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Supply and demand effects in television viewing. A time series analysis

MAURICE VERGEER, ROB EISINGA
and PHILIP HANS FRANSES

E-Mails: m.vergeer@maw.ru.nl; r.eisinga@maw.ru.nl; franses@ese.eur.nl

Abstract

In this study we analyze daily data on television viewing in the Netherlands. We postulate hypotheses on supply and demand factors that could impact the amount of daily viewing time. Although the general assumption is that supply and demand often correlate, we see that for television this is only marginally the case. Especially diversity of program supply, often deemed very important in media markets, does not affect (positively or negatively) television viewing behavior. Most variation in television viewing can be attributed to habit and to regular events (e. g. weekends, Christmas) and to unexpected events (e. g. the 9/11 WTC attack). We also find that weather conditions interact with program types, so that, for example, in winter times people favor entertainment programs even more, suggesting that people use television for mood management.

Keywords: television program supply, program diversity, mood management, choice options, time series analysis

Introduction

Commercial television in the Netherlands was introduced in the late 1980s. Compared to other European countries, the introduction occurred relatively late. Up to 1989, the Netherlands had public service broadcasting with only two channels, but shared by many broadcasting organizations. The limited airtime was allocated to specific public broadcasting associations depending on the amount of members. Since then, the Netherlands has swiftly made up for the late adoption of commercial television. The number of channels targeting the general Dutch audience increased to ten general interest channels in 2005. These are operated by four program packagers (NPO, RTL, SBS and Talpa¹), in total supplying three public service channels and seven commercial channels. For a

relatively small country like the Netherlands, the availability of ten channels aimed at the general audience is quite large.

Given this increase in the number of channels in a relatively short time span, it is interesting to examine the consequences this has had, if at all, for television viewing habits of the Dutch population. In this study we examine these consequences in the context of supply and demand. The transformation from a public service system to a mixed system consisting of public channels and commercial channels has put pressure on the supply side; in other words, the nature of the programs of the competitors in this television market. While the commercial channels have gained market share, the public channels' share decreased to about one-third of the total number of viewers in 2005. Furthermore, a market consisting of ten channels implies strong competition to acquire advertising revenues.

Given the changes in the Dutch television landscape in the last two decades, the question (RQ1) arises as to how this may have affected the general audience's television viewing. With the increase of channels, the program supply has changed too. Whether these changes have affected daily television viewing is unclear. Additionally, people's daily viewing time does not only depend on the supply of programs. Other factors such as weather conditions, societal events, and the way people's time is structured during the week also affect the time that is available for watching television.

The performance of the media system, in this case the national television system, is a focal issue for the Dutch government (www.minocw.nl). The introduction of commercial television in 1989 initiated a political debate about the performance of the broadcasting media as a whole and Public Service Broadcasting (PSB) in particular. A prominent part in this debate is whether a television system should obey the so-called marketplace model or the public policy model. The marketplace model assumes that the system "obeys the majoritarian rule of satisfying the immediate gratifications of as many individual audience members as possible" (Hellman, 2001, p.182). The public service model, on the other hand, aims to reflect and provide equal access to various social groups and interests in society as well as a wide range of program content.

Although these ideal-typical models appear to be diametrically opposite, none appear in western countries in its pure form. However, in both models television program viewer ratings are important for the evaluation of broadcasting performance. For commercial broadcasters such ratings are crucial for acquiring advertising revenues. For public service broadcasters, who are financed by the tax payer, those ratings would assure the legitimacy of PSB. Therefore, although the argument differs for commercial and public service broadcasters, they both view

ratings as important indicators. Hence, the time that people spend watching television is an important performance indicator for both public service broadcasters and commercial broadcasters.

Because program ratings, in terms of reach and market share, as derived from the time that people watch television in general or specific programs or channels in particular, are so important, many studies have tried to explain exposure to television channels and programs. These studies can be categorized into those that search for explanations in either individual variation or structural variation (Webster and Wang, 1992).

First, there are studies that examine watching television from an individual perspective using people's interests, needs and social circumstances as explanations (see, for example, Heeter, 1985; Palmgreen, Wenner and Rosengren, 1985; Rubin, 1983; Vergeer, Coenders and Scheepers, 2009). In these studies, people's time budget is an additional factor to the aforementioned ones. Individuals have numerous choices as how to spend their time, such as work, sports, reading, personal hygiene or watching television, all of which compete for the same scarce amount of time. Variations in how these time budgets are composed affect the time people spend on television.

The second set of studies does not focus on individual differences but on structural ones, studying the audience at large (cf. Roe and Vandebosch, 1996; Van der Wurff, 2004a). Audience behavior is then typically analyzed by aggregating individual behavior and external factors that influence audience behavior such as the programs aired on television or weather conditions. Since not all television programs are equally enjoyed by all individuals and not all channels offer the same kinds of programs, differences in television program supply may affect the amount of time people in general watch television. The main research question (RQ2) here is: To what extent do external factors (i.e. weather conditions and societal events) affect the audience's demand for television? So, basically, the literature contains studies that focus on the demand side and those that focus on the supply side. It is the purpose of our study to incorporate both aspects into a single model.

Theory

Explanations derived from the supply side

Channel and program supply. Since the late 1980s, the number of channels in the Netherlands has increased substantially from two PSB channels in 2005 to ten channels (three PSB and seven commercial ones) today, which target the general Dutch audience. In theory this extends the

number of minutes broadcast per hour from 120 to 600 minutes, a 400% increase. For each hour of viewing time, individuals can choose from about 22 hours of program supply. This profusion of content (see Van Cuilenburg, 2005) shows that viewers have ample channel choice options. From this it might be argued that when more channels become available, and consequently individuals have more channel options to choose from, aggregate viewing time increases. This is based on the assumption that in a free market demand and supply of goods and services correspond with each other. We therefore hypothesize:

H 1: The more channels available to the audience, the more time the audience spends watching television.

Although the increase in channels implies more choice options that might lead to more time spent viewing TV, it is a crude assumption. An association between the number of channels and time spent watching TV might be due to differences in programming and thus program choice options. Standard economic theory also predicts that an increase in suppliers may result in more suppliers offering the same product (cf. Van der Wurff and Van Cuilenburg, 2001). This seems particularly true for television programs where an “increase in program choice options does not facilitate program choice based on program type preferences” (Youn, 1994, p. 466). Programming strategies such as mimicking or blunting in fact reduce program choice options.

Webster and Wakshlag (1983) distinguish between an active audience and a passive audience. From the perspective of an active audience, people have certain needs that they try to fulfill by actively choosing those programs that are expected to meet these needs (cf. Napoli, 1999). In contrast, the passive audience refers to ‘viewer availability’ irrespective of the television programs. Increased program type diversity allows people to maximize their interests (Jeffres, 1978). However, a 400% increase in channels will not be matched by a similar increase of airtime for all program categories, especially not on a daily basis. One reason is that not all channels broadcast television programs 24 hours a day. Second, daytime television has increased, resulting in more total daily airtime. Third, specific program types may have more than average airtime on specific days (for example, sports programs on Sundays). As not all types of programs are equally popular, we expect that increases in airtime of different program types will have different effects on the audience’s daily viewing time. Note that although television program supply can increase quite unrestrictedly, the time the audience can spend watching television is limited due to time budget restraints. We thus expect a positive relation

between program type supply and audience's viewing time. The hypothesis is as follows:

H 2: The more daily airtime for specific program types, the more time the audience spends on watching television.

Content diversity as choice options. In our study, system diversity is defined as the open diversity of program supply by all channels aiming to reach the general public (McQuail, 1992; Roessler, 2008). System diversity can be viewed as an indicator of program choice options. The greater the variety of programs aired within a particular time span, the more choice options are available to the public. A greater supply of different program types increases the likelihood that program preferences of individuals are met, and this may result in more daily viewing time. As such, decreasing content diversity, as is observed in the Netherlands (Van der Wurff, 2004b), suggests that people have fewer program choice options, even though the number of channels and the airtime have increased.

However, this finding may be misleading for a number of reasons. First, as measures of system diversity are primarily based on *relative* distributions of categories, they fail to account for *absolute* increases or decreases. Second, because diversity measures are often composite measures based on relative distributions, they fail to show which specific constituent category (i. e., program type) is responsible for the change in diversity. Moreover, even changes in the relative distribution across program types over time may not be revealed in changes in the level of diversity². Third, all diversity measures assume some level of aggregation unit. Choosing the aggregating unit (e. g., per hour, day, week, month, quarter or year) has implications for interpreting the level of diversity. The smaller the unit (e. g., hour), the better diversity measures reflect viewers' program choice options. Vergeer (2005) showed that open diversity calculated per hour shows considerably more variation at higher levels of aggregation. The aforementioned considerations imply that diversity measures, if they are to be interpreted in terms of choice options, should only be used when the absolute amount on which the percentages are calculated is taken into account. Furthermore, diversity should be measured at a small aggregation unit, where the hour is the most preferable aggregation unit and year the least preferable. In this study we choose hour as the aggregation unit and take the daily average of the hourly program choice options. The hypothesis therefore reads as follows:

H 3: The more program choice options the audience has, the more time the audience spends watching television, even after controlling the absolute airtime of program types and the number of channels.

Although hypothesis 3 is plausible, it can be argued that in a broadcasting system of ten general interest channels there is enough program supply to ensure program diversity. When three of the channels are provided by the Public Service Broadcaster (PSB), the sheer abundance of program supply should generate enough program diversity to match the audience's preferences. A stringent and normative regulation of the program supply, intended to cater for minority preferences, often associated with public service broadcasters, would then be less effective and superfluous. However, in a situation with few channels it is expected that viewers benefit more from many program choice options than in a TV landscape with many channels. The positive effect of program choice options on viewing time depends on the number of channels available: the positive effect is expected to be larger in a situation where a smaller number of channels are available. In contrast, when the audience can choose from many channels, increased program choice options are not expected to add extra viewing time. We therefore pose the following interaction hypothesis:

H 4: The more channel options are available, the weaker the positive effect of program choice options on the audience's viewing time.

Explanations derived from the demand side

Webster and Wakshlag (1983) identify viewer availability as a concept that explains why people watch television, irrespective of television programs that refer to viewer needs. The explanations we will put to a test are weather conditions, regular routines that affect the daily composition of time budgets, and watching television to repair people's moods.

Weather conditions. Research into the relation between seasonality and daily television viewing time suggests that during the summer the average viewing time is lower than in the winter (Barnett, Chang, Fink and Richards, 1991; Roe and Vandebosch, 1996). The interpretation of these findings is frequently offered in terms of the available daylight (photoperiod) and specific weather conditions. For example, Roe and Vandebosch (1996) show that higher temperature, more sunshine, and more daylight time decrease television viewing, whereas more precipitation, more snow and more wind have a positive effect on television viewing time. Surprisingly, Roe and Vandebosch (1996) identify simultaneous effects for both the season and the weather conditions on daily average viewing time, which implies that season and weather conditions are no substitutes. Increased daylight, temperature and sunshine as well as less precipitation, wind and cloud covering are conducive to increased outdoor activities. In general, we hypothesize that:

H 5: Weather conditions conducive to outdoor activities lead to less time spent watching television.

Weekly regularities in audiences' time expenditures. Apart from the fact that people's decision to watch certain types of programs depends on what is on offer on all channels, people's first decision is whether to watch television at all. People can spend their time on all sorts of activities, watching television being merely one of many options. Activities can be categorized into (a) obligatory (like occupational, educational and household) activities, (b) personal care (like eating and sleep) and (c) leisure time (anything else) (Vergeer et al., 2009). A full day, lasting 24 hours, is ultimately made up of these three types of activities. In general, the time displacement hypothesis states that, as the daily amount of time is limited to 24 hours, an increase of time spent on one activity must decrease the time spent on the other two main activities, assuming people can only perform one activity at a time. More specifically, several activities may reduce the time people spend watching television, but the activities differ for specific days of the week. For most people, Monday through Friday (the working days) consists for the most part of obligatory time. Saturday and Sunday (the weekend days) consist mainly of free time. Although the time spent on personal care has remained fairly constant in the last four decades, obligatory time has increased slightly at the cost of free time (Van den Broek, Breedveld, De Hart, and Huysmans, 2004). Although free time has thus decreased, the *relative amount* of free time spent on watching television has increased. Knulst (1999) concludes that people's free time is easily consumed by television which acts like a sponge, absorbing people's spare time. This implies that people, having more leisure time during weekends, will spend more time on watching television (cf. Huysmans, 2001). The hypothesis thus reads as:

H 6: The audience spends more time watching television on weekend days than on working days.

Not only differences between business and weekend days may exist, also business days may slightly differ from another. For example, in larger Dutch cities on Thursday evenings, shops are open until about 9 pm, while on other business days they close around 6 pm. Therefore, on Thursday evenings shopping competes with television viewing, which normally takes place around the same time (Huysmans, 2001). The hypothesis is as follows:

H 7: The audience spends less time watching television on Thursdays than on other days.

Several studies deal with measuring repeat viewing, that is, the percentage of people who have watched one specific program and who also watch another episode. The findings range from 24% to 55% (cf. Webster and Wang, 1992). Although there is considerable variation in these estimates, the general idea is that viewing behavior on a specific day might correlate with viewing behavior on previous days. Regular programming patterns will be reflected in routine viewing behavior resulting in autocorrelation of the daily time spent watching television for consecutive days or even weeks. As such we expect a positive autocorrelation in viewing time. More specifically, some programs or even program types (theme nights like sports nights or crime nights) are aired on a daily basis while others are aired on a weekly basis. Therefore we also expect that viewing time has an intra-weekly cycle.

H 8: The audience's daily viewing time has an intra-week cycle.

Mood and program types. There is substantial literature on the interaction between mood and viewing television. Stressful events can lead to more viewing (Anderson, Collins, Schmitt, and Jacobvitz, 1996), troubles are watched away (Moskalenko and Heine, 2003), and television viewing is used by people to escape from everyday worries (Lee and Lee, 1995). Although daily aggregated data cannot be used to analyze the individual-level correlation between mood and television viewing, it is well known that the weather (and season in general) is correlated with mood (Parker and Tavasolli, 2000). Better weather conditions improve mood. For television viewing this implies that winter times lead to more minutes of watching.

As seasonal moods can be repaired by watching, we further hypothesize that sad moods would lead to watching more entertainment programs and fewer informative programs. Taking account of the weather conditions, we therefore propose the following interaction hypotheses:

H 9: The lesser the average sunshine and the lower the average temperatures, the stronger the effect of entertainment programs on television viewing.

H 10: The lesser the average sunshine and the lower the average temperatures, the weaker the effect of informative programs on television viewing.

Method

Data

The data on daily viewing time and daily program supply have been collected by NOS, the overall governing organization of the public service broadcaster in the Netherlands. The data consist of the aggregated daily viewing time of approximately 2,900 individuals in 1,245 households, who represent the Dutch population of six years and older, from January 15, 1996 until, and including, November 29, 2005 ($N = 3653$). The measurement instrument is a so-called people meter (a.k.a. telemetric viewing data), an electronic device that people use to log onto the system. The device monitors the TV channels, the TV programs and the time an individual watches. The analysis incorporates the ten Dutch-language channels that provide a diverse program package targeted at the general public. We thus exclude special interest channels (like those that uniquely broadcast music, fashion, sports or news). The ten channels of our interest have a total market share of about 80%.

Data on weather conditions were obtained from the Royal Netherlands Meteorological Institute (www.knmi.nl).

Measurements

The dependent variable, the *audience's daily television viewing time*, measures the time (in minutes) individuals on a daily average spend watching television. The *number of channels* is measured by only including channels that offer a diverse program package targeting the general public in the Netherlands. The *daily broadcasting supply for specific program types* has been computed by aggregating the program duration (i.e. minutes per day) for all programs on all channels per day that belong to the same program type. We distinguish six categories: news and education, entertainment, fiction, sports, music, and children's programs.

An index for *program choice options*, as indicated by the content diversity, was calculated using Simpson's D_z (see Formula 1) based on the proportions of the program types.

Formula 1 Simpson's D_z

$$D_z = 1 - \frac{\sum P_i^2}{\left(1 - \frac{1}{k}\right)}$$

P = proportion airtime of program type i ;

k = number of program types;

0 = no choice options, 1 = maximum choice options

McDonald and Dimmick (2003) conclude in their evaluation of a number of diversity indicators that Simpson's D_z captures the duality of diversity simultaneously. It takes into account the numbers of categories as well as the distribution of the elements across these categories. From the tested indicators, Simpson's D_z appears to be amongst the most sensitive. Simpson's D_z (minimum = 0, maximum = 1) can be interpreted as the probability that two programs are classified in the same category. The proportions for program types are calculated hourly per day. Subsequently Simpson's D_z is computed per hour per day, after which the daily mean of D_z is computed.

Nighttime is measured as the time from sunset to sunrise (in minutes). Temperature was calculated using 10-weather-station averages and includes daily mean temperature in degrees Celsius. The daily mean outside temperature ranged from -12.1 to 25.8°C (10.2 – 78.4°F) with a mean of 10.32 ($SD = 6.19$) degrees Celsius ($M = 50.6$, $SD = 11.1^\circ\text{F}$). The fraction of maximum possible sunshine duration ranged from 0 to 93.3% with a mean of 36.33% ($SD = 26.17$). In an unreported preliminary analysis, we found that these three variables are the most relevant for the final regression model. For each weekday a dummy variable was included in the model. Means and standard deviations of variables included in the model are reported in the appendix.

Time series analysis

To analyze the longitudinal data, a time series regression model was applied. The time series model included a linear deterministic *trend term* t to identify an upward trend, two harmonic regressors³ to capture intra-year seasonality and to approximate an intra-month cycle, that is, regular patterns which, in this case, are estimated by the wave-like sine and cosine patterns. To describe the mood-related variables, we included interaction terms that relate the program types with the weather variables. For example, we included a multiplicative variable like *Number of minutes of sports programs * fraction of absent sunshine*. Interactions refer to conditional effects: the effect of a variable on another variable, which depends on the level of a third variable (cf. Cohen, Cohen, West, and Aiken, 2002).

To test for the effects of *events*, we included dummy variables for specific events, like the UEFA football finals, skating tournaments, the wedding of the crown prince, and the 9/11 attacks in the US (0 = absent, 1 = present). The included variables in the final model are based on an (unreported) preliminary screening. Additionally, we included dummy variables for Easter, Mardi Gras, Whit Sunday, and other religion-related days.

Finally, the regression model was evaluated for violations of general assumptions (linearity, normality, autocorrelation). This led to the inclusion of several *lags of the dependent variable* audience's daily television viewing time (i. e. lags 1 to 14). Furthermore, in this study the time series analysis focuses on explaining the audience's viewing time. However, it can be argued that the viewing time in the past as a proxy for audience preference affects program supply: Program schedulers learn from past viewing behavior how to compile future broadcasting schedules. Both relations together make a recursive model consisting of two separate equations. In our study, we focus only on one equation of the recursive model: explaining current audience's viewing time with past program supply. As such, there is no problem with endogeneity and the parameters can be estimated by using OLS. A check on stationarity revealed its absence (Dickey-Fuller test = -3.175).

Results

Supply side

To answer the question whether the rising trend of watching television can be explained by channel and program supply, we turn to the results of the time series regression analysis (Table 1 to Table 3⁴). Table 1 shows that in the period 1995–2005 viewing time autonomously increased by more than 2.5 minutes per year on average, which is about half an hour in ten years ($b = 6.989$).

Table 1 also shows the findings with respect to channel and program supply. The increase in channels from seven to ten does not lead to more time spent watching television, refuting hypothesis 1. As for program supply, only one program type had a positive effect on television viewing time, namely news and education: The more news and education were aired, the more the audience spent watching television. Other program types (i. e., entertainment and sports) showed no effects or even negative effects. For instance, the more broadcasters dedicate airtime to fictional, children's or music programs, the less time the audience spends watching television. Hypothesis 2 therefore is not supported.

With respect to the program choice options, the number of choice options is unrelated to viewing time. As such, a more diverse program supply that offers the audience more choice options does not entice people to watch more television. This implies that hypothesis 3 is not supported. Furthermore, even in a situation where the number of channels is limited, and program diversity is thought to be more important than in a situation of abundance, more program choice option is unrelated to viewing time. This finding refutes hypothesis 4.

Table 1. *Time spent watching television explained by trend, channel and program supply.*

Variable	Parameter estimate	Standard error
Intercept	119.6***	33.27
Trend/1000	6.989***	0.564
<i>Channel and program supply</i>		
Number of channels	--4.130	3.471
<i>Program types (minutes per day)</i>		
News and education	0.012***	0.001
Entertainment	-0.004	0.004
Fiction	-0.009***	0.004
Sports	-0.006	0.004
Children's programs	-0.016***	0.005
Music programs	-0.053***	0.009
Program choice options (diversity)	-36.67	40.74
No. of channels * program choice options	-0.354	5.077

$p < .01$, ** $< .05$, $N = 3653$

Demand side

Table 2 shows that there are intra-year and intra-month regularities in viewing time as well as weekly regularities. With respect to regular viewing patterns during the year, we see that watching television is highest in the first and fourth quarter and lowest in the second and third quarter (peak approximately in mid-June and trough in mid-December). There is a difference of 75 minutes between the peak and the lowest point. Within months there is a small but significant fluctuation of \pm three minutes.

Table 2. *Time spent watching television explained by seasonality and weekday.*

Variable	Parameter estimate	Standard error
<i>Seasonality</i>		
$\cos 2 \pi t/365$	37.38***	6.168
$\sin 2 \pi t/365$	-7.533***	1.765
$\cos 2 \pi t/28$	-2.936**	1.167
$\sin 2 \pi t/28$	1.273	1.113
<i>Weekday</i>		
Sunday	20.53***	1.127
Monday	reference category	
Tuesday	5.341***	0.069
Wednesday	5.049***	0.965
Thursday	2.521***	0.975
Friday	10.01***	0.997
Saturday	11.17***	1.154

*** $p < .01$, ** $< .05$, $n = 3653$

Table 3. Time spent watching television explained by weather conditions: main effects and interactions with program types.

Variable	Parameter estimate	Standard error
<i>Main effects</i>		
Night time (minutes per day)	-0.063***	0.024
Sunshine	-0.023	0.042
Daily mean temperature	-0.039	0.019
<i>Interaction effect: Multiplied by daily mean temperature, divided by 1000</i>		
News and education (minutes per day)	0.031***	0.004
Entertainment (minutes per day)	-0.028**	0.014
Fiction (minutes per day)	-0.022***	0.008
Sports (minutes per day)	-0.050***	0.012
Children's programs (minutes per day)	-0.066***	0.014
Music (minutes per day)	-0.133***	0.025
<i>Interaction effects: Multiplied by sunshine, divided by 1000</i>		
News and education (minutes per day)	0.016**	0.008
Entertainment (minutes per day)	-0.011	0.032
Fiction (minutes per day)	-0.058***	0.018
Sports (minutes per day)	-0.119***	0.024
Children's programs (minutes per day)	-0.045	0.032
Music (minutes per day)	-0.317***	0.057

*** $p < .01$, ** $< .05$, $n = 3653$

These results show that the television weekend starts on Friday and ends on Sunday. Friday shows 10 more minutes television viewing, Saturday 11 more minutes and on Sunday 20 minutes more than on Monday. Monday and Thursday show the lowest viewing time during the entire week. Thursday differs significantly from all other week days: the p -value of the difference between Wednesday and Thursday equals .0083. All other comparisons with Thursday have even smaller p -values. Hypotheses 6 to 8 are confirmed.

Table 3 shows the findings regarding weather conditions and its interactions with program type supply. The findings show that the longer the nighttime, the less time is spent watching television, a finding that is contradictory to what was expected. This might be explained by the simultaneous inclusion of nighttime and seasonality which in itself correlate positively. However, this finding suggests nighttime and seasonality are not substitutable in their effects. Furthermore, sunshine and the temperature are unrelated to watching television. These findings refute hypothesis 5. This suggests that seasonal influence is an important explanatory factor whereas the irregular sunshine and temperature do not affect viewing behavior.

Although program supply and weather conditions fail to show strong relations with watching television, interactions between program supply

Table 4. *Relative contribution of (sets of) variables to the fit of the model.*

Variables	R^2 if (sets of) variables are deleted	ΔR^2
Events	0.872	-5.32%
Memory (autoregressive lags)	0.888	-3.58%
Intra-weekly seasonality	0.911	-1.09%
Mood-related variables	0.913	-0.87%
Trend	0.917	-0.43%
Program types and program choice options	0.918	-0.33%
Annual and monthly seasonality	0.919	-0.22%
Weather-related variables	0.920	-0.11%

all variables included: $R^2 = 0.921$. Sets of variables sorted in descending order of explanatory power

and weather conditions do show significant relations: When temperature and sunshine increase, the effect of program supply on viewing time decreases. This finding, conversely, implies that the program supply effect increases if the days get colder and cloudier. This applies to most program types. However, news and education, entertainment and children's programs are exceptions. Whereas the latter two show negative interaction effects for temperature, news and education shows consistent positive effects. This indicates, conversely, that the better the circumstances for watching television indoors (i. e., lower temperature and less sunshine), the more negative the effect the supply of news and education has on viewing time. These findings support hypotheses 9 and 10.

To assess the explanatory power we calculated the relative contribution of (sets of) variables to the overall fit of the model. *Table 4* shows that controlling for societal events and holidays is not in vain as it accounts for the highest explained variance ($\Delta R^2 = -5.32\%$), followed by the autoregressive (memory) variables ($\Delta R^2 = -3.58\%$). These findings show that the audience's viewing behavior is subject to two strong factors. On one hand, viewing behavior is influenced by societal events that take place at irregular and even unpredictable intervals. At the same time, television viewing is highly predictable by the audience's past viewing behavior, as demonstrated by the decrease in fit due when autoregressive lags are eliminated. The program types that are broadcast have only a small effect on the audience's daily viewing time.

Discussion

In this study we set out to explore relations between the nature of program supply (RQ1) and viewing time by the audience, controlling for additional factors such as weather conditions (RQ2). Summarizing the

main results, the time series analysis showed that program supply characteristics have limited effects on the daily viewing time. For instance, the number of channels has no effect. The impact of channel increase on the audience's viewing behavior most likely was stronger when channel supply increased from a very small number to a larger one, or when the first commercial channels were introduced.

Regarding the program types these channels air, only an increase in news and educational programs increases the daily viewing time. News and education showed the strongest and most consistent increase of all program types. All other program types have no (i. e. entertainment, sports) or even negative effects (fiction, children's programs, music). These findings suggest that the audience's preference for news and sports is at the cost of watching fiction, children's and music programs, even though the total amount of viewing time increased. At least it suggests that the net effect of airing these types of programs is that it drives more people away from the TV set than it attracts.

Program choice options as a concept are unrelated to the time spent watching television: Although program choice options slightly decreased during the ten year period, this did not result in less viewing time.

Weather conditions (RQ2) showed only marginal and counterintuitive influence on watching television, although there are consistent patterns of seasonality. Whereas the main effects of weather conditions are small or absent, the interaction effects between weather conditions and program supply on watching television suggests otherwise. An increase in the supply of certain program types (entertainment, fiction, sport, music) in periods with less sunshine and lower temperatures increases viewing time. This finding seems supportive of mood management theory: Offering more news and education on colder days and days with less sunshine tends to decrease viewing time. This may indicate that people do not prefer hard information in these periods, but want to escape the dark and cold winter days by watching fictional and amusing content. Furthermore, because there is already an abundance of airtime devoted to news and education, additional airtime seems counterproductive. As such, the negative effect of news and education and entertainment on viewing time seems to refer to a ceiling effect in terms of diminishing marginal utility.

These results indicate that program supply at the systemic level shows little effect on viewing time. As such increasing the total size of the viewing market by changing the program supply seems difficult. Watching television as such appears to be a routine activity. Once people are watching television, the question is what program to watch. It is suggested that, instead of people watching the program that they are most interested in, a view derived from the Uses and Gratification Approach,

people watch the least objectionable program (LOP), as introduced by Klein (Newcomb, 2004). Although LOP assumes limited choice options, there are two reasons for it to be valid, even in a multi-channel system. First, audience patterns of watching television seem quite stable and unaffected by changes in program supply. It explains merely a small percentage of variance as compared to other explanations. Second, although program supply in terms of quantity has increased, the program diversity has decreased. This suggests that the increase in program supply led to an increase of similar programs, leading to fewer choice options. However, having fewer choice options does not affect the amount of time spent on watching television.

The two most important factors that explain watching television are regular and irregular societal events and past behavior. Regarding societal events, as these are infrequent, sometimes regular and irregular, they disrupt the routine viewing behavior. Irregular events are often televised as unplanned events (e. g. major disasters). Because of their incidental nature they are unexpected and often unusual and therefore attract attention. Regular events (e. g., major sports events) on the other hand are planned television events or regularly occurring events (e. g., religious holidays) that coincide with an increased leisure time.

What the future holds for national television and its audience is not clear. Changes will probably come from new technology, allowing the audience increased access to more channels. Three increasingly popular platforms are relevant to the Netherlands: digital broadcasting (cable and terrestrial), streaming video on the internet, and IPTV. As for digital broadcasting, only the introduction of additional channels is expected to have additional viewing effects in the near future. These additional channels are special interest channels (e. g. sports, music, fashion, religion), aiming at niche markets. Interactive features on digital channels are still largely unavailable and as such will not influence viewing behavior. Video streaming on the internet (e. g. live broadcasts of channels, repeats of recently aired programs) and on the private home networks is becoming increasingly popular. However, compared to watching regular TV channels, its use is still very marginal. Finally, IPTV is a technology that delivers the signal using the Internet Protocol. Although 10% of Dutch households are IPTV-capable networks, merely one percent uses it (SPOT, 2009).

Apart from the question whether new technology will change viewing behavior, the question is whether watching audiovisual material using these different technologies still classifies as watching television. For instance, sitting alone behind a computer (a so-called lean forward medium) watching audiovisual content is quite different from watching television (a so-called lean backward medium) in the company of others in

the living room. At the same time so-called media extenders (e. g. Xbox 360, Apple TV) make it easier to stream audiovisual content on the computer's hard drive to the regular television set in the living room. A final development is the increasing mobility for watching audiovisual content: Not only does terrestrial distribution of the digital TV signal clean up the cable jungle in the living room, it also allows television to be watched everywhere where a signal can be received. Watching television and audiovisual content can be done increasingly using a number of portable devices (e. g. PlayStation Portable, smart phones, DVD-players). These developments may, in the long run, alter watching experiences and increase differences in watching experiences: Watching television on a mobile phone screen is very different from watching television on a 42" high definition screen. However, given these multiple platform options to watch television, measuring people's television behavior continuously will become more difficult. Measuring television behavior was relatively uncomplicated with a small number of analog channels only accessible in the living room. Nowadays, and even more so in the future, people can use analog and digital channels, accessible from the TV, the computer, or the mobile phone, watching a program live or at any given moment in time (i. e. time shifting). The changes mentioned here raise theoretical and methodological questions about watching television that provide a challenge for future research.

Bionotes

Maurice Vergeer is Associate Professor at the Department of Communication at Radboud University, Nijmegen.

Rob Eisinga is Professor at the Department of Social Science Research Methodology at Radboud University, Nijmegen.

Philip Hans Franses is Professor at the Econometric Institute and the Department of Business Economics at the Erasmus University Rotterdam.

Notes

1. Due to low viewer ratings, Talpa (renamed Tien on December 15, 2006) ceased to broadcast on August 13, 2007, whereupon its most successful programs were acquired by RTL Netherlands for which RTL introduced a new channel called RTL8.
2. A composite measure of diversity using relative distributions (e. g. Simpson's D_2) results in the same level of diversity when program type A and type B have the distribution of 30% vs. 70% or the opposite 70% vs. 30%.
3. Harmonic regressors are used to assess whether there are periodic rhythms in the time series.

(1) Harmonic regressors to capture intra-year seasonality equal:

$$\cos \frac{2\pi t}{365}, \sin \frac{2\pi t}{365}$$

(2) Harmonic regressors to approximately capture an intra-month cycle equal:

$$\cos \frac{2\pi t}{28}, \sin \frac{2\pi t}{28}$$

4. Although results are presented in separate tables, they originate from a single multivariate analysis.

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Appendix

Means and Standard Deviations

Variables	<i>N</i>	<i>M</i>	<i>SD</i>
Time spent watching TV (minutes per day)	3653	169.309	31.630
Number of channels	3653	8.189	0.929
Program type (minutes per day)			
News and education	3653	2946.974	872.314
Entertainment	3653	770.271	206.846
Fiction	3653	1777.267	384.645
Sports	3653	390.371	285.380
Children's programs	3653	556.047	237.174
Music	3653	110.957	121.689
Program Choice Options (diversity)	3653	6902.620	400.083
Nighttime (minutes per day)	3653	583.515	183.556
Sunshine	3653	14.275	3.059
Daily mean temperature	3653	10.3150	6.187