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An Examination of the Relative Efficiency of Public and Private Television Broadcasting in Canada

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by

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I. Introduction and Executive Summary

The behavior of privately owned firms relative to managerial or government controlled organizations has been a topic of great interest to both academics and those responsible for public policy. Crown Corporations which are not self-supporting, such as the CBC, are particularly worthy of investigation since any lack of efficiency must be made up through taxation of the citizenry. The purpose of the research presented in this paper has been to examine in some detail the performance of CBC owned television stations relative to their private counterparts, both those affiliated with CBC and those independent of the CBC.

The concept of efficiency is multidimensional, of course, and we would like to be able to answer such questions as whether or not the CBC system is efficient at producing shows, administering the broadcast facility, hiring employees, buying equipment, etc. Unfortunately, many of these latter considerations, while very important, are very difficult to measure in detail, particularly since the goals of the CBC are not the same as, say, the CTV network. A profit maximizing system would be interested in maximizing audience value to advertisers at the lowest cost. The CBC system has many cultural objectives which are inconsistent with the maximization of audience value. Thus the type of programs and employees hired by CBC may well be different from the private systems without indicating a lack of efficiency.

However, there are several aspects of efficiency which should not be influenced by these cultural objectives. In particular, those parts of the CBC which are primarily engaged in the transmission of programs should be very similar to their private counterparts. We can envision breaking the activities of the CBC into two components, the first being program creation, essentially carried on at the national level and the second being the

transmission of broadcasts (which is essentially carried on at the local level) and the sale of advertising time. We shall focus our attention on these latter activities.

The sale of advertising is done at the national level by the CBC. However, a portion of the revenues is transferred back to the stations based to some degree on that station's contribution to total revenues (this is discussed in detail in section 4). For private stations, some or all advertising is done at the local level, and for those stations affiliated with CTV or CBC, some advertising is done by the network with a portion returned to the stations. Focusing on this activity, the sale of advertising time, is one of the primary components of this paper. We find that the evidence in Sections 6 and 7 indicates that the public broadcasters appear to be somewhat less efficient at this activity (usually 20% or more) than their private counterparts. This result does not have enough statistical power to be held with certainty, however although it was found while holding many other factors constant through the statistical use of regression analysis.

The other area of consideration, broadcasting costs, is also examined at the level of the station. Since much of a network station's activities consist in retransmitting the programs of the network, the scope for variations in programming quality between stations should not be significant. Most of the audience consists of prime-time viewers and the only significant local programming in this period usually consists of news presentations. Thus, although the CBC was established to enhance cultural identity it is unlikely that programming at the local CBC level could reflect this goal and thus the cost of local programming for the CBC owned stations should not differ much from that of private stations. It is the cost differentials in local broadcasting which we attempt to measure.

Expenditures were compared between private and public stations, controlling for several other variables through the technique of regression analysis. The results of these regressions indicated that CBC owned and operated stations had very much higher costs of operation, with enough statistical power to warrant a high degree of confidence. A reasonable inference from these results would be that public ownership has led to double or triple the costs of operation for these broadcasters, a rather startling conclusion with strong policy implications.

The final test consisted of examining a variation of the profit rate. Using the contruct of the price-cost margin, we find that private stations were much more profitable than public counterparts. CBC owned stations lost at least $26 million on the whole, while the private stations earned $86 million. These results were not surprising, given the results on revenues and costs. These tests were conducted after making several corrections to the data. These corrections were always more than sufficient to compensate the CBC owned stations for institutional constraints on their profitability. For this reason it is likely that CBC owned and operated stations perform somewhat less efficiently than indicated with the adjusted data.

Such powerful results warrant further investigation to determine the reason behind them. We cannot rule out a problem of data comparability although many attempts were made to ensure such comparability.
A detailed examination of the accounting practices of the CBC would be useful in this regard.

The final section of this report contains recommendations and conclusions. Besides the above recommendation, several others were made based on the results found in earlier sections. It was felt that detailed public disclosure by the CBC of its various component operations would tend to force an increase in efficiency . A more radical alternative, with a greater probability of increasing efficiency (or at least not forcing

taxpayers to shoulder this inefficiency) would be for the CBC to divest itself of its broadcasting operations, in essence making all CBC broadcasters private affiliates. Other alternatives, such as greater public scrutiny or new watchdog agencies are also discussed. The conclusions of this report can be put in two statements, the second conditional on the first.

(1) Further investigation of possible extenuating factors which could possibly negate the findings of this study.

(2) Barring such factors, remedial action be taken to bring the efficiency of CBC owned and operated stations up to the level of their private counterparts. Divestiture of broadcasting operations should be given serious consideration.

2. The Audience Revenue Relationship - Explanatory Variables

One of our purposes is to determine if CBC owned stations generate advertising revenues in an efficient manner. To this end we shall compare the performance of CBC owned stations with groups of private stations. The ability to generate advertising revenue, independent of the efficiency of the sales effort, will depend on the characteristics of the viewing audience. Factors such as size of the audience, income of the viewers, distance from the transmitter, intensity of viewing etc. will all influence the price that can be charged and the revenues which can be earned.

We shall attempt, by the use of statistical methods, to determine the advertising rates (or revenues) which could be generated for an audience with any given set of characteristics. The relationship between the price of an item and its characteristics determining the price is known as a hedonic price function. Economic analyses of this particular relationship often refer to it as Audience-Revenue relationship. Our first examination will use price of advertising time as the variable to be explained by audience characteristics. In a later section we will examine this relationship for advertising revenues. The nature of the statistical estimation will be identical for both variables.

The form of analysis used is known as regression analysis. Using this analysis allows us to examine the relationship between any single explanatory (independent) variable and the variable to be explained (dependent variable) as if all other variables were held constant. For our first set of regressions the thirty-second spot advertising rate will be the dependent variables. The next section describes in detail the various independent variables to be used in the analysis.

Explanatory Variables

1. Audience Size: It is rather obvious that advertisers, wishing to increase sales by convincing a large number of people to buy a certain product, will value larger audiences more than smaller audiences, if the other audience characteristics are equivalent. Audience size of a given television station is reported by the Bureau of Broadcast Measurement (BBM). Through the use of individual diaries which record individual's viewing for a particular week, the BBM is able to estimate the total number of viewing man-hours for individual stations, decomposed into the various localities in which people live.

By examining these data we can separate viewers into two groups based on distance from the transmitter to their residences. Those viewers located within a station's B contour (defined as all areas where reception occurs 90% of the time for 50% of televisions) are classified as local, those viewers located outside this contour are classified as distant. This contour roughly approximates a circle with a radius of 50 miles. Since measurements are in terms of viewing hours, AUDL measures the weekly viewing man-hours of a station for residents within the station's B contour while AUDD measures the weekly viewing man-hours for residents outside the B contour.

2. Audience Size Squared: This variable, which is the squared sum of AUDL plus AUDD, is included to pick up possible non-linearities in the relationship between audience size and advertising rates. There is good evidence, from preceding work, that this relationship is non-linear. Park [1968, 1979], Fisher, McGowan and Evans (FME) [1980] and Liebowitz [1980] all found significant non-linearities. Park and Liebowitz found this term to be significantly negative, indicating that advertising revenue increases at a decreasing

rate as audience increases. FME think they have found the opposite effect but see Liebowitz [1981] for a demonstration that FME's results are consistent with a decreasing increase in advertising rates (revenues).

3. Income: This variable is measured as the per capita income reported on income tax forms by geographic region. It is calculated for a television station's audience by weighting the income of each area, in which viewers of the station reside, by the number of viewing hours in that area. This procedure is considerably more involved than the usual one [used in Park, FME and McFadyen, Hoskins and Gillen (MHG)] which consists of assigning the income of the city of broadcast origination to the station. In these data more than 40% of viewers do not live in the city of broadcast origination with this percentage in the range of 70-80% for some stations. Thus there is a much higher likelihood that the measurements used here are more representative of the actual values than was the case with previous studies.

As the average viewer's income increases it is thought that advertisers value the viewer more highly thus leading to an expected positive coefficient. Past studies have usually found a positive coefficient.

4. Audience Segmentation: This variable measures the concentration of groups into which viewers segment themselves through their viewing habits. The only use of this variable to data has been in Liebowitz [1980]. Audience segmentation is defined as the negative of the squared sum of audience shares in a given area, or:

$$AS_J = \sum_{i=1}^{M} -S_i^2$$

J=1,...,x - the number of areas
i=1,...,m - the number of stations in an area.

To calculate AS for a particular station the AS for every area in which a station has viewers is included in a weighted average identical to that used in constructing the income variable.

Audience segmentation is thought to influence the desirability of an audience to advertisers for several reasons. First, when viewers have a large number of alternative programs to choose from, they are more likely to find one which they enjoy and to which they pay close attention. This may make them more receptive to advertising messages. Second, viewers are likely to make program choices along certain taste or socio-economic lines. Groups of people with homogeneous tastes make it easier for advertisers to reach particular types of people than groups with more heterogeneous tastes. For example, people who enjoy following sports may be the target for a sports magazine advertising to increase its circulation. If a sports event is the only program available to viewers many are likely to watch who do not have a great interest in sports. When several other choices of programming are available, many viewers will no longer watch the sports show leaving an audience for the sports show which has a great interest in sports and which is most receptive to the idea of buying a sports magazine. Thus, <u>for a given size audience</u>, the magazine would pay more for an audience which chose to watch sports when there were alternative choices than for an audience which had fewer alternatives.

The AS variable used here will indicate program diversity under certain conditions but may not indicate diversity in others. When creating models of taste diversity, economists often assume a population which can be broken up into a small number of perfectly homogeneous groups. Then one can construct a world where AS does not measure "true" diversity. E.g., assume that there are two types of people, 90% of whom value comedy and 10% of whom value news.

Let there be two television stations. If both show identical quality comedies, they will equally share the 90% of viewers who value comedy, so that the AS variable will give a value of $-.5 = -[(.5)^2 + (.5)^2]$. However if the second station were to show news, the AS variable will give a value of $-.82 = -[(.9)^2 + (.1)^2]$: indicating less diversity. However, we as model builders know that diversity has increased.

This last example is dependent on several stringent assumptions: (1) each audience group is perfectly homogeneous; (2) each comedy or news program is identically valued by viewers in a given group. Such assumptions are very implausible and empirically counterfactual.

Unfortunately, some economists have used such models to make judgements about program diversity [see P. Steiner, 1954]. In these models programs are divided into category (western, comedy, drama, news, etc.) and the addition of a new show is only thought to increase diversity if it opens a previously empty category. The assumption that all shows in a given category are identical can be easily tested--do viewers randomly choose among them? If Dynasty is run against Dallas will they split the audience equally and will the audience composition change from week to week? Both are predictions of the model and it is well known that both are false. One must admit that there is diversity even among shows which could be put in the same category.

Is the diversity of shows within a category greater or less than that between categories? We must acknowledge methodological difficulties even in just asking this question. Is diversity determined by the model builder or by the perceptions of viewers? Can we compare perceived diversity between different viewers? Is it not like comparing utilities?

The approach taken in this paper is to remain agnostic regarding the absolute diversity of programs. The variation in tastes between geographic

areas is assumed to be similar (although the tastes themselves might be very different) and each viewer is given equal weight. This can be best illustrated by an example. Assume there exists only one network station in a city and everyone watches it. Now compare the increase in viewing intensity which occurs with the importation of either an educational station or another network station. Let us assume that the educational station would take about 10% of the audience whereas the other network would take about 50%. In the former case 10% of the audience has greater viewer intensity while in the latter case 50% have greater viewer intensity. Since we do not know the perceived difference in diversity or the true increase in viewing intensity per viewer, we assume that with five times as many viewers with increased intensity, the network station increases total viewing intensity more than the educational station does. The AS measure takes the number of viewers affected into account whereas previous commentators took only their own model building preferences into account. In the end, this measure must be judged empirically, not through a priori reasoning.

It should also be pointed out that the AS measure should be negatively related to monopoly power, since it is a measure of market concentration. In the study by MHG this measure had a negative coefficient. However, they did not calculate AS for all stations in an area but merely for those broadcasting locally. This local measure was then applied to all broadcasters, regardless of the percent of viewers not located locally. Thus their AS measure is quite a different animal than the one in this paper.

5. Network Affiliation: Stations were categorized according to network affiliation. Dummy variables were included for CBC owned (CBCO), CBC affiliated (CBCA), CTV affiliated and independents (IND). Independents include the Global and TVA mini-networks.

The inclusion of dummy variables allows the intercept of the regression to vary between network affiliation. Since it is also possible that the slope of the relationship between audience size and advertising rates (revenues) also differs between network affiliations an interaction term between the network dummy and AUDD was created for each network where

INT1 = CBCO x (AUDD + AUDL)
INT2 = CBCA x (AUDD + AUDL)
INT3 = CTV x (AUDD + AUDL)
INT4 = IND x (AUDD + AUDL)

6. Language of Broadcast: A dummy variable was included to take account of possible differences between French and English speaking audiences by advertisers. The variable FR equals one if the broadcast is in French.

3. Rates Versus Revenues - Theory

Advertising rates and revenues are variables which, if properly constructed, correspond to different economic concepts. Advertising rates correspond to prices, which in equilibrium are determined by supply and demand. Advertising revenues are equal to price times quantity, also determined by supply and demand. The determination of rates and revenues can be illustrated under the alternative possibilities of competition or monopoly power. We shall examine three.

(1) If advertising rates are determined competitively on a national basis, we would expect all stations to charge a price proportional to the size and quality of its audience. Given its audience characteristics, each station would face a horizontal demand curve such as S_1 in Figure 1. The height of the demand curve would depend on the size and quality of the audience, so that two stations with different size audiences would have different demand curves. Since a station could not raise its price without losing its audience, it would be content to sell all the commercials it could at the going rate as long as it does not alienate and reduce its audience. Programs allow only a fixed amount of time for commercials, and government rules limit the amount of time which can be devoted to commercials. Thus the supply of commercial time which the station can sell is fixed. Because of these institutional constraints it is <u>not</u> likely that individual stations can influence their audience (and demand for advertising) by changing the number of commercials they sell. If a station sells less than its allowed maximum, it will have to fill the remaining time with other messages or announcements

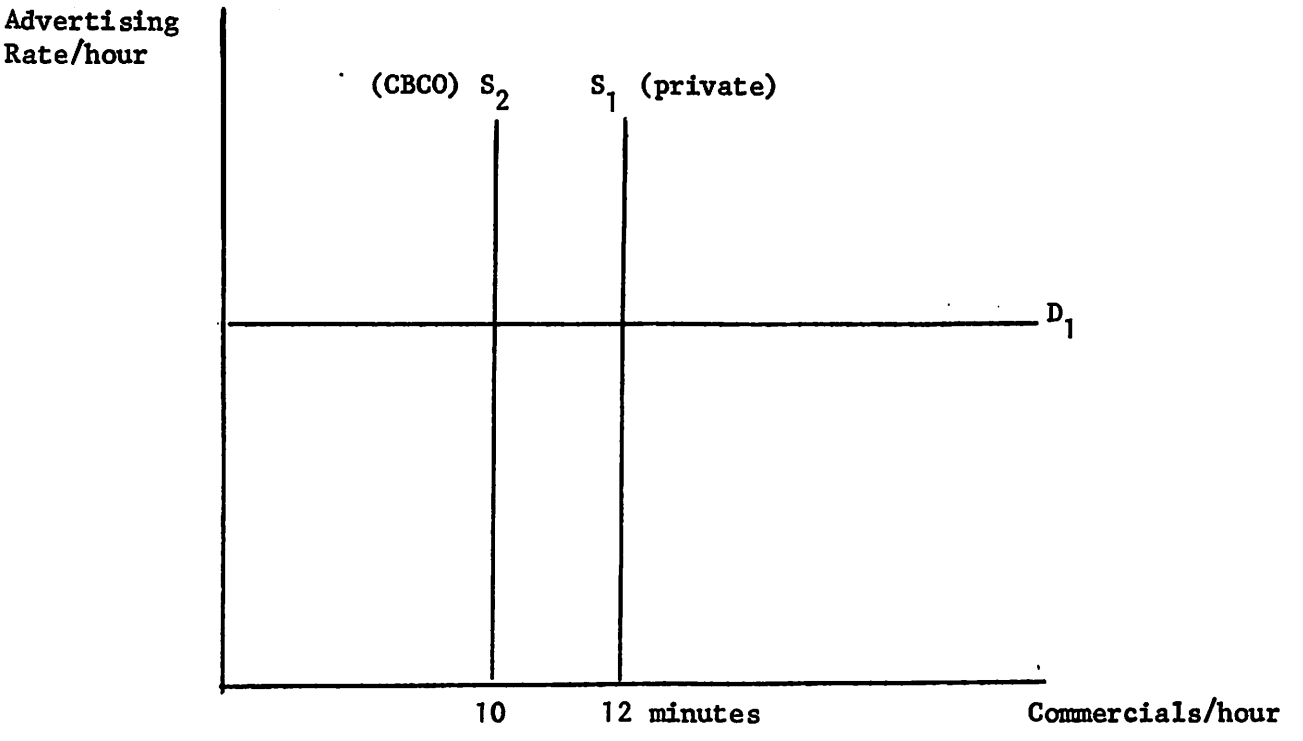
Advertising
Rate/hour
(CBCO) S_2
S_1 (private)
D_1
10
12 minutes
Commercials/hour

Figure 1

amenable to being shown in very short time intervals (as educational networks often do). Since these non-commercial messages are unlikely to increase audience size it will maximize profits for the station to sell all available time. Private stations, which are allowed 12 minutes of advertising, will have larger revenues than CBC owned stations, which are only allowed 10 minutes per hour, even if the audiences are identical in size. This smaller supply of advertising time for CBCO stations is represented by S_2 in Figure 1. If one makes adjustments to alter revenue data so to compensate for the different amounts of advertising time available, both revenues and advertising rates (if properly measured) would give identical results. This nationally competitive market is incompatible with a nonlinear relationship between audience size and advertising rates (or revenues).

(2) A different scenario emerges if we assume that each station faces a downward sloping demand for its advertising time. We have already argued that the institutional constraints are such that no profit-maximizing station would unilaterally choose to reduce the number of non-program minutes in a broadcast hour. The station can choose between advertising its own programming (thus increasing its audience) or advertising someone's product. The marginal cost of providing a message is merely this opportunity cost of a foregone increase in audience. The profit maximizing position for a station under the circumstances is illustrated in Figure 2. This diagram is somewhat more complex than the standard demand-supply diagram. The demand curve is a usual ceteris paribus demand which means that audience size and characteristics are held constant along the curve. The particular demand drawn in the diagram is that which exists for the audience which watches this station when it sells 12 minutes of advertising per hour.

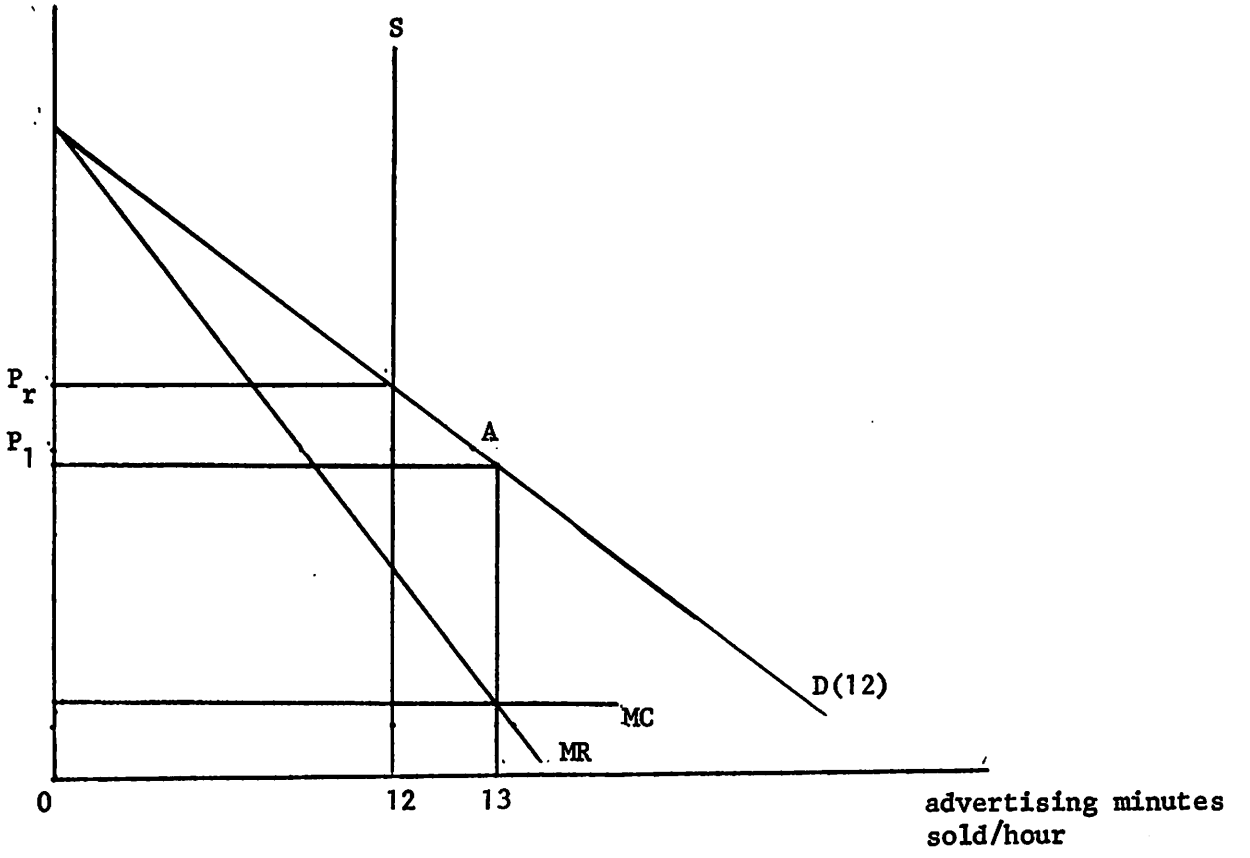

Figure 2

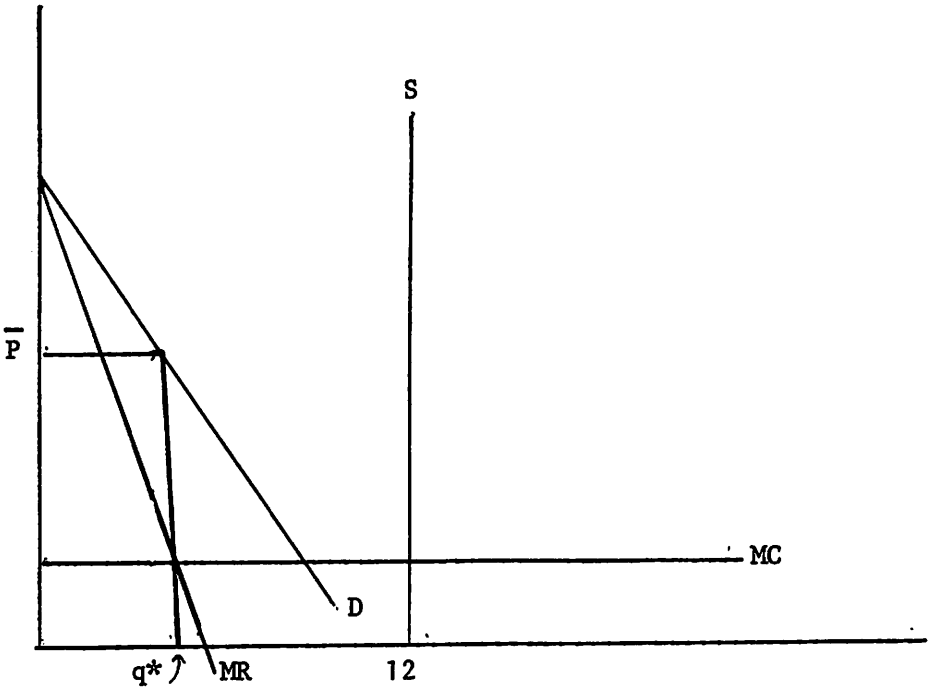

Figure 3

If the station were to sell 13 minutes the demand would decrease due to the presumed reduction in audience size due to fewer minutes of attractive programming. The reduction in revenue below that represented by the rectangle OP_1A13 is equivalent, by construction, to the area under the MC curve between 12 and 13 minutes. Revenues are reduced because the demand, with 10 minutes of advertising, lies below D(12) and thus the price would be less than P_1. As drawn in Figure 2, the profit maximizing output is 13 minutes. Legal constraints, however, will limit the quantity sold to 12 minutes.

This analysis illustrates an interesting consideration. When marginal revenue intersects marginal cost at a quantity greater than the legal limit, the station will try to sell all the time available. When the intersection occurs at a quantity less than the legal limit (as per Figure 3) the firm will sell less than its permitted quantity. In this latter case the advertising rates (P) will not be perfectly correlated with revenues, whereas in the former case they would.

Which stations are likely to be described by Figure 3? It seems reasonable to assume that small stations will tend to have their marginal revenue (and perhaps demand) intersecting the quantity axis (and necessarily the MC curve) to the left of the vertical supply more often than those of large stations. If so, small stations will have higher ratios of price/revenue than large stations. Also, a non-linear (a decreasing increase) relationship between advertising rates and audience size would be expected. Since small stations would not be constrained by S, they would have greater scale adjusted revenues and profits than the larger stations so that a non-linear revenue relationship is also possible, though it would probably be somewhat less pronounced.

(3) It might be the case that rates are determined competitively within local markets. This is rather simple to analyze. Each station in a city takes the price, determined competitively within that city, as given and thus each station sells all its possible advertising time. The competitive price within one city is determined by demand and supply within that city. Since this is likely to differ between cities, different prices likely will be established in different cities. In different cities, otherwise identical stations would have different advertising rates and revenues.

Empirically, the number of stations does not increase proportionally with increase in city size so that large stations are usually located in large cities. From the former observation we might expect the advertising rate per viewer in large cities to be higher than that in small cities since the number of advertising minutes per viewer is lower in large cities. This would imply an audience-revenue (rate) relationship which was non-linear with an increasing positive slope as audience size increased. This implication will be shown to be counterfactual in the following sections.

4. Rates vs. Revenues - Measurement

The economic magnitudes of price and revenues are well defined and in principle amenable to measurement. However, the reality is such that both advertising rates and revenues are rather imperfect measures.

Advertising rates reflect list prices when the true prices which concern us are transaction prices. Rate cards often state various discount policies but it is impossible to compute an index number which correctly reflects these discounts without knowing the behavior of consumers and the transaction prices, which are unavailable. The other difficulty with rates is that some stations may choose not to sell all available advertising time, in which case relative rates may not fully reflect the true market conditions. Another simple difficulty is that some stations have longer broadcast days than others so that for two stations with the same advertising rates (and audience per hour) the station with the longer broadcast day will have a larger total audience. Since our audience measure is weekly man viewing hours, revenues would better reflect total audience size under these circumstances.

Revenue data, unfortunately, also suffer from many imperfections, making comparability between stations difficult. Total revenue is divided into five categories: local time sales; national time sales; network payments; syndication revenue and other revenue. These last two categories do not reflect advertising revenues and thus must be eliminated from the revenue regressions. Local and national time sales reflect advertising sold by the station to either national or local advertisers but since this distinction is artificial and not universally applied these two categories are best merged into one. The last category, network payments, presents the most difficulty. Both the CBC and CTV networks sell advertising on a network basis, with a

certain number of advertising slots being allocated for these purposes. The revenues generated can be allocated to the various member stations in several possible ways. CTV redistributes these revenues in proportion to the relative revenues generated by the member stations, which would appear to be an economically efficient method. CBC redistributes its payments according to a formula, the details of which they would not divulge except to say that stations are broken up into three size categories and that small stations were more highly reimbursed than large stations (a result borne out by the later empirical work). This latter factor is a minor problem compared to the network policy of keeping a large fraction of network sales as compensation for providing programming to the stations. Bruce Parks, of CTV, estimated that the network only paid back to the stations 16.5% of the revenues generated through network advertising. Mr. Payette of the CBC estimated that network's average payback at 25%. Thus the revenues of those stations affiliated with these networks are understated because the network payment component is much smaller than the advertising revenues generated. For this reason, network payments should be multiplied by a factor of 1/.165 for CTV affiliates, and 1/.25 for CBC stations. One must also realize that expenditures for programming are also affected by these policies and symmetrical adjustments (detailed below) must be made with this variable.

Another serious difficulty with revenue data consists of the institutional restrictions imposed on the CBC. First, CBC-owned stations can only permit ten minuts of advertising per hour, whereas private stations can show twelve minutes. For a given audience, this will reduce advertising revenues for CBC-owned stations (we assume an elastic demand curve since private stations seem to take advantage of the extra two minutes available to them).

Multiplying CBC-owned stations' revenues by a factor of 1.2 (and the network payments for CBC affiliates by the same factor) should be more than enough to compensate for this differential.

An additional problem arises with the CBC network policy of not allowing commercials during certain types of programming (public affairs and drama). There are about five to seven hours per week of prime or near-prime time programming which fall in this category. Since this represents about 15% of prime time programming (most revenue is generated during prime time), multiplying the already corrected revenues by 115% should more than compensate for this institutional constraint on the revenues of CBC stations.

Another minor problem with revenues is that they are net of agency commission and these commissions may not be identical for all transactions or all networks.

Fortunately, even with these problems, advertising rates and revenues perform in a very similar manner. The simple correlation between rates and revenues is .92 unadjusted and .91 adjusted. (The simple correlation between adjusted and unadjusted revenues is .93.) The regression results are very similar using either of these variables and so no choice need really be made between them. Such a choice, if one had been necessary, would have been contentious since there is no clear-cut superiority in either one.

5. The Problem of Heteroscedasticity

There are several assumptions underlying the use of regression analysis which if they do not hold are likely to cause misinterpretation of our results. One of these assumptions is known as homoscedasticity, or a constant variance in the distribution of the error terms. The estimation of the relationship between a dependent variable and several independent variables is assumed to be handicapped because of random fluctuations such that the value of the dependent variable fluctuates around the value implied by the values of the independent variables. If there were no such fluctuations, a regression which included all the variables influencing the dependent variables would be able to predict the value of the dependent variable associated with every observation. These random fluctuations are assumed to have the same (normal) distribution regardless of the values of the variables. In many instances, the range of values of the variables is so great that it is unlikely that the variance of the distribution of error terms is constant. For example, if the random fluctuations were in the range of 1% of the value of the dependent variable, then one would expect the variance of the error term to quadruple whenever the dependent variable doubled. When the variance increases in this manner it is called heteroscedasticity.

Heteroscedasticity is quite common in cross-section studies, of which this is one. The problem caused by heteroscedasticity concerns confidence we have in the precision of our estimates. It is well-known that even with heteroscedasticity, our estimated coefficients are unbiased, which means that the estimated coefficient centers on the true underlying value. One difficulty is that estimators are no longer efficient, which means that another linear unbiased estimator exists which would have greater precision. Of more importance is the fact that the estimated standard error (the distribution of possible

values for a coefficient) is now biased such that we cannot be sure how precise our estimates really are. In a homoscedastic world one can use the standard errors to determine the range of values which the true coefficients would be likely to lie within (confidence interval) or the likelihood that true values could be zero for some nonzero value of the estimated coefficients (significance test). In other words, our t-statistics are biased. There are ways to try to correct for heteroscedasticity. However, because the uncorrected results (ordinary least squares or OLS) are unbiased, they are still quite useful. The cure for heteroscedasticity may be worse than the disease.

We tested for heteroscedasticity using a Goldfield-Quandt test with our advertising rate data. Because of the large range of audience sizes in our data it was likely that the random fluctuations of advertising rates were greater for large audiences than for small audiences. The Goldfield-Quandt test requires that we rank our observations by audience size, remove some of the observations in the middle and compare the estimated variance of disturbance terms for the low group and the high group. If heteroscedasticity occurs, the estimated variance of the high group will be larger than that of the small group.

Thus we ranked the 72 stations by audience size, removed the middle 16 and ran separated regressions of the following form[1] on the 28 largest and the 28 smallest stations:

(1) $ADRT = K + a\ AUDL + b\ AUDV + c\ ASQ + d\ INC + e\ AS + f\ FR + g\ CBCO + u$

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[1] These regressions are slightly different than the ones occurring later in the paper. Moreover, the important relationship is between audience size and advertising rates and the slight difference in specification will not alter this relationship.

where u is the random error and all the other variables are as previously defined.

The sum of the squared residuals divided by the number of observations is an estimate of the variance of the disturbance terms. The ratio of the values from the large and small audience groups forms an F-test such that any value greater than 3.00 indicates that there is less than a 1% change that heteroscedasticity is not present. Our calculated value was 19.07, indicating an overwhelming likelihood of heteroscedasticity.

A technique for alleviating heteroscedasticity is to use generalized least squares (GLS). The variable thought to be associated with the variance of the disturbance term is used to deflate all the observations. For example, a common assumption would be $E(u^2) = \sigma^2 X^2$; that is, that the variance of the random error (the mean of u is zero) grows with the square of some exogenous variable X. Multiplying each variable of each observation by $\frac{1}{X}$ would remove the heteroscedasticity.[2] Sometimes it is assumed that this variance grows directly with X, and then we would multiply each observation by $1/\sqrt{X}$.

A somewhat more satisfying approach is to measure the relationship between $E(u^2)$ and X. To this end we disaggregated the data into 6 groups of 12 stations, with stations again ranked by size of audience since audience size is assumed to be the variable related to the variance of the disturbance term. A regression such as (1) was run for each group. The squared sum of residuals (the estimator of $E(u^2)$) was calculated, along with the mean value of audience size. The results from these six regressions allowed us to run the following regression:

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[2] See Johnston (1972), p.214 or Kmenta (1971), p.256 for more complete discussions of these points.

(2) $\log RESQ = \alpha + \beta \log \overline{AUD}$

The coefficient β gives the relationship between RESQ and $\overline{AUD}$ of the following form:

(3) $RESQ = \overline{AUD}^{\beta}$

where RESQ is $E(u^2)$, $\overline{AUD}$ is X and α is σ^2. Thus (3) can be rewritten as

(3') $E(u^2) = \sigma^2 X^{\beta}$

where β tells us how the variance of the random term grows with X. Using the six available observations (2) was estimated as:

$$\log RESQ = \underset{(0.99)}{-1.7} + \underset{(2.67)}{1.30} \log \overline{AUD} \qquad R^2 = 0.64$$

t-statistics are in parentheses.

Thus, dividing all data by $1/(AUD)^{.65}$ should remove heteroscedasticity. The standard error of β is such that the likelihood that β could be less than 1 is approximately 30%, while the likelihood that it is more than 2 is 15%. Thus we might wish to examine several possible corrections for heteroscedasticity.

Fisher, McGowan and Evans (1980), in a recent paper, have used a slightly different correction for heteroscedasticity. They assumed $E(u^2)$ grew with the square of the number of potential television households.[3] We can make a similar correction using data from the A. C. Neilson Company on the number of television households (HH) in a given locality and assuming that a station's potential number of viewers is based only on its city of origination. This correction is less appealing from a theoretical vantage because there is no compelling reason why the number of households should be related to the variance of the error term, except that the size of a station is related to potential audience.

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[3]Their correction was somewhat unusual in that they did not inflate all the data by 1/X. For a criticism of their approach, see Liebowitz (1981).

Thus there are four possible corrections which have been used. The corrections consist of deflating all data by either 1/AUD, $1/(AUD)^{.65}$, $1/(AUD)^{.5}$, or 1/HH. These results will be presented along with the OLS results. One might ask how successful these corrections were at removing the heteroscedasticity. The answer is not all that successful. The Goldfield-Quandt test was applied after each of these corrections to the data after ordering the observations by the size of $\frac{AUD}{c}$ where c is the particular correction used. In each case the ratio of the sums of squared residuals dropped significantly from the original value of 19.04 to a value in the neighborhood of 4 (4.16 for $1/(AUD)^{.65}$, 3.38 for AUD^{-1}, 2.21 for $(AUD)^{-1/2}$, and 3.78 for HH). In each instance we still reject the assumption of homoscedasticity since the likelihood of a ratio greater than 2.94 (2.16) is less than 1% (5%) if the errors really were distributed homoscedastically. The measured standard errors and t-statistics are still likely to be biased.

The correction for heteroscedasticity will leave the estimated coefficients unbiased as long as it is not correlated with the error terms. However, it will often be the case that some correlation will in fact exist (particularly when a new variable such as HH is introduced), and thus the GLS regressions may introduce a bias of their own. Thus changes in the coefficients, introduced by the switch from OLS to GLS should be viewed with some suspicion. If we believe that OLS represents the proper specification of the model then we would tend to favor the OLS results.

6. The Results with Advertising Rates

The regression that was run had the following form:

$$ADRT = K + a\ AUDL + b\ AUDD + c\ ASQ + d\ AS + e\ INC + f\ FR + g\ INT2$$
$$+ g\ INT\ 2 + h\ CBCA + i\ INT\ 3 + j\ CTV + k\ INTY + \ell\ IND$$

The coefficients g-ℓ are those of primary interest since they allow us to determine how the various categories of broadcasters differ from one another. For example, the coefficient g measures the difference between CBC-owned and CBC-affiliate stations in the slope of the relationship between audience size and advertising rate, while the coefficient h measures their difference in intercepts. Figure 4 demonstrates several possibilities. The line CBCO represents the relationship between audience size and advertising rates holding all other variables (such as income or AS) at their mean values. The line represented by R_1 has both a higher slope and intercept (thus both g and h are positive) than CBCO. This indicates that for any given audience size the advertising rate will be higher for stations on R_1. The line R_2 (g positive, h negative) indicates that small (less than AUD_2) CBC-owned stations have higher advertising rates than small stations on R_2, with the opposite being true for large stations. A line such as R_3 (g positive, h negative) indicates that for audiences smaller than AUD_3, stations on R_3 change more but for audiences greater than AUD_3 they change less. A line such as R_4 (both g and h negative) indicates that stations on R_4 always charge less than CBC owned stations.[4]

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[4] This approach assumes a linear relationship between advertising rates and audience size. Past research has indicated a slight nonlinearity (Liebowitz [1980]; Park [1970, 1979]) of statistical significance. The results of Table 1 indicate that the nonlinearity (the coefficient of ASQ) is not statistically significant, although of the same sign as the previous studies. Liebowitz (1980) demonstrated the minimal impact of this nonlinearity on advertising rates. Thus the assumption of a linear relationship should do little violence to the results.

Table 1 lists the regression results for each of our five regressions. The results are generally in line with our expectations. Larger audiences increase advertising rates with local viewers worth more than distant viewers. The relationship between advertising rates and audience increases at a slightly decreasing rate, but the difference from linearity is not significant. Higher incomes of viewers increase advertising rates, although the result is not always significant for our various corrections. Increased audience segmentation increases advertising rates, except for the HH correction where the coefficient is not significant. The French binary variable is always negative but significant only for the HH correction.

In the OLS equation every intercept and slope coefficient is positive. Since the CBC-owned stations do not have dummy variables in these regressions, they are the base results for which the coefficients g-ℓ give the deviations. Thus every non-CBCO television category is like R1 in Figure 4. The only coefficient which approaches significance is that of the intercept for independent stations. However, the test for significance requires the joint effect of both the slope and intercept terms for each station category. This test is conducted by examining the increase in explanatory power (R^2) of the regression where the two variables are added to the regression. Thus, for example, to determine the significance of CTV station's rate differentials we must run the regression without INT3 and and CTV and then with them. The appropriate test statistic then becomes[5]

$$F_{(T-P,N-t)} = \frac{R_T^2 - R_P^2}{1 - R_T^2} \cdot \frac{N-T}{T-P}$$

where T = total number of independent variables
P = partial number of independent variables
N = number of observations

In this case T = 13, P = 11 and N = 72. Table 2 gives the calculations for each category for each regression.

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[5] See Kmenta (1971), p. 370.

Table 1

Regression with Intercepts and Interaction terms;
Various Corrections for Heteroscedasticity; Dependent Variable = Advertising Rates

Variable	No Correction	$(AUD)^{.65}$ Correction	$(AUD)^{.5}$ Correction	$(AUD)^{1}$ Correction	HH Correction
AUDL	0.0332***	0.03056***	0.0311***	0.0284***	0.0276***
	(6.72)	(5.2)	(5.77)	(4.07)	(3.46)
AUDD	0.0169**	0.02054*	0.0199*	0.0215*	0.0195*
	(2.31)	(2.06)	(2.19)	(1.84)	(2.34)
ASQ	$-0.19E^{-6}$	$-0.3699E^{-6}$	$-0.29E^{-6}$	$-0.51E^{-6}$	$-0.214E^{-6}$
	(1.18)	(1.52)	(1.44)	(1.28)	(0.91)
AS	181.0***	149.0***	157.0***	112.0***	26.0
	(2.78)	(3.51)	(3.40)	(3.35)	(1.01)
INC	0.0200**	0.0043	0.0065	0.0022	0.0058**
	(2.00)	(0.81)	(1.04)	(0.65)	(2.32)
FR	-12.9	-19.6	-19.7	-18.2	-41.9
	(0.63)	(1.54)	(1.44)	(1.58)	(4.33)
INT2	0.0049	0.0055	0.0055	+0.0056	0.0111
	(0.70)	(0.74)	(0.76)	(0.68)	(1.65)
CBCA	4.72	-1.39	-0.99	-0.43	12.16
	(0.16)	(0.09)	(0.06)	(0.03)	(0.63)
INT3	0.0066	0.0127**	0.0114**	0.0147**	0.0066
	(1.58)	(2.27)	(2.28)	(2.02)	(1.01)
CTV	21.5	-14.47	-11.2	-17.9	1.49
	(0.62)	(0.87)	(0.58)	(1.35)	(0.08)
INT4	0.0042	0.0126	0.00897	0.0239	0.0067
	(0.91)	(1.80)	(1.42)	(2.74)	(0.95)
IND	73.2*	45.7*	57.9**	19.4	17.6
	(1.97)	(1.97)	(2.23)	(1.07)	(0.91)
K	-10.7	56.4	47.8	56.0**	-1.7
	(0.17)	(1.65)	(1.32)	(2.21)	(0.07)
R^2	0.901	0.527	0.646	0.800	0.888
N of observations	72	72	72	72	72

* - 90% confidence level
** - 95% confidence level
*** - 99% confidence level

AUDL = Local Audience; AUDD = distant audience; ASQ = total audience squared; AS = Audience Segmentation; INC = Income; FR = French Broadcast; INT2 = CBCA x Audience; CBCA = CBC Affiliate; INT3 = CTV x Audience; CTV = dummy for CTV; INT = IND x Audience; IND = dummy for independent or TVA.

Figure 4

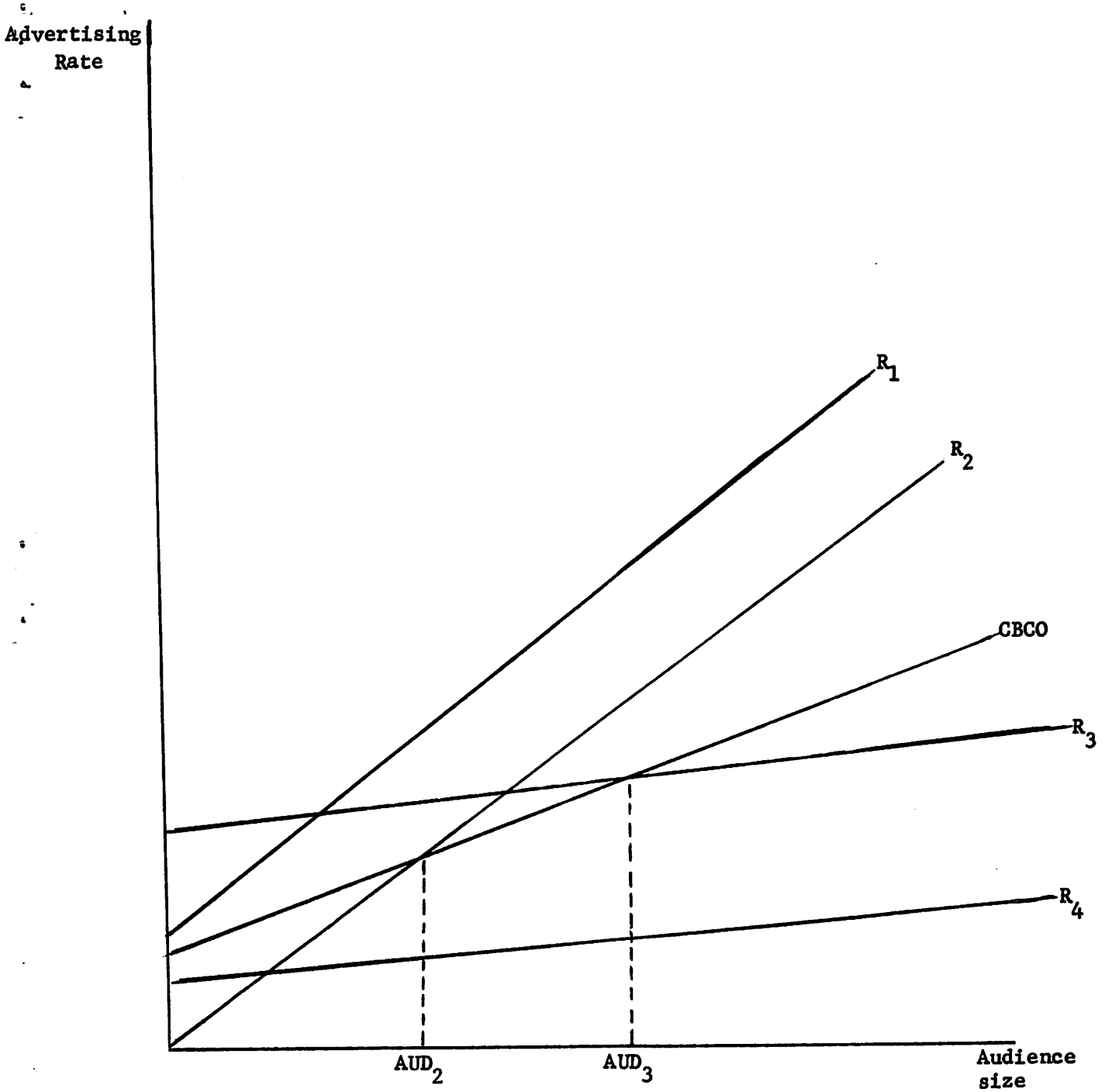

Table 2

Impact of Network Affiliation on Advertising Rates

Comparison is with CBC Owned Stations

Network Affiliation	OLS	$(AUD)^{.65}$	$(AUD)^{.50}$	AUD	HH
IND	8.24* +67%	10.24* +74%	9.89* +72%	11.50* +92%	4.31** +35%
CBCA	.80 +20%	.51 +19%	.56 +18%	.56 +19%	11.60* +45%
CTV	4.82** +38%	2.70 +32%	2.99 +29%	2.07 +35%	1.77 +23%

Upper figure is F statistic indicating the increase in explanatory power. When the intercept and interaction terms for a given network are included in a regression of the form

$$NRT = K + a\ AUDL + bAUDD + cINC + dASQ + eAS + fINT_j + gINT_k + hNET_x + iNET_z$$

where $INT_{j,k}$ and $NET_{x,y}$ refer to the other two networks not being examined.

Lower figure is the estimated advertising rate differential based on the coefficients from the regressions in Table 1 given the average size of CBC owned stations. In other words it measures the change in advertising rate which would occur if CBD owned stations priced their advertising time in the same manner as the indicated network. These figures are based on the mean audience size of CBD owned (4496) and mean advertising rate of CBC owned (137).

* indicates 1% level of significance

** indicates 5% level of significance

Examination of the other columns of Table 1 indicate that the intercept terms for CTV and CBCA are sometimes negative leading to relationships such as R2 in Figure 4. However, the interaction (slope differential) terms are positive in all regressions.

From Table 2 for OLS one can see that one cannot reject (at the 95% level of confidence) the hypothesis that CTV (or IND) stations charge higher advertising rates than CBC-owned stations since the F-statistic for both groups is greater than the critical values of 3.15. CBC-affiliates are not statistically significant. This result is generally held up with the various AUD corrections, except that CTV is sometimes not significant. The results are somewhat different with the HH correction where we find that CBC-affiliates have the most significant differentials from CBC-owned stations with independents having somewhat less significant (but still greater than 95%) differentials, and CTV having insignificant differentials.

In Table 2 we also calculate the percentage differential in advertising rates between CBCO and other categories for the average size CBCO audience with other average characteristics (i.e., the percentage change in advertising rates which we would expect from an average CBCO station if it had been in another category with the same size audience).

When examining Table 2 one result stands out consistently: CBC-owned stations charge less than other categories of station, quite independent of measured audience characteristics. While this difference is not always significant, its consistency under alternative specifications of our regressions indicates a robustness independent of the individual tests of significance. It seems fair to conclude that CBC-owned stations charge lower rates and would be able to increase their rates by between 18% and 92%, given their audience characteristics. We shall have more to say in this regard after we examine the audience revenues.

Allowing the intercepts to differ as we have done implies that an audience of zero size could allow a positive or negative price to exist. In fact the intercepts are generally insignificantly different from zero. The economic rationale for a non-zero intercept are rather hard to come by so that one could argue that all intercepts should be forced through the origin. The results of such regressions are given in Table 3. The extra flexibility given when intercepts are calculated may be more appropriate if a non-linearity exists in this relationship for very small audience sizes, for which our data have no observations. Any damage done by allowing intercepts should be minimal, given that they are little different from zero. The results of Table 3 are not much different than those of Tables 1 and 2. CBC-owned stations still always seem to charge less than other networks.

We might conclude from this last finding that CBC audiences are somehow less valuable than others. The CBC network does in fact make this claim. A spokesman for the CBC (Mr. Payette) claims that many viewers of the CBC programs are over 49 years of age and that these viewers are less highly valued by advertisers than younger viewers. In addition, much of the CBC program caters to people interested in unusual and non-commercial type programming and it is quite possible that these people are not very responsive to advertising messages. Since both CBC-owned and affiliated stations carry much of the same programming, both categories might do worse than the other networks.

TABLE 3

REGRESSIONS - FORCED THROUGH ORIGIN

	No corr.	$(AUD)^{.65}$	$(AUD)^{.5}$	AUD	HH
AUDL	.0344***	.0337***	.0342***	.0320***	.0244***
	(8.5)	(6.38)	(6.92)	(5.55)	(4.96)
AUDD	.0191***	.0212**	.0207**	.0242**	.0171**
	(2.84)	(2.14)	(2.31)	(2.11)	(2.40)
ASQ	$-.364E^{-9}$***	$-.56E^{-6}$**	$-.50E^{-6}$**	$-.65E^{-6}$	$-.17E^{-6}$
	(2.91)	(2.35)	(2.61)	(1.58)	(.73)
AS	+18.8***	82.7***	99.4***	58***	11
	(3.81)	(3.24)	(3.26)	(3.59)	(.91)
INC	.0203***	.0117***	.0132***	.0094***	.0068***
	(4.85)	(5.73)	(5.41)	(7.16)	(6.50)
FR	-14.4	-14.9**	-18.4*	-9.4**	-45.4***
	(.71)	(2.02)	(1.89)	(2.23)	(5.12)
INT2	.00326	.00427	.00379	.00651	.01489***
	(.74)	(.84)	(.77)	(1.25)	(4.84)
INT3	.00846***	.01082***	.01032**	.00884	.00731*
	(3.07)	(2.28)	(2.46)	(1.49)	(1.99)
INT4	.01123***	.02012***	.01720***	.02807***	.01172***
	(3.67)	(3.73)	(3.58)	(4.29)	(2.83)
R^2	.91236	.46469	.60027	.77153	.88161
IND	+37%	+66%	+56%	+92%	+39%
CBCA	+11%	+14%	+12%	+21%	+49%
CTV	+28%	+36%	+34%	+29%	+24%

These lower figures imply the percentage change in advertising rates which would be charged if CBC owned stations behaved according to the estimated result for the other networks.

* = 90%

** = 95%

*** = 99%

7. Results Using Revenues

Regressions identical with those of the last section were run with advertising revenues as the dependent variable. Because of the differing network policies regarding advertising (discussed above) several adjustments were made to the data before the regressions were run. See section 4 for details. In addition, data were unavailable for several stations and others had to be excluded because data were aggregated for stations with single ownership but different network affiliations, reducing the number of observations from 72 to 63.

Just as was the case with advertising rates, heteroscedasticity was thought to be a strong possibility and thus a Goldfield-Quandt test was performed. The results indicated a strong likelihood of heteroscedasticity (F=34.2). Using a procedure similar to that of the last section, the relationship between audience size and the variance of revenues was estimated with the following regression resulting:

$$\log RESQ = \underset{(6.07)}{6.49} + \underset{(3.53)}{1.45} \log \overline{Aud} \qquad R^2 = .88609$$

The GLS procedure is to multiply all observations by $1/(\text{Audience})^{.725}$. As before, we shall report the results for several possible corrections.

As before, it is worthwhile to determine the extent to which our attempts to remove heteroscedasticity have succeeded. The Goldfield-Quandt test gave values of 2.90 for $(\text{Aud})^{.725}$, 3.08 for Aud, 6.06 for $\text{Aud}^{.5}$ and 28.84 for HH. Because the HH adjustment had virtually no effect on heteroscedasticity it was felt that results from such a deflation would be of no value and thus they are not reported in the following tables.

The coefficients in Table 4 using advertising revenues tell the same general story as those using advertising rates, which is not surprising since the correlation between rates and revenues is .91. Larger audiences increase revenues,with local viewers being worth 1.3 to 3.3 times as much as distant viewers (a slightly more pronounced difference than those with rates). The non-linearity is always negative but never significant. To aid the comparison of the revenue and rate regressions, Table 5 presents elasticities, which are not influenced by the units of the dependent variable. The elasticities give the ratio of the percentage change in the dependent variable from its mean when the independent variable is changed some percentage from its mean value. From this we can see that the revenue non-linearity is larger than the rate non-linearity with the OLS estimate but the opposite result holds with our optimum GLS estimates. We conclude that the non-linearity is not distinguishable between those cases. Essentially the same thing can be said for audience segmentation, which is again always positive and significant. The impact of income is also similar to the rate regressions, being always positive but often insignificant.

Given the similarities between the audience characteristics coefficients, it would not be surprising if the network affiliations also were not much changed. The details are given in Table 6. The relationship between CBCO and CBCA is almost identical with those found using rates--i.e., CBCA seems to earn 10-15% greater revenues[6] but the results are not significant. The relationship with CTV is also very similar to the previous results with CTV earning 25-40% higher revenues (for the average CBCO audience) with this result being on the border of statistical significance. The major surprise concerns the relative performance of the independent (including TVA) stations. Whereas these stations

[6] Revenues for CBC affiliates are partly generated by network sales. If the CBC is less efficient at selling advertising it would be reflected in lower revenues for CBCA stations as well. Adjusted network payments make up 43% of adjusted CBCA revenues. Thus we should multiply any difference between CBCA and CBCO stations by a factor of 1.75 to achieve a more realistic appraisal.

TABLE 4

Revenue Regressions

	OLS	$1/(AUD)^{.725}$	$(Aud)^{1}$	$Aud^{.50}$	Unadjusted Revenues
AUDL	1532***	1272***	1242***	1310***	940***
	(4.72)	(4.75)	(4.48)	(4.74)	(3.86)
AUDD	432	676	903*	528	287
	(.91)	(1.50)	(1.93)	(1.18)	(.81)
ASQ	- .0170	-.0058	-.0069	-.0065	-.0130
	(1.47)	(.47)	(.43)	(.61)	(1.5)
AS	+10208**	+5468***	5197***	5934**	7167**
	(2.56)	(3.12)	(3.90)	(2.62)	(2.40)
INC	1027	138	48	272	644
	(1.66)	(.59)	(.29)	(.84)	(1.40)
FR	-1594527	-1711352***	-1580248***	-1830135**	-940588
	(1.25)	(3.00)	(3.63)	(2.46)	(.98)
CBCA	-827977	-809786	-624729	-947927	233,899
	(.46)	(1.12)	(1.04)	(1.03)	(.17)
INT2	263	343	306	358	49
	(.62)	(1.06)	(.953)	(1.06)	(.15)
CTV	1111350	-138732	-916175	391840	1940,005
	(.37)	(.05)	(.26)	(.14)	(.87)
INT3	353	470	541	426	282
	(1.18)	(1.16)	(1.07)	(1.19)	(1.26)
IND	-3679976	-400914	-219968	-765344	-1289763
	(1.56)	(.45)	(.33)	(.65)	(.77)
INT4	494	53	10	136	790***
	(1.65)	(.18)	(.31)	(.45)	(3.51)
K	161144	2555880	2732823***	2233180	-448364
	(.04)	(1.91)	(2.89)	(1.20)	(.16)
R^2	.85762	.49432	.60326	.63103	.88047
N	63	63	63	63	63

* significant at 90% level of confidence
** significant at 95% level of confidence
*** significant at 99% level of confidence

TABLE 5

Elasticities for Rate and Revenue Regressions

	OLS		GLS $1/(\text{Aud})^{.725}$	
	Rates	Revenue	Rates	Revenue
AUDL	.66	.79	.55	.62
AUDD	.11	.08	.11	.11
ASQ	-.06	-.14	-.06	-.03
AS	.27	.36	.41	.37
INC	.43	.54	.17	.13
FR	-.01	-.04	-.04	-.07
CBCA	.01	-.03	-.01	-.08
INT2	.02	.03	.04	.06
CTV	.02	.03	-.02	0
INT3	.06	.09	.08	.08
IND	.06	-.07	.04	-.01
INT4	.03	.08	.05	0

TABLE 6

Impact and Significance of Network Affiliation on Advertising Revenues - Comparison with CBC Owned Stations

Network Affiliation	OLS	$Aud^{.725}$	$Aud^{.50}$	Aud	Unadjusted Revenues
IND	1.55 -22%	.12 -2%	.21 -2%	.10 -3%	10.23** +41%
CBCA	.19 + 7%	.67 +14%	.62 +12%	.56 +14%	.12 + 8%
CTV	3.83* +46%	2.42 +35%	3.00 +40%	1.65 +27%	7.05** +55%

Upper value is F-statistic indicating the increase in explanatory power when the interaction and intercepts are allowed to vary for a particular network affiliation.

Lower value is the estimated rate differential between the network of interest and CBCO, as if the CBC owned stations were to behave in a manner analogous to the particular private network. These figures are based on the average CBCO audience (4727) and the mean advertising revenues of CBCO stations ($6,000,000).

*95% level

**99% level

charged rates about 70% above those of CBCO, always a statistically significant difference, their revenues appear to be lower than those of CBCO stations, with a difference of -22% with OLS and an average point estimate of -2% and a complete lack of statistical significance with the GLS estimate.

The last columns of Tables 4 and 6 refer to results with unadjusted revenues. By unadjusted we mean that the network payments are added directly to local and national time sales of the station. Since the network payments are no longer multiplied by a factor greater than one, the stations which have small or zero network payments (independents) would be expected to rise in the relative revenue rankings. In fact this happens, with independents shifting from a 22% inferiority (OLS) compared to CBCO, to a position of a 41% advantage. Obviously this revenue adjustment has an important influence on our results. Because this adjustment is believed to be appropriate, we discard the results with unadjusted data.

Of some interest is the nature of the difference in revenues as audience size changes. All three groups of private stations have steeper curves relating revenue and audience than CBCO. Independent and CBC affiliates have curves like R_2 in Figure 4 whereas CTV has a curve like either R_2 or R_1. This means that large private stations do better than large CBCO but that small private stations sometimes do worse. This might reflect a conscious policy by the CBC to equalize the revenues it returns to its stations. The CBC will not reveal its payback formula for its owned and operated stations but it is known that the network pays less than a proportionate amount of network sales back to its large affiliates and a more than proportionate amount to its small affiliates. This effect might not show up very well in the CBCA results because (1) private affiliates earn the majority of their revenues with station sales and (2) the levelling efforts of the CBC with regard to private affiliates is probably not very large.

The conclusions to emerge from this section are mixed. CBC owned and operated stations appear to do better than independent stations and somewhat worse than CBC affiliates or CTV stations. The overall impression, when heteroscedasticity is accounted for, is that CBCO charge less than their private counterparts but that this difference is not very great. The comparison with CBCA is most important because of the almost identical programming carried on the two as well as their similar audience sizes (the mean audience for the various groups is CBCO: 4727, CBCA: 2965, CTV: 9773, IND: 8425).

8. Other Tests of Efficiency

There are many aspects of efficiency other than those involved in the selling of advertising time. The economic literature on the cost efficiency of regulated or publicly owned firms is replete with examples of excessive costs for these firms compared to their private counterparts. This cost differential has often been estimated to be in the range of 100%.

The most serious impediment to examining cost differentials between firms is that of comparability. Most firms sell different products, operate in different locations, use slightly different production processes, etc. This poses great difficulties for the researcher interested in making cost comparisons. For these reasons profitability is often used as a proxy for efficiency (and ironically, also for monopoly power).

For the purposes of this study detailed cost comparisons (i.e., components of cost) are not possible, mainly because data from the CBC-owned and operated stations are extremely aggregated and allow only a general examination. However, the industry under examination is well defined, narrow in scope and fairly homogeneous both in its product and in its production technology and these qualities will greatly enhance the value of the results which are obtained.

Measuring the cost efficiency of CBCO stations requires data on costs, and of variables which influence cost. For example, a station with a small transmitter and a small staff, which may serve a small community, may be just as efficient at its task, as a large station in a large city. A station is efficient if it achieves a given audience at the lowest possible cost.

There are several reasons to expect that these costs will increase less than proportionately as station (audience) size increases. Such a

relationship between size and costs, where average costs fall, is known as economies of scale or increasing returns to scale. Such economies seem likely because the cost of transmitters increases less than proportionately with an increase in effective broadcasting power. Also, television cameras, lights and studios are not perfectly divisible so that there is a minimum cost of operating, no matter how small a station. A small station in Medicine Hat will require at least one camera, a cameraman, and an announcer if it is going to show local news. A station in Toronto, with a much larger potential audience, requires no more than this, although it may choose to buy more cameras and hire more people for its news. The relationship between costs and size is in fact an empirical proposition.

Other variables may influence the cost of broadcasting. A station which engages in much original programming will have higher costs since creating programs is usually more costly than buying them. These higher costs should be balanced by syndication revenues. We shall measure program creation by the percentage of revenues made up of syndication revenues (called VI). Another variable of interest is income of viewers which may indicate the cost of doing business in the station's home city (e.g., higher wages paid to employees) and thus may influence broadcasting costs.

The final variables which may influence costs is the nature of ownership. This is determined by the affiliation of the station, i.e., CBCO or one of the private categories. Economic theory implies that private ownership leads to the most efficient use of resources (although under a regulatory regime this may no longer be true) so that CBCO stations may be less efficient than their private counterparts but would not be expected to be more efficient.

The usual method for comparing efficiency is to examine profitability. Profits are not directly available for our data, nor are assets, which are used to normalize profits. The only variables available are the already discussed revenue data and a variable called total expenditure. Total expenditure is defined for private stations as employee remuneration, program acquisition, technical, sales and administrative costs.[7] Capital costs are not included. One must be careful in comparing these values between networks however. Independent and TVA stations pay directly for all their outside programming whereas CTV and CBCA stations pay for their network programming indirectly when the network sells advertising time for the station but does not return the full value. Thus, all else equal, because of these institutional arrangements, a CTV station would appear to have lower revenues and lower costs than independents. This was taken account of when we ran the revenue data. A similar adjustment can be made for the expenses.

A measure of profitability sometimes used in industry studies is the profit/sales ratio. A similar variable, called the price-cost margin (a misleading term--see Liebowitz [1980B]) is constructed using only variable costs, instead of total cost, when determining profits. That is to say the price-cost margin equals (TR-VC)/TR, where VC is variable cost and TR is total revenue, whereas (TR-FC-VC)/TR is the profit/sales ratio where FC is fixed costs. The price cost margin is inferior to profit/sales ratios because

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[7]The definition of total expenditures for CBCO stations appears to be virtually identical. Total expenditures for CBCO consists of the same categories and unless some major variation in accounting exists between CBCO and private stations, these results should be comparable.

variations in depreciation (fixed) costs are an important economic factor in true profitability. However, for our purposes, with a well defined industry where firms have (hopefully) very similar capital/sales ratios, the price-cost margin (PCM) should be informative regarding relative efficiency. Use of the PCM does not negate the difficulty caused by network policies in costing programs to their affiliates. CTV, by loading the program costs into reduced revenues, will cause its affiliates to have higher PCM's than independent stations which treat these costs as costs leading to both higher revenues and costs. The numerator is the same, regardless of which costing procedure is used but loading costs into decreased revenues lowers the denominator for CTV stations. Thus the PCM's cannot merely use the total revenue and total expenditure data.

The approach we have taken is to rearrange the data so that all stations can be directly compared to independents. This was done in the following manner. Total revenue was adjusted in the same manner as it was in the last section where network payments by CTV and CBC to their affiliates and owned stations were multiplied by a scale factor to determine the total advertising revenue generated by a station's audience in network sales. This was added to local time sales and national time sales to get a variable called REVT, which is total advertising revenue, as used in the previous section. To this we add syndication (SR) and other revenue (OREV) to get adjusted total revenue. Adjusted total expenditure (TE1) consists of nominal total expenditure reported in the data plus the imputed payments to the network for the use of its programming. This payment equals the amount of revenue held back by the station (REVT - local time sales - national time sales - network payments). Since independent stations (including TVA) report all revenues generated by their station and consider all payment for shows as a direct expenditure, they need no adjustment.

The expenditure regressions are presented in Table 7. The regressions are estimated for both unadjusted and adjusted expenditures. We also show the adjusted regression with a correction for heteroscedasticity. A Goldfield-Quandt test gave a value of 7.82 for the adjusted expenditures. An examination of residuals gave the following regression:

$$\log RESQ = \underset{(10.7)}{9.66} + \underset{(3.19)}{.80} \log \overline{AUD} \qquad R^2 = .77$$

Thus dividing all variables by $(AUD)^{.40}$ should correct for heteroscedasticity. In fact, the Goldfield-Quandt F dropped to 2.23 when this was done indicating that the likelihood of heteroscedasticity is much lower.

Examination of the economic variables does not generate any surprises. Expenditures increase at a decreasing rate with audience size, as we suspected (this result is not quite significant). VI (vertical integration) measures a station's production of programs as indicated by the percentage of total revenue constituted by syndication revenue. As one would expect this variable has a very significant positive impact on costs. Audience segmentation has a somewhat different interpretation in expenditure space as opposed to revenue space. It now indicates the amount of competition that a station faces for its audience. As this competition increases (as AS increases) a station may spend more to keep its market share (remember that viewers are now worth more as AS increases). In fact, audience segmentation has about the same impact on expenditures as it does on revenues. The positive (but not significant) coefficient on income indicates weak increasing costs of doing business in high income areas.

The most interesting and surprising results concern the network affiliation variables. These variables indicate very significant differences

Table 7

Expenditure Regressions

	TE1	TE	TE1 $1/AUD^{.40}$
AUD	758**	416	1083***
	(2.52)	(1.67)	(3.50)
ASQ	-.0225*	-.0174*	-.0116
	(1.94)	(1.82)	(.89)
VI	6.60 E7***	4.14 E7***	4.288 E7***
	(5.48)	(4.90)	(3.28)
AS	13209***	10051***	9397***
	(3.40)	(3.13)	(3.05)
INC	684	463	550
	(1.1)	(.90)	(1.2)
CBCA	-5.227 E6***	-4.199 E6***	-3.766 E6***
	(2.85)	(2.77)	(2.93)
INT2	160	86	-92
	(.37)	(.24)	(.21)
CTV	-6.035 E6**	-4.811 E6**	-3.869 E6
	(2.14)	(2.06)	(1.15)
INT3	676	494	246
	(2.30)	(2.03)	(.57)
IND	-8.456 E6***	-5.738 E6***	-2.525 E6
	(3.68)	(3.02)	(1.52)
INT4	794**	950***	-132
	(2.64)	(3.84)	(.72)
K	6.008 E6	4.970 E6	3.868 E6
	(1.62)	(1.63)	(1.47)
R^2	.81881	.80251	.58028
N	63	63	63
Mean of Dependent Variable	7.723 E6	5.424 E6	7.723 E6

TE1: Adjusted Expenditure TE: Unadjusted Expenditure

AUD = audience; ASQ = $(AUD)^2$; VI = vertical integration; AS = audience segementation; INC = income; CBCA = CBC affiliate; INT2 = CBCA x AUD; CTV = CTV affiliate; INT3 = CTV x AUD; IND = Independent of TVA; INT4 = IND x AUD

* - 90% level of confidence
** - 95% level of confidence
*** - 99% level of confidence

between CBCO and private networks in the costs of broadcasting. Referring back to Figure 4, and relabelling the revenue as expenditure, each private network has an expenditure curve like R_1, i.e., lower intercepts but usually steeper slopes. When the correction is made for heteroscedasticity independents and CBCA have curves like R_4. Such results indicate that small CBCO stations have much higher costs than private stations while large enough CBCO stations would have lower costs. The catch-up point occurs at a considerably larger audience size than that of the average CBCO. According to Table 8 for the average size CBCO station costs run from a minimum of 59% higher than CTV to 203% higher than independents using the OLS regression of TE1. The uncorrected expenditure regressions imply a range of from 54% to 117%. The corrected regressions give a range from 30% to 233%. The most important comparison (for reasons discussed in section (9) is that with CBC affiliates. The CBC-owned stations have estimated cost differentials ranging from 117% to 233%. All in all, CBCO stations seem to have expenses that are much greater than equal sized private stations. This result, in conjunction with the estimated revenue differentials indicate a strong likelihood that CBCO stations will be considerably less profitable than their private counterparts. The regressions reported in Table 9 bear this out with a vengeance.

Of the non-network regressions included in the price-cost margin regressions, only audience has a significant impact. The other variables are all so close to zero that we shall not examine them in detail. The positive coefficient on audience indicates increased profitability for large stations, which is not too surprising given the existence of economies of scale (which appear stronger than any non-linearity in the audience revenue relationship).

Table 8

	TE1	TE	TE1/(AUD)$^{.40}$
CBCA	-58 %	-54 %	-70 %
CTV	-37 %	-35 %	-46 %
IND	-61 %	-41 %	-41 %

The numbers represent the percentage decrease in costs which would accrue to average CBCO broadcasters if they performed with equal efficiency to private stations.

	TE1	TE	TE1/(AUD)$^{.40}$
CBCA	+138% 33,000	+117% 49,000	+233 % no catch-up
CTV	+ 59% 8,900	+ 54 % 9,740	+ 85 % 15,700
IND	+203% 10,600	+ 69 % 6,040	+ 69% no catch-up

These values represent the increase in costs which would occur if private stations of a size equal to an average CBCO station were to perform with the efficiency of CBCO stations. The lower values give the catch-up audience sizes. The average CBCO is 4,727. The four largest CBCO audiences in descending order are 21,000; 11,500; 6,637; 6,318.

Column 1 represents the adjusted expenditure (cost) data. Column 2 gives results for unadjusted data. Column 3 gives results for adjusted data after the correction for heteroscedasticity has has been made.

Table 9

PCM Regressions

	PCM3	PCM1
AUD	.0078***	.0148**
	(2.42)	(2.42)
AS2	$-.8\,E^{-7}$	$-.6\,E^{-8}$
	(.80)	(.03)
INC	.00003	.002
	(0)	(.21)
AS	-.020	.055
	(.49)	(.72)
VI	-20.6	53
	(.23)	(.31)
CBCA	95.3***	234***
	(5.97)	(7.74)
INTC	-.0081**	-.0171**
	(2.11)	(2.34)
CTV	74.3***	228***
	(3.07)	(4.96)
INT3	-.0051**	-.0137***
	(2.03)	(2.87)
IND	59.1***	227***
	(2.99)	(6.07)
INT4	-.0033	-.0133***
	(1.29)	(2.76)
R^2	.57888	.75184
N	63	63
Mean	2.49	-28.65

PCM3 - adjusted price-cost margin
PCM1 - unadjusted price-cost margin

* - significant at 90% confidence level
** - significant at 95% confidence level
*** - significant at 99% confidence level

Once again, the most interesting results lie in the network coefficients. These coefficients have a familiar pattern. Small CBCO stations have lower PCM's than private stations while large CBCO stations would have higher PCM's than large private stations. However, the size required for CBCO stations to achieve parity is in the vicinity of 15,000 more viewing units per week. Of nineteen CBCO stations, only one has an audience larger than 15,000. For the average size CBCO station, the PCM is very much below those of private stations. In fact, the average PCM of CBCO stations is negative! The average CBCO adjusted PCM (PCM3) is -.375, and unadjusted (PCM1) is -1.503. This latter figure implies that for every advertising dollar sold a CBCO station loses one dollar and fifty cents. The adjusted PCM obviously improves the CBCO results but they are still very different from those of the private sector which average +.20. The regression results indicate that the PCM for the average CBCO station would rise to about .10 if they performed as private stations. The unadjusted numbers indicate that CBCO stations as a group lost $48 million in 1978. The adjusted figures indicate a loss of $26 million. Compare this to profits of $86 million (adjusted) for all private broadcasters (including $12 million for CBC private affiliates or $80 million unadjusted). The efficiency of the CBC seems far inferior to that of private broadcasters.

9. Conclusions

There are several objections which could be raised to the findings of this paper, several of which we shall try to answer here. Firstly, one could claim that CBC owned stations serve a different function than that of private stations. In particular, since the government has desired that CBC be available to all Canadians, perhaps the CBC has set up operations which were known to be uneconomic but which helped bring CBC programming to all Canadians. One might suspect that the government set up stations in remote areas when private entrepreneurs were unwilling. Such behavior might be expected to fall off our regression line. However, this belief is fallacious. The early history of the CBC was such that the government wished to own all CBC broadcasters, and it was only because the public demanded television at a time when CBC did not have sufficient funds to provide it that CBC relinquished some control and allowed private affiliates to join the CBC network (no non-CBC broadcasts were allowed in an area until it was already served by a CBC station). In its early history the CBC took most of the major metropolitan centres (Toronto, Vancouver, Calgary, Edmonton, Winnipeg, Ottawa, Montreal) for itself, leaving the private affiliates many of the less attractive locations. Table 10 lists the sizes of all CBC owned and affiliated stations. The claim that CBC owned stations function in less profitable circumstances is clearly not justified.

A second objection to the findings of this study concerns the difference in program quality carried by different stations. One could claim, with some justification, that CBC programming is of a different nature than that of private broadcasters and that CBC broadcasters do not fully pay for it. In other words, the CBC expects to lose money in its production of programs and the losses it generates (covered by a government subsidy in the hundreds

Table 10

Audience Sizes of CBC Owned vs. Private Stations
Weekly Man Viewing Hours (in thousands)

CBCO (Public)	CBCA (Private)
597	451
1241	465
1301	742
1309	983
1558	1453
1576	1600
2071	1730
2300	1773
3188	2147
3400	2169
3638	-2556
4049	2600
5663	2722
5887	3138
6318	-3150
6586	3187
6637	3708
11500	6313
21000	6480
	7040
	7855

of millions of dollars) could never be absorbed by its broadcasters, thus they are charged an arbitrary amount much less than the true cost of programming. Affiliates of the CTV network, on the other hand, pay the full cost of the programming which they broadcast. Because the payment which the CBC charges to its broadcasters for its programming must be arbitrary, one could claim direct comparisons of the costs of CBC and CTV stations must be impossible. Such an argument, though quite forceful, does not affect the findings of this paper since the arbitrary cost of programs charged by the CBC is paid by both CBC owned and CBC affiliated stations. Thus a comparison between these two groups is of greatest interest and it is the comparison with the private CBC stations where the public CBC stations do the worst, with costs double or triple those of the private affiliates.

The final objection, which cannot be ruled out at this time, concerns the nature of the data. We have done our best to ensure comparability between the network categories. The advertising rate data suffer no comparability problems. The revenue data, if our sources of information are correct, have been made comparable by the adjustments made. The expenditure data for CBC owned stations appear, by the nature of the terms used in their construction (wages and salaries, transmission costs, administration, production costs, etc.) to be comparable to that of private stations. However, the CBC owned stations report their figures only to the CBC whereas the private stations report their figures in detail to Statistics Canada every year. For the purposes of this paper CBC provided an expenditure figure for each station but the detailed information regarding the magnitudes of the various cost components (which are available for private stations) was not available. It is possible that such detailed information might alter the conclusions of this study. However, full disclosure would be the only way for the CBC to demonstrate that the

conclusions of this paper might be reversed. Since the CBC is a public organization, there would seem to be no confidentiality rules which would be jeopardized by such disclosure.

In closing, there are several recommendations which we can make given our empirical findings. First, these results are so powerful as to warrant investigation of the reasons why CBC owned and operated stations appear to function so inefficiently. An examination of accounting procedures could quickly verify or explain the results of this paper. If these results are upheld two major courses of action are possible.

The first would attempt to remove inefficiency within the present arrangement of public ownership of broadcasters. Full disclosure, closer monitoring of individual stations, accounting and administrative reforms are all likely to have some effect, at least temporarily. Profit incentives for managers or a no subsidy rule might also be effective.

The second possible course of action would be to privatize the CBC owned and operated stations. Since they are usually in large and profitable markets there would likely be willing buyers who would then become private CBC affiliates. Private broadcasting would seem to present no threat to the cultural objectives of the CBC which would then be able to use more of its revenues for program production instead of subsidizing broadcasters. It would also allow the CBC to concentrate all its efforts on the production of programming. If there were future plans to eliminate advertising, this solution would of course be incompatible with them.

Whatever the future unfolding of events the findings of this paper unambiguously call for some action on the part of the authorities involved.

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