

Network Externalities and Standardization: A Classroom Demonstration

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Abstract: This paper presents a classroom game that can be used to demonstrate network externalities, standardization, and switching costs. In the basic game students independently choose a technology whose value depends on the total number of students choosing that technology. In the next round, sequential decision-making is allowed which quickly leads to standardization. Introducing imperfect information and switching costs into subsequent rounds can lead to the real-world phenomenon of an inferior technology becoming the standard. This exercise can be used in Principles of Economics classes to teach these important concepts without requiring mathematical models. In more advanced classes, construction of the mathematical model behind the game may be assigned.

Keywords: classroom experiments, network externality, switching cost, framing effects

Introduction

One challenge many instructors face is that of incorporating the latest economic concepts into lectures when the theory underlying these concepts is more complex than the standard material taught in a principles class. The importance of network externalities in the "information economy" is a timely example. Network externalities exist when the value of a product or service to a consumer depends on how many other people also use the product or service. The externality may be direct -- I can only send you a fax if you also have a fax machine -- or indirect -- the more people that own DVDs, the more movie classics will be put out on DVDs. This classroom game is designed to introduce students to the concepts of network externalities, standardization, and switching costs

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without requiring any complex mathematical models. In more advanced classes, the game may be followed with an assignment to construct the underlying mathematical model.

Our game is a straightforward demonstration of how network externalities can lead to the dominance of one technology, regardless of its technical superiority over or inferiority to an alternate technology. It focuses solely on the consumer side of the market, with simple setup and execution.¹ In each round there are two competing technologies. The number of students that choose a technology determines the size of that technology's network and the payoff to a student from choosing the technology. In the initial round of the game, students' choices are made simultaneously. In subsequent rounds, the game is changed to introduce sequential decision-making, limited information, and switching costs.

Conducting the Demonstration

This game can easily accommodate any number of students, although the effects are more obvious in classes with more than 20 students. In classes larger than about 60 students you may want to have students work in teams, although any overheard communication is undesirable for reasons described below. Alternatively in a large class you could have different sets of students participate in different rounds. Depending on the number of participants in each round, you may want to have one or two students act as assistants. Other than copies of the instructions and record sheets, the only materials you need to conduct the demonstration are

¹ Bergstrom and Miller (2000) also have developed a classroom game on network externalities. Their experiment is more complex and includes both sides of the market

index cards and envelopes. For each participant (individual or team) you will need two index cards and one envelope per round.² Mark the envelopes with the number of the round in which they will be used. Include in each envelope two cards with different symbols, representing the competing choice of technologies in the current round.

In choosing the technology symbols, it is especially important to be aware of the potential for framing effects (Kahneman and Tversky, 1979). If students view one choice as “focal,” they will expect others to make that choice. In effect, the participants would be given an indication of the eventual winner. For this reason, any pair of symbols should not provide a focal choice—for example, One versus Two. Likewise, each round’s technology symbols should not be related to previous periods’ symbols so that prior dominance will not factor into the current choices. We have had success using eight different colors, though recommend avoiding red. You should also avoid potential framing effects caused by the ordering of the index cards by randomizing which technology is on top in each envelope. It is important to tell students that they are not allowed to talk during the demonstration prior to passing out the envelopes, as any remark could allow students to coordinate on one technology.

The key characteristic of a market with network externalities is that a consumer's utility depends in part on the size of the network. Let each individual's utility function be $u_i = x + a*s$ where s is the size of the network. The values of x and a that you use will depend on the number of students in the class. A rough rule of thumb is that x/a should be between $n/2$ and n where n is the number of participants in each round. This will ensure that the network externalities are large enough to make a difference in utility

² The index cards and envelopes can be reused in later demonstrations.

choice, but not so large that any underlying differences in the technology are irrelevant. Write the utility function on the board or provide students with a utility schedule so that they can calculate their utility for each round of the game.

Distribute the instructions, record sheets, and envelopes to the students.³ Each student should have a copy of the instructions, but you only need to distribute one record sheet per team if you are using teams. If all students will participate in each round, distribute the set of envelopes (one for each round) to each participant. If you are having different students participate in each round, distribute one envelope to each student. Read through the beginning of the instructions out loud and have students follow along. Emphasize the importance of students not talking during the game and announce sanctions for talking, if necessary.

Round 1 requires all students to make a simultaneous brand choice, giving them experience with the network externality's effect on utility. Read the instructions for Round 1 and give students a minute to make their brand choices. Ask students to hold the index card that they have chosen up to their chest (with the brand choice hidden) to indicate that they have made their choice. Once all choices have been made, ask the students to reveal their choices by turning their cards over and holding them in the air. Have your assistants count the number choosing each brand, and post these numbers on the board or on the overhead record sheet provided in appendix 3. Talk through the utility calculations for the two brands and have students compute their overall utility for the round, that is their total utility for the 10 periods.

In Round 2, choices are made sequentially: students may postpone their choice, but once it is made it is fixed. First read the instructions for Round 2 and then give students a minute to make their choices for period 1. You should highlight the fact that if

students do not choose a technology in period 1, they receive zero utility for that period. Students should again indicate that they have made a choice by holding a card up to their chest. After a minute announce that no more choices can be made for period 1. Ask those who have made choices to reveal their choice and count totals for brand. Post this information on the board and proceed to the next period. Generally, all students will have made their choice by the end of period two or three. Once all choices are made, have students compute their overall utility for the round, using the same decision for all remaining periods.

In Round 3, information on brand choice is noisy. As in Round 2, give students a minute to make their technology choice for period 1. Rather than having students reveal their choice, have your assistants collect the cards and bring them to the front. Shuffle the cards and reveal one half of them and post this information on the board. Note that this information should not be used to calculate utility, as utility will depend on the total number of students in the network. Therefore you must also record, but not post, the total adopting each technology in period 1. Proceed with additional periods until all choices are made, only revealing half of the unrevealed decisions each time. Once all choices are made, post the true total for each brand for each period and have students use this to calculate utility.

Round 4 introduces heterogeneity between the brands and switching costs. Periods 1 through 3 proceed as in Round 2. After Period 3 choices are revealed and utility is calculated, flip a coin to reveal which brand is superior. In smaller classes, you may want to force an effect by selecting the smaller network as the superior brand. Then for each period 4 through 10, people using the superior

³ If you have different sets of students participate in each round, you will need to modify the instructions.

technology receive $x/4$ additional units of utility. People who wish to switch from their original technology to the superior technology may do so, but at a cost of x .

Classroom Discussion

Begin the class discussion by defining the term "network externalities." We recommend conducting this experiment after you have discussed the basic concept of externalities. However, if you have not yet defined externalities in class, explain that externalities exist in cases where one person's consumption directly influences another person's utility. Network externalities are a special kind of externalities where one person's utility depends on the number of other people in that person's network, that is the number of other people making the same technology or brand choice. Ask students to provide example of markets in which there are network externalities. Usually students will provide examples of direct network externalities: telephones, fax machines, e-mail, instant messaging, and fads. Less obvious are indirect network externalities, that is when the size of the network affects the supply of complementary goods: computer operating systems and software, video game players and games, DVD players and movies in DVD format, etc.

Talk about the difference in results between Rounds 1 and 2, that is between simultaneous and sequential choice. Did students get more or less utility when choice was sequential? How did allowing for sequential choice affect the size of the two networks? The key with network externalities is that markets are generally very "tippy": as soon as one network is noticeably larger than the other, the rest of the market joins the larger network. Point out that what is really important is information, not timing. The good thing about

delaying a decision is that buyers gain information about what other consumers are doing. The bad thing about delaying a decision is having one less period of utility. Ask students to think about real life situations in which it would make sense to wait and see what the dominant network would be and situations where you would not want to wait.

Ask students to explain what happened in Round 3. Discuss how getting information slowly might induce some people to make the wrong choice. Talk about situations where this might occur, that is when is it difficult to get information about other's choices. Ask students to identify some sources of information: direct sources of information include observations of others' choices and sales figures and indirect sources include availability of complementary products.

Discuss how the introduction of switching costs affected whether people wanted to switch to the superior technology. Switching costs occur in many markets. For example, a direct cost must often be paid to switch long distance telephone carriers, while an indirect cost must be paid to switch computer operating systems (in terms of the time to learn how to use the new one). In markets with network externalities, switching costs can cause even more inertia. Even if the one-time switching cost is lower than the repeated increase in utility after the switch, individuals won't unilaterally switch to a better technology when the network benefits of the inferior technology outweigh the improvement in the superior technology. Each participant cannot guarantee that enough others will also switch. In this game, if there were no network effects, individuals should switch because the one-time cost, x , is less than the added benefit, $\frac{x}{4} + 6 + 1.5x$.

Finally, discuss other aspects of network externalities that are not explicitly demonstrated in the game: how framing can create focal equilibria. Discuss how brand names can influence technology choice. What if the brands had been letters of the alphabet or numbers? Would the existence of name dominance have influenced their choice? See if students can distinguish between choosing a particular brand because the name is dominant or choosing that brand because they expect other students to also choose that brand. Discuss how analysts' reviews of products may have as much to do with indicating a future equilibrium as with actually evaluating the technical features of any particular product.

Possible Assignments

Have students find an article that illustrates the concept of network externalities. Ask them to describe the most important dynamic features of the product and market concerned. Is there uncertainty upon introduction about which product is best? Do technical articles that follow introduction help users understand brands' features or the likelihood that others will buy one brand over another? What strategies do firms pursue to make consumers expect that many users will adopt their brand or product? Consider both pricing and non-price strategies. The applications to the Internet companies are particularly timely. Do network externalities help explain the need for "dot com" companies to burn through so much of their investors' cash so quickly before becoming profitable? How is the "dot com" shakeout explained in terms of network externalities?

Have students think about how network externalities can be depicted with demand curves. One textbook that discusses both positive and negative network externalities' effect on a demand curve is Pindyck and Rubinfeld (2001). You may also ask students to

consider some of the extensions in the following discussion and predict how outcomes in them may be similar to or different from those observed in the four rounds conducted during class.

Extensions and Variations

There are a number of ways this demonstration can be customized for your classroom:

- ? Pick names for the two technologies that could lead to an *a priori* advantage, for example Brand A and Brand F or VHS and Beta.
- ? Let groups of students ("neighborhoods") communicate prior to technology choice. To make sure that their discussions are not overheard by other neighborhoods, have all communications be done through notes.
- ? Decrease the percentage of choices revealed in the noisy information treatment to 1/3 or 1/4 and see how increasing noise affects the results.
- ? For more advanced classes, create heterogeneous preferences by replacing x with the value on a playing card. Use a uniform distribution of values from 2 to 10 and play a couple rounds of the sequential game. You may want to shuffle cards between rounds, so that students experience the game from different points of view. Talk about who makes their brand choice first and how their choice affects what network is used.
- ? Use a more complex utility function that will have decreasing marginal returns to the network size, such as $u_i = x + as - bs^2$.

Concluding Remarks

For further reading on network externalities, many industrial organization textbooks and intermediate microeconomics textbooks now contain a section on network externalities. On the Internet there is a highly rated site on networks developed by Nicholas Economides (1995-2001). On a less technical level (at least in terms of the economic theory) students may find the article on the evolution of competing instant messaging protocols by Jeff Tyson (1998-2001) to be both interesting and relevant.

References

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Appendix 1: Instructions

Instructions

You have been given an envelope for each round of this game. Inside each envelope are two cards, representing two different brands of the same product. In each round, you must decide which of the two brands to buy. Each round is also divided into ten periods.

During any of the ten periods in which you have not chosen a brand, you receive zero utility. The utility you receive during the periods after you have chosen a brand is determined by the utility schedule written on the board. Each round of the game will have slightly different rules, as explained below.

Do not talk to anyone else about your brand choice throughout this game.

Round 1 (Envelope 1)

Choose one of the two brands, hold it so no one else can see it; everyone will reveal their choices together. Your utility for all ten periods will be determined by this brand choice and the choices of everyone else according to the utility schedule written on the board. After everyone's choices have been revealed and you have been told how many of each brand has been chosen, record the same utility for all ten periods in this round.

Round 2 (Envelope 2)

You can now decide in each period whether to choose a brand or not, but once you have chosen you cannot change your choice. Your utility during any period during which you have not chosen a brand is zero. If you have chosen a brand, your utility for that period will be determined by the utility schedule on the board. After everyone's decisions have been made in each period you will be told how many of each brand have been chosen by that point, and you can record your utility for the period.

Round 3 (Envelope 3)

This round is like Round 2, except that in each period you will receive only limited information about the number of people who have chosen each brand. After the first period, half of the choices that have been made will be randomly chosen and revealed. Your utility for the period is based on the known number of people using your brand, i.e., the number that has been revealed. After each succeeding period, half of the remaining unrevealed choices will be revealed. Once all choices are made all choices will be revealed.

Round 4 (Envelope 4)

This round is like Round 2, except that one of the two brands will be randomly chosen to provide a higher utility than the other brand after the third period's decision. During any period after that point, if you have chosen a brand, you can change to the other but must pay to do so.

Appendix 2: Record Sheet

Record Sheet

Name _____

	Pd. 1	Pd. 2	Pd. 3	Pd. 4	Pd. 5	Pd. 6	Pd. 7	Pd. 8	Pd. 9	Pd. 10	
Round 1											
Brand Chosen											
Total Number Choosing Brand											Total Round 1 Utility
Utility											
Round 2											
Brand Chosen											
Total Number Choosing Brand											Total Round 2 Utility
Utility											
Round 3											
Brand Chosen											
Total Number Choosing Brand											Total Round 3 Utility
Utility											
Round 4											
Brand Chosen											
Total Number Choosing Brand											Total Round 4 Utility
Utility											

