E C O N O M I C S B U L L E T I N

Should Cheat Sheets be Used as Study Aids in Economics Tests?

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Abstract

This paper reports an experiment that investigates the effectiveness of cheat sheets as study aids for economics tests. A cheat sheet is a piece of paper that students can write anything they want on and use during a test. I find that both preparing and using a cheat sheet improves students' test performance. Additionally, there is no evidence that students become over dependent on their cheat sheets for answers.

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1. Introduction

Many economics instructors allow students to use cheat sheets as study aids for economics tests. A cheat sheet is a piece of paper that students can write anything they wish on and use during a test. Nonetheless, the effects of creating and using cheat sheets on students' test performance have not been examined under typical test-taking conditions. This paper reports an experiment that investigates the effects of preparing and using cheat sheets on students' test performance. The results of the experiment can help economics instructors decide whether to allow their students to use cheat sheets.

Participants in the experiment were solicited from four principles economics classes. They took a test that was based on material taught in their class. Roughly a third of the students were allowed to prepare a cheat sheet and use it during the test (Card Use treatment). Another third of the students were asked to prepare a cheat sheet, but were unexpectedly prohibited from using it during the test (Card Removal treatment). The rest of the students were not asked to prepare a cheat sheet (No Card treatment).

Both preparing and using a cheat sheet can potentially affect students' test performance. The *coding hypothesis* states that preparing a cheat sheet is an efficient way to code material for memory. Since students are given a limited space to write on, they must summarize (or code) the material that they are tested on. Studies suggest that coding helps students memorize and understand information (see Wickelgren, 1975 for summary). If the coding hypothesis is correct, then students in the Card Removal (CR) treatment should perform significantly better than students in the No Card (NC) treatment. On the other hand, the *over-dependency hypothesis* states that students who prepare a cheat sheet with the assumption that they will use it during the test become over-dependent on their cheat sheet for answers. Students who can use a cheat sheet may become over-confident and reduce the amount of time that they spend preparing for a test. If the over-dependency hypothesis is correct, then students in the CR treatment should perform significantly worse than students in the NC treatment. A third possibility is that preparing a cheat sheet does not significantly affect students' test performance.

Being able to use a cheat sheet during the exam may also affect students' test performance. The *use hypothesis* implies that students benefit from using a cheat sheet during an exam because it provides them with answers and/or it provides them with information that helps them derive answers. Using a cheat sheet may reduce the need for rote memorization, such as memorizing equations, and allow students to answer more complex analytical questions. Accordingly, students in the Card Use (CU) treatment should perform significantly better than students in the CR treatment. Alternatively, using a cheat sheet on the exam may not significantly improve students' test performance.

Finally, the *combined effect hypothesis* states that preparing a cheat sheet and using a cheat sheet on the exam significantly improves students' test performance, but preparing a cheat sheet or using it alone does not significantly improve students' test performance. Accordingly, students in the CU treatment should perform significantly better than students in the NC treatment. Alternatively, preparing and using a cheat sheet may not significantly affect students' test performance.

There are several reasons why instructors may allow students to use cheat sheets. First, some instructors may want to help their students organize and study the material. If the coding hypothesis is correct, then cheat sheets help students prepare for exams. Secondly, some instructors may wish to test students on their ability to analyze rather than memorize

information. If the use hypothesis is true for a test that is composed of analytical questions (defined as questions that require reasoning to solve, not just memorization), then allowing students to use cheat sheets may be reducing their need for rote memorization and improving their ability to analyze information. On the other hand, most instructors do not want to see their students become over-dependent on their cheat sheet for answers. If the over-dependency hypothesis is correct, then allowing students to use cheat sheets may reduce the effectiveness of their preparation. Finally, if the combined effect hypothesis is true, then students must be permitted to both prepare and use cheat sheets in order to benefit from them.

To the best of my knowledge there was only one experiment that investigated the effects of cheat sheets on students' test performance. Dorsel and Cundiff (1979) find that students who prepared a cheat sheet for a psychology test but were unexpectedly prohibited from using it did worse than students who prepared and used a cheat sheet, who did not prepare a cheat sheet, or who prepared a cheat sheet with the knowledge that they will not use it on the test. The average score of the students in the other three treatments was roughly the same. The results of Dorsel and Cundiff's, hereinafter DC, experiment lend strong support to the over-dependency hypothesis, but do not support the coding, use, or combined effect hypotheses.

DC, however, designed their experiment in a way that promoted dependency on cheat sheets. DC only gave participants 10 minutes to study a 434-word prose passage. They instructed participants to select key letters from words in the passage instead of allowing students to decide what to write on their cheat sheet. Additionally, DC did not give participants any external incentives to do well on the test. Given the short amount of time that students had to prepare their cheat sheet, the fact that they had to prepare their sheet in a way that promoted dependency, and the lack of incentives to do well on the test, it is not surprising that students became overly-dependent on their cheat sheet. Moreover, DC's experiment may not apply to economics. Unlike psychology students, economics students usually need to learn equations and graphs and answer more analytical questions.

This experiment investigates the effectiveness of cheat sheets as study aids under typical test-taking conditions in post-secondary economics classes. Students who participated in the experiment were given 10 days to prepare for an exam that was based on material covered in their class. Additionally, participants were awarded bonus points based on their score relative to other participants in their treatment in order to provide an incentive for them to work hard

The results of this experiment support the combined effect hypothesis, but do not lend strong support to the coding hypothesis or the use hypothesis. Moreover, in contrast to DC's experiment, I find that students do not become over-dependent on their cheat sheet. I also find, via a survey, that most students consider using a cheat sheet helpful. Nonetheless, most of them report favoring open-book tests over using cheat sheets. The final section of this paper discusses the advantages that cheat sheets have over open-book tests.

2. Experimental Procedures and Design

Subjects were undergraduate students from the University of Hawaii. They were solicited from two principles microeconomics classes (hereinafter, Micro 1 and Micro 2) and two principles macroeconomics classes (Macro 1 and Macro 2). The experiment took place on the weekend, outside of class, and participation was strictly voluntary. Students were informed that if they chose to participate in the experiment they would take a test that was based on material covered in their class. Participants were promised bonus points worth up to 5% of their class grade. Students automatically received 1.5% of their class grade in bonus points for participating in the experiment and up to 3.5% in additional bonus points based on their test score relative to other participants in their treatment.[1]

Initially, students in each class were randomly divided into two groups. Roughly two thirds of the students were told that they can write anything they want on a 3.5 by 5 inch index card, a so-called cheat sheet, that was given to them in class and then use it during the exam. Students were not given instructions on how to prepare their cheat sheet. The remaining students (No Card treatment) were told that they would not be able to use any study aids during the test. The announcement was made 10 days before the test and was repeated two days later during the following class.

When participants arrived at the laboratory they showed their ID to verify their identity. Half of the participants who prepared a cheat sheet were informed that they would not be able to use it, and they turned in their cheat sheet (Card Removal treatment). The rest of the participants who prepared a cheat sheet were permitted to use it (Card Use treatment). Participants in the CU treatment were seated in a separate section of the classroom. Participants were given 30 minutes to complete an economics test that consisted of 30 analytical, multiple-choice problems. All the questions required at least some basic analysis; each questions required a least two steps to solve. Each of the classes was given a different exam; however, the questions were selected from the same test bank and each test had approximately the same level of difficulty. (The tests had the same level of difficulty based on the assigned difficulty for each question in test bank.)

Participants were not allowed to use a calculator or any other study aid (besides a cheat sheet if they were in the CU treatment). In order to ensure that participants were not using any unauthorized aids, they were carefully monitored by two proctors. After taking the test, participants were asked to complete a short survey that asked them for some personal information and about their attitudes towards cheat sheets and other study aids.

299, or 61.15%, of the students who were eligible to participate in experiment did so.[2] Participation rates varied slightly across the classes with Micro 2 having the higher participation rate (65%) and Macro 2 having the lowest participation rate (52%). Of the 299 participants, 143 (47.8%) were males and 156 (52.2%) were females. 35.5% of the participants were freshmen, 44.5% were sophomores, 12.0% were juniors, 6.0% were seniors, and 2.0% were either unclassified or did not declare their classification. The composition of the participants was quite similar to the composition of all the eligible students in terms of gender and class standings.

[1] The additional bonus points were based on the participants' relative score because participants in one treatment may have had an unfair advantage over participants in other treatments.

[2] In addition to the 299 participants, students who had another, documented obligation during the time of the experiment were given the option of taking the test at a different time. Only 10 students exercised this option. These students were given bonus points, but their scores were not included in the experiment.

3. Results and Analysis

3.1. Data Analysis

The results of the experiment including the mean score, standard deviation, number of participants, and the participation rate (the percent of eligible students in a given category that participated in the experiment) for each treatment in each class are reported in Table 1. All the tables are presented in appendix A. The highest possible score on the test was 30 points.

**** Table 1****

In all 4 classes participants in the NC treatment obtained the lowest average score, participants in the CR treatment obtained the second highest average score, and participants in the CU treatment obtained the highest score. The average scores varied between the classes. Participants in the Macro 2 class earned the highest average score, 16.27, and participants in the Micro 1 class earned the lowest average score, 13.91. Since the tests had approximately the same level of difficulty, differences in average scores amongst the classes were probably caused by differences in students' abilities and/or in the quality of instruction.

Next, I examine the four hypotheses that are stated in the introduction section by using a mean difference test to examine whether the average scores between the three treatments are significantly different in each of the four classes. The coding hypothesis is accepted if the average score of participants in the CR treatment is significantly higher than the average score of participants in the NC treatment. On the other hand, the over-dependency hypothesis is accepted if the average score of participants in the CR treatment is significantly lower than the average score of participants in the NC treatment. If the average scores of participants in the NC and CR treatments are not significantly different from each other, then the null hypothesis that preparing a cheat sheet does not affect students' test performance can not be rejected.

The use hypothesis can be accepted if the average score of the participants in the CU treatment is significantly higher than the average score of participants in the CR treatment. If not, the null hypothesis that using a cheat sheet does not significantly improve students' test performance can not be rejected. Finally, the combined effect hypothesis is accepted if the average score of participants in the CU treatment is significantly higher that the average score of participants in the NC treatment. If not, the null hypothesis that preparing and using a cheat sheet does not significantly improve students' test performance can not be rejected.

Table 2 reports the results of testing the effects of preparing a cheat sheet (Preparation Effect), using a cheat sheet (Use Effect), and doing both (Combined Effect). The P-values in Table 2 are the probabilities that the null hypothesis is correct for each effect. Percent Change is the change in percent points (whereas, 30 points equals 100%) between the average scores of different treatments. It shows the percent change between the NC and CR treatments for the coding effect, between the CR and CU treatments for the use effect, and between the NC and CU treatments for the combined effect.

****Table 2****

In all four classes, the null hypothesis that participants in the CR treatment received the same average score as participants in the NC treatment can not be rejected with a 5% level of significance. Nonetheless, participants in CR treatment obtained a higher average score than

participants in the NC treatment in all four classes, scoring 3.57% more points. Furthermore, in the Micro 2 and Macro 1 classes the coding hypothesis can be accepted with a 10% level of significance. Therefore, there are some evidence that the coding hypothesis is correct, but they are not statistically significant.

In all four classes, the null hypothesis that participants in the CU treatment received the same average score as participants in the CR treatment can not be rejected with a 5% level of significance. Nonetheless, participants in the CU treatment obtained a higher average score than participants in the CR treatment in all four classes, scoring 3.5% more points. Even though the use hypothesis and coding hypothesis can not be accepted, there is some evidence that they may be correct. If the sample size was larger or more weight was placed on the test, thus inducing students to study more, these hypotheses may have been accepted. The sample size was relatively small and the participants' average grade was relatively low, indicating that they probably did not study very hard for the test.

The combined effect hypothesis can be accepted with a 5% level of significance in all four classes. Therefore, although the increases that result from preparing a cheat sheet or using it are not statistically significant on their own, being able to both prepare and use a cheat sheet had a significant, positive effect of students' test performance. Preparing and using a cheat sheet increased the participants' scores by between 6.5% in the Micro 2 class and 8.13% in the Macro 2 class. Note that the average increase in scores caused by preparing a cheat sheet (3.57%) is almost the same as the average increase caused by using one (3.5%), indicating that the coding effect and the use effect are equally important. Although in two of the classes, Micro 2 and Macro 2, the coding effect is substantially larger than the use effect. More research is needed to reveal which one of these effects is more important.

3.2. Survey Results

A survey conducted after the test (see Appendix B) revealed that most participants had a favorable opinion towards cheat sheets. 78.6% of the participants considered using a cheat sheet either very helpful or helpful. Only 6.0% of the participants thought that cheat sheets were not helpful.[3] 17.4% of the participants indicated that they would like to use a cheat sheet on all their economics tests, even if their instructors intend to give harder exams when allowing students to use cheat sheets. 67.9% of the participants stated that they would like to use a cheat sheet, but only if their instructors would not give harder exams when allowing students to use cheat sheets. 8.7% of the participants indicated that they would prefer not to use cheat sheets during tests. Out of the 26 participants who preferred not to use a cheat sheet, 11 marked that cheat sheets take too long to prepare and 13 marked that they do not feel comfortable using them during exams. One participant commented, "Students should only be tested on what they can memorize."

Despite having a favorable opinion towards cheat sheets, only 16.4% of the participants answered that they would prefer to use a cheat sheet if they could only use one type of study aid during exams. The majority of the participants preferred either an open-notes test (47.5%) or an open-text test (22.1%), which means that they favored using their class notes or their textbook during exams. 2.0% of the participants preferred using programmable calculators, 5.0% preferred a closed-book test with no study aids, and 7.0% of the participants did not respond to the question.

67.2% of the participants reported studying for the exam for two hours or less, 20.7% reported studying for 3 to 5 hours, 5.7% reported studying for 6 to 10 hours, and only 3.3%

[3] 13 out of the 18 students who did not consider cheat sheets helpful were in the NC treatment

reported studying for more than 10 hours. On average, students who were asked to prepare a cheat sheet reported spending more time preparing for the exam than students in the NC treatment. 40.7% of the participants in the CU and CR treatments claimed to have studied for more that 2 hours, compared to only 14.4% in the NC treatment.

In general, participants who had to prepare a cheat sheet studied longer, possibly because they had to spend time preparing their cheat sheet. This raises an interesting question – did students who prepared a cheat sheet do better on the exam because preparing a cheat sheet helped them code the material or simply because they spent more time preparing for the test? To answer this question I ran a mean difference test while controlling for preparation time by looking only at participants in each treatment that reported working for 2 hours or less.[4] Table 3 shows the effects of preparing and using a cheat sheet for participants that only studied for 2 hours or less.

**** Table 3 ****

Most of the results still hold when controlling for preparation time. In all four classes participants in the CR treatment obtained a higher average score than participants in the NC treatment, participants in the CU treatment received a higher score than participants in the CR treatment, and the combined effect hypothesis is accepted. However, in the two Microeconomics classes the coding hypothesis can be accepted with a 5% level of significance. This indicates that preparing a cheat sheet has a significant and positive effect on students' test performance, even, or perhaps especially, when they spend little time studying for the test.

At the end of the experiment, the cheat sheets were collected from the participants and analyzed. 97.3% of the participants in the CU and CR treatments included equations, 60.3% included at least one graph, 51.1% wrote key points, and 38.4% wrote definition for terms on their cheat sheet. Most of the participants that wrote definitions or key points on their cheat sheet used symbols, abbreviations, acronyms, and shorthand notation to summarize (or code) information. Some students also included numerical examples and short illustrations to help them remember how to solve certain problems.

4. Discussion

The results of this experiment indicate that preparing a cheat sheet and using a cheat sheet both help students improve their test performance, although neither of these effects is statistically significant at the 5% level. The combined effect of preparing and using cheat sheets is positive and statistically significant in all four classes, even when controlling for preparation time. Moreover, in contrast to Dorsel and Cundiff's experiment, participants did not become over-dependent on their cheat sheet for answers. Quite the opposite, students who prepared a cheat sheet spent more time studying for the test and, on average, received a higher score even when they could not use it.

[4] Admittedly, looking at participants who studied for two hours or less does not completely control for time spent studying, since there may still be some small variation in study time between the treatment (say, two hours on average, as opposed to one). Looking at participants that worked for any other period of time does not make sense since there are too few observations to get a statistically significant result (especially in the NC treatment).

A survey conducted following the experiment reveals that most students have a favorable opinion towards cheat sheets but prefer open-book tests (either open-notes or open-text). Although there are no studies that compare the effectiveness of cheat sheets to other study aids, there are several studies that compare the effectiveness of open-book tests to closed-book tests. Researchers find that open-book tests reduce counter-productive anxiety (Feldhusen, 1961) and increase students' confidence (Francis, 1982). Moreover, open-book tests reduce the need for rote memorization and allow students to focus on more complex analysis (Feldhusen, 1961). Open-book tests, however, have some critical shortcomings. Students taking open-book tests often spend a lot of time consulting their notes during the exam (Boniface, 1985). Tanner (1970) also finds that students spend less time preparing for open-book tests than they do preparing for closed-book tests. Finally, Ioannidou (1997) concludes that students who took an open-book test did not perform better than students who took the same exam as a closed-book test.

Allowing students to use cheat sheets may have the same benefits as open-book tests without the drawbacks that occur when open-book tests are used. Since all the information is summarized on a small piece of paper, students do not waste a great deal of time sifting through their notes during exams when using a cheat sheet. Additionally, unlike open-book tests, which seem to lead students to engage in less preparation, cheat sheets seem to induce students to spend more time preparing for an exam. In this experiment students who were assigned to the CR and CU treatments reported spending more time preparing for the test than students in the NC treatment. At minimum, students have to invest time preparing their cheat sheet. Another important advantage of using cheat sheets is that it forces students to code the material. On the other hand, students who prepare for an open-book test often passively read the material in search of references in the text instead of finding ways to code the material.

Based on the results of this experiment I recommend the use of cheat sheets as study aids in economics tests. Preparing a cheat sheet seems to help students learn the material and improves their test performance. Additionally, students who can use a cheat sheet seem to perform better on analytical questions, which indicates that cheat sheets may reduce the need for rote memorization. Therefore, instructors who allow their students to use cheat sheets can ask them more complex analytical question that help develop the students' thinking.

Cheat sheets have several noteworthy advantages over other study aids. As this experiment shows, allowing students to use cheat sheets does not promote over-dependency. Additionally, unlike open-book tests, students do not spend too much time looking through their notes during tests, or end up studying less. In the future I intend to investigate whether cheat sheets also reduce counter-productive anxiety during exams. I also intend to investigate the effects of other study aids as open-book tests and programmable calculators on the test performance of economics students.

Appendix A: Tables

Table 1. Summary of Statistics (by Class)

Class		All 3 Treatments	No Card	Card Removal	Card Use
Micro 1	Average	13.91	12.89	13.83	15.05
	St. Deviation	3.56	3.97	3.24	3.42
	Number	70	19	29	22
	Participation Rate	61%	50%	78%	59%
Micro 2	Average	15.92	14.73	16.23	16.68
	St. Deviation	4.11	4.40	3.93	3.81
	Number	93	30	26	37
	Participation Rate	65%	64%	55%	77%
Macro 1	Average	14.89	13.68	14.9	15.97
	St. Deviation	3.50	3.28	3.41	3.54
	Number	80	22	29	29
	Participation Rate	63%	52%	69%	69%
Macro 2	Average	16.27	14. 89	16.5	17.33
	St. Deviation	4.28	4.91	3.58	4.02
	Number	56	19	16	21
	Participation Rate	52%	53%	46%	58%
All 4 Classes	Average	15.25	14.12	15.19	16.24
	St. Deviation	3.94	4.23	3.64	3.74
	Number	299	90	100	109
	Participation Rate	61%	55%	61%	67%

Table 2. Statistical Analysis of Hypotheses

Class		Preparation Effect	Use Effect	Combined Effect
Micro 1	P-value	.1977	.1003	.0329
	Percent Change	3.13%	4.07%	7.20%
Micro 2	P-value	.0901	.3300	.0281
	Percent Change	5.00%	1.50%	6.5%
Macro 1	P-Value	.0985	.1635	.0130
	Percent Change	4.07%	3.57%	7.63%
Macro 2	P-Value	.1314	.2514	.0436
	Percent Change	5.37%	2.76%	8.13%

Table 3. Statistical Analysis of Hypotheses (Controlling for Study Time)

Class		Preparation Effect	Use Effect	Combined Effect
Micro 1	P-value	0.0446	0.3015	0.0179
	Percent Change	6.52%	1.95%	8.46%
Micro 2	P-value	0.0409	0.1635	0.0054
	Percent Change	7.47%	4.52%	11.99%
Macro 1	P-Value	0.1762	0.1151	0.015
	Percent Change	3.60%	3.68%	8.54%
Macro 2	P-Value	0.1587	0.2611	0.0485
	Percent Change	5.42%	3.58%	9.00%

Appendix B: Survey and Survey Results

The following questions were presented on the survey that was given to the participants. The results of the survey are summarized in Table 4.

1. **What is your gender?**
(a) Male (b) Female

2. **What is your class standing?**
(a) Freshman (b) Sophomore
(c) Junior (d) Senior
(e) Graduate student

3. **How many hours, in your estimate, did you spend studying for this examination?**
(a) 2 hours or less (b) 3 - 5 hours
(c) 6 - 10 hours (d) 11- 20 hours
(e) More than 20 hours

4. **Do you consider using a cheat sheet during an exam helpful?**
(a) Very Helpful (b) Somewhat Helpful
(c) Not Helpful (d) Undecided

5. **Would you like to be able to use a cheat sheet during all of your economics tests**
(a) Yes, even if the teacher gives harder tests when allowing students to use a cheat sheet
(b) Yes, but only if the teacher doesn't give harder tests when allowing students to use cheat sheet
(c) No. They take too long to prepare
(d) No. I don't feel comfortable using them during the examination
(e) No. For some other reason that is not stated in (c) or (d). What is your reason?

6. **Which of the following study aid do you prefer to use during a test? (Choose only one)**
(a) No Study Aid
(b) A cheat sheet (being able to write anything on an index card and use it during the exam)
(c) Programmable Calculator
(d) Open Notes (being able to use any notes that you have during the exam)
(e) Open book (being able to use your textbook or any other relevant book during the exam)

Table 4. Summary of Survey Results (Percent of participants who selected each answer)

Question	1	2	3	4	5	6
Answered A	47.8	35.5	67.2	39.8	17.4	5.0
Answered B	52.2	44.5	20.7	38.8	67.9	16.4
Answered C		12.0	5.7	6.0	3.7	2.0
Answered D		6.0	2.0	6.7	4.5	47.5
Answered E		0	1.3		.7	22.1
No Answer	0	2.0	3.0	8.7	6.0	7.0

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