Studio Teaching in an Undergraduate Course in Options and Futures

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Abstract

As indicated by Becker and Watts (2001), teaching in economics and finance is still mostly done in a *Chalk and Talk* passive learning environment. This paper reports on an active, hands-on approach implemented for business students enrolled in an undergraduate course in options and futures at HEC Montréal. The proposed environment adapts and extends the studio approach first developed for Introductory Physics at Rensselaer Polytechnic Institute (Wilson, 1994). Its implementation at HEC Montréal relies extensively on the use of laptop computers where students are given team assignments to be worked out on Excel spreadsheets. Throughout the course, extensive discussions are conducted either among the students or with the instructor.

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1. Introduction

As brought up by Becker and Watts (2001), the teaching of economics and finance is mostly done through a *Chalk and Talk* passive learning environment. For many reasons, such an approach cannot be entirely satisfactory. First, as advocated in Chickering and Ehrmann (1996), learning is not a *spectator sport*. Indeed, a passive environment renders difficult the implementation of a regular and quick feedback process, which is found by many to be a key factor for an appropriate learning setting (Johnson and Goltz 2000). Recent changes in business schools also motivate the search for new teaching approaches in economics and finance. For example, more and more business schools witness the emergence of graduate and undergraduate programs in which a laptop computer is compulsory. In such wired classroom settings, a course entirely based on the traditional lecture approach may fall short of reaching some of the goals targeted by such programs.

For these reasons, an approach focusing on an active, hands-on experience was developed at HEC Montréal for an undergraduate course in options and futures. This paper reports on this experience, which is inspired by the studio approach first developed for Introductory Physics at Rensselaer Polytechnic Institute (Wilson, 1994). The studio approach is a learning environment "which allows students to become far more engaged with one another, with the instructor, and with the course material".[2] Its implementation at HEC Montréal relies extensively on the use of laptop computers, which are now compulsory since 1998. Typically, our studio course in options and futures rests on Excel spreadsheet-based team assignments designed to minimize traditional lectures in order to favour individual contacts between the instructor and each student. Most of the time the assignment takes the form of stylized facts to be explained or a practical problem commonly encountered by market participants, illustrated with real and/or simulated financial data.

There are many advantages to such a learning environment. First, the discussions among students and the direct interaction with the instructor can provide almost immediate one-to-one feedback adapted to the different needs of the students. This is important since the frequency of feedback is usually found to be a key factor in courseware design (Johnson and Goltz 2000). Second, spreadsheet programs are by now considered to be indispensable tools for all financial professionals. Providing learning experiences with such a tool is therefore of prime importance. Finally, some of the concepts associated with options and futures are highly abstract; we find that combining on-hand guidance by the instructor with the manipulation of real data by the students brings some of these abstract concepts to life.

This document is organized as follows: the general principles of the studio approach are covered first. The extension of this method to an undergraduate course in options and futures is then explained; special attention is given to the various parameters of the experiment (class size, class configuration, role of the instructor, grading, exams, building financial models with a spreadsheet, etc.). The last section of the paper reports on some tentative assessment of the method, from the point of view of both the

[2] See Wilson (1994).

instructors and the students using the *Seven Principles* of Chickering and Ehrmann (1996). We conclude by exploring some further developments of this new hands-on learning environment.

2. Studio Method in Physics[3]

The roots of the studio method at Rensselaer Polytechnic Institute (RPI) can be found in a serious questioning of the effectiveness of the traditional lecture format (especially in large lecture rooms) and the advances in computing, communication and learning theories emphasizing more hands-on and cooperative learning. The traditional physics course usually deployed in a series of two-hour lectures (in a large auditorium), two-hour recitations and two-hour laboratory sessions was reconfigured into two, two-hour studio sessions involving roughly 50 students. According to Wilson (1994), each studio session would typically follow the following format:

- Students are assigned in advance required readings from the chosen textbook
- The first portion of the class is devoted to the discussion of a homework assignment (20 minutes).
- A short quiz is then given to assess the reading of the day.
- The instructor briefly presents the topic of the day in a mini-lecture (10-20 minutes).
- An experiment is conducted: for example a student is asked to throw a ball whose movement is recorded on video, digitized on a computer and made available over the network.
- The students, working in teams, analyze the motion of the ball using various tools, including a spreadsheet (20-40 minutes).
- The course ends with a quiz and a round-up of the experiment followed by a short introduction to the readings for the next class.

Wilson (1994) reports that the studio approach was well received both by the students and the faculty. Students did not do worse on testing, which is very positive considering that the studio format is shorter.[4]

3. Transposition of the Studio Method to an Undergraduate Course in Options and Futures

In the 2001 fall term, the studio method was adapted to an undergraduate options and futures course given at HEC Montréal. This course was typically given to sections of 30

[3] The section draws heavily from Wilson (1994) and from a visit that one of the authors made to RPI. See also Williams (1997) for a Canadian experience.

[4] Cummins et al. (1999) reports on an attempt to measure more rigorously the students' learning gains: per se, the plain studio approach, despite its interactive nature, does not lead to much better learning; however, slight variations to include some research-based activities led to much better learning gains.

to 55 third-year finance students.[5] The course was partially redesigned to take advantage of the new Virtuose initiative implemented in 1998 at HEC Montréal, which required that each student own a laptop computer.

In the previous years, the course was organized in a lecture format using Hull (2001) 3rd edition textbook with occasional spreadsheet demonstrations by the instructor. Not surprisingly, the lecture format came with its usual drawbacks, which were compounded by some institutional details: for example, second and third year courses at HEC Montréal are given in a three-hour format. It was difficult to keep the students' attention for a long period of time even when questions and class participation were strongly encouraged. Furthermore, team assignments involving data and models often missed their learning goals since they were often done by the team specialist! Although some colleagues at HEC Montréal were sometimes using the computer labs to carry out lectures, the use of the labs on a regular basis was not seen as a workable possibility at the time. Personal computing with students knowing Excel from previous courses was seen as a facilitating condition.

Much of the studio format and approach was retained, albeit adapted to a three-hour time frame. Specifically:

- Students are assigned some required reading from the Hull textbook as well as end of chapter problems.
- For key chapters, a short quiz is given to assess the reading of the day.
- The topic of the day and the theory or stylized facts to be explained are reviewed in a mini-lecture (approximately 30 to 45 minutes).
- The students are then given the team assignment. The required Excel file, including the necessary data, template etc., is usually downloaded by the students from the course web site.
- Fifteen minutes before the end of the class, students are asked to send their Excel answer file to the class instructor electronically.
- The studio session ends with a round-up of the assignment by the instructor.

Not surprisingly, the course depends heavily on the set of assignments devised with the following requirements:

- The topic has to be tightly integrated with the textbook reading.
- Ideally, the assignment should begin with some stylized facts or theoretical arguments to be explained.
- The instructions have to be clearly stated with no ambiguity in terms of actions, explanations and spreadsheet computations.
- The time necessary to devise the spreadsheet, insert the comments, etc. has to be tightly monitored.

[5] Business students are not known for their good mathematical background although many of them followed an operations research course emphasizing the use of the Excel Solver, which is quite powerful and useful to solve financial problems.

- The questions devised have to highlight some key fundamental concepts to ensure that a correct answer equates with a good understanding.

A series of ten team assignments were therefore devised as described above (see Appendix B for a sample assignment). The three remaining lectures (the first lecture, a lecture on interest rate futures and a lecture introducing options to students) were given in a traditional format.[6] Typically, each term, two sections of approximately 30 to 55 students enroll in the course. Each group is usually assigned a u-shaped lecture room.

The assignments went as the studio accounts predicted. The students worked in teams to answer the questions and often exchanged information with each other. Constant feedback from the instructor, who was moving around the room, was an integral part of the course. Questions were diverse and ranging from technical points to issues related to the models, their use or the data. As it is often the case in these lab-type environments, a number of practical issues emerged and proved to be important:

- To avoid screen swapping, a paper version of the assignment was handed out to the students.
- While all the members of a team were working on the assignment, only one file per team was sent electronically at the end of the studio session.
- Only one of the assignment questions, randomly chosen, was graded by the TA. This avoided the overload of grading work associated with large classes of 50 or more students while keeping an incentive for the students to hand in proper work.
- At the beginning, calibrating the length of the assignment was tricky. However, it became easier to do over the years while some questions were included as a supplement for highly motivated students.
- Many students were often not taking a break.
- Electronic solutions were provided on a web site.

Practical issues regarding the implementation of a proper set of incentives are also very important with such a course format. A first incentive is provided by the short quiz at the beginning of key courses. This motivates the students to perform the necessary work prior to the class, which is a key requirement with such an approach. In the implementation done at HEC Montréal, the quiz represents 10% of the final grade. The class team assignments are worth 20% of the final grade. In order to further motivate and encourage the participation of all students to the assignments (i.e. avoid the team specialist problem) the mid-term and final exams contain many questions and problems directly related to the class assignments. In our implementation, these exams together accounted for 70% of the final grade.

Finally, other points worth mentioning are as follows:

- In order to help the student to adequately perform the pre-class work, we found significant to indicate the importance that they should assign to each section of the

[6] At HEC Montréal, each course includes 13 three-hour sessions, a mid-term and a final.

required readings. This gave the students some confidence that their time and efforts outside the class were well spent.

- Calibrating the length of the short lecture before the class assignment was also tricky. When first introduced to the approach advocated here, some instructors experienced insecurity because they felt that they could do a better job with the traditional lecture format. This anxiety can be lowered by increasing the length of the mini-lecture.

- Students should clearly understand that the team assignment is a learning tool as opposed to an evaluation tool. It is therefore important for the instructor to remind this point to students who sometimes have a misconception of the goals targeted with the team assignments.

4. Tentative Assessment

As we will see, it will prove difficult to assess in a rigorous fashion the studio format since this experiment was not part of a research program with a control group, random assignment of students and instructors, specific measurement of learning outcomes, etc. It is thus impossible to report the impact of the approach on measures such as the peformance of students at exams, the understanding and retention of key concepts and the impact on course enrolment. Consequently we will only provide two types of indirect measures. First, some summary statistics regarding the teaching evaluation of the course by the students will be presented and discussed in sub-sectin 4.1. Then, the well-known seven principles of Chickering and Ehrmann (1996) explained in Appendix A will be used in sub-section 4.2 as a rough benchmark for the type of learning activities conducted in the options and futures studio course.

4.1 Teaching Evaluation Results

Table 1 presents some summary statistics taken from the HEC Montréal mandatory standard teaching evaluation questionnaire which is completed by the students at the end of the course before the final exam. We focus on the results of three key questions that we think are more closely related to the pedagogical approach used, the others beeing more targeted to the performance of the instructor in the class. The questions address respectively : i. the links between the course and the real world; ii. the learning climate of the class ; iii. the overall assessment of the students regarding their learning in the course. The answers to the questions are measured on a scale from one to four with four representing the highest satisfaction level. In this table, we focus on the differences between the average scores obtained with and without the studio approach. These numbers should be interpreted with care since various factors can influence the results: small sample, different time periods, different instructors, different cohorts of students, different class sizes. Taking into account these caveats, some interesting observations can nevertheless be highlighted :

- No sizable differences in overall assessement of learning could be found between the two approaches. This indicates that students rank in a similar fashion both approaches. This is encouraging since the implementation of this strikingly different teaching approach does not lead to any major evaluation drawback.

Table 1

	Links course and real world	Climate	Overall assessement of learning
Average traditional minus average Studio	-0.13	-0.11	0.13
Standard deviation traditional minus standard deviation Studio	0.15	0.08	0.01

Average (standard deviation) traditional is the average of the scores obtained in the 8 different sections taugth from fall 1999 to winter 2001 by 5 different instructors with a traditional chalk and talk passive environment. Average (standard deviation) Studio is the average of the scores obtained in the 14 different sections taugth from fall 2001 to winter 2004 by 5 different instructors with the Studio approach.

- The intensive use of Excel team assignements supervised by the instructor does lead to some observable differences in favour of the Studio approach regarding i) the links between the course and the real world and ii) the learning climate of the class. For both questions, the scores are higher and show a lower dispersion. This could be indicative that the studio approach can be used succesfully to improve the quality of the learning environment in these two key dimensions. It is worth noting that the first dimension is especially important for business schools considering their more professional curriculum.

4.2 Seven Principles Results

The follwing observations can be made regarding the Chickering and Ehrmann's principles :

- The studio format led to much more interaction between the students and the instructor (principle 1). Most of the class time was spent answering questions from students. Some questions were quite simple but reflected a genuine misunderstanding of key issues that should have been mastered in previous courses. Other questions could be quite advanced and could lead to some interesting follow-up on current research and issues.

- The studio format is designed to foster team work where students can explain to each other some key concepts or computational issues (principle 2). It is an interesting exercise to witness. In the current design, no attempt was made to set up the teams in random fashion; students work with friends from past courses.

- The studio format is based on active learning (principle 3). Students are really active in class since they have to complete and send an assignment. It is certainly much more difficult than to just sit in class. It could become quite an exhausting task at times.

- In the studio format, feedback is immediate (almost!) and personalized (principle 4). When students are "stuck", the instructor's comments are very much appreciated because the team can move on.

- In the studio format, students are putting a minimum of four to five hours a week (including the three hours of in-class work) on the course (principle 5). The design of the course emphasizes the coverage of the most important material, which ensures a more progressive path since students are more likely to have mastered the key concepts. Required reading is done by most students since they learn early in the course that it is a real prerequisite to the assignments.

- The whole process of doing a class assignment collectively does foster some kind of high level expectations (principle 6).

- The studio format does not fare well on the last principle (principle 7). It is a very focused approach that does not suit the learning preferences of some students. The same comment also applies to traditional lectures.

From a faculty point of view, the studio format is interesting since (1) it can help to quickly identify the more difficult aspects of the course; (2) it fosters continuous improvement as the assignments are modified according to the students' questions; (3) it is not as demanding in terms of delivery performance and (4) it is quite robust in terms of replacement or use of adjunct professors or TAs! Since the inception of this approach, four different lecturers and professors have used it at HEC Montréal.

From the students' point of view, the studio format can be quite demanding and some high achievers can find the exercise a bit stressful. They want to finish on time and get the best grade possible. Timing is again a key issue here.

5. Conclusion

The studio teaching method applied to an undergraduate course in options and futures has been a positive experience so far. From a narrow tool perspective, the intensive use of a spreadsheet program is quite interesting for analyzing data, solving equations numerically, doing Monte-Carlo simulations and performing graphical data analysis. The

team-assignment set-up coupled with instructor feedback is a very effective environment to foster real progressive learning, although no direct objective measure of this is provided in this paper.

The studio format has some drawbacks. For instance, its success depends very much on the students' attitude and preparation, which are not constant over the semester. Furthermore, the format can be quite disturbing for some students accustomed to regular lectures as they adapt slowly to the new rules of the game. The studio format is also quite demanding in the beginning as the instructor needs to set up a series of effective assignments tailored to the textbook used for the course (with a possible lock-in situation).

Studio teaching is not the only way to design interactive learning environments as instructors have used labs, in-class experiments, case studies, etc.[7] However, the studio format used in conjunction with laptops is certainly an interesting alternative to the *Chalk and Talk* baseline scenario.

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[7] See Becker and Watts (1998), Bergstrom and Miller (1997), Cardell et al. (1996) and Murray (1999).

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Appendix A: Chickering and Ehrmann Seven Principles[8]

1. Good Practice Encourages Contacts Between Students and Faculty

Frequent student-faculty contact in and out of class is a most important factor in student motivation and involvement. Faculty concern helps students get through rough times and keep on working. Knowing a few faculty members well enhances students' intellectual commitment and encourages them to think about their own values and plans.

2. Good Practice Develops Reciprocity and Cooperation Among Students

Learning is enhanced when it is more like a team effort than a solo race. Good learning, like good work, is collaborative and social, not competitive and isolated. Working with others often increases involvement in learning. Sharing one's ideas and responding to others' improves thinking and deepens understanding.

3. Good Practice Uses Active Learning Techniques

Learning is not a spectator sport. Students do not learn much just sitting in classes listening to teachers, memorizing prepackaged assignments, and spitting out answers. They must talk about what they are learning, write reflectively about it, relate it to past experiences, and apply it to their daily lives. They must make what they learn part of themselves.

4. Good Practice Gives Prompt Feedback

Knowing what you know and don't know focuses your learning. In getting started, students need help in assessing their existing knowledge and competence. Then, in classes, students need frequent opportunities to perform and receive feedback on their performance. At various points during college, and at its end, students need chances to reflect on what they have learned, what they still need to know, and how they might assess themselves.

5. Good Practice Emphasizes Time on Task

Time plus energy equals learning. Learning to use one's time well is critical for students and professionals alike. Allocating realistic amounts of time means effective learning for students and effective teaching for faculty.

6. Good Practice Communicates High Expectations

Expect more and you will get it. High expectations are important for everyone — for the poorly prepared, for those unwilling to exert themselves, and for the bright and well motivated. Expecting students to perform well becomes a self-fulfilling prophecy.

7. Good Practice Respects Diverse Talents and Ways of Learning

Many roads lead to learning. Different students bring different talents and styles to college. Brilliant students in a seminar might be all thumbs in a lab or studio; students rich in hands-on experience may not do so well with theory. Students need opportunities to show their talents and learn in ways that work for them. Then they can be pushed to learn in new ways that do not come so easily.

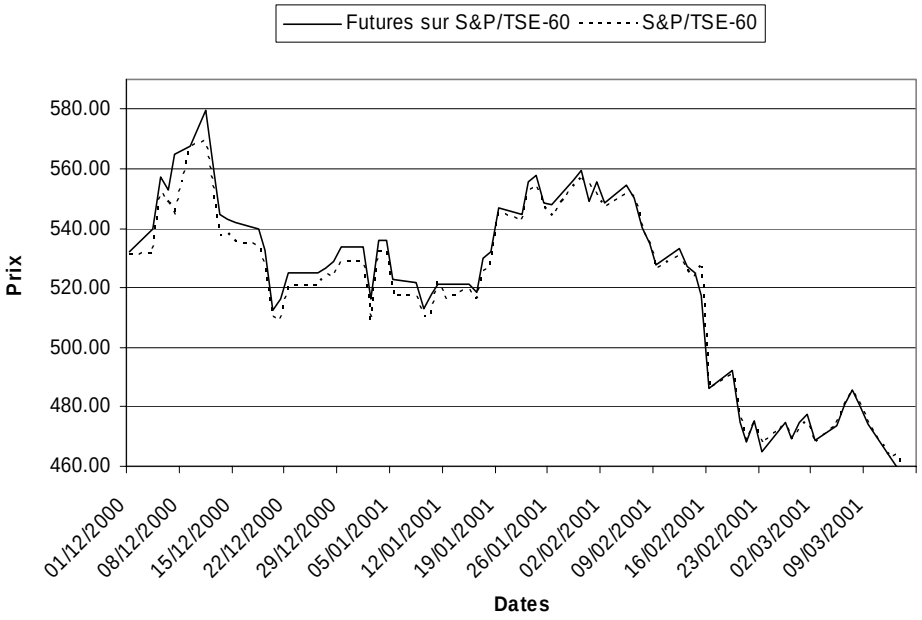
[8] Source: Chickering and Ehrmann (1996).

Appendix B: Sample Team Assignment

3-210-99 Options and Futures Fall 2003

Excel spreadsheet team assignment

Here is a time series graph of the Settlement prices for the S&P/TSE-60 Futures contract and the S&P/TSE-60 index level (details regarding the specifications of this contract are available in the Appendix of this document).



As seen on this graph, the relationship between the two series is not perfect. For example, the differences are more important during the first few days then towards the end of the sample. The central theme of the assigned readings this week focused on a model that is able to explain these differences. This assignment will explore some of the concepts associated with this theme.

Question 1

a) Compute the differences between these two series.
b) Produce a time series plot of these differences.
c) Briefly comment on the graph and on the computed series i.e.

- Are the computed differences generally positive or negative?
- Is the average different from zero?
- Is the average for the first half of the sample larger than the one for the second part of the sample?
- Are these the results we should expect?

Question 2

From the assigned readings, you now know there is a simple model which can be used to compute theoretical Futures prices.

a) Using the data in your spreadsheet and an assumption regarding the annual dividend rate of the underlying index, compute the theoretical Futures prices for each day until the maturity of the contract using the model explained in your assigned readings.
b) Compute the differences between the theoretical Futures prices and observed Futures prices.
c) Produce a time series plot of these differences.
d) Briefly comment on the graph and on the computed series i.e.

- Are the computed differences generally positive or negative?
- Are the computed differences smaller or larger than those computed in question 1?

e) Modify your assumption regarding the dividend rate and briefly comment on how these changes affect the graph and the computed series.

Question 3

Unfortunately, the dividend rate is an unobserved quantity. We therefore need an estimate of this number. The model developed in your readings provides a way to obtain such an estimate. Since we have access to the observed Futures settlement price, we could try finding the dividend rate that produces a theoretical price equal to the observed price.

$$F_{observed} = Se^{(r-q)T}$$

a) Using the above equation, find an expression that would allow you to obtain a value for the annual dividend rate.
b) Using the data in your spreadsheet, compute the dividend rate for each day until the maturity of the contract.
c) Briefly comment on your results.

- Are the computed numbers coherent?
- What is the average and variance of the computed numbers?
- Are the computed dividend rates more variable toward the maturity of the contract? Why?
- What numbers would you obtain if the model provided a perfect explanation of Futures prices?

Question 4

Suppose we are at the end of the day on December 1st 2000. On this day, you have entered with a short position in a Forward contract which is exactly identical to the Futures contract examined previously (same maturity date, same underlying security, etc.). The Forward price was set to 532.15.

a) For each day between December 1st and the maturity date, indicate the value of the Forward contract.

b) For each day between December 1st and the maturity date, indicate the cash flow associated to the Forward contract.

Question 5

As you have seen, the model developed in your readings does not provide a perfect explanation of the Futures prices. The theoretical prices are sometimes off from the observed prices. Yet, it is often very useful to have a model which explains Futures prices. Why?