

Blind Pretesting and Student Performance in an Undergraduate Corporate Finance Course

Brian C. Payne^a
U.S. Air Force Academy

Thomas C. O'Malley^b
U.S. Air Force Academy

ABSTRACT

Using a unique sample of college students at a service academy, this paper explores whether the testing effect can be applied to an introductory corporate finance course. Prior research on the testing effect has been used non-quantitative subject matter. We introduce the testing effect to undergraduate finance and find evidence that administering a blind pretest at the beginning of the semester improves final exam performance at the end of the semester. This performance improvement occurs without providing feedback to students or instructors. The improvement is largest for average and below average students.

This version: September 28, 2015

JEL Classification: A2

Keywords: Finance Education, Economic Education, Testing Effect

^aCorresponding author. Department of Management, 2354 Fairchild Dr, US Air Force Academy, CO, 80840. Email: brian.payne@usafa.edu. Tel: 719.333.2334. Fax: 713.333.9715.

^bDepartment of Management, 2354 Fairchild Dr, US Air Force Academy, CO, 80840. Email: thomas.omalley@usafa.edu. Tel: 719.333.8259. Fax: 713.333.9715.

INTRODUCTION

Corporate finance courses have long challenged undergraduate business majors. It is well known that many students dread taking finance. The quantitative nature of finance clearly discourages some. Anecdotes abound of business students delaying enrollment in finance courses as long as possible. Deferring enrollment will likely exacerbate student difficulties though because finance material is integrative. Mastering finance material requires that the student understand a number of fundamental concepts from accounting and economics.

Given these challenges, researchers have been eager to identify the determinants of academic success in finance and economics coursework. Research in this area can help with a fundamental problem facing finance educators and learners alike and identify the optimal learning conditions to meet these challenges. Extant research looks at academic factors, such as student entrance exam scores, performance in prerequisite courses and grade point average (GPA). Studies also look at course design and instructor traits. Still other studies focus on the role that demographic factors such as gender or age may play.

Some of these research findings may have already paid dividends in the classroom. Test data taken from the major field test in business shows a significant improvement in finance scores over time. The major field test measures the business-related knowledge of seniors in undergraduate business programs. Each year the Educational Testing Service (ETS) Comparative Data Guide publishes aggregate scores of the core business areas including finance. In 2000, the ETS data listed finance as last of eight business topic areas. By 2014 ETS data shows marked improvement with finance ranked fifth in nine areas¹.

Further gains in student learning may require the application of recent insights in the psychology of learning. This research has yielded a better understanding of how people learn and what facilitates effective learning. Some of these findings have yet to be systematically applied to undergraduate finance. This paper documents the application of one such insight to a core corporate finance course.

In this study, we evaluate the pedagogical effectiveness of pretests within the context of an undergraduate corporate finance course. A pretest instrument is administered to undergraduate finance students on the first day of class. The students do not have an opportunity to study course material before testing, which is why it is labeled a *blind* pretest. The pretest is a multiple choice test with questions and answers qualitatively similar to those found on the final exam. Neither the students nor the instructors are provided any pretest feedback throughout the semester. Performance on the final exam is then evaluated and compared to that of a similar control group that did not take the pretest. Including a robust set of academic and demographic controls, we find evidence that suggests blind pretesting is associated with improved final exam performance, particularly for average and lower-performing students.

This study's contributions to the research literature are three-fold. The findings here: (1) confirm that blind pretesting can add value to student learning/achievement in a classroom setting, (2) suggest that blind pretesting can add value in a corporate finance course, an academic discipline that blends soft and hard science, and (3) indicate that average and lower-performing students may benefit disproportionately from using pretests.

LITERATURE REVIEW

The literature review will provide a brief synopsis of two streams of research. First, we summarize pretesting as a learning catalyst. Second, we review the determinants of student performance in undergraduate finance that we will use as controls in order to appropriately isolate any potential pretesting effect.

The Testing Effect

¹ https://www.ets.org/s/mft/pdf/acdg_business.pdf

Tests have traditionally been used to assess learning, but for a while researchers have known that testing may actually facilitate student learning. This remarkable discovery is labeled the *testing effect*. Few educators utilize the testing effect however. Anecdotal evidence suggests that within the finance, accounting and economics community pretests are rarely used. This is not surprising given the general lack of awareness of the testing effect. Though the testing effect is not widely known, it is powerful and reliable in a large number of contexts and has been verified in experimental and classroom settings (Roediger and Karpicke, 2006a).

Bjork (1975) stands out among the earliest studies to speculate on why testing may function as learning event. What is clear from this study is that information is not merely accessed. Instead, the act of retrieving information alters how that information is stored in memory. The process of retrieving information alters the accessibility of this information, making it more recallable in the future.

Taking a test may be a more effective learning strategy over long periods of time than simply reviewing material a second time. In experiments using word list recall, Hogan and Kintsch (1971) and Thompson, Wenger, and Bartling (1978) each find that a testing approach is superior to a pure study approach for long-term retention. Roediger and Karpicke (2006b) compare the studying of a prose passage once and taking a test versus studying the same passage twice. They find that the first strategy generates better recall when the time delay between the pretest and the recall test is more than one day.

Tests that appear to be unsuccessful do not necessarily impede learning. On the contrary, failed attempts at retrieving information can actually help the learning process. Kornell, Hays & Bjork (2009) conduct experiments that ensure learners will be unsuccessful at retrieving information. Using a variety of test content and answer formats, the authors find that unsuccessful tests assist future learning rather than hinder it. Moreover, learning occurs even when no corrective feedback is provided to the student (Carrier & Pashler, 1992).

Some educators have used pretests in a formative sense to identify the state of student's knowledge at the beginning of a course. Formative evaluation can be quite effective to facilitate learning if the instructor is willing to adapt and make real-time changes to the course. On at least one occasion, the efficacy of this approach has been demonstrated in teaching finance. Heinfeldt and Wolf (2002) introduce formative evaluation to an introductory undergraduate finance course. The use of pre- and post-tests provides beneficial information to finance instructors and assists students in learning the material.

While formative evaluation can indirectly affect student learning, pretests can also be used to directly affect student learning by harnessing the testing effect. The testing effect is powerful and reliable but not widely used in the classroom. Research has confirmed the power of classroom tests but the efficacy of the testing effect has not been tested in a finance setting. This study is arguably the first to do so. This is important since the testing effect has been generally evaluated outside the hard sciences. Finance bridges the gap between hard and soft science. Therefore, a classroom evaluation of the testing effect could potentially benefit the teaching of accounting, economics and other disciplines that are both hard and soft science.

Determinants of Performance in Undergraduate Finance

Researchers have investigated a number of factors that may influence student performance in undergraduate finance and economics. Bellico (1972) finds that freshman and sophomore GPA is predictive of performance in economics. Transferring from community college is negatively related to performing well. Simpson and Sumrall (1979) is perhaps the first study to systematically identify the determinants of student performance within an introductory finance course. Age and performance in prior economics classes is positively related to performance but transferring from another school and increasing work hours are associated with worse grades. Perhaps the best predictor of performance in introductory finance is prior performance in accounting (Shaffer and Calkins, 1980).

The controls used in this study are mostly found in two large sample studies that each focus on student performance in undergraduate finance. Borde, Byrd and Modani (1998) look at performance in introductory finance and find females and community college transfer students underperform. GPA, performance in accounting and fewer hours of employment are associated with better performance. In a follow-up study, Terry (2002) finds significant performance differences linked to GPA, major, gender, performance in prerequisite courses, the student's major and whether the course took place in summer.

INSTITUTIONAL AND SAMPLE DESCRIPTION

This study expands the testing effect literature while accounting for the performance determinants in finance. Here we analyze the effectiveness of a blind pretest on the performance of students in a corporate finance course at the US Air Force Academy. As the first required finance course for these students, the course analyzed is simultaneously an introductory finance course, akin to Terry (2002), and an intermediate course, analogous to Fields (2013), in that it employs a graduate-level textbook and corresponding approach. Final exam scores are compared between students who took a blind pre-test at the beginning of the semester with those who did not, controlling for a variety of factors that previous studies have found are associated with performance in related finance courses.

Before explaining the sample details, it is useful to understand that the US Air Force Academy presents a conducive environment for pedagogical studies. Its purpose is similar to that of the US Military Academy or the US Naval Academy. Upon graduation, cadets receive not only a four year degree but are also commissioned as officers in the Air Force. Given this, the institution has multi-faceted goals that include not only academic achievement but also military leadership, athletic accomplishment and character development. This drives both the system's treatment of students and students' individual decisions about allocating their time. Students must perform at a satisfactory level in each dimension to successfully graduate.

This institution takes many steps to ensure unbiased treatment of officer candidates as they make progress toward each institutional goal. Students in a class all begin their time at the Air Force Academy together and in lock-step complete a four-year program. The four year program is never shortened and extended only in rare circumstances. Once a cohort of cadets starts the program, there are no additional student transfers from community colleges or other institutions. These cadets are prohibited from living off campus and live in one of two dormitories. Each student is assigned to one of forty 'squadrons' made up of approximately 100 students representing all four classes and virtually every possible demographic dimension. There are no academic fraternities, sports sororities or religion-based dormitories that could serve as factors that systematically bias our results.

The overall academic experience is remarkably consistent from student to student. Students select an academic major but cannot choose their instructors or semester course schedules. All students experience a very similar core, or general, curriculum for the first two years before beginning their majors courses. Each student takes from five to seven courses in any given semester, with the average converging on six courses as the students approach their junior year (96% of our sample) and senior year (the other 4% of our sample). They are randomly-assigned to class periods and instructors so that all students can attend class yet still have time to meet at a common time with their flying team, military unit, or sports team. Outside of the classroom, all students have military- and athletic-related commitments. Depending on the position or team, these commitments can vary substantially. There are no concessions in a student's academic requirements because of these roles however. Overall, the unique academic setting of the US Air Force Academy makes it difficult to argue that any system-induced in-classroom or beyond-the-classroom bias affects the results of a study such as this one.

As for the specific study design, this analysis spans two academic years and includes results from spring 2014 and spring 2015 semesters. The entire sample includes 197 students across 10 sections of a corporate finance course taught by two instructors. The spring 2014 students represent the control group

and did not take a blind pre-test for this course. Since testing can facilitate learning not only in cued recall, free recall and short-answer tests, but also in a multiple choice format (Bjork, Soderstrom and Little, 2015), the treatment group received a 15-minute, 17-question multiple choice pre-test on lesson two of the semester. The questions were representative of the final exam for this particular course. We label this instrument the blind pre-test. It is blind because these students have not been exposed to this corporate finance material at any point in the in the two-and-one-half years prior to taking this course. We posit its effectiveness based on the findings of Kornell, Hays, and Bjork (2009), who determine that the testing effect can be valid even if students are not exposed beforehand to the material over which they are tested.

Some demographic factors identified in prior works are not included in this study given the unique nature of the educational institution and related student sample. For example, age is not specified here in this model. The student population is tightly clustered since by law newly enrolled students must be no older than 23 years old. Outside employment is also not considered in this paper since employment is expressly forbidden by the institution. Additionally, transferring from a community college or other educational institution is not controlled for in this paper since it is not possible within the highly controlled environment of a service academy.

Students were not allowed to transcribe, photograph, or keep the blind pre-test. The two instructors administering the pretest informed the students that they were not expected to know the tested material and that these questions were representative of the final exam questions that the students should expect to answer by the end of the course. Instead of recommending memorization, the instructors told the students that it was worth their time to attempt to answer the questions correctly. The instructors collected the completed pretests which were then filed away. It is important to note that the instructors did not grade the blind pretests. Doing so would have permitted instructors to make adjustments to the course by under- or over-emphasizing certain content. This approach was chosen to isolate any potential testing effect and is consistent with Carrier and Pashler (1992) who find that students do not need to receive feedback for testing to facilitate learning.

The classroom environment and approach was nearly identical for both the control and treatment groups. The only observable, material differences between semesters we identify are (a) the student populations and (b) the current events instructors subjectively introduced to their classrooms. The same two instructors taught both the control and treatment semesters. Both instructors in this study have terminal degrees in the areas of finance, and both have been teaching at the same institution for at least five years (10 semesters) before the spring 2014 semester. Each instructor had taught this course for multiple years and approached the classroom and course content just as they had done in prior years. The syllabus of course material for both semesters was identical as was the textbook edition, the lecture slides, in-class workshop exercises, and mid-semester exams.² Quizzes across groups were identical in concept and format, however, for workout problems the instructors changed some of the numbers to test computational abilities instead of whether the student had received a copy of a prior semester's quizzes.

Using the spring 2014 and spring 2015 semesters as the control and treatment group provides a clean experimental design. Using semesters prior to spring 2014 would have increased the sample size but would have introduced multiple sources of noise. The course switched from a fall-only offering to a spring-only offering in 2013. Thus, beginning the study in spring 2014 allowed for a one-year period of transition from fall to spring. Additionally, this course is not offered in the summer at the Air Force Academy, prohibiting any noisiness that could result if we were to compare the effects of condensed offerings on these results. Another reason for this two-semester analysis includes the stability of the 49-question multiple-choice final exam, which was kept identical for the two semesters studied. Its contents have never been

² Exams in this course are not returned permanently to students. Instead, students can review them in the instructors' offices at any time—that is, students have visitation rights but not custody. On the other hand, students do receive their quizzes permanently.

released publicly. Finally, as noted before, we evaluate spring 2014 and spring 2015 due to their identical course content and team of terminal-degree holding instructors.

METHOD OF ANALYSIS

A two period model is developed in which the corporate finance final exam score measured at the end of the semester is a function of the modeled characteristics at the beginning of the semester. The variable of interest, *Pretest*, is a binary variable equal to one if the student took the pretest and zero otherwise. The discussion below identifies the vector of controls used. Equation (1) provides the conceptual framework.

$$\text{Final Exam} = f(\text{Pretest, GPA, IC, Male, Management Major, Senior, Acct Prereq, Instructor}) \quad (1)$$

Consistent with prior studies, we use incoming *GPA*, or the student's cumulative GPA when entering this course, as a proxy for student ability.³ Prior studies have addressed the significant presence of intercollegiate athletes at this service academy (see Payne, Bredthauer, Martin, and Merrell, 2014). We use a binary variable where one signifies intercollegiate status and zero an absence of this status (*IC*). Gender is captured with a binary variable where male equals one and female zero. Since prior studies have assessed the effect of academic major on course grades, we do the same. A binary variable is used and is equal to one if the student's major is Management; zero otherwise. The non-Management majors typically include students majoring in Economics.

The binary variable, *Senior*, equals one if the student is a senior taking the course and zero if a junior. A small minority of the students are seniors who experience a one year delay between the end of their prerequisite accounting course and the subject corporate finance course. We control for this difference among individuals because of the obvious lag between the prerequisite material and the finance material for the seniors. Also, there could be an additional and compounding "senioritis" effect, as the senior cadets are mere days from graduation. These seniors already know what their first jobs and locations will be after graduation, and (observationally) sometimes approach difficult courses in their final semesters as pass/fail propositions. Given these realities, we do not anticipate a positive relationship between senior status and final exam performance. Financial Accounting (*Acct Prereq*) is the only prerequisite course for the subject corporate finance course. This variable represents the GPA in this course as measured on a 4.0 scale. Lastly, instructor fixed effects are captured with a final binary variable.

RESULTS

Descriptive Results

Table 1 shows the summary statistics for the student population. Panel A depicts the entire sample of 197 students. *Final Exam* measures the integer number of correct answers on the 49-question final exam in the

³ The incoming cumulative GPA measure at the US Air Force Academy is a remarkably "apples to apples" measure of student academic performance in this unique environment. This is the case because the students have previously taken two and one-half years of a core, or general, curriculum that is over 80% common across all cadets and over 93% common for cadets with the same academic major (e.g., Management major). They have also taken 2-4 common courses in their major, to include the Financial Accounting prerequisite. Finally, the institution and Management Department take deliberate measures to control so-called "grade inflation" as well as the cross-sectional variance of different instructors (i.e., standardized curriculum, group instructor grading parties, and/or grading curves within an individual instructor's students).

corporate finance course. Its mean is approximately 29.5 questions correct with a standard deviation of almost 6 questions. Measured on a 4.00 scale, the average incoming GPA for these students is 2.65. We note that approximately 39 percent of our student sample is intercollegiate athletes and 84 percent of our sample is male. The average grade for all students in the Financial Accounting prerequisite course approaches a B (2.94)—again, measured on a 4.00 scale. Approximately 97 percent of these students are *Management* majors. The sample student population consists of 96% juniors who took the accounting prerequisite during the immediately preceding fall semester. The balance, 4%, are seniors (*Senior*).

We next check for systematic differences between the control and treatment groups by subdividing this overall sample into those who did not take the blind pretest (spring 2014) and those who did (spring 2015). The final column shows the differences in mean sub-sample values and results of a T-test of these differences. We find evidence that those who took the blind pretest answered a little more than three questions correctly on the final exam than did those who did not take the blind pretest. Also, there is a significantly higher proportion of intercollegiate athletes in the control group (45 percent) than in the blind pretest group (31 percent). Otherwise, there is no statistical difference in these groups' average incoming GPA, the gender composition, the prerequisite accounting course grade, the proportion of *Management* majors, or the proportion of senior cadets.

Since one contribution of this paper to the existing literature on pretesting is the analysis of which students derive benefits from pretesting, Table 1, Panel B further subdivides the whole sample into thirds, or terciles, by ability. Once again, we use incoming GPA as our measure of ability and divide each group—control and treatment—into thirds by their incoming GPAs. The one-third of students with the highest GPAs represent the “high performing” tercile, the one-third with the lowest GPAs represent the “low performing” tercile, and the middle one-third are the “mid performing” tercile. The intent here is to discern whether blind pretesting asymmetrically benefits one tranche of students relative to another.

In the aggregate, Table 1, Panel B shows that the incoming GPA is positively related to the corporate finance final exam performance and the grade in the prerequisite accounting course. The mean values for each of these three measures decrease monotonically from tercile one to tercile three. These patterns are consistent in both the control group (No Pretest (2014)) and the treatment group (Pretest (2015)). Overall non-*Management* majors and seniors tend to decrease as a proportion of the sub-samples moving from higher-to-lower performing terciles, there is no clear monotonic relationship when broken out by control and treatment groups.

Because we ultimately want to test whether the blind pretest induces any difference between otherwise similar students, the last column in Panel B once again tests for differences between these performance terciles. While there are no consistent differences between the control and treatment groups across all three terciles, some insights emerge. For high performers, final exam scores are not significantly different for the group with the blind pretest; this is not the case for the lower two terciles, as the blind pretest students experience significantly higher mean scores on the final exam. Pretested students in tercile one are disproportionately female, have lower average prerequisite accounting grades, and are significantly more senior than the control sample. Besides the aforementioned final exam grade difference, tercile two has more seniors in the control group than the treatment group, which has none. Finally, in tercile three the pretested group has a higher incoming GPA and lower number of intercollegiate athletes than the control group.

Overall, these univariate results suggest that blind pretesting is associated with higher final exam scores in this sample of students. Furthermore, the performance increase occurs primarily in the lower-performing subset of this student group.

Pretesting Matters

Given the statistical differences between the control and treatment sub-samples in Table 1, we must address these issues before reaching any conclusions about the value of blind pretesting in an this

undergraduate corporate finance course. We therefore use regression analysis to disentangle any potential blind pretest effects from other drivers of final exam performance.

Before presenting the regression results, it is insightful to discuss the correlations between the variables in our analysis and their impact on the subsequent regression analysis. Including highly-correlated variables as independent variables in regression analysis can lead to erroneous conclusions. Table 2 presents these pairwise correlation results among our variables. In addition to the variables shown in Table 1, Table 2 includes a binary variable *Pretest*, which is one for a spring 2015 observation and zero for a spring 2014 observation. Notably, high positive correlation exists in all three pair permutations of *Final Exam*, *GPA*, and *Accounting Prereq*, ranging from 0.45 to 0.62. Since the *Final Exam* score represents the dependent variable, the methodological concern would be including both *GPA* and *Accounting Prereq* concurrently. We therefore present models that both include and exclude the accounting prerequisite grade. Other pairwise correlation values do not cause as much concern, as each measures at most 0.26 in absolute value. We use these others simultaneously in our regression models.

Table 3 shows the regression model results for the whole sample. The coefficients for the first model represent the average change in the final exam score, all else held constant: having taken a blind pretest (*Pretest*); for a one grade point change in incoming *GPA*; when having intercollegiate athlete (*IC*) status; if a *male*; as a *Management* major; when taking corporate finance as a final semester senior (*Senior*); and for a one grade point change in the financial accounting prerequisite grade (*Accounting Prereq*). The second model omits the financial accounting prerequisite grade. Both models control for any instructor fixed effects, since we can assume that the instructors differ in their individual approaches given differences in education, experiences, personal style and other factors.

If there are no meaningful systematic differences between the spring 2014 and spring 2015 semesters—and as described in the prior section, we know nothing to speak of—then these results suggest that a blind pretest is associated with improved final exam scores. This result occurs after controlling for factors known to be correlated with academic performance, such as past *GPA*, gender, academic major, lag between prerequisite course and follow-on course, and prerequisite performance. Additionally, both models indicate that that final exam performance is significantly and positively related to incoming *GPA* (i.e., ability). In the first model, which includes the accounting prerequisite, we also unsurprisingly find that performance in this prerequisite is significantly and positively related to the corporate finance final exam performance, despite this variable's relatively high correlation with another regressor, *GPA*. Consistent with previous findings, we see no effect on final exam performance due to gender or academic major. Intercollegiate and Senior status has no significant statistical relationship with final exam performance in this sample.

Pretesting Matters - Asymmetric Effects

Given the authors' admitted initial skepticism about the efficacy of a blind pretest in corporate finance, it is quite interesting that a "preview" of the calculations and concepts that students will experience in a corporate finance course appears to generate significant learning value. However, perhaps most interesting for us as educators is whether this blind pretest value is equally distributed among the student population. That is, does a blind pretest lift all (learning) boats? This question is addressed in Table 4. It shows the same regression results as Table 3 performed for each of the three separate performance terciles. As before, we divided students into three terciles by sorting them according to their incoming *GPA*. Tercile one (three) includes the highest- (lowest-) performing one-third of the students as measured by *GPA*. We label these sub-groups High Performers and Low Performers, respectively. The middle tercile, tercile two, has an original label: the Mid Performers.

Using the same variable definitions as in Table 3, some observations immediately stand out. First, in contrast to the whole sample findings, for high performing students the positive impact of pretesting is

not as readily apparent. The effect is insignificant in one specification and barely significant at conventional levels in another. As expected, incoming GPA is significant for the high performers; and our priors about any lag or “senioritis” effect comes to the fore in this high performing tercile (i.e., the significantly negative value on *Senior*). That is, regardless of having a blind pretest, intercollegiate status, a certain gender, academic major, or prerequisite accounting grade, the only significant explanatory variables for the final exam grade for these high performers is their incoming GPA and whether they are second-semester seniors. Our interpretation: those who have historically done well will continue to do well on this finance final exam, unless they have time to forget prerequisite material and/or perceive no incentive to perform at their highest level (read: final semester seniors). In summary, a blind pretest has a debatable statistical effect on these high-performers’ final exam achievements.

On the other hand, a blind pretest is associated with significantly higher final exam performance in both the lower two tercile performers, across all model specifications. In fact, on average, experiencing a blind pretest accompanies seven to eight percent increase in final exam performance for these mid and lower performing students. This result approaches the ten percent increase seen in Bjork, et. al. (2015). However, the result here occurs using a multiple-choice final exam that consists of many quantitatively-based workout problems. It encourages those of us seeking to enhance the academic performance of at-risk, lower-performing students, particularly in subjects that are more quantitative in nature.

While the mid performing tercile essentially mimics the findings of the whole sample, ignoring the constant, the results in the low performing tercile are somewhat confounding. For starters, final exam performance is not statistically related to GPA. In fact, the coefficient estimate is negative, which belies prior studies, our whole sample results, and intuition. Perhaps an explanation for this outcome lies in the fact that while not significant at conventional levels, both the academic major (*Management*) and prerequisite (*Acct Prereq*) coefficients are positively-signed and have p-values of 0.105 and 0.115, respectively. That is, for students who have struggled academically in general—that is, they have low GPAs relative to their peers—final exam performance is not related to their overall level of struggle. Instead, their final exam performance in a particular class is more related to their demonstrated ability in that course’s prerequisite(s) or courses more central to their choice of academic major. Needless to say, the instructors in this corporate finance course are reflecting deeply on the methods used in spring 2015, as they are clearly associated with improved final exam performance for lower level students.

We conditionally accept these findings, knowing that the testing effect associated with the blind pretest is not the only potential explanation for the enhanced final exam performance. It is possible (and we’d sure hope) that our teaching effectiveness improved seven or eight percent year-over-year! Yet, based on our course and instructor feedback, this explanation is doubtful. There may be an omitted variable that better explains our findings. Other systematic differences between spring 2014 and spring 2015 may exist that we have not captured (e.g., overall mood of the student body, the growth of CNBC, record high stock market levels, super novas, extra eclipses, global warming, a break in the Colorado drought, etc.). At this point we are not aware of any systematic differences in the spring 2015 semester that would have directly and materially explained this increase in these students’ final exam performance.

CONCLUSIONS AND FUTURE RESEARCH

Using a sample of just under 200 students over the course of two semesters, we find that taking a blind pretest is associated with significantly higher performance on the final exam in a required corporate finance course at the US Air Force Academy. At this institution many sources of variability found at other institutions are not present. In this unique environment we identify a real-world (not experimental) improvement in final exam performance among students who take a blind pretest at the beginning of a required corporate finance course. This blind pretest does not explicitly test knowledge presumed from prerequisite courses but instead provides final exam representative questions for the finance course students

are about to take. This performance delta remains robust after controlling for previously-determined predictive factors, such as student GPA, intercollegiate athlete status, gender, academic major, time lag since a prerequisite course, and performance in a prerequisite course.

Perhaps most interestingly, we find asymmetric effects. After subdividing the students into three groups based on previous overall academic performance, we find that the blind pretest effect does not hold universally across the groups. Instead, the positive effect is concentrated among the lower two-thirds of students. This result suggests that blind pretesting, or showing key course concepts in an exam question form, could enable these mid- and lower-performing students to see the areas upon which to focus their intellectual energy over the course of the semester.

Pretesting has become an area of substantial pedagogical interest among researchers and educators alike. The so-called testing effect has broad implication to education as educators continually endeavor to determine what pedagogical techniques will better reach students.⁴ This study contributes to the analysis of pretesting as a pedagogical technique to enhance academic performance.

As with all social science research, this natural experiment leaves additional room for explanation, exploration, and improvement. Consequently, we encourage future research on the effectiveness of blind pretesting. As this study is perhaps the first to analyze the testing effect in finance, which is both a quantitative and qualitative subject, we posit a similar blind pretesting approach could improve student performance in the hard sciences. Additionally, a more longitudinal or broader matched sample would only provide more compelling evidence—either that our students were anomalous or that, more likely in our opinion, there is merit to pretesting in a corporate finance course. Unfortunately, with our instructor scenario, which includes frequent faculty rotations and limited terminal-degree holding instructors with many years of teaching experience, the two semesters in this study represents our best opportunity for the foreseeable future.

Even considering these potential improvements to studying the efficacy of blind pretesting, as initial skeptics we have become believers through this analysis. While we would like to believe the results stemmed from a significant increase in teaching performance or perhaps an effective use of current events, this interpretation is only self-serving and we are too realistic to presume this is the case. And as economists, we weigh the certain marginal cost of time spent creating the pretest and the 15 minutes spent in class administering it against the potential marginal benefit of improved performance suggested in this study. Given the uncertain but apparently positive payoff, particularly for the lower performing students, we intend to implement this tool in our classes going forward.

⁴ Carey, Benedict, “Why Flunking Exams is Actually a Good Thing,” New York Times Magazine, September 4, 2014, <http://nyti.ms/1qzU2mk>

REFERENCES

- Bellico, R. (1972). Prediction of undergraduate achievement in economics. *The Journal of Economic Education*, Fall, 54-55.
- Bjork, R. A. (1975). Retrieval as a memory modifier. In R. Solso (Ed.), *Information processing and cognition: the Loyola Symposium* (pp. 123-144). Hillsdale, NJ: Erlbaum.
- Bjork, E. L., Soderstrom, N. C., & Little, J. L. (2015). Can multiple-choice testing induce desirable difficulties? Evidence from the laboratory and the classroom. *The American Journal of Psychology*, 128, 229-239.
- Borde, S. F., Byrd, A. K. & Modani, N. K. (1998). Determinants of student performance in introductory corporate finance courses. *Journal of Financial Education*, 24, 23-30.
- Carrier, M. & Pashler, H. (1992). The influence of retrieval on retention. *Memory & Cognition*, 34, 268-276.
- Fields, L. P. (2013). Mandatory prerequisite testing and performance in intermediate corporate finance. *Journal of Financial Education*, 39, 19-28.
- Heinfeldt, J. & Wolf, F. (2002). Outcomes assessment and opportunities to modify student investment strategies: The use of Pre- and Post-Tests in a Basic Finance Course. *Journal of Financial Education*, 28, 42-53.
- Hogan, R.M. & Kintsch, W. (1971). Differential effects of study and test trials on long-term recognition and recall. *Journal of Verbal Learning and Verbal Behavior*, 10, 562-567. *Journal of Financial Education*, 28, 42-53.
- Kornell, N., Hays, M. J. & Bjork, R. A. (2009). Unsuccessful retrieval attempts enhance subsequent learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 35, 989-998.
- Payne, B. C., Bredthauer, J. S., Martin, J. A. & Merrell, J. C. (2014). Minding the Terrazzo Gap between Athletes and Nonathletes: Representativeness, Integration, and Academic Performance at the U.S. Air Force Academy. *Journal of Sports Economics*, 1, 1-19.
- Roediger, H. L. III & Karpicke, J. D. (2006a). The power of testing memory: Basic research and implications for educational practice. *Perspectives on Psychological Science*, 1, 181-210.
- Roediger, H. L. III & Karpicke, J. D. (2006b). Test-enhanced learning: Taking memory tests improves long-term retention. *Psychological Science*, 17, 249-255.
- Schaffer, B. F. & Calkins, D. O. (1980). An appraisal of prerequisites to business finance. *Journal of Financial Education*, Fall, 51-55.

Simpson, W. G. & Sumrall, B. P. (1979). The determinants of objective test scores by finance students. *Journal of Financial Education*, Fall, 58-62.

Terry, A. (2002). Student performance in the introductory corporate finance course. *Journal of Financial Education*, 28, 28-41.

Thompson, C.P., Wenger, S.K. & Bartling, C.A. (1978). How recall facilitates subsequent recall: A reappraisal. *Journal of Experimental Psychology: Human Learning and Memory*, 4, 210-221.