

Essays in Educational Economics and Industry Structure

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Abstract

My dissertation contains two separate components. One part is a theoretical examination of the effect of ownership structure on format choice in the radio industry. I use a Hotelling type location model to study the effects of mergers in the radio industry. I find that common ownership of two radio stations results in format choices that are more similar than under competitive ownership, and also that the stations will advertise more if they are operated under common ownership. Welfare results are ambiguous, but there is evidence that total welfare might decrease as the result of a merger, with obvious policy implications for the Federal Trade Commission and the Antitrust Division of the Department of Justice who evaluate and regulate mergers in all industries.

The second component is an empirical study designed to assess the effectiveness of a mathematical tutorial that I authored in conjunction with colleagues in the Math department here at Virginia Tech. I taught four large sections of Principles of Macroeconomics in the spring and fall of 2001. Each class met on MWF; two sections at 8 AM, one at 10:10 AM, and one at 1:25 PM. I required one of the sections (8 AM Spring) to review the module and take a proficiency quiz to demonstrate their skill level in basic math that is used in the Economics Principles course. Final average in the course is the dependant variable in a regression designed to discover which variables have explanatory power in determining performance in introductory economics. Besides exposure to the math module, I include other independent variables describing class time, semester, demographics and effort. In addition, I collected qualitative information about the students' perceptions of the module's effectiveness and administration.

I find that exposure to the Math module does not have a significant effect on performance in the course. However, within the treatment group, there is a positive significant effect

of time spent using the module on performance. Also, being registered for an 8 AM section has a significant negative effect. Overall, student comments indicate a dislike for the module. Students report that they prefer learning math skills through lectures by the professor and use of textbooks.

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Introduction to Educational Economics

Many studies have sought to determine which student characteristics are determinants of success in college courses. Explanatory variables typically found in the literature include various demographic, effort, and background data. In this paper, I include measures of many of these factors in an attempt to demonstrate the robustness of these results. This paper differs from previous research, however, in two important ways.

First, I test the effect of exposure to a Mathematics/Economics module on students' performance in introductory economics. This module was co-authored with two members of the Mathematics faculty at Virginia Tech. It is described in more detail below. An idea central to this project is that if math skills are an important determinant of success in an introductory economics course, then perhaps there are ways to improve those skills during the course, and therefore improve economic learning. Clearly nothing can be done *ex post* about a student's SAT score or the number of math classes taken prior to the beginning of the course. However, a review module might be an effective way to improve math skills. The module might accomplish this without demanding a lot of class time. Most professors agree that they would rather teach economics in their classes than review high school mathematics, and this approach allows the use of technology to reduce the amount of class time spent on such review, while still accomplishing the goal of enhanced performance.

Second, I test the effect on student performance of taking the class at 8 am. My experience with teaching 8 am classes suggests that students perform more poorly at that early hour. One obvious reason is that the tendency to miss class is much greater at that time, but even after controlling for attendance, I find some evidence that students are more likely to be unsuccessful when taking a class at 8 am.

Previous Research

Many authors have studied the effects of different factors on performance in an introductory economics class. Much of the research has documented the importance of math skills on student performance in introductory economics. Durden and Ellis (1995) found that the Math SAT score was positively and significantly related to success in economics. They collected survey data from 3 classes of Principles of economics totaling 364 students, and found that every 100 points obtained on the Math Sat score increased the average in Principles of Economics by an estimated 1.1 points. This finding was significant at the 1-percent level. In addition, they found that having taken a course in calculus increased a student's average in Principles of Economics by an estimated 3.3 points. This finding was significant at the 5-percent level.

Williams, Waulder, and Duggal (1992) found Math SAT score to be a major determinant of success in Principles of Economics on multiple choice and numerical/spatial exams, but not essay exams. Their data were collected from a sample of 150 students at Widener University, and while their study was initially intended to ascertain whether or not gender makes a difference in performance in Principles of Economics, they discovered that a 100 point increase in Math SAT score translated into an estimated 2-percentage point increase in their score on multiple choice exams, and a 4-percentage point increase in their score on numerical/spatial exams. Both of these estimates were significant at the 1-percent level. They did not, however, find that having taken calculus had a significant effect on performance. This latter finding is in contrast with results from Anderson, Benjamin, and Fuss (1994), who used a sample of 3898 students at the University of Toronto, and found that having taken calculus had a positive and significant effect on student grades in introductory economics. This result must be interpreted with care, since their study only included persons whose calculus grade was among their top six reported grades from that year, and therefore excluded persons who did poorly in calculus.

Lumsden and Scott (1987) found that achieving an A level in Mathematics contributed positively and significantly to student success on multiple-choice economics exams.

Their study included 1240 students from 17 different universities in the United Kingdom, and their estimates, which are significant at the 5-percent level indicated that achieving an A in high school mathematics increased performance on a standard economics multiple choice exam by .61 correct questions out of twenty.

Much of the literature is also concerned with the impact of class attendance on performance. Durden and Ellis (1995), Park and Kerr (1990), Romer (1993), Akpom and Huller (1994), and Schmidt (1983) all found a positive relationship between attendance and course grade. The results of Durden and Ellis (1995) suggested that only excessive absenteeism (more than four absences during a semester) was costly to a student's performance. They estimated that missing 5 or 6 classes caused a reduction in overall average of 3.228 points; that missing 7 or 8 classes cost a student 3.475 points, and that missing more than 8 classes cost a student 3.521 points.

Using a sample of 97 students, Park and Kerr used an OLS regression and estimated that each missed class caused a reduction of .0622 in the students grade point average for the class, where an A was assigned a value of 3, a B was assigned a value of 2, a C was assigned a value of 1, and a D or an F was assigned a value of 0. In other words, a student who missed 8 classes was likely to receive a grade which was half a letter grade lower than a student who missed no classes. This finding was significant at the 5-percent level.

Romer, using a sample of 195 students from three different sized universities, reported that each 10-percent increase in number of classes attended resulted in a .219 increase in the grade point average for the course, where grade point average was measured in the standard A=4, B=3, C=2, D=1 manner. So a student who attended all classes on average obtained a grade over two letter grades higher than a student who attended none of the lectures. Akpom and Huller also found a statistically significant positive effect of attendance on performance in introductory economics, although the functional form used in their regression make the magnitude of this result difficult to interpret. Schmidt finds

that an increase in the number of hours spent in lecture of 1-percent translated into an increase in the percentage correct of .215-percent.

Very little work has been done on the effect of the scheduled class meeting time on academic performance. Ford (1972) and Akpom and Huller (1994) found no significant effect of class time on academic performance. However, their studies were each limited to describing class time as either an evening class or a day class. This classification was intended in both studies to account for part-time and professional students who typically take classes at night. In a related article, Henebry (1997) reported that students had a better chance to pass a class when they chose a class that met three times a week, instead of twice a week, and she also reported that meeting twice a week was better than meeting only once a week

Anderson, Benjamin, and Fuss (1994), and Lumsden and Scott (1987) found evidence that men perform better on multiple-choice examinations than women. This seems to be a general result that applies to other fields besides economics. Brasfield, Harrison, and McCoy (1993) find that having taken economics courses in high school contributed positively to students' grades.

The Use of Technology and other Tools in the Teaching of Principles of Economics

Becker and Watts (1996 and 2001) assert that despite an interest and emphasis on the use of technology in the teaching of introductory economics, the majority of economics teachers at the university level still resort to the traditional “chalk and talk” method of teaching. While journals, instructor’s manuals for principles courses and other publications often suggest other teaching techniques, the literature reveals a small amount of evidence concerning the use of technology in the economics classroom.

A notable exception is a study by Agarwal and Day (1999) which assess the impact of the use of the internet in enhancing economic learning. They supplemented their standard

lecture with email and a discussion list to facilitate student-teacher communication, and the use of the World Wide Web to disseminate information to students. They test three separate hypotheses that the use of the internet affects learning and retention; that it affects student evaluations of instructors; and that it affects student attitudes toward economics. They collected data from two sections of graduate microeconomics and two sections of undergraduate macroeconomics. They find that, using the scores on the Test of Understanding College Economics III (TUCE) as the independent variable, internet enhancement in the classroom positively and significantly affected learning and retention. Also, internet use positively and significantly affected student evaluations of instructors. Finally, internet use positively affected students' attitude toward economics in the graduate class, but had no significant impact in the undergraduate class.

Brown and Liedholm (2002) discovered that using an online method of instruction had a negative impact on student learning. They taught three different types of courses. The first was a traditional lecture class which met for three hours per week, the second a hybrid class which met two hours per week and was supplemented with online materials, and the third was a virtual class which had no lectures and was conducted entirely online. Their findings indicate that learning was worse in the virtual class, especially with regard to questions which required a more sophisticated application of economic techniques.

Cohn, et al (2001) used an experimental design which included four sections of Principles taught at the University of South Carolina and concluded that using graphs in the Principles course had no significant impact on learning.

Simkins (1999) provides two examples of implementing the Internet into the economics classroom. He required students to form groups and access the internet to find relevant information about a particular Federal Reserve District. After summarizing the relevant economic conditions, each group provided a policy recommendation in a simulated Federal Open Market Committee meeting. To finalize the project, all of the groups were required to reach a consensus concerning a hypothetical interest rate change, and then they each wrote a summary report. Also, Simkins suggested using the Iowa Electronic

Markets to give students a hands-on introduction to the workings of economic markets. He does not, however, provide any evidence of the effectiveness of these pedagogical techniques.

Stone (1999) integrated what he called “computer-based lecture (CBL)” into his classroom. Using an interactive commercial software package called Toolbook, he incorporates sound, video, and computer graphics into his lectures. He asserts that this enhances learning by maintaining student attention and increasing the clarity and accuracy of lectures material such as graphs and charts. He uses an example of price floors and ceilings which comes from his lecture. He discusses four applications of this technology, including improved classroom discussion, incorporating writing exercises and cases, economic experiments, and student presentations. While his exposition is compelling, his evidence that these techniques are effective at improving student learning is anecdotal at best.

Similarly, Greenlaw (1999) provides subjective evidence that using a commercial form of groupware called Forum provides students with a learning forum superior to the traditional lecture setting. Forum allows the instructor to create a “common, hypertext workspace” in which students can communicate with the instructor and each other. Forum allows the use of both text and graphics tailored to the particular subject matter. He suggests that the benefits of using Forum come from stretching the time frame for learning. That is, because concepts and remarks can be revisited and reviewed at any time after they are posted, students have more time to think about ideas and responses to discussion questions, and therefore might give more sophisticated responses. Also, the responsibility for learning is shifted away from the instructor and toward the student. While a typical lecture might be more carefully thought out, the process of “digging” through materials might improve learning retention. Again, it is important to note that the author’s conclusions are subjective, and the need for a more formal evaluation of this technique is in order.

Other articles provide resources to interested instructors. Daniel (1999) presents the reader with techniques of using Java in their websites and potential applications. Java allows the instructor to program interactive features into their webpages, including graphical calculators and spreadsheets. Websites are provided to get help in implementing these applications. McCain (1999) has written and made available an online economics textbook. Parks (1999) gives suggestions on effective use of email and other web applications. Kaufman and Kaufman (2002) describe an interactive graphing tool used in their Principles classes. Vachris (1999) is one of many authors who provide outlines for a distance learning economics course.

Finally, there are a number of references which can be found illustrating experiments which can be used by instructors in their classes (see Dickinson (2002) for conducting the Ultimatum game; Oxoby (2001) for an experiment on Monopoly; Garrett (2000) for an Entry and Exit game). Proponents of the use of experiments in the classroom suggest that they are effective learning tools because of their ability to heighten attention and participation in class, and because the student is required to actively learn a particular concept rather than simply having it explained to them. While the articles concerning experiments typically include the results of the experiments which were run, only two provide objective analysis of the effectiveness of these tools. Gremmons and Potters (1997) test the effectiveness of supplementing standard lectures in macroeconomics with a SIER (simulating international economic relations) game. They test for learning achievement and retention, and they find that students who were exposed to the SIER game performed better on a multiple choice exam on the topic covered than those who only received a lecture covering the same topic. Furthermore, they find that retention of the knowledge on a surprise test administered several weeks later was greater in the gaming group. Frank (1997) Discovered that students exposed to an experiment designed to illustrate the “tragedy of the commons” performed significantly better on a multiple choice exam than those who merely received a lecture on the topic. These studies combined with the wealth of anecdotal evidence about the effectiveness of using in-class experiments to enhance learning suggest a bright future for their incorporation in Principles of Economics classes.

The Instructional Module

In conjunction with the Math Department at Virginia Tech, I authored a Math/Economics module designed to sharpen the math skills typically used in introductory economics. Components of the Module include graphing and algebra skills. The module is interactive, with practice questions as well as step-by-step coverage of these basic concepts. The module can be viewed at

<http://course-delivery.emporium.math.vt.edu/econ/Tutorial/Econ.html>

The contents of the module include calculating the slope of a line, determining the equation of a line, graphing lines, shifting the graphs of lines, solving single variable equations, solving systems of two equations with two unknowns, and working with percentages and inverse functions. The module contains detailed explanations of the concepts, examples with economic content, and a practice quiz with which the student can test his or her ability. For example, the subsection on the slope of a line contains elements about the definition of a line; the definition of the slope of a line; lines with positive, negative, zero and undefined slopes; finding the point slope and slope-intercept equations of a line; practice problems requiring the user to calculate the slope of a line or find the equation of a line; and several economic applications illustrating the use of slope.

Procedure

Four sections of Principles of Macroeconomics at Virginia Tech were used in this analysis as shown in Table 1. In the spring of 2001 one class, consisting of 172 students met at 8am. This class was given an in-class demonstration of the Instructional Module, and the students were required to take a proficiency quiz at a separate testing center. The proficiency quiz consisted of 12 questions involving basic math concepts typically used in introductory economics. The other class consisting of 542 students met at 10:10am, and this class was not exposed to the Instructional Module. In the fall of 2001, another class consisting of 363 students met at 8am. Finally, a fourth class consisting of 213

students met at 1:25pm. Neither of these classes was exposed to the module. All sections met three times a week for 50 minutes each. This is summarized in **Table 1**.

The measure of student performance in my study is the students' final average in Economics 2006, Introduction to Macroeconomics. There were four midterm examinations in the class, and the best three scores were used to determine the students' midterm average. The midterm average was then averaged with the final grade, with the midterm average counting 67.5%, and the final counting 32.5%. The data for the control variables were collected from a survey given in the four sections of Principles of Macroeconomics during the spring and fall Semesters 2001 at Virginia Tech. The sample population consisted of 740 students who completed the entire survey. In addition, the survey included qualitative questions designed to measure students' perception of the usefulness of the module. These responses are summarized in **Table 4**.

Data and Analysis

The independent variables in the regression include academic year, grade point average, the square of the grade point average, gender, age, race, number of math classes taken at the calculus level or above, the number of those math classes in which the student received a B or better, Math SAT score, the student's grade in Principles of Microeconomics (a prerequisite for Principles of Macroeconomics), the type of class (required for major, required for core curriculum, or elective), number of hours spent studying outside of class, number of hours working at a paying job per week, number of classes missed, major, whether the class was taken at 8 AM, whether the class was taken in the spring or the fall, and whether or not the class was exposed to the Instructional Module. All of the variable names, descriptions, means and standard deviations are given in **Table 2**.

The variable **Performance** was regressed on all other variables. The results of this regression are given in **Table 3**.¹

Interpretation

The coefficient of the treatment variable, **Math Module**, is negative but statistically insignificant. Thus there is no evidence that the module was effective in improving performance when implemented in the manner described earlier. By no means should we conclude from this that the module is of no value. It may indeed be useful when implemented in an alternative manner. One suggestion is to first identify students who have weak math skills, possibly by giving the class an initial math assessment test. The module might be effective when it is targeted to those students who fail to achieve a certain threshold on the assessment exam. In attempting to evaluate the differential effect of exposure to the module by students with weaker math skills, I conducted the analysis on sub-samples of the population. Using students who achieved a Math SAT score of below 500, I find that exposure to the module still has an insignificant effect on performance ($t = -0.49$). Alternative models truncated the population by including only those students who had two or fewer math classes in which they made a B or better, and by including only students who had a GPA of less than 2.5. In none of these scenarios was there a positive significant effect of the math module.

¹ The results were corrected for heteroskedasticity by using a feasible generalized least squares regression (*Econometric Analysis*, Greene, 2001). These results are the ones given. After the corrected regression was run, the Ramsey Reset test for linearity generated a p-value of .5775, so I do not reject the null hypothesis of linearity of the model. Seven outliers were dropped from the analysis. After this adjustment of the sample, the resulting p-value generated by a skewness-kurtosis test for normality is .1434, and the p-value for the Shapiro-Wilk test for normal data is .0995, so I fail to reject the null hypothesis that the residuals in this regression are distributed normally. Finally, the p-value generated by the Cook-Weisburg test for heteroskedasticity is .0771, indicating that the problem of heteroskedasticity was corrected in a satisfactory manner.

The coefficient of the **Eightam** variable is negative and significant at the 10% level (5% level for a one-tailed test), providing some evidence that students perform more poorly at that early hour, even after controlling for attendance. The results suggest that taking the class at eight o'clock in the morning decreases the student's average by 1.66 points. It should be pointed out that students might self-select into different classes, which may confound this result. For example, less motivated students may register for classes later and therefore be forced to take the class at 8:00.

In order to properly specify the model, it was necessary to include the **GPA Squared** variable. This coefficient is positive and significant, while the coefficient of **GPA** is negative and significant. A quick calculation reveals that when grade point average is below 1.6831, **Performance** decreases as **GPA** increases. At grade point average levels higher than 1.6831, the opposite is true. The latter result is intuitively clear. A possible explanation for the former result is that students with very low grade point averages, possibly on or facing academic probation, work harder to succeed.

Results that are consistent with prior expectations include the positive and significant coefficients of **Male**, **SAT**, **Attendance**, **MathB**, and **Sci/Eng** and **Grade2005**. Earlier studies have found that men tend to perform better on multiple choice examinations than women, and performance in this study was indeed measured by results of multiple-choice exams. In this study, men on average score 1.44 percentage points higher than women. **SAT** and **MathB** are both measures of mastery of mathematical concepts typically used in economics courses. Every 100 points higher that a student scores on their Math SAT test yields an increase of .96 percentage points in their final score. Every additional math class at the calculus level or beyond in which a student makes a B grade or better means an estimated 0.7 points higher on their final average. Also, Science and Engineering majors tend to need good math skills for success in those curriculums, and therefore receive more intensive math training. I find that Science and Engineering majors score an estimated 2.99 points higher on their final average than do the other students. The positive effect of attendance on academic performance has been documented by other studies. I find that each additional class a student attends increases their final average by

an estimated .54 points. It seems obvious that students who do well in the first semester of economics would tend to perform better in the second semester, and this is indeed the case. I find that an increase of one level in the grade earned in Principles of Microeconomics (e.g., from a B to a B+) translates into an estimated increase of .32 points in the student's final average. Finally, the negative and significant coefficient on **Age** is consistent with the notion that, other things constant, older students would reveal a tendency to stay in an academic class for longer than usual, suggesting retarded progress. In this study, a one-year increase in student age means an estimated decrease of .52 points in their final average.

In order to obtain a more detailed analysis, the **Class** and **Work** variables were divided into separate categories and modeled as separate dummy variables in the regression. The regression suggests that freshman do worse than other classes, and that achieving the status of being a senior is significantly and positively related to performance in the class. This result may be due to differences in the sample over class rank. Achieving a higher class level might "weed out" those students who have demonstrated sub-par academic achievement, and seniors in particular, who have extra motivation to do well in order to graduate, may put more effort into the course. This also might occur because seniors have developed social capital and have friends who have taken the course, have access to old exams, and have other advantages that freshman might not. Anderson, Benjamin, and Fuss obtained a similar result and offered an explanation consistent with this idea.

This study suggests that working does not have a significant effect on a student's academic performance until the students starts working over 20 hours per week. It is interesting that students who work 30-40 hours per week are also not negatively affected. This might be due to better time management skills or a greater commitment to doing well both academically and financially. Also, students who must work a substantial number of hours might appreciate the value of their education more than students who work little or not at all. The results of the **Work6** coefficient must be interpreted with caution, because there were only two students who reported that they worked more than 40 hours per week.

Survey Results

Results of a survey given only to the students who were exposed to the module are summarized in **Table 4**. It is clear from this data that students do not like learning math skills from a computerized module. This in large part might help to explain the insignificant effect the module had on class performance.

Data and Analysis from the Treatment Class

In order to further the analysis, I ran a regression using only the data from the treatment class. The dependent variable Average was regressed on some of the independent variables, and the results are given in Table 5. From this regression, several things stand out. First, the amount of time spent using the module (HOURS) positively and significantly affected the performance of the student in the class. Second, those with lower SAT scores benefited more from using the module. These results suggest that there is an effective way to use the module. Specifically, targeting those with low SAT scores and implementing methods to increase the time spent using the module should enhance the module's effectiveness.

Given these results, it is interesting to find out who actually used the module. To do this, I regressed the number of hours spent using the module (HOURS) on several of the student characteristic variables. These results are given in Table 6. This information reveals that students with low SAT scores are more likely to use the module. Also, there is some evidence that females use the module more than males, but that coefficient is not statistically significant.

Combining the information from these two regressions, there is evidence that the module did serve a useful purpose. Specifically, it enhanced performance by those with low Math SAT scores, and in fact those students were more likely to use the module.

TABLES

Table 1 (Procedure)

Semester	Number of Students	Class Time	Exposed to Module
Spring 2001	172	8:00 am	Yes
Spring 2001	542	10:10 am	No
Fall 2001	363	8:00 am	No
Fall 2001	213	1:25 PM	No

Table 2 (Descriptive Data)

Variable	Explanation	Mean	S D
Performance	The student's final average in the class, calculated by averaging the three highest midterms, each counting 22.5%, and the final exam, counting 32.5%	76.73	9.96
AY	The student's academic year (1=Freshman; 2=Sophomore; 3=Junior; 4=Senior; 5=Other)	2.22	.63
GPA	The student's self reported grade point average	2.82	.67
GPA Square	The square of GPA	8.41	3.32
Math Module	A dummy variable which takes a value of 0 if the student was not exposed to the math module, and 1 if the student was exposed to the math module	.11	.31
Male	A dummy variable which takes a value of 1 if the student is a male, and 0 if the student is a female	.59	.49
Age	The student's age in years	19.73	.99
Black/Hispanic	A dummy variable which takes on the value 1 if the student is black or Hispanic, and 0 otherwise	.05	.23
Other	A dummy variable which takes on the value 0 if the student is white, black or Hispanic, and 1 otherwise	.13	.33
Work	The number of self reported hours that the student worked per week for pay during the semester. Hours worked were broken into categories as follows: 1) 0 2) 1-10 3) 11-20 4) 21-30 5) 31-40 6) over 40	1.57	1.02
Math	The number of math classes taken at the calculus level or beyond, including high school	3.94	1.84
Math B+	The number of math classes taken at the calculus level or beyond in which the student received at least a B	2.79	1.77
SAT	The student's score on their math SAT divided by 10	59.94	8.56
Grade 2005	The student's grade in Econ 2005--Principles of Microeconomics. Grades were reported as follows: 1= D or D-; 2 = D+; 3 = C-; 4 = C; 5 = C+; 6 = B-; 7 = B; 8 = B+; 9 = A-10 = A	4.80	2.20
Study	The number of self reported hours that the student spent studying for Econ 2006 outside of class	2.17	1.99
Attendance	9 minus the number of classes missed during the semester (students who missed more than 9 classes received a zero for this variable)	4.66	2.85
Elective	A dummy variable which takes a value of 1 if the class was a free elective for the student, and 0 otherwise	.16	.37
Sci/Eng	A dummy variable which takes a value of 1 if the student was a science or engineering major, and 0 otherwise	.13	.34
Econ Major	A dummy variable which takes a value of 1 if the student was an economics major, and a value of 0 otherwise	.11	.31
Eightam	A dummy variable which has a value of 0 if the student was not in an 8 am section, and a value of 1 if the student was in an 8 am section	.42	.49
Fall	A dummy variable that has a value of 0 if the student was enrolled in the class during the spring semester and a value of 1 if the student was enrolled during the fall semester.	.46	.50

Table 3 (Regression Results)

Variable	Parameter Estimate	Standard Error	t Value
Intercept	77.16	6.69	11.53
AY2 (Sophomores)	.73	1.06	0.69
AY3 (Juniors)	1.18	1.49	0.79
AY4 (Seniors)	3.71	1.84	2.02
GPA Squared	3.71	.36	10.23
GPA	-12.47	1.73	-7.21
Math Module	-1.23	1.35	-0.91
Male	1.44	.58	2.47
Age	-.5159	.26	-1.97
Black/Hispanic	1.24	1.20	1.03
Other	1.12	.79	1.42
Work2 (1-10 hrs per week)	-.79	.89	-0.88
Work3 (10-20)	-.42	.96	-0.44
Work4 (20-30)	-3.61	1.23	-2.93
Work5 (30-40)	-.64	1.73	-0.37
Work6 (over 40)	-11.45	5.41	-2.12
Math	-.38	.27	-1.40
Math B	.70	.29	2.40
SAT	.10	.04	2.46
Grade 2005	.32	.14	2.29
Study	.11	.16	0.65
Attendance	.54	.11	5.06
Sci/Eng	2.99	.84	3.57
Econ Major	.82	.92	0.89
Fall	6.64	.95	6.98
Eightam	-1.66	.90	-1.85
N	740		
Adjusted R²	.983		

Table 4 (Survey Results)

Number of Hours Spent Using the Module	Number of Times Accessing the Module	Preferred Method of Learning Mathematical Material	Useful Parts of the Module	Useful Material Covered in the Module
One: 53.8%	One: 23.7%	Book: 18.3%	Examples: 40.9%	Slope: 20.4%
Two: 19.4%	Two: 31.2%	Lecture: 44.1%	Practice Problems: 50.5%	Graphing: 16.1%
Three: 9.7%	Three: 19.4%	Tutor: 16.1%	Explanations: 19.4%	Solving single variable equation: 16.1%
Four: 3.2%	Four: 7.5%	Fellow Student: 18.3%	Econ Applications: 8.6%	Solving system of two equations: 28%
Five: 1%	Five: 5.4%	Module: 3.2%	Graphics: 8.6%	Percentages: 23.7%
Zero: 12.9%	Zero: 12.9%		None: 29%	None: 45.2%

There were 93 respondents. Percentages in columns 4 and 5 add up to over 100% because students were allowed to choose more than one choice for those questions.

Table 5 (Effectiveness in the Treatment Class)

Dependent Variable is AVERAGE

Variable	Parameter Estimate	Standard Error	t Value
Hours	15.54	5.56	2.8
Hours*SAT	-0.26	0.10	-2.69
Math	1.21	0.86	1.4
MathB	-1.04	0.94	-1.1
SAT	0.50	0.21	2.33
GPA	3.82	2.07	1.85
Grade2005	2.47	0.57	4.33
Blackhis	2.67	7.56	0.35
Other	7.64	4.27	1.79
Othermajor	8.46	3.86	2.19
Scieng	5.67	4.47	1.27
Male	2.10	1.99	1.06
Constant	8.39	13.77	0.61

Table 6 (Use of the Module)

Dependent Variable is HOURS

Variable	Coefficient	Standard Error	t Value
SAT	-.048	0.01	-4.11
GPA	.17	0.17	1
Male	-.21	0.20	-1.06
Elective	.09	0.21	0.4
Constant	3.8	0.79	4.85

Conclusion

In this article I have studied the characteristics that determine a student's success in introductory economics. Unlike previous research, I have included in my analysis exposure to an online tutorial and class meeting time as explanatory characteristics. While the online tutorial appears to have done little to enhance student performance, there is evidence that taking the class at 8 AM is detrimental to student's learning. Since there is very little research on this, more work should be done to determine, if possible, which class meeting times are most conducive to performance in economics and other subjects. Another idea for future research is to implement the online tutorial in a different manner; in particular to first screen students, and target the tutorial toward those who do not perform as well on a pre-test of basic math ability. It would be useful to learn which students (if any) benefit from such a tutorial.

The effects of other explanatory characteristics included in the model are generally consistent with previous research. Those with significant positive effects include being male, higher attendance, higher math SAT score, being a science or engineering major, higher grades in the previous economics course, a greater number of math classes receiving a B or better, obtaining a higher academic status (especially for seniors), and higher GPA. Those with significant negative effects on performance include a greater number of hours worked and older ages.

Introduction to Radio Mergers

Since the Telecommunications Act of 1996 relaxed radio ownership restrictions², there has been an explosion of radio mergers. In the first year following the passage of the Telecom Act there were over 1000 radio mergers, about 140 of which automatically came before the Department of Justice for review under the requirements of the Hart-Scott-Rodino Act. Only three resulted in action by the Department of Justice, and those mergers were allowed under the provision of divestiture of one or more of the stations.

Here I explore the implications of radio mergers using a variation of the standard Hotelling location model. The key feature that distinguishes radio and media in general from other firms is the nature of obtaining revenue. Radio stations typically give their product away "for free" and collect revenue through advertising sales. Consumers must choose which station, if any, to listen to based on the format of the radio stations and the level of advertising. The stations attempt to maximize profits by selling audiences to advertisers. A lower level of advertising will attract a larger audience, *ceteris paribus*. The level of advertising is analogous to the price paid by consumers in "conventional" markets, but differs in that consumers who pay a monetary price still receive the complete product, while advertising actually reduces the quantity of the product supplied. While this is not true in certain forms of media such as newspapers and magazines, an advertisement during a radio broadcast lowers the amount of time available for regular programming.

In this paper, I find that in a duopoly, competing firms offer more diversified formats and lower advertising levels, while two stations that merge will offer more similar formats with higher advertising levels. This is in direct contrast to the results of many previous studies. Welfare implications of mergers are ambiguous. My model shows that mergers may increase or decrease social welfare as measured by total economic surplus. Mergers

²For a synopsis of the main provisions of the Telecommunications Act of 1996, see Ekeuland, Ford, and Koutsky, *Market Power In Radio Markets: An Empirical Analysis of Local and National Concentration*, 43 *Journal of Law and Economics* 157-84 (2000).

increase total economic surplus if the price at which firms can sell their advertising space is sufficiently high or if the loss of utility incurred by consumers from having to listen to lesser preferred programming is sufficiently low.

Previous Research

A substantial amount of literature exists addressing the question of programming format in the television and radio industries. The major issues include welfare comparisons between different types of industry structures, comparisons between advertiser based revenue versus consumer based revenue, and the issue of whether or not there exists a bias toward popular programming and away from minority-tastes programming. Many of the models are based on the television industry, but can readily be applied to radio as well.

The literature on the effect of ownership structure on format choice begins with an important article by Steiner (1952). He compares the outcome of a monopolistic television industry with a triopoly. The results obtained are driven by several strong assumptions. First, he constructs viewer preferences among three alternative programs. Viewers are divided into groups of different sizes, with members of each group all having the same first choice among the alternatives. Specifically, it is assumed that there are 8750 viewers and 3 programs such that 5000 viewers rank program 1 as their first choice, 2500 rank program 2 as their first choice, and the remaining 1250 rank program 3 as their first choice. Furthermore, viewers are assumed to watch either their first choice or not watch at all. Channel capacity in the industry is set at 3.

Under one market structure, separate audience-maximizing agents individually own each station. All viewers are assumed to be of equal value to the stations, and in the event that two or more stations show the same program, the audience for that program is divided equally among those stations. Under the monopolistic market structure, one agent operates all three stations, with the goal to maximize total audience among all three

stations. Costs of programming are normalized to zero, so each station has an incentive to broadcast something as long as there is an audience greater than zero.

Under the separate ownership market structure, given the preferences above, 2 stations will show program 1, with each getting an audience of 2500, and the third station will show program 2, also getting an audience of 2500. Program 3 will not be shown. Under the common ownership structure, the monopolist will show all three programs, and thereby capture the entire audience.

Using this ad hoc example, Steiner first identified a bias against minority-taste programming that can result from the individually owned market structure. Minority-taste programming is loosely defined as programming which appeals to audiences of relatively small cardinality. Although the assumptions needed to obtain this result are extremely strong, the literature shows that this bias remains through many alterations of the model.

Rothenburg (1962) relaxes the assumption that viewers will only watch their first choice. Instead, he posits that there is a “common-denominator” program that all viewers will watch. Viewer preferences are as follows: 5000 viewers will watch only program 1, 2500 prefer program 2, but will watch program 1 if program 2 is not shown, and 1250 prefer program 3, but will watch program 1 if program 3 is not available. Not surprisingly, program duplication is even more pronounced in the individually owned setting, with all three stations showing program 1. Both the Rothenburg paper and the Steiner paper explore only certain audience distributions, and their results are limited in generality.

Rothenburg also explores the effect of allowing more stations. In this case, as the number of stations increases, it becomes optimal at some point for the stations to show different programs, as the audience for the “common-denominator” program is divided into smaller and smaller parts. Thus, the bias against minority programming might well disappear with an unlimited number of stations.

By varying patterns of viewer choice, audience preference distributions, cost structures of the firms, and channel capacities, Beebe (1977) generalizes Steiner's model, analyzing 36 different situations. The resulting program patterns for each situation under a monopoly setting are compared to those resulting from individual station ownership. The comparisons include which setting provides more choices, which setting obtains the greater audience, and which setting would win a vote among viewers where viewers vote for the structure which gives them their highest choice.

Among the important findings, Beebe discovers situations where the Steiner result—that a monopoly structure provides more viewer choices than the individually owned structure—does not hold. If the viewer groups are fairly close in size, competitors will no longer engage in program duplication. Not only is Steiner's result sensitive to his highly skewed preference distribution, but also to the assumption that viewers will only watch their most preferred program. If viewers are assumed to be willing to watch a “common denominator” program, the monopolist will quite likely show only this program. Thus, the individually owned setting will likely produce more first (or preferred) choices than a monopoly structure.

Welfare comparisons are not always straightforward, as there exist cases where one structure satisfies more first choices, but the other structure attracts a larger total audience. Also, even a structure that satisfies more first choices and attracts a larger total audience might not be Pareto superior to its counterpart since there might exist at least one individual (or group of homogeneous individuals) who receives a higher choice under the latter structure than the former. More specific structure on viewer choices, such as a cardinal ranking of programs instead of an ordinal one, is necessary to compare many of the outcomes.

Beebe's analysis allows for the fact that listening to a program has an opportunity cost for the listener. This opportunity cost determines a reservation utility—a level of listening satisfaction which the viewer must obtain in order to be willing to watch any program at all. The analysis indicates that viewers who have such reservation utility and thus might

not attend any station's programming are more likely to be shown their preferred choices in a monopoly setting. Beebe cites adequate channel capacity as a necessary condition for minority programs to be shown given profit maximization and advertiser-generated revenues. A sufficient condition for minority programming to be shown in a competitive setting is the above combined with the existence of a group of viewers which ranks that program highest and is greater in number than the break-even constraint. In a monopoly setting, a sufficient condition for a minority program to be shown are both of the above combined with the viewer group's refusal to watch an alternative program. In either situation, the break-even constraint is determined by the firms' cost structure, and it is entirely possible that for sufficiently high costs, some channels will go unused.

Spence and Owen (1977) include a "willingness-to-pay" factor in their analysis of market structure and its effect on performance. Their analysis takes aim at pay TV, where revenue is generated directly from the viewers as well as or instead of from advertisers. This aspect is not readily applicable to the radio industry, where all revenue is generated from advertisers, but they do also consider the behavior of a TV structure where advertisers are the sole source of funds.

Spence and Owen also discover a bias against minority-taste programming. Indeed, they find it to be greater in an advertiser paid setting than when the stations receive money directly from viewers. The reasoning is straightforward. It is assumed that advertising revenue is a direct function of the number of viewers, and so if advertisers are the sole source of revenue, then the only thing that matters to the advertisers is the number of persons in the audience. Because intensity of preferences and audience demographics are not considered, it is readily apparent that a program offered at a zero price which gains an audience of size n will be shown over a program which gains an audience of size $n-1$, even though the program which the $n-1$ group prefers might be extremely valuable to that group whereas the program preferred by the group of n viewers might be just barely preferred to not viewing. When the viewers actually pay to see the program, their willingness-to-pay somewhat alleviates this problem, but a bias still exists toward mass appeal programming and away from minority-taste programming. Spence and Owen also

find a related bias against expensive programs. That is, stations might choose to show a less expensive program even though a more expensive one might generate greater overall benefits.

Wildman and Owen (1985) extend the analysis of the Spence/Owen model to include advertising time as a choice variable. A fundamental assumption in this model is that the market for advertising is perfectly competitive, and therefore the price of advertising is constant. Also, viewers are assumed to dislike advertising. In this context, advertising is viewed as a cost to watching a program and the station attempts to maximize the number of “audience-minutes”—the number of advertising minutes multiplied by the total number of viewers. The solution to the profit-maximizing problem of the station is exactly analogous to the solution of the traditional profit-maximizing behavior of a firm facing a downward sloping demand curve. The number of viewers for a particular program is a function of the amount of advertising which that program has. As with any maximization done by a firm facing a downward sloping demand curve, there is a deadweight loss with price (the amount of advertising) being too high, and quantity (number of viewers) being too low for social efficiency.

Noam explores the role of the government in providing public service programs and concludes that such programming becomes less and less attractive as the number of channels becomes greater. This is consistent with the deregulation result mentioned earlier, and is fairly obvious. Noam does conclude that the presence of a public station which broadcasts a minority-taste program will give private stations incentive to produce programs which appeal to mass audiences.

It is worth mentioning at this point that one way for a government to reduce the bias against minority-taste programming is to subsidize public stations that broadcast programs that are preferred by smaller audiences. This has been undertaken in both TV and radio. However, the deregulation of the cable TV industry in the late 1970's and early 1980's, which effectively allowed for the expansion of the number of channels available, greatly lessened support for publicly funded programming. Since the

expansion of the number of channels encourages stations to creep into the realm of minority-taste programming, this is not surprising.

Kehoe (1989), following de Palma, Ginsburgh, Papageorgiou, and Thisse, develops a model of radio formatting which shows that social welfare can be increased from that of the equilibrium outcome if firms located on the outside of a product space move even further outside. The model is set within the Hotelling framework. The dispersed equilibrium is generated by the assumption that there exists a degree of heterogeneity among listeners. Thus, a random variable, assumed to be iid, is added to each agent's utility function.

The results of the model include a theorem which states that in equilibrium, the stations located on the outside of the product space would increase total surplus if they were to move even farther to the outside. This is interpreted to mean that there is a bias against minority-taste programming. Kehoe is able to obtain this result within a spatial competition framework without having to include intensity (cardinal utility) of preferences as Spence and Owen do.

An empirical study by Berry and Waldfogel (2001) provides some evidence that radio mergers result in more diversified programming formats being offered relative to the number of stations in the market. They also find however that radio station consolidation reduces entry into the market, and so the number of stations operating in a market might also be reduced. Their conclusions suggest that a common ownership group might choose formats for their stations strategically in order to lower entry into a market. They take advantage of the natural experiment occurring because of the Telecommunications Act, analyzing market structure and performance before and after the implementation of that legislation.

The Competition Model

In this model, I assume that consumers are differentiated by their preferences for different radio formats. I also assume that consumers dislike advertisements. Thus, I think of radio format as a horizontal characteristic, while the advertising level of the stations is a vertical characteristic.

Consider 2 firms that compete for advertising revenue in the following 2-stage game. First, each firm simultaneously chooses a format, which I model a la Hotelling as a choice $x_i \in [0,1]$, $i=\{1,2\}$. Without loss of generality, let $x_1 \leq x_2$. In the second stage, each firm simultaneously chooses an advertising level, $a_i \in [0,1]$, $i=\{1,2\}$. It is reasonable to think that format would be chosen first. Formats require a large repertoire of CDs, tapes, etc to adequately provide a particular genre of music. In the case of news, sports or talk radio, a consistent set of personalities is necessary to maintain audience loyalty. Advertising contracts, on the other hand, are typically short lived and can thus be altered more easily. The firms' choice of x_i and a_i determines a location in the two-dimensional space $[0,1] \times [0,1]$.

A consumer located at $c \in [0,1]$ gains utility from listening to station i located at (x_i, a_i) at the constant rate of $U_i = u - t*(d_i)$, where u is a utility parameter which represents the rate of utility gained from listening to a consumer's ideal station with no commercials, t is a disutility parameter, and d_i is distance from a consumer's location in the unit interval, $[0,1]$, to station i 's location in the 2-dimensional space, $[0,1] \times [0,1]$. Thus, $d_i = \sqrt{(c - x_i)^2 + a_i^2}$. In this utility specification, ads on preferred stations are preferable to ads on less preferred stations. This utility specification also has the appealing property that the cross partial derivative of utility with respect to distance and advertising is negative. Advertisements on preferred stations, while preferable to ads on less preferred stations, still cut into the more valued programming time of the preferred station. Therefore, additional ads on stations located close to the consumer on the horizontal axis

reduce utility at a greater rate than additional ads on stations located farther away. This seems intuitively plausible. A consumer listening to a program that she really enjoys will suffer more when a commercial comes on than a consumer listening to a program that she doesn't really like that much, even though the former commercial is more enjoyable than the latter.

I assume that all consumers have the same opportunity cost of listening to the radio, which I normalize to zero. Thus, consumers are differentiated only by their location in the horizontal format space. This allows me to focus on the effects of merger between the two stations.

I assume that programming is divided into program periods of a given length. During a program period, a consumer has three options. She can listen to station 1 for the program period, listen to station 2 for the program period, or not listen. Since the opportunity cost of listening is 0, consumers will listen as long as $U_i \geq 0$, for some i . A consumer who is just indifferent to listening to either station for the entire program period is located at $c^*(x_1, x_2, a_1, a_2)$, the implicit function which solves $U_1 = U_2$. Clearly $U_1 = U_2$ if and only if $d_1 = d_2$.

Firms generate revenue based on the amount of advertising time, a_i , times the amount of consumers who listen to the ads. I assume that the market for advertising is perfectly competitive, so that firms can sell all the advertising they want at a constant price, A . I normalize production costs to zero, so that profit for firm i is given by:

$$\Pi_i = A * a_i * D_i, \quad i = \{1,2\},$$

where D_i is the demand captured by Firm i . Firm i will capture all of the consumers for whom $U_i > 0$ **and** $U_i > U_j$, $i, j \in \{1,2\}$, $i \neq j$. Given the utility specification above, there will be two locations where a consumer listening to a firm gains exactly 0 utility--one to the right of the firm, and one to the left. Therefore the demand faced by station 1

is equal to $\min\{c^*, c_1^R\} - \max\{0, c_1^L\}$, where c_1^R is the location of the consumer to the right of Firm 1 who gains exactly 0 utility by listening to Firm 1, and c_1^L is the location of the consumer to the left of Firm 1 who gains exactly 0 utility by listening to Firm 1. Similarly, Firm 2's demand will be $\min\{1, c_2^R\} - \max\{c^*, c_2^L\}$ where c_2^R is the location of the consumer to the right of Firm 2 who gains exactly 0 utility by listening to Firm 2, and c_2^L is the location of the consumer to the left of Firm 2 who gains exactly 0 utility by listening to Firm 2.

The following proposition demonstrates that when consumers have significant distaste for station formats that are less than ideal, then two independently operated stations will diversify so that they each capture a disjoint set of consumers, and effectively operate as independent monopolies.

Proposition 1: If $t \geq 2u\sqrt{2}$, then the firms will diversify to the point that each has a separate monopoly.

Proof: I will show that given these parameter values, a profit maximizing monopolist will generate demand of no more than half of the consumers. Therefore, there is "room" for two firms to act as individual monopolists, which is an equilibrium.

The maximum profit a firm can make is the profit obtained as a monopolist. If the market is not "covered" by a monopolist located at $x \in [0,1]$, meaning that some consumers would receive utility less than 0 and therefore not listen, and the monopolist locates close enough to $x = \frac{1}{2}$ so that consumers located at $c = 0$ and $c = 1$ receive utility less than or equal to 0, then the demand facing a monopolist can be found by determining the locations of the consumers who gain exactly zero utility. Given the utility specification I am using, there are two locations where the consumer gains exactly 0 utility, one to the right of x and one to the left. Call these locations c^R and c^L , respectively. Since utility is strictly decreasing in distance, all consumers to the left of

c^R and to the right of c^L will listen, and all other consumers will not listen. These locations are:

$$c^R = x + \frac{\sqrt{u^2 - a^2 t^2}}{t} \text{ and}$$

$$c^L = x - \frac{\sqrt{u^2 - a^2 t^2}}{t}.$$

Demand is given by $c^R - c^L = 2 \frac{\sqrt{u^2 - a^2 t^2}}{t}$.

The monopolist's profit is then given by

$$\Pi = A * a * 2 \frac{\sqrt{u^2 - a^2 t^2}}{t}.$$

The first order condition for profit maximization is

$$\frac{\partial \Pi}{\partial a} = - \frac{4a^2 t^2 + 2u^2}{\sqrt{-a^2 t^4 + t^2 u^2}} = 0.$$

Solving for a , I obtain

$$a^* = \frac{u}{t\sqrt{2}}.$$

Demand for the monopolist when $a^* = \frac{u}{t\sqrt{2}}$ is:

$$D = \frac{\sqrt{2} * u}{t}. \text{ Solving } D = \frac{1}{2}, \text{ I obtain } t = 2u\sqrt{2}. \text{ Since } D \text{ is strictly decreasing in } t, \text{ I}$$

conclude that if $t \geq 2u\sqrt{2}$, then the maximum demand that a single firm can have at the profit maximizing level of advertising equals $\frac{1}{2}$. Therefore with 2 firms, as long as $t \geq$

$2u\sqrt{2}$, there exist locations (in particular $x_1 = \frac{1}{4}$ and $x_2 = \frac{3}{4}$) such that each gains monopoly profit. Since this maximizes profit for each firm, this is an equilibrium

outcome. All other equilibria involve variations of location which allow each firm to gain monopoly profit. QED

Proposition 2: If $t \leq \frac{3u}{2}$ then the firms locate at $(x_1, x_2) = (1/6, 5/6)$, with $(a_1, a_2) = (\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}})$.

Proof: This is verified by solving the two firms' optimization problems using backward induction. The consumer who is indifferent between listening to station 1 and station 2 is located at

$c^* = \frac{a_1^2 - a_2^2 + x_1^2 - x_2^2}{2(x_1 - x_2)}$. Taking locations as given, the first order conditions for profit

maximization in the advertising subgame are:

$$\frac{\partial \Pi_1}{\partial a_1} = \frac{a_1^2}{x_1 - x_2} + \frac{a_1^2 - a_2^2 + x_1^2 - x_2^2}{2(x_1 - x_2)} = 0$$

$$\frac{\partial \Pi_2}{\partial a_2} = 1 + \frac{a_2^2}{x_1 - x_2} - \frac{a_1^2 - a_2^2 + x_1^2 - x_2^2}{2(x_1 - x_2)} = 0.$$

Solving these equations simultaneously, I obtain

$$a_1^* = \frac{\sqrt{-x_1 - x_1^2 + x_2 + x_2^2}}{2} \text{ and}$$

$$a_2^* = \frac{\sqrt{-3x_1 + x_1^2 + 3x_2 - x_2^2}}{2}. \text{ The second order conditions for profit maximization}$$

hold:

$$\frac{\partial^2 \Pi_1}{\partial a_1^2} = \frac{3a_1}{x_1 - x_2} \leq 0 \text{ (since } x_1 \leq x_2 \text{);}$$

$$\frac{\partial^2 \Pi_2}{\partial a_2^2} = \frac{3a_2}{x_1 - x_2} \leq 0 \text{ (since } x_1 \leq x_2 \text{).}$$

As can be easily seen by inspection, the closer the firms are together, the lower the levels of advertising in equilibrium.

Substituting these values into the firms' profit functions, I get

$$\Pi_1 = \frac{(1 + x_1 + x_2)\sqrt{-x_1 - x_1^2 + x_2 + x_2^2}}{8} \text{ and}$$

$$\Pi_2 = \frac{-(-3 + x_1 + x_2)\sqrt{-3x_1 + x_1^2 + 3x_2 - x_2^2}}{8}$$

The first order conditions for profit maximization with respect to locations are

$$\frac{\partial \Pi_1}{\partial x_1} = \frac{-1 - 4x_1^2 + x_2 + 2x_2^2 - x_1(5 + 2x_2)}{16\sqrt{-x_1 - x_1^2 + x_2 + x_2^2}} = 0 \text{ and}$$

$$\frac{\partial \Pi_2}{\partial x_2} = \frac{9 - 2x_1^2 - 15x_2 + 4x_2^2 + x_1(3 + 2x_2)}{16\sqrt{-3x_1 + x_1^2 - x_2(-3 + x_2)}} = 0.$$

Solving these first order conditions simultaneously for x_1 and x_2 , I obtain

$$x_1^* = \frac{1}{6}$$

$$x_2^* = \frac{5}{6}.$$

Again, the second order conditions hold:

$$\frac{\partial^2 \Pi_1}{\partial x_1^2} = -\frac{\sqrt{3}}{4}.$$

$$\frac{\partial^2 \Pi_2}{\partial x_2^2} = -\frac{\sqrt{3}}{4}$$

The complete solution to the model is

$$x_1^* = \frac{1}{6}$$

$$x_2^* = \frac{5}{6}$$

$$a_1^* = a_2^* = \frac{1}{\sqrt{3}}$$

$$\Pi_1^* = \Pi_2^* = \frac{A}{2\sqrt{3}}$$

Finally, I note that the utility level of the consumer located at c^* is ≥ 0 , provided that $t \leq \frac{3u}{2}$. This last step is necessary to ensure that demand for Firm 1 is equal to c^* , demand for Firm 2 is equal to $(1-c^*)$, and thus the profit functions used in the analysis are correct. If $t > \frac{3u}{2}$, then the consumer located at c^* will receive utility less than 0. In this case, the firms could increase profit by moving closer to the center because demand for Firm 1 would be strictly increasing in location, and demand for Firm 2 would be strictly decreasing in location. This is because the market is not "covered". Since the profit functions are concave in both advertising and location, the equilibrium is unique.

QED

Merger

Here I analyze the advertising and location choices of the firms if they were to merge under common ownership. I assume that a merger results in a single decision maker who operates both stations and maximizes total (joint) profits. In order to make meaningful comparisons to the competition model, I restrict my analysis to the case where $t \leq \frac{3u}{2}$.

As shown in Proposition 2, this means that, in the competitive case, the firms do not act as separate monopolists, and that the entire market is covered.

Proposition 3 shows that if consumers do not really mind what they are listening to, then the firms will advertise all of the time. The parameter assumptions in this proposition are close to the spirit of earlier models where audiences are assumed to listen to one program or another, but never choose to not listen. Such a consumer would either have a very low opportunity cost of listening, or a great tolerance for almost any type of programming. One might consider a person driving in a car or working out--situations where listening to a radio program does not preclude other activity.

Proposition 3: If $t \leq \frac{4u}{\sqrt{17}}$, then two stations operating under common ownership will each advertise all of the time ($a_i = 1, i=1,2$).

Proof: For this very low level of t , advertising all of the time still captures the entire market between the two firms. If $t = \frac{4u}{\sqrt{17}}$, then the firms will locate at $x_1 = \frac{1}{4}$, $x_2 = \frac{3}{4}$. If $t < \frac{4u}{\sqrt{17}}$, then there are an infinite number of location choices that allow the firms to capture the entire market together while advertising all of the time. Clearly this will maximize the joint profits of the firm. QED

The parameter restrictions in the following proposition allow for a meaningful comparison to the competitive case described by Proposition 2:

Proposition 4: If $\frac{4u}{\sqrt{17}} < t < \frac{3u}{2}$, then the firms will locate at $x_1 = \frac{1}{4}$, $x_2 = \frac{3}{4}$. The advertising levels are $a_1^* = a_2^* = \frac{\sqrt{16u^2 - t^2}}{4t}$.

Proof: This advertising level allows the firms to capture the entire market between them. Suppose by construction that Firm 1 locates at $x_1 = \frac{1}{4}$. Given the parameter restrictions stated above, if Firm 1 advertises at the level of $a_1 = \frac{\sqrt{16u^2 - t^2}}{4t}$, then the consumers located at $c = 0$ and $c = \frac{1}{2}$ gain exactly 0 utility by listening to Firm 1. All consumers located at $c \in (0, \frac{1}{2})$ gain positive utility listening to Firm 1. Similarly, if Firm 2 located at $x = \frac{3}{4}$ and advertised at the level of $a_2 = \frac{\sqrt{16u^2 - t^2}}{4t}$, then consumers located at $c =$

$\frac{1}{2}$ and $c = 1$ gain exactly 0 utility by listening to station 2. All consumers located at $c \in (\frac{1}{2}, 1)$ gain positive utility from listening to station 2. Thus, consumers located at $c \in (0, \frac{1}{2})$ listen to Firm 1, and consumers located at $c \in (\frac{1}{2}, 1)$ listen to Firm 2. (Whether the consumers located at $c = 0$, $c = \frac{1}{2}$ and $c = 1$ listen or not is immaterial to the optimization since they each occupy a space of measure 0.) In this situation, advertising less would not increase profits since the firms are already capturing the entire market between them. Advertising more by either station would decrease profit, since at that level of advertising the derivative of profit with respect to advertising for each station is negative:

$$\frac{\partial \Pi_i}{\partial a_i} = \frac{A(t^2 - 8u^2)}{t^2}, \quad i=1,2 \quad \text{when} \quad a_i = \frac{\sqrt{16u^2 - t^2}}{4t}.$$

It is easily verified that this is negative as long as t falls within the range specified in Proposition 4. QED

Operating Costs

The previous analysis was done having normalized the cost of operating a station to 0. However, in the merger case, this assumption loses generality. Specifically, if the cost of operating a station is greater than $\frac{A(\sqrt{16u^2 - t^2} - 2\sqrt{4u^2 - t^2})}{t}$, then the profit-maximizing common ownership will shut down one station and operate as a single firm monopolist. It should be noted that if $\sqrt{2}u < t < \frac{3u}{2}$, then the single-firm monopolist will no longer "cover" the market. The single-firm monopolist will set an advertising level of $a^* = \frac{u}{\sqrt{2}t}$. If $t < u\sqrt{2}$ then the market will be covered. Otherwise, there will be some consumers who do not listen to the programming. In this situation, the single-firm monopolist will have some leeway as to format selection and will not necessarily choose the middle of the location space.

Welfare

Total welfare in each scenario is the sum of profits by the firms plus utility by all consumers. If the market is covered, this is given by:

$$W = \int_0^{c^*} u_1 dc + \int_{c^*}^1 u_2 dc + \Pi_1 + \Pi_2$$

Total welfare in equilibrium in the competitive case is equal to

$$W^C = \frac{A}{\sqrt{3}} + u - \frac{t}{36} \left(8 + \sqrt{13} + 12 \text{Arcsinh} \left[\frac{1}{2\sqrt{3}} \right] + 12 \text{Arcsinh} \left[\frac{1}{\sqrt{3}} \right] \right) \cong 0.57735A + u - 0.600415t$$

and total welfare in equilibrium in the merger case is

$$W^M = A \frac{\sqrt{16u^2 - t}}{4t} + \frac{u}{2} + \left(\frac{16u^2 - t^2}{16t} \right) \text{Log} \left[1 - \frac{2t}{t + 4u} \right].$$

The difference $(W^C - W^M)$ is a decreasing function of A . Depending upon the parameter values, it is possible for either the merger case or the competitive case to yield greater welfare. For example, if $U = t = 1$, then if $A < .968$, the difference between welfare in the competitive case and welfare in the merger case is positive, so welfare is greater in the competitive case. If $A > .969$ then the opposite is true. The interpretation is clear: when firms can sell their advertising units at a high price, the increase in firms' profits resulting from merger outweighs the decrease in consumer utility.

I can also say that in the competition model the firms are too far apart for social efficiency.

$$\frac{\partial W^C}{\partial x_1} = 2t \left(\sqrt{a1^2 + \left(x1 - \frac{1}{2}\right)^2} - \sqrt{a1^2 + x1^2} \right) + \frac{(a1 - a2)A(a2^2 - a1^2 + (x1 - x2)^2)}{2(x1 - x2)^2}$$

Substituting the equilibrium values of x_1, x_2, a_1 and a_2 , $\frac{\partial W}{\partial x_1} = 0.0657415t$ which is greater than 0 as long as t is greater than 0. Therefore, total welfare would increase if Firm 1 moved closer to the center. Similarly, in equilibrium, the derivative of total welfare with respect to x_2 is $-0.657415t$, indicating that total welfare would increase if Firm 2 moved closer to the center.

In equilibrium, $\frac{\partial W^C}{\partial a_i} \cong A/2 - .481577t$, $i=1,2$. Therefore if $A < 0.963153t$ then there is too much advertising, and if $A > 0.963153t$ there is too little advertising.

In the merger model, $\frac{\partial W^M}{\partial x_i} = 0$ in equilibrium, $i=1,2$, indicating that the firms are located at the welfare maximizing locations. This is a standard result, and follows from the fact that $(x_1, x_2) = (\frac{1}{4}, \frac{3}{4})$ will minimize total "transportation" costs of consumers.

Finally,

$$\frac{\partial W^M}{\partial a_1} = \frac{2A + t^3 \sqrt{16u^2 - t^2} \text{LOG}\left(\frac{\sqrt{1-t^6 + 16t^4u^2} - 1}{\sqrt{1-t^6 + 16u^2} + 1}\right)}{4}.$$

Since this is increasing in A , if

$$A > -\frac{1}{2}(t^3 \sqrt{-t^2 + 16U^2}) \text{LOG}\left[\frac{\sqrt{1-t^6 + 16t^4u^2} - 1}{\sqrt{1-t^6 + 16t^4u^2} + 1}\right],$$

then there is too little advertising in the merger model, and if

$$A < -\frac{1}{2}(t^3 \sqrt{-t^2 + 16u^2}) \text{LOG}\left[\frac{\sqrt{1-t^6 + 16t^4u^2} - 1}{\sqrt{1-t^6 + 16t^4u^2} + 1}\right],$$

then there is too much advertising for social optimality.

For example, if $u = t = 1$, this threshold is $\cong 0.98921$.

Conclusion

In contrast to earlier papers, I have found that a switch from competitive ownership to common ownership of radio stations might result in format choices which are more similar under the common ownership scheme. While welfare implications are ambiguous, there is some evidence that competitive ownership might be more efficient than monopoly. The results are driven by the utility specification which includes a measure of viewers' intensity of preferences as well as the possibility that consumers might choose not to listen at all. This utility specification assumes that consumers are affected by both advertising time and format choice, which seems to accurately capture the flavor of advertiser supported markets.

I also find that the principle of maximum differentiation found by d'Aspremont, Gabszewicz and Thisse (1979) does not hold under the preference assumptions of this paper. In their paper, the cost of consuming a product equals the transportation cost associated with the purchase of a product **plus** the monetary price of the product. Here the "price" of the product can be thought of as the level of advertising time, but this price is not separable from the utility diminution resulting from listening to a less than ideal station format.

The results of this paper suggest that radio mergers may lessen economic efficiency through their effect on total advertising time. A weakness here, however, is that the benefits to the advertisers are not considered. One might reasonably think that a monopolistic radio industry would create higher prices for advertisers, leading to welfare reductions. A more robust model which explores this is in order.

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