ECORE
INTERNATIONAL ASSOCIATION FOR RESEARCH AND TEACHING
Economics, Finance, Operations Research, Econometrics and Statistics

++ research ++ teaching ++

ECORE DISCUSSION PAPER

2008/44

The TV News Scheduling Game When the Newscaster\'s Face Matters.

Jean GABSZEWICZ
Didier LAUSSEL
Nathalie SONNAC

CORE
Université catholique de Louvain

ECARES
Université Libre de Bruxelles

The TV news scheduling game when the newscaster's face matters

Jean J. Gabszewicz
CORE, Université catholique de Louvain

Didier Laussel
Université de la Méditerranée

Nathalie Sonnac
Université Paris II

May 2008

Abstract

The present note first provides an alternative formulation of the Cancian, Bills and Bergström (1995)-problem which discards the non-existence difficulty and consequently allows to consider some extensions of the TV-newscast scheduling game.The extension we consider consists in assuming that viewers'preferences between the competing channels do not depend only on the timing of their broadcast, but also on some other characteristics , like the content of the show or the identity of the newscaster. Then we identify a sufficient condition on the dispersion of these preferences over the viewers'population guaranteeing the existence of a unique Nash equilibrium. It turns out that, at this equilibrium, both networks broadcast their news at the same instant.

1 Introduction

In an interesting contribution, Cancian, Bills and Bergström (1995) (henceforth CBB) have exhibited some technical difficulties which may occur when TV-broadcasters compete in *program scheduling.* These authors consider the problem of scheduling evening television newscasts : two TV-networks have each to decide non cooperatively at what time to broadcast their show so as to maximise audience size. Assuming that viewers want to watch the news as soon as they get home from work, the authors show that the resulting game has no pure strategy Nash equilibrium[1]. The present note first provides an alternative formulation of the CBB-problem which discards the non-existence difficulty and consequently allows to consider some extensions of the TV-newscast scheduling game.The extension we consider consists in assuming that viewers'preferences between the competing channels do not depend only on the timing of their broadcast, but also on some other characteristics , like the content of the show or the identity of the newscaster. Then we identify a sufficient condition on the dispersion of these preferences over the viewers'population guaranteeing the existence of a unique Nash equilibrium. It turns out that, at this equilibrium, both networks broadcast their news at the same instant.

2 The CBB-problem

Consider a time interval $[T_{\min}, T_{\max}]$ corresponding to some period in the evening. At each instant t in this interval there is a TV-watcher, which we denote by t, coming back at home and willing to attend the TV-channel which is the first to broadcast its news after his arrival. There are two TV-channels i, $i = 1, 2$, and each one of them has to decide non cooperatively at which instant t_i in $[T_{\min}, T_{\max}]$ to broadcast its news. For simplicity, we take the interval $[T_{\min}, T_{\max}]$ to be the $[0, 1]$ interval. Each network aims at maximising audience.

[1] The existence of a unique mixed strategy Nash equilibrium for the CBB program scheduling game has been proved in Gabszewicz, Laussel and Lebreton (2007)

The only difference between the two channels is their time of news' diffusion. This problem can be formalised in terms of a normal form game, -we call it the *TV newscast scheduling game*- , with the channels as *players*, the time interval $[0, 1]$ as *strategies*, and audiences A_i as *payoffs*, namely

$$A_i(t_1, t_2) = t_i$$

when $t_i < t_j$;

$$A_i(t_1, t_2) = t_i - t_j$$

when $t_j < t_i$, and

$$A_i(t_1, t_2) = \frac{t_i}{2}$$

when $t_j = t_i, t_i, t_j \in [0, 1], i = 1, 2$. It is easy to show that this game has no Nash equilibrium in pure strategies (see Cancian, Bills and Bergstrom, 1995).

The non-existence difficulty obtained within the original CBB problem crucially hinges on their assumption concerning the behaviour of TV-watchers with respect to their "ideal" hours of broadcasting time.Here we propose an alternative version of the problem which allows to discard this difficulty. This alternative version is directly inspired from the median voter problem in voting theory. To introduce this version, we start by supposing that the whole potential audience is already present at home in the beginning of the time interval $[0, 1]$. Furthermore, we assume now that TV-watchers differ among them because, for some unspecified reasons, some of them prefer to watch the news in the beginning of the evening while others on the contrary prefer to delay this event. More precisely,we suppose that TV-watchers are uniformly ranked in the interval $[0, 1]$ by order of their *ideal* time for attending news. We also assume that the farther the time a channel broadcasts its news from this ideal instant, the lower the utility of the viewer for watching that channel. Finally, all TV-watchers are assumed to view the news within one channel. Given these assumptions and assuming $t_1 \leq t_2$, the payoffs of the program scheduling game now write as[2]

$$A_1(t_1, t_2) \quad = \quad \frac{t_1 + t_2}{2} \qquad (1)$$

[2]In the reverse case, $A_1(t_1, t_2)$ becomes $A_2(t_1, t_2)$ and vice-versa.

$$A_2(t_1,t_2) \quad = \quad 1-\frac{t_1+t_2}{2}$$

when $t_1 < t_2$, and

$$A_1(t_1,t_2) = A_2(t_1,t_2) = \frac{1}{2} \tag{2}$$

when $t_1 = t_2$. It is easy to show that the above version of the CBB-game has a unique pure strategy Nash equilibrium, namely, the pair $(t_1^*, t_2^*) = \left(\frac{1}{2}, \frac{1}{2}\right)$ at which both channels obtain half of the total audience.[3]. Thus, this alternative formulation of the program scheduling game, with payoff functions (1) and (2) above, allows to go round the non-existence technical difficulty encountered in the Cancian and *al.* initial proposal.

3 A variant of the TV-news scheduling game

Generally, TV-viewers'preferences about channels'news not only depend on the timing of their broadcast, but also on other elements like the news'content, the identity of the presentator, or the brand image of the channel. These characteristics, combined with viewers'preferences about broadcasting hours, determine which channel a viewer will finally select. In order to extend the analysis to such extra-characteristics, let us start by assuming that all TV-watchers prefer to watch channel 1 to channel 2 *whenever they broadcast their news at the same instant of time.* This assumption is easily introduced into the model by supposing that viewer t incurs a utility loss equal to $|t-\tau|$ when he watches channel 1 broadcasting its news at time τ, and equal to $|t-\tau+\beta|, \beta > 0$, when watching channel 2 broadcasting at τ. The number β thus measures the increase in utility a TV-viewer obtains when watching his preferred channel when both channels broadcast their news simultaneously. It is easy to see that, due to the uniform preferences of viewers for the extra-characteristics, whatever the strategy t_2 selected by its opponent, channel 1 can evict channel 2 by selecting

[3]The proof goes as for the median voter theorem in the case of a unform distribution of voters.

$t_1 = t_2$. Consequently there exists no equilibrium with both channels sharing the total audience.

More significant is a situation where the preferences of viewers with respect to the extra-characteristics of the channels are dispersed over the population. For instance, it seems reasonable to think that viewers' preferences for the TV-newscasters are heterogeneous : not only some may prefer the newscaster of channel 1 to the one of channel 2 while the reverse is true for others, but their preferences may also vary in intensity. To introduce formally this heterogeneity into the model, we suppose that, at each point of time t, there is a set of viewers who are identical in terms of their preferences for the broadcasting time of the channels : all of them consider the instant t as their ideal broadcasting instant. This set is identified as the *viewers of type t*. However we now suppose that the number β, measuring the increase (or decrease) of utility that TV-viewers of type t obtain when watching channel 1 when both channels broadcast their news simultaneously, is no longer constant over the type, but varies over the set of viewers of type t. More precisely, we suppose that a viewer of type t incurs a utility loss (or a utility gain, when β is negative) equal to $(t-\tau)^2+\beta$ when he watches channel 1 broadcasting its news at time τ, and equal to $(t-\tau)^2$ while watching channel 2 when it broadcasts at time τ, with β uniformly distributed on some interval $[\beta_{\min}, \beta_{\max}]$ with density equal to $\frac{1}{\beta_{\max}-\beta_{\min}}$[4]. Figure 1 represents the set of TV-viewers on the rectangle $[0,1] \times [\beta_{\min}, \beta_{\max}]$.

$$insert figure 1$$

For each type t and each pair of strategies $(t_1, t_2), t_1 < t_2$, define by $\beta\left(t;(t_1,t_2)\right)$ the TV-viewer who is indifferent between watching news at channel 1 and channel 2, namely, $\beta\left(t;(t_1,t_2)\right)$ solves

$$(t-t_1)^2+\beta\left(t;(t_1,t_2)\right)=(t-t_2)^2$$

[4]Notice that $\beta(t)<0$ implies that type t prefers channel 2 to channel 1 when they broadcast their news at the same time.

or

$$\beta\left(t;\left(t_1,t_2\right)\right)=\left(t_1-t_2\right)\left(t_1+t_2-2t\right). \tag{3}$$

The existence of $\beta\left(t;\left(t_1,t_2\right)\right)$ requires that $\beta\left(t;\left(t_1,t_2\right)\right)\in\left[\beta_{\min},\beta_{\max}\right]$, a property which is not *a priori* guaranteed for any pair of strategies $(t_1,\ t_2)$. This would require that, whatever the pair of strategies $(t_1,\ t_2)$, there exists, for each type t of TV-watchers, some of them who prefer to watch channel 1's news, while some others of the same type prefer to watch those of channel 2. The next lemma identifies a sufficient condition for this property to be satisfied, in terms of the dispersion of viewers'preferences on the extra-characteristics of the channels.

Lemma 1 $[-1,1]\subset\left[\beta_{\min},\beta_{\max}\right]\Rightarrow\beta\left(t;\left(t_1,t_2\right)\right)\in\left]\beta_{\min},\beta_{\max}\right[.$

Proof:

The proof follows immediately from the definition of $\beta\left(t;\left(t_1,t_2\right)\right)$ (see (3.1)), noting that the inequality

$$\left(t_1-t_2\right)\left(t_1+t_2-2t\right)\leq\beta_{\max}$$

must be satisfied for the largest value of $\left(t_1-t_2\right)\left(t_1+t_2-2t\right)$, which implies $\beta_{\max}\geq 1$, and the inequality

$$\beta_{\min}\leq\left(t_1-t_2\right)\left(t_1+t_2-2t\right)$$

must be satisfied for the smallest value of $\left(t_1-t_2\right)\left(t_1+t_2-2t\right)$, which implies $\beta_{\min}\leq -1$. Q.E.D.

It follows from the above lemma that all type-t viewers whose β -value exceeds $\beta\left(t;\left(t_1,t_2\right)\right)$ watch news at channel 1 while the remaining ones ($\beta<\beta\left(t;\left(t_1,t_2\right)\right)$) watch channel 2. Given a pair of strategies $\left(t_1,t_2\right)$, the audience $A_1\left(t_1,t_2;t\right)$ of channel 1, among TV-viewers of type t, is thus equal to the length of the interval $\left[\beta\left(t;\left(t_1,t_2\right)\right),\beta_{\max}\right]$, multiplied by the density $\frac{1}{\beta_{\max}-\beta_{\min}}$, or

$$A_1\left(t_1,t_2;t\right)=\frac{\beta_{\max}-\beta\left(t;\left(t_1,t_2\right)\right)}{\beta_{\max}-\beta_{\min}}.$$

Furthermore, the *total* audience $A_1(t_1, t_2)$ of channel 1 obtains as

$$\begin{aligned} A_1(t_1, t_2) &= \int_0^1 A_1(t_1, t_2; t)\, dt \\ &= \int_0^1 \frac{\beta_{\max} - (t_1 - t_2)(t_1 + t_2 - 2t)}{\beta_{\max} - \beta_{\min}} dt \\ &= \frac{1}{\beta_{\max} - \beta_{\min}} \left[\beta_{\max} - (t_1 - t_2)(t_1 + t_2 - 1)\right]. \end{aligned} \tag{4}$$

Similarly, we obtain the total audience $A_2(t_1, t_2)$ of channel 2 as

$$A_2(t_1, t_2) = \frac{1}{\beta_{\max} - \beta_{\min}} \left[(t_1 - t_2)(t_1 + t_2 - 1) - \beta_{\min}\right]. \tag{5}$$

The functions $A_i(t_1, t_2)$, $i = 1, 2$, are the payoff functions of the program scheduling game. As shown in proposition 1, the sufficient condition identified in lemma 1 is also sufficient to guarantee the existence of a unique equilibrium for the program scheduling game.

Proposition 1 *If* $[-1, 1] \subset [\beta_{\min}, \beta_{\max}]$, *there exists a unique Nash equilibrium in pure strategies, namely* $(t_1^*, t_2^*) = \left(\frac{1}{2}, \frac{1}{2}\right)$; *furthermore, this equilibrium is in dominant strategies.*

Proof : Using the first order necessary condition, which is also sufficient, we get from (3.3)

$$\frac{\partial A_1}{\partial t_1} = \frac{1}{\beta_{\max} - \beta_{\min}} (1 - 2t_1) = 0 \Leftrightarrow t_1 = t_1^* = \frac{1}{2}.$$

Furthermore, this condition is independent of the value of t_2 so that $\frac{1}{2}$ is the unique best reply against any strategy t_2 of channel 2. A similar reasoning, using (3.4), applies to show that $t_2^* = \frac{1}{2}$ is also the unique best reply for channel 2 against any strategy of its opponent. Q.E.D.

3.1 Bibliography

References

[1] Cancian,M., A.Bills and T. Bergström (1995). Hotelling location problem with directional constraints : an application to television news scheduling. *The Journal of Industrial Economics.* 43, 121-124.

[2] Gabszewicz, J. D. Laussel and M. Lebreton (2007). The mixed strategy Nash equilibrium of the television news scheduling game. forthcoming, *The Journal of Industrial Economics.*