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An Introductory Microeconomics In-class Experiment to Reinforce the Marginal Utility/Price Maximization Rule and the Integration of Modern Theory

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Abstract

This paper presents an in-class experiment used as a teaching tool in an introductory microeconomics class at the undergraduate college level. It is directed at a critical but challenging concept for principles students—constrained utility maximization and a methodology to intuit preferences. The experimental project is nested in the literature pertaining to the current transition in microeconomic theory motivated by contributions from behavioral economics and transactions-cost economics, among other elements; modern pedagogical models; experimental economics; and experiments as in-classroom teaching tools. While not dispositive as to the general efficacy of in-class experiments, the paper provides an example of an alternative instructional approach which is helpful to principles students under strictly defined protocols. The benefits to students include heightened understanding of the core subject topic, greater interest in the subject matter, a closer connection to real-world economics, and enhanced critical thinking capabilities.

Keywords: experimental economics, modern microeconomics, principles classes, alternative pedagogy

JEL Codes: A22, C91, D03, D11

1 Introduction

This paper describes an experiment used as a teaching tool in an introductory microeconomics class at the undergraduate college level. Benedict and Hoag (2002, 31) present a paper to investigate, "why students are apprehensive about their principles of economics classes." Citing weaknesses in math, the authors opine, "alternative teaching methodologies may reduce the level of apprehension in the introductory courses" (Benedict and Hoag 2002, 31).

One such alternative method is the use of experimental economics. However, the general efficacy of this approach is not settled (Cartwright and Stepanova 2012, Durham et al. 2007, Dickie 2006, Walker 1987). The experiment described in this paper draws on the literature pertaining to transitions in microeconomic theory, general pedagogical approaches, experimental economics, and experiments as in-classroom teaching tools.

1.1 Motivation for the Paper

The direct motivation for the experimental approach resulted from possible student confusion about a critical consumer constrained optimization concept, as evidenced by systematic errors on an early semester test on consumer-choice and utility-maximization theory in a course taught by this author. Table 1 provides an example of a question from the relevant test that most students answered incorrectly.[2]

Table 1: Example of Systematic Student Errors on Constrained Optimization

Test question**:**

10. A consumer with a *fixed income* will maximize utility when each good is purchased in amounts such that the:

A. Total utility is the same for each good.
B. Marginal utility of each good is maximized.
C. Marginal utility per dollar spent is the same for all goods. (Correct answer)
D. Marginal utility per dollar spent is maximized for each good.
[Emphasis added]

Answer C. is correct, but most students answered B., with some choosing A. or D. This may indicate that students were not certain about guidelines relating to constrained utility maximization. However, as pointed out by one observer, C. is at least poorly worded and in fact is also incorrect. The phrase "per dollar spent" refers to expenditure, not price, and therefore does not reflect the proper theoretical constrained-utility-maximization rule This imprecise wording exists in the textbook in some instances (McConnell, Brue and Flynn 2015, 156) and in others is stated correctly (McConnell, Brue and Flynn 2015, 157-158). The reference to "fixed income" in the test question identified a constrained-optimization context. The crucial concept for maximization in this context is that for all goods i = 1 to N, $MU_i/P_i = MU_{j\neq i}/P_{j\neq i}$ where MU_i is marginal utility for good i, and P_i is the

[2] Note that the test question came directly from a McGraw-Hill Connect™ on-line test bank associated with the textbook, McConnell, Brue and Flynn (2015).

price of good *i*. Despite the previously cited poor wording, this concept was stressed in the examples in the textbook (McConnell, Brue and Flynn 2015, 152-153), in lectures, and in instructions regarding experimental design.[3] Yet confusion remained.

Typically this core optimization principle is illustrated via two-good examples as the calculations are less complex. There is nothing wrong with using a two good example—any extension of the number of goods would only serve to add unjustified complexity and increase student confusion. This is true of the instant course with no math prerequisite (described in section 1.3), but also in higher level courses where calculus approaches such as use of Lagrangian multipliers are utilized, and adding goods would increase the number of equations to the problem, requiring linear-algebra techniques for example solution. Indeed, the constrained-maximization rule delineated in the previous paragraph is derived by a Lagrangian-multiplier process. The experimental motivation, therefore, appropriately finds its application in a two-good setting.

The second motivation for the experiment was the insight that student confusion might have been exacerbated by the transitional nature of modern microeconomics due to contributions from behavioral economics and transactions-cost economics, among other rudiments. An introductory course, to be relevant and credible, must address this attribute of modern microeconomics and consumer theory. This is discussed in detail in sub-sections 2.1 and 2.1.2. A possible contributor to what appears to be math-related student uncertainty regarding the constrained-optimization rule may also reflect reaction to the seeming rigidity of the rule. In fact, the rule does not depend on neoclassical descriptions of consumer preference structures and would still obtain under modern, more flexible, views of preferences. An in-classroom experiment can help address this dichotomy.

The third motivation for the in-class experiment is that the transitional nature of microeconomics affords a distinctive opportunity for the development of analytical and creative thinking in students, in contrast to learning by rote. This is also described in sub-sections 2.1 and 2.1.2.

1.2 Background on the School

It is informative to consider the subject experiment in the context of the characteristics of the college where the experiment was used. The college of interest is the Northern Virginia Community College (NOVA). NOVA is the second largest community college in the United States (NOVA 2016). It is also highly ranked among community colleges and other non-university colleges.[4]

[3] This concept was also stressed in the midterm research paper assignment. For copies of the various examples of all of these foci please contact the author.

[4] As measured by one often-cited source NOVA is ranked as the third best community college overall in the United States and number one in the state of Virginia and the southern region of the United States. NOVA does not have an economics major; that is subsumed primarily within the business program. NOVA is ranked as the second best business community college in the United States, and number one in both Virginia and the southern region (Best-Community-Colleges.com 2016). As to faculty, based on student evaluations from one of several sources, NOVA is highly rated among collegiate institutions (RateMyTeachers.com 2016). This source may be prone to adverse-selection bias.

Most important for this paper, however, is the series of guaranteed-admission agreements (GAA) that NOVA has with all of the flagship universities in the Commonwealth of Virginia Collegiate system, as well as similar agreements with other institutions outside of Virginia and internationally (NOVA 2016a).[5] Under these agreements, students who achieve the GPA specified in each separate agreement are guaranteed admittance as third-year students in the relevant universities upon graduation from two-year programs at NOVA. What this means to instructors is that it is incumbent upon them to teach introductory economics courses at NOVA in a manner roughly equivalent to principles classes taught at the flagship universities. Instructors have a responsibility to prepare students to take additional economics courses as upperclass persons at these universities.

1.3 Class Characteristics

The experiment that is the subject of this paper was conducted in a 200-level Principles of Microeconomics course, with 23 students. Although there is a 100-level Survey of Economics course, the principles course is in effect an introductory course. It has neither an economics nor math prerequisite. For most students, this was their first collegiate economics class. The majority of students, however, are participants in the GAA program discussed in section 1.2. Many are either business or engineering majors where an economics course is a requirement.

Due to the small class size, in contrast to most large-lecture principles courses, the subject class could be structured in a quasi-seminar format, allowing use of alternative teaching techniques such as manageable in-class experiments and games.[6] The lack of a math prerequisite, however, along with general math weaknesses among many students required creative methods to address such concepts as constrained optimization.[7]

1.4 Organization of the Paper

The remainder of the paper is structured as follows. Section 2 identifies the theoretical and methodological issues which through survey of the appropriate literature informed experimental protocols and design, and post-experiment activities. Section 3 describes the pre-experiment activities, the actual experiment, and the key post-experiment assignment. Section 4, Results, is primarily devoted to the apex of the paper: an assessment of student performance on post-experiment projects. Section 5, Discussion, offers generalized treatment of subjects not covered in Section 4. Section 6 completes the paper with conclusions.

[5] In Virginia NOVA has guaranteed-admission agreements with the University of Virginia, Virginia Polythechnical Institute and State University, George Mason University, James Madison University, Virginia Commonwealth University, the College of William & Mary, and others. In addition NOVA has a guaranteed-admissions agreement with the University of New Mexico, and Memorandums of Understanding with American University in Washington DC, and Abertay University in Dundee, Scotland.

[6] Besides the experiment described in this article, the class played the "ultimate game" and the "prisoners' dilemma game" during consideration of bounded rationality and information asymmetries.

[7] Early in the semester, math-refresher homework was assigned which enhanced understanding of topics that usually require math solidity.

2 Theoretical Issues and Methodological Protocols

2.1 Theory Challenges—Teaching Modern Microeconomics in a Transitional Environment

Modern microeconomics is currently undergoing modification of some of the rigid simplifying assumptions pertaining to consumer preference structures and utility maximization adopted in antiquity to enable reasonable economic computations in a technically primitive but factually complex environment (Gayer and Viscusi 2013).[8] The objective is a tractable model of consumer behavior with better predictive power, which includes more realistic psychological insights as well as transactions-costs concepts such as information asymmetries between sellers and consumers (Camerer and Lowenstein 2004, Simon 1955).[9]

This presents a major challenge for instructors and students alike. In particular the critical concept of "rationality," traditionally taught with reference to neoclassical definitions, must be amended for both plausibility and relevance to critically thinking students without descending the slippery slope of the non-rigourous notion of ubiquitous consumer "irrationality."[10]

Many if not most economists embrace "bounded or procedural rationality" (Simon 1955), albeit with the caveat that the concept requires refinement. Bounded rationality encompasses the heterogeneity of individuals' preference structures which are not static, human fallibility, and limitations on cognitive and informational resources. Humans nonetheless are assumed to strive for decisions consistent with progress towards approximate optimization of their preference structures (Dichaut et al. 2009, Chorvat et al. 2005, Camerer and Lowenstein 2004, Jolls et al. 1998, Simon 1959, Simon 1955).

Instructors should view the tension in positive microeconomic theory as an opportunity to foster critical thinking and debate. Creative thinking thrives when there are no absolutes—when within bounds there are no right or wrong answers. The takeaway is that the transitional nature of positive microeconomics provides a unique opportunity for principles students to apply analytical thinking in the learning process. This distinctive environment provides especially fertile ground for properly designed in-class experiments

[8] Such expedient but unrealistic assumptions' longevity extends to 1890 when Alfred Marshall published his *Principles of Economics* (Marshall 1890).

[9] The notion of including psychological insights in the standard model is nothing new, and was even seen in the writings of Adam Smith in his 1759 book *The Theory of Moral Sentiments* (Smith 1759), which predated *Wealth of Nations* by 17 years and included many of the observations found in modern behavioral economics.

[10] As stated by one author: "'Irrationality' the quality of being devoid of reason, is a highly pejorative term in our culture. To call someone irrational is to malign him or her, for an irrational person lacks normal mental clarity or coherence, or behaves absurdly, unreasonably, or foolishly. Because this kind of behavior is, by its very nature, beyond the scope of rational inquiry, over the years scholars have gradually reduced its domain" (Lamoreaux 2001, 632). In light of this view, to consider "irrationality" an analytical economic concept is to render microeconomics tautological, and largely irrelevant. Deviations from traditional rationality precepts would simply be deemed irrational—by definition not subject to any investigation of predictive hypotheses.

regarding consumer behavior which allow students to participate in and observe decisions and reactions in real time, and analyze results and test hypotheses critically, *ex post*, outside of the straight-jacket of settled doctrine.

2.1.1 The "Traditional" Approach to Teaching Principles of Microeconomics

The traditional teaching of a microeconomics principles course has several characteristics. First, the theory of the firm and market structure are typically taught first, with consumer theory reserved for a latter portion of the course. This is evidenced by the structure of textbooks, including the one used in the course taught by the author (McConnell, Brue and Flynn 2015). Of course textbooks are usually modular, so this topic ordering is not obligatory.

A second characteristic is the sequential nature in which consumer behavior is taught. An initial and heavy emphasis is on the neoclassical model of consumer preference structures and decision-making, with amendments taught later as special topics. Modern consumer-theory insights are typically relegated to a new chapter added in later editions of textbooks that haven't changed much in decades, and lectures often mirror the texbooks (McConnell, Brue and Flynn 2015).

The third characteristic is the use of arithmetic constructs to illustrate concepts that in real life are not amenable to quantitative observation. An example is found in utility-maximization explanations where both total and marginal utility are expressed as "utils," in turn employed in preference ordering.[11] Indeed the constrained optimization rule described in 1.1 is usually explained through expressing the marginal-utility/price relationship as the ratio of the quantity of utils to price.

A fourth characteristic of the traditional teaching method is that in-class experiments are often designed to "prove" neoclassical concepts of consumer behavior. An example of this is found in Walker (1987) which describes an experiment to express consumer demand solely as a function of price changes, and which is designed to experimentally establish a well-functioning monotonic demand curve. This is made explicit by the author: "The value (and most important purpose) of this kind of exercise is its use as a tool to demonstrate rational behavior as economists traditionally characterize it" (Walker 1987, 55).

There is nothing intrinsically wrong with the traditional teaching approach as many believe that the purpose of a principles course is to imbue in students a strong foundation of basic economic ideas. No definitive empirical evidence has been produced that demonstrates that more "modern" approaches are more effective. Further, in real-world educational settings instructors, themselves, face a constrained optimization situation.[12] However

[11] This "shortcut" teaching technique also finds its genesis in the 1890s (Marshall 1890).

[12] Real institutional issues dictate that, especially for principles courses, use of integrated textbook/on-line support materials, usually reflecting traditional methodology, is efficient. However, integrated materials can be expensive for students, and instructors cannot just marginalize students' investments. Open-source options are not usually not considered

there is concern that the traditional method might dampen critical thinking. It may also prove less attractive to students who must suspend their disbelief; diminishing enthusiasm and discouraging further exploration of economics. Finally, as described in 2.1.2, the shortcuts and artificial tools of traditional techniques may not be necessary to effectively teach principles of microeconomics.

2.1.2 A More "Modern" Principles-of-Microeconomics Pedagogy

A more modern approach to teaching a microeconomics principles course would alter some of the characteristics linked to the traditional methodology described in 2.1.1.[13] For example the topic structure would be reversed—consumer theory would be taught before the theory of the firm. Why is this important? The principles course is often the first economics course students take. And students are all consumers, therefore personal experience can be brought to bear, easing internalization of core concepts, or allowing instructors to identify disconnects between experience and fundamental concepts. Experiential learning can be quite useful in promoting more flexible and comprehensive learning, and better knowledge retention (Kolb et al. 2000). As stressed by Burdina and Sauer (2015, 29):

> The theory of Generative learning . . . posits the learner relates new information to information she already understands by creating her own connections between new concepts and prior stored information. The new content that she is exposed to may integrate seemlessly into her schema, may be partially or incorrectly processed, or may be rejected entirely if it conflicts with what the learner already "knows" to be true.

In the author's principles class, the generative-learning model and the benefits of experiential learning were considered self-evident; consumer theory was taught first, and the concept was embodied in the experiment that is the focus of this paper. If a conflict arises between principal economic concepts and experience, the result is an opportunity for critical thinking. Humans rarely can ignore unsettled mental outcomes on important issues. Introspection follows naturally to resolve the conflict which, if "nudged" by the instructor, can lead to solidified understanding of essential economic principles that are reinforced by experience—not just drilled and memorized, but not truly internalized.

This type of topic-ordering is also being seen in newly emerging teaching materials. An example is the quasi-textbook by Dixit (2014) entitled *Microeconomics: A Very Short Introduction*. The book's first major topic is consumer theory, which receives extensive attention.

The second modification concerns the sequential instructional nature of principles courses. There is no reason why the neoclassical model, behavioral and transactions-cost economics insights such as bounded rationality,

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for principles courses although some schools, including NOVA, are exploring these options. In the interim, instructors must find creative ways to honor student investments while also introducing modern innovations.

[13] The terms "traditional" and "modern" are used solely as identifiers; no value judgement is placed on one or the other.

and the like cannot be introduced and explored simultaneously. The inevitable mental clashes that arise are positive developments—they demand further introspection and creative thinking. When teaching an economic discipline that is in flux this is also intellectually honest.

Sequential teaching may also cause problems where a student's inclination is to place greater weight on the first approach taught and stressed, in this case a depiction left basically intact since its inception in the 1890s, while treating later models as also-rans which are subsequently marginalized. Of course the opposite response—rebellion—is also possible. Dixit (2014) does not present consumer theory sequentially, and this author's approach was to teach the diverse representations of modern microeconomics simultaneously, subject to the constraints of the textbook.

A third component of modern microeconomics pedagogy is to jettison arithmetic shortcuts designed in good faith to make the learning of more abstract concepts, like preferences, more transparent. But quantifying the unquantifiable can inadvertently sow confusion and squelch creative analysis. There is no technique to measure quantities of utils. Students, through life experiences, are frequently adequate judges of choice reactions to things *that are* quantifiable, like prices. If judgement errors are made, the resulting mental conflicts offer further creative-thinking occasions.

Finally, in-class experiments should not be designed to "prove" a concept, or even produce a high probability of illustrating a theory deemed dispositive. In-class experimental design must not reflect results-dependence. This is discussed in detail in 2.2.1 and 2.2.2.

2.2 Methodological Challenges

To be consistent with the teaching methodology outlined in 2.1.2, an in-class experiment must be firmly grounded in the protocols of *research-oriented* experimental economics. This will become evident when the relevant protocols are presented in 2.2.1. In addition the literature on the efficacy of in-class experiments as teaching tools describes further protocols that must be considered for pedagogical purposes. These are described in 2.2.2. Finally 2.2.3 synthesizes these two literatures and provides the protocols upon which the subject experimental design was based.

2.2.1 Research-based Experimental Economics Protocols

Davis and Holt (1993) provide some basic rules for economics experiments: 1) Details such as clear, explicit, and replicable instructions are important, and must be reported in detail;[14] 2) Careful attention must apply to experimental design in order to focus on a very limited number of items of interest, and avoid the tainting of

[14] The authors stress this for purposes of experimental replication for verification purposes, but it is also important in an educational environment. Detailed instructions enhance student clarity. But explicit, reported instructions are also necessary to expand the innovations portfolio of other instructors who may desire to use specific experiments in their own classes.

results from spurious explanations; and 3) The complexity of the experiment must be "appropriate to the problem being investigated" (Davis and Holt 1993, 201).

Bardsley et al. (2010) list some additional notable protocols: 1) Experimental design need not be limited to markets and equilibria, "as it is simply not the case that economic theory is intended to apply only to markets" (Bardsley et al. 2010, 333); 2) An observed anamoly is not necessarily indicative of poor experimental control as individuals' preferences reflect internal subjectivity; and 3) "The discovery of *some* pattern in the results of an experiment is not as surprising as the discovery of a *specific* pattern that was predicted in advance" (Bardsley et al. 2010, 335). This latter goes to the modern-methodology concept, discussed in 2.1.2, that in-class experiments should not be designed to prove a concept.

Results-independence is a fundamental experimental protocol both in research experiments and teaching-oriented in-class experiments. Houser (2008) stresses "transparence," an iterative process of replication, which serves to promote the credence of outcomes. An essential component of this process is that experiments not be results-dependent.[15] Smith (1985) argues that negative experimental outcomes improve experimental techniques, and experiments that only produce desired results do not enhance knowledge. This is echoed by Davis and Holt (1993).

2.2.2 Classroom Experiments as Teaching Tools: Separate Protocols

One of the most important additional experimental protocols from the economics education literature concerns student participation in experimental design. Bosley (2016, 1) notes that, "student-owned experiments constructed 'from the ground up' might have benefits that exceed pre-designed classroom experiences." This view mirrors the experience of Mertins and Henrik (2010) who are especially concerned with behavioral economics, a topic that features in the experiment that is the subject of this paper. Student-experimental-design can be a double-edged sword. Clearly student engagement enhances the learning exerience. However un-bounded engagement can lead to violations of other protocols such as focus on a limited set of concepts, simplicity, and designs that mitigate extraneous or nonsensical results; in turn eroding the educational benefits. This is treated in the Discussion section 5.

A second key protocol concerns post-experiment activities. Cartwright and Stepanova (2012) conducted an empirical analysis of experiments performed in first-year economics courses and found statistical evidence that students performed better on test questions on topics that were also the subjects of in-class experiments if they had to analyze experimental data *ex post* and write research reports.

Durham et al. (2007) add these additional insights: 1) Due to the time-related costs of in-class experiments, they should be narrowly focussed on limited topics; 2) For similar reasons in-class experiments should be directed at

[15] Note that in a time-constrained in-class experiment, replication can be achieved by repeated trials of the same experiment in a short time period.

select areas where students are struggling and might be assisted by direct engagement; 3) In-class experiments must be kept simple in design and instructions; and 4) Properly-designed in-class experiments may produce tangential benefits to students. This latter insight is investigated in Discussion section 5 with respect to the subject experiment.

The final additional protocols are described by Holt (1999), and mirror the research protocols attributed to Davis and Holt (1993) in 2.2.1. Detailed instructions for in-classroom experiments are stressed, but serve a different function than those for research experiments:

> In a classroom exercise, the reading of instructions has a different value. It ensures that essential details are not overlooked by the instructor and that inessential side comments are avoided. One of the common errors in running classroom experiments is to add a lot of interjected comments that can delay the quick start needed to save time for *ex post* discussions (Holt 1999, 606).

Holt also notes time constraints and suggests that in-class experiments should be rationed to concentrate only on critical concepts. He also agrees with Durham et al. (2007) that experiments should address areas of student confusion (Holt 1999).

2.2.3 Specific Protocols for the Utility-maximization/Preference-revelation Experiment

Based on the theoretical challenge discussed in 2.1, the modern teaching methods discussed in 2.1.2, and the experimental protocols listed in 2.2.1 and 2.2.2 the protocols employed in the design of the in-class experiment that is the subject of this paper are the following:

1. The primary focus of the experiment was the constrained-utility-maximization rule provided in 1.1. Other items of interest were limited to behavioral aspects of consumer decision-making, consumer and seller reactions to information asymmetries, and bounded rationality in consumers and sellers.
2. Controlled student participation in experimental design was a point of stress.
3. Explicit and detailed instructions, developed iteratively based on student reaction, were repeated frequently in rubrics to the experiment assignment, follow-up emails to students, and verbally on several occasions in lectures, as well as a comprehensive listing directly prior to conducting the experiment.
4. The experiment involved an initial (first unit) consumer choice between two products where information asymmetries applied to both sellers and buyers, and no artificial constructs like utils were employed. The decision-making occurred in a non-market, intra-equilibrium environment.
5. Repetition occurred through repeated trials of the same experiment by the same group of students. Each trial concerned a choice of an initial unit, thereby abstracting from market concepts such as diminishing marginal utility. However, as discussed later, this protocol may have produced an inadvertent design flaw.

6. The experiment was not designed to be results-dependent. Anomalies were expected and deviations from the constrained-optimization rules were not generally considered design flaws, but rather opportunities for analysis.
7. The experimental design was simple with built-in controls to prevent extraneous and distracting phenomena such as strategic behavior.
8. The experiment was immediately followed in the same class period by student discussion of preliminary results.
9. The students were assigned a significant *ex post* project which involved analyzing the experimental data and writing a research report.

3 The Experiment

3.1 Experimental Information Accumulation and Preparation

To begin the project all students were instructed to send a private email to the author listing two products that in their minds could characterize a choice event that they might confront. Product descriptions were lean, basically a simple identification of the products and possibly their brand. This was necessary to limit experimental complexity. The students were asked to indicate which product was preferred, based on their subjective qualitative preference structures, *ignoring prices*. Note the design feature that the product space was defined by individual students, not by the instructor. Students were admonished to maintain strict privacy regarding the transmitted information—it was not to be shared with anyone but the author. This set the first of two information asymmetries.

From all of the student product-pair submissions the author chose five pairs considered to be the most theoretically interesting, and most likely to provide experimental data that would provoke the most lively student debate and analysis. These five pairs would be inputs in five separate experiments involving five separate student teams.

Based on price data from multiple sources, the author assigned a wholesale-seller cost to each product. Price slips were produced which listed seller-cost for each product which would be issued to each of the two "sellers" in each of the five experiment teams as discussed below. This product/cost information was known only to the seller of the product. This set the second information asymmetry. An example of a template for the product/cost slips for one of the five experiments is displayed in Figure 1.

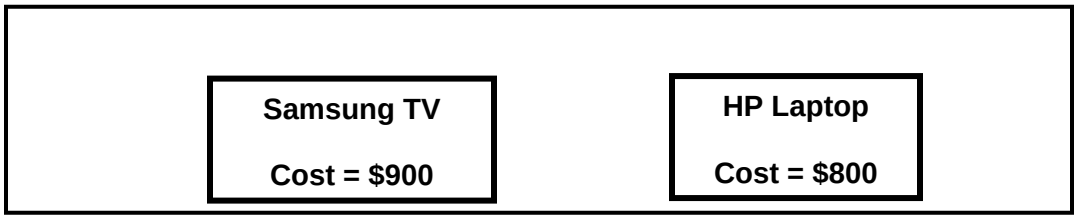

Figure 1: Recreation of Experiment 2 Notes for Two Sellers Listing Sellers' Costs

The accumulation of the five product pairs and associated preferences, and construction of wholesale-costs for sellers defined as retailers constituted the necessary information accumulation and manipulation for the experiments inputs.

3.2 Experimental Design and Rules

1. Students were divided into five groups of four, one team for each product-pair experiment. This guaranteed an experimental role for every student.
2. Each experimental team included one buyer. The buyer was the student that had submitted the chosen product pair and was the only member of the team to know which of the two products was preferred—an attribute that was strictly enforced by the instructor during conduct of the experiment to maintain the information asymmetry.
3. Each experimental team included two sellers, one for each product. Sellers were chosen in class from the students not selected as buyers directly before performance of the experiment. Product/cost slips were also distributed directly prior to the experiment with the strict admonition that each product/cost slip was to be closely held and in no way shared with any other student, a protocol strictly monitored by the instructor. The timing of seller assignment and product-cost-slip distribution were controls to minimize erosion of the information asymmetry.
4. The final member of the team was a rapporteur/referee. Her/his role was to record the actions of sellers and reactions of buyers, as well as to ensure a complete prohibition of non-sanctioned communication. The rapporteur for each experiment was furnished a template to record the relevant experimental information. An example is provided in Table 2.

Table 2: Experimental Template

Experiment #			
	Product 1	Product 2	
Trial	Proposed Price	Proposed Price	Buyer's Decision if Any
1			
2			
3			
4			
5			

5. To prevent any strategic behavior, no verbal communication was permitted among any team players. This also preserved the two information asymmetries.
6. The general structure of the experiment was for each seller to offer a retail price above wholesale cost which would afford a profit. The buyer could compare her/his pure marginal utility assessment to the offered prices, but could pick only one of the two products, or reject both. This latter was a representation of a financial constraint as it implied that at any set of relative prices, the buyer could only afford one of the two products. Although the MU/P relationship was stressed in the instructions (instructions were provided in

repeated emails to the students, and in lectures, as discussed in Protocol 3 in section 2.2.3.[16]), behavioral aspects such as emotional motivations, in turn influenced by the cost information asymmetry, might also affect a buyer's decision.

7. The experiment consisted of five trials for purposes to be explained. It began in trial 1 with each seller passing a slip of paper with a proposed retail price to the rapporteur. *Ex ante* each seller's proposed price was unknown to the other seller. The rapporteur would record the prices on the template and pass it to the buyer. The buyer would then record the product choice if any, and return the template to the rapporteur.
8. The template, reflecting the two proposed retail prices and the buyer's decision was sequentially shown to each of the sellers, but absolutely no intra-team communication was allowed.
9. From observation of the Trial 1 results each seller would attempt to intuit the buyer's preference structure, and the other seller's cost. She/he would then would propose an adjusted retail price for Trial 2 via the secret procedure employed in Trial 1, either to change the buyer's choice or to increase her/his profit level. The trial 2 results would then be viewed sequentially by sellers through the procedures used in Trial 1 and further revised prices would be proposed for Trial 3. These procedures would be repeated for five trials, after which the experiment would conclude.
10. There are two important aspects to the experimental design. First *each* trial was considered to be an *initial* choice exercise (mirroring the movie "Groundhog Day") so that diminishing marginal utility did not enter decision-making. The repeated trials did, however, allow for experiential learning by sellers (and buyers), facilitating discernment of possible patterns; as well as anomalies to the MU/P rule that could have behavioral or transactions-cost explanations.
11. Upon completion of the experiment, information on preferences and seller costs were added to the experimental templates for use in post-experiment intra-team and total class discussion.

3.2 Addressing Challenges on Experiment Day

Information regarding the protocols listed in 2.2.3 and the specific rules described in 3.1 had, as stated, been repeatedly provided in rubrics and other written communications, as well as verbally during a dedicated portion of every lecture within three weeks of the experiment. There was a steady informational build-up leading to experiment day which stressed the importance of the entire experimental process, reinforced by required active student involvement in initial experimental design. Students were well aware that the data produced by the experiment would form the cornerstone of students' research papers, which would serve as a midterm exam with substantial weight in their final course grade. This factor was stressed in a final email from the author delivered on the day of the class in which the experiment was to be conducted.

[16] Copies of these emails are available upon request from the author. *Ex pos*t, the research paper midterm assignment specifically addresses the MU/P rule. For space reasons, these sources are not presented in this article, but all instructional materials are available upon email request to the author.

Nonetheless students' natural distractions from other courses and assignments, and standard time and cognitive-resource constraints, was evident in repeated student questions that reflected uncertainty during classes even a week before experiment day. Also, since in-class experiments were completely novel to students, a bit of stage fright might have been manifested since students understood that their performance during the experiment (as with pre-experiment activity) would influence their midterm grade. In retrospect, this anxiety could have been mitigated by a more explicit explanation of how experimental performance would be evaluated for midterm grading purposes, with, for example, an emphasis on active participation rather than getting "right" answers. Therefore, directly prior to conducting the in-class experiment students were presented verbally with a succinct delineation of the rules and protocols as well as a streamlined explanation of the pedagogical reasons for, and the related goals of, the experiment.

Whereas these final instructions did enhance experimental performance for many students, the instructions alone were not sufficient to ensure an educationally beneficial experience. Until students were actually in the crucible, jitters were evident, and in some cases rules and protocols were not followed in initial trials. A vital aspect of experiment-day activity was intensive instructor-monitoring of the progress of the experiment. The author circulated among the five teams during each trial, and directly communicated with all participants after every trial, to ensure that instructions were being followed and extraneous diversions avoided.

Human nature, personality traits, and reliance on prior work experience which could trump strict protocols unsurprisingly made the prohibition-on-communication rule one of the more difficult to enforce. Yet this rule was essential as it was the dominant way to preclude strategic behavior.[17] In one case a seller attempted to bargain with a buyer who had not chosen his/her product in a previous trial by "throwing in" many additional items not included in the lean product description. This was quickly nipped in the bud and the experiment briefly stopped to reiterate the non-communication rule. The non-communication rule was observed in the remainder of the experiment. Absent strict monitoring of the experiment, much unproductive mischief may have occurred.

3.3 The Research Paper: Midterm Exam

As indicated in Rule 9 in 3.2, experimental data, with preferences and seller-costs added, was distributed to students quickly after the end of the experiment in the same class period. Discussions, with instructor oversight, were first held by individual experiment teams, and then the entire class engaged in debate including preliminary analysis of results, and a critique of the experimental design.[18] This set the stage for the final portion

[17] A modification to the experiment in fact would present an interesting and effective way to observe strategic behavior, but experimental protocols required items of interest to be strictly limited. Expanding the narrow focus of the experiment defined by protocol 1 in 2.2.3 would have seriously diluted the educational benefits of the experiment.

[18] The subject class was a once a week meeting with a 2 hour and 40 minute duration. While the class length normally presented a challenge with regards to lesson planning to maintain student attention, it was a benefit on experiment day.

of the class where the capstone research paper was assigned verbally. This was followed up by a detailed set of written rubrics for the midterm research paper within four days, and students were given thirteen days to complete the assignment.

The format of the research paper relied on empirical observations by Dynan and Cate (2009) of the usefulness of structured versus unstructured writing assignments. The authors differentiate between lower- and higher-order learning. Lower-order learning is defined as basic conceptual knowledge and simple applications. Higher-order learning involves more complex analytics and evaluation. The authors' results imply that structured writing assignments enhance lower-order learning but do little to improve higher-order learning. For the latter, more unstructured writing assignments prove more advantageous to students. This logically follows as analysis of more complex information requires more creativity, and giving students more mental room to roam provides the proper environment for critical thinking.

The research paper of course required higher-order learning, but the assignment was also a midterm exam which had to be amenable to assessment of students' proficiency in lower-order learning as regards the basic course concepts of consumer theory. As such the assignment was bifurcated between structured and unstructured portions of the paper.

To enhance student interest and ownership, the midterm research paper was "marketed" as akin to an academic research paper that might find its way into a peer-reviewed journal. Thus the paper's structure was required to include an introduction, a "literature survey," a discussion of experimental design and operation, an analysis of the data with reference to the limited items of interest, and a summary section that would, among other things, critically evaluate the experiment and make suggestions for alterations that would boost the achievement of the experiment's goals.[19]

The literature survey was in fact merely a summary of all of the primary concepts in the course curriculum pertaining to consumer decision-making and utility-maximization theory, with a special empahasis on constrained optimization. The "literature" was only required to include course materials; comprising the textbook, linked on-line resources, and class lectures. [20] Since this is lower-order learning, this portion of the paper was a structured assignment.

The summary of experimental design and operation was also somewhat structured; here the source material was the written rubrics, protocols, and rules, and the verbal instructions provided by the author.

There was adequate time for pre-experiment instruction and explanation, the experiment was conducted in a leisurely fashion, and plenty of time remained for post-experiment discussion.

[19] A copy of the midterm assignment is available from the author upon request.

[20] This literature included the relevant textbook chapters (McConnell et al. 2015), the related McGraw Hill on-line resources Connect™ and LearnSmart™, and lectures and PowerPoint™ presentations by the author. Chicago citation rules were in effect for direct quotes, close paraphrases, and reference to any outside sources, but were relaxed for general summaries from course materials where a simple statement of attribution was sufficient.

The analytical section began the unstructured part of the paper as the assignment affirmed that in the section, "utmost creativity was required." Specific instructions for the analytical section provided wide technical latitude, consistent with a principles course:

> Look for patterns, consistencies with traditional theory, and anomolies from that theory. You may use any techniques you deem appropriate, including simply eyeballing data, using simple math, graphs, even elementary statistics. But no math is required. A thorough, critical and creative observation of the data can produce "robust" results.

The final "summary" section was similarly designed as an unstructured portion of the paper, again allowing wide lattitude for creativity and critical thinking:

> You do not have to try to prove that the neoclassical microeconomics consumer theory is right or wrong. . . Just summarize your results, be critical, and discuss possibilities for future research. Focus your conclusions on your unique observations, elements that confused you, results that made theories more salient, curiosities, anomalies—any new thought motivated by the data.

4 Results

4.1 A Brief Author Suggestion for Experimental Data Analysis

The effectiveness of the experiment is best analyzed through critical observation of students' research papers, provided in 4.2. Prior to this investigation, however, a brief data-analysis example by the author will serve to put these papers into context.

Table 3, in the first four columns, displays the data attached to the mid-term assignment. A fourth column, not provided to students, has been added which displays, for each trial in each experiment, the ratio of the proposed retail price of the preferred product to that of the non-preferred product. One possible strategy to intuit buyers' preferences, or to isolate anomalies, is to view choices in the context of these relative prices.

Consider experiment 2. In the first trial the relative proposed price ratio is 115.3% and the preferred good, the Samsung TV, is chosen. This result implies, based on a strict reading of the constrained optimization rule, at least that $MU_{SamsungTV}/MU_{HPLaptop} > 1.153$. In the second trial the relative price ratio is 136.3% and the HP Laptop is chosen, implying that $MU_{SamsungTV}/MU_{HPLaptop} < 1.363$. Observation of all 5 trials and switching behavior suggests that the marginal utility ratio is approximately bounded between 1.26 and 1.34.[21]

Table 3: Data from Class Experiment

Experiment 1	Generic Smartphone ***Pref.**** Seller's Cost=$175	Generic Laptop Seller's Cost=$150	

[21] The subjective, unobservable marginal-utility-ratio boundaries can only be approximated because the price-ratio data are discreet, not continuous, and there are only a few data points. But even these limited data are sufficient for students to roughly intuit preference structures, which is adequate for teaching purposes.

Trial	Proposed Price	Proposed Price	Buyer's Decision if Any	Relative prices: Preferred/Non-preferred
1	$300	$220	Smartphone	136.4%
2	$600	$200	Smartphone	300.0%
3	$550	$185	Laptop	297.3%
4	$400	$190	Laptop	210.5%
5	$200	$185	Smartphone	108.1%
Experiment 2	**Samsung TV *Pref.****	**HP Laptop**		
	Seller's Cost=$900	**Seller's Cost=$800**		
Trial	**Proposed Price**	**Proposed Price**	**Buyer's Decision if Any**	**Relative prices: Preferred/Non-preferred**
1	$1,499	$1,300	Samsung TV	115.3%
2	$1,499	$1,100	HP Laptop	136.3%
3	$1,395	$1,100	Samsung TV	126.8%
4	$1,400	$1,000	Laptop	140.0%
5	$1,350	$1,000	Laptop	135.0%
Experiment 3	**Caribbean Cruise *Pref.****	**Caribbean All-Inclusive Vacation**		
	Seller's Cost = $800	**Seller's cost = $700**		
Trial	**Proposed Price**	**Proposed Price**	**Buyer's Decision if Any**	**Relative prices: Preferred/Non-preferred**
1	$1,200	$900	Caribbean Cruise	133.3%
2	$1,100	$900	Inclusive Vacation	122.2%
3	$1,100	$875	Caribbean Cruise	125.7%
4	$1,050	$850	Caribbean Cruise	123.5%
5	$1,000	$800	Caribbean Cruise	125.0%
	PS4 *Pref.**	**X Box One**		
Experiment 4	**Seller's Cost= $200**	**Seller's Cost=$250**		
Trial	**Proposed Price**	**Proposed Price**	**Buyer's Decision if Any**	**Relative prices: Preferred/Non-preferred**
1	$350	$300	Both Rejected	116.7%
2	$315	$290	PS4	108.6%
3	$305	$290	PS4	105.2%
4	$325	$275	X Box 1	118.2%
5	$360	$270	PS4	133.3%
	Smoothie *Pref.**	**Mocha Latte**		
Experiment 5	**Seller's Cost= $2.00**	**Seller's Cost=$2.50**		
Trial	**Proposed Price**	**Proposed Price**	**Buyer's Decision if Any**	**Relative prices: Preferred/Non-preferred**
1	$2.04	$3.75	Smoothie	54.4%
2	$2.06	$3.00	Smoothie	68.7%
3	$2.08	$2.55	Smoothie	81.6%
4	$2.18	$2.52	Mocha Latte	86.5%
5	$2.13	$2.52	Smoothie	84.5%

* Preference relates to the preference structure, known only to the buyer, as if the two goods were costless. It is the pure marginal utility, where Good 1 is the preferred good and $MU_1 > MU_2$.

Experiment 1 contains an anomaly. When the relative price ratio is 136.4%, the preferred Smartphone is chosen. When the relative price ratio rises to 300% in Trial 2, the Smartphone is still chosen. Yet when in trial 3 the ratio drops slightly to 297.3%, the Laptop is chosen. Only when the relative price ratio drops to 108.1% in Trial 5 is the Smartphone again picked. The Trial 2 anomaly requires critical analysis. Otherwise the subjective marginal utility ratio appears to be approximately nested between 1.36 and 2.97. Experiments 3 and 4 contain definite anomalies.[22] These anomalies may have resulted from an inadvertent experimental design flaw

[22] One case might be attributed to choice-effecting emotions relating to perceived unfairness in proposed prices, and the other deviation might reflect a possible impetuous decision in one trial in the face of an otherwise completely dominant partiality for the preferred product. This speculation is based on post-experiment debriefs of the relevant student buyers.

produced by repeated trials of the same experiment by the same teams. Remedies to this are considered in Discussion 5.2. Further discussion of patterns and anomalies are best left to the analysis of student research papers in 4.2.

4.2 Student Analysis and Assessment: A Survey of Midterm-Exam Research Papers

Assessing the effectiveness of the experimental approach that is the subject of this paper, given the class size, is not possible through a quantitative analysis.[23] Nonetheless quantitative analysis is always preferred. Repetition of this experiment would produce a more robust data set. In addition, conducting this experiment in much larger lecture-style-format classes would allow for the random assignment of students to control and experiment groups with subsequent binomial-variable quantitative assessments of test results. This would be particularly valuable.

A qualitative analysis of student research papers will suffice as long as this analysis is anchored in limited but strict criteria that relate both to experimental design and other methodological issues, and goal achievement which is reflective of the motivations listed in 1.1, and elaborated on throughout the paper. The criteria are whether: 1) The experimental protocols listed in 2.2.3 and the rules summarized in 3.2, distributed in written and verbal form, were sufficient to provide for student clarity and a smoothly functioning, targeted experiment; 2) Student understanding of the fundamental constrained-utility-maximization rule was enhanced by the experiment; and 3) The experiment stimulated critical and creative analytical thinking which was reflected in midterm research reports. Additional general commentary is offered in Discussion section 5.

4.2.1 Were the Experimental Protocols and Rules and their Communication Commensurate with the Task?

Assessment of this criterion is based on a survey of the portions of student research papers devoted to description of experimental design, and additional comments in other paper sections. The overwhelming majority of students wrote very detailed experimental-design sections that accurately portrayed the protocols, rules, and process of the experiment, as well as the purpose of these instructions. Significantly virtually every student stressed the two information asymmetries, and why these experimental components were noteworthy. The purpose of the experiment appeared to be well understood. Selective quotes from student papers illustrate some specific items of interest.

The students understood the importance of experimental controls and monitoring to prevent extraneous events such as strategic behavior. Referring to the rapporteur one student stated that, "my group had a middle man to make sure no insider deals happened and nobody messed with the results. Much like a moderator in a debate to

[23] The relevant data are limited to 23 research papers. An empirical analysis would have to measure student improvement from the early-semester test mentioned in 1.1 to the midterm research paper. The former only concerned the core constrained utility maximization rule, while the latter included other learning characteristics; therefore a direct comparison would be over-identified. Even if a direct empirical comparison could be designed, the dearth of data would seriously diminish the probability of statistically-significant results.

keep everyone on topic and not get side tracked. . . [O]nce the sellers made their price it was fixed. They were not allowed to bargain, or cut some type of deal with the buyer." Another student opined: "It is important to have these experiments be monitored and controlled, like the one that was performed in class."

Experimental purpose had to be transparent. The experimental protocols stressed that the experiment not be results-dependent, but rather designed to explore consumer decision-making freely. This was well understood by students. As one student said: "Through this class experiment, one was able to better understand the thought process of consumers." Another student viewed the experiment as a hypothesis test, not an illustration of a concept deemed to be settled: "The purpose of this paper is to see how the use of experimental techniques are used to test traditional consumer decision-making under the traditional microeconomic theory of consumer behavior." A third student stressed critical thinking and individual analysis: "With the use of experiments we are able to determine and make assumptions for ourselves about whether or not the relationship between utility and price are really connected . . ."

A related protocol stated that the subject experiment was designed to be non-market and intra-equilibrium. This was understood by students. One student complained that as opposed to consumer research, economic experiments were problematic, "due to economists' traditional focus on market outcomes as opposed to individual behavior."

Another central component of the protocols was student participation in experimental design. One student addressed this succinctly in the summary section:

> Experiments facilitate more active learning than traditional lecture and discussion methods. In standard classroom experiments students are active in the sense that they generate data through their own decisions and are engaged in social interaction. However, classroom experiments do not realize the full potential of active learning. Our experience can be summarized as follows. Instead of using traditional classroom experiments, students were encouraged to develop variants of . . . experiments on their own. Thus, they became active learners both by designing and conducting the experiment, and by conducting an analysis of the generated data.

While evidence from student research papers seems to imply that the experiment was properly designed and purpose, protocols, and rules well understood, some students offered constructive criticism of experimental design. These criticisms are investigated in Discussion section 5.

4.2.2 Was student understanding of the fundamental constrained-utility-maximization rule enhanced by the experiment?

The answer to this question is found in the literature-survey and data-analysis portions of students' research papers. In the former almost every student correctly identified the constrained-optimization rule. In the analytical section, many students applied mathematical techniques equivalent to the author's method in 4.1 to

test the rule against experimental data in order to ascertain patterns consistent with the rule as well as to identify anomalies. Other students used more rudimentary, non-rigorous reasoning in their analytical sections to test the rule against experimental results. Therefore, it appears that student understanding of the constrained-utility-optimization rule did significantly improve relative to the early-semester test results as a result of the entire experimental process.

There was a troubling aspect, however, to this new student cognizance. As suspected and mentioned in 1.1, many students made clear their belief that the optimization rule was narrow and rigid, and solely an artifact of neoclassical theory. The ramifications of this are treated in Discussion section 5.

4.2.3 Did the experiment stimulate critical and creative analytical thinking?

Ironically the "troubling aspect" mentioned in 4.2.2 served to illustrate students' embrace of independent, critical thought and analysis. Interpreting the constrained-utility-maximization rule to be a rigid neoclassical construct motivated students, when viewing deviations from that rule, to zealously apply, in particular, behavioral concepts to explain the anomalies. Although not necessarily made explicit, student explanations implied a good understanding of bounded rationality. Most encouraging, students, with only a few exceptions, did not attribute deviations to irrationality. Further, students, in general, did not force explanations; in many cases they admitted that they lacked the tools for definitive analysis of observed anomalies, suggesting that further research was required—a perfectly respectable response from students in an introductory economics class.

Behavioral explanations were concerned primarily with preferences, deemed to have dominant weight in consumer decision-making.[24] The analytical sections of student research papers were characterized by comments such as, "[T]his is proof that the buyer is more satisfaction oriented than price oriented," "In each experiment the preferred product was picked more times over the other product, confirming that people buy with preferences," "most people went with their initial instinct and chose their preference," or, "if the price is a little more expensive than a different, similar price, they are more likely to buy the one that is preferred to them."

Other comments directly suggest student understanding of bounded rationality. This was inferred from analyses that interpreted the equal MU/P rule loosely instead of rigidly: "In every instance, once the prices got too drastic, the consumer picked a different option . . . [T]he consumers seemed to change their mind about what price differences would work for them and what wouldn't," "Buyers would generally buy preferred products . . . only changing purchasing decisions when there was a drastic change in [the price of] the un-preferred option," or most succinctly:

[24] This conclusion was certainly over-stressed, and could be inaccurate. Nonetheless, in a principles course where students lacked sophisticated analytical tools, this emphasis was evidence that students had internalized modern concepts of preference-structures, and were attempting to apply them creatively to experimental data that did not follow a predictable pattern in some of the experiments.

> Because utility is subjective, it varies from person to person and even from moment to moment. We also learn that utility theory acknowledges that preferences vary and therefore are never stable or complete. Using preference and utility, therefore, we conclude that purchases are rendered through a marginal cost versus marginal benefit analysis.

This bounded-rationality concept of heterogeneous and changeable preferences was explicitly considered in the analytical sections of many student research papers. Representative statements included, "there is still the matter of individuality to each consumer that is also prevalent when it comes to buying decisions," "Utility is subjective. I do not agree with the fact that preferences are static," and: "It illustrates how people's preferences change even in a short period of time. In a long term people's preferences can change dramatically."

To this author, creative thinking by students appeared to be prevalent in experimental research papers as demonstrated by the abundant use, as analytical tools, of modern microeconomic concepts such as heterogeneous preferences, implied bounded rationality, and emphasis on preferences in a behavioral context.

5 Discussion

5.1 General Observations

The reader will have noticed that the author placed intense, some may think excessive, emphasis on theoretical challenges, and the literature on research- and education-oriented economics experiments. Similarly protocols, experimental rules, and conduct of the experiment received detailed treatment. This was done intentionally for two reasons. First, other instructors might want to use the subject experiment in their own microeconomics principles courses. Second, repetitive use of this experiment will generate a much more extensive data set, which can be used to determine the effectiveness of the experiment as a teaching tool, as well as to motivate suggested alterations to the experiment.

More basically, the experiment that was the focus of this paper was narrowly focused on one issue. But in the modern transitional environment, there are many issues which present pedagogical challenges in principles courses. This paper advances the economics education literature by presenting a template for addressing these challenges. Components include a firm anchoring in the relevant theoretical literature, adherence to research-based economics experiment protocols, and application of the lessons of others who have identified elements of effective in-class experiments.

5.2 Possible Improvements in Experimental Design and Implementation

As previously stated, sequential trials of the same experiment by the same team may have produced an inadvertent experimental design flaw where players possibly learned from prior trials in unintended ways. Given the constraints of the class size, this flaw could still be addressed, for example, by switching buyers to a different experiment after each trial; or to still allow intended experiential learning, increase the number of trials

to say 10 or 15, and switch buyers after a few trials. Limiting buyers' and sellers' trials in any given experiment might address this unintended learning.

The student performance assessment noted that students tended to treat the subject constrained-utility-maximization rule as strictly linked to neoclassical theory. This is evidence of the problems associated with sequential teaching since the rule is typically incorporated in textbooks in chapters dedicated to neoclassical theory, but in the instant case it also reflects a teaching error by the author rather than a defect in experimental design. The rule applies when preferences are heterogeneous and not static. Even when preferences change, at the instant a consumer is deciding between purchases where opportunity cost is in play, the rule is still valid. The author, in lectures, should have made this abundantly clear when the rule was introduced and discussed, especially after confusion was revealed in the early-semester test.

As discussed, student participation in experimental design is a double-edged sword. Some students complained, for example, that some product pairs were not sufficiently close in the product space, resulting in analytical difficulties regarding product choice. Further inspection of this factor is required to improve experimental design. Certainly student engagement in design is to be encouraged, but a balance must be struck between this positive aspect and the specter of violation of important experimental protocols designed to maximize the educational experience.

5.3 Tangential Experimental Benefits to Students

Durham et al. (2007) portray empirical evidence of causality between use of in-class experiments as teaching tools and improvement in student attitudes towards the study of economics. They cite to evidence that attitude-improvement, in turn, enhances retention of subject information. They also note that, "better attitudes will likely result in students enrolling in advanced economics courses," and improve attendance and student involvement in economic courses (Durham et al. 2007, 177).

These findings were sustained by evidence associated with the subject experiment in the author's class. An anecdote serves to illustrate the effects of the experiment. The author encouraged, within reason, student involvement in course design. At the very beginning of the semester students were queried about whether they would prefer the final exam to be a traditional in-class closed-book one, emphasizing multiple-choice questions, or a take-home research essay. The almost unanimous vote was for a traditional exam. After the experimental project that served as their midterm exam the students were surveyed again on their final-exam preferences. The results were completely reversed. Following the experiment and research paper, the overwhelming majority of students students stated their preference for a research-based paper as their final exam.

This paper began by noting that principles students are often apprehensive about economics courses, and that alternative teaching approaches might mitigate this discomfort (Benedict and Hoag 2002). After the first lecture the author chatted with the students about their concerns regarding the course. One student in particular said

that she was frightened by economics, but she would stick with the course. On experiment day, the author queried the student about her view of the experiment. She confidently stated that it was quite familiar due to her shopping experience in everyday life. This anecdote, reflected generally among the class' students, showed the value of the subject experiment in utilization of experiential learning, and provided support for the generative learning model promoted by Burdina and Saur (2015).

6 Conclusions

Microeconomic theory's transition produces a teaching challenge for instructors of principles courses. Theoretical evolution is not limited to microeconomics, however, and is equally applicable to macroeconomics and other principles courses.

This paper has described in detail an in-class experiment designed to address a specific microeconomic concept that is known to be a source of confusion to students taking their first collegiate-level economics course. Assessment of performance in student research papers implies that under strict protocols, an in-class experiment is an effective tool to mitigate this type of topic-specific student uncertainty. This is, however, a narrow result and caution should be used in attempting to extend this paper's conclusions to the general subject of the effectiveness of in-class experiments as pedagogical aids.

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