competition at your school.

2. Do the finalists take a special course in order to prepare for the CFC competition? Is this a credit course?

3. In your view which students who did not participate in the competition would best represent a comparable group of students to those on your team? (Some ideas that we have considered include: honors students, department of economics award recipients, students in a course on contemporary macroeconomics.)

4) Can you help us survey past graduates of the CFC competition at your school? If so, what would you suggest as the best way to proceed?

5) How would you evaluate the educational value of the CFC? Please explain.

6) (Optional) Which techniques do you consider to be most effective in preparing a team for the CFC competition? Has your CFC coaching experience changed the way you teach other courses?
THE LOGIC MODEL OF THE CFC COMPETITION SELECTION PROCESS AT THE UNIVERSITY OF DELAWARE

Activity: During the spring semester, senior students actively recruit and train lower-level students to be part of the team to be selected in the fall semester.

Activity: During the meeting, students sign in by providing their email addresses and other contact information.

Activity: The faculty mentor sets up an interactive website on socialcast and provides students with information on how to interact with each other and share ideas.

Activity: The final exam is held in which about 30-40 student volunteers attend.

Activity: Those students who do not dropout are randomly assigned to small groups of about 5-10 students.

Activity: Each group prepares for a mock competition by conducting research, analyzing data, making charts, etc.

Activity: The students write a research paper on key econ variables, analyze data, and make presentations in addition to Q&A.

Activity: A panel of judges makes a decision on the team that will compete in the national competition.

Activity: Some students dropout after the initial information meeting.

Activity: Some students dropout after realizing they don't have the time or will.

INPUT
- Facilities
- Economics & Business faculty
- Economics & Business student
- CFC Program

OUTPUT
- 5 students are selected to represent the University of Delaware in the Federal Reserve Bank District CFC competition.
Appendix E

DATE: September 23, 2011

TO: DAVID SIMON
FROM: University of Delaware IRB

STUDY TITLE: [272417-1] Evaluation of the educational value of the College Fed Challenge competition.

SUBMISSION TYPE: New Project

ACTION: DETERMINATION OF EXEMPT STATUS
DECISION DATE: September 23, 2011

REVIEW CATEGORY: Exemption category #1

Thank you for your submission of New Project materials for this research study. The University of Delaware IRB has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will put a copy of this correspondence on file in our office. Please remember to notify us if you make any substantial changes to the project.

If you have any questions, please contact Jody-Lynn Berg at (302) 831-1119 or jlberg@udel.edu. Please include your study title and reference number in all correspondence with this office.