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## Paper and online assignments in economics: A comparison with panel data

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### ABSTRACT

This paper compares the effectiveness of online and paper-based assignments and tutorials using summative assessment results. Students in a large managerial economics course at NUI Galway were asked to do three assignments online using Aplia and one on paper. We examined whether a student's performance on a particular section of the exam was affected (a) by how s/he performed on the corresponding assignment and (b) by whether the student completed the corresponding assignment on paper or online. Our results suggest that the paper assignments were generally more effective than online assignments in preparing students to answer exam questions.

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## 1. Introduction

The use of online assignment systems in economics and other disciplines has expanded significantly in recent years. The most widely used system in economics is Aplia which is a computer application designed to replace and/or supplement traditional paper-based assignments. The main features of Aplia are: (1) interactive content including problem sets, experiments and news analysis; (2) digital editions of a textbook; (3) assignment sets that are customized to specific textbooks; and, (4) immediate feedback for both students and instructors. The development of online assignment systems is partly driven by technological progress in the education production process. It is also supported by theories of the learning process which regard assessment as a key element in the

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feedback process that enables the learner to improve and which suggest that there should be more frequent assessments with greater emphasis on students using assignments as a guide to their own learning (Hargreaves, 2005; Karpicke and Blunt, 2011).

While technological progress and theoretical developments are clearly important motivations for adopting online assignment systems, the question of most interest to instructors and researchers is whether online assignments are as effective as paper assignments in helping students achieve desired learning outcomes. A number of papers have been published on this question in recent years. Much of this work has compared the performance of one group of students who did assignments online with another group of students who did assignments on paper (for example, Lee et al., 2010; Nguyen and Trimarchi, 2010). This makes it difficult to know whether differences in performance are due to the type of assignments the students did or other factors that might vary between one group and another.

This paper examines whether there are any differences between online and paper assignments by examining how students performed in a final examination of a course in managerial economics that was taught at NUI Galway in 2009. The examination was written as eight distinct sections with each section containing questions on a particular topic in the course. These topics had also featured in assignments that were completed by the students throughout the semester. For example, there was an assignment on production and costs and there was a section of the exam devoted solely to questions on production and costs. For four of the topics in the course we randomly assigned one quarter of the students to do an assignment on paper while the remaining students had to do an assignment on the same topic using Aplia. Our basic test is to examine whether a student's performance on these particular topics in the exam is affected (a) by how s/he performed on the corresponding assignment and (b) by whether the student completed the corresponding assignment on paper or online.

While the examination contained eight sections, and there was an assignment corresponding to each of the eight sections, there were in fact a total of ten topics taught in the course with an assignment for each topic. The first and second topics in the course did not feature in the examination at all. The marks which were available for the assignments in the course were based on the students' performance in the best eight of their assignments. Thus students might choose not to do certain assignments if they felt that they had done well enough on their other assignments. Another important detail is that students were only required to complete six of the eight sections on the exam. Some students therefore might have done six sections in the exam having done all of the corresponding assignments online but, fortunately for us, enough students chose to do the section on the exam corresponding to the assignment that they did on paper that we are able to test our main hypothesis. We are also able to test whether the choice of picking a particular section on the exam is affected by whether the student had done an assignment on the corresponding topic and, if so, whether the assignment had been done on paper or online.

The structure of the course and the exam at NUI Galway and the corresponding set of assignments were designed to give us the best possible data to address the limitations of earlier studies and the best possible chance of answering the main question of whether paper or online assignments are better for preparing students for examinations. Our dataset minimizes any potential endogeneity problems because the students were not given any choice over whether they could do a particular assignment on paper or online. The randomization to written assignments was based solely on an alphabetical ordering of the students. In addition, since the students were required to do six out of the eight sections on the exam we have up to six observations on exam performance for each student with corresponding data in most cases on assignment performance. This allowed us to use panel data techniques to analyze our data. Finally, we were able to test whether students were more likely to do online assignments instead of written ones (since they did not have to do all of the assignments) and test whether completing an assignment in itself had any effect on examination performance on the corresponding topic.

## **2. Literature review**

In recent years, a number of papers have examined the effectiveness of Aplia and other online assignment systems in economics. Collins et al. (2008) analyzed the effect of using Aplia in an introductory microeconomics class at Bellarmine University. Students were required to do practice

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