Technical Appendices to: Is Having More Channels Really Better?

A Model of Competition Among Commercial Television Broadcasters
1 Advertising Rates for Syndicated Programs

In this appendix we provide results of an empirical analysis of the relationship between average advertising rates for a 30-second spot (on a national audience basis) and average ratings levels for 30 syndicated programs during the 1998-1999 television season. The ratings data are from Nielsen Media Research (published in the September 13-19, 1999 issue of Variety), while the advertising rate data is from a survey of advertising agencies and media buyers that appeared in the January 18, 1999 issue of Advertising Age. The average ratings data reflect the entire 1998-1999 season (mid-August 1998 to mid-August 1999), while the advertising rate data, based on its publication date, only covers roughly the first quarter of the season. While this situation is less than ideal, we believe that this difference results in a conservative estimate of the role of ratings on advertising rates. Table TA1.1 provides the names, average ratings, and average advertising rates for the 30 programs included in our analysis, while Figure TA1.1 provides a scatter plot of the ratings and advertising rate data.

An examination of Figure TA1.1 reveals two distinct ratings–advertising rate lines in the data. To help identify potential differences between the two relationships, program labels are provided for four of the data points that comprise the “lower” of the two lines. The four shows (The Oprah Winfrey Show, Judge Judy, Jeopardy!, and Wheel of Fortune) are either talk, game, or court shows. A close examination of Table TA1.1 reveals a similar pattern for other talk, game, and court shows, while the “upper” ratings–advertising rate line is composed of dramatic programs (i.e., situation comedies, crime dramas, and science fiction and fantasy programs) and news magazines. As a result, the data clearly reveal the existence of two broad classes of syndicated programs, the first consists of all dramatic programs and news magazines, while the second is made up of talk, game, and court shows.

Univariate regression analysis was conducted to examine the effect of average ratings on advertising rates within each of the two broad classes of syndicated programs. This analysis indicates that total ratings alone explain most of the variance in advertising rates across programs. Specifically, average ratings explain 91% of the variance in advertising rates for the first broad class of
programs (all dramatic programs and news magazines) and 72% of the variance for the second broad class (talk, game, and court shows). In addition, a multiple regression model was run that included the program’s average rating, a dummy variable that indicated whether the program was a game, talk, or court show, and an interaction term between the program genre dummy variable and the average rating of the program. This pooled regression explains 90% of the variance in advertising rates. As a result, within each of the two (very) broad classes of programs, total ratings are overwhelmingly responsible for determining advertising rates.
Table TA1.1 Average Ratings and Spot Rates for 30 Syndicated Programs

<table>
<thead>
<tr>
<th>Program</th>
<th>Rating</th>
<th>Rate ($)</th>
<th>Program</th>
<th>Rating</th>
<th>Rate ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ER</td>
<td>4.1</td>
<td>66,000</td>
<td>Entertainment Tonight</td>
<td>5.7</td>
<td>105,000</td>
</tr>
<tr>
<td>Frasier</td>
<td>5.3</td>
<td>93,000</td>
<td>Extra</td>
<td>3.7</td>
<td>65,000</td>
</tr>
<tr>
<td>Friends</td>
<td>6.4</td>
<td>140,000</td>
<td>Inside Edition</td>
<td>3.3</td>
<td>25,000</td>
</tr>
<tr>
<td>Home Improvement</td>
<td>5.0</td>
<td>102,000</td>
<td>Jenny Jones Show</td>
<td>3.1</td>
<td>21,000</td>
</tr>
<tr>
<td>Mad About You</td>
<td>2.6</td>
<td>46,000</td>
<td>Live with Regis and Kathie Lee</td>
<td>3.2</td>
<td>22,000</td>
</tr>
<tr>
<td>NYPD Blue</td>
<td>3.1</td>
<td>23,000</td>
<td>Maury</td>
<td>3.1</td>
<td>12,000</td>
</tr>
<tr>
<td>Seinfeld</td>
<td>6.1</td>
<td>137,000</td>
<td>Oprah Winfrey Show</td>
<td>6.3</td>
<td>60,000</td>
</tr>
<tr>
<td>Simpsons</td>
<td>3.8</td>
<td>69,000</td>
<td>Ricki Lake</td>
<td>3.3</td>
<td>19,000</td>
</tr>
<tr>
<td>Walker Texas Ranger</td>
<td>3.5</td>
<td>31,000</td>
<td>Rosie O’Donnell Show</td>
<td>3.6</td>
<td>39,000</td>
</tr>
<tr>
<td>X-Files</td>
<td>5.1</td>
<td>89,000</td>
<td>Sally Jessy Raphael</td>
<td>3.7</td>
<td>16,000</td>
</tr>
<tr>
<td>Journeys of Hercules</td>
<td>3.6</td>
<td>47,000</td>
<td>Hollywood Squares</td>
<td>4.0</td>
<td>47,000</td>
</tr>
<tr>
<td>Baywatch</td>
<td>3.2</td>
<td>37,000</td>
<td>Jeopardy!</td>
<td>9.1</td>
<td>63,000</td>
</tr>
<tr>
<td>Star Trek: Deep Space 9</td>
<td>3.8</td>
<td>59,000</td>
<td>Wheel of Fortune</td>
<td>10.9</td>
<td>69,000</td>
</tr>
<tr>
<td>V.I.P.</td>
<td>2.9</td>
<td>27,000</td>
<td>Judge Joe Brown</td>
<td>3.2</td>
<td>8,000</td>
</tr>
<tr>
<td>Xena, Warrior Princess</td>
<td>3.8</td>
<td>46,000</td>
<td>Judge Judy</td>
<td>6.7</td>
<td>35,000</td>
</tr>
</tbody>
</table>

Figure TA1.1 Average Ratings and Spot Rates for Syndicated Programs
2 The Nature of the Static Duopoly Equilibrium

In this appendix we examine the nature of the static duopoly equilibrium over different ranges of the cost of quality provision parameter \(c\). We accomplish this through the development of four lemmas which are the basis for a final theorem that describes the relationship between the cost of quality provision and the nature of the static duopoly equilibrium. Throughout this appendix we assume, without loss of generality, that broadcaster \(A\) is located on the left-hand side of the market, and broadcaster \(B\) is located on the right-hand side.

Lemma TA2.1 When \(c \in [4, \infty)\) there is a pure strategy Nash equilibrium in which each broadcaster acts as a local monopolist, each offers a program with quality level \(v^{A*} = v^{B*} = 1/c\), and broadcasters \(A\) and \(B\) are indifferent to any positions along the horizontal dimension so long as their potential market boundaries do not overlap one another.

In order for the two broadcasters not to directly compete with one another, it must be the case that \(v^{A*} = v^{B*} \leq 1/4\), which occurs when \(c \geq 4\). When the two broadcasters are not in competition with one another (i.e., their respective potential market boundaries do not overlap), the marginal revenue from quality improvements is equal to two as it is for a monopolist. As a result, both broadcasters set quality at the monopoly level \(v^{A*} = v^{B*} = 1/c\). Since they inefficiently split the demand in the portions of their potential market areas when their boundaries overlap one another, they find it optimal to avoid doing so.

Lemma TA2.2 Assuming a pure strategy Nash equilibrium exists, and \(c \in (2, 4)\), then \(v^{A*} = v^{B*} = 1/4\), \(d^{A*} = 1/4\), and \(d^{B*} = 3/4\), and the equilibrium is unique.

As described in §3.2.1, the transition from local monopoly to direct competition causes the marginal revenue curve for quality provision to become discontinuous at \(v^{A*} = v^{B*} = 1/4\). As \(c\) approaches 2 from below (a situation in which the broadcasters are in direct competition) the optimal quality levels for both firms are again \(v^{A*} = v^{B*} = 1/(2c) = 1/4\). Conversely, as \(c\) approaches 4 from
above (in which case the firms act as local monopolists) the optimal quality levels for both firms are again \( v^{A*} = v^{B*} = 1/c = 1/4 \). In both instances broadcaster A’s optimal location is at \( d^{A*} = v^{A*} = 1/4 \) and broadcaster B’s is at \( d^{B*} = 1 - v^{B*} = 3/4 \) since neither broadcaster wants to overlap the market boundaries, nor have their potential market areas overlap one another. The range of \( c \in (2,4) \) corresponds to the discontinuous portion of the quality provision marginal revenue curve, and neither broadcaster can equate marginal revenue with marginal cost. At this point we need to show that \( v^{A*} = v^{B*} = 1/4, d^{A*} = 1/4 \) and \( d^{B*} = 3/4 \) is indeed the equilibrium when \( c \in (2,4) \). To do this, we fix broadcaster A at \( v^A = d^A = 1/4 \) and show that broadcaster B does not have an incentive to leave \( v^B = 1/4 \) and \( d^B = 3/4 \). The case of fixing broadcaster B and examining the optimal strategy for broadcaster A is symmetric.

Broadcaster B has two options when leaving \( v^B = 1/4 \) and \( d^B = 3/4 \). It can either increase \( v^B \) by a positive amount \( \varepsilon \) and move to \( d^B = 3/4 - \varepsilon \), or decrease \( v^B \) by \( \varepsilon \) and move to \( d^B = 3/4 + \varepsilon \). Before it moves, the two broadcasters just touch each other in the center with their respective hinterlands marginally covered, so \( q^A = q^B = 1/2 \). Broadcaster B’s profit is \( \pi^B = 1/2 - c(1/4)^2 = 1/2 - c/16 \). If it increases \( v^B \), then the indifferent viewer locates at \( \bar{x}^+ = 1/2 + 1/4 - (1/4 + \varepsilon) = 1/2 - \varepsilon \). Thus \( q^{B+} = 1 - \bar{x} = 1/2 + \varepsilon \), which leads to a profit of

\[
\pi^{B+} = 1/2 + \varepsilon - c(1/4 + \varepsilon)^2 \\
= [(1/2) - c/16] + \varepsilon[1 - (c/2) - c\varepsilon] \\
= \pi^B + \varepsilon[1 - (c/2) - c\varepsilon].
\]

Since \( c \in (2,4) \), we have \(-1 < (1-c/2) < 0\), so \( \pi^{B+} < \pi^B \). Thus broadcaster B will not increase its quality.

On the other hand, if \( v^B \) is decreased by \( \varepsilon \), then broadcaster B obtains a profit of

\[
\pi^{B-} = \pi^B + \varepsilon[(c/2) - 2] - c\varepsilon^2.
\]
Again, since $c \in (2, 4)$, it is the situation that $-1 < (c/2 - 2) < 0$. Therefore $\pi^{B^*} < \pi^B$ and broadcaster $B$ will not decrease its quality. In summary, broadcaster $B$ does not have an incentive to unilaterally move away from its equilibrium positions.

Rosen (1965) shows that if the payoff function (Broadcaster $A$’s profit function in this instance) is strictly concave, then a pure strategy Nash equilibrium is unique. Broadcaster $A$’s profit function is strictly concave for changes in both location and quality (Figure TA2.1 illustrates this point for changes in Broadcaster $A$’s location when $c = 2.7$, $v^B = 1/4$, and $d^B = 3/4$). As a result, the equilibrium is unique. □

**Lemma TA2.3** If $c \in [0, 8/3)$ a broadcaster would find it profitable to play an aggressive high quality strategy against its rival.

Within the range $0 < c \leq 1$, both broadcasters have a strong incentive to be in the market center since $1/(2c) \leq 1/2$. While the two broadcasters will share the market equally if each of them sets a quality level of $1/2$, either of them can then increase its quality level by an infinitesimal amount ($\varepsilon$) above $1/2$ in an effort to capture the entire market viewership. Since the other broadcaster’s ratings fall to zero, it would find it optimal to increase its quality level infinitesimally above its rival, since it would then capture the entire market. This strategic interaction results in a quality war. To examine the extent to which this type of aggressive quality setting is profitable, and whether there is a resulting pure strategy equilibrium, we compare optimal profits when neither broadcaster engages in this strategy with the profits obtained by locating at the center with quality set at $v = 1/2 + \varepsilon$ in an effort to drive out the other competitor.

Without considering the use of aggressive quality setting behavior, when $1 < c \leq 2$, each broadcaster will set equilibrium quality level of $1/(2c)$, receive a demand of $1/2$, incur a quality cost of $1/(4c)$, and obtain profits of $1/2 - 1/(4c)$. If one broadcaster acts aggressively by setting $v = 1/2 + \varepsilon$, its profit will be $1 - c(1/2 + \varepsilon)^2$, which at the limit approaches $1 - c/4$. Examining the values of $c$ for which $1 - c/4 > 1/2 - 1/(4c)$, following an aggressive quality setting strategy is always profitable when $1 < c \leq 2$, and this behavior is even more profitable when $c \leq 1$. When $2 < c \leq 4$ (the range over which the marginal revenue from quality improvements is
discontinuous) the profit levels when neither broadcaster engages in aggressive quality setting are 
$1/2 - c(1/4)^2$. When $c \leq 8/3$ an aggressive broadcaster would be able to earn a higher profit by 
setting a high quality level that would allow it to capture the entire potential viewership. □

**Lemma TA2.4** When a broadcaster finds it profitable to engage in aggressive quality 
setting in an effort to obtain the entire market viewership, a quality war will result in 
which no rival has an incentive to stop increasing its quality level until the profit from 
doing so becomes zero.

We need to show that during a quality war, one rival does not find it more profitable to set a 
lower quality level, and move toward one end of the market, rather than to continue with a slightly 
higher quality level, while staying at the market center, in an effort to capture the entire viewership. 
Assume that quality competition has driven up broadcaster $A$’s quality to the range ($1/2 < v^A \leq 
1/\sqrt{c}$), does broadcaster $B$ still find it most profitable to set $v^B = v^A + \varepsilon$ in an effort to capture 
all viewers? If it does, its profits will be $\pi^B = 1 - c(v^A + \varepsilon)^2$. On the other hand, if broadcaster 
$B$ decides to retreat from top-off competition, it will set $v^B < v^A$, and move toward one end of the market (say the right-hand side), making sure that its market coverage slightly exceeds 1 
so that it gains all viewers on that end of the market. To do this broadcaster $B$ needs to have 
$v^B = (1 - d^B) + (v^A - 1/2)$ and thus $\pi' = (1 - d^B) - c(v^B)^2 = 1/2 - v^A + v^B - c(v^B)^2$. In 
order for broadcaster $B$ to have any viewership, $v^B$ needs to be greater than $v^A - 1/2$.

If broadcaster $B$ is going to end the quality war, then a level of $v^A$ must exist such that $\pi < \pi'$. 
Solving this inequality leads to two conditions:

$$\frac{1-k}{2c} < v^B < \frac{1+k}{2c}$$

where $k = \sqrt{1 + 4c^2(v^A)^2 - 4cv^A - 2c}$. The value of $k$ will only take on feasible values when 
v^A > 1/(2c) + 1/\sqrt{2c}$, making $\pi < \pi'$ possible. Since $v^A \leq 1/\sqrt{c}$, the minimum requirement 
for $\pi < \pi'$ is $1/\sqrt{c} > 1/(2c) + 1/\sqrt{2c}$. This occurs only if $c > 2.91$. However, as discussed in 
the text, broadcasters will only engage in aggressive quality setting if $c < 8/3$. As a result, it is
never the case that a broadcaster would stop during a quality war. Once started, a quality war will continue until \( v = 1/\sqrt{c} \), driving broadcaster profitability to zero. Once profits are driven to zero, \( v^{A*} = v^{B*} = 0 \) becomes the optimal strategy, and quality levels drop in the market. However, one of the broadcasters would find it optimal to set quality to a strictly positive level, and the quality war would resume. As a result, no pure strategy Nash equilibrium exists. \( \Box \)

We characterize the nature of duopoly competition over different values of the cost parameter \( c \) in the following theorem, with the proof implicit on the preceding lemmas.

**Theorem TA2.1** The cost of quality provision influences the duopoly market equilibrium in the following way:

1. When \( c \in [0, 8/3) \) no equilibrium in pure strategies exists.

2. When \( c \in [8/3, 4) \) there is a pure strategy Nash equilibrium in which each broadcaster receives half of the total potential ratings, both broadcasters set a quality of \( v^A = v^B = 1/4 \), and they locate at \( d^A = 1/4, d^B = 3/4 \).

3. When \( c \in [4, \infty) \) there is a pure strategy Nash equilibrium in which each broadcaster acts as a local monopolist, each offers a program with quality level \( v^{A*} = v^{B*} = 1/c \), and broadcasters A and B are indifferent to any positions along the horizontal dimension so long as their market boundaries do not overlap one another.
Figure TA2.1 Broadcaster A’s Profits Across Locations when $c = 2.7$, $v^B = 0.25$, and $d^B = 0.75$
3 Triopoly competitive behavior

In this appendix we extend the model of §3 to a triopoly market. For ease of exposition we assume broadcaster $A$ is at the left-hand side of the market, broadcaster $C$ is at the right, and broadcaster $B$ lies in between. As with the duopolists, each of the three broadcasters may face two exclusive situations: local monopoly and direct competition. In the case of local monopoly we know that each broadcaster sets a quality level of $1/c$ at equilibrium. However, since there are now three rivals in the market, the local monopoly situation requires $v^* \leq (1/6)$, thus $c \geq 6$. The market is not fully covered and the broadcasters face a range of locations over which they are indifferent.

When broadcasters directly compete the two “exterior” broadcasters have a marginal revenue of 1. What needs to be determined is the marginal revenue of broadcaster $B$ who faces competition from both sides. Two indifferent positions exist at broadcaster $B$’s left-hand and right-hand sides (denoted by subscripts $L$ and $R$). They are respectively $x_L = 1/4 - v^B/2 + v^A$ and $x_R = 3/4 + v^B/2 - v^C$. Thus $B$’s demand function is $q^B = x_R - x_L = 1/2 + v^B - v^A - v^C$, and its marginal revenue equals 1. As a result, the three broadcasters will each set a quality level of $v^* = 1/(2c)$. When aggressive quality setting competition is ruled-out, direct competition occurs when $(1/6) \leq v^* \leq (1/2)$, which requires that $1 \leq c \leq 3$. The range of discontinuity in marginal revenue now becomes $c \in (3, 6)$. The sticky equilibrium starts at a higher value of $c$ and the sticky range is longer than it is in the duopoly industry.

Using identical methods to those used in Technical Appendix 2, we examined the range of $c$ over which broadcasters engage in a quality war. This analysis indicates that no pure strategy Nash equilibrium exists when $c \leq 4$. When $4 < c \leq 6$, which corresponds to the range over which the marginal revenue of quality provision is discontinuous, the equilibrium quality level for each broadcaster is $v^* = 1/6$, while the equilibrium quality level is $v^* = 1/c$ when $c > 6$. Our analysis indicates that even though there are fewer competitors, the duopolists set a higher level of quality when $c$ is between 4 and 6 than do the broadcasters in a triopoly market. As a result of these higher quality levels, viewer welfare is greater in the duopoly market than in the triopoly market when $c$ is between 4 and 4.9. Therefore, the results that a market with more competitors may result in
lower quality levels and lower viewer welfare compared to a market with fewer competitors also applies in the comparison between duopoly and triopoly market structures.
4 Sequential equilibrium in a duopoly when viewers are forward-looking

In the two-period game with forward-looking viewers we assume that the order of moves is as follows: (1) broadcasters first choose their program offerings for both time slots and (2) viewers then observe the program schedule (say by reading *TV Guide*) and then decide which programs/channels to watch in both time slots. A viewer makes her viewing choice before the first time slot based on the aggregated utility over both time slots.

Assuming that she watches television in both time periods, a viewer has four options to choose from: (1) watch broadcaster *A* in both periods (*AA*); (2) watch *A* in period-one and then switch to *B* in period-two (*AB*); (3) watch *B* in period-one and then switch to *A* (*BA*); or (4) watch *B* in both periods (*BB*). The two-period utility for a viewer located at *x* under each of the four possible scenarios is given by

\[
U_{AA} = v_1^A - |x - v_1^A| + v_2^A - |x - v_2^A| \\
U_{AB} = v_1^A - |x - v_1^A| + v_2^B - |1 - v_2^B - x| - \alpha \\
U_{BA} = v_1^B - |1 - x - v_1^B| + v_2^A - |x - v_2^A| - \alpha \\
U_{BB} = v_1^B - |1 - x - v_1^B| + v_2^B - |1 - x - v_2^B|
\]

If this viewer decides to watch *AA*, then it must be the case that \( U_{AA} > U_{AB}, U_{AA} > U_{BA}, \) and \( U_{AA} > U_{BB} \). Similar sets of inequalities must hold for the other three viewing options. Table TA4.1 provides the conditions on *x* that must hold under each of the four viewing possibilities.

The conditions in Table TA4.1 indicate that both quality levels and the magnitude of the switching cost are considered by a forward-looking viewer. The difference between the quality levels in the two time slots determines whether someone will switch channels. For instance, if the advantage of broadcaster *A*’s program in period two (i.e., \( v_2^A - v_2^B \)) is less than that in period one (i.e., \( v_1^A - v_1^B \)), then some viewers who locate in the middle range of the market will watch *A* first and then switch to *B*. Based on these conditions, we can determine the percentage of each type of
viewer in the market over the two time periods, are:

\[
q_{AA} = \begin{cases} 
  \frac{v_2^A - v_2^B + (1 + \alpha)/2}{2}, & \text{if } v_1^A - v_1^B > v_2^A - v_2^B + \alpha \\
  \frac{1 + v_1^A - v_1^B + v_2^A - v_2^B}{2}, & \text{if } v_1^A - v_1^B + \alpha > v_1^A - v_1^B > v_2^A - v_2^B - \alpha \\
  v_1^A - v_1^B + (1 + \alpha)/2, & \text{if } v_1^A - v_1^B < v_2^A - v_2^B - \alpha 
\end{cases}
\]

\[
q_{AB} = \begin{cases} 
  (v_1^A - v_1^B) - (v_2^A - v_2^B) - \alpha, & \text{if } v_1^A - v_1^B > v_2^A - v_2^B + \alpha \\
  0, & \text{otherwise}
\end{cases}
\]

\[
q_{BA} = \begin{cases} 
  (v_2^A - v_2^B) - (v_1^A - v_1^B) - \alpha, & \text{if } v_1^A - v_1^B < v_2^A - v_2^B - \alpha \\
  0, & \text{otherwise}
\end{cases}
\]

\[
q_{BB} = \begin{cases} 
  v_1^B - v_1^A + (1 + \alpha)/2, & \text{if } v_1^A - v_1^B > v_2^A - v_2^B + \alpha \\
  \frac{1 + v_2^B - v_1^A + v_1^B - v_2^A}{2}, & \text{if } v_2^A - v_2^B + \alpha > v_1^A - v_1^B > v_2^A - v_2^B - \alpha \\
  v_2^B - v_2^A + (1 + \alpha)/2, & \text{if } v_1^A - v_1^B < v_2^A - v_2^B - \alpha 
\end{cases}
\]

where \(q_{AA}\) is the percentage of type (AA) viewers, \(q_{AB}\) is the percentage of type (AB) viewers, \(q_{BA}\) is the percentage of type (BA) viewers, and \(q_{BB}\) is the percentage of type (BB) viewers.

The allocation of viewers across the four different types directly leads to the demand each broadcaster receives, and allows us to determine the broadcasters’ equilibrium strategies. As in the lead-in effect model with myopic viewers, backward induction can be used to find the equilibrium quality levels in each period. To do this, we begin by examining how broadcaster A’s selection of \(v_2^A\), given levels of \(v_1^A, v_1^B,\) and \(v_2^B\), influences viewing patterns over the two time slots. Specifically, viewers will choose AA or BB if \(v_1^A - v_1^B + v_2^B + \alpha > v_2^A - v_2^B - \alpha\), AA, AB, or BB if \(v_2^A < v_1^A - v_1^B + v_2^B - \alpha\), and AA, BA, or BB if \(v_2^A > v_1^A - v_1^B + v_2^B + \alpha\).

Broadcaster A’s total demand is calculated for each possible situation by adding up viewers who watch it in either time slot. For instance, if \(v_2^A < v_1^A - v_1^B + v_2^B - \alpha\) then all viewers will fall in the set \(\{AA, AB, BB\}\), broadcaster A’s total demand over the two time periods is calculated as the weighted sum of these three groups — those who watch A in both periods, those that watch A only in period-one, and those who watch A only in period-two.

Through some algebraic manipulation it can be shown that for all three of the cases described
above, broadcaster A’s total demand equals

\[ \sum q^A = q_1^A + q_2^A = 1 + v_1^A - v_1^B + v_2^A - v_2^B. \]

The marginal revenue associated with changes in \( v_2^A \) equals 1. As a result, the two broadcasters would find it optimal to set \( v_2^{A*} = v_2^{B*} = 1/(2c) \) as the equilibrium quality for their program offerings in period-two. Using backward induction to solve for the equilibrium quality in the first period results in the broadcasters selecting \( v_1^{A*} = v_1^{B*} = 1/(2c) \) as well.

The analysis up to this point has not considered the possibility that either broadcasters may follow an aggressive quality strategy designed to capture the entire market. Over some range of \( c \), a broadcaster may be tempted to follow such a strategy. An analysis nearly identical to that in Technical Appendix 2 was used to examine the range of \( c \) over which a quality war occurs. This analysis indicates that the range of \( c \) over which a broadcaster would elect to follow an aggressive quality strategy is smaller than it is for both the static game and the dynamic game with myopic viewers. As a direct result of this, the range of \( c \) over which a pure strategy equilibrium exists is larger (through a left-hand side extension of the range) as well. The intuition behind this finding is that when viewers are forward-looking, they tend to watch one channel over the two time periods to avoid incurring the switching cost. Thus, the potential “punishment” of being dominated by a rival who uses an aggressive quality strategy is severe. A broadcaster needs to retaliate against its rival’s use of a this strategy by setting a very high quality level. In response, the rival who initiates the quality war must set very high quality levels in both periods to make sure that the use of the strategy pays off. As a result, the profitability of following an aggressive quality strategy is reduced, making it an attractive strategy only for much lower values of \( c \) relative to the static game and the dynamic game with myopic viewers. The incremental increase in the range of \( c \) over which a pure strategy equilibrium exists corresponds to values of \( c \) under which the monopoly market structure provides higher quality and net consumer surplus than does the duopoly market structure. Specifically, the range of \( c \) over which the monopoly market structure provides greater
viewer welfare than the duopoly market when viewers are forward-looking is \((0.23 < c < 2.83)\).
Table TA4.1 Viewing Choice of Forward-looking Viewers

<table>
<thead>
<tr>
<th>Viewing decision</th>
<th>Utility conditions</th>
<th>Location conditions</th>
</tr>
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<tbody>
<tr>
<td><strong>AA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$U_{AA} &gt; U_{AB}$</td>
<td>$x &lt; v_2^A - v_2^B + (1+\alpha)/2$</td>
<td></td>
</tr>
<tr>
<td>$U_{AA} &gt; U_{BA}$</td>
<td>$x &lt; v_1^A - v_1^B + (1+\alpha)/2$</td>
<td></td>
</tr>
<tr>
<td>$U_{AA} &gt; U_{BB}$</td>
<td>$x &lt; (1+v_1^A - v_1^B + v_2^A - v_2^B)/2$</td>
<td></td>
</tr>
<tr>
<td><strong>AB</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$U_{AB} &gt; U_{AA}$</td>
<td>$x &gt; v_2^A - v_2^B + (1+\alpha)/2$</td>
<td></td>
</tr>
<tr>
<td>$U_{AB} &gt; U_{BA}$</td>
<td>$v_1^A - v_1^B &gt; v_2^A - v_2^B$</td>
<td></td>
</tr>
<tr>
<td>$U_{AB} &gt; U_{BB}$</td>
<td>$x &lt; v_1^A - v_1^B + (1-\alpha)/2$</td>
<td></td>
</tr>
<tr>
<td><strong>BA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$U_{BA} &gt; U_{AA}$</td>
<td>$x &gt; v_1^A - v_1^B + (1+\alpha)/2$</td>
<td></td>
</tr>
<tr>
<td>$U_{BA} &gt; U_{AB}$</td>
<td>$v_1^A - v_1^B &lt; v_2^A - v_2^B$</td>
<td></td>
</tr>
<tr>
<td>$U_{BA} &gt; U_{BB}$</td>
<td>$x &lt; v_1^A - v_1^B + (1-\alpha)/2$</td>
<td></td>
</tr>
<tr>
<td><strong>BB</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$U_{BB} &gt; U_{AA}$</td>
<td>$x &gt; (1+v_1^A - v_1^B + v_2^A - v_2^B)/2$</td>
<td></td>
</tr>
<tr>
<td>$U_{BB} &gt; U_{AB}$</td>
<td>$x &gt; v_1^A - v_1^B + (1-\alpha)/2$</td>
<td></td>
</tr>
<tr>
<td>$U_{BB} &gt; U_{BA}$</td>
<td>$x &gt; v_2^A - v_2^B + (1-\alpha)/2$</td>
<td></td>
</tr>
</tbody>
</table>